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Adapted & (dis)ability sport

Edited by
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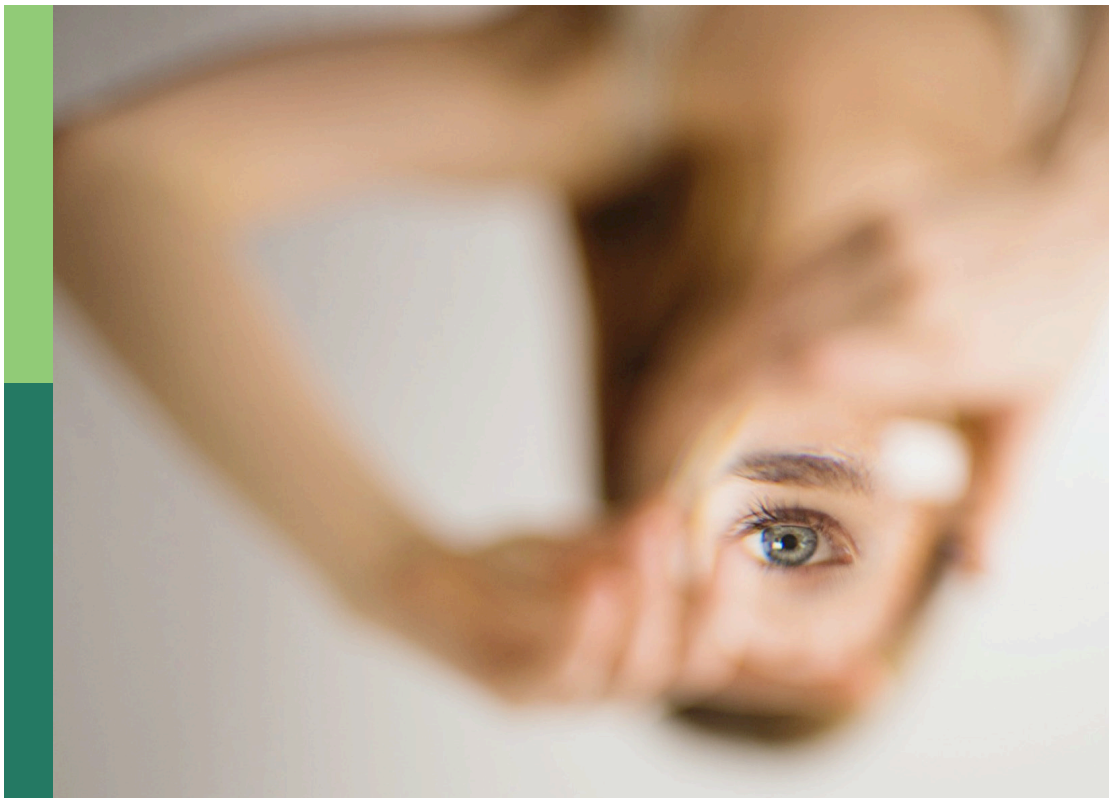

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Adapted & (dis)ability sport

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Editorial: Adapted & (dis)ability sport

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disability, sport, adapted sport, psychology, performance analysis, physiology, socio-cultural

Editorial on the Research Topic
Adapted & (dis)ability sport

In recent years, international policies and priorities have increasingly aligned to raise awareness of adapted and (dis)ability sports (Hammond et al., 2022). This alignment has significantly elevated the profile and presence of these sports at all levels, leading to greater public, private, and media engagement globally. As a result, there are now more opportunities than ever for participation, viewing, and research in the field. With this heightened societal awareness and support, it is crucial to centralize, promote and enhance the status of high-quality research and knowledge exchange across all academic disciplines. This will deepen our understanding of every aspect of adapted and (dis)ability sports.

However, despite these advances, current research in this area is often fragmented, published in single-discipline-focused books or collections, and frequently concentrating on one sport, specific adaptions or (dis)ability, or a primary focus on the Paralympic movement (Kohe and Peters, 2017). While this research is valuable, its placement in broader non-(dis)ability-focused sports publications limits its accessibility and impact. As the field continues to grow, it is essential to foster interdisciplinary collaborations that incorporate various perspectives, physiological, psychological, technical, tactical and sociological, to fully understand and improve the experiences, wellbeing and performances of athletes with (dis)abilities.

In response to these challenges, this Research Topic was initiated to address this by creating a critical mass of research, knowledge exchange and contributions from authors representing all disciplines relevant to the study of adapted and (dis)ability sports. The intention was to present a Research Topic that not only enriches the academic landscape but also provides practical insights for athletes, coaches, and stakeholders involved in adapted and (dis)ability sports.

Of particular note, this Research Topic drew attention from academics and practitioners from a range of countries resulting in the publication of 14 articles improving the research knowledge of the following topics: empowerment and social inclusion through sport (five articles), performance and technical analyses in (dis)ability sports (four articles), physical and mental health in athletes with (dis)abilities (three articles), youth and mentorship in (dis)ability sports (one article), and barriers and accessibility in (dis)ability sports (two articles).

The exploration of empowerment and social inclusion through sport was explored across five studies, each highlighting different aspects of how sports participation impacts athletes with (dis)abilities. Participation in sports empowers individuals by enhancing self-confidence, providing a sense of agency, and helping athletes redefine their personal

identities, as explored by Alhumaid et al. in their study on Saudi women with physical impairments. Motivation, both intrinsic, such as the drive for self-improvement, and extrinsic, like recognition from others, plays a crucial role in overcoming barriers, including structural constraints and societal stigma, as highlighted by Sarol's research on wheelchair basketball players. The psychological benefits of sports, particularly improvements in wellbeing and life satisfaction, are well-documented across the studies. Puce, Okwen, et al.'s critical review emphasizes the multidimensional nature of wellbeing, while Van Biesen and Morbee's study shows how Paralympic athletes safeguarded their mental health during the Tokyo 2020 postponement through adaptive motivational profiles. Puce, Biz, et al.'s large-scale survey further reveals that para-athletes exhibit higher levels of hedonic wellbeing compared to (dis)abled individuals not involved in competitive sports. Adapted and (dis)ability sports also act as a vital tool for social inclusion, enabling athletes to form connections, gain social recognition, and challenge feelings of exclusion, as demonstrated by Alhumaid et al.. Despite these benefits, however, many athletes still face significant obstacles in accessing sports, from resource limitations to societal attitudes, highlighting the need for continued efforts to create inclusive environments that support their full participation.

Several articles in this Research Topic focus on performance analysis and technical evaluations in adapted and (dis)ability sports, showcasing critical contributions to the field ($n = 4$). Becerra-Muñoz et al. provided an analytical insight into women's wheelchair basketball lineups at the Tokyo 2020 Paralympic Games, focusing on the impact of game-related statistics on lineup efficiency and success. This work further highlighted the importance of specific performance metrics, such as field goal efficiency and assists, in informing coaching decisions. Similarly, Suárez-Iglesias et al. examined the physiological demands of adaptive seated slalom waterskiing, comparing traditional and alternative deep-water start techniques for athletes with paraplegia, underscoring the need for tailored training programs. Meanwhile, Minder et al. investigate the neuromuscular activation and perceived exertion in wheelchair propulsion, revealing critical insights into performance fatigability and potential shoulder injury risks. While, Arnet et al. analyzed the biomechanical properties of treadmills used in exercise testing for elite wheelchair athletes, emphasizing the significance of standardized equipment validation for accurate performance assessments. Collectively, these studies contribute to a deeper understanding of the complexities of performance in adapted sports and offer valuable implications for training and competitive strategies.

Furthermore, two significant studies explored areas of physical and mental health in athletes with (dis)abilities. Urbański et al. investigated the mental health challenges faced by elite Polish athletes with disabilities during the COVID-19 pandemic, revealing that pandemic-specific coping strategies significantly predict levels of anxiety and depression. This suggests that these athletes may require tailored interventions to address the unique stressors related to the pandemic, highlighting the importance of understanding specific coping mechanisms in promoting mental wellbeing. Complementing this, Castle et al. examined the health and wellbeing of Ukrainian veterans with disabilities during a preparatory camp for the 2022 Warrior Games. Their findings indicated that while overall sleep, mood, and competition-related emotions remained relatively stable, there were notable challenges, such as low sleep duration and increased anxiety. The study reinforces the critical role of family support and the motivation to represent one's country in fostering resilience among participants. Together, these two studies shed light on the multifaceted aspects of mental health in athletes with (dis)abilities and emphasize the need for targeted support systems to enhance their overall wellbeing.

Additionally, the exploration of youth and mentorship in (dis)ability sports is a notable highlight of this Research Topic, as highlighted by Wedege et al., who examined the experiences of children with acquired brain injuries and their caregivers at peer mentorship sports camps. This longitudinal qualitative study found that Active Rehabilitation camps enriched participants' lives by fostering social connections, enhancing coping skills, and improving psychological functioning. These findings underscore the critical role of peer mentorship in promoting empowerment and social inclusion, aligning with the Research Topic's aim to highlight community support for the health and wellbeing of individuals with disabilities.

Finally, two studies surrounding barriers and accessibility in adapted and (dis)ability sports conclude the articles on this Research Topic. Meier et al. explored the challenges faced by blind and visually impaired (BVI) students in specialized physical education (PE), revealing that PE teachers can either facilitate or hinder participation. The study emphasizes the need to amplify BVI students' voices and suggests digital solutions to enhance their engagement. Carretti et al. provided a narrative review on the benefits of physical activity for balance control in visually impaired individuals, advocating for tailored exercise protocols and recognizing the crucial role of adapted physical activity specialists. Together, these studies highlight the necessity of addressing participation barriers and promoting accessible sports opportunities for individuals with disabilities.

In conclusion, this Research Topic makes a significant contribution to the field of adapted and (dis)ability sports, bringing together diverse insights from 14 articles that encompass empowerment, performance analysis, mental health, youth mentorship, and barriers to participation. However, it is important to note that the number of submissions remains modest when considering the vast network of academic and applied professionals engaged in this area, highlighting a critical challenge in knowledge sharing. National governing bodies, the International Paralympic Committee, and other organizations focused on adapted and (dis)ability sports play a vital role in fostering an environment that encourages research collaboration and the dissemination of findings. They must actively promote initiatives that inspire both researchers and practitioners to share their insights and experiences.

Notably, many of the studies presented have begun to address the fragmentation that has characterized current research, moving away from narrow, single-discipline perspectives to offer interdisciplinary insights encompassing physiological, sociological, and performance-related factors. By exploring a broader scope of adapted and (dis)ability sports and providing practical implications for athletes, coaches, and stakeholders, these articles pave the way for a more cohesive and comprehensive understanding of the field.

This potential for greater collaboration and knowledge exchange is crucial for advancing the quality of research and practice in adapted and (dis)ability sports.

To build on this momentum, there is an urgent need for enhanced collaboration, resource allocation, and support for knowledge exchange initiatives. By fostering these efforts, we can create a more integrated understanding of adapted and (dis)ability sports, ultimately enriching the experiences and outcomes for athletes and stakeholders involved in this vital field.

Author contributions

DP: Writing – original draft, Writing – review & editing. RH: Writing – original draft, Writing – review & editing. JF: Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Comparing rolling resistance of two treadmills and its influence on exercise testing in wheelchair athletics

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Standardized laboratory exercise testing is common in sport settings and rehabilitation. The advantages of laboratory-based compared to field testing include the use of calibrated equipment and the possibility of keeping environmental conditions within narrow limits, making test results highly comparable and reproducible. However, when using different equipment (e.g., treadmills), the results might deviate and impair comparability. The aim of this study was to compare the biomechanical properties (rolling resistance, speed, inclination) of two treadmills regularly used for exercise testing in elite wheelchair athletes. During the experiment, speed and inclination of two treadmills (same model and producer, different manufacturing year and belt material) were verified. Standardized drag tests were performed to assess rolling resistance. Power output conducted by the athlete during later exercise tests was calculated based on the results. Speed and inclination deviated only slightly from the values indicated by the producer. Rolling resistance caused by different belt material was mainly accountable for the differences in power output between the treadmills. In general, athletes had to deliver 10% more power output on one of the treadmills compared to the other. Concluding from these results: if different treadmills are used for testing, a proper validation is recommended to avoid misleading interpretations of test results.

KEYWORDS

testing, equipment, reproducibility, athletes, wheelchair

1. Introduction

Standardized laboratory exercise testing is common in rehabilitation and sport settings whereas numerous testing methods and protocols are applied. Common tests with wheelchair athletes are the lactate minimum test (Perret et al., 2012) or the VO_2 max test (Leicht et al., 2013). These tests indicate the endurance exercise capacity and are a helpful tool to determine training intensity zones and to guide the training process. The advantages of laboratory-based compared to field testing include the use of calibrated equipment and the possibility of keeping environmental conditions (e.g., temperature, humidity) within narrow limits, making test results highly comparable and reproducible. Especially in elite

sports, such characteristics are of utmost interest to detect minimal performance differences, as small time differences of less than 0.5% of the racing time decide over winning or losing a medal at international championships, such as Paralympic Games (Perret, 2017). Typical diurnal fluctuations of performance are commonly at around 1% of the time trial performance (Fiedler et al., 2022).

In wheelchair athletics standardized endurance exercise testing is often performed on a treadmill (Perret et al., 2012). Ideally, these tests are always performed on the same treadmill and under the same environmental conditions to make test results as comparable as possible. However, this prerequisite seems not always to be given as athletes from a national team often train and test at different locations. In order to warrant a high measurement quality as well as a fair comparison of test results between athletes, regular quality controls of the equipment seems therefore highly recommended. In fact, some years ago a study compared several treadmills which were used for exercise testing in with a spinal cord injury in eight Dutch rehabilitation centers (de Groot et al., 2006). Although the exactly same type of treadmill was used in seven of eight centers, the standardized wheelchair drag tests revealed significant differences between different locations. Treadmill speed, inclination and rolling resistance seemed to be the most critical factors which have to be taken into account.

Recently, our institution replaced the treadmill for exercise testing of elite wheelchair racing athletes. This device was bought to replace the former, exactly same type of treadmill from the same company. However, being aware of the pitfalls found in the above-mentioned study in a rehabilitation setting (de Groot et al., 2006), a critical investigation comparing the two devices seemed to be reasonable to avoid uncertainty of our athletes based on potential misinterpretations of test results. Thus, the aim of the present study was to compare the biomechanical properties (rolling resistance, speed, inclination) of two treadmills regularly used for exercise testing in elite wheelchair athletes under standardized controlled conditions. We hypothesize that rolling resistance, speed and inclination of the two treadmills are consistent.

2. Materials and methods

Two treadmills were compared. Treadmill A: Cosmos Saturn, HP Cosmos, Traunstein, Germany with a black belt (width 1 m, length 2.5 m), year of manufacture 2005. Treadmill A was in use for 16 years. Treadmill B: Cosmos Saturn, HP Cosmos, Traunstein, Germany with a green belt (width 1.25 m, length 3 m), year of manufacture 2020. Treadmill B was in use for 1 year. Data has been analyzed descriptively to address the research question.

2.1. Speed

The speed of the two treadmills was compared with and without a racing wheelchair (Eliminator OSR Racing, Top End, tire pressure of 8 bar, loaded with a weight of 80 kg) driving on the treadmill, while the treadmill had an inclination of 0 and 10%. The wheelchair was attached to a fixation system, which slides alongside the treadmill and holds the wheelchair in a secured position (Figure 1). The time duration of 50 complete revolutions of the treadmill belt was measured. The following speeds were revised: 10, 15, 20 and 25 km/h.

2.2. Inclination

The inclination of the treadmill belt was measured at 0 to 10% (steps of 1%) with a digital inclinometer (PRO 360, SPI, Garden Grove, United States) during all drag tests to assess rolling resistance.

2.3. Rolling resistance

A systematic set of drag tests was performed to assess rolling resistance (van der Woude et al., 1986). During the drag tests, the racing wheelchair was attached with a rope to a force sensor (Futek model LSB200, Futek, Irvine, United States). To keep the wheelchair on track, it was secured with a fixation system (Figure 1). The drag test was performed for both treadmills with six different loading conditions (Table 1). The loading conditions were chosen to represent a spectrum of possible testing conditions, e.g., different weight of the athletes (condition 1 and 2 vs. condition 3–6), different tire pressure (condition 1, 3 and 5 vs. condition 2, 4 and 6). In addition to the standardized weights placed in the wheelchair (condition 1–4) we performed the drag test with an athlete (condition 5 and 6), whose weight was corresponding to condition 3 and 4. The participant was a wheelchair athlete with a spinal cord injury (33 years, 80.5 kg). The wheelchair used for the experiment was the personal racing wheelchair of the participant and thus well fitted to the participants anthropometry.

Each drag test was performed at a speed of 4 km/h and at inclinations from 0 to 10% (steps of 1%) according to van der Woude et al. (1986). At level treadmill, the measurement of the drag force might be unstable. Therefore, drag force at 0% inclination was not measured directly, but determined through extrapolation *via* a linear regression analysis (van der Woude et al., 1986).

2.4. Resulting power output for athlete

With the calculated drag force, the measured speed and inclination of the treadmills we calculated the power output which has to be conducted by the athlete during later exercise tests to meet the test conditions. Typical exercise conditions of 2% inclination and speeds of 10 km/h, 20 km/h and 30 km/h were chosen.

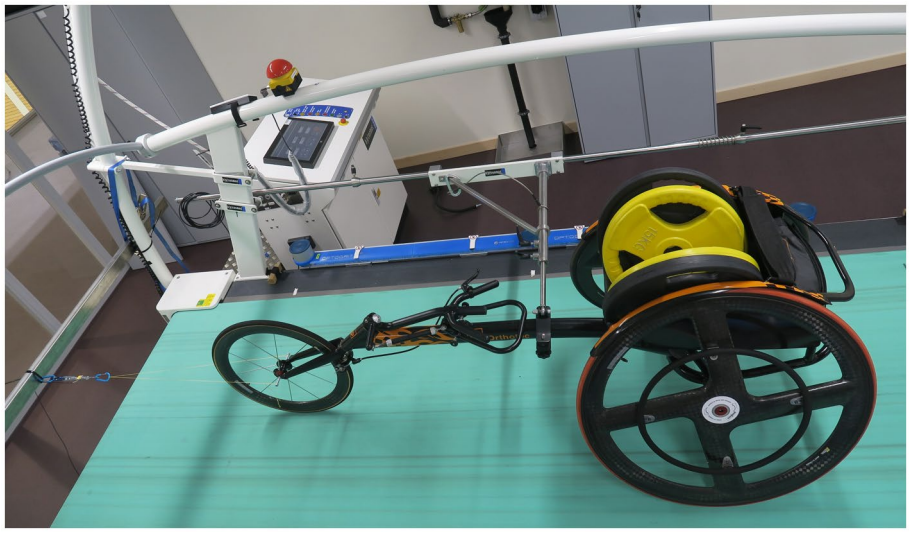

FIGURE 1
Wheelchair on the treadmill, loaded with a weight of 80kg for the drag test, attached to the fixation system alongside of the treadmill and to the force sensor in front.

TABLE 1 Different conditions at which the drag test was performed.

Condition	Load	Weight [kg]	Tire pressure [bar]
1	Weights	50.9	6
2	Weights	50.9	8
3	Weights	81.9	6
4	Weights	81.9	8
5	Participant	80.5	6
6	Participant	80.5	8

TABLE 2 Mean of measured speed of both treadmills (A, B).

Speed indicated [km/h]		10	15	20	25
A	Measured [km/h]	10.08	15.17	20.20	25.26
B	Measured [km/h]	10.04	15.05	20.06	25.07

3. Results

3.1. Speed

The speed of the treadmill was not affected by the different conditions (with/without wheelchair on treadmill at 0 and 10% inclination). The mean of the speed measured at the different conditions of both treadmills is indicated in Table 2. The difference between the measured speed and the speed indicated at the treadmill was between 0.3% and 1.1% of the indicated speed.

3.2. Inclination

The inclinations of both treadmills are listed in Table 3. Differences between treadmills were maximally 0.1°. The difference between the measured inclination and the inclination shown at the treadmill was between −0.2° and 0.1°. Predefined angles were set to 0.57° (1% of inclination) per step. The step size of the actual slope varied between 0.5° and 0.6°, which is within the accuracy of the inclinometer. Only one step size of treadmill A was 0.7° and thus slightly deviating from the intended step size of 0.57°.

3.3. Rolling resistance

The correlation coefficient of the linear regression to determine drag force at 0° was very high (0.9996–0.9999). Measured and calculated drag forces of condition 1 and 3 are displayed in Figure 2. All results of the drag tests are listed in Table 4.

4. Discussion

The comparison of the two treadmills (same brand, same mode, but different belt material) showed that slight differences exist between the treadmills, and that mainly belt properties result in noticeable differences for the athlete when doing a performance test.

For both treadmills, speed and inclination only deviate marginally from the indicated speed and inclination. Differences between indicated and measured speed and inclination reported by de Groot et al. were higher than measured in this study (de Groot et al., 2006). When measuring actual belt velocity of 7 identical Bonte treadmills running at 2 km/h, de Groot et al. reported values of 1.5 km/h to 1.9 km/h. This is a maximal difference of 20% of intended velocity. In our comparison of two

TABLE 3 Measured inclination in degree of both treadmills (A, B) for the indicated inclination.

Incli-nation	0° (0%)	0.6° (1%)	1.1° (2%)	1.7° (3%)	2.3° (4%)	2.7° (5%)	3.4° (6%)	4.0° (7%)	4.6° (8%)	5.1° (9%)	5.7° (10%)
A	−0.2°	0.5°	1.0°	1.6°	2.2°	2.7°	3.3°	3.9°	4.4°	5.0°	5.5°
B	−0.1°	0.5°	1.1°	1.7°	2.2°	2.8°	3.4°	3.9°	4.5°	5.1°	5.6°

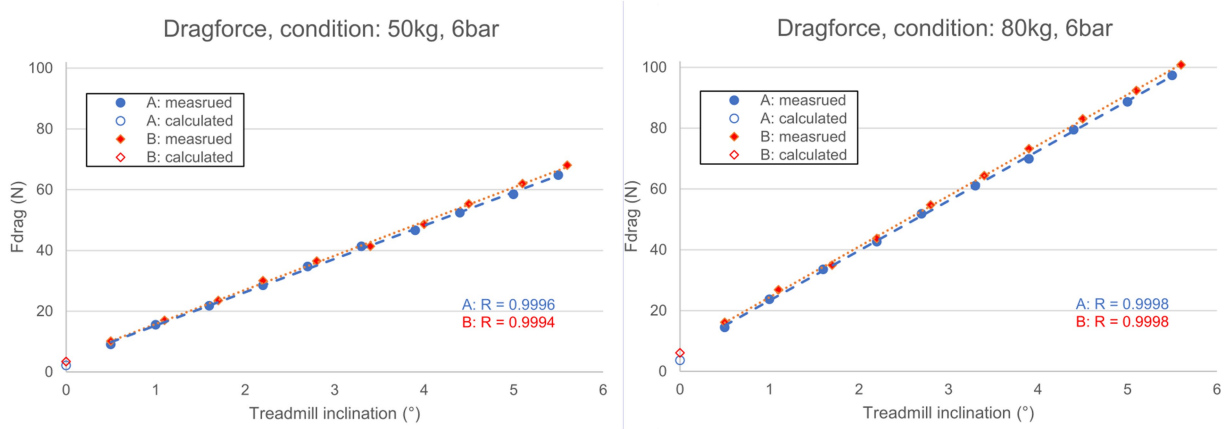

FIGURE 2
Measured and calculated drag forces, obtained from the drag test.

Cosmos Saturn Treadmills, the maximal difference was 0.8% of the intended velocity. Regarding inclination, de Groot et al. measured step sizes of 0.22° to 0.42° when aiming at 0.36° per step. This is a higher difference than measured in our study, where we found step sizes of 0.5° to 0.6° when aiming at 0.57° per step. Thus, compared to previous studies, the deviation of speed and inclination of the two treadmills compared in our study is small.

Rolling resistance varies between the two treadmills, likely resulting from different belt material. From previous studies it is known that the surface accounts for a high variance in rolling resistance (Ott and Pearlman, 2021). For example, carpet has approximately 3 times higher rolling resistance than concrete or linoleum (Hoffman et al., 2003; Sauret et al., 2012). The different belt material might also account for the different reaction on change in tire pressure. Increasing tire pressure in the standardized conditions (wheelchair loaded with given weight) from 6 to 8 bar results in an increased rolling resistance on treadmill A and in a decreased rolling resistance on treadmill B. A decrease in rolling resistance has been seen earlier when increasing tire pressure on a manual wheelchair (Pavlidou et al., 2015). When the participant was sitting in the wheelchair, the reaction on increasing tire pressure was reversed. This change might be related to differences in weight distribution and the resulting change in the location of center of mass. The weights were placed into the seat of the racing wheelchair; therefore, center of mass was located more toward the back of the wheelchair and the back wheels placed more pressure onto the belt. When the participant was sitting in the wheelchair, he placed his hand on the steering mechanism of the wheelchair. This will result in a forward shift of the center of mass and even a small change in mass distribution can have a significant impact on rolling resistance (Ott and Pearlman, 2021).

Considering all the differences and slight deviations it results in a noticeable difference for the athlete when doing a performance test. At a lower speed of 10 km/h, lighter athletes (50 kg) have to deliver about 5 W more on treadmill B compared to treadmill A in order to keep up with the speed. Heavier athletes (80 kg) have to deliver 7 W more on treadmill B compared to A at the same condition. At faster conditions (25 km/h) the differences are even higher. Lighter athletes have to deliver approximately 11 W more on treadmill B compared to A, for heavier athletes it results in a mean difference of 16 W. In general, athletes have to deliver 10% more power output on treadmill B compared to treadmill A (Table 4).

4.1. Practical implications

Today, medal decisions at international competitions such as Paralympic Games or World Championships lie within a split second (Perret, 2017). Therefore, reliable exercise testing procedures and results have to be warranted for athletes, coaches and exercise physiologists to make clear statements and give correct and feasible training advices. The present investigation showed that two treadmills from the same manufacturer used under comparable conditions (e.g., same speed, incline, weight and tire pressure) even resulted in considerable differences. A limitation of the present study is that comparisons made in the present study are based on one specific treadmill model. However, results from previous studies have shown similar or higher differences for other treadmill models (de Groot et al., 2006). The differences found in

TABLE 4 Results of the drag test comparing both treadmills (A, B): calculated rolling resistance (Fdrag) at the level treadmill, and calculated power output at the conditions used during later exercise testing with athletes (inclination of 2%, speed of 10km/h, 15km/h, 20km/h and 25km/h).

Condition	Treadmill	Fdrag	Power output at 2% incline			
			10km/h	15km/h	20km/h	25km/h
1: 50 kg, 6 bar	A	4.3 N	42.8 W	64.4 W	85.8 W	107.3 W
	B	4.6 N	47.2 W	70.7 W	94.3 W	117.8 W
2: 50 kg, 8 bar	A	4.9 N	41.5 W	62.4 W	83.1 W	104.0 W
	B	4.4 N	46.7 W	70.1 W	93.4 W	116.7 W
3: 80 kg, 6 bar	A	6.9 N	65.2 W	98.1 W	130.6 W	163.4 W
	B	7.7 N	72.6 W	108.8 W	145.1 W	181.3 W
4: 80 kg, 8 bar	A	7.2 N	66.2 W	99.6 W	132.6 W	165.8 W
	B	7.4 N	71.9 W	107.7 W	143.6 W	179.4 W
5: participant, 6 bar	A	5.8 N	60.9 W	91.7 W	122.1 W	152.7 W
	B	6.8 N	69.2 W	103.8 W	138.3 W	172.8 W
6: participant, 8 bar	A	4.3 N	61.8 W	93.0 W	123.8 W	154.8 W
	B	6.2 N	68.3 W	102.4 W	136.5 W	170.6 W

both studies are much higher than an expected error of measurement or the daily performance fluctuation (Fiedler et al., 2022). Thus, beside the regular quality management routine of an exercise testing laboratory and stable environmental conditions (temperature, humidity) it is highly recommended to keep also an eye on the athletes' equipment and to use always the same tire pressure. In addition, the exactly same testing device with a standardized setting has to be used. If a new treadmill is installed, a proper validation is recommended before athletes are tested to avoid misleading interpretations of test results. Finally, athletes and coaches have to be sensitized that the use of different devices at different locations my lead to different results and has to be avoided.

4.2. Conclusion

The discrepancies between the two Cosmos Saturn treadmills resulted in different calculated power outputs at given conditions. Speed and inclination deviated only slightly from the values indicated by the manufacturer and therefore did not contribute much to the change in power output. It was mainly the rolling resistance caused by the different belt material that was accountable for the differences in power output between the treadmills. In order to draw meaningful conclusions from performance tests, athletes should always be measured on the same treadmill using the same tire pressure. If different treadmills are used for testing, a proper validation is recommended in advance to avoid misleading interpretations of test results.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

UA, CP, and FA initiated the study and contributed to the conception and design of the study. UA and FA performed the data collection. UA was responsible for all analyzes, drafting, and finalization of the paper. All authors critically revised the paper and have read and approved the final paper.

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Well-being and quality of life in people with disabilities practicing sports, athletes with disabilities, and para-athletes: Insights from a critical review of the literature

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Global well-being (GWB) is a complex, multi-dimensional, and multi-faceted construct that can be explored from two different, but often overlapping, complementary perspectives: the subjective and the objective ones. The subjective perspective, in turn, is comprised of two dimensions: namely, the hedonic and the eudaimonic standpoints. Within the former dimension, researchers have developed the concept of subjective hedonic well-being (SHWB), whereas, within the latter, they have built the framework of psychological and social well-being (PSWB). Disabled people have poorer well-being due to their pathology and may more frequently suffer from anxiety and depressive disorders than their able-bodied counterparts. Sports participation is an essential way to cope with disability. On the other hand, compared with their able-bodied peers, athletes with disabilities and para-athletes undergo a unique series of stressors. Little is known in terms of hedonic and eudaimonic well-being and quality of life in this specific population. Here, we review the literature, with an emphasis on the current state-of-art and gaps in knowledge that need to be addressed by future research. High-quality, large-scale investigations are needed to have a better understanding of the self-perceived (hedonic) and objective (eudaimonic) well-being and quality of life of disabled people practicing sports, athletes with disabilities, and para-athletes.

KEYWORDS

global well-being, quality of life, hedonic well-being, eudaimonic well-being, sports-related well-being, disabled athletes and para-athletes, critical review

Well-being and quality of life

Global well-being (GWB) is a complex, multi-dimensional, and multi-faceted construct that can be explored from two different, but often overlapping, complementary perspectives: the subjective and the objective ones. The subjective perspective, in turn, is comprised of two dimensions: namely, the hedonic and the eudaimonic standpoints (Ryan and Deci, 2001; Ryff et al., 2021). Within the former dimension, researchers have developed the concept of subjective

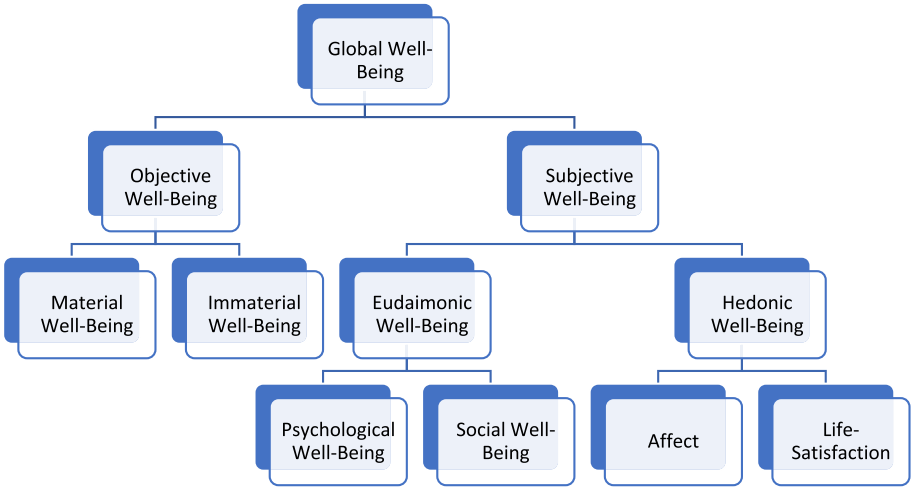

FIGURE 1
A summary of the various dimensions of well-being.

hedonic well-being (SHWB; Diener, 1984; Busseri and Sadava, 2011), whereas, within the latter, they have built the framework of psychological and social well-being (PSWB; Waterman, 1993; Keyes, 1998; Ryff, 2014).

SHWB relates to how individuals experience and rate different aspects of their lives and can be defined as "a broad category of phenomena that includes people's emotional responses, domain satisfactions, and global judgments of life satisfaction" (Diener et al., 1999). This construct is generally employed to quantitatively evaluate mental health and happiness, and it has been found to be a major predictor of individual wellness, health, and longevity (Sears et al., 2014). SHWB can be conceived as "tripartite," there is to say, consisting of three broad components: namely (i) life satisfaction (long-term rating of satisfaction overall or domain-specific, referring to the workplace, partners, friends/colleagues, children, etc.); (ii) positive affect; and (iii) negative affect (Busseri and Sadava, 2011; Ryff et al., 2021). Happiness is conceived as the balance between positive and negative affect (Diener et al., 2005). Among the different existing instruments (Cooke et al., 2016), SHWB can be measured using a widespread and well-documented survey index, namely the "Psychological General Well-Being Index" (PGWBI; Dupuy, 1984), which provides an assessment of self-perceived psychological well-being in terms of different domains, including (i) depressed mood; (ii) anxiety; (iii) vitality; (iv) positive well-being; (v) self-control; and (vi) general health.

PSWB consists of psychological well-being (PWB) and social well-being (SoWB). The former can be understood according to the six-factor model, which sees PWB as a construct consisting of six components: namely (i) awareness and acceptance of personal limitations (self-acceptance); (ii) cultivating positive connections, and meaningful relationships with others; (iii) being self-determining, and setting goals based on personal convictions and standards (autonomy); (iv) navigating life's circumstances (environmental mastery); (v) attributing meaning and direction to life (purpose in life); and (vi) being welcoming to new experiences, continuously developing and improving oneself over time (personal growth). These components are all essential and mutually influence each other (Ryff, 1989; Ryff, 2014). Similarly, SoWB is comprised of the following dimensions: (i) social acceptance; (ii) social actualization; (iii) social contribution; (iv) social coherence; and (v) social integration (Lundqvist and Sandin, 2014; Joshanloo, 2022).

Despite being conceptually different, at least partially, the two models of well-being (hedonic and eudaimonic) are overlapping, with prominent theorists (such as Aristotle, Jung, Maslow, Allport, Rogers, Erikson, Frankl, Jahoda, Neugarten, or Bühler) having contributed to the development of both (Ryff, 1989; Ryff and Singer, 2008; Ryff, 2016).

These two concepts parallel the dichotomy introduced in the field of behavioral economics and applied psychology by Daniel Kahneman: (i) "experienced well-being," which corresponds to hedonic well-being (as previously said, a dynamic balance between positive affect, pleasure, and happiness, and negative affect, distress, or misery); and (ii) "evaluative wellbeing," which corresponds to eudaimonic well-being (that is to say, autonomy, personal growth, and meaning/purpose in life; Kahneman, 1999; Salvador-Carulla et al., 2014).

The concept of objective well-being defines well-being in terms of quality of life indicators, as "the list of goods that are necessary for a good life" (Bohnke and Kohler, 2008) including material resources (like income, food, or housing) and social attributes (such as education, health, "political voice," or social capital, like family, friendship and social networks and connections, and social inclusion), among others (Western and Tomaszewski, 2016).

The objectivist approach to well-being has been mostly pioneered by Amartya Sen, with his work in welfare economics (Sen, 1973). Another prominent theorist and scholar of objective well-being is Martha Nussbaum (Anand et al., 2004). Altogether, their contributions are known as the Sen–Nussbaum approach to well-being. Objective well-being is also, sometimes, called "contextual well-being."

The various dimensions of global well-being are summarized in Figure 1.

These various concepts of well-being have been recently adapted and translated, as well as integrated, into the sports world (Lundqvist and Sandin, 2014). Well-being, as experienced by athletes, especially elite ones, is particularly rich, complex, and nuanced, depending also on the specific context that surrounds the athlete (Lundqvist, 2011; Lundqvist and Sandin, 2014). The sports arena is, indeed, challenging and rewarding at the same time, as it provides venues to explore new opportunities, experience success as well as failure, and interact and

connect with peers (Mack et al., 2012). On the other hand, athletes have to cope with heavy training schedules, psychological challenges, like internal and external pressures, various transition phases, and logistic-organizational stressors, as well as injuries, and performance plateau (Lundqvist and Sandin, 2014). Global and sports-related well-being can be conceived as "an interplay of satisfaction with life, sport experiences and perceived health combined with experienced enjoyment and happiness in both ordinary life and sport" (Lundqvist and Sandin, 2014).

According to Lundqvist (2011), global and sports-related well-being consists of a hedonic component [SWB in sport (SWB-S)], and of a eudaimonic component. SWB-S consists of sports satisfaction, and sports-related affect, while PWB in sport (PWB-S) is comprised of (i) self-acceptance as an athlete, (ii) positive relation to the coach and teammates, (iii) autonomy in sports practice, (iv) sports environmental mastery, (v) purpose in sport, and (vi) personal growth as an athlete. Finally, SoWB in sport (SoWB-S) consists of (i) social acceptance in sport, (ii) social actualization through sport, (iii) social contribution to sport, (iv) social coherence in sport, and (v) social integration in sport.

Related to well-being, there are other constructs, like the quality of life (Prutkin and Feinstein, 2002), health-related quality of life (HRQoL), happiness, human functioning, and health-related human functioning (HRHF; Salvador-Carulla et al., 2014), which can be regarded as (sometimes overlapping, sometimes different and complementary) subcategories of well-being (Salvador-Carulla et al., 2014). The former construct can be defined as "a person's perception of his/her position in life within the context of the culture and value systems in which he/she lives and in relation to his/her goals, expectations, standards, and concerns" (The WHOQOL Group, 1994). The latter constructs (namely, human functioning, and HRHF) are relevant when it comes to the scholarly investigation of disability.

Disability

Disability can be defined as "a difficulty in functioning at the body, person or societal level, in one or more domains, as experienced by an individual with a health condition in interaction with contextual factors" (Raggi et al., 2010). According to the World Health Organization (WHO), a person with a disability can be defined as a person having "a problem in body function or structure, an activity limitation," and/or "a difficulty in executing a task or action; with a participation restriction." People with disabilities represent a large portion of the general population, currently being more than 1 billion people worldwide. They have to cope with (either structural or perceived) obstacles and barriers that hinder their full participation in society and engagement with daily activities.

Currently, there is disagreement about the most respectful and appropriate way to refer to individuals with disabilities: "person-first language" (which focuses on the person rather than the disability), or "identity-first language." Here, we want to acknowledge that, while the first option has the benefit of emphasizing the person's individuality with the intention of reducing disability-related discrimination and stereotypes, on the other hand, its use may sound "awkward" and "unconventional" (Taboas et al., 2022). Paradoxically and unintentionally, its use could result in drawing "attention to the disability" (Taboas et al., 2022). Also, the disability community is beginning to "support the use of identity-first language that embraces all aspects of one's identity" (Taboas et al., 2022), different from professionals who work in the disability community (Taboas et al., 2022). However, some survey-based studies seem to suggest that "both types of language are preferred by different groups of … [disability] stakeholder groups" (Taboas et al., 2022). Since language is highly dynamic and constantly under flux and the choice of "person-first language" or "identity-first language" reflects the evolution of language, culture, and society (Krista et al., 2022), in this critical review, we will use a mix and a variety of language, alternating between "person-first language" and "identity-first language," choosing to use terms flexibly throughout our work. In doing so, we follow the suggestions of Dunn and Andrews (2015). We are aware of this choice and we clearly state it as a "reflexive research practice" (Krista et al., 2022). In this way, the reader can have a clear understanding of the choices and decisions, we have made while conducting the research and drafting our manuscript. Also, we state that we stand and will always stand with the members of the disability community and that we do not have any demeaning or derogatory attitude toward them.

A fair, just society should ensure the observation and application of the principles of gender, equity, inclusion, and diversity (GEID). People with disabilities have the right to access school, workplace, and justice, receive healthcare provisions and take part in cultural and sports activities, as stated by the United Nations (UN) Human Rights Office of the High Commissioner. However, despite being apparently protected by the law, the voices of subjects with disability are generally unheard and their needs are often unmet. In the last decade, the 2008 "UN Convention on the Rights of Persons with Disabilities" has reiterated the societal onus to ensure people with disabilities, as well as other vulnerable and marginalized populations, dignity, respect, and human rights. The inclusion of diverse athletes, like those with a disability, has been growing in the last years, with paralympic events attracting a significantly increased portion of para-athletes, since the first sports event ("Silent Games") took place in 1924, in Paris (France), involving 148 disabled athletes from a few European countries. Initially conceived as a rehabilitation sport, based on the vision of Dr. Ludwig Guttmann (1899–1980; Chun et al., 2021), inclusive sport has gradually shifted to recreational and competitive sport. In 1960, the first edition of the Paralympic Games was organized. Despite this, athletes with disability remain significantly sidelined in the sports community and in the coverage by mass and social media (Wolbring and Martin, 2018). In the existing scholarly literature, athletes with a disability are dramatically under-represented with respect to their able-bodied counterparts, with a significant dearth of data and available evidence concerning their well-being and quality of life (Macdougall et al., 2015), determinants of fatigue and performance outcomes, as well as optimal training programs and strategies, and rehabilitation protocols.

Generally, people with disabilities report poorer well-being due to their health status and underlying conditions, and may more frequently suffer from anxiety and depressive disorders than their able-bodied counterparts (Krahn et al., 2015; Tough et al., 2017), even though they can develop particular skills and strategies in order to face adverse situations—this is known as the "disability paradox" (Albrecht and Devlieger, 1999), even if it has been questioned and challenged by some scholars (Koch, 2000). Being engaged in regular, structured physical activity, like sports participation, is an essential way to adapt to and cope with disability (Shephard, 1991; Ascione et al., 2018; Kiuppis, 2018; Puce et al., 2019; Maugeri et al., 2020). On the other hand, compared with their able-bodied peers, disabled athletes known also as para-athletes undergo a unique series of stressors that deeply influence the process of forming a new identity (Brewer et al., 1994), such as physical access, communication, or economic-financial barriers, discriminating, and demeaning attitudes, and unprofessional coaching (Iezzoni, 2009; Jefferies et al., 2012). If practicing sports can result in improved inclusion, and, therefore, enhanced self-acceptance as well as social acceptance

(Trigueros et al., 2021), less is known in terms of well-being, both from a subjective and objective perspective, in this specific population.

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A systematic review of the literature (Macdougall et al., 2015) retrieved 12 studies comparing the well-being of Para and Olympic sports athletes. However, the authors found that there were insufficient data to conduct a meta-analysis for the dimension of SWB—life satisfaction or long-term affect. Moreover, the effect sizes from individual studies were contrasting, both in terms of magnitude and direction. While two studies (Horvat et al., 1989; Wisniowska et al., 2012) reported statistically significant differences in favor of Olympic sports athletes for life satisfaction, total mood-disturbance differences, fatigue, and depression, one study (Pensgaard et al., 1999) reported opposite findings, by computing significant differences in favor of para-athletes for satisfaction with effort and results from a major competition. Finally, two studies (Horvat et al., 1989; White and Croce, 1992) could not report any significant differences between the two athletic populations for long-term affect across anger, anxiety, confusion, tension, or vigor. Besides such conflicting findings, even fewer studies exist comparing para-athletes and disabled subjects non-practicing competitive para-sports.

As such, there seems to be little evidence of the psychological benefits of competitive sports for disabled individuals, probably due to the paucity of studies addressing this topic. Moreover, the existing scholarly research is limited to specific disabilities, para-sports disciplines, settings, and geographic contexts, with samples generally consisting of a limited number of participants. Furthermore, there is a marked lack of comparative data exploring the differences in well-being between para-athletes and individuals with disabilities who do not play competitive sports. Therefore, given this dearth of information, this review study was conducted to fill in this gap of knowledge.

Available research (either observational or interventional) conducted on able-bodied athletes and the general population has emphasized the value of different forms of physical activity, either unstructured or structured (including exercise, and sport), in terms of the promotion and enhancement of various components of well-being and physical self-perception, with a "multiplier effect," with engagement improving general health and well-being, which, in turn, encourages further sports participation, with subsequent further enhancements in general health and well-being, resulting in a virtuous circle (Downward et al., 2018). Improvements in both hedonic and eudaimonic well-being were found. For instance, Edwards et al. (2004) explored the relationship between sports involving diverse types of regular exercise, such as hockey and health club activities (team and individual sports involving aerobic and resistance exercise, respectively), and mental and physical health. The authors measured eudaimonic well-being, by utilizing Ryff's conceptual framework. The authors recruited and compared 60 university hockey players, 27 health club members, and 111 non-exercising students. The latter population was found to display less well-being and physical self-perception. Specifically focusing on SHWB, Wilson et al. (2022) quantitatively assessed the correlation between sports participation and well-being in cohorts of adolescents (aged 11–17 years), in New Zealand. Hedonic well-being was assessed utilizing a single-item graded on a 10-point Likert scale ranging from 1 ("very unhappy") to 10 ("very happy"), following the "Organisation for Economic Co-operation and Development" (OECD) guidelines on measuring SHWB. Better hedonic well-being was found to be associated with participation in any sport vs. none. Of note, well-being was not associated with participation in physical education or *solo* sport. During the still ongoing "Coronavirus Disease 2019" (COVID-19) pandemic, sports students exhibited higher levels of SHWB (increased positive affect and reduced negative affect), when compared with music students (Habe et al., 2021). Several parameters were identified mediating the link between sports participation and SHWB, including age, sex/gender, income, relationship status, intensity, and duration of physical activity, among others (Ruseski et al., 2014; Wicker and Frick, 2015; Zhang et al., 2022). Overall, physical activity was found to be related to positive affect, but unrelated to negative affect, enhancing SHWB, with effects consistently shown across all age groups and a variety of settings (individual vs. team sports, light vs. moderate and hard intensity, aerobic vs. anaerobic and mixed exercise), and prior fitness levels (Buecker et al., 2021).

Specifically concerning competitive sports, some studies (Saw et al., 2016; Watson et al., 2017; Abbott et al., 2018; Watson and Brickson, 2018, 2019) identified some associations between SHWB and sports-related parameters, like training load, training-induced stress (Saw et al., 2016; Watson et al., 2017; Watson and Brickson, 2018, 2019), match location, match result, and the quality of the opposition during a soccer match (Abbott et al., 2018), as well as social identification with college sports teams (Graupensperger et al., 2020). In general, the authors deployed in-house developed questionnaires, with a few studies using reliable instruments complemented by the use of objective measures.

Less is known about the impact of sports participation on well-being among the disabled population, even though a growing body of scholarly research has shown that practicing sports at a competitive level such as Paralympic sports, directly and indirectly (through the related emotional, motivational, and social characteristics that characterize the sports environment), could make a greater contribution to the SHWB and PSWB of individuals with disabilities, helping them grow and cope with the challenges of life, favoring the acceptance of one's health status, the assumption of responsibilities, and the achievement of personal goals (Puce et al., 2017).

Previous surveys specifically focusing on the perceived psychological and emotional well-being of para-athletes compared with disabled people who did not practice competitive sports have shown greater well-being of the former population, underlining the strength of competitive sports, which are able to act on different areas such as (i) the emotional sphere, through the experience of achieving a predetermined goal; (ii) the motivational sphere, through the possibility of competing fairly with opponents having the same degree of functionality; (iii) the social sphere, through the establishment of lasting, meaningful interpersonal relationships within the team; and (iv) the physical sphere, through the maximization of residual motor capacity and the development of new abilities.

For instance, para-sports such as para-swimming have been shown to be useful for facilitating self and social acceptance, for the development of identity and a sense of normalization (Pack et al., 2017), improving the quality of life, reducing anxiety, and increasing self-esteem (Vita et al., 2016).

These findings are comparable to previous surveys of wheelchair sports (like basketball, tennis, and rugby) competition participants. The

researchers found that para-athletes have lower rates of depression, tension, anger, and confusion, as well as an increase in life satisfaction (Paulsen et al., 1990; Fiorilli et al., 2013; Nagata, 2014) and more positive perceptions of one's health and well-being than non-para-sports participants (Greenwood et al., 1990; Campbell and Jones, 1994; Martin et al., 2011; Litchke et al., 2012).

A recently published survey (Mira et al., 2022) studied 31 of the 33 athletes of the Portuguese Paralympic team (aged 34.45 ± 11.7 years, 21 men and 10 women), participating in several para-sports disciplines (namely, para-athletics, para-badminton, boccia, para-canoe, para-cycling, equestrian, judo, and para-swimming). The findings highlighted high values of life satisfaction, high positive affect, and low negative affect levels. Moreover, the authors were able to report high levels of resilience and social support.

However, due to the extremely competitive sports environment para-athletes can experience several sport-specific and disability-specific stressors that are potentially detrimental to personal well-being (Macdougall et al., 2016). For example, the training methodologies in terms of volumes, intensity, and recoveries of para-athletes are very similar to those of normal athletes, even if each type of impairment may respond differently to the training load, and this can lead to overtraining, burnout, pain, and injuries (Puce et al., 2018). Furthermore, frequent travel, often difficult from a logistical point of view, can lead to greater psychological stress levels, reduction in the quantity (hours) and quality of sleep, and eating disorders.

Also, there is the possibility that a para-athlete will be assigned to an incorrect functional para-sports class, this could cause frustration, poor sport-related satisfaction, and, in some cases, retirement from competitions (Swartz et al., 2019).

Finally, there is also evidence that participation in competitive sports has an impact on the athletic identity of individuals with disabilities (Kokaridas et al., 2009; Pack et al., 2017). Perceiving oneself exclusively as an athlete implies not only positive aspects such as motivation, goal orientation, and sense of empowerment, but also negative aspects such as exclusivity (i.e., inability to identify with other roles) and negative affectivity (i.e., negative emotional responses to injury, retirement, or other sources; Martin et al., 1995, 1997).

Limitations of the overviewed studies include their cross-sectional study design, the use of either only self-report measures that may result in reporting and recalling bias, or objective measures, without exploring the subjective perspective of the participants. Several para-sports disciplines are not represented in the literature and some of those investigated may be under-represented. Moreover, the sample size of these studies is usually small. Further, several existing studies are not underpinned by a precise psychological theory/framework of well-being, and some of them fail to capture its multi-dimensional nature, using tools consisting of a single item or a few items, instead of employing a theoretically grounded, psychometrically sound and multi-faceted tool, specifically devised for disabled people and para-athletes. Also, indicators and scales have been developed and tested predominantly in the Global North, with populations mainly consisting of white, male university students. As such, the measures and indicators should not be assumed to be applicable to other populations. The disability community is heterogeneous, but its variety has not been sufficiently captured by the scholarly literature. More attention to GEID principles should be paid.

Conclusions and future directions

This review study contributed to a better understanding of subjective and objective well-being and quality of life among people with disabilities practicing sports, athletes with disabilities, and para-athletes. However, future studies should elucidate the relationships between hedonic and eudaimonic well-being in this specific population, especially from a longitudinal (rather than cross-sectional) perspective. Future indications also include the investigation of the mechanistic pathways that can link practicing sports with well-being outcomes in the disabled population. These studies should adopt a more multi-dimensional perspective, attempting to disentangle the complexities underlying overlapping/complementary constructs such as well-being (GWB, hedonic/SHWB, eudaimonic/PSWB, and objective/contextual well-being), quality of life, HRQoL, human functioning, and HRHF. Particular effort should be paid avoiding to present disability through a medical model lens, with impairment as a medicalized defect of functioning (Smith et al., 2016; Bundon et al., 2022).

Currently, a comprehensive, conceptually and theoretically grounded, scholarly sound map/taxonomy of an array of health-related "meta-constructs" or "meta-categories" (wellbeing, health condition/health status, human functioning, disease/pathology, disability, etc.) is urgently needed (Cieza and Stucki, 2008; Salvador-Carulla and Gasca, 2010). A mapping/scoping exercise should be conducted to identify operational definitions of these identities/meta-identities, their conceptual hierarchy, and their granularity and complexities, in terms of the various (sub-)domains, (sub-)dimensions, and (sub-)facets (Salvador-Carulla et al., 2014). This should lead to a person-centered framework "ranging from ill-health/ill-being to good-health/well-being that incorporates all major aspects of well-being in its preliminary conceptual map: positive and negative polarity, condition status and functioning, experiences of health and contributors to ill and to good health" (Mezzich et al., 2010; Salvador-Carulla et al., 2014).

Truly inclusive health, disease, and disability ontologies are still lacking (Sefotho, 2021), with health and well-being usually understood as normative, rather than foundational concepts. There is also a lack of tools for assessing the well-being of persons with disabilities. A major step forward is represented by the "World Health Organization Quality of Life" (WHOQOL) disabilities module (WHOQOL-DIS) for people with physical and intellectual disabilities (Power et al., 2010). Moreover, these constructs can be complemented by the assessment of the so-called "objective well-being" and related constructs, such as human flourishing and capabilities (Nussbaum, 2006; Bloodworth et al., 2012). In the specific case of disabled subjects, objective scales include the Karnofsky index, which was introduced in the healthcare field to quantitatively assess the performance status of patients with malignancies and people with disabilities, the clinical indexes of "Activities of Daily Living" (ADL), and the "World Health Organization Disability Assessment Schedule 2.0" (WHODAS 2.0; Karnofsky and Burchenal, 1948; Katz et al., 1963; Ustün et al., 2010; Kostanjsek et al., 2011; Na and Streim, 2017).

This would advance our understanding of disability and would assist and inform the data-driven, evidence-based design and implementation of interventions aimed at improving and enhancing the well-being, quality of life, and functioning of disabled people (Ferrario and Guarino, 2009; Riddle, 2013). Understanding disability status and associated well-being can help policy- and decision-makers, as well as service providers, devise adequate, effective programs. Currently, only a few scales exist assessing GWB in disabled individuals from both a subjective and objective standpoint, including the "Integral Quality of Life Scale"

(Verdugo et al., 2009), consisting of eight major domains (self-determination, rights, emotional well-being, social inclusion, personal development, interpersonal relationships, material well-being, and physical wellbeing), which, however, has been developed for and tested in persons with intellectual disabilities. To these domains, Davidson et al. (2017) have added the following: environment, family, recreation and leisure activities, and, safety/security. Finally, health-, well-being-, disability-related ontologies, and semantic maps can be "translated" and "adapted" to the sports arena, and connected with sports-related ontologies and semantic maps (Ramkumar and Poorna, 2017), to assist sports scientists and managers, instructors, and coaches in the development of adequate training strategies.

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LP, PO, MY, GA, RP, JK, and NB conceived and drafted the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

PO, MY, GA, and RP were employed by Effective Basic Services (eBASE).

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A cross-sectional study of sleep, mood, well-being, motivations, and perceived support in Ukrainian veterans and active-duty military personnel with disability, and their supporters, preparing for a sporting event

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Purpose: The benefits of sports and exercise to the lives and rehabilitative journeys of military veterans with disabilities is increasingly well-documented but veteran sporting events remain underexplored. Addressing this topic, the current article seeks to provide insight into the health and well-being of Team Ukraine during a 5-week preparatory camp in the UK before attendance at the 2022 Warrior Games.

Materials and methods: Two surveys were run, one toward the beginning and one toward the end of the camp. Eighteen of the 55 veterans and serving personnel (with disability), support staff, and family members in attendance responded to both surveys. Data on sleep, mood, and competition-related emotions, motivations for participation and perceived support were gathered. Data were analysed descriptively, and sleep, mood, and competition-related emotion responses were categorised to explore improvements, maintenance, or worsening in these areas.

Results and conclusion: Sleep, mood, and competition-related emotions were relatively stable, although sleep duration was low, and there were some increases in daytime dysfunction, anxiety, nervousness, and feeling tense. Family was the most important source of support and representation of one's country and raising awareness of Ukraine's circumstances were the most important motivational factors. Findings offer insight into not only the health and well-being experiences associated with participation in this disabled veteran sporting event, but also the important role played by this event in meeting collective goals relating to this unique time in Ukraine's history.

KEYWORDS

competition, sports, disability, veteran, sleep, military, well-being, mood

Introduction

Research highlights the benefits of sports and physical activity to the lives and rehabilitative journeys of military veterans (Caddick and Smith, 2014). Veterans with traumatic injuries or chronic illness have noted the motivating nature of sports, with a focus on capacity and success rather than illness or injury, and the availability of immediate short- and long-term feedback when participating in sports (Brittain et al., 2022). Participation in sports and physical activity has been associated with improved subjective (e.g., active coping and social participation), psychological (e.g., increased determination, focus on ability, improved self-concept), and social well-being among combat veterans (Caddick and Smith, 2014). Furthermore, physical benefits such as increased mobility, strength, and aerobic capacity (Addison et al., 2019; Briggs and Oursler, 2021), weight loss and increased fitness (Brittain et al., 2022), and reductions in the symptomology of mental health conditions such as post-traumatic stress disorder (PTSD) have been identified in veterans with disabilities, traumatic injuries or chronic illness (Walter et al., 2021). Outdoor and nature-based activities, such as fishing, water and snow sports, riding, and archery, have been found to provide a wide range of benefits to veterans, including facilitating positive mood and establishing new coping methods through motivation and challenge (Bennett et al., 2017; Craig et al., 2020), opportunities for social bonding (Lundberg et al., 2016), as well as reductions in PTSD symptomology (Gelkopf et al., 2013; Crawford, 2016; Wheeler et al., 2020).

Literature has also explored the experiences, benefits, and challenges of participating in sporting events for veterans with disabilities (Roberts et al., 2019, 2021). Participants at the National Veterans Wheelchair Games (NVWG) and Winter Sports Clinic (NVWSC, both held in the USA) reported increased mobility and acceptance of their disability (Sporner et al., 2009). Invictus Games competitors have cited improvements in physical and mental health and performance, and social interactions (Roberts et al., 2021), opportunities to develop goal-setting and teamwork skills, and a chance to reconnect with a military identity (Brittain et al., 2022). Research has also considered the experiences of participants of The Warrior Games (run by the USA's Department of Defence). Peterson et al. (2017) found that time spent participating in organised sporting events impacted on skills relating to performance strategy, with those who had participated for over a year demonstrating greater skills relating to self-talk, goal setting and activation prior to competition than those who had less than 1 year of experience. Similarly, Laferrier et al. (2017) found that registered athletes at the NVWSC, the Warrior Games, and the NVWG, had significantly higher self-esteem scores than those not involved in sports and exercise, with this score also being significantly higher immediately following participation in a sporting event compared to 1 and 3 months after an event. Participation in sports and exercise was also associated with significantly lower scores on depression measures, and higher post-traumatic growth and quality of life scores. Those who had been participating in sports and exercise for longer periods also scored significantly higher on measures compared to those who had participated for less time. However, negative experiences have also been identified, such as a perceived lack of goals after the games, "post-games blues," and experiences of stress before and during the games (Roberts et al., 2019, 2021). Veteran sporting events remain an underexplored topic, and there has been limited research in this area in recent years due to the cancellation of events during the COVID-19 pandemic.

In 2022, the United States Department of Defence invited Ukrainian veterans and personnel injured in the current conflict to compete alongside American and Canadian service teams in the Warrior Games ("the Games") held in Florida. The Games were attended by 61 Ukrainian competitors and support staff, including a small number of widows and children of deceased personnel; 55 of these individuals attended a training camp in the United Kingdom (UK) to prepare for the Games, hosted by Blind Veterans UK. Veteran participants were airlifted directly from an active warzone and military duties. The camp consisted of an intensive 5-week schedule of training sessions, psychotherapy sessions, and recreational trips. This camp provided an opportunity to gain unique insight into experiences associated with Team Ukraine's preparations for the Games. The current study aimed to explore aspects of the team's health and well-being during this time, and factors that might impact on their experiences of preparing for the Games. Addressing this objective, the current article answers the following questions:

(1) How, if at all, did mood, well-being, sleep, and competition-related emotions change in members of Team Ukraine over the course of their UK-based preparations for the Games?

(2) What motivations for participation in the Games were most important to members of Team Ukraine?

(3) What sources of support were perceived as most important to Team Ukraine during their preparations for the Games in UK?

Materials and methods

Two online surveys were conducted, one at the start and another at the end of the camp, to gather quantitative data relating to demographics, health and well-being, motivations for participation, and perceived support. Open-ended questions collected qualitative data on participants' preparations, motivations, goals, and achievements. The current article reports quantitative findings only. Run as part of the evaluation of the training camp, the current study did not require approval from an ethics panel; this was confirmed by the Chair of the Medical Sciences Interdivisional Research Ethics Committee at the University of Oxford.

Participants and recruitment

A total of 55 veterans, current serving personnel, widowed spouses and support staff were airlifted out of Ukraine by the British military to attend the training camp in the UK to prepare for the Games. All 55 members of Team Ukraine who attended the training camp were invited to take part in the surveys. Participation was voluntary. The Ukrainian team leadership notified the team of the study. Participants were able to access the surveys using a link or QR code in a flyer provided in English and Ukrainian. The team leadership also shared a link *via* a private communication app accessible only to the team. A member of the research team was present throughout the camp to answer any questions.

Materials

Surveys 1 and 2 gathered data on sleep, mood, well-being, and competition-related emotions. Survey 1 (S1) explored age, type of disability, role in team, participation in different sporting events, previous sporting competition experience and motivations for taking part in the Games. Survey 2 (S2) assessed gender and asked participants to reflect on the importance of different sources of support during their preparations.

Questionnaires for both surveys were designed to minimise the impact of the research on the team's training schedule and preparations for the Games. As such, relevant individual items were selected from existing scales or surveys or developed for the survey. Sleep was assessed using four items from the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). The full PSQI scale score has an internal consistency of $\alpha = 0.83$ and a test–retest reliability of $r = 0.87$ (Buysse et al., 1989). The items selected in the current study explored subjective sleep quality (one item), sleep duration (one item), and daytime dysfunction (two items). Ukrainian translations were obtained from the MAPI Research Trust.

Mood was assessed using 10 items from the Ukrainian version of the European Social Survey (2010) (ESS). The items explored how often people felt, for example, "depressed" or "happy" in the past week. Responses were selected from a scale ranging from "None or almost none of the time" to "All or almost all of the time." One item, "Felt guilty," was added to acknowledge the guilt that those involved in active duties might experience when absent from their unit and comrades in Ukraine.

Personal well-being was assessed using two items from the ONS-4: life satisfaction and feeling like life is worthwhile (Office for National Statistics, 2018). The ONS-4 have been assessed through multiple waves of cognitive interviews and are regularly included in large general population surveys in the UK. The items require participants to give a response on a scale of 0 to 10 (where 0 is "not at all" and 10 is "completely") to indicate the extent to which they feel satisfied with life and like life is worthwhile. ONS-4 items relating to anxiety and happiness were omitted to avoid duplication with ESS items.

Competition-related emotions were assessed using items addressing current anxiety relating to the upcoming competition from all three subscales (Worry, Concentration Disruption, Somatic Trait Anxiety) of The Sport Anxiety Scale-2 (SAS-2) (Smith et al., 2006). Participants were asked to rate the extent to which they felt a certain way from 1, "not at all" to 4, "very much." Additional items, "I feel. . . confident/excited/supported" and "I am looking forward to competing" were included to explore positive emotions. Total score alpha coefficients exceeding 0.89 have been reported across all age groups (including children and adults) for the SAS-2 (Smith et al., 2006), suggesting internal consistency. The SAS-2 has been found to be reliable, gender invariant, and to have strong construct validity (Madrigal et al., 2018), although, it has not yet been validated with a Ukrainian sample. In the current study the full sub-scales were not employed; only items dealing with current, state, anxiety (e.g., "I feel nervous") and not hypothetical experiences (e.g., "My mind wanders during sport competition") were included. This reflected the need to minimise participant burden and training disruption.

A question was developed for S1 to assess participants' motivations for their involvement in the Games. Participants were asked to rate how important a range of 14 possible reasons, such as spending time with other veterans or representing their country, were in their decision to take part in the Games, on a scale ranging from "extremely important" to "not at all important." The importance of different sources of support was assessed with a question developed for S2. This question asked participants to rate on a scale ranging from 1, "not at all" to 6, "completely," how important nine different sources of support (e.g., their unit, family, or fellow competitors) were to them during their preparations. All questions included a "Prefer not to say" response option.

Except for questions where Ukrainian translations were available, the questionnaires were translated into Ukrainian by a professional translation agency and checked by a member of Team Ukraine.

Procedure

S1 was run the second week of Team Ukraine's time in the UK (22nd–26th July) and S2 ran during their final days in the UK (14th–18th August). Paper and English versions were available, but all participants completed the surveys online in Ukrainian. The surveys were delivered using the online survey platform SmartSurvey. An accessible survey template was used to ensure accessibility for participants with visual impairment. Participants were provided with an information sheet and required to provide informed consent at the beginning of S1. Participants reconfirmed their consent to participate before completing S2.

Analysis

Due to the selection of individual items from scales, no full-scale scores were computed. Frequencies of responses are reported, along with descriptive statistics such as mean, standard deviation and range where relevant. These provide an overview of sample demographics, sleep, mood, well-being, and competition-related emotions at the two timespoints, and data relating to motivations for participation and perceived sources of support. Change scores were created to explore if respondents' sleep, mood, well-being, and competition-related emotions had improved, stayed the same, or got worse. Due to the small sample size, comparative statistical analysis and subgroup analysis was not undertaken.

Results

Demographics and upcoming sporting events

After excluding 2 partial responses, a total of 18 of the 55 camp attendees completed both surveys (36% response rate). **Table 1** shows sample demographics, and the events

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TABLE 1 Sample demographics and sports to be competed in at the Warrior games.

		M (*SD*, range)	% (*n*)
Age		38.83 (9.67, 25–56)	
Sex	Female		33.3 (6)
	Male		66.7 (12)
Disabilities	Number	1.61 (1.58, 0–4)	
	VI		27.8 (5)
	Hearing		16.7 (3)
	Limb loss		16.7 (3)
	Mobility		38.9 (7)
	Pain		22.2 (4)
	Other		38.9 (7)
Mental health conditions	Number	0.44 (0.70, 0–2)	
	Anxiety		–
	PTSD		22.2 (4)
	Depression		5.6 (1)
	Emotional/behavioural difficulties		16.7 (3)
	Other mental health conditions		–
	Prefer not to say		5.6 (1)
Role in team	Athlete (active-duty military member)		16.7 (3)
	Athlete (veteran, who re-joined active duty)		22.2 (4)
	Athlete (veteran)		22.2 (4)
	Coach		5.6 (1)
	Family		11.1 (2)
	Support		22.2 (4)
Sports events	Number	5.5 (4.18, 2–17)	
Team sports:	Volleyball		45.5 (5)
	Basketball		27.3 (3)
	Rugby		9.1 (1)
	Powerlifting		45.5 (5)
Archery:	Team		36.4 (4)
	Individual		72.7 (8)
Track:	100 m		9.1 (1)
	1500 m		18.2 (2)
	Relay		9.1 (1)
Field:	Discus		18.2 (2)
	Shot put		18.2 (2)
Cycling:	Road		18.2 (2)
	Time		9.1 (1)
Rowing:	1-min		27.3 (3)
	4-min		36.4 (4)
Swimming:	50 m freestyle		36.4 (4)
	100 m freestyle		18.2 (2)
	Backstroke		27.3 (3)
	Breaststroke		9.1 (1)
Air rifle:	Prone		9.1 (1)
	Standing		18.2 (2)

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TABLE 2 Categorical change in mood, sleep, and competition-related emotions.

	Better	Same	Worse
	%	%	%
Personal well-being (*n* = 18)			
Life satisfaction	27.8	50	16.7
Life is worthwhile	27.8	38.9	33.3
Mood (*n* = 18)			
Felt cheerful	22.2	61.1	16.7
Felt depressed	–	83.3	11.1
Felt happy	33.3	50	16.7
Felt lonely	16.7	66.7	11.1
Felt sad	5.6	77.8	11.1
Couldn't get going	5.6	61.1	27.8
Had a lot of energy	38.9	50	5.6
Felt anxious	27.8	33.3	33.3
Felt calm	22.2	55.6	16.7
Felt enthusiastic	5.6	72.2	22.2
Felt guilty	16.7	66.7	11.1
Sleep (*n* = 18)			
Self-reported sleep quality	44.4	44.4	5.6
Hours of sleep	33.3	50	11.1
Stay awake during activities	16.7	38.9	27.8
Keep up enthusiasm to get things done	16.7	55.6	22.2
Competition-related emotions (*n* = 11, athletes only)			
Feel nervous	18.2	54.5	27.3
Feel confident	18.2	81.8	–
Feel tense	18.2	27.3	45.5
Feel excited	–	54.5	45.5
Feel supported	–	81.8	9.1
Have self-doubts	18.2	63.6	18.2
Worried about reaching goal	36.4	27.3	36.4
Looking forward to competing	18.2	63.3	9.1
Concerned may not do as well as could	36.4	45.5	9.1
Concerned about performing poorly	45.5	27.3	18.2
Concerned others will be disappointed	36.4	36.4	27.3
Concerned I won't be able to concentrate	18.2	63.6	9.1

Missing responses and "Prefer not to say" responses are not shown. Percentages refer to the *n* shown for each section. Percentages may not add up to 100% due to rounding, missing responses and "Prefer not to say" responses.

competitors participated in. Respondents were aged 25–56 years (M = 38.38 years, SD = 9.67). Six respondents were female (33%). The sample consisted of 3 military personnel on active duty (16.7%), 4 veterans who had re-joined active duty (22.2%), 4 veterans (22.2%) (collectively referred to throughout as the "veteran" group), 4 members of support staff (22.2%), 2 family members who had taken the place of fallen team members (11.1%), and one coach (5.6%). Respondents reported an average of 1.61 disabilities (SD = 1.58, range: 0–4), most commonly disabilities affecting mobility (n = 7). Seven also reported "Other" disabilities, whilst 5 reported a visual impairment (VI), 4 a chronic pain condition, 3 a hearing impairment, and 3 limb loss. Six participants reported multiple disabilities. Mental health conditions were evident but less prevalent; PTSD was most common (n = 4), followed by emotional or behavioural difficulties (n = 3). Health data was self-reported and may not have reflected clinical diagnoses. Respondents participated in an average of 3.83 (SD = 4.33) and a maximum of 17 sporting events.

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TABLE 3 Sleep, personal well-being, and sources of support in Survey 1 and Survey 2.

		Survey 1		Survey 2	
		n	*M* (*SD*)	*n*	*M* (*SD*)
Sleep	Sleep duration	17	6.18 (1.59)	18	6.67 (1.14)
Personal well-being	Life satisfaction	17	7.71 (2.47)	18	8.17 (1.82)
	Life being worthwhile	18	8.56 (1.5)	18	8.33 (1.94)
Sources of support	Family			17	5.35 (1.54)
	Sports coaches and trainers			16	5.25 (1.24)
	Friends			17	4.88 (1.54)
	Hosts in the United Kingdom			14	4.43 (1.56)
	Military unit			12	4.17 (1.64)
	Physiotherapist or other rehabilitative support			14	3.93 (1.98)
	Fellow competitors			13	3.92 (1.55)
	Sports psychologist			15	3.67 (2.09)
	Religion or spirituality			16	3.63 (2.22)

n = valid responses excluding missing responses and "Prefer not to say" responses. M, mean; SD, standard deviation.

Sleep and mood

For most participants sleep, life satisfaction, life being worthwhile, and mood did not change between the surveys (Table 2). There was a small increase in mean sleep duration (from 6.18 to 6.67 h) (Table 3), and minimum sleep duration (from 3 to 4 h). However, participants were more likely to report poorer sleep duration at S2 than improved sleep duration. The proportion of participants who rated their sleep quality as "fairly" or "very good" increased from 50.0% at S1 to 83.3% at S2, but the number of participants who reported "very bad" sleep also increased from 1 to 2 (Table 4). In contrast, instances of daytime dysfunction, including difficulties staying awake during the day and keeping up enthusiasm to get things done, appeared to increase at S2 (Table 4). Whilst sleep quality and duration improved for a greater number of individuals than it worsened, the 2 daytime dysfunction items worsened for a greater number of individuals than the number for whom it improved (Figure 1).

Mean life satisfaction increased from 7.71 (*SD* = 2.47) to 8.17 at S2 (*SD* = 1.82) but mean life being worthwhile decreased slightly from 8.56 (*SD* = 1.50) to 8.33 (*SD* = 1.94). As seen in Figure 1, more people felt cheerful, happy, full of energy and calm more often, and lonely and guilty less often, at S2. However, more people also felt depressed, sad, that they couldn't get going and anxious more often, and enthusiastic less often. For instance, while 61.1% felt happy at least most of the time at S1, this increased to 88.9% at S2. A greater number of respondents felt anxious "some of the time" at S2, and a smaller number felt anxious "none or almost none of the time" (Table 5).

Competition-related emotions

Competition-related emotions stayed largely the same among the 11 athletes competing in the Warrior Games (Table 6). A greater number of respondents improved than worsened for 6 of the 12 items: "Feel confident," "Looking forward to competing," "Concerned may not do as well as could," "Concerned about performing poorly," "Concerned others will be disappointed," "Concerned I won't be able to concentrate" (Figure 1). However, a greater number of respondents felt more nervous and tense, and less excited at S2 than the number that reported improvements on these items.

TABLE 4 Self-reported sleep quality and daytime dysfunction in Survey 1 and Survey 2.

		Survey 1	Survey 2
Variable	Response options	*n* (%)	*n* (%)
Sleep quality	Very good	–	2 (11.1)
	Fairly good	9 (50.0)	13 (72.2)
	Fairly bad	7 (38.9)	1 (5.6)
	Very bad	1 (5.9)	2 (11.1)
Staying awake	Not during the past month	6 (33.3)	5 (27.8)
	Less than once or twice	4 (22.2)	6 (33.3)
	Once or twice a week	5 (27.8)	7 (38.9)
	3 or more times a week	–	–
	Prefer not to say	3 (16.7)	–
Enthusiasm	No problem at all	7 (38.9)	7 (38.9)
	Only a very slight problem	7 (38.9)	6 (33.3)
	Somewhat of a problem	2 (11.1)	5 (27.8)
	A very big problem	1 (5.6)	–
	Prefer not to say	1 (5.6)	–

n = frequency of respondents who gave this answer, %, proportion of respondents who gave this answer based on full sample. Missing responses are not shown. Percentages may not add up to 100% due to rounding, missing responses, and "Prefer not to say" responses.

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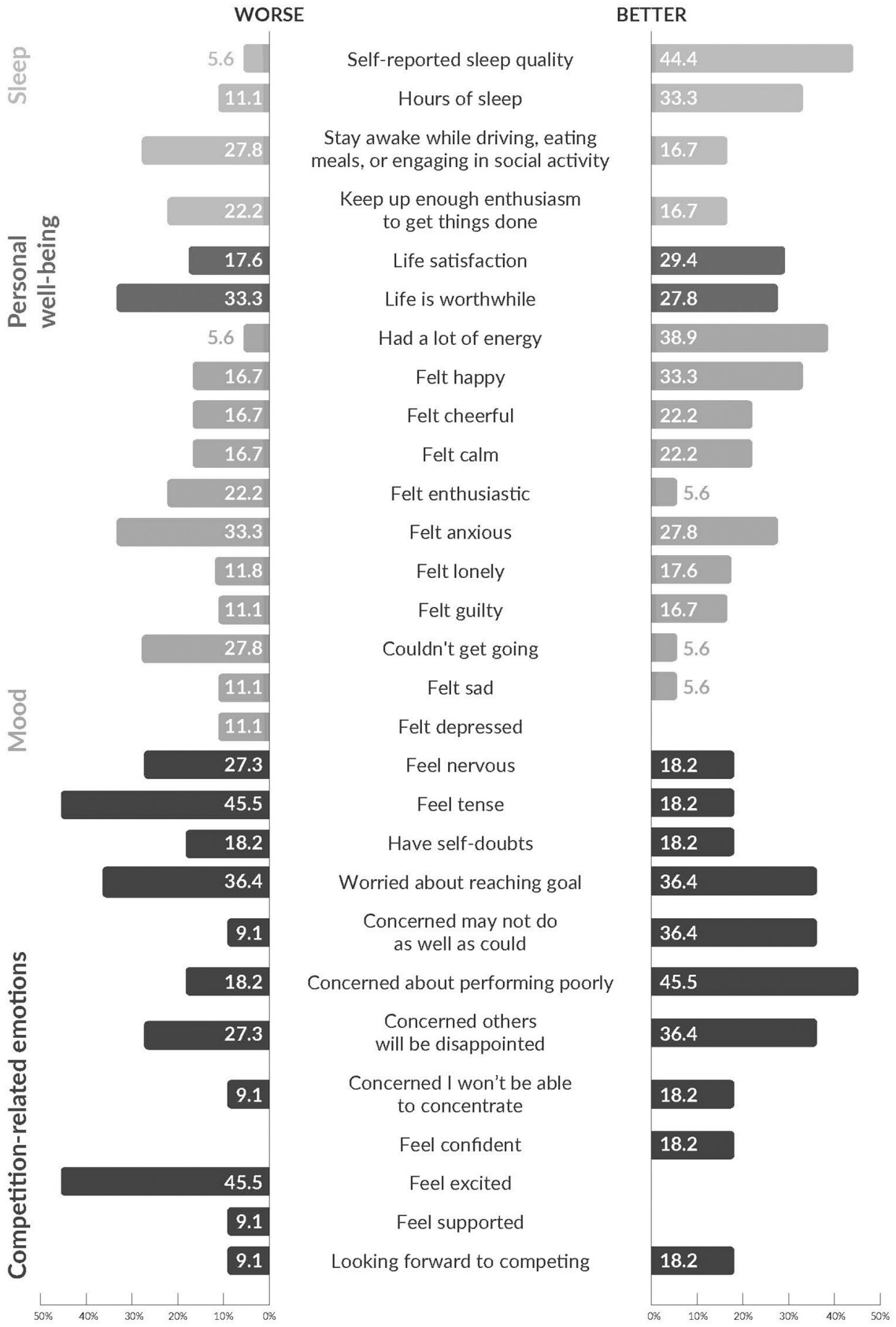

FIGURE 1
Categorical change in mood, sleep, and competition-related emotions.

Motivational factors

A majority considered the opportunity to raise awareness of the current situation in their country (n = 13), to represent their country (n = 11), and spend time with other veterans with disabilities (n = 8) to be "extremely important" motivational factors (Table 7). In contrast, the opportunity to demonstrate their abilities to others and make friends and family proud appeared less important, with 3 participants (16.7%), respectively, rating these items as "not at all important."

Perceived sources of support

Support from family (M = 5.35, SD = 1.54), sports coaches and trainers (M = 5.25, SD = 1.24), and friends (M = 4.88, SD = 1.54) were considered most important during preparations for the Games (Table 3). Family elicited the greatest number of "completely important" responses (n = 14, 77.8%). Religion or spirituality (M = 3.63, SD = 2.22), and the sports psychologist (M = 3.67, SD = 2.09), were considered least important as sources of support, although the same number of respondents (n = 5, 27.8%) considered religion and spirituality to be "not at all important" as "completely important."

Discussion

Sleep quality and duration were maintained at S2 for the majority of the sample (Table 2). However, mean sleep duration at both timepoints was lower than the current recommendations of 7–9 h for adults (National Center for Chronic Disease Prevention [CPD], 2017). Literature documents the negative impact of active military duty on sleep and circadian patterns (Shattuck et al., 2018), and of sports training camps on both sleep efficiency and sleep duration (Pitchford et al., 2017; Thornton et al., 2017). One study found that, whilst time in bed increased during a training camp for Australian football players, hours of actual sleep did not (Pitchford et al., 2017). It is possible that respondents' prior participation in active combat and a full week of training had already restricted sleep duration by the time of S1. It should also be noted that several respondents were living with disability; over a third reported a disability that affected mobility, and just under a third reported a VI. Disability in general, and VI specifically (Peltzer and Phaswana-Mafuya, 2017), have often been associated

TABLE 5 Mood in Survey 1 and Survey 2.

		(Almost) all of the time	Most of the time	Some of the time	(Almost) none of the time
		n (%)	*n* (%)	*n* (%)	*n* (%)
Felt cheerful	S1	7 (38.9)	9 (50.0)	2 (11.1)	–
	S2	9 (50.0)	6 (33.3)	3 (16.7)	–
Felt depressed	S1	–	–	4 (22.2)	14 (77.8)
	S2	–	–	6 (33.3)	11 (61.1)
Felt happy	S1	4 (22.2)	7 (38.9)	6 (33.3)	1 (5.6)
	S2	2 (11.1)	14 (77.8)	1 (5.6)	1 (5.6)
Felt lonely	S1	–	1 (5.6)	6 (33.3)	11 (61.1)
	S2	–	1 (5.6)	5 (27.8)	11 (61.1)
Felt sad	S1	–	–	11 (61.1)	7 (38.9)
	S2	–	–	11 (61.1)	6 (33.3)
Could not get going	S1	–	–	4 (22.2)	13 (72.2)
	S2	–	–	8 (44.4)	10 (55.6)
Felt you had a lot of energy	S1	2 (11.1)	11 (61.1)	5 (27.8)	–
	S2	5 (27.8)	11 (61.1)	1 (5.6)	–
Felt anxious	S1	1 (5.6)	1 (5.6)	6 (33.3)	10 (55.6)
	S2	–	1 (5.6)	9 (50)	7 (38.9)
Felt calm and peaceful	S1	5 (27.8)	10 (55.6)	3 (16.7)	–
	S2	5 (27.8)	10 (55.6)	2 (11.1)	–
Felt enthusiastic about what I was doing	S1	7 (38.9)	11 (61.1)	–	–
	S2	6 (33.3)	10 (55.6)	2 (11.1)	–
Felt guilty	S1	1 (5.6)	1 (5.6)	2 (11.1)	14 (77.8)
	S2	–	–	5 (27.8)	12 (66.7)

S1, Survey 1; S2, Survey 2; *n*, frequency of respondents who gave this answer; %, proportion of respondents who gave this answer; M, mean; SD, standard deviation.

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TABLE 6 Competition-related emotions in Survey 1 and Survey 2 in the 11 athletes competing in the Warrior games.

		Not at all	Somewhat	Moderately so	Very much so
		n (%)	*n* (%)	*n* (%)	*n* (%)
Feel nervous	S1[1]	4 (36.4)	3 (27.3)	4 (36.4)	–
	S2[1]	4 (36.4)	3 (27.3)	4 (36.4)	–
Have self-doubts	S1[1]	6 (54.5)	4 (36.4)	1 (9.1)	–
	S2[1]	7 (63.3)	3 (27.3)	–	1 (9.1)
Feel confident	S1[1]	1 (9.1)	1 (9.1)	5 (45.5)	4 (36.4)
	S2[1]	1 (9.1)	1 (9.1)	3 (27.3)	6 (54.5)
Feel tense	S1[1]	5 (45.5)	3 (27.3)	2 (18.2)	–
	S2[1]	2 (18.2)	5 (45.5)	3 (27.3)	–
Concerned I may not do as well in competition as I could	S1[1]	2 (18.2)	4 (36.4)	2 (18.2)	2 (18.2)
	S2[1]	4 (36.4)	3 (27.3)	2 (18.2)	1 (9.1)
Concerned about performing poorly	S1[1]	3 (27.3)	4 (36.4)	3 (27.3)	–
	S2[1]	6 (54.5)	2 (18.2)	1 (9.1)	1 (9.1)
Feel excited	S1[1]	2 (18.2)	2 (18.2)	5 (45.5)	2 (18.2)
	S2[1]	2 (18.2)	7 (63.6)	1 (9.1)	1 (9.1)
Worried about reaching my goal	S1[1]	–	4 (36.4)	4 (36.4)	3 (27.3)
	S2[1]	2 (18.2)	2 (18.2)	3 (27.3)	4 (36.4)
Concerned others will be disappointed in my performance	S1[1]	5 (45.5)	5 (45.5)	1 (9.1)	–
	S2[1]	8 (72.7)	1 (9.1)	1 (9.1)	1 (9.1)
Looking forward to competing	S1[1]	1 (9.1)	2 (18.2)	1 (9.1)	6 (54.5)
	S2[1]	1 (9.1)	1 (9.1)	4 (36.4)	5 (45.5)
Concerned I won't be able to concentrate	S1[1]	5 (45.5)	3 (27.3)	2 (18.2)	–
	S2[1]	7 (63.6)	2 (18.2)	1 (9.1)	1 (9.1)
Feel supported	S1[1]	–	–	2 (18.2)	8 (72.7)
	S2[1]	–	1 (9.1)	1 (9.1)	9 (81.8)

S1, Survey 1; S2, Survey 2; *n*, frequency of respondents who gave this answer; %, proportion of respondents who gave this answer; M, mean; SD, standard deviation.
[1]Responses are shown for athletes only ($n = 11$).

with poorer sleep, including too much or too little sleep and lower subjective sleep quality. This may be of particular significance for the current sample, for whom exposure to a high intensity training programme and different time zones for both training and the upcoming event may have increased the importance of optimal recovery and their overall sleep requirement (Esteves et al., 2019). Indeed, whilst sleep duration did not decrease between the two surveys, some indicated poorer daytime functioning at S2. Whilst physical activity is generally found to enhance sleep (Driver and Taylor, 2000), increased levels of physical activity without a simultaneous increase in sleep duration may have meant that for some, their sleep requirements were not met during this time. The potential negative physical and psychological outcomes of poor sleep have been evidenced elsewhere in athletes, including altered perceptions of exertion (Fullagar et al., 2015), negative impacts on mood and sporting performance (Fullagar et al., 2015), and increased injury risk due to greater daytime dysfunction (Mah et al., 2018).

As with sleep, well-being and mood remained largely the same across the two surveys. There is evidence that personnel involved in military combat often experience guilt, associated with enjoying one's life whilst comrades might not be so fortunate (Castro et al., 2015). It is easy to envision how such feelings might be fostered within the environment of a UK-based training camp when one's unit remained engaged in active combat. However, most participants did not feel guilty, or only some of the time at both timepoints. A full and demanding training programme, and participants' view of the Games as a means of assisting with Ukraine's war efforts, may have mediated feelings of guilt. In contrast, there was an increase in the number of participants who felt anxious at least "some of the time," and a decrease in those who felt anxious "none or almost none of the time." It is perhaps surprising that anxiety did not decrease. Research has evidenced the deteriorations in psycho-emotional status associated with the onset of the ongoing conflict in Ukraine (Kurapov et al., 2022), and the link between combat duties and increased anxiety

TABLE 7 Motivation for participating in the Warrior games (Survey 1 only).

	Extremely important	Quite important	Not very important	Not important at all
	n (%)	*n* (%)	*n* (%)	*n* (%)
Raise awareness of current situation in my country	13 (72.2)	5 (27.8)	–	–
Represent my country	11 (61.1)	5 (27.8)	–	–
Spend time with other veterans with disabilities	8 (44.4)	5 (27.8)	2 (11.1)	2 (11.1)
Be challenged	7 (38.9)	8 (44.4)	1 (5.6)	1 (5.6)
Work toward a goal	7 (38.9)	9 (50.0)	–	1 (5.6)
Make my friends and family proud	5 (27.8)	5 (27.8)	3 (16.7)	3 (16.7)
Make my country proud	4 (22.2)	8 (44.4)	2 (11.1)	1 (5.6)
Improve my physical health	4 (22.2)	13 (72.2)	1 (5.6)	1 (5.6)
Improve my sporting abilities	4 (22.2)	12 (66.7)	2 (11.1)	–
Experience something outside usual routine	4 (22.2)	6 (33.3)	8 (44.4)	–
Demonstrate my abilities to others	3 (16.7)	6 (16.7)	5 (27.8)	3 (16.7)
Travel	3 (16.7)	8 (44.4)	7 (38.9)	–
Take my mind off things	3 (16.7)	7 (38.9)	6 (33.3)	2 (11.1)
Take part in competitive sport	2 (11.1)	4 (22.2)	8 (44.4)	1 (5.6)

n, frequency of respondents who gave this answer; %, proportion of respondents who gave this answer; M, mean; SD, standard deviation.

in military personnel (Pietrzak et al., 2012). Whilst the training camp offered time away from the conflict and any military duties, sports camps are associated with high levels of both physical and mental fatigue (Buchheit et al., 2013). By S2, respondents had spent several weeks away from home, family and comrades. The negative impacts of itinerant work and separation from support networks has been documented in both military and sporting literature (Wiens and Boss, 2006; Dehghansai et al., 2021). It is possible that competition-related emotions may have also influenced anxiety. The majority of respondents indicated that they felt more tense by S2, levels of excitement did not improve for any respondents, and nervousness increased for a greater number than it improved. These emotions may have been heightened due to the immanency of the Games at S2. Whilst participation in veteran sporting activities has been associated with psychological benefits (Laferrier et al., 2017; Walter et al., 2021), such events have also been found to increase stress and negative emotions such as anger, and to decrease positive emotions such as excitement (Roberts et al., 2019). It is notable that more respondents improved on performance-related items (e.g., concerns about doing well and disappointing others). This suggests that, whilst feelings of nervousness and tension were present, overall, the team felt prepared for the Games. Feeling nervous is common in athletes prior to competitions and may, in fact, be useful if managed effectively, offering individuals increased perceptions of control and a focus for positive mental imagery (Wadey and Hanton, 2008).

Despite the physical separation, family was considered the most important source of support during respondents' preparations. Yet, the expectations of family members in relation to competition outcomes were of little importance. This reflects existing evidence of the grounding role played by family and significant others during periods of training and competition (Kristiansen and Roberts, 2010; Özdemir, 2019) providing a source of love and support that is not contingent on success or performance (Hellstedt, 2005).

Respondents acknowledged the importance of several factors in their decision to participate in the Games, many of which reflected those identified in existing research on veteran sporting events: to improve health and well-being, achieve a goal, and to reconnect with military life (Sporner et al., 2009; Roberts et al., 2021). The opportunity to spend time with other veterans with disability was considered an extremely important factor in several participants' decisions to attend the Games, further evidencing the value of being able to bond with individuals with similar experiences for attendees at veteran sporting events (Sporner et al., 2009; Roberts et al., 2021). Team Ukraine's participation in the Warrior Games comes at a unique time in their history, and results suggest that respondents also sought the opportunity to represent their country and raise awareness of the ongoing conflict on an international stage. This highlights the continued role of sporting events, and sports more generally, as socio-political platforms of protest and demonstration (Kaufman and Wolff, 2010).

Limitations and future research

This paper offers insight into the experiences of a small but unique cohort of Warrior Games attendees. This means that findings may not be generalisable to a broader veteran sample, and the small sample size meant that comparative analysis was not possible. However, it does provide novel insight into the experiences associated with sports participation during times of conflict for veterans and military personnel, and the unique role it might fulfil during this time. Given the importance of participating as a means of raising awareness and representing one's country

in the current study, consideration of the perceptions of other competing teams would be useful in establishing if, and how, Team Ukraine achieved these goals through their participation. Such research would contribute not only to a better understanding of the impact of veterans' sports participation on the individual, but also the wider political implications of national representation at such events. Exploration of other nations' experiences of preparing for veteran sporting events may also be valuable in identifying cultural differences in motivational factors, training approach, attitudes, and impacts of participation.

Results indicated increased daytime dysfunction and changes to some aspects of mood and competition-related emotions. However, data pertaining to the period prior to respondents' arrival in the UK, or during the Games, was not available, and the time between surveys was small. Furthermore, it was not possible to deliver S1 immediately on participants' arrival in the UK, due to the context of their arrival and the prioritisation of the mental and physical well-being of participants and the start of their training schedule. The current project needed to be designed and delivered within a small timeframe to ensure access to this unique sample population, with continued uncertainty regarding if, and when, team Ukraine would arrive in the UK. Whilst future research which seeks to gather data on health and well-being prior to training camps and beyond participation in sporting events would be beneficial, the realities of doing so with the current sample, many of whom were engaged in active armed conflict prior to the training camp and would return to these duties following the Games, meant that this was not possible in the current study. Future research which considers sleep, and other health and well-being markers, during disabled veterans' participation in sports and exercise activities, training camps, and competitions, could be used to inform the development of effective schedules of training and rest, ensuring enjoyment, positive health and well-being outcomes, and optimum recovery and performance.

Conclusion

This study offers insight into the health and well-being of the Ukrainian 2022 Warrior Games team during a UK-based training camp. Results showed that sleep, mood, and competition-related emotions remained largely similar over the course of the camp, although, sleep duration was low at both time points and daytime dysfunction increased, along with feelings of nervousness and tension. This was despite participants indicating that overall, they felt prepared for the Games. Despite the physical separation from loved ones, family was considered an important source of support during the training camp. Respondents perceived the Games as a platform on which to raise awareness of the ongoing war. This demonstrates the role played by sporting events in addressing not only personal goals, but also a shared political agenda. Future research should seek to establish the incidence of, and mechanisms underlying, positive and negative psychological experiences and associated changes in markers of health and well-being prior to, during, and following participation in veteran sporting events. This would help to inform the design of training and support programmes for veteran-athletes, with implications for other amateur and disabled athlete groups.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CC and RG conceptualised the study. CC, RG, and NH contributed to study design, methodology, reviewed, and edited the manuscript. CC and NH designed the survey, collected and analysed data, and managed the project. CC wrote the first draft of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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"The show must go on": How Paralympic athletes safeguarded their mental well-being and motivation to train for the postponed Tokyo 2020 games

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Introduction: After the decision to postpone the Tokyo 2020 Games due to the COVID-19 pandemic, athletes had to adjust to a novel situation with feelings of uncertainty and insecurity. Grounded in Self-Determination Theory, this study was the first to examine whether different motivational profiles among Paralympic athletes can be identified, and to link these profiles with the athletes' emotional, cognitive, and performance-related outcomes in times of a pandemic.

Methods: Five months before the start of the Paralympic Games, the participants (N=32; mean age=33.2±6.8years) completed an online questionnaire measuring their demographics, basic psychological needs, perceived stress, depressive symptoms, general well-being, and motivational self-regulation strategies. Two months after the Games, they completed a second online questionnaire measuring their actual and perceived performance at the past Games.

Results: Through K-means cluster analysis, three distinct clusters were identified based on the athletes' dominant type of motivation, these are, dominantly amotivated (n=11), autonomously motivated (n=12), and controlled motivated (n=9). Comparisons of athletes' emotional, cognitive, and performance-related outcomes depending on their motivational profile revealed that the athletes with a dominantly amotivated profile had the least adaptive outcomes (i.e., low need satisfaction, high need frustration, and more depressive symptoms). Athletes with a dominantly autonomously motivated profile made less use of controlling self-motivating strategies compared to the other two profiles. Moreover, their actual performance at the Paralympic Games was better.

Discussion: Although none of the athletes were at severe risk for depression or showed extremely high levels of stress, these results confirm that improving the quality of athletes' motivation can safeguard their well-being and enhance performance in Paralympic Sports.

KEYWORDS

motivation, COVID-19, basic psychological needs, selfregulation, performance, mental health, self-determination theory, para-sport

Introduction

Across the world, corona measures were taken to contain the spreading of the COVID-19 virus (e.g., lockdown, wearing face masks, keeping social distance, etc.). Most, if not all, aspects

of everyday life have been impacted by these measures, and the protracted nature of the situation has led to feelings of uncertainty and insecurity (Vermote et al., 2022), as well as negative mental health outcomes such as depression, anxiety, and traumatic stress in various cultures and populations (Boden et al., 2021). One of the hard-hit sectors was the sports sector (Asif and Toresdahl, 2022). In particular, athletes who were preparing for the Tokyo 2020 Paralympic Games were dealt a hard blow immediately after the first COVID-19 outbreak, since the decision to postpone the Games to the year 2021 was taken in March 2020 (IOC, 2020). This decision was followed by a year of uncertainty as to whether the Paralympic Games would actually take place because of the unpredictable nature of the pandemic, with its multiple waves. Moreover, the uncertainty remained until the last moment before departure (IPC, 2021), as the increasing number of positive cases in Japan during the precedent Olympic Games caused opposition among the local Japanese population. In this study, we examined whether the Paralympic athletes' general motivation for partaking in their sport determined emotional, cognitive, and performance-related outcomes during the pandemic. More specifically, we considered several indicators of athletes' well-being, their use of motivational self-regulating strategies to cope with the uncertain period leading up to the Paralympic Games, as well as their actual and perceived performance at the Games. The study was conducted among all Belgian Dutch-speaking Paralympians at two time points. The first assessment took place in March 2021, 1 year after the decision to postpone the Paralympic games, at the start of the third Corona wave in Belgium, and 5 months before the scheduled Paralympic Games in 2021. The second assessment was completed in November 2021, 2 months after the Paralympic Games took place.

Emotional, cognitive, and performance-related impact of the COVID-19 pandemic

As suggested by the Self-Determination Theory (SDT) (Deci and Ryan, 2012), people are only able to become self-determined when their three basic psychological needs for autonomy, competence, and relatedness are fulfilled. First, a sense of autonomy occurs when people can make their own decisions, and feel in control of their own lives (Deci and Ryan, 2012). Second, the need for relatedness is fulfilled when people have meaningful social contacts (Patrick et al., 2007). Finally, the need for competence refers to the need of experiencing mastery of a task. In a recent study by Vermote et al. (2022) during the COVID-19 pandemic, it was demonstrated that the satisfaction of these three basic psychological needs related to better well-being, while need frustration predicted deteriorating effects on mental health over time. These and other authors (Šakan et al., 2020; Cantarero et al., 2021) have made a strong case for not seeing the satisfaction of the psychological needs for autonomy, competence, and relatedness as a 'luxury good', but considering the satisfaction of these needs important in times of insecurity, not at least to safeguard well-being. However, the COVID-19 measures caused a significant modification of people's daily routines, thereby depriving or even undermining the three innate and universal psychological needs for autonomy, relatedness, and competence. In times of full or partial lockdown, the need for autonomy was under threat since many restrictions, postponements, or cancelations were made. For instance, closing down sports facilities like swimming pools disrupted athletes' training routines. Even in countries where governments facilitated exceptions for professional athletes to continue their training practice, the international travel restrictions led to the cancelation or postponement of most competitive events. Likewise, athletes' need for relatedness was under threat, as isolation and keeping distance (e.g., from friends, family members, and teammates) were core aspects of the measures imposed to prevent the COVID-19 virus to spread. Finally, especially for Paralympic athletes, the disruption of the preparation for one of the most important competitive events of their career potentially hampered or undermined their competence satisfaction (Puce et al., 2022). Moreover, given the postponement or cancelation of competitions, it was difficult for athletes to judge properly where they stood in terms of adjusting their intermediate goals compared to opponents.

All these stressors related to the COVID-19 pandemic came on top of the usual stressors experienced by Paralympic athletes in preparation for major competitions as previously identified by Jefferies et al. (2012) and Dehghansai et al. (2021), such as worries about their contribution to their team, the adequacy of their training and preparation, how they will manage psychosocial pressures, budgetary constraints, or injury prevention. Therefore, next to the Paralympians' need-based experiences, we also considered their perceived stress and depressive symptoms. These are indicators of mental health which is an important indicator of well-being (Giles et al., 2020). There are reasons to believe that levels of depression and stress were increased among Paralympians during the COVID-19 pandemic, as they were in the global non-athletic (Xiong et al., 2020) and athletic (Di Fronso et al., 2022; Lambert et al., 2022) population. We know from studies on non-athletes with disabilities that the COVID-19 situation has had an even more negative impact on their mental health compared to the global population (Theis et al., 2021). Moreover, a critical scoping review of the literature on the impact of the pandemic on athletes with disabilities by Puce et al. (2022) identified 16 studies, 8 of which examined their mental health and/or well-being. A higher burden in para-athletes compared to athletes without disabilities was demonstrated, with more positive screenings for anxiety, depression, poor sleep quality (Nabhan et al., 2021), and a higher perceived negative impact on their training and performance of loneliness, psychological inflexibility, anxiety (Clemente-Suárez et al., 2020). On the other hand, Italian disabled athletes reported lower distress levels to adverse events compared to athletes without disabilities (Fiorilli et al., 2021) which was explained by the potential buffer effect of having the experience of living with impairment. Therefore, it remains unclear to what extent Paralympic athletes' perceived stress and depressive symptoms were affected by the imposed COVID-19 restrictions.

In addition to possible effects on athletes' well-being, the postponement of the Paralympic Games and the uncertainty about whether the Games would continue next year also implied a cognitive challenge, since it put pressure on athletes' motivation to maintain their strict training schedule (Lambert et al., 2022). Paralympic athletes function at the highest level and therefore follow an extremely strict living and training schedule. Most athletes followed such schedules for at least 4 years to peak both mentally and physically at the Games, often with a rest period scheduled afterward. The postponement of the Paralympic Games meant that they had to maintain this strict schedule for another year, without being 100% sure that the Games would actually take place in 2021. Given this

uncertainty, it was crucial for Paralympians to keep themselves motivated by employing cognitive motivational self-regulatory strategies. Motivational self-regulation involves the use of active coping strategies to modify or maintain one's own motivation in difficult circumstances (Boekaerts, 1996; Engelschalk et al., 2016). These cognitive motivational self-regulating strategies can be more autonomous or more controlled in nature (Morbée et al., 2022). Autonomous self-motivating strategies aim at initiating the activity by arousing interest and reminding oneself of its relevance. Controlling self-motivating strategies, on the other hand, involve athletes' strategies to initiate and persist in an activity by self-controlling their behavior. For instance, by reminding themselves that it is their responsibility to keep up their training schedule, by buttressing the successful completion of their training with feelings of pride and self-aggrandizement, by relying on external factors to get themselves going, or by projecting the controlling voices of others onto themselves. Previous research showed that autonomous self-regulation strategies are associated with less boredom, physical pain, and more life satisfaction, whereas controlled self-regulation strategies are associated with more boredom, physical pain, and reduced task pleasure (Waterschoot et al., 2021; Morbée et al., 2022).

But in the end, what elite-level athletes and their coaches are probably most interested in, is if and to what extent the postponement of the Paralympic Games affected the athletes' performance. An additional year of training can be perceived as positive for the performance of athletes who were not yet at the top of their abilities when the final selection for the Games had to be made, providing them with more opportunities for additional training and growth. For athletes who leaned more toward the end of their careers, or were more vulnerable to injuries, an additional year of training in difficult circumstances might have had a deteriorating effect on their performance, with a lower chance of making the final selection or winning a medal. Previous research on the impact of the pandemic on athletic performance at the Games is scarce. The review by Puce et al. (2022) retrieved only one study that investigated the impact of COVID-19 confinement on performance outcomes in para-athletes (Schipman et al., 2022). Specifically, the authors recorded the results of the 10 best world performers in Olympic and Paralympic events since 2010, and noticed that the performance decrements were dramatical, as previously only observed during the two World Wars. The present study will add to the existing knowledge about the impact of the pandemic on performance, by including measures of actual and perceived performance.

However, although the aforementioned research showed that the pandemic most likely had emotional, cognitive, and even performance-related effects on Paralympic athletes, no study has examined what factors might explain why some athletes were more or less resilient during this uncertain but crucial period leading up to the Paralympic Games. Therefore, in this study, we examined whether Paralympic athletes' motivation for their sport could determine whether they managed to respond more or less resiliently in terms of emotional, cognitive, and performance-related outcomes.

Motivation to sport

According to SDT, one of the most influential contemporary motivational frameworks within sports psychology (Hagger and Chatzisarantis, 2007), both the quantity and quality of Paralympic athletes' motivation play a key role in athletes' emotional, cognitive, and performance-related sports experiences (Ryan and Deci, 2017; Bautista et al., 2019). Regarding the quality, three types of motivation can be distinguished, these are, autonomous motivation, controlled motivation, and amotivation. Autonomous motivation can be considered high-quality motivation because it entails experiencing a sports activity as self-initiated, enjoyable, or congruent with one's interests and values (Vansteenkiste et al., 2010). Controlled motivation, on the other hand, involves the engagement in a sports activity based on external (e.g., reward, punishments) or internal (e.g., feelings of pride or guilt) pressured reasons, and thus represents a form of low-quality motivation (Vansteenkiste et al., 2010). Finally, amotivation reflects a total lack of intentionality. Previous research has convincingly shown that autonomous motivation and amotivation are associated with, respectively, the most and least desirable outcomes, such as athletes' positive and negative affect, depressive feelings, and performance (Assor et al., 2009; Gillet et al., 2009; Haerens et al., 2018) whereas the correlates for controlled motivation fall in-between. However, the vast majority of these studies were carried out among low-competitive level athletes. Although laymen's beliefs suggest that pressure may help professional athletes to push themselves beyond their limits and harden them to develop coping resources, empirical studies within elite athletes revealed that the different types of motivation yielded a similar pattern of correlates among professional athletes. To illustrate, autonomous motivation in elite athletes related to desirable outcomes such as doping avoidance and injury rehabilitation (Chan and Hagger, 2012; Chan et al., 2015), whereas controlled motivation and amotivation related to negative outcomes such as burn-out and symptoms of overtraining (Lonsdale and Hodge, 2011; Chan et al., 2015; Trčková and Burešová, 2019).

Regardless of their performance level, most athletes endorse multiple reasons to engage in sports which then get combined into specific motivational profiles, that is, a configuration of motives that provide greater insight into the overall motivational pattern of an athlete (Vansteenkiste and Mouratidis, 2016). There are only a few SDT-based studies that attempted to identify such motivational profiles in adult athletes (Gillet et al., 2009; Rottensteiner et al., 2015). Typically, four different profiles are distinguished (i.e., with athletes scoring high or low on both good and poor quality of motivation, or high on either and low on the other), each of which is differently associated with a diverse set of outcomes. However, only one of these studies has linked these motivational profiles to COVID-19-related outcomes (Morbée et al., 2022). The results of this study suggested that athletes with a more qualitative motivational profile (i.e., characterized by autonomous motivation to engage in sport) managed to handle the uncertain situation in more resilient ways compared to athletes with a poor qualitative motivational profile (characterized by high levels of controlled motivation and amotivation), or a high/low-quantity (characterized by, respectively, high/low levels of autonomous and controlled motivation). However, this study was conducted exclusively among non-disabled cyclists at all competition levels (from amateur to professional) and included only "soft" outcomes (i.e., basic psychological needs and motivational self-regulation strategies). Whether these findings can be generalized to disabled athletes at the highest international level, and whether motivation also plays a role in "hard" performance outcomes, remains unclear.

Present study

It was the purpose of the present study to investigate emotional (i.e., basic psychological need satisfaction and frustration, stress, depressive symptoms, and general well-being), cognitive (i.e., motivational self-regulation strategies), and performance-related outcomes in relation to elite Paralympic athletes' motivation while preparing for the Paralympic Games in a lockdown period. First, as a rather explorative aim, the scores on the emotional, cognitive, and performance-related outcomes were compared between athletes with various types of impairment (physical, visual, and intellectual impairment), gender (male versus female), type of sport (i.e., individual versus team athletes), and impact of COVID-19 on their training routines (more, less, or equal training volume during the pandemic compared to before). The first main aim was to identify the motivational profiles of Paralympic athletes based on the types of motivation as distinguished within SDT (i.e., autonomous motivation, controlled motivation, and amotivation). The second aim was to verify whether these motivational profiles were associated with several indicators of athletes' well-being, their cognitive motivational self-regulation strategies to cope with the uncertainty that went along with the postponement of the Paralympic Games, as well as with their actual and perceived performance at the Paralympic Games. Based on the findings by Morbée et al. (2022), we expected Paralympic athletes with a profile characterized by high autonomous motivation and low controlled and amotivation to yield the most adaptive pattern of outcomes compared to athletes with a motivation profile dominated by controlled motivation or amotivation.

Method

Participants

The sample included all 32 (24 males and 8 females) Dutch-speaking Belgian athletes on the short-list to represent Team Belgium at the Paralympic Games in Tokyo, which took place in 2021. The age of the athletes ranged from 20 to 45 years ($M = 33.22$; SD = 6.75). The athletes competed in eight Paralympic disciplines, namely cycling (34%), boccia (3%), goalball (19%), athletics (16%), badminton (3%), para-equestrian (9%), wheelchair tennis (3%), and table tennis (13%). The majority of the participants competed in individual sports (81%) compared to 19% in goalball which is a team sport. The majority of athletes had a physical impairment (PI = 60%), followed by visual impairment (VI = 34%), and intellectual impairment (II = 6%). The self-reported impact of the COVID-19 pandemic on their training volume during the pandemic was neutral (i.e., no change in training volume) for 37.5% of the athletes, negative (less training volume) for 50% of the athletes, and positive (more training volume) for 12.5% of the athletes. Recruitment of athletes was facilitated by the disability sports confederation 'Parantee-Psylos' who approved this study and invited their athletes to participate. A summary of the demographic characteristics can be found in Table 1.

TABLE 1 Descriptive information about the participants.

Total (*n*)	32
Male/female ratio (*n*)	24/8
Age (M ± SD)	33.22 ± 6.75
Sport (%)	
Cycling	34
Goalball	19
Athletics	16
Table tennis	13
Para-equestrian	9
Wheelchair tennis	3
Badminton	3
Impairment type (%)	
Physical impairment	60
Visual impairment	34
Intellectual impairment	6
Impact of Covid on training volume (%)	
Neutral (no change)	37.5
Negative (less)	50
Positive (more)	12.5

Procedure

An online survey format using the Qualtrics XM software was used for data collection at two moments in time. The first questionnaire was completed by the athletes in March 2021, 5 months before the start of the Paralympic Games, at the start of the third Corona wave in Flanders, in times of a partial lockdown. The second questionnaire was completed in November 2021, 2 months after the Paralympic Games took place. The first survey took approximately 25 min to complete, and the second survey took a maximum of 10 min. After having given their informed consent by e-mail, participants were given access to the online survey. The pre-games questionnaire consisted of participants' demographic data (age, gender, type of sport, impairment classification, and training situation before and during the pandemic), several indicators of well-being, and their use of motivational self-regulating strategies. This first questionnaire was given to all Dutch-speaking Paralympic athletes on the short-list of Team Belgium and was filled out by 100% of them. The post-games questionnaire assessed the athletes' actual and perceived performance during the Games. From the original sample of 32 athletes, four athletes dropped out for the second questionnaire because of mental health issues ($n = 1$), dissatisfaction with the non-selection for the Games (n = 2), or loss of interest in the study ($n = 1$). A visual representation (i.e., flowchart) of the procedure can be found in Figure 1. Ethical approval for the study was given by the Education-Support Committee (OBC) of KU Leuven.

Materials

Pre-game questionnaire

Motivation

The shortened version of the Behavioral Regulation in Sport Questionnaire BSRQ-revised 2; adapted from Lonsdale et al. (2008), as successfully used in the study by Morbée et al. (2022) assessed the

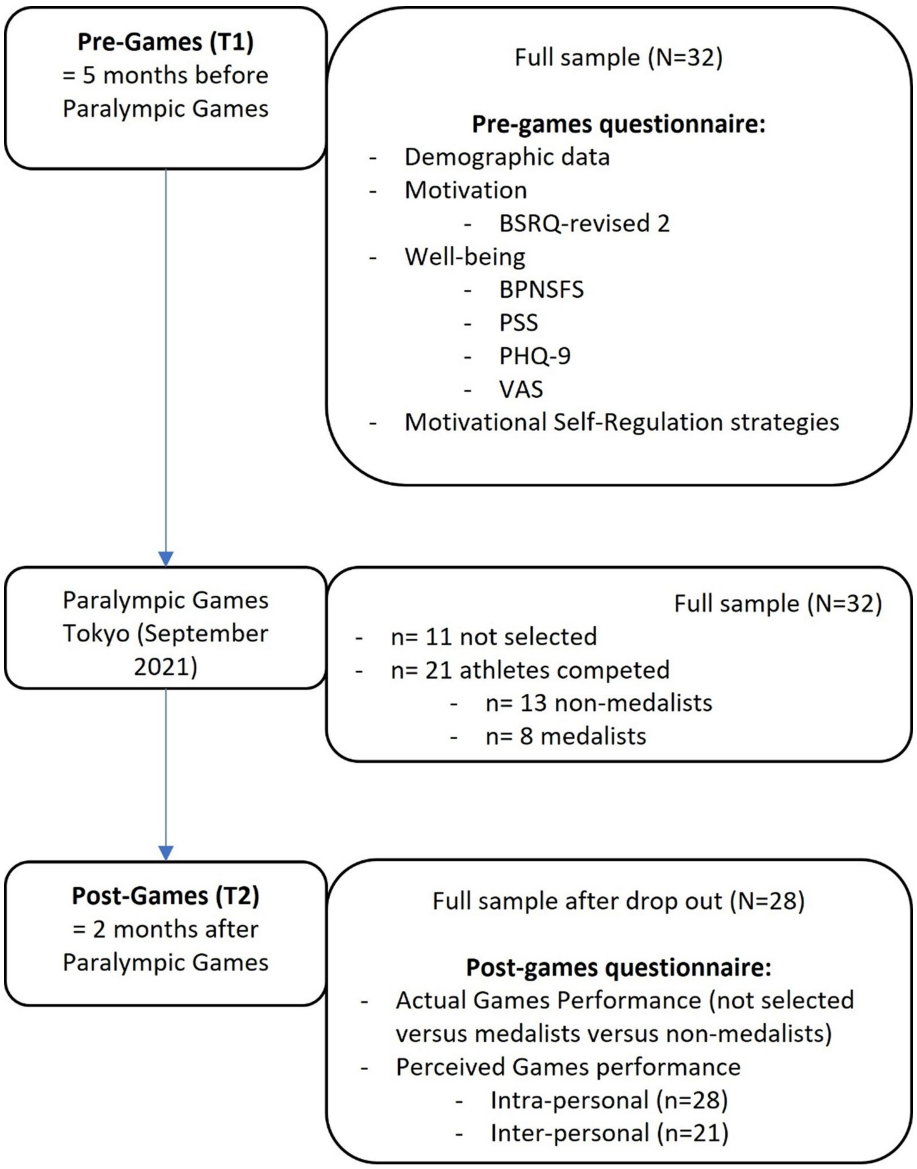

FIGURE 1
Flowchart of the procedure. BSRQ=behavioral regulation in sport questionnaire, BPNSFS=Basic Psychological Need Satisfaction and Frustration Scale, PSS=Perceived Stress Scale, PHQ=Patient Health Questionnaire, VAS=Visual Analog Scale.

participants' general sports motivation based on SDT. After the stem "I put effort in my sports…," a total of 28 items surveyed three categories of autonomous motivation (16 items, e.g., "because I enjoy it"), controlled motivation (8 items, e.g., "because I would feel ashamed if I did not"), and amotivation (4 items, e.g., "but I actually wonder why"). The three scales were scored on a 5-point Likert scale from 1 (Totally not applicable to me) to 5 (Totally applicable to me). The internal consistencies in this study were good to excellent ($\alpha_{autonomous} = 0.84$, $\alpha_{controlled} = 0.81$, $\alpha_{amotivation} = 0.94$).

Well-being

Basic Psychological Needs. A short version of The Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS; adapted for sports from Chen et al. (2015)) was used for this study. The questionnaire has a total of 12 items with two items per need (autonomy frustration/satisfaction, relatedness frustration/satisfaction, and competence frustration/satisfaction), cumulated into the two variables need satisfaction (e.g., "I currently feel a sense of choice and freedom in the things I undertake for my sport") and need frustration (e.g., "I currently feel insecure about my sporting abilities"). All items were scored on a 5-point Likert scale ranging from 1 (Totally not applicable to me) to 5 (Totally applicable to me). The internal consistencies in this study were acceptable ($\alpha_{satisfaction} = 0.69$, $\alpha_{frustration} = 0.62$).

Perceived Stress. The Perceived Stress Scale (PSS) is the most widely used instrument to assess self-perception of stress with established acceptable psychometric properties (Lee, 2012). By means of 10 items (e.g., "In the past month, how often did you feel that difficulties were piling up to the point that you could not overcome them?") on a 5-point Likert scale from 0 (never) to 4 (very often), the

degree to which individuals appraised situations as stressful during the previous month was assessed (Cohen et al., 1983). The cumulated score reflects the perceived stress on a scale from 0 to 40. The internal consistency in this study was good ($\alpha = 0.79$).

Depressive Symptoms. The Patient Health Questionnaire (PHQ-9) is a validated diagnostic screening tool for the presence and severity of depressive symptoms (Gilbody et al., 2007; Nandakumar et al., 2019) during the past two weeks. The scale consists of 9 items (e.g., "little interest or pleasure in doing things?") to be scored on a 4-point Likert scale ranging from 0 (not true at all) to 3 (almost every day). The internal consistency in this study was acceptable ($\alpha = 0.62$).

General Wellbeing. A Visual Analog Scale (VAS) was added as a control tool in this study for the Paralympians to situate themselves on a continuum from 0 to 10 with respect to the general question of how they were feeling.

Motivational self-regulation strategies

The Motivational Self-Regulation Strategies in Sports Questionnaire (Morbée et al., 2022) assessed the Paralympians' strategies to self-regulate their motivation. Based on 27 items, loading on autonomous motivational strategies (12 items; e.g., "finding out how the training can be personally valuable for me"), controlled strategies (12 items; e.g., "reminding myself that sometimes you have to do things in life against your will"), and lack of strategies (3 items; e.g., "I can not think of any ways to motivate myself to train"). Athletes completed this questionnaire on a scale ranging from 1 (Totally not applicable to me) to 5 (Totally applicable to me). The internal consistencies in this study were acceptable to good ($\alpha_{autonomous} = 0.73$, $\alpha_{controlled} = 0.82$, $\alpha_{amotivation} = 0.69$).

Post-game questionnaire

Actual and perceived games performance

As an indicator of actual (i.e., objective) performance, the sample was divided into three subsamples based on whether or not they qualified for the final selection of athletes who effectively participated in the Tokyo Paralympic Games and whether or not they won a medal during the Games. From our sample, 11 athletes did not qualify for the final selection (i.e., non-selected athletes). Of the remaining 21 athletes who actually competed during the Games, 8 athletes brought one or more medals home (i.e., Paralympic medalists brought 10 medals in total) and 13 did not win a medal (i.e., Paralympic non-medalists).

To assess the perceived (i.e., subjective) intra- and interpersonal performance, the validated items from the questionnaire of Haerens et al. (2018) were used. However, the language was simplified to be understandable by Paralympic athletes with intellectual disabilities or brain injuries. The questionnaire consisted of two parts and was filled out by 28 of the athletes (21 athletes who competed during the Games and 7 non-selected athletes). For athletes who gave permission ($n = 26$), the same questionnaire was also filled out by their personal coach. In the first part, the intrapersonal perceived performance was assessed, defined as the extent to which the athletes (or coaches) were satisfied with the progression athletes had made during the preparation for the Games on a physical and technical level (i.e., body components), and on a tactical and mental level (i.e., the mind-components). The second part, measuring the interpersonal perceived performance, was only filled out by the 21 Paralympians (and their coaches) who participated in the Games. It assessed the general satisfaction with the athletes' performance during the Games and how they judged this performance against competitors in the same category.

Data analysis

In a series of preliminary analyzes, descriptive statistics were performed and the data set was checked for outliers. Spearman correlations were used to investigate the association between all study variables.

Before examining our main aims, the distribution across the athletes' motivation scores, and their scores on the emotional, cognitive, and performance-related outcomes (using the non-parametric Kruskal Wallis H test) were compared between athletes with various types of impairment (physical, visual, and intellectual impairment), gender (male versus female), type of sport (i.e., individual versus team athletes), and impact of COVID-19 on their training routines (more, less or equal training volume).

The variables used for the cluster analysis were the standardized scores (z-value) for the participants' general motivation. To detect motivational profiles, we performed a K-means cluster analysis, using the SPSS software (IBM SPSS Statistics 24, SPSS Inc., Chicago, United States) (Aim 1). Once the number of clusters (i.e., motivational profiles) was determined, a multivariate analysis of variance (MANOVA) determined the differences between the clusters in terms of the dependent variables (basic psychological need satisfaction and frustration, perceived stress, depressive symptoms, general wellbeing, motivational self-regulation strategies, and perceived performance). In addition, regarding the perceived performance, it was investigated whether the coach versus athletes judged the athletes' performance differently using Repeated Measures Anova. Finally, a cross-tabulation was performed to analyze the differences between the motivational clusters in terms of actual performance (Aim 2).

Results

Preliminary analyzes

Descriptive statistics for all variables (mean values, SD, minimum, maximum, skewness, and kurtosis) can be found in Table 2. No cases were identified as outliers.

The strength of the relation between all dependent variables based on Spearman rank correlations is shown in Table 3. Autonomous motivation was positively related to autonomous self-regulation strategies. Controlled motivation and amotivation were positively related to need frustration, depressive symptoms, controlled self-regulation strategies, and lack of self-regulation strategies, while being negatively related to need satisfaction. Moreover, controlled motivation was also negatively associated with general well-being, but positively related to autonomous self-regulation strategies.

Differences between groups based on impairment, type of sport, gender, and perceived impact of COVID-19

The athletes with visual impairments scored significantly lower on the use of autonomous self-regulation strategies ($M = 18.09 \pm 3.53$)

TABLE 2 Descriptive statistics for all study variables.

Domain	Variable	*N*	M±SD	Min	Max	Skewness	Kurtosis
Demographics	Age	32	33.22 ± 6.75	20	±45	−0.50	−0.47
General motivation	Autonomous type	32	18.19 ± 4.38	11	27	0.02	−0.97
	Controlled type	32	66.19 ± 10.26	47	94	0.40	0.37
	Amotivation	32	5.63 ± 3.16	0	12	0.02	−0.96
Well-being	Need satisfaction	32	17.47 ± 2.98	9	24	−0.85	1.66
	Need frustration	32	5.63 ± 3.16	0	12	0.02	−0.96
	Depressive symptoms	32	2.16 ± 2.63	0	9	1.20	0.34
	Perceived stress	32	11.28 ± 5.31	3	21	0.14	−1.06
	General well-being	32	7.87 ± 1.41	5	10	−1.14	−0.96
Motivational self-regulation strategies	Autonomous strategy	32	20.84 ± 4.65	11	30	0.19	−0.21
	Controlled strategy	32	26.13 ± 8.66	8	43	0.07	−0.68
	Lack of strategies	32	1.75 ± 2.03	0	8	1.52	2.55
Perceived Performance (athlete-report)	Intrapersonal-body	27	10.48 ± 2.61	2	13	−2.23	5.55
	Intrapersonal-mind	28	10.43 ± 1.95	5	13	−0.98	0.67
	Interpersonal	18	8.67 ± 3.36	2	13	−0.40	−0.59
Perceived Performance (coach-report)	Intrapersonal-body	25	10.36 ± 2.18	5	14	−0.53	0.24
	Intrapersonal-mind	25	9.76 ± 1.71	5	14	−0.35	2.30
	Intrapersonal	18	10.33 ± 3.09	3	14	−1.03	0.66

compared to athletes with physical impairments ($M = 18.09 \pm 3.53$; $p = 0.022$), but did not significantly differ from the athletes with intellectual impairment ($M = 19.00 \pm 4.24$).

Gender differences were found for some indicators of perceived performance with male athletes scoring higher compared to female athletes. These gender differences were found for both athlete- (Mmale $= 9.85 \pm 2.73$ versus Mfemale $= 5.60 \pm 3.05$; $p = 0.03$) and coach-rated interpersonal performance (Mmale $= 11.42 \pm 2.39$ versus Mfemale $= 8.17 \pm 3.37$; $p = 0.04$), as well as for the mind aspect of intra-personal performance rated by the coach (Mmale $= 10.22 \pm 1.48$ versus Mfemale $= 8.57 \pm 1.81$; $p = 0.03$).

The athletes who engaged in an individual sport had significantly higher scores for autonomous motivation (M = 21.12 ± 4.71), compared to team athletes (M = 16.67 ± 3.27; $p = 0.035$).

The subsample of athletes who were positively affected by the COVID-19 pandemic in terms of training volume had a significantly higher score ($M = 9.50 \pm 0.58$) on general well-being compared to the non-affected group ($M = 7.92 \pm 1.31$; $p = 0.04$) and the negatively affected subsample ($M = 7.40 \pm 1.41$; $p = 0.007$).

Motivational profile (first Aim)

Through K-means cluster analysis, three distinct clusters were identified based on the type of motivation of the athletes. Each cluster contains athletes with another dominant type of motivation. Figure 2 depicts the three clusters, labeled as dominantly amotivated ($n = 11$), dominantly autonomously motivated ($n = 12$), and dominantly controlled motivated ($n = 9$).

Differences in emotional, cognitive, and performance-related outcomes depending on motivational profile (second aim)

The differences in athletes' emotional, cognitive, and performance-related outcomes depending on their motivational profile are presented in Table 4. With respect to the basic psychological needs, athletes with a dominantly amotivated profile scored lower on need satisfaction compared to athletes with a dominantly controlled motivated profile and higher on need frustration compared to the other two profiles. They also reported more depressive symptoms and less general well-being compared to the dominantly autonomously motivated profile. Athletes with a dominantly autonomously motivated profile made less use of controlling strategies compared to the other two profiles. No other significant differences were found between the groups.

In addition, regarding the perceived performance, we investigated whether the coach versus athletes judged the athletes' performance differently. The results of perceived intra- and interpersonal performance by athletes and their coaches are shown in Figure 3. Intra-personal performance was not judged significantly different by athletes versus their coaches, apart from the mental aspect which was judged higher by athletes compared to the coach ($F = 4.65$, $p < 0.05$). The interpersonal performance was perceived as significantly higher by the coaches versus the athletes ($F = 17.18$, $p < 0.001$).

Finally, athletes' actual performance depended upon their motivational profile ($\chi^2 = 10.40$, $p = 0.03$). None of the medal winners was predominantly amotivated, whereas 75% of them was predominantly autonomously motivated. Of the athletes that did not

TABLE 3 Spearman rank correlations between all study variables.

	Age	AM	CM	A	NS	NF	DS	PS	GWB	AS	CS	LS	PPARB	PPARM	PPARI	PPCRB	PPCRM	PPCRI
Age	1																	
Autonomous motivation (AM)	−0.01	1																
Controlled motivation (CM)	−0.08	0.08	1															
Amotivation (A)	−0.17	−0.54**	0.46**	1														
Need Satisfaction (NS)	0.25	0.13	.-0.45**	−0.46**	1													
Need Frustration (NF)	−0.27	−0.27	0.45**	0.51**	−0.41*	1												
Depressive symptoms (DS)	−0.27	−0.20	0.60*	0.43*	−0.25	0.42*	1											
Perceived stress (PS)	−0.24	−0.15	0.22	0.10	−0.03	0.28	0.35	1										
General well-being (GWB)	0.07	0.18	−0.49**	−0.33	−0.22	−0.20	−0.70**	−0.39*	1									
Autonomous strategy (AS)	−0.20	0.52**	0.38*	0.04	−0.07	0.12	0.17	0.16	−0.22	1								
Controlled strategy (CS)	−0.12	−0.15	0.37*	0.42*	−0.22	0.27	0.39*	0.05	0.01	0.13	1							
Lack of strategy (LS)	−0.11	−0.32	0.50**	0.40*	−0.11	0.30	0.58**	0.10	−0.28	−0.20	0.48**	1						
Intra body athlete (PPARB)	−0.22	0.25	−0.31	−0.12	−0.12	−0.11	−0.09	0.18	0.10	−0.10	−0.22	−0.10	1					
Intra mind athlete (PPARM)	−0.14	0.20	−0.17	0.24	−0.11	0.24	−0.07	0.13	0.22	−0.05	−0.10	−0.11	0.28	1				
Inter athlete (PPARI)	0.03	−0.07	−0.23	−0.14	0.18	−0.14	−0.39	−0.26	0.51*	−0.13	−0.18	−0.18	0.11	0.10	1			
Intra body coach (PPCRB)	−0.13	−0.14	−0.01	−0.14	0.21	−0.14	−0.32	−0.22	0.17	0.09	−0.18	−0.12	0.44*	−0.29	0.60*	1		
Intra mind coach (PPCRM)	−0.25	−0.08	0.07	0.22	−0.28	0.22	−0.05	−0.16	0.04	0.01	0.11	0.13	−0.08	−0.17	0.73**	0.40*	1	
Inter coach (PPCRI)	0.10	−0.32	−0.15	−0.35	0.26	−0.35	−0.41	−0.49*	0.45	−0.13	−0.06	−0.39	0.04	−0.18	0.87**	0.68**	0.67**	1

*$p \leq 0.05$ (two-tailed); **$p \leq 0.01$ (two-tailed). PP = Perceived Performance, CR = coach report, AR = athlete report.

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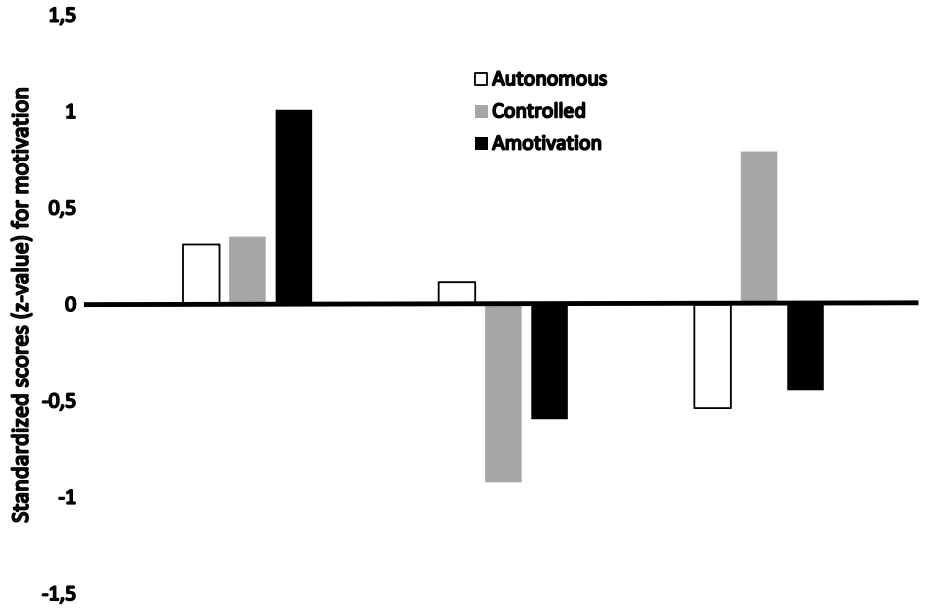

FIGURE 2
Visual representation of the three clusters of Paralympic athletes based on motivational profile.

TABLE 4 Differences in well-being, motivational self-regulation strategies, and perceived performance between groups of athletes with distinct motivational profiles.

		Motivational profile (Mean±SD)				
Domain	Variables	Dominantly amotivation	Dominantly autonomous	Dominantly controlled	*P*	post-hoc
Basic psychological needs	Need satisfaction	15.91 ± 3.21	17.33 ± 2.64	19.56 ± 1.94	0.019*	a < c
	Need frustration	8.82 ± 1.66	3.75 ± 2.98	4.22 ± 2.54	<001*	a > b = c
Well-being	Depressive symptoms	4.09 ± 2.70	0.75 ± 1.06	1.67 ± 2.63	0.004*	a > b
	Perceived stress	13.91 ± 5.63	11.00 ± 4.51	8.44 ± 4.77	0.066	
	General wellbeing	7.00 ± 1.16	8.42 ± 1.24	8.11 ± 1.54	0.047*	a < b
Motivational self-regulation strategies	Autonomous strategy	21.64 ± 4.13	18.42 ± 3.78	23.11 ± 5.23	0.052	
	Controlled strategy	29.55 ± 7.58	19.83 ± 7.06	30.33 ± 7.41	0.003*	a = c > b
	Lack of strategies	2.73 ± 2.69	1.17 ± 1.12	1.33 ± 1.80	0.141	
Perceived Perfomance (athlete-report)	Intrapersonal-body	10.10 ± 3.00	11.50 ± 1.43	9.5 ± 3.15	0.283	
	Intrapersonal-mind	10.5 ± 1.90	10.81 ± 1.25	9.7 ± 2.87	0.517	
	Interpersonal	7.33 ± 3.44	9.22 ± 3.19	9.67 ± ±4.16	0.511	
Perceived Perfomance (coach-report)	Intrapersonal-body	10.00 ± 1.33	10.40 ± 2.72	11.00 ± 2.65	0.719	
	Intrapersonal-mind	9.90 ± 1.29	9.50 ± 2.32	10.00 ± 1.22	0.833	
	Intrapersonal	9.00 ± 3.03	10.5 ± 3.06	13.50 ± 0.71	0.203	

*$p < 0.05$, SD = standard deviation.

make the final selection, 45% was predominantly controlled motivated, 36% predominantly amotivated, and only 18% predominantly autonomously motivated.

Discussion

One of the hard-hit sectors of the COVID-19 pandemic was the sports sector. Both recreational and elite athletes had to cope with uncertainty, regularly changing measures that impacted their training routines, and the cancelation of competitive events. Several studies indicated that the COVID-19 pandemic impacted athletes' well-being and performance (e.g., Puce et al., 2022), but why some athletes suffered more than others remained unknown. Only one previous study looked at whether athletes' ability to cope with the pandemic depended on their motivation (Morbée et al., 2022). The purpose of the current study was to shed new light on this topic by focussing on elite athletes with disabilities, thereby considering "hard"

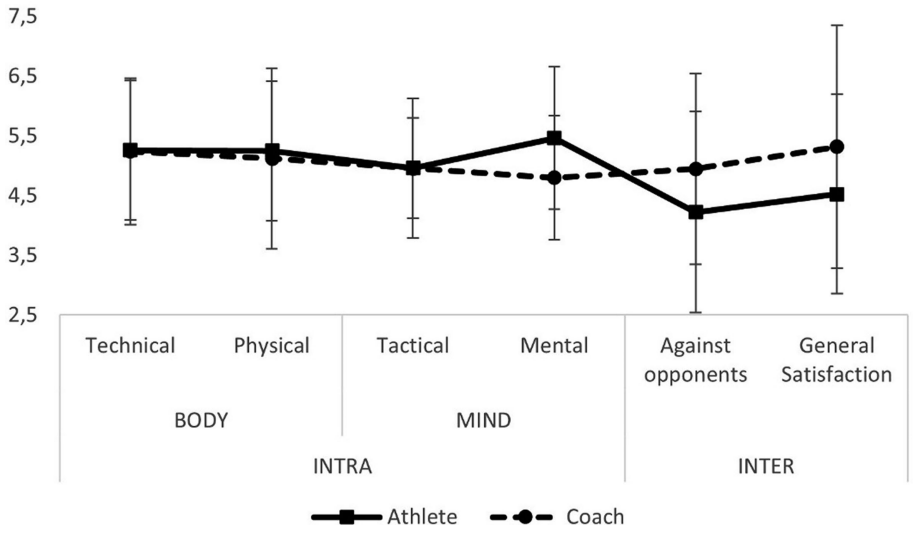

FIGURE 3
Comparison of perceived intra- and interpersonal performance between Paralympic athletes and their personal coaches.

performance-related measures in addition to "soft" outcomes such as well-being and motivational self-regulating strategies.

Wellbeing and athletic identity

An encouraging finding of our study was that Paralympians perceived their overall well-being positively during their preparation for the Tokyo Games, as indicated by two observations. First, 5 months before the Games, none of the athletes were at high risk for depression. The Patient Health Questionnaire is often used as a screening tool for diagnosing depression with a cut-off score of 10 (Manea et al., 2012) and none of the athletes in our sample obtained scores higher than nine. Our finding is in contrast with the study by Busch et al. (2022) who reported significantly lower scores on a short form of the PHS in German Paralympic athletes compared to a matched control group in the general population during eight measurement time points in the first year of the pandemic (March 2020 to April 2021). Second, a similar observation could be made regarding the perceived stress scale. None of the athletes in our sample showed alarmingly increased levels of stress, 12 of the athletes showed moderate stress levels (14–26 points), and the majority of athletes ($n = 20$) was situated in the low-stress category (0–13 points) (Lee, 2012). A similar finding was seen in the study by Fiorilli et al. (2021) who reported that only 8.22% of Italian athletes with disabilities compared to 30.14% of athletes without disabilities were affected by subjective distress during the pandemic. Although there is not a huge body of literature available about how the pandemic affects the perceived stress of athletes with disabilities (Puce et al., 2022, 2023) the opposite might have been expected because emerging research indicates that the COVID-19 pandemic increased psychological distress in the general population and even more among high-risk groups (Lorant et al., 2021). People with disabilities are seen as a high-risk group because they have less access to socioeconomic resources and supportive social networks (Goldmann and Galea, 2014). These and other unique stressors and challenges could worsen mental health for people with disabilities during the COVID-19 crisis. On the contrary, Paralympic athletes are a specific subgroup of people with disabilities, whose self-concepts are known to be tied to their athlete roles (Guerrero and Martin, 2018). Previous studies revealed that athletes with disabilities have equally strong athletic identities compared to athletes without disabilities (Groff and Zabriskie, 2006). A study that was performed on US Paralympians during the COVID-19 pandemic by Hu et al. (2021) looked at how athletic identity was affected by sport disruption. Most of the Paralympians in that qualitative study described their athletic identity as being challenged and negatively impacted. They experienced psychological struggles, mostly because of facility closures and cancelations of competitions. It was difficult for them to identify as athletes without the continuous training and high-level competition they practiced prior to the pandemic. The situation in Belgium might have been perceived more positively by the athletes in our sample, as the government facilitated exceptions for elite levels athletes (Olympians and Paralympians) to keep up with their training routines. Athletic identity was not measured in our study but we might assume that the Belgian Paralympians were able to identify with the athlete roles during the pandemic and safeguard their well-being as they were able to continue their physical preparations for the Games at least to some extent. Another possible explanation might be that elite Paralympic athletes have emerged as having better strategies to cope with stressful situations, because they are regularly facing these types of situations in their roles as athletes (e.g., performing under pressure in competition). Also, having an impairment might have brought them into several life experiences in which they have learned to adopt coping mechanisms (e.g., discrimination, inaccessibility) (Fiorilli et al., 2021). As such, they might have their adaptive cognitive emotion regulation skills better developed compared to others, which helps them to apply these strategies over the COVID-19 lockdown period.

Characteristics of the motivational profiles

Previous research demonstrated that motivation is not a unidimensional construct and every athlete combines different types

of motivation in a motivational profile (e.g., Vansteenkiste et al., 2009; Emm-Collison et al., 2020; Morbée et al., 2022). The first aim of this study was to identify the motivational profiles of Paralympic athletes based on the qualitatively different types of motivation as proposed by SDT (i.e., autonomous motivation, controlled motivation, and amotivation). Whereas Morbée et al. (2022) distinguished four motivational profiles in cyclists based on the quality and quantity of their motivation, the present study revealed only three clusters of motivational types in the sample of Paralympic athletes. The first profile was the one in which all types of motivation were present but with amotivation most dominant. The second profile was the one in which the autonomous type of motivation (good quality) was most dominant, although relatively low in quantity. In the third profile, the controlled type of motivation was the most dominant. The three motivational profiles were equally distributed among the athletes who were preparing for the Tokyo Games, with, respectively, 9 (dominantly amotivated), 11 (dominantly autonomously motivated), and 12 (dominantly controlled motivated) athletes matching the three profiles.

Relation between motivational profile and emotional and cognitive outcomes

Beneficial outcomes (e.g., resilience to cope, need satisfaction, well-being) have been mostly attributed in the literature to the autonomous type of motivation whereas more negative outcomes (need frustration, ill-being) are more often related to amotivation or controlled motivation (Vansteenkiste et al., 2009; Standage and Ryan, 2020). Most apparent in our sample of Paralympic athletes was the detrimental effect of the predominantly amotivated profile on indicators of ill-being such as basic psychological need frustration, which corresponded to findings from previous studies (Morbée et al., 2022; Vermote et al., 2022). The athletes characterized by relatively high scores on amotivation scored lower on need satisfaction and higher on need frustration compared to the other athletes. Although the scores on the checklist for depressive symptoms were not clinically problematic for the predominantly amotivated Paralympians, they scored significantly worse compared to the Paralympians in the other groups. Moreover, their general well-being was significantly lower and their perceived stress level higher although not significant ($p = 0.06$). It has been repeatedly shown in the literature (Langan et al., 2016; Cuevas et al., 2018; Haraldsen et al., 2021) that a motivational profile characterized by a combination of controlled motivation and amotivation (i.e., "poor quality") is the least adaptive of all profiles, and related to negative outcomes such as ill-being, anxiety, and perfectionism. In this study, we confirm that this relation is also upheld for elite athletes with disabilities.

With respect to the use of self-regulation strategies, the athletes characterized by predominantly controlled motivation and amotivation in our study were more likely to adopt more controlling self-regulatory strategies compared to the athletes with predominantly autonomously motivational profiles. On the other hand, we did not find proof in our study that the Paralympians with a predominantly autonomously motivated profile would also have more resilient responses to cope with the postponement of the Paralympic Games. This finding is in line with the results of Morbée et al. (2022), who also did not find a significant difference between the motivational profiles in terms of autonomous motivational self-regulation strategies. An explanation might be that the predominantly autonomously motivated profile was characterized dominantly by autonomous motivation in the absolute sense, although relatively low compared to the dominance of autonomous motivation in the dominantly amotivated profile. An alternative explanation might be that all participants already found resilient ways to cope with the pandemic given our survey was conducted after about a year of living with the COVID-19 pandemic.

Performance

Whereas positive outcomes such as mental well-being and resilience have been attributed to good quality (i.e., predominantly autonomously motivated) motivational profiles in previous research, there is a lack of knowledge about the process and the mechanisms by which motivation affects performance in elite athletes. This study wanted to contribute to filling this gap in the literature, being one of the first in which the motivational profile of athletes is investigated in relation to a "hard" indicator such as performance in a highly competitive sports context. In the sports science literature (including disability sports science), a lot of attention has been dedicated to performance optimization by means of "hard" sciences such as sports physiology (e.g., effects of physiological parameters on goalball technical performance) (Alves et al., 2018) or biomechanics (e.g., optimal wheelchair configuration in para-sports) (Rietveld et al., 2021). It is more recently that researchers and practitioners started to apply concepts from "softer" sciences such as sports psychology for performance optimization. It might be due to the less tangible resources used in sports psychological interventions or unfamiliarity with this relatively novel area of research impeding athletes or researchers to implement it in their training practice (Gee, 2010). The most common use of sports psychology in relation to performance optimization is by means of the 'negative' approach, i.e., providing strategies to the athlete to cope with factors that potentially decrease their performance (e.g., anxiety, stress). There is only a paucity of studies aiming to unravel how positive factors such as good quality types of motivation enhance performance during competitions. In the majority of these studies, the findings revealed that autonomous motivation is associated with the best objective measures of performance, for example in youth tennis players (Cece et al., 2020), youth table tennis players (Martinent et al., 2018), judokas (Gillet et al., 2010), and female esthetic group gymnasts (Koka et al., 2020). We are not aware of studies examining the relation between athletes' motivation and performance in elite Paralympic athletes. However, in an experimental study by Cheon et al. (2015), a coach intervention was implemented to help Paralympic coaches to adopt a more motivating (e.g., autonomy-supportive) style during the preparation for the 2012 London Paralympic Games. Results showed that athletes of coaches in the experimental condition were significantly more likely to win a medal than were athletes of the coaches in the control condition who applied a more demotivating (e.g., controlling) coaching style. Although not explicitly studied, better motivation of athletes with a more motivating coach could be at the root of their better performance. In our study, we obtained a similar finding, as Paralympic athletes' actual performance at the Games was related to their motivational profile, with the majority of Paralympic medal winners (75%) belonging to the predominantly autonomously

motivated profile whereas the majority of non-medal winners (54%) were predominantly amotivated and the majority of non-selected athletes (46%) identifying with the controlled motivational type. Future research is necessary but the results of our study are at least promising for future practice as it might help athletes and coaches to invest in the development of a good quality motivation for optimal performance. This contradicts the popular belief that coaches (especially at the highest levels) may do well to adopt a harsh, demotivating style with their athletes to help them reach their maximum potential (Jowett and Cockerill, 2003).

Strengths and limitations

The main strength of this study is that it is unique in its kind, as we were able to recruit all the Dutch-speaking athletes on the Team Belgium Paralympic Games shortlist for the first questionnaire (response rate 100%), making it a fully representative sample. Moreover, the present study addressed a broad set of both "soft" and "hard" outcomes in relation to motivational profiles, including their actual and perceived performance at the Paralympic Games assessed in a multi-informant way.

However, some limitations of this study must be acknowledged when analyzing and interpreting the findings. First, the relatively small sample can be considered the main limitation. Therefore, the results of the cluster analysis should be interpreted with caution. Second, because of the purposeful sampling approach, we were not able to guarantee a balanced male–female ratio (male: 75%; female: 25%), nor a balanced ratio of impairment groups (PI: 60%; VI: 34%; II: 6%) or type of sports (individual: 81%; team: 19%). In future studies, we could increase the sample and the ratio by going beyond the borders and including Paralympic athletes from other nations. A third limitation concerns the reliability of the measuring instruments, with some scales of the questionnaires showing questionable internal consistency. Although the assessment tools that we used were proven valid and reliable in previous research, we might need to consider more adaptations to the instruments for use with athletes with intellectual, visual, and/or physical disabilities, including cerebral palsy. In an attempt to address this concern, we allowed the athletes with intellectual disabilities to have a trustee present to support them to fill out the questionnaire, but as a side effect, this might have reduced objectivity. Fourth, the type of design (cross-sectional) might also have influenced our results, since we assessed all variables (except for athlete performance) at one moment in time only. The motivation and well-being of a person can fluctuate from day to day, so the outcomes could be impacted by confounding variables we did not control (e.g., mood, the severity of COVID-19 restrictions). To reduce the influence of these confounding variables on internal validity, a follow-up test could have improved the accuracy of measurements in a test–retest design. The follow-up test we included in our own study only included measures of performance, but did not include variables measured at the first time point. We deliberately decided to limit the length of this follow-up questionnaire to avoid dropout. Another disadvantage of the cross-sectional designs is the inability to draw conclusions on causalities. Furthermore, the conceptualization and assessment of well-being in sports have been extensively debated by psychology scholars. There is a variety of definitions and various conceptual and theoretical perspectives on well-being (Giles et al., 2020). In our study, we used a combination of sport-specific measures of well-being (e.g., BPNSFS) and more general assessments (e.g., PHQ-9, PSS). A future study could benefit from a more conceptual approach taking into account the more recent views and available knowledge (Puce et al., 2023). Finally, we did not include a control sample of recreational or sub-elite athletes with disabilities or elite athletes without disabilities which might also have provided interesting comparisons.

Future directions and practical implications

For future research, a longitudinal study design with a broader sample of athletes could be established to examine causal relationships and define specific characteristics within a motivational profile. Also, the differences in motivation and well-being of various types of Paralympic or Olympic athletes competing at different levels of performance, during times of a pandemic versus non-pandemic times could be considered. Based on the results of this study, we were able to draw some meaningful conclusions and recommendations for future support of Paralympic athletes toward coaches and support staff. The sports psychologist of the Paralympic team approved this study and is using the principles of SDT to support the athletes and coaches. Although the sporting world has now returned to a sense of normalcy, the threat of athletes testing positive for COVID-19 or any other infectious disease may be seen for years to come (Asif and Toresdahl, 2022). Therefore, in the future, it is recommended to teach the coaches how they can further support their athletes to adopt the most adaptive motivational profiles and apply self-regulation strategies to stay autonomously motivated in difficult circumstances. Furthermore, we recommend educating the athletes about their own motivational profiles, how they can enhance autonomous motivation, and the potential impact this might have on their well-being and performance.

Conclusion

This study was unique in being the first of its kind to examine Paralympic athletes' resilience in times of a global pandemic. An encouraging finding was that the well-being of Paralympic athletes was not significantly affected during their preparation for the Tokyo Games in difficult circumstances. We distinguished three motivational profiles, which were equally distributed among the sample (i.e., dominantly amotivated, $n = 9$; dominantly autonomously motivated, $n = 11$; and dominantly controlled motivated, $n = 12$). The Paralympians with a motivational profile that was characterized by predominantly amotivation to engage in sport managed to handle the uncertain situation evoked by the pandemic in less resilient ways. These athletes reported the highest level of need frustration and the lowest level of need satisfaction, and their well-being was lower compared to the other Paralympians with a profile characterized by high-quality motivation. Next, also Paralympic athletes' actual performance during the Games appeared to be related to their motivational profile. Specifically, the majority of Paralympic medal winners (75%) belonged to the predominantly autonomously motivated profile, whereas the majority of non-medal winners (54%) were predominantly amotivated, and the majority of non-selected athletes (46%) identified with the controlled motivational type. The results of this study confirm the importance of

appropriate psychological support for elite athletes, including those with disabilities. Improving the quality of their motivational profiles can safeguard their well-being and enhance performance in Paralympic Sport.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by KU Leuven/UZ Leuven. The patients/participants provided their written informed consent to participate in this study.

Author contributions

DB conceptualizing and drafting the article, revising it critically for important intellectual content, final approval of the version to be published, and accountability for all aspects of the work. SM conceptualizing and revising the study critically for important intellectual content, final approval of the version to be published, and accountability for all aspects of the work. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Young para-athletes display more hedonic well-being than people with disabilities not taking part in competitive sports: insights from a multi-country survey

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Hedonic well-being relates to how individuals experience and rate their lives. People with disabilities due to their pathology may more frequently suffer from anxiety and depressive disorders than their able-bodied counterparts. Sports participation is an essential way to cope with disability. On the other hand, compared with their able-bodied peers, para-athletes undergo a unique series of stressors. Little is known in terms of hedonic well-being in this specific population. We present the results of a multi-country survey of self-perceived hedonic well-being by para-athletes of different sports disciplines and a control group (disabled individuals not playing competitive sports), using the "Psychological General Well-Being Index" (PGWBI). We included 1,208 participants, aged 17.39 years, 58.4% male, 41.6% female, and 70.3% para-athletes. Para-athletes exhibited higher well-being than disabled people, for all domains of the PGWBI scale. The nature of disability/impairment was significant, with those with acquired disability reporting lower well-being. Those taking part in wheelchair basketball, para-athletics, and para-swimming competitions had a higher likelihood of reporting well-being, whereas those engaged in wheelchair rugby exhibited lower well-being compared with controls. This large-scale investigation can enable a better understanding of the self-perceived hedonic well-being of disabled people.

KEYWORDS

global well-being, hedonic well-being, sports-related well-being, disabled athletes, para-athletes, multi-country survey

1. Introduction

Human well-being, as a complex, multi-dimensional construct, consists of hedonic and eudaimonic dimensions (Ryan and Deci, 2001). The former, also known as subjective well-being (SWB), relates to how individuals live and evaluate aspects of their lives (Diener, 1984), in terms of overall and domain-specific life satisfaction, and positive and negative affect, the balance of which is known as happiness. Eudaimonic well-being, also known as psychological and social well-being, is, instead, related to self-acceptance, meaningful connections, autonomy, environmental mastery, purpose in life, and personal growth (Kim et al., 2022). Even if these two models of well-being (hedonic/SWB and eudaimonic/psychological and social well-being) are theoretically diverging, they partially overlap (Ryan and Deci, 2001). Recently, these concepts have been adapted to the elite sports world (Lundqvist, 2011): well-being, as experienced by athletes is complex and nuanced (Lundqvist and Sandin, 2014). The sports arena can be, indeed, either challenging or rewarding, providing new opportunities and situations to explore (Filbay et al., 2019; Giles et al., 2020). On the one hand, athletes can connect with peers and the public, having stimulating interactions that improve self-confidence and control of their environment (Jones et al., 1994). On the other hand, besides success, they can experience failure, and they have to undergo heavy training programs, and nutritional restrictions daily with the risk of incurring overtraining, injury, and burnout (Rice et al., 2016). Also, they have to cope with a variety of challenges, and stressors (Mack et al., 2012) that can put their mental health and well-being at risk (McLoughlin et al., 2021). People with disabilities usually report poorer well-being due to their underlying conditions (Tilly, 2008; Krahn et al., 2015; Tough et al., 2017), even if they can overcome adverse situations by adopting coping strategies (Bahmani et al., 2022). Practicing sports and exercising can help face disability-related stressors (Puce et al., 2017; Ascione, 2018; Kiuppis, 2018; Puce et al., 2019), even though, compared with their able-bodied counterparts, athletes with disabilities and para-athletes encounter a unique series of stressors, from discrimination, retaliation, and stigmatizing situations, including demeaning attitudes and unprofessional coaching, to physical access, communication, or economic-financial barriers (Iezzoni, 2009; Jefferies et al., 2012). If sport and physical activity are well-known to facilitate inclusion, favor social acceptance, and improve self-esteem (Trigueros et al., 2021), there is a paucity of data concerning well-being from a hedonic perspective in this specific population (Macdougall et al., 2015). The existing scholarly literature reports contrasting results and rarely compares para-athletes with subjects with disabilities non-practicing competitive para-sports, providing little evidence on the psychological benefits of competitive sports for individuals with disabilities. Furthermore, research is limited to specific types of disability/impairment, as well as to selected para-sports disciplines, settings, and geographic contexts, with small sample sizes. Therefore, given this dearth of information, this study was conducted to fill in this gap of knowledge. Our aim was to test the specific hypothesis that the practice of competitive sports would have a positive impact on the well-being of the participants. In this cross-sectional study, we present the results of a multi-country survey of self-perceived hedonic well-being by para-athletes of different sports disciplines and a control group (people with disabilities, not playing competitive sports). Our main independent variable was competitive sporting practice, but we also looked at the participant's sex/gender, age, type of impairment, way of administration of the survey, and country of provenience. We believe that a large-scale investigation can enable a better understanding of the self-perceived hedonic well-being and related needs of people with disabilities and whether competitive sports-associated stressors can affect the quality of life-related outcomes.

2. Materials and methods

2.1. Study participants

1,408 participants were enrolled in the present study. Due to missing data (95 among para-athletes and 105 among disabled people), 200 questionnaires were discarded. Data about 1,208 participants (85.8%) were retained. Socio-demographic features of the discarded and retained groups did not differ in a statistically significant way.

Included subjects were aged 17.39 ± 3.44 (median 17) years, 705 (58.4%) male and 503 (41.6%) female, were considered in the present analysis. 849 (70.3%) were para-athletes, and the remainder 359 (29.7%) were disabled people not taking part in competitive sports. According to para-sport discipline, 105 (12.4%) were engaged in para-athletics, 78 (9.2%) in wheelchair rugby, 66 (7.8%) in boccia, 61 (7.2%) in blind football, 27 (3.2%) in goalball, 31 (3.7%) in judo, 353 (41.6%) in para-swimming, 33 (3.9%) in para-table-tennis, 20 (2.4%) in para-sailing, and 75 (8.8%) in wheelchair basket. In terms of geographic provenience, 294 (24.3%) were from Western Europe, 449 (37.2%) from Southern Europe, 381 (31.5%) from Northern Europe, and 84 (7.0%) from Central-Eastern Europe. 819 (67.8%) and 389 (32.2%) were from urban and rural environments, respectively. Disability/impairment was congenital in 830 (68.7%) cases and acquired in 378 (31.3%) cases. It was musculoskeletal in 370 (30.6%) cases, sensory in 148 (12.3%) cases, neurological in 589 (48.8%) cases, and intellectual/relational in 101 (8.4%) cases. In 362 cases (30.0%), the participant required help in filling in the questionnaire. 274 (22.7%) filled in the questionnaire during the competitive period.

2.2. Procedure

This study was designed as a case–control, questionnaire-based, cross-sectional survey. Its major findings have been reported in accordance with the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) checklists (Vandenbroucke et al., 2007). A portion of the cases were young para-athletes who participated in the "European Para Youth Games" (EPYG), which took place from 9 to 15 October 2017, in Liguria, Italy. EPYG is an international, competitive, and multisport competition for youth athletes with disabilities (aged 12–23 years) organized and regulated by the International Paralympic Committee (IPC). This event, which takes place every 2 or 3 years, is hosted each time in a different European country. One month before the event, the notification and information on the questionnaires were published on the official web page of the event and sent by e-mail to the federations of the various para-sports disciplines. This email and the web page of the event contained a link to a web form developed using the Google Forms cloud-based service, consisting of an explanatory note, a

form in which subjects were asked to express their willingness or unwillingness to participate in the survey, the questionnaires to be filled in, and an additional questionnaire containing help information. The same questionnaires and explanatory notes were administered to a reference sample of disabled young people who do not practice competitive sports, of similar age, by sending the link to the event web page via email to rehabilitation clinics based in the European countries participating in the event. To reach the largest possible number of both para-athletes and disabled individuals non-practicing sports, the web form remained open until July 2019 for both populations. The study protocol was approved by the local ethics committee and published in a peer-reviewed international scholarly journal (Puce et al., 2017). The study was prospectively registered within the ISRCTN ("International trial registry") repository (registration code ISRCTN14389453).

2.3. Psychometric tool

Among the various tools for calculating hedonic well-being (Cooke et al., 2016), the "Psychological General Well-Being Index" (PGWBI) was chosen (Dupuy, 1984). This represents a commonly employed and reliable survey index that measures self-perceived psychological health and well-being over the past 4 weeks (Paleari et al., 2021). This tool was developed in the United States and has subsequently been tested in other countries on large samples of the general population, as well as specific patient and population groups, including athletes and sportspeople with disabilities (Puce et al., 2019; Maugeri et al., 2020). The questionnaire score results in six domains, and each domain consists of three to five items: i.e., 3 items for depression, self-control, and general health, 4 items for vitality and positive well-being, and 5 items for anxiety.

For example: "Have you been bothered by nervousness or your "nerves" during the past month?" is a specific anxiety rating question and requires an answer ranging from "Extremely so – to the point where I could not work or take care of things" for severe anxiety to "Not at all" for no anxiety. Furthermore, each item is rated on a Likert-like scale from 0 (the most negative option) to 5 (the most positive option); the global summary score reflects severe distress between 0 and 60 while reflects levels of moderate distress and positive well-being between 61 and 72 and 73 and 110 points, respectively, with a maximum of 110 points representing the best attainable level of hedonic well-being.

2.4. Statistical analysis

An *a priori* sample size and power analysis was conducted, using G*Power software (version 3.1.9.7, Heinrich Heine University Düsseldorf, Düsseldorf, Germany). In the existing scholarly literature, only a few studies have compared the quality of life in people with disabilities practicing or not practicing sports, reporting large effect sizes (Fiorilli et al., 2013; Dantas et al., 2022). To detect a large effect size, with an alpha error probability of 0.05 and a power of 0.80, a sample of 102 participants would have been enough, whereas to detect a small effect size, with the same parameters, a sample of 620 individuals would have been needed.

Once collected, questionnaire data were analyzed in terms of skewness, kurtosis, and normal distribution. Descriptive statistics were carried out, by computing means, standard deviations, and medians. The psychometric properties of the tool, including the Cronbach's alpha, were also assessed: overall, the Cronbach's alpha coefficient was 0.93, with the coefficient varying from 0.63 to 0.80 for each domain (namely, the anxiety scale has a coefficient of 0.74, the depressed mood scale a coefficient of 0.80, the positive well-being scale a coefficient of 0.70, the self-control scale a coefficient of 0.76, the general health scale a coefficient of 0.65, and the vitality scale a coefficient of 0.63). These values are well in line with those reported in the literature, confirming the reliability of the data collected.

Univariate and multivariate analyses were conducted to shed light on the determinants of well-being among athletes with disabilities. Different models were run, and the best one was selected based on the deviance, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), McFadden's R^2, Nagelkerke's pseudo-R^2, Cox and Snell's R^2, and overall model chi-squared test. Effect sizes were also computed. All analyses were done using the "Statistical Package for Social Sciences" (SPSS for Windows, version 26.0, Armonk, IBM, NY, United States). We test at an alpha level of 0.05.

3. Results

3.1. Hedonic well-being

The scores of the PGWBI broken down according to each domain for the entire study population are shown in Table 1. 461 (38.2%) of the population exhibited well-being, whilst 206 (17.1%) and 541 (44.8%) displayed moderate and severe distress, respectively. Stratifying according to the type of population, 419 (49.4%) para-athletes reported well-being, 161 (19.0%), and 269 (31.7%) exhibited moderate and severe distress. Forty-two (11.7%) people with disabilities (not participating in competitive sports) reported well-being, 45 (12.5%) had moderate distress, and 272 (75.8%) exhibited severe distress. Differences for all variables under study (overall PGWBI and all domain scores) between the two populations are significant ($p < 0.001$), with large effect sizes (Table 2).

TABLE 1 The "Psychological General Well-Being Index" (PGWBI) scores are presented, broken down according to PGWBI domains in the overall study population.

PGWBI domain	Overall study population (n =1,208)
Anxiety score	15.41 ± 4.82
Depressed mood score	9.38 ± 3.63
Positive well-being score	10.56 ± 3.99
Self-control score	8.59 ± 3.47
Vitality score	12.25 ± 3.73
General health score	9.91 ± 3.28
PGWBI summary score	66.10 ± 18.35

TABLE 2 The "Psychological General Well-Being Index" (PGWBI) scores for each PGWBI domain, broken down according to the type of population (disabled people, *n*=359, versus para-athletes, *n*=849).

PGWBI domain	People with disabilities (*n* =359)	Para-athletes (*n* =849)	Effect size
Anxiety score	12.14 ± 4.28	16.79 ± 4.34	1.08 [95%CI 0.95–1.21]
Depressed mood score	7.51 ± 2.96	10.18 ± 3.60	0.78 [95%CI 0.65–0.91]
Positive well-being score	8.07 ± 2.94	11.62 ± 3.90	0.98 [95%CI 0.85–1.10]
Self-control score	6.72 ± 2.70	9.39 ± 3.46	0.82 [95%CI 0.69–0.95]
Vitality score	9.75 ± 2.90	13.30 ± 3.54	1.06 [95%CI 0.93–1.19]
General health score	7.92 ± 3.00	10.75 ± 3.02	0.94 [95%CI 0.81–1.07]
PGWBI summary score	52.11 ± 15.16	72.02 ± 16.25	1.25 [95%CI 1.12–1.38]

TABLE 3 The "Psychological General Well-Being Index" (PGWBI) scores for each PGWBI domain, broken down according to socio-demographic/clinical variables.

Socio-demographic/ clinical variable	Anxiety score	Depressed mood score	Positive well-being score	Self-control score	Vitality score	General health score	PGWBI summary score
Sex/gender							
Female (*n* = 503)	15.41 ± 4.67	9.53 ± 3.59	10.49 ± 3.97	8.72 ± 3.37	11.89 ± 3.63	9.86 ± 3.38	65.89 ± 18.45
Male (*n* = 705)	15.41 ± 4.92	9.28 ± 3.67	10.61 ± 4.01	8.51 ± 3.54	12.50 ± 3.79	9.94 ± 3.20	66.26 ± 18.29
Age (years)							
11–17 (*n* = 638)	16.07 ± 4.87	9.75 ± 3.67	11.02 ± 3.98	8.93 ± 3.51	12.61 ± 3.73	10.16 ± 3.30	68.54 ± 18.49
18–23 (*n* = 570)	14.67 ± 4.65	8.97 ± 3.55	10.05 ± 3.94	8.22 ± 3.39	11.84 ± 3.70	9.62 ± 3.24	63.37 ± 17.81
Disability type							
Muskuloskeletal (*n* = 370)	15.52 ± 4.87	9.42 ± 3.59	10.44 ± 4.19	8.60 ± 3.59	12.49 ± 3.80	10.37 ± 3.32	66.84 ± 18.79
Sensory (*n* = 148)	14.95 ± 4.61	8.64 ± 3.80	10.39 ± 3.87	8.51 ± 3.09	12.03 ± 3.55	9.51 ± 3.12	64.01 ± 17.17
Neurological (*n* = 589)	15.24 ± 4.78	9.21 ± 3.55	10.30 ± 3.81	8.46 ± 3.42	11.88 ± 3.65	9.49 ± 3.20	64.59 ± 17.77
Intellectual-relational (*n* = 101)	16.62 ± 4.99	11.36 ± 3.38	12.81 ± 3.77	9.51 ± 3.76	13.82 ± 3.80	11.22 ± 3.27	75.34 ± 19.01
Congenital disability (*n* = 830)	16.16 ± 4.58	9.87 ± 3.56	11.20 ± 3.93	9.06 ± 3.48	12.92 ± 3.59	10.28 ± 3.21	69.48 ± 17.63
Acquired disability (*n* = 378)	13.77 ± 4.94	8.33 ± 3.58	9.17 ± 3.76	7.58 ± 3.23	10.77 ± 3.63	9.09 ± 3.29	58.70 ± 17.71

3.2. Determinants of hedonic well-being

In the univariate analyses (Tables 3, 4), concerning the PGWB overall score, para-athletics and para-swimming reported the highest value, while wheelchair basketball yielded an intermediate value and the remainder the lowest one. Besides para-sports disciplines, also the nature of the disability/impairment (congenital versus acquired) was found to be statistically significant. In the multivariate analysis, the PGWB score was dichotomized into two categories: being positive and experiencing moderate-to-severe psychological distress. The nature of disability/impairment was statistically significant, with those with acquired disability reporting lower well-being (OR 0.19 [0.13–0.26], $p < 0.001$). Those taking part in wheelchair basketball, para-athletics, and para-swimming competitions had a higher likelihood of reporting well-being (OR 51.51 [95%CI 26.51–104.0.3], $p < 0.001$; OR 47.93 [95%CI 26.66–89.55], $p < 0.001$; and OR 46.51 [95%CI 30.37–72.40], $p < 0.001$), whereas those engaged in wheelchair rugby exhibited lower well-being when compared to their counterparts not participating in competitive sports (OR 0.46 [95%CI 0.22–0.91], $p = 0.032$) (Table 5).

4. Discussion

In the present study, we found that para-athletes reported higher hedonic SWB levels than their counterparts with disabilities not practicing competitive para-sports. In the univariate analyses, concerning the PGWBI overall score, para-athletics and para-swimming reported the highest value, while wheelchair basketball yielded an intermediate value and the remainder the lowest one. Besides para-sports disciplines, also the nature of the disability/impairment (congenital versus acquired) was significant. In the multivariate analysis, the nature of disability/impairment was statistically significant, with those with acquired disability reporting lower well-being. Those taking part in wheelchair basketball, para-athletics, and para-swimming competitions had a higher likelihood of reporting well-being, whereas those engaged in wheelchair rugby exhibited lower well-being when compared with controls. An accumulating body of scholarly research carried out on able-bodied athletes and the general population has shown the beneficial impacts of sport and exercise, in terms of improvement in well-being, which, in turn, results in further sports participation and engagement,

TABLE 4 The "Psychological General Well-Being Index" (PGWBI) scores for each PGWBI domain, broken down according to para-sports discipline.

Para-sports discipline	Anxiety score	Depressed mood score	Positive well-being score	Self-control score	Vital score	General health score	PGWBI summary score
Para-athletics ($n = 105$)	18.54 ± 4.16	7.51 ± 2.96	13.42 ± 3.44	11.16 ± 2.62	14.42 ± 3.31	12.13 ± 2.54	82.03 ± 14.06
Wheelchair rugby ($n = 78$)	14.27 ± 5.22	12.35 ± 2.17	7.12 ± 3.28	4.77 ± 2.01	12.68 ± 4.37	10.44 ± 3.02	54.59 ± 6.26
Boccia ($n = 66$)	12.88 ± 2.97	5.32 ± 1.98	10.53 ± 2.33	7.85 ± 1.96	10.94 ± 2.16	8.09 ± 1.92	58.48 ± 8.69
Blind football ($n = 61$)	16.36 ± 4.19	8.20 ± 2.01	8.66 ± 3.05	5.80 ± 2.05	12.20 ± 3.46	7.89 ± 2.59	56.98 ± 6.83
Goalbal ($n = 27$)	13.78 ± 2.29	6.08 ± 1.70	9.89 ± 3.43	7.89 ± 2.49	12.37 ± 2.76	8.19 ± 1.90	59.07 ± 4.59
Judo ($n = 31$)	13.71 ± 3.38	6.96 ± 2.92	10.94 ± 3.24	7.45 ± 2.28	11.84 ± 3.12	7.87 ± 2.11	58.58 ± 6.07
Para-swimming ($n = 353$)	18.33 ± 3.69	6.77 ± 2.67	13.25 ± 3.39	11.20 ± 2.70	14.04 ± 3.47	11.99 ± 2.23	81.19 ± 13.32
Para-table-tennis ($n = 33$)	14.52 ± 4.06	12.37 ± 2.13	9.27 ± 3.07	6.33 ± 2.10	13.18 ± 3.13	7.24 ± 2.56	56.64 ± 6.04
Para-sailing ($n = 20$)	14.85 ± 3.23	7.20 ± 4.21	7.90 ± 2.15	6.70 ± 3.45	11.70 ± 3.53	8.40 ± 4.04	56.75 ± 7.08
Wheelchair basketball ($n = 75$)	17.39 ± 3.63	12.11 ± 2.11	12.39 ± 3.33	10.81 ± 2.61	13.32 ± 3.25	12.21 ± 2.29	78.21 ± 12.31

generating a virtuous circle, with subsequent further enhancements in SWB – the so-called "multiplier effect" theory (Downward et al., 2018). However, the impact on hedonic SWB is less studied. For instance, Wilson et al. (2022) measured the correlation between sports participation and hedonic well-being in adolescents aged 11–17 years, in New Zealand, finding a positive association. However, hedonic SWB was evaluated using a single item rather than a full-length psychometric tool. Hedonic SWB and sports participation have been shown to be mediated by a range of parameters, including age, sex/gender, socio-economic income, relationship status, prior fitness levels, intensity (light versus moderate and high intensity), type (aerobic versus anaerobic and mixed exercise), and duration of physical activity, and sports setting (individual versus team sports) (Ruseski et al., 2014; Wicker and Frick, 2015; Buecker et al., 2021; Habe et al., 2021; Li et al., 2022). Overall, physical activity was found to be related to positive affect, but unrelated to negative affect, enhancing well-being, with effects consistently shown across all age groups and a variety of settings (Buecker et al., 2021). Specifically, regarding competitive sports, some studies (Wann et al., 2015; Fessi et al., 2016; Saw et al., 2016; Watson et al., 2017; Abbott et al., 2018; Fessi and Moalla, 2018; Watson and Brickson, 2018; Watson and Brickson, 2019; Graupensperger et al., 2020; Li et al., 2020; Nobari et al., 2021) identified some associations between well-being and sports-related parameters, like training load, training-induced stress (Saw et al., 2016; Watson and Brickson, 2018; Watson and Brickson, 2019; Nobari et al., 2021), match period (pre-season versus in-season period) (Fessi et al., 2016), match location, match result, and the quality of the opposition during a match (Abbott et al., 2018), and match-induced perceived exertion and fatigue (Fessi and Moalla, 2018), as well as athlete's identity (Li et al., 2022), social connections, and social identification with college sports teams (Wann et al., 2015; Graupensperger et al., 2020). If the effects of sports engagement on well-being in the able-bodied athlete population is well-known, less has been researched in the disabled athlete community. However, this topic has been attracting increasing scholarly interest, with research documenting that practicing para-sports and participating in events such as the Paralympic Games can contribute to the well-being of disabled individuals. The precise mechanisms are to be elucidated yet, but it can be speculated that a series of direct and indirect, emotional, societal, and motivational factors characterizing the sports arena can, on the one hand, help face challenging circumstances, promote self-acceptance, enhance self-esteem (Vita et al., 2016; Pack et al., 2017), and even reach ambitious goals (Puce et al., 2023). On the other hand, these studies suffer from a few shortcomings, including the use of non-validated, subjective tools, rarely complemented by objective tools (Puce et al., 2023). Positive effects of physical activity and exercise have been shown for a variety of para-sports, like para-swimming (Vita et al., 2016; Pack et al., 2017), and wheelchair sports (Kokaridas et al., 2009; Fiorilli et al., 2013), as well as other paralympic disciplines (Mira et al., 2022). This beneficial impact is, at least partially, counteracted by the competitive nature of the sports environment (Macdougall et al., 2016), characterized by strenuous training schedules (Puce et al., 2018) and organizational-logistical challenges (Hernández-Segura et al., 2022). Besides the positive effects of practicing para-sports, our study found a statistically significant impact of the nature of the disability/impairment (congenital versus acquired). Based on several more recent studies and some earlier studies, whether people were born with or acquired the disability later in life appears to be an important variable when considering psychological well-being. For example, Campbell (1995) compared the psychological well-being associated with congenital versus acquired disability in 93 para-athletes in different sports (track and field, swimming, table tennis, and weightlifting). The authors found that athletes with acquired disabilities reported greater psychological well-being. Additionally, those with a congenital disability had higher anxiety and lower self-control and self-esteem. These results would seem to confirm Wright (1983) findings that people with congenital disabilities in early childhood do not acquire the knowledge and experience necessary to be "independent adults." Such deficiencies would make these people psychologically fragile and unable to overcome stressful situations. Another possible hypothesis supporting the findings of Campbell (1995) is referred to as the "growth through adversity" theory (Joseph and Linley, 2005; Plews-Ogan et al., 2019). According to this theory, people can experience positive behavioral changes after going through highly stressful adverse events. Thus, adversity can provide opportunities for the development of important character traits such as better relationships with others, identification of new possibilities for one's life, greater personal strength, spiritual change, and a greater appreciation of life. However, there is also evidence regarding the

TABLE 5 Multivariable regression model shedding light on the predictors of the "Psychological General Well-being Index" (PGWBI) summary score.

		95% confidence interval					95% confidence interval	
Predictor	Estimate	Lower	Upper	SE	*Z*-value	value of *p*	Odds ratio	Lower	Upper
Age	−0.0295	−0.0664	0.00804	0.0188	−1.5662	0.117	0.971	0.936	1.008
Sex/gender									
Male (vs. female)	0.1067	−0.1820	0.39666	0.1475	0.7237	0.469	1.113	0.834	1.487
Country/geographic provenience									
Southern Europe (vs. Western Europe)	0.3131	−0.0525	0.68159	0.1871	1.6732	0.094	1.368	0.949	1.977
Northern Europe (vs. Western Europe)	0.2823	−0.0881	0.65415	0.1892	1.4919	0.136	1.326	0.916	1.924
Central-Eastern Europe (vs. Western Europe)	0.0690	−0.5292	0.65391	0.3012	0.2291	0.819	1.071	0.589	1.923
Socio-economic status									
Urban (vs. rural)	−0.1149	−0.4153	0.18483	0.1530	−0.7511	0.453	0.891	0.660	1.203
Type of disability									
Sensory (vs. musculoskeletal)	−0.0981	−0.7175	0.52193	0.3158	−0.3108	0.756	0.907	0.488	1.685
Neurological (vs. musculoskeletal)	0.0171	−0.3197	0.35511	0.1720	0.0992	0.921	1.017	0.726	1.426
Intellectual-relational (vs. musculoskeletal)	0.3582	−0.3005	1.02543	0.3380	1.0597	0.289	1.431	0.740	2.788
Administration									
With aid (vs. without aid)	0.3106	−0.0899	0.71111	0.2042	1.5214	0.128	1.364	0.914	2.036
Classification of disability									
Acquired (vs. congenital)	−1.6894	−2.0280	−1.36223	0.1697	−9.9557	<0.001	0.185	0.132	0.256
Timing of administration									
During the competition (vs. outside of the competition)	0.2147	−0.1785	0.61103	0.2012	1.0674	0.286	1.240	0.836	1.842
Para-sports discipline									
Para-athletics (vs. no competitive para-sport)	3.8698	3.2831	4.49479	0.3083	12.5514	<0.001	47.931	26.658	89.549
Wheelchair rugby (vs. no competitive para-sport)	−0.7722	−1.5176	−0.09251	0.3611	−2.1384	0.032	0.462	0.219	0.912
Boccia (vs. no competitive para-sport)	0.3981	−0.2405	1.02024	0.3209	1.2407	0.215	1.489	0.786	2.774
Blind football (vs. no competitive para-sport)	−0.2145	−0.8851	0.41560	0.3301	−0.6496	0.516	0.807	0.413	1.515
Goalball (vs. no competitive para-sport)	−0.4001	−1.4428	0.57157	0.5099	−0.7846	0.433	0.670	0.236	1.771
Judo (vs. no competitive para-sport)	0.5570	−0.3160	1.41534	0.4403	1.2652	0.206	1.745	0.729	4.118
Para-swimming (vs. no competitive para-sport)	3.8396	3.4135	4.28223	0.2215	17.3371	<0.001	46.505	30.372	72.401
Para-table-tennis (vs. no competitive para-sport)	−0.4244	−1.3970	0.43113	0.4603	−0.9220	0.357	0.654	0.247	1.539
Para-sailing (vs. no competitive para-sport)	−0.4592	−1.7716	0.64123	0.6013	−0.7637	0.445	0.632	0.170	1.899
Wheelchair basketball (vs. no competitive para-sport)	3.9418	3.2773	4.64466	0.3480	11.3275	<0.001	51.510	26.505	104.028

SE, standard error.

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negative aspects of acquired disabilities. For example, people with recently acquired impairments are prone to lower self-efficacy and show low motivation for competitive sports (Greguol et al., 2015; Veldhuijzen van Zanten et al., 2015; Dehghansai et al., 2020). Thus, although post-traumatic growth is often associated with positive psychological outcomes, it is important to consider that this may occur in parallel with the experience of negative traumatic symptoms yet not fully metabolized (Day, 2013). Providing an explanation and interpretation of our results (acquired disabilities reported lower well-being values) by comparing them with the results of previous studies becomes difficult and cumbersome. The main reason is that we have no data that can attest to how long ago the disability was acquired. Additionally, everyone is unique, which will result in different rehabilitation and athletic pathways regardless of the nature of the disability (Molik et al., 2010; Pinder et al., 2023). Finally, our study documented a sport-specific impact on well-being, with individuals taking part in wheelchair basketball, para-athletics, and para-swimming competitions having a higher likelihood of reporting well-being, different from those engaged in wheelchair rugby, who, in turn, exhibited lower well-being compared with controls. In the Paralympic world, there are sports for athletes with a narrow range of impairments. For example, wheelchair rugby is aimed at people with three or four limb disabilities and was introduced for players with more severe mobility impairments who were unable to participate in wheelchair basketball. Furthermore, Boccia is a sport suitable mainly for people with severe cerebral palsy and spinal cord injuries who would hardly find space in other sports. Also, sports such as blind football, judo, and goalball are sports suitable only for visually impaired athletes. These para-sports appear to induce less well-being than sports such as para-swimming and para-athletics which include a broad spectrum of impairments, including physical, vision, and intellectual disabilities. A possible hypothesis regarding this difference could be given by the fact that the degree and type of functional limitation would become the main criterion for choosing one specific sport over another (Molik et al., 2010). Therefore, the emotions associated with sports, which are the key to a long and rewarding career regardless of competitive results, would be lacking. While we speculate that these factors have an influence and can explain our findings, all these parameters should be formally investigated in future high-quality studies.

The significance and the added value of the present study lie in its ability to provide relevant stakeholders with valuable access to real-life data concerning the well-being of para-athletes. By examining and analyzing this data, researchers and practitioners can gain valuable insights into the specific challenges and factors affecting the quality of life of para-athletes. This knowledge, in turn, serves as a foundation for designing targeted interventions that integrate multiple disciplines, such as sports science, psychology, and rehabilitation. Tailoring these interventions to the unique needs and characteristics of different para-sports disciplines is crucial. Each sport may present distinct physical, psychological, and social demands for athletes, requiring specialized approaches to enhance their well-being and performance.

By considering the specific requirements of each para-sports discipline, multi-disciplinary interventions can be crafted to address the challenges faced by athletes, aiming to optimize their overall quality of life. These interventions may include elements such as physical training programs, psychological support, nutritional guidance, assistive technologies, and social inclusion initiatives. The ultimate goal is to empower para-athletes, helping them overcome barriers, maximize their potential, and lead fulfilling lives both within and beyond the realm of sports. In summary, the practical implications of the present study lie in the utilization of real-life data to inform the design of tailored, multi-disciplinary interventions for para-athletes. By considering the unique needs and characteristics of specific para-sports disciplines, these interventions aim to enhance the well-being and overall quality of life for individuals involved, fostering inclusivity, empowerment, and success in both sports and everyday life.

4.1. Limitations and strengths

Limitations of the present study include its cross-sectional study design. Moreover, several para-sports disciplines are not represented and some of those represented may be under-represented. Furthermore, the samples recruited are not representative of the various countries, and it has not been possible to gather data from every European country.

On the other hand, some strengths that should be recognized are the use of validated tools, the large sample size, the cross-country nature of the investigation, the high retention rate of the study, an *a priori* protocol study that was developed and published in a peer-reviewed article (Puce et al., 2017), and a thorough, extensive statistical analysis of the collected data.

5. Conclusions and future directions

This study has made a valuable contribution to enhancing our understanding of the well-being of young para-athletes. It highlights that engaging in competitive sports can have a positive impact on their hedonic well-being, which encompasses aspects related to happiness, pleasure, and positive emotions. The findings suggest that participation in sports can be a significant source of enjoyment and fulfillment for youth with disabilities. However, it is important to note that future studies should consider adopting a longitudinal design rather than a cross-sectional approach. While the present study provides valuable insights, a longitudinal design would allow for a more comprehensive examination of the well-being of young para-athletes over an extended period of time. This would enable researchers to investigate how participation in competitive sports impacts various dimensions of well-being, including not only hedonic well-being but also eudaimonic well-being, which pertains to personal growth, self-realization, and a sense of purpose. A longitudinal study would enable researchers to follow para-athletes' well-being trajectories, capturing changes and fluctuations over time. It could help identify critical periods or developmental milestones when interventions or support systems may be most beneficial. Additionally, a longitudinal approach would allow for the exploration of potential causal relationships between sports participation and well-being, shedding light on the mechanisms through which sports contribute to enhanced well-being among young para-athletes. Such studies would enable researchers and practitioners to develop more targeted interventions and support systems that promote long-term well-being and holistic development among young para-athletes.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving human participants were reviewed and approved by University of Genoa. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LP, CB, NB, and PR conceived and drafted the manuscript. LP and NB collected and analyzed data. LP, CB, MC, DS, LG, CT, LM, KT, MS, NB, and PR revised the manuscript. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Physical activity and sport practice to improve balance control of visually impaired individuals: a narrative review with future perspectives

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Visual disability negatively impacts balance, everyday self-efficacy, and mobility and often leads affected subjects to perceive physical exercise as a burdensome challenge thus discouraging them from practicing. Despite the well-proven benefits of regular physical activity in visually impaired people, especially addressing postural control, there are no specific guidelines and most of the available literature seems to be flawed by critical issues. Given the wide heterogeneity and the multidimensional needs of this population, a more realistic and target-specific perspective is needed in order to properly investigate and promote exercise practice and adherence for balance improvement. On this basis, through a critical overview of the recent literature, the present article aimed to enrich the current knowledge about this topic by providing innovative suggestions, both practical and methodological, and specifically deepening the disability-related deficits and peculiarities of different age ranges. Moreover, since a multidisciplinary approach is advisable when designing and leading exercise protocols tailored to visually impaired individuals, such innovative hints also highlighted the central role of the adapted physical activity specialist, hence contributing to foster its official professional recognition and involvement in this field.

KEYWORDS

visual disability, adapted physical activity, sport practice, balance training, postural control, exercise specialist

Introduction

Global health is currently jeopardized by three main trends, precisely, ageing population, globalization, and technological advance all of which promoting unhealthy behaviors and frames. Inevitably, the growing prevalence of chronic diseases and their risk factors is rapidly becoming a concerning global issue (1, 2). Physical inactivity, currently identified as the fourth leading risk factor for global mortality, is rising worldwide thus negatively affecting general health of all ages population (3–7). Sedentary lifestyle is associated with decreased quality of life and physical functioning, both causing socio-economic and psychophysical burdens on public health and individual daily life (8, 9). In an aging society, visual impairment is an increasingly prevalent condition especially in developed countries because of the uprising incidence of age-related eye diseases and diabetic retinopathy (10–13). Age regardless, vision impairment has been found to be strongly linked with lower everyday self-efficacy/functioning, both psychologically and physically

(14–17) when compared with sighted peers (18–20). In particular, given the disability-related balance and postural control deficit (21–24), visually impaired (VI) individuals show higher risk of falls and accidental injuries (19, 25, 26), therefore perceiving exercise as an overwhelming challenge. Such conditions deeply impact autonomy, social interaction, overall wellbeing, and leisure/sport activity participation (27–32). Despite the well-known benefits of regular physical activity in disabled subjects (33–35), no VI-specific directives are available, and a large proportion of VI individuals does not meet the daily movement guidelines established for the general population (15, 36–39). Fear of falling and postural/proprioceptive control deficiencies play a crucial role in such lack of exercise, frequently leading those individuals to avoid any recreative or sportive physical engagement opportunity (12, 16, 20, 22, 28).

Balance control is the result of an orchestrated integration of visual, vestibular, and proprioceptive input, and deeply affects static and dynamic posture, both in daily life activities and in the recreative/sportive ones (40–43). When alterations occur in even one of those balance-related systems, psychophysical disorders, disabilities, loss of autonomy and functionality inevitably onset (14, 44). It has been widely demonstrated, in all age groups, that regular physical activity improves balance by stimulating proprioceptive postural control, general and segmental coordination, strength, and reaction time (41, 45). Despite the extensive scientific evidence, most studies focused on elderly fall prevention or post-injury and pathological frames rehabilitation, while just a few investigated balance training protocols specifically addressed to VI subjects (10, 46–52). Actually, regarding this target group, many studies deepened the topic more in a social inclusion than in a functional and performative perspective (53–56). Moreover, in case of visual disability, given the high percentage of aging-related onset, the wide range of visual deficit, and the safety purposed need of working out in small class, research often struggled to provide an exhaustive overview of the more effective methodological approaches for this variegated population (57). Visual impairment term includes a broad spectrum of etiology, time of onset and severity level which significantly affect subjective peculiarities and needs (58, 59). In order to provide a global and safe management of such heterogeneity, a multidimensional methodological approach might be preferred. Specifically regarding the training field, protocols should involve both collective and individual sessions, which should be designed, leaded and monitored by an adapted exercise specialist (60, 61).

Given the proved weight of postural control on health and quality of life, especially in case of visual disability (27), an updated review of the current knowledge, enriched with an evidence-based overview of the most innovative tools and technologies, might help designing easily applicable and age-tailored protocols for the VI population.

Specific aims and methods

On the aforementioned basis, the present narrative review aimed to offer not only a comprehensive summary of the recent literature investigating balance training for VI subjects but also innovative cues for future applications in that field. In detail, current balance training methodologies tailored to this target population were deepened in an age range-perspective aiming to provide a specific focus without losing the overall view. Indeed, presenting and discussing, side by side, the current research findings for each age group may ease to identify specific needs and balance sensitive/critical periods, thus guiding and optimizing field-specific investments. Hopefully, such perspective might also provide methodological tools to boost protocol adherence and effectiveness, together with a growing awareness of the central role of the adapted physical activity specialist. Concerning the applied criteria to source the investigated literature, a multiple database search (Pubmed, Web of Science and Scopus) was performed. Specifically, English language papers published from 2000 to 2023 have been found using keywords and sentences such as "visual disability", "physical activity intervention for visually impaired", "visually impaired balance", "balance training and visual impairment", "postural control in blind subjects", "adapted sport and visual disability", and subjectively prioritizing recent investigations and innovative methodological approaches/tools. Moreover, drawn from the identified articles bibliography and using the "similar articles" suggestions provided by scientific database, further literature fulfilling the abovementioned subjective criteria was selected.

Visual impairment implications on postural control

Congenital or acquired visual disability leads to psychophysical development delays and motor pattern alterations that consequently affect postural control (62–64). Posture, strongly linked to stability, balance and functionality, is a multidimensional concept able to impact daily life activities, social interaction, autonomy, and quality of life (65, 66). Motor behaviors, either purposeful or involuntary, are characterized by a bidirectional interplay between the body and the surrounding environment (19, 67). Such inevitable interaction is primarily influenced and driven by visual input, thus giving to this sensory system a crucial role in postural control and adjustments (68–72). Vision is indispensable to provide instant information regarding body-space interaction, movement precision/orientation and motor action timing. Visual impairment often isolates subjects from the external environment thus depriving them of the sensorimotor feedback needed for functional body mechanics acquisition and effective development of postural reflexes (64). The loss of the aforementioned feedback results in postural deviations chiefly characterized by backward leaning trunk, increased dorsal kyphosis, dropped shoulders, head forward compensating position, and valgus flat feet (63, 73, 74). All these anatomo-functional abnormalities, added to uncoordinated limb movements, decreased gait speed, spatial orientation difficulties and body image alteration, lead to faulty motor patterns and dynamic balance control issues (75–78).

Since posture turned out to be a psychosomatic affair, visual impairment can negatively impact not only motricity but also educational and social growth, thus feeding a dangerous vicious cycle (79). Blind children, due to disability-related development delays, exhibit poor body language, and ineffective facial expressions, gestures, and communication (31, 80). Though knowing sport and leisure activities benefits, overprotective parents often prevent them to experience those formative occasions (81–83). Unfortunately, postural control, both in terms of perception and execution, cannot be learnt and mastered without a constant interaction with others in a real environmental context. This lack of learning and peer-interacting opportunities, in addition to boosting fear and frustration, deeply affects postural behaviors (68, 84, 85).

Postural stability is referred to the body skill of maintaining balance and it is often assessed through postural sway analysis and quantification (86, 87). According to research findings, visual disability-affected individuals generally show increased postural sways hence experiencing higher fear of falling (88, 89). Such evaluation tool can help outlining a postural profile in semi-static and study setting, but it is fundamental to remind that human postural control is predominantly motion and reality connected (90). Therefore, balance control of VI individuals should be investigated not only in a fall prevention perspective, but through a comprehensive analysis of the main motor pattern performance in daily life frames, taking into account the disability-related alterations and compensative strategies (91, 92).

Adapted physical activity benefits on balance control in visually impaired individuals

Fundamental motor skills play a key role in learning/development of complex gestures required to effectively perform daily life activities and participate in specific physical activity and sport contexts. Among them, balance and stability skills, both static and dynamic, have the power to influence the correct structuring of motor competence as well as physical fitness level and psychophysical health (93–95).

It has been recently demonstrated that children motor competence perception is more impacting than actual motor abilities on their overall fitness level (96–99). During childhood, physical activity promotes motor skill development and, before self-awareness acquisition, children practice it despite their real competence and results, thus unintentionally increasing motor learning opportunities. After that stage, detectable at about the age of eight, a vicious spiral of physical activity disengagement onsets in children showing low motor competence (100–103). Literature has frequently reported that VI children and adolescents, when compared to sighted peers, tend to conduct a more sedentary life and to exhibit lower physical fitness (20, 31, 62, 104–108). This latter, along with a coherent motor skills impairment, seems to arise mostly from low participation in physical and after-school sport activities (37, 94, 109–111). Similarly, concerns regarding instructor methodological competence, environmental safety, lack of support, convenience and mobility often lead VI adults to not engage in physical/sport activities (112–115). Several studies reported that lower postural stability of VI individuals, compared to sighted ones, is due to the absence of natural compensatory mechanisms based on enhanced non-visual input use for balance control (91, 116–118).

Considering the elderly population, research mainly investigated balance control and fall prevention in healthy subjects affected by age-related visual dysfunctions. Conversely, only a few studies addressed visually disabled individuals highlighting that multimodal exercises can improve their postural control (119, 120). Accordingly, it has been suggested that balance control improvement in sight impaired people requires a conscious behavioral compensation achievable through a targeted training involving balance and navigation skills (121, 122). Based on this evidence, recent research highlighted a positive link between habitual physical activity levels and balance performance in those subjects, as briefly summarized in **Table 1**. In fact, blind individuals regularly practicing physical exercise show more functional gait pattern and perform better in balance and navigation tasks than sedentary peers (111, 122, 148). Precisely, it has been shown that a 12-week specific training protocol can significantly increase blind adults balance performance, thus confirming the effectiveness of adapted physical activity on their postural control and everyday mobility enhancement (149). Regarding VI children and adolescents, a further study detected that higher amount of physical exercise was deeply related to a postural sway decrease and an improvement in single-leg stance time, orientation abilities, and dynamic gait stability (123, 128). Since balance skills and spatial cognitive functions are development-dependent, the interrelation between motor activity and postural control should be especially promoted during childhood and adolescence (132, 133). Exploiting such learning-sensitive phase, the onset of disability-related balance deficit, postural alterations, mobility issues and fall fear could be effectively prevented or counteracted through a ludic, active, and challenging approach. Despite that, there is an evident lack of literature concerning the most effective exercise types, duration and methodologies in the visually disabled population (129). Since these individuals mostly rely on proprioceptive and vestibular input for postural control, to date, it seems that training protocols promoting such vicariant sense recruitment may be more effective (27, 71, 127, 137, 150, 151).

Evidence-based training methodologies and sport activities

Literature specifically addressing balance training for VI people is scarce and presents critical issues often attributed to research design weaknesses or errors, as reported in recent reviews (130, 142, 152). The main intrinsic issues concern the small sample size investigated and the consequent statistical reliability, as well as gender and age imbalance showing a clear predominance of female and elderly participation. In addition, there are almost

TABLE 1 Summary of current knowledge (2000–2023) and future perspectives of balance training for visually impaired individuals.

Investigated age range	Main objectives	Applied methodologies (References)	Demonstrated benefits	Highlighted critical issues (References)	Future perspectives (References)
Children and youth (6–12 years old)	Inclusiveness, general physical fitness, balance, and coordination	Recreational physical activity (123–125), Yoga (126), Dance and Pilates (127)	Psychophysical health, social interaction, autonomy and self-esteem, correct structuring of motor competence, orientation abilities, dynamic gait stability	No specific guidelines, small sample size, protocol shortness, no exercise specialist leading, insufficient family involvement (128–131)	Early proprioceptive training, school-based protocol integration, holistic psychophysical engagement, graduated adapted physical activity specialist involvement (27, 61, 127, 132)
Adolescents and young adults (13–30 years old)	Social integration, general physical fitness, healthy lifestyle promotion	Leisure and general physical activity (133, 134), rope jumping (112)	Fall fear prevention, psychophysical well-being, orientation abilities, dynamic gait stability, single-leg stance time, coordination	No specific guidelines, mall sample size, protocol shortness, no ludic/enjoyable approach, insufficient socio-economic support to families, no adapted exercise specialist leading (54, 128, 130, 135)	Autonomous urban mobility facilitation, blind sport promotion, technological tools, multimodal proprioceptive training, holistic psychophysical engagement, graduated adapted physical activity specialist involvement (27, 56, 61, 136)
Over 50 adults and elderly	Fall prevention, daily life self-efficacy, general health and successful aging promotion, inclusiveness	General balance training and Otago exercise program (60, 119, 120, 122, 137, 138), Tai-Chi (46), Yoga (139), Pilates (140), Dance (27, 49, 141)	Self-efficacy in daily life activities, autonomy, psychophysical well-being and quality of life, postural control, functional gait patterns, navigation skills	Small sample size, age/gender imbalance, protocol shortness, facilities accessibility, no adapted exercise specialist leading, sanitary approach (28, 131, 142–145)	Core stability training, multimodal proprioceptive training, quantitative assessment of functional parameters through wearable devices, virtual reality training, blind sport promotion, graduated adapted physical activity specialist involvement (27, 54, 61, 146, 147)

none quantitative evaluation tools validated for this target population (57), and most of the studies last 8–12 weeks or less, thus being supposed to limit exercise psychophysical benefits and their maintenance over time (131) (**Figure 1**). Actually, if analyzed in a target-specific perspective, those potential limitations frequently reflect the peculiar multidimensional and safety needs of this heterogeneous population. In particular, adapted physical activity protocols tailored to VI subjects should be conceived, leaded and carried on in small groups thus granting collective and individual support, assistance, and safety (61). Regarding overrepresentation of female and elderly participants it must be considered that such proportion simply reflects the real socio-demographic characteristics of the worldwide population affected by visual impairment (58, 153). Finally, concerning protocols duration, it has been demonstrated that balance improvement is more affected by the frequency and peculiarities of the proprioceptive input applied than the intervention length (154, 155). Honestly, targeted physical exercise benefits maintenance, especially in disabled subjects, strongly relies on constant practice over time (156, 157). However, this criticality should not be imputed to study design weakness but more to the scarcity of field-specific investments in term of research funds, blind sports promotion, facilities accessibility, and involvement of adapted physical activity graduated specialists (28, 143–145) (**Figure 1**). Considering this necessary premise, current evidence emerged from interventions aimed to balance improvement in VI individuals are hereafter reported and concisely summarized in **Table 1**. Several studies were fall prevention aimed and, hence, they frequently addressed elderly and over fifty subject sample. As far as the applied methodology is concerned, some interventions used general balance training protocols while others opted for a validated exercise program such as Otago (60, 119, 120, 122, 138, 151). Additionally, recent evidence about Tai-Chi, yoga, Pilates and dance benefits on VI adults and elderly balance highlighted the relevance of a holistic involvement of this target population (27, 46, 49, 139–141). Focusing on research addressing balance improvement of young subjects affected by visual impairment, there is no univocal evidence about preferable or more effective methodologies and activities to apply (128). Therefore, current literature ranges from general physical activity protocols, even school integrated, to coordinative exercise such as rope jumping and holistic disciplines like yoga, dance, and Pilates (112, 124–127, 134). Since balance skills are development sensitive and the perception of motor competences, as well as family support, can deeply impact exercise engagement, adapted sports for VI children and adolescents should become a socio-economic and educational investment priority (56, 136, 158, 159). Finally, there is a variegated body of literature investigating athletes affected by visual impairment, both amateur or competitive, which considered and managed balance control as a crucial sport performance prerequisite (77, 160–169). Given the essential link between dynamic balance, anatomo-functional prerequisites and their on-field/in-game adaptation, it is widely believed that these targeted interventions should be conducted respecting and recalling the real sport specific frame (61).

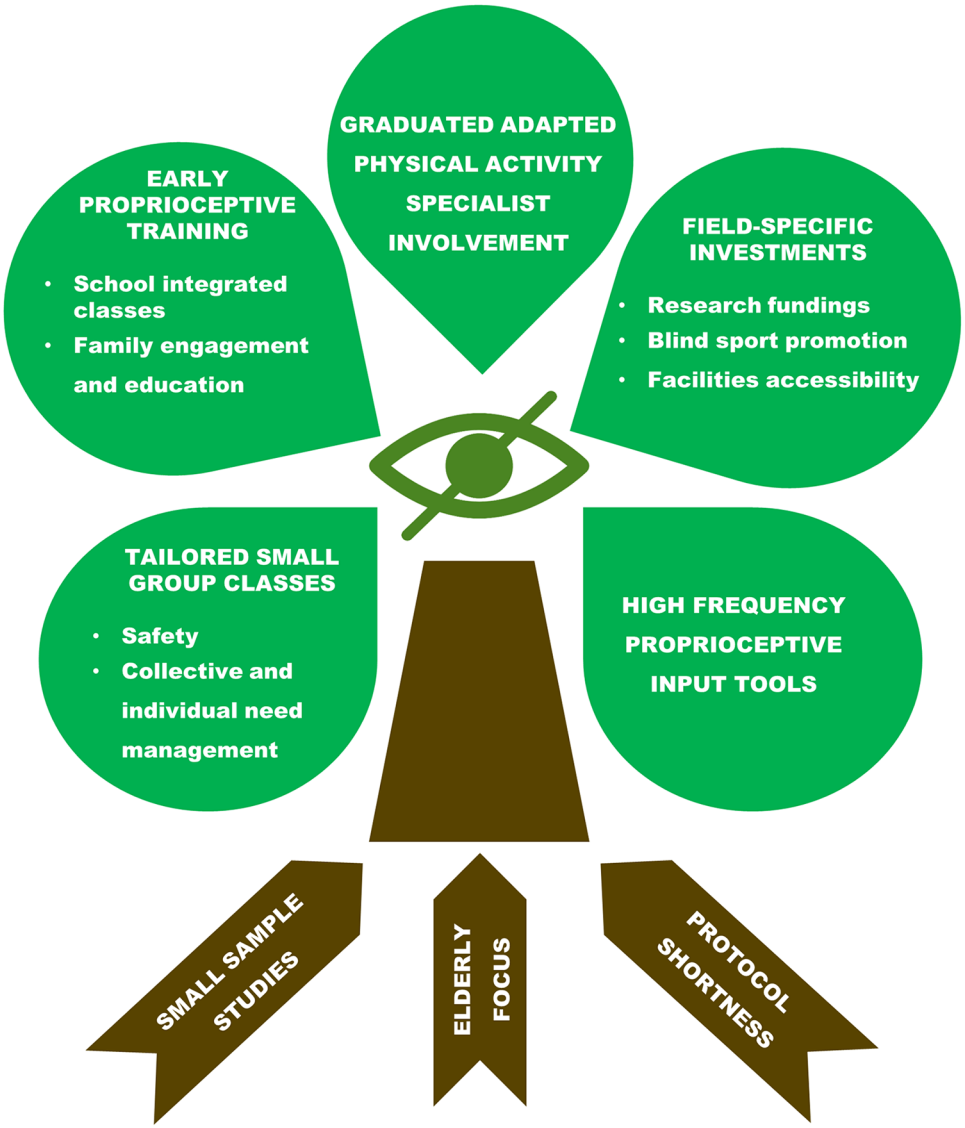

FIGURE 1
Tree diagram of the evidence-based critical issues (brown labels on tree roots) and the related applicable suggestions (green labels on tree crown) to improve balance control of visually impaired individuals through physical activity and sport practice.

Future perspectives and innovations

Although the well documented cause-effect relationship between physical inactivity and overall health parameters maintenance, balance control included, little is still known about visual impairment tailored exercise (170). Recent innovative approaches focused on core stability training, unstable surface utilization and multimodal proprioceptive input have reported findings worthy to be deepened (49, 171–174). At the same time, it is available in literature a rising application of virtual reality and technological tools, like wearable devices, able to monitor physical/functional parameters or to provide haptic and vibration feedback aimed to balance training of VI individuals (146, 147, 175, 176). Despite those few pioneering interventions, the main critical issues are related to the lack of guideline and literature investigating exercise effectiveness in a dose-response perspective on this target population. Indeed, almost all research applied low-intensity physical activities thus frequently overlooking the crucial link between fitness, motor competence perception and anatomo-functional parameters such as postural control (142). In future investigations, though focusing on balance and stability, it should be recommended to integrate such aimed protocols with moderate and vigorous intensity physical activities, hence globally affecting overall fitness and functionality (177). Moreover, there is scarcity of literature investigating the involvement and enjoyment of VI population approaching and consistently carrying on exercise practice (135). Indeed, the complex needs of these subjects require a global management able to consider not only protocols application and effectiveness, but also disability-specific communication and workout leading strategies to make them enjoyable and attractive, ultimately promoting exercise adherence (61, 131, 178). Unfortunately, balance improvement

interventions addressing those who are visual impairment affected are often fall prevention oriented or based exclusively on basic daily life activities and mobility training (4, 5, 12, 14, 15, 41, 48, 179, 180). Despite the undeniable importance of the aforementioned aims, such a mostly sanitary/rehabilitative approach risks to discourage visually disabled individuals, especially youth, to perceive physical exercise as pleasant and worthy of engagement. On the basis of the rising recognition of health-related disparities experienced and reported by disabled people, it becomes crucial to grant them inclusiveness without losing sight both of their integration with healthy population and their peculiar needs (54). Therefore, given the well-known holistic involvement of disabled subjects during exercise practice and the acquired multidisciplinary competences of the graduated adapted physical activity specialists, it is advisable that they become the official professionals operating in such a sensitive field.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

GC: Conceptualization, Writing – original draft, Writing – review & editing. MM: Conceptualization, Writing – original draft, Writing – review & editing. MM: Conceptualization, Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Pandemic-specific coping, anxiety, and depression across multiple waves of COVID-19 in elite athletes with disabilities

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Objectives: Competitive athletes have faced many of the same mental health challenges experienced by the general population during the COVID-19 pandemic. The purpose of the current study was to examine the extent to which pandemic-specific coping predicted anxiety and depression over and above general coping styles in elite athletes with disabilities across multiple waves of the COVID-19 pandemic.

Methods: Participants were 91 athletes (60 men and 31 women) in the Polish Paralympic Preparation Program before the 2020 Tokyo Summer Paralympic Games and 2022 Beijing Winter Paralympic Games. The Coping Inventory for Stressful Situations and an open-ended item asking participants to describe coping resources they had used to overcome stressful situations caused by the pandemic were administered in April 2021, and the Hospital Anxiety and Depression Scale was administered in April, July, and November of 2021.

Results: General coping styles were not significantly associated with pandemic-specific coping, anxiety, or depression in the July and November 2021 assessments. Pandemic-specific coping was related prospectively to both anxiety and depression across the July and November 2021 assessments when controlling for age, gender, general coping styles, and April 2021 anxiety and depression, respectively.

Conclusion: The findings suggest that elite athletes with disabilities may cope with pandemic-related stress differently from how they cope with stress in general and that pandemic-specific coping may be relevant to mental health outcomes during the COVID-19 pandemic. This information may be useful in the development of interventions to assist elite athletes with disabilities cope with pandemics and other atypical stressors.

KEYWORDS

coping styles, mental health, paralympic, COVID-19, anxiety, depression

Introduction

In March 2020, the WHO (2020) declared the disease caused by the SARS-CoV-2 novel coronavirus (i.e., COVID-19) a global pandemic. Nations around the world implemented measures such as social distancing, lockdowns, quarantines, and travel restrictions to reduce the spread of infection. The COVID-19 pandemic and attempts to mitigate its effects had a rapid

and dramatic adverse impact on social, economic, and healthcare systems worldwide (Nicola et al., 2020), producing a vast array of stressors for the public (Xiong et al., 2020; Ciciurkaite et al., 2022).

The COVID-19 pandemic has presented a multitude of challenges for various segments of the population, such as athletes with disabilities, including Paralympic athletes. Research has suggested that athletes with disabilities may be at an increased risk of contracting the virus, especially if their disabilities pertain to respiratory or immune system issues, or involve visual and motor impairments (International Paralympic Committee, 2020; Akashi et al., 2022; Muti et al., 2022). Once infected, the effects of COVID-19 or lockdown measures on these athletes with disabilities can be complex. Beyond the direct health consequences of COVID-19, there can be negative effects on anxiety levels, sleep patterns, eating habits, and other areas of daily functioning (Hall et al., 2021; Taheri et al., 2023a,b). During the COVID-19 pandemic, in addition to the challenges faced by the general population, athletes in general and athletes with disabilities in particular have had to contend with sport-specific stressors. Among these stressors are reduced interactions with coaches and teammates, cancelations or postponements of competitions, and limited access to training facilities. Naturally, these effects have led to decreased physical activity, diminished training volume, and deteriorated physical fitness, which in turn have affected return-to-play decisions and heightened the risk of injury (Hu et al., 2021; Urbański et al., 2021; Vincent et al., 2022). As a consequence, there have been significant setbacks in performance continuity and readiness, resulting in a regression of previously acquired skill levels (Cavaggioni et al., 2022; Puce et al., 2022). In contrast, Shaw et al. (2021) reported no negative impact of COVID-19 on para-athlete training, suggesting that the pandemic did not interfere with training activities, and other studies' investigators have observed that Paralympic athletes actually had a positive reaction to the COVID-19 situation (Clemente-Suárez et al., 2020; Martínez-Patiño et al., 2021). Potential explanations for these discrepant findings include variations in the type and specificity of sports practiced by study participants, use of cross-sectional research designs, timing of data collection in relation to the corresponding phase of the pandemic, and small sample sizes of some of the studies (Puce et al., 2022).

Accompanying the disruptive and stress-inducing effects of the COVID-19 pandemic was a decline in the mental health of the general population marked by increases in anxiety and depression (Vindegaard and Benros, 2020; Xiong et al., 2020). Similar deleterious effects of the pandemic on mental health have been documented in athletes (Denerel and Lima, 2021; Jia et al., 2022; Vincent et al., 2022), especially high-level (i.e., elite) athletes (Jia et al., 2022). A comprehensive meta-analysis by Puce et al. (2022) highlighted numerous areas in which athletes with disabilities have been affected by COVID-19. One factor that may help athletes to mitigate the impact of the COVID-19 pandemic on mental health is coping, which refers to the cognitive and behavioral attempts that people make to manage the demands of situations they perceive as stressful (Lazarus and Folkman, 1984). Coping efforts initiated by athletes in response to the pandemic include adjusting their goals (Costa et al., 2022), engaging in sport training, doing other activities, talking with their coaches (and others), and keeping a positive mindset (Bezzina et al., 2021; Hong and Allen, 2022). Findings from quantitative studies have shown that self-reported use of coping strategies such as receiving social support, maintaining social connections (Graupensperger et al., 2020), cognitive restructuring, keeping emotionally calm (Leguizamo et al., 2021), and mindfulness (Myall et al., 2021) are positively associated with mental health outcomes during the COVID-19 pandemic.

Pété et al. (2022) adopted a person-centered approach to investigate athletes' preferred combination of strategies to cope with the COVID-19 pandemic. Four coping profiles were identified: (a) active and social, (b) avoidant, (c) engaged, and (d) self-reliant. Athletes with the active and social profile reported high levels of cognitive restructuring, distraction, and problem solving. Athletes with the avoidant profile endorsed the use of avoidant strategies such as denial, disengagement, and substance use. Athletes with the engaged profile expressed a preference for problem solving and cognitive restructuring. Athletes with the self-reliant profile reported moderate levels of distraction and cognitive restructuring. The highest level of anxiety was reported by athletes with the avoidant coping profile.

As noted by Pété et al. (2022), athletes have faced "unprecedented and unknown situations with increased risk of exposure to multiple stressors" (p. 238) during the COVID-19 pandemic. The health risks and inequitable effects of pandemic-related restrictions have been especially pronounced among elite athletes with disabilities (Bundon et al., 2022), who have been included in relatively few studies of athlete mental health during the COVID-19 pandemic (Jia et al., 2022). Although athletes with disabilities reported less distress during the pandemic than able-bodied athletes in one study (Fiorilli et al., 2021), persons with disabilities reported experiencing greater pandemic-related stress than persons without disabilities in the general population, and Paralympic athletes reported lower levels of mental health than a sample matched on age and gender from the general population (Busch et al., 2022) in other studies. Moreover, given the uniqueness of the circumstances, it is possible that the item content on standardized coping inventories may not fully capture the range of coping activities with which people engage and that responses to such inventories may not reflect what people do when confronted by the set of stressors characteristic of the COVID-19 pandemic (Urbański et al., 2023). It is, therefore, necessary to consider pandemic-specific coping efforts when investigating the association between coping and mental health outcomes during the pandemic. Consequently, the purpose of the current study was to examine prospectively and for the first time the extent to which pandemic-specific coping was related to anxiety and depression in elite athletes with disabilities when statistically controlling for more general coping tendencies (i.e., avoidance-, emotion-, and task-oriented coping) over multiple assessments.

Methods

Participants

Participants were 91 individuals (60 men and 31 women) enrolled in the Polish Paralympic Preparation Program in advance of the 2020 Tokyo Summer Paralympic Games (held in August and September 2021) and 2022 Beijing Winter Paralympic Games (held in March

2022). Participants reported a wide variety of disabilities: amputation ($n = 26$, 29%), spinal cord injury ($n = 20$, 22%), visual impairment ($n = 16$, 18%), cerebral palsy ($n = 6$, 7%), muscular dystrophy ($n = 1$, 1%), and other ($n = 22$, 24%). Participants represented a wide variety of sports as well, with swimming ($n = 15$, 17%), athletics ($n = 14$, 15%), goalball ($n = 12$, 13%), cycling ($n = 11$, 12%), and fencing ($n = 10$, 11%) reported most frequently. Participants reported a mean age of 31.02 ($SD = 12.04$) years, a mean of 17.85 ($SD = 14.48$) years since the occurrence of their injury or diagnosis of disease, and a mean of 9.56 ($SD = 7.92$) years of Paralympic experience.

Measures

As part of a larger study of psychological responses to the COVID-19 pandemic, participants completed measures of demographic and sport-related variables, coping, anxiety, and depression. Demographic and sport-related variables assessed via a self-report questionnaire included age, gender, disability, duration of disability, sport, Paralympic experience, actual hours of training, and intended hours of training.

Coping with stressors in general was assessed with the Polish version (Strelau et al., 2005) of the Coping Inventory for Stressful Situations (CISS; Endler and Parker, 1994). Responses to the 48 items on the CISS are given on a 5-point Likert-type scale from 1 (*not at all*) to 5 (*very much*). The CISS has subscales measuring avoidance-oriented coping (AO), emotion-oriented coping (EO), and task-oriented coping (TO) over the prior month. Strelau et al. presented support for the reliability and validity of the Polish version of the CISS, including Cronbach's alpha coefficients ranging from 0.74 to 0.88. In the current study, Cronbach's alpha coefficients of 0.88, 0.92, and 0.92 were obtained for the AO, EO, and TO subscales, respectively. The Polish version of the CISS was used to assess coping during the COVID-19 pandemic in a previous study (Rogowska et al., 2021). To assess coping specific to the COVID-19 pandemic, participants were asked to describe coping resources they had used to overcome stressful situations caused by the pandemic. An open-ended item was used due to the novelty of the pandemic situation and the lack of an appropriate extant measure of the construct for athletes with disabilities.

Anxiety and depression were assessed with the Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983), which has frequently been used for this purpose in samples of persons with disabilities (Woolrich et al., 2006). The HADS consists of two 7-item subscales measuring anxiety (HADS-A) and depression (HADS-D), respectively. Responses to HADS items are given on a scale from 0 (*very rarely*) to 3 (*often*). Thus, total scores on the HADS-A and HADS-D range from 0 to 21. Higher scores on the HADS-A and HADS-D correspond with higher levels of anxiety and depression, respectively. Cronbach's alpha coefficients in the current study were 0.81 for the HADS-A and 0.72 for the HADS-D.

Procedure

This study adhered to the Declaration of Helsinki of the World Medical Association and received approval from the Ethical Committee of Poznań University of Medical Sciences (KB-742/21). A longitudinal research design was implemented such that data were collected during two waves of a high COVID-19 infection rate in Poland (April 2021 and November 2021) and one wave of a low COVID-19 infection rate in Poland (July 2021). Initially, athletes involved in the Polish Paralympic Preparation Program were recruited for participation electronically and were sent an online survey link on the Google Forms platform in April 2021. Survey completion reminders were sent for a two-week period. Participants gave informed consent prior to completion of the survey. The survey included the questionnaire requesting demographic and sport-related information, the CISS, the pandemic-specific coping item, and HADS. The online surveys for which links were sent to participants in July 2021 and November 2021 both included the HADS.

Data analysis

Descriptive statistics were calculated for the demographic- and disability-related variables, the CISS, and the HADS. A content analysis was performed on responses to the pandemic-specific coping item in which, after an initial examination of the data, a preliminary set of 10 general categories was identified, clarified through discussion between two investigators, and subsequently consolidated into six categories. Two independent raters then placed the open-ended responses into the categories and reached consensus. For participants who provided responses in two or more categories, only the first category identified was used in subsequent analyses.

To examine the extent to which differences in pandemic-specific coping in April 2021 were related prospectively to anxiety in July 2021 and November 2021, a mixed analysis of covariance (ANCOVA) with one within-subjects factor (i.e., time of assessment: July 2021 and November 2021), one between-subjects factor (i.e., pandemic-specific coping category), and six covariates (i.e., age, gender, April 2021 HADS-A scores, and CISS AO, EO, and TO scores) were performed on HADS-A scores. A parallel mixed ANCOVA was performed on HADS-D scores, substituting April 2021 HADS-D scores for April 2021 HADS-A scores as a covariate. An identical approach was taken for the longitudinal analyses comparing HADS scores in November 2021. A MANOVA was also conducted to compare April 2021 CISS AO, EO, and TO scores across pandemic-specific coping categories. Statistical analyses were conducted with IBM SPSS Statistics (Chicago, IL, United States) version 26.

Results

Means and standard deviations of HADS-A and HADS-D scores for every pandemic-specific coping category are presented in Table 1. Responses to the pandemic-specific coping item tended to be brief, with a mean of 4.10 ($SD = 4.72$) words, a median of 2 words, and a mode of 1 word ($n = 38$, 42%). In the content analysis, six categories of responses to the pandemic-specific coping item were identified: cognitive coping ($n = 44$), social engagement ($n = 17$), no coping resources needed or listed ($n = 11$), maintaining composure/calmness ($n = 9$), distracting/engaging/sport behavior ($n = 9$), and other coping strategies ($n = 1$). Examples of cognitive coping included "optimism," "positive attitude," and "rational approach." Examples of social

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TABLE 1 Means (and standard deviations) of HADS-A and HADS-D scores for pandemic-specific coping categories.

Variable		Pandemic-specific coping category				
		Cognitive coping (*n*=44)	Composure/ calmness (*n*=9)	Distracting behavior (*n*=9)	Social engagement (*n*=17)	No coping needed or listed (*n*=11)
HADS-A						
	April 2021	5.41 (3.81)	7.33 (3.67)	5.22 (3.87)	6.24 (3.11)	5.70 (3.65)
	July 2021	4.09 (3.50)	6.44 (6.04)	4.56 (3.32)	5.76 (2.93)	5.36 (3.72)
	Nov. 2021	4.93 (2.65)	5.78 (2.49)	5.11 (3.06)	6.29 (2.54)	7.18 (3.13)
HADS-D						
	April 2021	3.45 (2.59)	4.67 (3.24)	3.33 (3.57)	4.82 (3.91)	4.18 (4.31)
	July 2021	3.39 (2.95)	6.44 (5.74)	3.89 (3.33)	4.76 (3.87)	4.64 (4.13)
	Nov. 2021	4.05 (2.71)	5.00 (1.80)	6.33 (4.27)	6.00 (3.14)	6.45 (3.21)

TABLE 2 Summary of mixed ANCOVA for HADS-A scores.

	Wilks' lambda	*F*	df	*p*	Partial eta-squared
Multivariate within-subjects tests					
Time	1.00	0.07	1,66	0.79	0.00
Time X age	1.00	0.10	1,66	0.76	0.00
Time X gender	0.99	0.79	1,66	0.38	0.01
Time X CISS-AO	1.00	0.01	1,66	0.93	0.00
Time X CISS-EO	0.97	1.77	1,66	0.19	0.03
Time X CISS-TO	0.99	0.89	1,66	0.35	0.01
Time X April 2021 HADS-A	0.89	7.87	1,66	0.007	0.11
Time X pandemic-specific coping category	0.95	0.81	1,66	0.52	0.05
Between-subjects tests					
Age		3.32	1,66	0.08	0.05
Gender		0.09	1,66	0.76	0.00
CISS-AO		0.41	1,66	0.52	0.01
CISS-EO		3.33	1,66	0.07	0.05
CISS-TO		0.01	1,66	0.92	0.00
April 2021 HADS-A		48.81	1,66	0.00	0.43
Pandemic-specific coping category		2.54	4,66	0.048	0.13

engagement included "talking to beloved ones," "conversation," "family support," and "contact with friends." Examples of maintaining composure/calmness included "composure" and "calmness." Examples of distracting/engaging/sport behavior include "hobby," "reading books," and "sport training." The lone participant whose response was in the "other coping strategies" category was excluded from subsequent analyses.

Results of the ANCOVA comparing HADS-A scores of the five pandemic-specific coping categories across the July 2021 and November 2021 assessments are summarized in Table 2. Non-significant findings were obtained for the multivariate within-subjects tests of the time main effect ($p=0.79$) and the interactions between time and gender ($p=0.38$), AO coping ($p=0.93$), EO coping ($p=0.19$), TO coping ($p=0.35$), and pandemic-specific coping ($p=0.52$). Non-significant between-subjects effects were found for the age ($p=0.08$), gender ($p=0.76$), AO coping ($p=0.52$), EO coping ($p=0.07$), and TO coping ($p=0.92$) covariates. Significant effects were obtained for the interaction between time and HADS-A scores ($p=0.007$), the April 2021 HADS-A score covariate ($p<0.001$), and the between-subjects effect of the pandemic-specific coping category ($p=0.048$, partial-eta squared = 0.13). Paired comparisons revealed that participants in the no coping resources needed or listed category had significantly higher HADS-A scores than participants in the cognitive coping ($p=0.01$) and maintaining composure/calmness ($p=0.03$) categories across the July 2021 and November 2021 assessments.

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TABLE 3 Summary of mixed ANCOVA for HADS-D scores.

	Wilks' lambda	*F*	df	*p*	Partial eta-squared
Multivariate within-subjects tests					
Time	1.00	0.50	1,79	0.48	0.01
Time X age	0.99	0.63	1,79	0.43	0.01
Time X gender	0.95	4.43	1,79	0.04	0.05
Time X CISS-AO	1.00	0.17	1,79	0.69	0.00
Time X CISS-EO	1.00	0.18	1,79	0.68	0.00
Time X CISS-TO	1.00	0.16	1,79	0.70	0.00
Time X April 2021 HADS-D	0.90	8.65	1,79	0.004	0.10
Time X pandemic-specific coping category	0.89	2.32	1,79	0.06	0.11
Between-subjects					
Age		0.00	1,79	0.98	0.00
Gender		5.39	1,79	0.02	0.06
CISS-AO		0.19	1,79	0.66	0.00
CISS-EO		2.54	1,79	0.12	0.03
CISS-TO		0.66	1,79	0.42	0.01
April 2021 HADS-D		70.95	1,79	0.00	0.48
Pandemic-specific coping category		2.54	4,79	0.048	0.12

Results of the ANCOVA comparing HADS-D scores of the five pandemic-specific coping categories across the July 2021 and November 2021 assessments are summarized in Table 3. Non-significant findings were obtained for the multivariate within-subjects tests of the time main effect ($p = 0.48$) and the interactions between time and age ($p = 0.43$), AO coping ($p = 0.93$), EO coping ($p = 0.19$), TO coping ($p = 0.35$), and pandemic-specific coping ($p = 0.06$). Non-significant between-subjects effects were found for the age ($p = 0.98$), AO coping ($p = 0.66$), EO coping ($p = 0.12$), and TO coping ($p = 0.42$) covariates. Significant effects were obtained for the interaction between time and gender ($p = 0.04$), the interaction between time and April 2021 HADS-D scores ($p = 0.004$), the April 2021 HADS-D score covariate ($p < 0.001$), the gender ($p = 0.02$) covariate, and the between-subjects effect of the pandemic-specific coping category ($p = 0.048$, partial-eta squared = 0.12). Paired comparisons revealed that participants in the cognitive coping category had significantly lower HADS-D scores than participants in the no coping resources needed or listed ($p = 0.01$) and distracting/engaging/sport behavior ($p = 0.03$) categories across the July 2021 and November 2021 assessments. The MANOVA comparing April 2021 CISS AO, EO, and TO scores across pandemic-specific coping categories revealed a non-significant multivariate effect and no statistically significant univariate effects.

Discussion

In this study, the extent to which pandemic-specific coping was predictive of anxiety and depression in elite athletes with disabilities over and above general coping styles across multiple waves of the COVID-19 pandemic was investigated. Toward this aim, general coping styles were measured with a standardized self-report inventory and pandemic-specific coping was assessed with an open-ended item to capture unique efforts directed at dealing with stressors associated with the COVID-19 pandemic. Although analysis of participants' open-ended responses resulted in coping categories that bore at least superficial resemblance to the AO, EO, and TO coping styles assessed with the CISS, the pandemic-specificity of the categories was supported by the lack of significant differences on the AO, EO, and TO subscales across the categories. Thus, participants who generally tended to engage in EO coping, for example, did not necessarily report using social engagement to deal with the COVID-19 pandemic. This finding aligns with the transactional model of stress and coping (Lazarus and Folkman, 1984) in that the novelty and unpredictability of the COVID-19 pandemic may have influenced cognitive appraisals of the situation and subsequent coping efforts in atypical ways.

General tendencies for AO, EO, and TO coping were significantly related to neither anxiety nor depression in the prospective, longitudinal analyses. These findings contrast with those of other studies in which general measures of coping were associated with mental health outcomes during the COVID-19 pandemic (Graupensperger et al., 2020; Leguizamo et al., 2021; Myall et al., 2021). Conversely, pandemic-specific coping was associated prospectively with both anxiety and depression when statistically controlling for age, gender, general coping styles, and the April 2021 values for anxiety and depression, respectively, during July 2021 and November 2021. The difference between the findings of the current study and those of previous studies may be attributable to the fact that although the participants in the investigations of Graupensperger et al. (2020), Leguizamo et al. (2021), and Myall et al. (2021) were high-level athletes, they were

not athletes with disabilities. The COVID-19 pandemic may affect athletes with disabilities in unique ways that, consistent with the transactional model of stress and coping (Lazarus and Folkman, 1984), prompt coping efforts that diverge from the population of athletes in general (Puce et al., 2022).

The cross-group differences in anxiety were most pronounced between participants in the cognitive coping and maintaining composure/calmness groups and those in the no coping needed or listed group. These results speak to the potential long-term disadvantages of failing to deploy coping attempts and the advantages of cognitive coping and maintaining composure/calmness in the context of the COVID-19 pandemic. Participants in the cognitive coping and maintaining composure/calmness groups may have drawn upon their April 2021 coping experience to deal with pandemic-related stress in July and November, whereas participants in the no coping needed or listed group may have been unprepared to address pandemic-related stress in July and November 2021. As with anxiety, cognitive coping was associated with favorable outcomes for depression across the July 2021 and November 2021 assessments. Participants in the cognitive coping group reported lower levels of depression than those in the distracting/engaging/sport behavior and the no coping needed or listed groups. It is noteworthy that cognitive coping appeared not only to be an adaptive response to pandemic stress, but was also the most commonly indicated mode of dealing with the COVID-19 pandemic among the Polish athletes with disabilities in the current study. These findings align with the results of Fiorilli et al. (2021), which also pointed to the resilience and adaptability of disabled athletes during pandemic-related adversities. It is also important to note that coping effectiveness during this period might have been influenced by other factors not explored in these studies. Factors like motivation can drive engagement, including participation in physical activities and sports and the capability to overcome pandemic-related barriers (Han et al., 2021; Silva et al., 2022; Van Biesen and Morbee, 2023).

The elite Paralympic sample and prospective longitudinal assessments are clear strengths of the study, adding to the small body of research on coping and mental health in athletes with disabilities during the COVID-19 pandemic. Nevertheless, several limitations should be considered when interpreting the results. First, data were collected exclusively through self-report methods that are susceptible to the potential effects of forgetting and socially desirable responding, which may have affected the accuracy of the data. In future studies, observational methods and other approaches to data collection that do not rely solely on self-report should be considered to bolster confidence in the results. Second, the open-ended item used to assess pandemic-specific coping and the categorization scheme that was used to analyze responses to it have not been used previously and, therefore, have not been validated. Further inquiry is needed to determine the extent to which responses to the item reflect what respondents actually do to deal with the COVID-19 pandemic. Third, although the survey used in the study was sent to the entire population of participants in the Polish Paralympic Preparation Program, the sample size was smaller than would have been ideal for an investigation of this sort. Larger samples should be used in future research to increase both generalizability and statistical power. Fourth, given that participants were exclusively elite athletes with disabilities, the findings may not generalize to athletes with disabilities in general. Fifth, although a prospective longitudinal research design was used, three data collection episodes may not have been sufficient to adequately assess the full range of changes in coping and mental health over time. More frequent data collection episodes should be used in future research on the topic. Sixth, because a correlational research design was used in the current study, it is not possible to draw causal inferences from the findings. Experimental research designs should be used in future investigations to determine the extent to which various coping strategies influence the anxiety and depression of elite athletes with disabilities during a pandemic.

In addition to addressing the specific limitations of the current study, several more general suggestions for future research on the association between coping and mental health in the context of the COVID-19 pandemic are warranted. In line with the recommendations of Puce et al. (2022), it will be important for subsequent studies to engage the communities of interest in developing research questions and conducting the research, use psychometrically-sound instruments developed for the purpose and population under investigation, and implement multi-center, cross-national research designs.

Conclusion

From an applied standpoint, the current findings suggest that during a pandemic, elite athletes with disabilities may use coping strategies that deviate from how they normally cope with more ordinary stressors, and that enlisting pandemic-specific coping resources may reap mental health rewards over the course of multiple waves of increased infection. Participants in the current study gravitated toward cognitive coping strategies, a choice made in April 2021 that was associated with low levels of anxiety 7 months later in November 2021. Future experimental research is needed to evaluate the relative merits of various coping strategies in producing adaptive mental health outcomes during a pandemic for elite athletes with disabilities. Such research would contribute to the development of interventions to assist elite athletes with disabilities to cope with pandemics and other atypical stressors.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study was carried out in accordance with the Declaration of Helsinki of the World Medical Association and was approved by the Ethical Committee of Poznan University of Medical Sciences (KB-742/21). Written informed consent to participate in this study was provided by the patient/participants.

Author contributions

PKU: Writing – original draft, Writing – review & editing, Conceptualization, Investigation. TT: Writing – review & editing. BWB: Writing – original draft, Writing – review & editing, Conceptualization, Investigation.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Changes in neuromuscular activation, heart rate and rate of perceived exertion over the course of a wheelchair propulsion fatigue protocol

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Shoulder pain is common in persons with spinal cord injury and has been associated with wheelchair use. Fatigue related compensation strategies have been identified as possibly impacting the development of shoulder injury and pain. The purpose of this study was to investigate the progression of performance fatigability (i.e., decline in objective measure of performance including neuromuscular activation and increase in heart rate) and perceived fatigability (i.e., increased perceived exertion) during a 15-min fatigue protocol including maximum voluntary overground wheelchair propulsion. Fifty participants with paraplegic spinal cord injury completed three 4-min rounds of wheelchair propulsion, separated by 90 s of rest, on a figure-8 course consisting of two turns and full stops per lap in their manual wheelchairs (ClinicalTrials.gov: NCT03153033). Electromyography (EMG) signal of five muscles acting on the shoulder joint, heart rate (HR), and rate of perceived exertion (RPE) were measured at the beginning and end of every 4 min of propulsion. Root Mean Square (RMS) and Mean Power Frequency were calculated from EMG data. There was a significant increase in %RMS of the pectoralis major pars sternalis and trapezius pars descendens, HR, and RPE with greatest changes during the first 4 min of the protocol. The observed changes in neuromuscular activation in only two of the shoulder muscles may impact muscular imbalances and the development of shoulder injuries and should be further studied. The current study gives clearer insight into the mechanisms of performance fatigability and perceived fatigability throughout a wheelchair propulsion fatigue protocol.

KEYWORDS

spinal cord injury, shoulder pain, wheelchair propulsion, performance fatigability, perceived fatigability, neuromuscular activation

1 Introduction

Shoulder pain is a common problem in individuals with spinal cord injury (SCI) with a prevalence ranging from 36% to 70% (Gironda et al., 2004; Bossuyt et al., 2018) and chronic tendon degeneration is present in almost all wheelchair users (Arnet et al., 2022b; Jahanian et al., 2022). Socio-demographic factors like age (Alm et al., 2008) and gender (Bossuyt et al., 2018), characteristics of injury including level of injury (Sinnott et al., 2000), SCI severity and duration (Finley and Rodgers, 2004), and wheelchair use have all been associated with shoulder pathology and pain (Bossuyt et al., 2018). Even though previous studies showed that participation in wheelchair sports improves physical function and quality of life in individuals with SCI (McVeigh et al., 2009; Anneken et al., 2010) and Fullerton et al. (2003) describes possible protective mechanisms present in wheelchair athletes compared to their non-athletic counterparts the shoulder is a common site of complaints (Webborn and Emery, 2014; Heyward et al., 2017). Participation in wheelchair sports may lead to an increased risk of arm injury (Diaz et al., 2019). Karasuyama et al. (2022) states that factors and mechanisms of shoulder pain in wheelchair basketball are difficult to identify due to the presence of multiple potential factors. A systematic review by Heyward et al. (2017) came to the same conclusion and lists the following potential factors and underlying mechanisms for shoulder problems in wheelchair sports in general: overuse, weakness in shoulder adductors, internal and external rotators, decreased trunk control, poor driving posture in the wheelchair, poor scapular kinetics and muscular imbalances. Injury, pain and subsequent loss of mobility can influence a person's independence and decreases quality of life (Gutierrez et al., 2007). Therefore, it is important to find the causes and develop preventive strategies.

Wheelchair propulsion is a demanding, repetitive activity which can result in fatigue (Mercer et al., 2006). It was indicated that repetitive mechanical loading of tendons alters the biochemical tissue responses possibly leading to tissue injury (Devkota and Weinhold, 2010). To this effect, acute (Porter et al., 2020) and long-term (Pozzi et al., 2022) supraspinatus tendon changes have been shown to occur in response to repetitive loading. These and other findings lead to the theory of repetitive mechanical load being one of the main factors to predict tendon related pain (Lewis, 2010). Repetitive fatiguing propulsion is a part of everyday wheelchair use as well as many wheelchair sports including wheelchair basketball, racing, rugby and tennis. With fatigue, the neuromuscular system is unstable and susceptible to injury (Pol et al., 2019). Arnoczky (2007) argue that fatigue or altered kinematics during repetitive load could lead to single or repetitive abnormal loading cycles causing damage to the tendon. With respect to the shoulder, fatigue can lead to different factors causing shoulder pain in people with SCI, such as alteration of the position of the humeral head (Chopp et al., 2010), alteration of scapulothoracic and glenohumeral kinematics (Ebaugh et al., 2006), decrease in shoulder proprioception (Lee et al., 2003) and acute changes in thickness of the supraspinatus and long biceps tendon (Bossuyt et al., 2020b).

Enoka and Duchateau (2016) describe fatigue as a global symptom rather than a decrease in performance of a specific structure. In their taxonomy two attributes of fatigue are acknowledged: performance fatigability and perceived fatigability. This definition of fatigue and fatiguability was adopted for the study at hand. Performance fatigability depends on the contractile capabilities of the muscles involved and the capacity of the nervous system to provide adequate activation and feedback for a given task. This can be quantified with changes in heart rate (HR) representing a global parameter of fatigability, muscular activation through electromyography (EMG: quantified by mean power frequency (MPF) and root mean square (RMS) (De Luca, 1997)), and isometric or dynamic force both local parameters for fatigability. Perceived fatigability on the other hand depends on the initial value and rate of change in subjective sensations and focuses on homeostasis and the psychological state which can be quantified with the rate of perceived exertion (RPE) (Borg, 1990) representing another global parameter. It remains unclear how these global and local parameters of fatigability relate in manual wheelchair users.

Investigating the effect of fatigue on shoulder muscles can provide further insights into injury risk. Although it would be ideal to observe the effect of fatigue during daily life or game play (van Drongelen et al., 2007), the measurements that can be performed in these settings are limited and the level of standardisation is lower compared to a laboratory setting. With fatigue being highly task dependent, it is important for potential test protocols to be close to activities of daily life or game play (Barry and Enoka, 2007). A figure-8 fatigue protocol (F8F) developed by Collinger et al. (2010a) is executed on level ground in the participants' own wheelchair bringing the measurement of wheelchair propulsion induced fatigue closer to everyday activities. The protocol includes accelerations, deceleration, full stops and turns, which is closer to the conditions of everyday wheelchair propulsion and the training exercises included in several wheelchair sports and therefore potentially more relevant than fatigue measured during isometric or cyclic wheelchair propulsion movements (Collinger et al., 2010a). The short duration of F8F (15 min) and minimum requirement of equipment, make it a time-efficient and low-cost protocol that could be included in prospective cohort studies and assessments of wheelchair athletes to give, for example, guidance on readiness to return to play following an injury.

Studies using the F8F showed that the protocol resulted in (1) changes in biceps and supraspinatus tendon appearance (Collinger et al., 2010b; Bossuyt et al., 2020b), (2) shorter contact time in the first stroke of start-up propulsion (Bossuyt et al., 2020d), and increased neuromuscular activation in the M. pectoralis major, M. deltoideus and M. trapezius pars descendens as well as changes in stroke angle (Bossuyt et al., 2020a). To date, however, no study has investigated changes in muscle activity during the F8F itself limiting our understanding of the time-course of the development of performance and perceived fatigability. Therefore, the aim of this study was to investigate the progression in performance fatigability and perceived fatigability throughout the F8F and to investigate the relationship between local and global parameters of fatigability. We propose the following hypotheses: There will be significant changes in performance fatigability measured by mean power frequency (MPF) and root mean square (RMS) of the EMG signal of shoulder muscles and by HR throughout the F8F. Furthermore, there will be significant changes in perceived fatigability measured by RPE and significant correlation between local and global parameters of fatigability will be found.

2 Materials and methods

2.1 Study design and study population

This study, with a quasi-experimental one-group pretest-posttest design, was part of a larger project registered at

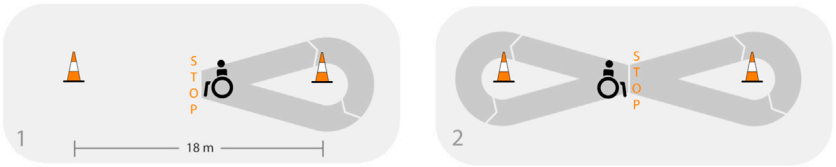

FIGURE 1
Adapted from Arnet et al. (2022a), licensed under CC BY 4.0: Illustration of one lap of the figure-8 protocol.

ClinicalTrials.gov (Identifier: NCT03153033; Registration date: 15 May 2017) (Bossuyt et al., 2020a; Bossuyt et al., 2020c; Bossuyt et al., 2020d; Arnet et al., 2022a). Ethical approval was granted by the Ethikkommision Nordwest-und Zentralschweiz (Project-ID: 2017-00355). A total of 50 participants were recruited via the Swiss Spinal Cord Injury Cohort Study (SwiSCI) database. Included for participation were individuals with diagnosed paraplegia (injury level T2 or below), nonprogressive traumatic or atraumatic SCI, 1 year or more after completion of inpatient rehabilitation, aged between 18 and 65, daily use of a manual wheelchair and no required support for moving around more than 100 m in a wheelchair. Exclusion criteria were as follows: patients in palliative care, congenitally caused SCI, neurodegenerative disorders or Guillain-Barré syndrome, pain in the upper limbs that restricts wheelchair propulsion, past shoulder, elbow or wrist fractures or dislocations that cause symptoms, history of cardiopulmonary problems that could be worsened by demanding physical activity.

2.2 Procedure

Written informed consent was obtained from all patients prior to the 4 h testing session which took place in the biomechanical laboratory at the Swiss Paraplegic Research. Participants were instructed to avoid strenuous exercise 48 h before the testing day. After familiarization with the procedures, several assessments were conducted before, during and after the F8F as part of the overall project and not further analyzed for this paper. The standardized procedures prior to the F8F lasted for about 3 h and included preparations for EMG and kinematic measurements, completion of questionnaires, wheelchair propulsion (15 m sprint and propulsion on a treadmill) and ultrasound examination of the shoulder. For further details on these assessments, which will not be part of the analysis in the current study, please consider the following publications: Bossuyt et al. (2020a); Bossuyt et al. (2020b); Bossuyt et al. (2020d); Arnet et al. (2022a). These previous studies published results from this dataset including changes in treadmill propulsion biomechanics and ultrasound measures of shoulder tendons and acromiohumeral distance before and after the F8F.

2.3 Figure-8 fatigue protocol

The F8F consists of three repetitions of 4 min of wheelchair propulsion along a figure-8 shaped course with 90 s of rest in between (Collinger et al., 2010a). Two cones were placed 18 m apart and the starting point as well as the direction of the 2 turns were marked on the floor. Participants were instructed to propel as many laps as possible in 4 min. Every lap includes a right and left turn and 2 full stops at the crossing point (Figure 1). Instructions and motivational input given during the protocol were standardized.

2.4 Data collection

Socio-demographic, personal and injury related information were self-reported. Muscle activity was recorded during the first and last 30 s of each 4 min propulsion of the F8F with the use of surface EMG (Telemyo 2400T Direct Transmission System, 305 Noraxon, Inc. United States) of the M. biceps brachii, M. pectoralis major pars sternalis, M. deltoideus pars acromialis, M. trapezius pars descendens and pars ascendens on the non-dominant side in accordance to the SENIAM guidelines (Hermens et al., 2000). The non-dominant side was chosen to minimize the influence of handedness. A wireless system and self-adhesive snap bipolar AG/AgCL surface electrodes were used to record EMG data at 1,500 Hz. HR was measured using a heart rate monitor Polar H800 (Polar, Electro, Finland) and RPE was captured with a 20 point Borg scale (Borg, 1990). Both parameters were measured and written down before and after every 4 min session of the F8F.

2.5 Data analysis

Raw EMG signals were offset corrected, rectified, filtered with a high pass (20 Hz) and low pass (3 Hz) 3rd order Butterworth filter. Smoothing was executed using moving average (0.05 s 50% overlap) (Supplementary Figure S1). This generated linear envelope was used to calculate the RMS which is expected to increase with fatigue (De Luca, 1997). The MPF, which is expected to decrease with fatigue (De Luca, 1997), was calculated using the raw EMG data. RMS and MPF of all six measurements of the five muscles were calculated with a short-time Fourier transformation (MacIsaac et al., 2001). RMS and MPF signals were calculated as a percentage of the initial RMS and MPF.

2.6 Statistical analysis

Statistical analysis was done with Statistical Package for the Social Sciences (SPSS Statistics 26, IBM). The hypotheses were tested with one-way repeated measure analysis of variance (ANOVA). The dependent variables were MPF and RMS and the independent

TABLE 1 Characteristics of the included participants and the participants excluded due to technical problems.

	Included (N = 43)	Excluded (N = 7)
Age (years)	50.2 ± 10.1	52.6 ± 6.8
Height (m)	173.9 ± 7.7	172.3 ± 9.2
Weight (Kg)	72.1 ± 13.3	74.3 ± 14.2
Time since injury (years)	27.1 ± 11.6	24.0 ± 12.5
Age at injury (years)	23.1 ± 10.1	28.6 ± 9.4
Sex (n, %) male	35 (81%)	4 (57%)
female	8 (19%)	3 (43%)
Cause of injury (n, %) traumatic	40 (93%)	6 (86%)
non-traumatic	3 (7%)	1 (14%)
Completeness (n, %) complete	7 (16%)	4 (57%) *
incomplete	36 (84%)	3 (43%) *
Dominant Hand (n, %) right	40 (93%)	7 (100%)
left	3 (7%)	0
Lesion level (n, %) T2-T6	18 (42%)	2 (29%)
T7-T12	18 (42%)	4 (57%)
L1-L5	7 (16%)	1 (14%)

* indicating significant difference between included and excluded group, $p < 0.05$.

variable was time (6 time points representing the beginning and end of every 4 min of the F8F). If Mauchly's test of sphericity was significant, Greenhouse Geisser Corrected *p*-values were used. If statistical significance was found, pairwise comparisons with Bonferroni corrections were used. Correlation coefficients (Spearman- or Pearson-Test) between changes in HR, RPE and RMS of muscles with significant effects for time, were calculated and interpreted according to the recommendation of Dancey and Reidy (2007) defining values 0.1 to 0.3 (−0.1 to −0.3) as weak, 0.4 to 0.6 (−0.4 to −0.6) as moderate and 0.7 to 0.9 (−0.7 to −0.9) as strong correlations. The level of significance was set to $p < 0.05$.

3 Results

Due to technical problems with the EMG, 7 of the 50 participants had to be excluded. Data of 43 participants were investigated (age: 50.2 ± 10.1 years, weight: 72.1 ± 13.3 kg, TSI: 27.1 ± 11.6 years, cause of injury: 93% traumatic, completeness: 84% incomplete, lesion level: 42% T2-T6, 42% T7-T12, 16% L1-L5, dominant hand: 93% right handed). Subject characteristics of the included participants did not significantly differ from the excluded participants except with regards to completeness of injury with 84% of the included participants had an incomplete injury compared to 43% in the excluded group (Table 1). During the F8F protocol, the participants completed 9.6 ± 1.4 laps (mean, SD) in the first bout of the protocol, 9.8 ± 1.4 in the second bout and 9.9 ± 1.5 in the last bout.

The Greenhouse Geisser corrected repeated measure ANOVA's showed a significant effect of time for HR (F (2.58, 105.58) = 378.88, $p < 0.001$, partial $\eta^2 = 0.90$), RPE (F (2.81, 117.99) = 199.12, $p < 0.001$, partial $\eta^2 = 0.83$) (Figure 2), RMS of M. trapezius pars descendens (F (1.83,71.31) = 9.01, $p < 0.001$, partial $\eta^2 = 0.19$) (Supplementary Figure S2) and RMS of M. pectoralis major pars sternalis (F (1.90, 72.05) = 8.50, $p < 0.01$, partial $\eta^2 = .18$) (Supplementary Figure S3). Post-hoc test results are reported in Figure 2 and Supplementary Figure S2, S3. No significant effects were found for the RMS of M. deltoideus pars accromialis (F (2.42,94.55) = 1.65, $p = 0.191$), M. trapezius pars ascendens (F (3.09, 120.57) = 0.946, $p = 0.423$), and M. Biceps brachii (F (3.67, 135.86) = 1.85, $p = 0.129$) (Figure 3). No significant effects were found for MPF of the five measured muscles.

Weak to moderate correlations were found between changes in HR and RPE as well as between changes in RMS of M. pectoralis pars sternalis and RMS of M. trapezius pars descendens. Table 2 gives an overview of the significant correlations. No other significant correlations (e.g., between changes in HR and changes in RMS) where found.

4 Discussion

This study investigated changes in local and global parameters of performance over the duration of the F8F. Significant changes indicating fatigability throughout the F8F were registered in HR, RPE and RMS of M. trapezius pars descendens and RMS of M. pectoralis major pars sternalis. More specifically the protocol showed changes in parameters of performance fatigability with an increase in mean heart rate from 79 ± 14 bpm right before the protocol to 159 ± 21 bpm right after the protocol and the expected HR and RMS patterns of M. trapezius pars descendens and M. pectoralis major pars sternalis during the protocol (increase at the end of every 4 min active propulsion phase, decrease after the 90 s rest). Furthermore, an increase in RPE as a parameter of perceived fatigability was observed from very light exertion to very hard exertion.

Interestingly, greatest changes in RMS were observed over the first 4 min of the F8F. The correlations between changes in RMS of the M. pectoralis major and RMS of the M. trapezius pars descendens showed that these two muscles fatigue simultaneously rather than sequentially. The correlation of changes in HR and RPE although weak further demonstrate the association of more global measures of performance and perceived fatigability. Nevertheless, these global measures of fatiguability did not correlate with the changes in RMS, a local measure of performance fatiguability.

An increase in RMS is related to an increase in estimated amplitude of force twitches of motor units and further demonstrates the size principle of recruitment of motor units present in fatiguing activities. In the unfatigued state, slow motor units are recruited, then during the course of activity or with increased intensity larger and faster motor units follow (De Luca, 1997). As the smaller motor units fatigue, fine coordination of the affected muscles could decrease, possibly leading to harmful changes. In case of wheelchair propulsion, scapulothoracic and glenohumeral movement patterns may be affected (Chopp et al., 2010). Fatigue in only a part of the shoulder stabilizing muscles could lead to/or increase muscle imbalances leading to more stress on the rotator cuff muscles and promoting shoulder injury and pain

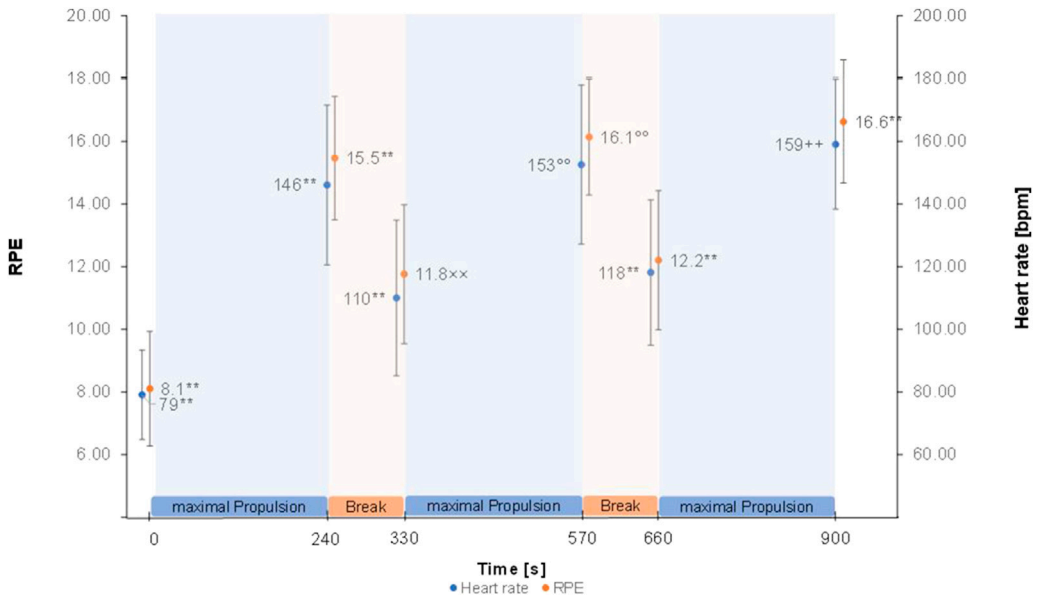

FIGURE 2
Heart rate and RPE means ± SD over the figure-8 fatigue (F8F) protocol. ** marking highly ($p < 0.001$) significant difference to all other points of measurement. ° marking highly significant difference to all other points of measurement except with 900 s ×× marking highly significant difference to all other points of measurement except with 660 s ++ marking highly significant difference to all other points of measurement except with 570 s.

(Burnham et al., 1993). These findings underline the importance of exercise programs targeting strengthening and thus reducing the fatigability of the scapular stabilizers (Van Straaten et al., 2014). Furthermore, with muscle imbalance being one of the possible underlying factors for increased risk of shoulder problems in wheelchair sports (Heyward et al., 2017) further examination of fatiguing propulsion in sport specific settings is crucial.

No consistent patterns regarding fatigue on a muscular level were observed for the M. deltoideus pars acromialis, M. trapezius pars ascendens, and M. biceps brachii. Slowik et al. (2016) found high variations in the activity of the M. deltoideus pars acromialis between the different propulsion techniques especially during the recovery phase of each wheelchair push. The unclear results regarding fatigue of the M. deltoideus pars acromialis could be explained by this wide variety of movement techniques during the recovery phase. Subgroup analyses comparing different propulsion and recovery phase techniques could give further insight in the topic.

The lack of changes of MPF data during the F8F may be related to the discontinuous nature of the used protocol including and varying technical approaches in propulsion, breaking and turning between different participants. MPF is recommended for the analysis of isometric or strictly cyclic tasks (MacIsaac et al., 2001). Other investigations with the same participants showed a reduction in MPF for M. Pectoralis major, M. deltoideus, M. trapezius pars ascendens and M. biceps brachii during cyclic wheelchair propulsion on a treadmill after the F8F (Bossuyt et al., 2020a). Furthermore differences to the findings of Bossuyt et al. (2020a) regarding RMS and MPF values and level of changes can be explained by the temporal differences in the measurement protocols. In the study at hand, EMG data was collected during the protocol and the first measurement of the protocol was taken as 100% for RMS and MPF. Bossuyt et al. (2020a) analysed fatigue using data from testing pre and post protocol treadmill tests at fixed power output and investigated absolute values of the MPF. Measuring during the protocol might ignore that some participants where already fatigued due to the preparation procedure and previous measurements (e.g., participants performed a sprint test and wheelchair propulsion on the treadmill). Furthermore, it is questionable if changes in MPF indicating fatigue would take more time after exposure to manifest.

Several limitations need to be acknowledged. First, although the F8F more closely mimics propulsion in daily life or game play there is more variation in real life in length, slope and velocity of wheelchair propulsion, there are different terrains with varying frictional resistance and turns require changing radii. Furthermore, many demanding activities of daily life, like transfers, pressure relief lifts, reaching over head and sport specific activities like throwing and receiving a ball or tackling are missing. Nevertheless, this study focussed on the most repetitive activity of daily life and sports for wheelchair users, namely, wheelchair propulsion. Secondly, it remains unclear at which state of fatigue, influenced by the standardized foregoing parts of the investigation as described earlier and their journey to the movement laboratory, the participants started the F8F. Nevertheless, all participants completed the same assessments prior to the F8F. Thirdly, 8 participants used drugs to treat upper extremity pain in the last 3 months, however none of them had pain that limited their ability to propel. Fourthly important muscles to additionally include would be M. deltoideus pars clavicularis and spinalis. As weakness in the M. deltoideus has shown to be compensated by the rotator cuff muscles and *vice versa* (Slowik et al., 2016) it is important to investigate the influence of fatiguing propulsion on all three anatomical parts of the M. deltoideus. Additionally, shifts in activation ratio between these muscles is seen as a potential cause

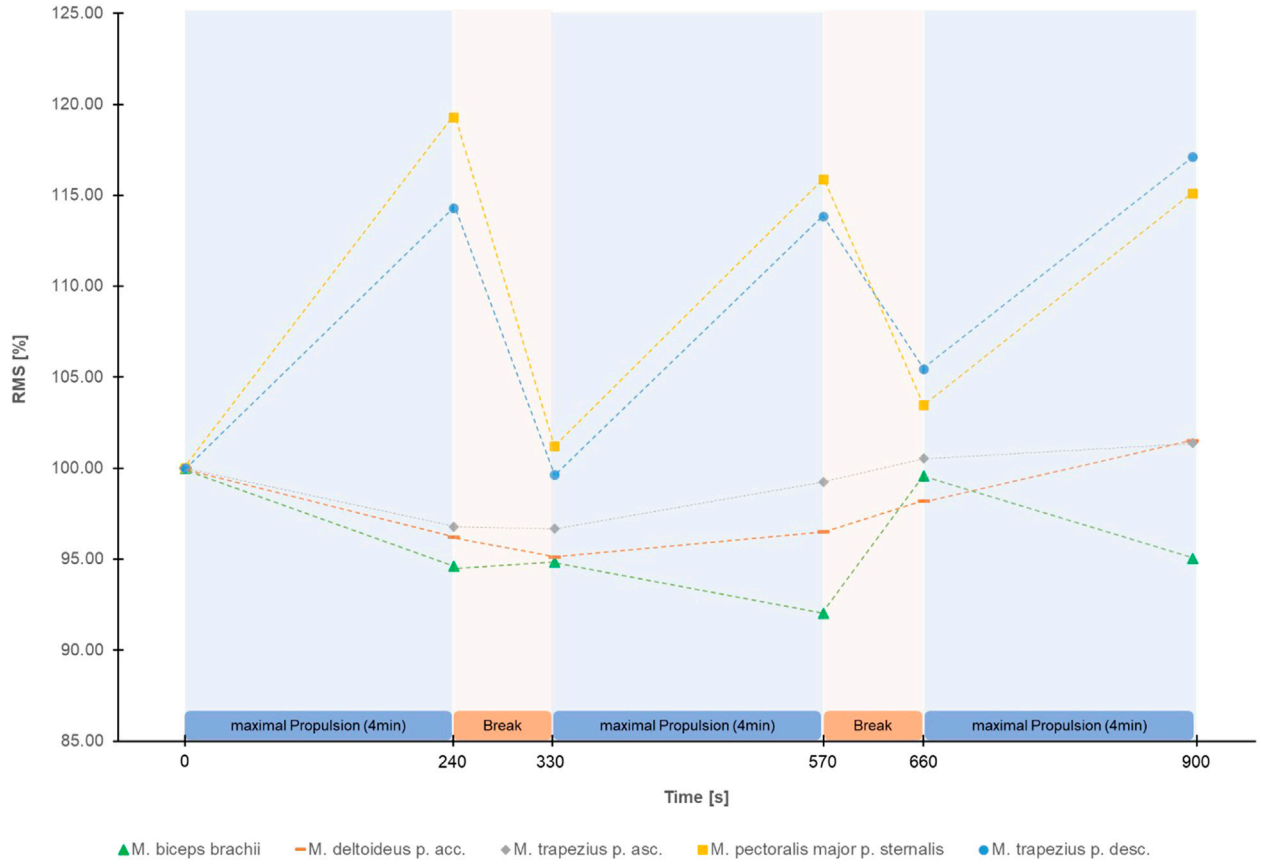

FIGURE 3
Mean Root Mean Square (RMS) in percentage of the start RMS of the EMG signal of the 5 shoulder muscles measured during the figure-8 fatigue (F8F) protocol.

TABLE 2 Spearman Rho for changes throughout and total change throughout the F8F.

		Propulsion 1 (0s–240s)	Rest 1 (240s–330s)	Propulsion 2 (330s–570s)	Rest 2 (570s–660s)	Propulsion 3 (660s–900s)	Total change (0s–900s)
Correlations between HR and RPE	R	0.395*	0.333*	0.310*	0.158	0.333*	0.322*
	Sig.	0.008	0.022	0.036	0.288	0.022	0.035
Correlation between RMS of TD and RMS of PM	R	0.460**	0.434**	0.397*	0.368*	0.523**	0.538**
	Sig.	0.003	0.005	0.010	0.020	0.000	0.000

(* marking a weak correlation (0.1–0.3), ** marking a moderate correlation (0.4–0.6)). Abbreviations: HR, heart rate; RPE, rate of perceived exertion; RMS, root mean square; TD, M. trapezius pars descendens; PM, M. pectoralis major pars sternalis.

for decreased joint stability (van Drongelen et al., 2013). Finally, the strict inclusion and exclusion criteria (for example, pain limiting the ability to propel or congenital causes of SCI) may mean the study is not applicable to certain populations.

To gain further knowledge about the influence of fatigue on the development of shoulder pain in people with SCI it is important to develop fatigue protocols that include daily life or sport specific activities, survey their fatiguing effects on the muscular, neural, cardio-vascular and cognitive function and further validate the parameters applied. For validation of existent or future fatigue protocols a gold standard measure for propulsion induced fatigue is needed. Furthermore, the addition of resting HR, peak HR, localised RPE and the assessment of pain before, during and after the protocol is recommended. Also, the development of specific protocols to assess fatigue and its effect during other activities of daily life like pressure relief lifts, overhead activities, reaching and propulsion on uneven ground as well as developing new and adapting existing protocols to the specific demands of individual wheelchair sports is important. Furthermore, the following parameters are recommended to be included in future studies on the topic at hand: temporal onset of muscular fatigue and pain,

propulsion technique, wheelchair settings, sitting posture and level of activity in daily life.

The current study is unique in giving clearer insight into the mechanisms of performance fatigability and perceived fatigability throughout the F8F, a protocol that has been used in previous investigations studying the effect of fatiguing wheelchair propulsion (Collinger et al., 2010a; Bossuyt et al., 2020a; Bossuyt et al., 2020c; Bossuyt et al., 2020d; Arnet et al., 2022a). Performance fatigability was shown in a consistent increase throughout the protocol in HR and RMS of the EMG signal of the M. pectoralis major pars sternalis and M. trapezius pars descendens. The subsequent significant consistent increase in RPE demonstrates the effect of the protocol with regards to perceived fatigability.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics statement

The studies involving humans were approved by the Ethikkommision Nordwest-und Zentralschweiz. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization: FB, MB, UA, and UM. Methodology: FB. Formal Analysis: UM. Investigation: FB, UM, and UA. Writing–Original Draft: UM. Writing–Review and Editing: UM, FB, MB, UA, and EM. Visualization: UM. Supervision: FB, MB, UA, and EM. Project administration: FB. Funding acquisition: FB and MB. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fphys.2023.1220969/full#supplementary-material

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Women's wheelchair basketball lineup analysis at the Tokyo 2020 paralympic games: game related statistics explaining team sport performance

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Introduction: Performance analysis through game-related statistics in wheelchair basketball (WB) has focused mainly on the study of the individual efficiency of players according to their functional classification. However, there is little evidence focusing on lineup performances (five players on court) and their composition. Thus, the objective of present study was to analyze the efficiency of the women's WB lineups used during the Tokyo 2020 Paralympic Games (PG) and to determine the variables that best discriminated the lineup performances according to the final point differential.
Methods: The sample comprised 507 lineups used in the 31 games by the 10 national teams during the competition. Fifty-one different lineup types (LTs) were categorized. A discriminant analysis was carried out to compare the lineups with a positive and negative point difference according to the game type (balanced and unbalanced games).
Results: It was found that LTs 16 (1-1.5-2.5-4-4.5), 47 (1-2-2.5-4-4.5) and 14 (1-1.5-2.5-4.5-4.5) had the best means of efficiency in field goals (LT 16 = 52%; LT 47 = 44% and LT = 40%), while LT 50 (1-2-3-4-4) obtained the highest mean difference in points (3.67 ± 10.67). The variables that best discriminated winner teams in balanced games were field goal efficiency (SC = 0.55), assists (SC = 0.50) and turnovers (SC = −0.41).
Discussion: Field goal efficiency, assists, turnovers and steals are the game-related statistics most associated with the success of a lineup used in balanced games in WB in PG competition; this could be taken into account by coaches when deciding how to compose a given lineup in a moment of the game, to adequately select players from different functional classifications for the final squad and to choose training content related to the indicated game-related statistics, as they explain success at this competition level.

KEYWORDS
game statistics, disability sport, paralympic sport, team performance, team sport, lineup analysis

1. Introduction

Wheelchair basketball (WB) is a sport of high intensity and dynamic game rhythm, which enjoys great popularity within the Paralympic Games (PG). In addition, WB is one of the sports most practiced by people with physical disabilities (1). It demands a good physical condition, technical expertise, teamwork and complex decision-making at elite

level (2–4). Most of its characteristics and rules are very similar to running basketball; however, the use of the wheelchair and the functional classification system are the main differences. For the competition, each player is classified into a functional class (FC) ranging from 1.0 to 4.5 according to their functional movement capacity (8 classes, differences of 0.5 between classes according to trunk control, function of upper and lower limbs) to ensure that the player is capable of carrying out fundamental technical actions, such as pushing the chair, braking, turning (5), dribbling, moving forward and shooting to the basket. The higher the functional class, the greater the player's functional ability to move. This, to a large extent, conditions the role and actions that the player executes on the court. The total sum of the FC of the five players on court must not exceed 14 points at international competitions (6). Due to its importance, the studies that analyze factors influencing sport performance in WB have increased considerably in recent years, mainly addressing aspects related to biomechanical analysis and individual player performance and, to a lesser extent, the analysis of team performance and its efficacy during competition (2, 4, 7, 8).

Thus, in the analysis of physical performance, research such as that of Granados et al. (3), Gil et al. (9) and Romarate et al. (10) assessed to different level WB players in pick-up test, maximal pass test, agility T-test and medicine ball throw, where identified that capacities such as power, arm strength, agility and stamina are decisive. Other authors have evaluated WB players in tests with and without the ball, thus determining physical performance profiles for the different FCs (11–14). The analysis of technical skills in WB has also been a field of considerable interest in the studies that have been carried out: The kinematic patterns of free throws have been analyzed to determine the individual technique adopted by each player based on their FC, their posture and their support in the wheelchair (15). Also, studies such as those by Limroongreungrat et al. (16), Bergamini et al. (17), Chénier et al. (18) and Wang et al. (1) have extensively studied how the fundamental technical actions (dribbling, driving the chair, passing and shooting) and the ranges of movement of the upper limbs influence player performance.

On the other hand, several studies have shown that there are differences in performance related game statistics between players of different FCs (19–22). Some of them analyzed differences in players' performance related to the game statistics during competition, comparing the interaction of FC and game position (22), FC and final team ranking (20), and FC and game time (23) with performance in field goals, free throws, assists, offensive and defensive rebounds, turnovers and steals, finding significant differences among all functional classes; however, these differences are appreciated the greater the distance is between functional classes, with no significant differences found between adjacent FCs.

In the analysis of team performance, Gómez et al. (19) analyzed the statistics related to the teams' play during men's and women's competitions at the international level and they identified the variables that best discriminated between winning and losing teams according to the game type (balanced and unbalanced). In addition, they assessed whether the quality of the opponent and the four basketball performance factors (field goal efficiency, turnover ratio, offensive rebound percentage and free throw efficiency) (24, 25) could predict the final difference in points by gender and type of game. Thus, they found that 2-point field goals scored, free throws, assists, and fouls received were the most determining factors in the men's competition, while 2-point field goals scored was the most determining factor in the women's competition. In this regard and in running basketball, the most important factors that discriminate the final result of a game (winner–loser) have also been analyzed; for example, Canuto and de Almeida (26) carried out a systematic review with meta-analysis on this issue, which indicated that, in line with the WB literature, field goal efficacy and assists, in addition to defensive rebounds, are the factors that best discriminate the final result of a game (winner–loser) in competition, taking into account the quality of the opponent and the phase of the competition.

Based on different studies that have been carried out in WB, it could be said that FC is a fundamental aspect to take into account when analyzing WB performance, as players with different functional class present differences in volume of action (6), physical performance (27–29) and playing role (21, 30). In this regard, the coach must take this aspect into account when choosing the players that will make up the final squad for a given competition: whom he/she must align in each game and situation in order to promote the best possible interactions between players and FCs so as to maximize collective performance in that specific competition, game and moment (31). However, even though it seems important to ask what kind of lineup type it is possible to configure according to the 12 (number of players per team) FCs of the players' team, what the prevalence is of a given lineup use in a given WB competition and what the game statistics are that indicate greater efficiency between one given lineup or another, there are very few studies following this direction.

In running basketball, not too many studies have been carried out analyzing the influence of different lineups on team performance. Sandri et al. (32) carried out an analysis of the influence of relationships between teammates on the court on the shooting performance index, finding differences in the individual performance of the player when accompanied by different combinations of teammates on the court. Clay and Clay (33) examined the impact of the use and depth of bench players on team performance and success, finding that a high rotation (multiple lineups) of players generates advantages, especially in defensive efficiency, while managing a short rotation (few lineups) can generate advantages in shooting percentages, ball control and other offensive performance variables. Other investigations have aimed at analyzing how the rotations and the different possible lineups on the field influence the offensive and defensive team performance, considering the role of the players (34) and their anthropometric characteristics (35).

In WB, García-Fresneda (36) analyzed the behavior and efficiency of the different lineups at the men's WB World Championship in 2014, categorizing the different lineups into

types according to the predominance of low (1.0–1.5), medium (2-3.5) and high (4–4.5) FC of the players on the roster. He found that the most prevalent lineups in that competition were type D (two low, one medium and two high), E (one low, two medium and two high) and C (three or more medium). In addition, he indicated that there were no significant differences between offensive and defensive tactical behavior, observing a predominance of positional offense and zone defense in the three types of lineups. There are multiple possibilities in the composition of the WB lineups, conditioned by the availability of players from different FCs in the team. However, there is not enough evidence regarding different LTs performance, analyzed through game statistics, to determine which are the most used according to the type of game and the phase of the competition. Additionally, the scarcity of studies in the female population in WB competition is noteworthy.

For all above, the aim of this study was twofold: firstly, to analyze the most used lineups in the women's WB competition at the Tokyo 2020 PG according to their game statistics (to determine which lineups seem to be the most efficient in balanced games). Secondly, to identify the game statistics that best discriminate between lineups with a positive and negative final point differential for balanced and unbalanced games.

2. Material and method

2.1. Sample

The official game statistics for the women's WB competition at the Tokyo 2020 PG were obtained from the official website: the "Line-Up Analysis" report concretely. The sample consisted of the 507 lineups used in 31 games played by the 10 national teams during the different phases of the competition: group phase (round robin per group) and playoff phase (quarterfinals, semifinals and final). The game-related statistics gathered were field goals scored (FGS) and received (FGR) (both successful and attempted), offensive rebounds (ORs), defensive rebounds (DRs), assists (ASs), turnovers (TOs) and steals (STs) both for and against. Fifty-one lineup types (LTs, combination of five players on court for a given team) were identified and categorized (from those 507 lineups), identifying their total frequency, number of games where they were used, phases of the competition in which each was used and players that made up each lineup according to their FC, and finally, distinguishing the different national teams that used a specific LT throughout the competition (**Figure 1**).

By criteria, lineups that had a value of less than one minute in playing time were not taken into account (24), thus leaving a final sample of 457 lineups for subsequent analysis. All the variables were normalized, taking into consideration the proposal for the normalization of the game statistics of each lineup by playing time (25) and efficacy percentages for TCs, ROs and RDs were calculated for each alignment (24). A k-means cluster was carried out to classify the games, depending final result, by point differential, but because in some games there was a great difference in points between the two teams at the end, the cut-off value obtained that separates the clusters was very high, classifying as even those games with differences greater than 45 points. Therefore, the cut-off point used by Gómez et al. (19), was considered. This classifies games ranging from 1 to 13 points as balanced games (9 games) and games with differences greater than 13 points as unbalanced games (22 games). The values of the 457 lineups were classified into two groups: those with a point difference (plus/minus) above 0 as a positive result (180 lineups) and those with differences equal to or less than 0 as a negative result (277 lineups) (**Figure 1**).

2.2. Statistical analysis

For the first aim, descriptive statistics were obtained for the variables calculated from game-related statistics and the four basketball performance factors. The value of the mean (M), the standard deviation (SD), the maximum value and the minimum value of the given game-related statistic of each LT that was used by the national teams for balanced games were taken into account. For the second aim, a discriminant analysis was carried out to identify the variables that best classify the lineups with a positive/negative final result of points in balanced and unbalanced games. Structural coefficients (SC) above $|0.30|$ made it possible to identify the variables that best contribute to differentiating LTs with a positive result from those that had a negative result (37). Validation of the discriminant models was performed using an exclusion classification. Cross-validation of the discriminant models was performed using the "leave-one-out" classification (38). The statistical analysis was carried out through Excel 2019 (Microsoft. Redmond, WA, United States, 2019) and IBM SPSS Statistics version 29 (IBM. Armonk, NY, United States, 2022). The significance level was set at $p < 0.05$.

3. Results

3.1. Descriptive analysis of the alignments

The 118 female players participating in the WB Tokyo 2020 PG competition by team, according to their FC, are indicated in **Table 1**. All national teams had 12 players for the competition, except for Algeria and Canada, who had 11 players in their squad. It can be seen that Netherlands was the only team that had at least one player for each functional class in its squad, unlike Australia, which only had players from five different FCs, with six class 1.0 players. On the other hand, teams like Algeria and Great Britain had up to four 4.0-point players available in their roster, while Canada and Germany had the same number for 4.5-point players. The functional classes that had the greatest presence of players in the competition were 1.0 (23 players), followed by 4.0 and 4.5 (20 players of each).

Table 2 shows each LT used during the competition, the FCs that compose it, the number of times the LT was used during the competition, the phases of the competition in which it was used,

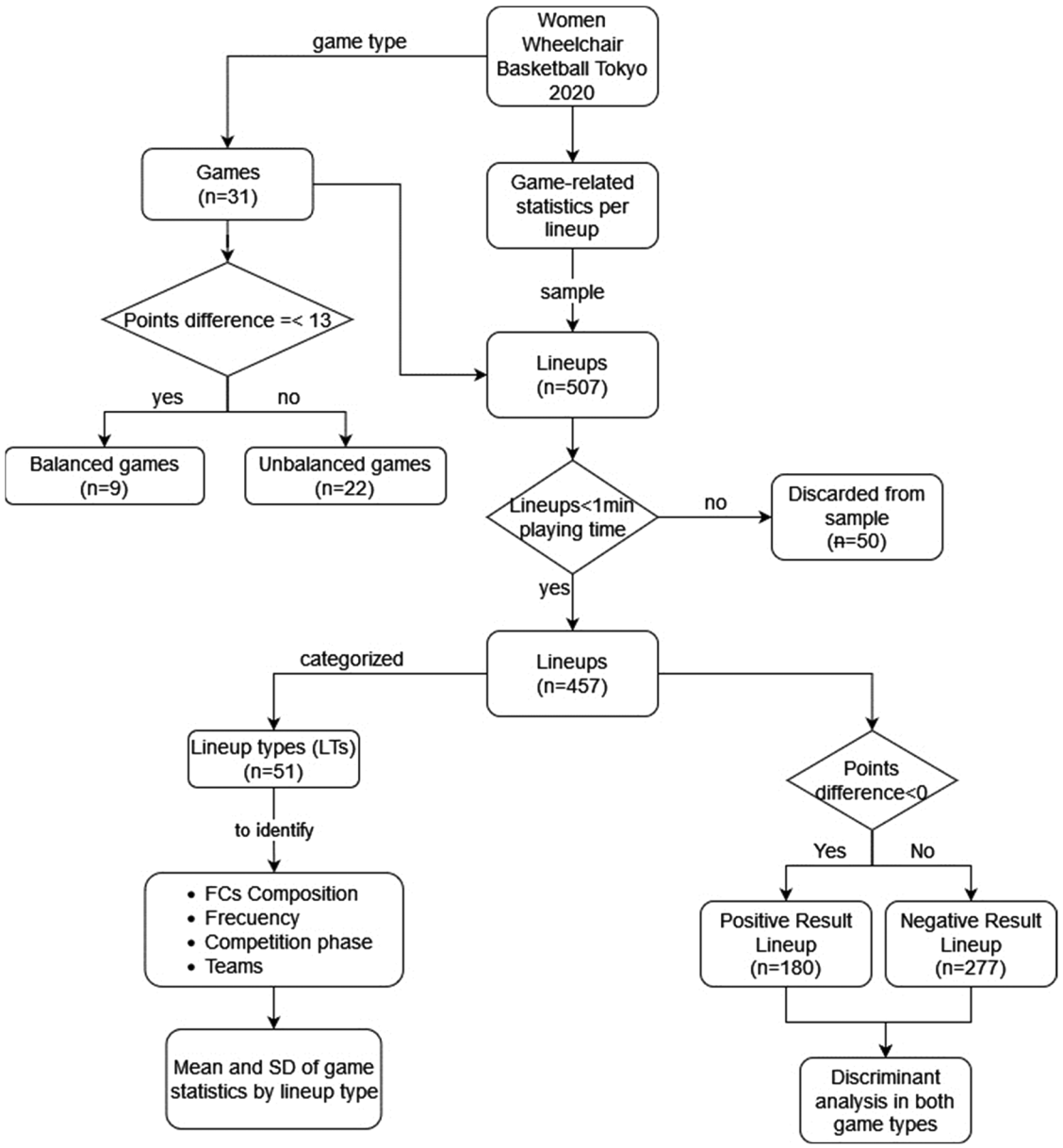

FIGURE 1
Flow chart of procedure.

the number of games in which it was used and the teams that used the given LT. Of the 47 different LTs categorized in the competition, all were used during the round robin phase, 24 LTs during the qualifying playoffs, 24 LTs in the quarterfinals, 8 LTs in the semifinals, 7 LTs in the bronze medal game, and 5 LTs in the gold medal final. The average LT number used during the competition was 7.5 per game. The highest number of LTs used was in games 19 and 53 (13 LTs). In games 2, 21 and 64 the lowest LT values used (3 LT) were found. Thus, the lineup that was repeated the most times during the competition was LT 14 (1-1.5-2.5-4.5-4.5), followed by LT 29 (1-1-2.5-4.5-4.5), LT 16 (1−1.5-2.5-4-4.5) and LT 23 (1-1.5-3-4-4.5), the latter obtained the highest values in the number of games (18) and national teams that used it (5).

In relation to the frequency analysis by competition phase, it was observed that LT 14 (1-1.5-2.5-4.5-4.5) was the one that was repeated the most times in each of the phases of the competition, during the round robin phase it was repeated 38 times, followed by LT 29 (1-1-2.5-4.5-4.5; 27 times) and LT 16 (1-1.5-2.5-4-4.5, 23 times). During the playoffs phase, for the quarterfinals LT 14 (1-1.5-2.5-4.5-4.5) was used 16 times, followed by LT 47 (1-2-2.5-4-4.5; 11 times) and LT 16 (1-1.5-2.5-4-4.5, 10 times). During the semifinals and games for the bronze medal and for the gold medal, LT 14 (1-1.5-2.5-4.5-4.5) was used 8 times, followed by LT 43 (1-2-2.5-3.5-4.5; 5 times), LT 18 (1-1.5-2-4.5-4.5, 4 times) and LT 23 (1-1.5-3-4-4.5, 4 times). Of the 31 games played, 9 had point differences of less than 13 (balanced games; six during the round robin phase, the two semifinals and the

TABLE 1 Players' functional classification by national teams at the 2020 Tokyo PG WB female competition.

	Functional Class								
Team	P1.0	P1.5	P2.0	P2.5	P3.0	P3.5	P4.0	P4.5	TP
Netherlands	2	2	1	2	1	1	2	1	12
China	2	2	2	0	1	0	3	2	12
United States	2	2	1	2	0	2	1	2	12
Germany	2	1	2	2	0	1	0	4	12
Canada	2	2	0	1	1	1	0	4	11
Japan	2	1	1	3	1	0	2	2	12
Great Britain	2	1	0	2	1	1	4	1	12
Spain	2	0	3	1	2	0	3	1	12
Australia	6	0	0	2	1	0	1	2	12
Algeria	1	2	0	2	1	0	4	1	11
Total	23	13	10	17	9	6	20	20	118

TP, Summary of players per team; P1.0-4.5, players with functional class 1.0-4.5.

bronze medal game); while the gold medal game resulted in a 19-points difference game.

The national teams used an average of 8.6 LTs during the whole competition, with Netherlands being the team that used the most LTs (18), followed by Great Britain (10) and Spain (10). In contrast, Japan was the team that used the least LTs during the competition (5), followed by China (6) and Canada (6). The descriptors for the game-related statistics in balanced games are presented in Table 3: during the competition phases, LT 14 (1-1.5-2.5-4.5-4.5) was the most used in balanced games, followed by LT 43 (1-2-2.5-3.5-4.5), LT 18 (1-1.5-2-4.5-4.5) and LT 23 (1-1.5-3-4-4.5), respectively. LT 50 (1-2-3-4-4), used by China, had the highest value in playing time (40 min) during the semifinal game against the United States, as well as the highest average (24.36 min ±13.72), followed by LT 23 (15.07 min ±9.05) and LT 43 (15.13 min ±14.61), all of them regarding playing time.

On the other hand, LT 50 (1-2-3-4-4) was used only by China (silver medal) in balanced games, obtained the highest average in the difference of points scored and received by lineup (plus/minus), followed by the LT 47 (1-2- 2.5-4-4.5) and LT 16 (1-1.5-2.5-4-4.5), the latter two used by Netherlands (gold medal) and Japan. For field goals efficiency (%FG), LT 16 obtained the highest value (100%) when it was used by Japan in game 39 (only two minutes of play and two field goals taken and scored), followed by LT 43 (1-2-2.5-3.5-4.5) and LT 38 (1-2.5-2.5-3.5-4.5) both reaching 83.3%, the latter two used by the United States. However, regarding the mean values for the same variable (% FG), LT 16 (1-1.5-2.5-4-4.5) obtained the highest value (52.3% ±25.4), followed by LT 47 (1-2-2.5-4-4.5; 43.8% ±22) and LT 14 (1-1.5-2.5-4.5-4.5; 39.9% ±14.9).

3.2. Lineup discriminant analysis by outcome

Means and standard deviations for the game-related statistics by point differential (plus/minus) related to the lineups used during the competition were assessed. Significant differences can be observed for both types of games: for balanced games, lineups with positive results presented better field goal efficiency, greater number of assists and steals and fewer turnovers. For unbalanced games, positive-scoring lineups had better field goal efficiency, offensive rebounding and defensive rebounding efficiency, more assists and steals, and reporting fewer turnovers, while fewer assists and ball steals from the rival lineup were assessed.

TABLE 2 Lineup types (LTs) used at the 2020 Tokyo PG WB female competition.

LT	Functional classes	F	Competition phase	G	Teams
14	1-1.5-2.5-4.5-4.5	68	RR-5/6°-QF-SF-3/4°	15	CAN-GER-JPN
29*	1-1-2.5-4.5-4.5	37	RR-9/10°-QF-3/4°	8	AUS-GER
16*	1-1.5-2.5-4-4.5	36	RR-9/10°-5/6°-QF-SF-F	15	ALG-JPN-NED
23	1-1.5-3-4-4.5	34	RR-5/6°-QF-SF-F	18	ALG-CHN-GBR-JPN-NED
47	1-2-2.5-4-4.5	34	RR-7/8°-5/6°-QF	14	SPA-JPN-NED-USA
50	1-2-3-4-4	27	RR-7/8°-QF-SF-F	12	CHN-SPA-NED
21*	1-1.5-3-3.5-4.5	25	RR-5/6°-QF-F	8	CAN-NED
43*	1-2-2.5-3.5-4.5	24	RR-QF-SF-3/4°	12	GER-NED-USA
30	1-1-2.5-4-4.5	22	RR-9/10°	5	AUS
39	1-2.5-2.5-4-4	22	RR-QF-7/8°	7	GBR-NED
34	1-1-3-4.5-4.5	16	RR-9/10°-5/6°-QF	9	AUS-CAN
15	1-1.5-2.5-4-4	13	RR-9/10°	5	ALG
32	1-1-3.5-4-4	13	RR-QF-7/8°	5	GBR
18	1-1.5-2-4.5-4.5	12	RR-QF-SF-3/4°	7	GER
37*	1-2.5-2.5-3.5-4	11	RR-QF-7/8°	7	GBR-NED
35*	1-1-3-4-4.5	8	RR-9/10°	5	AUS-CHN
40	1-2.5-3-3.5-4	8	RR-7/8°-QF-F	7	GBR-NED
9	1.5-2-2.5-4-4	7	RR-QF	4	JPN-NED
28	1-1-2.5-3-4.5	7	RR	3	AUS
31	1-1-2-4.5-4.5	7	RR-QF	3	GER
20	1-1.5-3.5-4-4	6	RR-QF	4	NED
33	1-1-3.5-4-4.5	6	RR-QF-SF	6	GBR-NED-USA
36	1-1-4-4-4	6	RR-QF-7/8°	4	GBR-SPA
38	1-2.5-2.5-3.5-4.5	6	RR-7/8°-SF-3/4°	5	USA-NED-GBR
42	1-2.5-3-3-4.5	6	RR-7/8°-QF	5	SPA
8	1.5-2-2.5-3.5-4.5	5	RR-QF-3/4°	4	NED-USA
22*	1-1.5-3-4-4	5	RR-9/10°-7/8°	4	ALG-GBR
27*	1-1-2.5-3-4	5	RR-9/10°	4	AUS-SPA

LT, lineup type; F, frequency; G, games; RR, round robin; QF, quarter final game; 9/10°, 9° place game; 7/8°; 7° place game; 5/6°, 5° place game; SF, semifinal game; 3/4°, bronze medal game; F, final game.
*Less than 14 points. CAN, Canada; GER, Germany; JPN, Japan; AUS, Australia; ALG, Algeria; NED, Netherlands; CHN, China; GBR, Great Britain; SPA, Spain; USA, United States.

The discriminant analysis differentiated between the lineups with a positive result from those that had a negative result for balanced and unbalanced games (see Table 4). The most decisive variables to discriminate the lineups with positive and negative results in balanced games (λ=0.51; CC = 0.70; $p < 0{,}001$) were field goal efficiency (SC = 0.55), assists (SC = 0.50) and turnovers (SC = −0.41). In unbalanced games (λ=0.45; CC = 0.74; $p <$ 0,001), field goals efficiency (SC = 0.73), assists (SC = 0.63) and assists from the opponent team (SC = −0.54) were the variables that best discriminate between lineups with positive and negative results. The cross-validation of the discriminant model reported a correct percentage of reclassification of the cases of 80.5% for balanced games and 89% for unbalanced games.

TABLE 3 Descriptive statistics of lineup types in balanced games at the 2020 Tokyo PG WB female competition.

LT	F	Teams		Min	Plus/Minus	%FG	%OR	%DR	AS	TO	ST
14	22	CAN-GER-JPN	M	5.04	−1.30	39.9	15.5	76.1	12.32	19.64	4.45
			SD	4.40	3.96	14.9	17.9	20.4	15.02	8.82	7.59
43	10	USA	M	15.13	−0.30	37.4	10.5	88.4	7.27	17.92	3.85
			SD	14.61	6.99	24.3	12.9	11.3	5.43	13.90	6.01
18	8	GER	M	7.53	−0.63	32.3	14.7	83.4	12.06	13.23	2.44
			SD	7.01	5.66	19.9	14.6	19.0	10.99	10.98	4.06
23	8	CHN-JPN-NED	M	15.07	0.88	37.7	17.3	79.8	9.43	15.85	3.96
			SD	9.05	6.83	7.9	13.0	13.7	6.94	7.09	5.13
16	7	JPN-NED	M	8.24	2.00	52.3	16.2	79.5	8.77	16.55	2.16
			SD	6.03	3.96	25.4	21.8	17.6	13.03	13.40	2.89
21	6	NED-CAN	M	3.61	1.17	24.1	45.0	70.0	16.24	10.40	5.56
			SD	1.92	3.37	28.5	46.4	34.6	18.89	11.43	8.86
47	6	NED-JPN	M	4.91	2.17	43.8	22.7	83.2	9.23	23.87	4.40
			SD	3.25	4.40	22.0	18.6	18.3	16.49	20.28	8.81
39	4	GBR	M	6.60	1.00	34.2	18.8	87.5	10.04	18.05	9.74
			SD	3.49	2.58	4.2	14.2	16.0	3.38	7.14	12.58
50	3	CNH	M	24.36	3.67	29.4	16.7	89.7	9.06	14.08	3.90
			SD	13.72	10.07	16.7	10.4	8.7	3.45	2.95	1.73

LT, lineup type; F, frequency; M, mean; SD, standard deviation; Plus/Minus, point difference result; FG, field goals efficiency; OR, offensive rebounds; DR, defensive rebounds; AS, assists; TO, turnovers; ST, steals.

TABLE 4 Means, standard deviations, and structural coefficients of lineup game-related statistics with positive and negative results in balanced and unbalanced games.

Game Statistics	Balanced games					Unbalanced games				
	Positive Result		Negative Result		SC	Positive Result		Negative Result		SC
	M	SD	M	SD		M	SD	M	SD	
% FG**	51.27	14.53	31.28	20.39	0.55*	52.36	17.00	22.28	19.45	0.73*
% OR	26.68	25.14	30.47	82.82	−0.03	27.53	26.86	18.61	21.57	0.17
% DR	83.32	14.66	80.03	19.68	0.09	83.38	17.16	71.90	29.01	0.21
AS**	23.28	11.75	13.41	8.76	0.50*	26.62	12.70	10.49	10.44	0.63*
TO**	6.40	5.80	14.41	11.73	−0.41*	9.18	10.38	17.23	15.80	−0.26
ST**	5.92	6.98	2.69	4.60	0.29	7.86	9.57	4.21	7.69	0.19
ASr	15.28	12.49	19.13	11.45	−0.16	8.34	8.75	23.84	15.25	−0.54*
TOr	13.27	14.24	8.58	8.88	0.21	18.64	15.01	10.69	12.26	0.27
STr	2.78	3.87	5.07	7.50	−0,18	3.64	6.56	7.50	9.92	0.20

*Values of the discriminant coefficients $\geq |0.30|$ ($p < 0.001$).
**Significant differences in balanced games ($p < 0.05$); There are significant differences in all variables in unbalanced games ($p < 0.05$). M, mean; SD, standard deviation; FG, field goals efficiency; OR, offensive rebounds; DR, defensive rebounds; AS, assists; TO, turnovers; ST, steals; ASr, rival assists; Tor, rival turnovers; STr, rival steals.

4. Discussion

To the best of our knowledge, there is no such lineup analysis available in the scientific literature regarding top-level female WB competition, with specific considerations for coaches when preparing the team roster (e.g., team configuration and representation of different functional classes) and managing lineups during competition (for example, indicating which game-related statistics explain LT performance in balanced games). In relation to the results obtained, it was relevant to observe that Netherlands, who had at least one player per each FC and was the team that used the largest number of different LTs during the competition (tripling the one that used the least number of LTs, Japan), was the team that won the gold medal. In contrast, Algeria, which had the lowest FC availability among its players, was in last place in the final competition ranking.

In this regard, Clay and Clay (33) highlighted in running basketball the advantage of having depth on the bench so as to have different rotation options and lineups. However, China won the silver medal, without having 2.5- and 3.5-point players on its roster and using a low number of LTs compared to the other teams. Furthermore, two of the six LTs used by China during the competition reported the highest value in points difference (LT 50) and the fourth best in %FG (LT 23). It should be noted that these two LTs were reported in the study by García-Fresneda (36) as the two most used during men's world championship in 2014. The FCs with the greatest presence of players in the competition (1.0-, 4.0- and 4.5-point players) were related to the

LTs most used by the national teams, thus predominating in the composition of the lineups: having the presence of two 1.0-point players and two players from 4 to 4.5 points on court. This distribution of the number of players per FC was related to those reported in the 2006 women's world championship by Molik et al. (20).

Seven out of nine LTs most used in balanced games (14, 18, 23, 16, 47, 39 and 50, see **Table 2**) showed at least two players (one 4.0-point player and one 4.5-point player) in their composition, which seems to indicate that there was a trend during the competition of using players with a higher FC by the teams (thus compensated with the use of 1.0- and 1.5-point players in the same LT). Similarly, seven out of nine LTs used in balanced games (14, 43, 18, 23, 16, 47 and 39) reported values greater than 30% in their % FG, reaching up to 52% for LT 16; these values are similar to those reported by Molik et al. (20) in the 2006 world championships and higher than the 1998 world championships reported by Vanlandewijck et al. (22), where the %FG was not higher than 30%. This seems to indicate that during recent years there has not been a significant change in the female WB performance in terms of field goals efficiency; however, in our study, not having 3- and 2-point field goals from the official lineup analysis report separately made it difficult to conclude this with certainty.

The most used LTs during the competition in balanced games coincide with the three predominant types (C, D and E) reported by García-Fresneda (36), but not the specific composition of the LTs: from the nine reported LTs in that study, two of these (50 and 23) appear as the most used LTs in this current study, with a percentage of 12%, five LTs (18, 16, 21, 47 and 39) with percentages between 0 and 1.5% and two LTs (14 and 43) were not used in the 2014 men's world championship (36). Thus, LT 16 and 47, for example, showed the highest values in point difference and high values in field goals efficiency, being two LTs that have a very similar composition (with only a FC difference in the second player in the lineup (1.5- and 2-point player). In this regard, it should be noted that eight LTs used did not reach the regulatory maximum of 14 points allowed (that is, they used less than 14 points on the court, see **Table 2**), which can be a tactical criterion (the case of Netherlands with LT 16, 29 and 43) as a derivative of the (lower) LT possibilities, depending on the team roster (see **Table 1**).

Field goal efficiency variables, assists and turnovers were the game statistics that best discriminated between the total number of lineups used that had a positive or negative result in point difference during balanced games, only coinciding with the discriminant variable of 2-point shots scored (SC = 0.37) reported by Gómez et al. (19) when comparing winning and losing female teams in balanced games at this performance level. This seems to indicate that today the women's competition, contrary to what was considered a few years ago (19), shows a greater diversity of tactics and strategies, given that, in addition to field goals, a greater number of assists (teamwork) and avoiding turnovers were decisive in the result. Likewise, ball steals (SC = 0.29) were also established as a game-related statistic that distinguishes winning teams, highlighting their greater defensive capacity. From the above, it seems that the skills related to handling the ball and passing are essential when it comes to performing at the highest level, avoiding losses as much as possible. In the same way, wheelchair skills to increase the defensive level and increase the losses of the opponents seem to be important at this elite competitive level (1, 20–22). This may lead to training content suggestions for coaches, in order to prioritize these elements when preparing for WB elite competition.

When it comes to unbalanced games, similarly to previous studies (19, 20), field goal efficiency was the most determining variable to explain the success in the final result of the games. Although the FG% was the most decisive variable, it was not the only one. It can be seen that there were differences in favor of LTs with a positive result of almost 50% in the means comparison of the game statistics. It would be interesting to analyze whether, in some of those unbalanced matches, the losing team in the play-by-play used one LT that worked better than another or, despite the rotations, the losing team was always inferior to its rival. Thus, future studies on lineup analysis should take into account when a given LT is capable of generating an unbalanced difference on the scoreboard (at the end of the game, but also after its participation).

One of the limitations of this work was that the game-related statistics for 2 and 3 field goal points and free throws of each LT were not available in the official report. Furthermore, although statistics against were taken into account (e.g., %FG received, rival assists, offensive rebounds against, etc.) these data were not discriminated e.g., by the LT of the rival team. Therefore, it becomes invaluable to identify which LTs performed best against a certain LT of the rival team. This consideration is important for future studies, in line with what was proposed by Francis et al. (31) on the importance of analyzing offensive statistics such as FG% taking into account the defensive actions of the rival team such as the pressure zone and other contextual variables. This is due to the fact that the design has adhered to the information that was available from the official lineup analysis report. In addition, considering the moment of the game in which the different LTs are used (i.e., time series analysis) could have expanded the information reported (39), explaining the changes at a certain moment based on the game situation. For future studies, in addition to trying to solve the previous limitations, it is intended to replicate the study for the male competition at the PG and to observe possible differences in performance. Furthermore, it would be interesting to explore whether there are significant differences in the game-related statistics for the same LTs when they are made up of different players and to analyze the impact of these substitutions during game development (and not only the different results of score differences in the final points): applications of "play by play" data analysis could be of interest in this regard.

5. Conclusions

The LT 14 (1-1.5-2.5-4.5-4.5) was the most used lineup throughout the entire competition, with a frequency almost double that of the second most used lineup. However, the LT 23 (1-1.5-3-

4-4.5), with fifty percent less use than the previous one, was used by up to five different teams. The team lineups that presented the best efficiency in the game-related statistics in the WB competition at the Tokyo PG female competition for balanced games were the lineup types 16 (1-1.5-2.5-4-4.5), 47 (1-2-2.5-4-4.5), 14 (1-1.5-2.5-4.5-4.5) and 50 (1-2-3-4-4). Moreover, field goal efficiency, assists and avoiding rival assists are more decisive factors in unbalanced games. On the other hand, field goal efficiency, assists, turnovers (avoid them) and steals are the game-related statistics that determine the success of a lineup used in balanced games in this competition. Both conclusions could be taken into account by coaches when deciding how to compose a given lineup in a moment of the game, to adequately select players from different FCs for the final squad and to choose training content related to the indicated game-related statistics as they explain success at this competition level.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

WB-M: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Validation, Writing – original draft, Writing – review and editing. JW: Conceptualization, Data curation, Investigation, Methodology, Software. JP-T: Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review and editing, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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"If only balls could talk…": barriers and opportunities to participation for students with blindness and visual impairment in specialized PE

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Purpose: For children with blindness and visual impairment (BVI) of all ages, disability sport and/or regular Physical Activity (PA) are deemed beneficial, promoting physical and mental health as well as increasing wellbeing and life satisfaction. In this regard, Physical Education (PE) serves as a foundation to regular and lifelong participation in PA, mainstream and/or disability sport. Research points towards manifold participation barriers for children with BVI in PE, which so far have mainly been investigated in inclusive settings and from the perspectives of sighted parents, teachers and peers. Consequently, people with BVI frequently consider PE a missed opportunity for lifelong PA. As transitioning from general to special schooling deems the only alternative to continue their education, questions arise in how far and in which ways specialized schools manage to accommodate their needs in PE. To address these gaps in literature, we investigated BVI students' perceived opportunities and barriers to participation in PE within a specialized school setting and their imaginations for possible (digital) improvements and solutions.

Materials and methods: Within the framework of Inclusive and Youth Participatory Action Research, we adopted the Mosaic Approach to investigate a sample of 19 students aged 14–20 at lower and upper secondary level in a specialized school in Austria. Data material included audio-recordings of interviews, student-guided school tours, photographs of significant places and objects and field protocols. The analysis was conducted with Interpretative Phenomenological Analysis.

Results and conclusion: Through the analysis, we identified three themes. The data material firstly revealed the complex intricacies of how PE teachers can act as facilitators and gatekeepers to autonomous PA. Secondly, material norms function not only as barriers to participation even in a specialized school setting, but also constitute the basis for social hierarchies between students with various degrees of visual impairment. Thirdly, students imagined manifold digital solutions to enhance participation derived from their perceived barriers. The findings contribute to amplifying BVI individuals' voices and provide revealing insights in how participation in PA is enabled and prohibited for students with BVI which can not only help to improve specialized but also inclusive settings.

KEYWORDS

physical education, blindness and visual impairment, special schooling, barriers, participation and inclusion, awareness raising, adapted physical education

Introduction

The global inclusion movement as well as the UN Convention on the Rights of Persons with Disabilities (1) lead to an increasing awareness for the need to overcome the exclusion of marginalized and discriminated groups in society. In that respect, people with disabilities in sport are increasingly becoming the focus of social and scientific considerations. Both mainstream sport (2) and disability sport (3) are commonly acknowledged for their high potential to assume social responsibility for the development of an equitable society (4), even though empirical evidence that such can be achieved has been lacking to date (5).

At the same time disability is conventionally underexplored in sports science research, both in competitive and in elite sports for people with disabilities. Disability sport primarily comes into focus where it submits to the immanent performance and enhancement logic of sport that can be exploited by the media, whereas risks of disempowerment usually go unnoticed (6, 7), as does the critical discussion of ableist implications (8). However, for people with blindness and visual impairment (BVI) of all ages disability sport and/or regular Physical Activity (PA) are deemed beneficial, promoting their physical and mental health as well as increasing wellbeing and life satisfaction (9). Moreover, regular PA can potentially improve BVI people's spatial orientation skills (10) and their sense of hearing (11). In contrast, international research repeatedly shows that people with disabilities generally show lower levels of PA than people without disabilities (12). Specifically, people with BVI display lower levels of motor competence (13, 14). Children and youth with BVI are less active in (disability) sports and regular PA and suffer from obesity more frequently (15, 16) compared to their sighted peers. Since low levels of motor skills can have a negative impact on participation in sports and movement culture, children with BVI need as much motor skills development as possible, including in the school subject Physical Education (PE). However, in terms of participation, children with BVI face particular barriers, i.e., lack of specialized sport activities and/or specialized instructors, the fear of getting injured (17, 18). In terms of regular PA, research suggests that PA behaviors develop continuously from childhood to adulthood (19). Hence, it is important to seek an understanding of youth PA behaviors to improve PA among individuals with BVI in adulthood. For youth with BVI, the most likely environment to learn about and participate in PA is school-based PE (20). Thus, PE can be seen as a unique possibility to serve a foundation to regular (and lifelong) participation in PA, mainstream and/or disability sport, and thereby can help to make a positive contribution to social, mental and physical well-being (21). However, students with disabilities continue to encounter extensive barriers both in inclusive and segregative schooling. Truly inclusive experiences are often inaccessible to these students (22).

In terms of research methodology, it should be noted that such research is typically conducted *on* students with disabilities (23, 24) and tends to emphasize the perspectives of nondisabled peers, parents, teachers, and experts, while systematically ignoring the voices of students with disabilities themselves (25). This is problematic as it limits our understanding of these students' thoughts, feelings, and experiences, which are central to designing mindful settings that allow for participation (26).

With regard to education, for children with BVI PE can serve as an important facilitator of physical and mental health as well as life satisfaction (9, 27). Yet, research points towards manifold participation barriers for children with BVI in PE. However, these barriers and possible solutions have so far mainly been investigated from the perspectives of sighted parents, teachers and fellow students (23, 28). In fact, while such research efforts have accumulated vast insights into how able-bodied individuals perceive and conceptualize BVI in PE and sports in general, the experiences and perspectives of individuals with BVI themselves have been conspicuous by their absence. This is problematic, as it limits our understanding of "inclusive experiences" and feelings of children and youth with BVI, which should be at the core of interpretations of inclusivity in general (26, 29). Consequently, PE has remained a context in which many students with BVI do not experience feelings of belonging, acceptance or value and consider it a missed opportunity to initiate lifelong PA (30–32).

Hence, to amplify their voices, research needs to further uncover BVI students' experiences of participation in PE, sports and PA from their very own perspective. In that respect, Giese (33) investigated BVI students' subjective constructions of participation barriers in inclusive PE. Since transitioning from general to special schooling deems the only plausible decision for many students with BVI to continue their education (34), questions arise in how far and in which ways specialized schools manage to accommodate the needs of students with BVI in PE. Furthermore, all studies to date have been conducted in removed interview settings whereas "none of that research explores disabled students' intersubjective experiences of belonging, acceptance, and value in the spaces where they find themselves" (35).

Against this background, we investigate the perceived barriers and opportunities to participation for students with BVI in specialized PE and how students with BVI imagine possible improvements and solutions in a participatory research approach. The results may help to improve opportunities of participation in inclusive PE settings as well as shed light on the potential shortcomings of PE in specialized settings in order to further strengthen the quality of education for students with BVI (1). In a wider context, the gained insights can potentially help to promote participation in sporting activities and thus increase opportunities for PA among children and youth with BVI, which will contribute positively to their health and wellbeing (1, 21). Through employing a participatory research approach, our study honors the UNCRPD's claim "Nothing about us without us", fosters awareness for the concerns of people with disabilities (UNCRPD, Art. 8) and contributes to increasing social justice (36, 37).

Materials and methods

Methodological framework: participatory action research with students with disabilities

This research was conducted in the tradition of Participatory Action Research (PAR), particularly leaning on principles of Inclusive Participatory Action Research (IPAR) (36, 38) and Youth Participatory Action Research (YPAR) (37).

Following a social constructionist perspective, we understand disability as a socially constructed identity category similar to gender or race. We understand the existence and subjective experience of one's abilities as a fundamental facet of the human relationship to the world, in which individuals relate to their surroundings in an efficacious, deliberate and enjoying manner (39). In that respect, ableism describes the underlying system of beliefs, processes and practices of preferring assumed species-typical normative abilities over others, resulting in the discrimination of those who are deemed "less able" and/or "impaired" due to failing to fulfill said norm (40). As all participatory methodologies, IPAR aspires to be "emancipatory, empowering and democratic and to illuminate social problems" (36) and aims to reveal the individual experiences of people with disabilities in order to comprehend and emphasize their concerns and needs (36). Similarly, YPAR is founded on the everyday experiences of young people and follows the premise of embracing their potential by working *with* them in solidarity instead of *for* them to make the world "a more just, equitable, and humane place to inhabit" (37).

Our research presented in this paper is part of a larger project funded by the Austrian Ministry of Education, Science and Research (BMBWF). The funding pool supports Participatory Action Research projects in which students of all school levels and other potential actors in the field are actively involved in the research process and thereby contribute to research which would otherwise not be possible (41).

The overarching research project aims at the participatory development of digital assistive technology for students with BVI in PE and sports. In the project, students with BVI from a general lower and upper secondary school specializing in blindness and visual impairment, sighted students from vocational schools specializing in mechatronics and computer science as well as their sighted teachers join a team scientists from sports pedagogy and biomechanics and become co-researchers in a participatory research process (37, 38). In the spirit of (I/Y)PAR and the UN-CRPD's claim "Nothing about us without us", students collaborate under the guidance of the scientists and develop digital assistive technologies for students with BVI in PE based on the BVI students' identified requirements and ideas (36). Developed prototypes are tested and refined jointly by sighted and students with BVI in PE, eventually will be presented to a wider audience and possibly serve as a starting point to making these assistive technologies available on a larger scale in the tradition of "open science" (42). The collaboration raises awareness for the life realities of individuals with BVI in the contexts of school and sports among sighted students and their teachers (1) and furthermore creates opportunities for empowerment and participation in the process of fostering inclusion and improving the situation of students with disabilities in PE and sports in the pursuit to increasing social justice in the educational system (1, 36, 37).

In this article we focus on the very first step of the project which aims to identify the perceived barriers and opportunities to participation of students with BVI in PE as well as their identified needs, requirements and ideas for improvement in a specialized school setting through—among other measures—digital assistive technology.

Our research questions are the following:

- How do students with BVI perceive barriers and opportunities to participation in PE in a specialized school setting?
- How do students with BVI imagine accessible PE in the (digitized) future?

Sample

The respective school had been selected due to its longstanding expertise in teaching students with BVI and its openness to enter three-year-long extensive collaboration in the overall project. Participants for this initial investigation were purposefully recruited based on the following criteria: (1) being at least 14 years of age[1], (2) attending the respective school specializing in BVI and consequently (3) being blind or visually impaired, (4) being willing to participate in an audio-recorded group interview and school tour. Students were invited to join the investigation with the help of their PE teachers and recruited by the researchers based on their interest to participate. The final sample consisted of $N = 19$ students (12f, 7m) aged 14–20. 16 of them were visually impaired and three were fully blind at the time of data collection (**Table 1**).

We decided not to ask the participants for their medical diagnoses, but instead chose to ask them "How come that you are attending this school?" and "What is your vision like at the moment?", which elicited an answer related to their vision in a broader social context. Some students gave their diagnosis, but others answered something along the lines of "Actually, I can see quite well…" followed by a description of their vision. Most interestingly, one girl described that according to her doctor she should be entirely blind, but in fact, she can recognize shapes and nobody knows how and why this is possible. It seemed to us as an ability quite important to her. Even though we acknowledge medical diagnoses do have a time, place and purpose, in our understanding, these descriptions were not only much more specific and informative than their diagnoses (which

[1]In Austria, 14 marks the age at which adolescents are legally competent to give informed consent to participate in research studies without the approval of a legal guardian.

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TABLE 1 Characteristics of the students.

Pseudonym	Age	Gender	Degree of VI
Michael	16 years	Male	Visually impaired
Vanja	18 years	Female	Blind
Lina	14 years	Female	Visually impaired
Samira	16 years	Female	Visually impaired
Laura	16 years	Female	Blind
Emma	15 years	Female	Visually impaired
Ayse	19 years	Female	Visually impaired
Sarah	16 years	Female	Visually impaired
Zahra	14 years	Female	Visually impaired
Nuri	14 years	Female	Visually impaired
Kerstin	14 years	Female	Visually impaired
Luca	15 years	Male	Visually impaired
Emir	16 years	Male	Visually impaired
Noah	16 years	Male	Visually impaired
Maximilian	20 years	Male	Visually impaired
Liam	17 years	Male	Visually impaired
Elena	15 years	Female	Blind
Sasha	14 years	Female	Visually impaired
Nikita	14 years	Male	Visually impaired

not all students were able to name), they were also remarkably revealing regarding the subjective meanings' participants assigned to their respective visual abilities.

All blind students had visited the respective school since primary level. All visually impaired students had received schooling in an inclusive setting during primary level and had transferred to the respective specialized school for BVI either at the transition to lower secondary level or during lower secondary level following recommendations of their teachers and due to self-reportedly not having their educational needs met in inclusive settings. 17 students had previously visited schools in Austria, one boy had transitioned from an inclusive lower secondary school in Germany and one girl had attended an inclusive primary school in Syria and inclusive lower secondary school in Austria before transitioning to the specialized school. Written informed consent was obtained from all students before the interviews. Data acquisition took place at the school during PE lessons or recess. No teachers were present for the entirety of the interviews.

Methods of data collection

Neither YPAR nor IPAR prescribes the utilization of specific research methods. Instead, methods of data acquisition and analysis have to be selected as appropriate to the specific research context. Since PAR methodologies have originated from various contexts of human rights activism advocating for social change and the liberation of marginalized groups, the critical reflection of power structures forms an integral part of designing and conducting any PAR project (43). In our case, we carefully considered how intersecting power structures of dis-/ability, age and formal education could affect the course of the project and data acquisition of the first project phase in particular.

Under these presuppositions, we found Clark's Mosaic Approach (44, 45) to be most suitable for our research endeavor. Originally developed in the context of researching young children's life-worlds in pedagogic institutions, the Mosaic Approach is a multi-method, participatory, reflexive, practice-oriented and adaptable approach which focuses on the lived experiences of participants and considers children and youth to be "competent, active meaning makers and explorers of their environment" (44). Following Burke (46), the Mosaic Approach proposes that "rather than being viewed as a neutral or passive 'container', if recognized at all, the school building, its various rooms and spaces, the walls, windows, doors and furniture together with outdoor 'nooks and crannies', gardens and open spaces are considered here to be active in shaping the experience of school and the understanding of education". This understanding corresponds to Haegele and Maher's conceptualization of educational spaces in the context of inclusion and BVI (35): "For us, education spaces are not fixed or absolute. Material spaces, such as schools, classrooms, playgrounds, and gymnasia, are not containers of human activity or blank canvases. Rather, they are socially constructed and (re) produced through human interactions". Being at school, as much as the learning that takes place in them, must be considered an embodied experience to be reconstructed as the relationship between spaces, people and objects (45).

Specific methods of data collection were carefully selected as a result of critical reflections upon which kinds of methods would actively involve the students, yet were equally accessible to all students from the sample. For our study this meant avoiding methods that rely solely on students' visual abilities while simultaneously providing a variety of ways for them to explore their ideas and engage in the conversation about their experiences in PE as well as using age-appropriate language in every step of the research endeavor (38, 47, 48). As a result of these reflections, we decided to conduct guided group interviews followed by student-led school tours as well as collect photographs of places and objects pointed out as relevant by the students and field notes.

Group interviews were performed in an empty classroom/gym hall between one researcher (first or second author) and groups of two to three students following an interview guideline based on Clark's (45) dimensions of people, places and objects comprising students' embodied experiences of schools, which we applied to the context of PE. After eliciting a broader description of their PE lessons, students were asked to elaborate on the persons involved in PE and their respective role (e.g., fellow students, teachers, assistants, etc.), describe the places and objects that were frequently used in PE (e.g., gym, garden, sports court, gym equipment) and recollect lessons they particularly liked and disliked as well as imagine a perfect PE lesson. We purposefully did not address any impairment-related adaptations or perceived barriers in PE directly and only at the very end asked them how it came about that they visited this particular school, to describe their eyesight and how they particularly perceived it during PE. This was done for two reasons: Firstly, we wanted to avoid reproducing a power dynamic in which students were stereotypically labeled as disabled by non-disabled, adult professionals, which might have left them feeling disempowered

and objectified (49). Secondly, as a precaution to avoid the reproduction of ableist notions and inadequate, unjustified assumptions of normality (50), we did not want to unnecessarily problematize BVI in ways that might not necessarily be relevant to the students themselves (37). In that way, students had the opportunity to give a more authentic account of how they perceived their life reality as BVI individuals in the context of PE and sports.

After the guided group interview, students were prompted to take the researcher on a school tour and show them the spaces in which PE lessons usually take place (47). Students were asked to describe each space in their own words, point out what they liked or disliked about it and why, and describe objects that were of particular importance to them. During these school tours, the researcher took images of spaces and objects of particular importance to the students[2]. The end of the school tour was marked by an imaginary future scenario in accordance with Clark (44) ("Imagine you could time-travel to 2050…"), asking students how they imagined the future of PE and which places to keep, expand, change and add. Data were complemented by reflexive field notes written by the researchers.

Data handling and analysis

Group interviews and school tours were audio-recorded, transcribed verbatim, grouped with respective photographs and field notes and imported into the qualitative data analysis software MAXQDA (51). Students' names were replaced by pseudonyms to ensure anonymity. Subsequently, we utilized Interpretative Phenomenological Analysis (IPA) (52) to analyze the data. IPA explores the embodied experiences of individuals and how individuals assign meaning to their personal and social environment, making it highly compatible with the methodological foundations of the Mosaic Approach (44, 45, 47) and a suitable method to answer our research questions.

IPA incorporates phenomenological (i.e., centering on individuals' lived experiences as personal accounts rather than objective descriptions), hermeneutic (i.e., relying on the researcher's interpretation for gaining insight in said experiences) and idiographic (i.e., emphasizing on each individual's experience through intensive analysis) elements. In other words, IPA is a method to gain understanding of the individual lived experiences of participants through the process of the researcher interpreting individuals' meaning making processes based on their individual accounts. The analysis was conducted in several steps as recommended by Smith et al. (52). Firstly, we (re-)immersed ourselves in the data material through multiple rounds of listening to the audios and reading the transcripts to familiarize ourselves with the data while secondly, adding comments and highlighting potentially significant passages. As a third step, the first and second author reduced the data for each case (data from one group of students including researchers' comments) to emergent themes, reflecting participants' statements as well as researchers' interpretations. Lastly, we identified convergent and divergent themes through comparison between cases. Recurring themes were then discussed among all three authors in terms of traceability, while divergent themes were debated until consensus was reached.

Quality of data

We applied several strategies to assess the quality of data (52, 53). Sensitivity of context was ensured by a rigorous and theoretically informed reflection of power dynamics in research design and researcher positionality. Moreover, results were presented including a considerable amount of insightful quotes from the data. Commitment and rigor were established by deriving the methods of data acquisition as well as the detailed construction of the interview guide from the methodological framework of the study as well as the authors' commitment to enter a three-year-long research collaboration with the participants' school. Transparency was addressed by the detailed description of recruitment, data collection and analysis whereas coherence was established through the congruence between theoretical foundations, research questions and methodological considerations.

Lastly, the potential impact and importance of the study lies in its capability to not only provide further insight into an existing issue but to also contribute to possible solutions in a way that empowers participants along the way, but will eventually be up for judgment by the scientific community and after finalizing the project (53).

Results

The analysis of the data material revealed three themes regarding how students with BVI perceive barriers and opportunities of participation in PE in a specialized school setting. In accordance with the theoretical and methodological background, what turned out to be perceived as a barrier or opportunity to participation is constituted through intertwined constellations between spaces, objects and people (45).

"She said, she would think about it…"—participation and autonomy

The first theme emerging from the analysis were the ways in which students negotiated questions of participation in terms of the ways they were granted autonomy when moving through the various spaces of the school, particularly those associated with PE. Through the interviews we learned that the school tried to

[2]For reasons of data protection, the students themselves were not in the images.

increase students' autonomy by designing the school as a barrier-free, secure space for students with BVI and by providing extensive mobility training at the school grounds, so that particularly blind students would be able to navigate through the school spaces without assistance.

> Lina: "[…] the sports hall, the gym or outside is a safe space for the students, even the blind, they know the facilities well, they have had mobility training there or they know where to go and whom to ask, if they need assistance. And then, we or the teacher help those blind or more visually impaired students […]" (Interview 2, 56-56)

With particular regard to PE-related spaces and opportunities for PA, the school had established several spaces for students to engage in PA, such as outdoor playgrounds, sports courts and a small school gym, a room with fitness equipment such as cardio machines and weights. PE teachers also had established a "fitness certificate", an authorization which students had to acquire in order to use the school gym independently. Teachers made use of the school gym during PE lessons, but the certificate allowed students to access it without a teacher present during recess or in their spare time[3]. For the certificate, PE teachers would provide students with specific training which involved basic orientation to move around the school gym as well as more specialized knowledge on how to use the machines in an appropriate and safe manner. In that sense, PE teachers play a major role in empowering students and facilitating autonomous participation in PA within the context of school, but also provide opportunities for students to prepare to use public gyms outside of school independently. However, as it turns out PE teachers could also easily become gatekeepers to PA, in case certain propositions are not being fulfilled, leading to feelings of frustration in the students. Upon further investigation and although PE teachers may have had plausible reasons, it remained unclear to the students why the proposition of the fitness certificate was not unfulfilled by their teacher. As one student describes:

> Vanja: "[…] She [the PE teacher] told us in the first couple of lessons, that if we are not happy with something, we should tell her and make suggestions to change it. So, we asked, if we could get our fitness certificate, so we could go to the fitness room any time we want without a teacher. She said, she would think about it. But up until now, nothing has happened." (Interview 1, 23-23)

Students described how their request to acquire their fitness certificate was not met, despite of their teacher asking them to share their wishes for PE and voice their opinions by making suggestions. One student points out:

> Luca: "Personally, I'd like to see us discussing our wishes and needs in PE, and seeing them being recognized as relevant." (Interview 5, 99-99)

Hence, the particular example of the school gym illustrates how PE teachers can simultaneously adopt the role of facilitators as well as gatekeepers to autonomous PA for students with BVI in a specialized school setting. Especially if students are left in the dark about reasons for denying them access, it may perpetuate feelings of exclusion and powerlessness. Furthermore, students described that the machines at the school gym were associated with certain barriers themselves:

> Michael: "[…] Maybe there could be like microchips in the training machines.
>
> Researcher: What would you use those for?
>
> A: Like for reading off the screens, it would be important for blind people to have like sound or a speech output. I don't know." (Interview 1, 94-94)

Students described that particularly digital cardio-machines were designed with sighted users in mind, as their operation required reading from a screen. As a consequence, in order for the students to use these machines to their full extent, they were yet again dependent on the assistance of their sighted PE teachers or partially sighted peers. Hence, when it comes to engaging with and participating in the movement activities of school spaces, the school gym serves as an illustrative example for how the characteristics of stakeholders' actions and properties of spaces and objects constitute opportunities and barriers to autonomous participation in PA. Students strongly expressed the desire for their perspectives to be taken seriously to be self-determined agents within PE/PA. In light of the above-mentioned intricacies, notions of facilitating and prohibiting PA for students with BVI lie closely together and attempts to foster autonomous participation can easily become lost opportunities.

"Sometimes the floor is louder than the ball…"—participation and material norms

The second theme centered around the question of how particular material norms in spaces for PA played a part in constituting opportunities and barriers to participation in PE and PA. In Austria, the so-called OENORM (54) is a collection of legally binding documents containing technical norms and standards by the Austrian Standards Institute. They determine specific requirements, procedures, measurements and guidelines for a variety of areas, among others public and school sports facilities, in order to ensure their security, quality and compatibility. Our analysis brought to light that the material

[3]As most specialized schools in German speaking countries, the school has a boarding home for students living further away.

conditions such as space, noise, lights, colors, etc. as well as their interplay, which are largely determined by these legally binding norms, are of crucial importance for participation in PE.

Although the OENORM (54) aspires to guarantee accessibility to (school) sports facilities by ensuring appropriate lighting, colors of floor markings, etc., the students criticized exactly these norms that should ensure their participation.

For instance, one student mentioned:

> Noah: "Uhm what else… the floor should have better color distinction. The lines should be thicker. And the playing field should be brighter and the edges should be darker, maybe black, so you can recognize things better. I mean it is already dark, but not really dark." (Interview 5, 230-230)

While this particular student expressed his requirement for better color distinctions of the playing field, he and his peers also pointed out throughout the interviews that visual perception can be very different between students, deducing that a visual "one size fits all" kind of solution may be inherently problematic. As a consequence, students imagined several digital and analogous solutions to foster participation when it comes to recognizing the lines of a playing field, which were not reliant on eyesight, for instance haptic stimuli:

> Maximilian: "[…] Maybe there could be a small notch where the line is, or something else that makes it easier to feel the line. It may be difficult to feel it through the shoes though […]" (Interview 6, 36-36)

Another example for problematic material norms was described with regards to the gym floor. It turned out that certain noises coming from the gym floor itself were perceived as a hindrance to their participation in certain games. One student mentioned:

> Luca: "[…] The floor creaks really loudly. When you walk, you can hear that it's quite old.
>
> Researcher: And is that a problem for you or is it just an unpleasant sound?
>
> L: It bothers me when we play soccer, because sometimes the floor is louder than the ball." (Interview 5, 172-172)

Students also mentioned that standardized diving objects made it more difficult to participate in diving activities depending on their visual abilities:

> Laura: "[…] It takes a bit longer. You have to dive all the way down to the ground and as a blind person, you have to like frisk the entire floor and it takes quite long with your breathing. It's made for sighted people. I mean blind people can do it too, but it's a bit more difficult." (Interview 2, 136–141)

Thus, the analysis uncovers that the inherent material norms of sport areas not only fail to consider the prerequisites of students with BVI for participation in PE and thus constitute a barrier. It further becomes evident that the orientation towards these norms itself perpetuates the ableist distinction between sighted, "more" or "less" visually impaired and fully blind students and creates the basis for blind students being in need of assistance in the first place. Hence, even in a specialized school material norms seem to pre-determine which abilities are required in order to participate.

"If only balls could talk…"—Imagining participation in digitized futures

The third theme centered around the students' imagined futures for PE. Throughout the interviews students described in great detail which aspects of PE were not accessible for them how and why, and which aspects they found bothersome in light of their impairment, despite the specialized setting they found themselves in. In the last section of the school tour students were encouraged to imagine the future of PE (44), regardless of how unrealistic their ideas may sound. Throughout the analysis it became evident that their imaginations of analogous and digital innovations were strongly informed by and directly correlated to the barriers they identified during the interviews.

One of the most central topics in PE lessons turned out to be ball games. Students described how sound balls (i.e., balls with a small mechanical bell inside of them which make a ringing sound when in motion) were frequently used in various kinds of ball games such as soccer, basketball or goal ball.

> Nuri: "We have this ball that makes a ringing sound."
>
> Kerstin: "There is a little bell inside and for example, if you roll or kick it, it makes a noise."
>
> Nuri: "But when the ball stops, blind students don't know where it is and cannot get it back. If only balls could talk… (laughs)." (Interview 4, 53–55)

Whereas sound balls were on the one hand deemed as a possible solution to make ball games (more) accessible to students with BVI, the solution was only partial and came with further potential challenges. Besides not being able to locate the ball whenever it came to rest, the sound was frequently reported as generally too soft or too brief. As a result, one blind student even described how she was offended by her teacher for not performing as expected when she could not hear the ball's sound:

> Michael: "It was quite noisy all around me. I could not concentrate well and could not hear where the ball was. Then the teacher said in front of everybody that I had issues with orientation, because I did not know where the ball was. She said I did not hear well."

> Vanja: "Well, when everyone around you is screaming, you just can't hear the ball ringing. Of course you don't have any sense of orientation." (Interview 1, 117–118)

As a solution, students imagined sound balls in different sizes, more vibrant colors and various consistencies that had the capacity to "talk". With the capacity to "talk", students referred to sound mechanisms that were more adaptive to specific scenarios and game contexts regarding the timing, duration and volume of sounds. Furthermore, sound balls should have a higher degree of sensitivity when responding to motion patterns.

Similarly, students reported current strategies to make soccer goals locatable through sound, but wished for basketball hoops and soccer goals that could "talk" as well, meaning that they are locatable through sounds and audibly responsive to the game.

> Luca: "Basketball hoops should make sounds, maybe soccer goals too. I mean, usually, the goalie knocks at the frame to indicate left and right." (Interview 5, 230)

> Nuri: "The hoops should have lights that turn green when you hit and red when you miss. Or they should talk."

> Kerstin: "Yeah, that would be cool!"

> Luca: "Yeah, for blind people that would be cool!" (Interview 4, 139–141)

Another predominant area for possible digital assistive technology were activities such as running, biking, rollerblading and ice skating. In that context, an aspect that became evident through the analysis was the question of interpersonal relationships and their significance for participation. Well-meaning teachers were reported to make an effort to enable blind students to participate in running activities through lesson arrangements in which blind students were forced to depend on the assistance of their sighted teachers. While acknowledging their need for assistance, such practices however were perceived as highly segregative and exclusionary and thus hindering PA as well as social participation. Blind students pointed out that for them the essence of participation lies in being with and possibly being assisted by their (partially sighted) peers instead of having to depend on their sighted teachers.

> Samira: "Yeah, I think that blind students should not always have to be stuck with the teacher, for instance when we go for a run outside. Blind students should be with the other [visually impaired] students and be part of the group."

> Laura: "Yes, because when a blind student runs by themselves, they can easily miss an obstacle and bump into something. So it's better to always have a [sighted] partner with you." (Interview 2, 46–47)

Based on the perception of this barrier, students mentioned very specific pieces of technology that would foster participation while engaging in PA. They imagined wristbands with sensors that can detect obstacles and provide acoustic or sensory feedback.

> Lina: "They should make something for obstacle detection for running. Like when blind people go running by themselves so that they don't bump into things."

> Samira: "Yeah, like a wristband."

> Lina: "…that beeps when you run and come too close to a tree for example." (Interview 2, 310–312)

In that sense, while students reported assistance from a sighted partner to be a feasible option to enable blind students to participate in such activities, their suggestion for a digital solution still attests for their desire for a higher degree of autonomous participation.

Discussion

This study investigated BVI students' perceived barriers and opportunities to participation in PE within a specialized school setting and their imagined (digital) improvements and solutions. Imagined improvements and solutions were directly derived from barriers to participation, which points towards the fact that even though PE teachers make efforts to foster participation in sporting activities, students still see room for improvement in order to accommodate their requirements and wishes for inclusion.

Even in the investigated specialized school setting, students with BVI reported barriers to participation in PE, which closely corresponds to reports from students with BVI in inclusive settings (26, 33, 55). Although the students in our study reported that their opportunities for participation in PE drastically improved after transferring to the specialized school, the reported barriers still caused the individuals in this study to feel frustrated and their feelings and needs disregarded, as reported in previous studies (28, 30, 56, 57). Hence, establishing so-called "specialized" settings in which students are encouraged to voice their needs and concerns does neither guarantee comprehensive accessibility and participation nor unclouded feelings of inclusion, self- or co-determination (31). As a result, PE can still easily deteriorate into a missed opportunity for individuals with BVI to increase long-lasting appreciation for PA (32) and may fail to initiate participation in mainstream and/or disability sport and to foster physical and mental health as well as wellbeing and life satisfaction (9, 21, 27).

The analysis showed that PE teachers play a crucial role in the process of fostering participation in specialized settings, similarly to inclusive settings (30). While PE teachers in this study were perceived as invested facilitators who are willing to accommodate students' perspectives and wishes, they simultaneously could easily act as gatekeepers to PA. Even in the specialized school setting under investigation, students with BVI were only granted access to sports-related spaces under specific circumstances (i.e., the fitness certificate), and if so, identified barriers that

prohibited them to fully engage in PA (i.e., cardio machines with screens). Thus, even in specialized settings students with BVI may not be able to fully participate in PA within the bodies they inhabit, as has previously been reported by Titchkosky (58) for inclusive PE settings and spaces. As a result, bodies deemed as "disabled" are essentially constructed as unable to occupy sports-related spaces. Such findings must be considered as problematic, as they raise questions as to whether creating specialized PE settings is solely a "lip service […] being paid to the notion [of inclusion] at the level educational […] practice (59). Reported invitations of the PE teachers to "make suggestions for improvement" may deteriorate into empty promises and result in PE teachers repeatedly being placed at the center of students' engagement and enjoyment of PE (20, 31). These findings confirm that even if intentions may be good, "unintended and often unnoticed consequences associated with integrating students with visual impairments into poorly accommodated activities can have detrimental effects" (30).

Moreover, material norms regarding the construction and design of spaces for PE/PA strongly contribute to excluding students with BVI from fully participating in sporting activities. These norms implicitly corroborate assumptions of physical normality and normal abilities and thus can easily perpetuate a deficit-oriented perspective, resulting in the discrimination of those who are deemed "less able" due to failing to fulfill a certain norm (40). Surprisingly, the analysis confirmed that these norms are in place in inclusive as well as specialized settings. Thereby, ableist notions of physical normality and assumptions of normal abilities even trickle into specialized settings, which have been established to accommodate the requirements of their target group. Less surprisingly, the students reported numerous barriers which specifically resulted from the uncritical application of those material norms to "specialized" PE spaces. As a result, the declaration of creating sports-related spaces as "safe" for students with BVI is in need of critical reflection (60).

BVI students' feelings of inclusion and belonging as well as their opportunities of participation stand in direct contradiction to the perpetuated universal notion of "one size fits all" when it comes to constructing and designing sports-related spaces according to material norms. The uncritical and ongoing adoption of material norms perpetuates ableist social hierarchies and reinforces a number of exclusionary dynamics, as reported in previous studies (26, 57). Partially sighted students value and appreciate their own visual abilities regardless of any diagnosed impairments, as should their abilities be valued by others, e.g., in teaching and learning in PE. These students wish for adaptations that enable them to make best use of their vision and want to fully rely on their visual abilities when accomplishing given tasks. Dismissing their visual abilities and treating them as "essentially" blind may lead to feelings of disempowerment and frustration. In other words, they express the wish to relate to their surroundings in an efficacious, deliberate and enjoying manner (39).

On the other hand, continuously creating environments in PE that require a certain degree of vision in order to accomplish tasks contribute to socially discriminating against blind students as they become reliant on the assistance of either their sighted teachers or partially sighted peers. Being forced to constantly rely on the assistance of others perpetuates a deficit-oriented perspective on respective individuals, resulting in the discrimination of those who are deemed "less able" due to failing to fulfill a certain norm (40). Students reported that having to rely on the teacher reinforces feelings of social exclusion from their classmates for blind students. At the same time, continuously providing assistance for blind students may have negative ramifications for partially sighted students such as feelings of obligation or (more implicitly) feelings of separation (61). Ultimately, the uncritical adoption of material norms perpetuates social ability-related hierarchies creating tops and bottoms, which marks a major characteristic of ableist orders as individuals are ranked in relation to their performances of abilities (62).

Lastly, students with BVI turned out not only being able to clearly identify opportunities and barriers of participation in PE as well as express their perspectives and wishes, they were also immensely resourceful regarding specific digital and analogous innovations that could be of assistance when participating autonomously in PE/PA.

Limitations and strengths

The presented study shows specific strengths and limitations, which will be critically reflected upon in the following. A particular strength of the study is that it addresses the proposed research gap in a methodologically innovative way. By adopting a participatory approach, our study takes into account the inherent power dynamics that come into play when researching in the field of sports, disability and adolescence. By being situated within a qualitative research paradigm, our study provides the individuals under investigation—in our case students with BVI—with the opportunity to express experiences, feelings and opinions from their very own perspective (63). Furthermore, by conducting group interviews and guided school tours to explore the PE-related spaces in a specialized setting, our study addresses an attested shortcoming of previous studies by conducting our data collection in the very spaces that we are investigating (35).

On the other hand, our study shows certain limitations. Firstly, due to the design of the entire research project the investigation took place in only one specialized school. Consequently, the transferability of the findings may be limited due to the specificity of our sample. Thus, further research in other schools specializing in BVI will be needed. Secondly, due to the qualitative nature of our study, the experiences of these participants may not be representative for PE experiences of students with BVI in other contexts. Typically, qualitative inquiries, including (I/Y)PAR studies, investigate samples in order to provide sufficient cases for the development of meaningful points of similarity and difference between participants, but not to get overwhelmed by the amount of data generated (52). Thirdly, to further remove BVI students' barriers to participation in PE it seems reasonable to investigate both the students and the teachers' perspective (64), which is one of the following steps of our study. Lastly, we approached the examination of BVI students' perspectives towards participation in

PE by using our considerable previous knowledge in sports pedagogy. This positionality should be critically considered when consuming this research, as BVI students' perceived barriers and opportunities to participation in PE and how they imagine possible improvements and solutions has been investigated through these filters.

Conclusions and future directions

The purpose of this study was to enhance our understanding of BVI students' perceived barriers and opportunities to participation in PE within a specialized school setting as well as their ways of imagining (digital) improvements and solutions. The unique and valuable contribution of the study is how students with BVI imagined possible improvements and solutions in this regard. The analysis of the data material revealed three themes, which identify barriers, opportunities, and imagined improvements and solutions that were viewed as critical towards PE participation in a specialized school setting from BVI students' point of view. The findings suggest that participation in PE would benefit from acknowledging students' voice, so they can interact fully with the PE spaces and the activities within them. In this regard, students' autonomy, a critical reflection of ableist notions intertwined in spaces, objects and stakeholders, and a critical examination of students' suggestions towards barriers are of critical importance. These findings provide support for the assertion that research should honor the UNCRPD's claim "Nothing about us without us" as it will amplify students' voices and will foster awareness for the concerns of people with disabilities (UNCRPD, Art. 8). Therefore, future (participatory) research should rely on students' lived experiences as potential signposts when it comes to removing barriers to participation. Teachers and their students should deliberately collaborate to co-construct supportive (64), accommodating environments that allow for social and pedagogical inclusion in specialized as well as inclusive PE settings. This may generate learnings for inclusive PE settings as well. In a wider context, such insights could not only help to promote participation in sporting activities and thus increase opportunities for PA among children and youth with BVI, but may also be crucial in contributing positively to their health, wellbeing and life satisfaction long-term and on a larger scale (1, 21).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Chair of the Ethics Committee Univ.-Prof. Mag. DDDr. Martin Voracek (University of Vienna). The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of University of Vienna (reference number 00879). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

Author contributions

SM: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. BH: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. MG: Conceptualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Empowering motivation: the journey of wheelchair basketball athletes to overcome constraints

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Introduction: The aim of this phenomenological study is to determine the motivational factors in the participation of wheelchair basketball players in sports according to Self-Determination Theory.

Methods: The study group of the research was determined by the criterion sampling method, which is one of the purposeful sampling methods. Accordingly, thirteen (13) wheelchair athletes constituted the study group. In the research, a personal information form and a semi-structured interview form were prepared as data collection tools within the framework of the self-determination theory. Interviews were conducted face-to-face with the prepared interview forms. The data were analyzed by reflexive thematic analysis method.

Results: Six (6) themes emerged: constraints, coping strategies, appreciation, positive feedback, need for existence, and development. Sixteen sub-themes related to these themes were identified.

Conclusion: The most significant factors causing a lack of motivation in wheelchair basketball athletes were observed to be structural constraints such as access to materials and facilities. Extrinsic sources of motivation were identified as the positive attitudes and behaviors of individuals in their environment, often related to admiration, appreciation, and being set as an example, and this situation has a positive impact on wheelchair basketball athletes. On the other hand, it can be stated that intrinsic motivations such as identity change, gaining self-confidence, and the feeling of success are crucial in overcoming constraints through sports participation.

KEYWORDS

wheelchair basketball, athlete, self-determination, motivation, constraints

1 Introduction

Sir Ludwig Guttmann introduced sports as a form of rehabilitation that helped increase the functionality and independence of individuals with disabilities after World War II. Since then, it has been recognized that regular participation in sports activities has many psychological, social and physical benefits for people with disabilities (Stephens et al., 2012). Sports play a role in preventing the exclusion of individuals with disabilities from participating in activities, just like their peers without disabilities, and have an impact on their psychological well-being (Moss et al., 2020; Koçak et al., 2023). Sports also provide individuals with disabilities the opportunity to socialize and play a significant role in accepting their disability status (Porretta, 2016). In addition, athletes with disabilities, like athletes without disabilities, are provided with the opportunity to compete with their peers (Steadward, 1990), and like all

athletes, they can have some common participation features such as the excitement of competition and being part of the team (Martin, 2019).

Excitement of competition and being a part of a team can be said to be important for every individual. In order to experience these emotions, wheelchair basketball is considered suitable for individuals with disabilities (Snyder et al., 2022). In recent years, there has been a positive increase in the perspective and participation in wheelchairs. In this context, examining the current position of wheelchair basketball for individuals/athletes with disabilities is crucial. In this context, wheelchair basketball and participation in this sport constitute an important subject of examination. The research conducted by Moss et al. (2020) evaluates wheelchair basketball as a socialization opportunity. On the other hand, it is seen to be an important factor in encouraging participation in terms of physical health. In this direction, Ramsden et al. (2023) stated that wheelchair basketball athletes' physical health and expectations are an important source of motivation. Additionally, Fiorilli et al. (2013) reported that athletes who participated in wheelchair basketball had better psychological well-being than those who did not participate. Moss et al. (2020) see wheelchair basketball as an important element in accepting disability as a 'meaningful pursuit that opens doors'. Again, Ramsden et al. (2023) also stated in their study that wheelchair basketball has positive effects on psychological health.

With the effect of the role of wheelchair basketball in increasing functionality and independence, wheelchair basketball has recently become a popular sport in which many athletes compete worldwide (Özen et al., 2016; Ramsden et al., 2023) and is becoming highly engaging and exciting for the audience (Cavalcante et al., 2022). In this respect, it is thought to be important to know the factors that motivate and maintain motivation for wheelchair basketball participation (Perreault and Vallerand, 2007).

In addition, in order to increase the participation of disabled individuals in general and wheelchair basketball in particular, it is important to understand the values and perceptions of the individual regarding the sports experience (Perreault and Vallerand, 2007; Bates et al., 2019; Ramsden et al., 2023). In this respect, there is a need for research examining the foundations of motivation from a subjective perspective (White and Duda, 1993; Perreault and Vallerand, 2007). In this context, the aim of this study is to determine the factors affecting the motivation of wheelchair basketball athletes within the framework of the self-determination theory, which was put forward by Ryan and Deci (2020) and frequently used in explaining participation motivation.

1.1 Theoretical framework

1.1.1 Self-determination theory and motivation

Self-determination theory is one of the prominent approaches to the study of human motivation. It started in the 1970s and was developed and formulated by Edward Deci and Richard Ryan in 1980 and 1985. Since then, theory and practice have been expanded (Adams et al., 2017). According to Ryan and Deci (2017), self-determination theory deals with the social conditions that facilitate or hinder human life and has been the subject of many scientific studies. The theory examines how biological, social and cultural conditions support or undermine the individual in areas such as psychological development and health. The Self-Determination Theory is a motivational theory. In this regard, the theory utilizes motivational structures to regulate the cognitive, affective, and behavioral variables of behaviors (Deci and Ryan, 1985). This theory has also included several mini-theories, namely: organismic integration theory, cognitive evaluation theory, basic psychological needs theory, goal contents theory, causality orientations theory, and relationships motivation theory (Ryan and Deci, 2018).

According to Ryan and Deci (2017, 2020) in self-determination theory, three behavioral regulation reasons (i.e., reasons for acting) are classified as amotivation, extrinsic motivation, and intrinsic motivation. Amotivation is the absence of intrinsic and extrinsic motivation for an individual's participation in an activity. In this respect, it falls outside motivated behaviors (Poulsen et al., 2006). Amotivation occurs as a result of not valuing an activity, feeling inadequate in doing the activity and believing that it will not yield a desired result (Ryan and Deci, 2000). The concept of amotivation is used to express how passive, ineffective, or purposeless individuals are regarding a range of potential actions, and amotivation manifests in different forms (Pelletier et al., 1999; Vansteenkiste et al., 2005). Firstly, it arises from a person's perception that they cannot control outcomes through any action, resulting in the belief that they cannot effectively perform the required actions. A second type of amotivation does not stem from concerns about competence or control but, rather, from a lack of interest, relevance, or value. Individuals become amotivated when behaviors have no meaning or interest for them, especially when they fail to connect with the fulfillment of needs. A third type of amotivation is the apparent lack of motivation for a specific action, which is actually a motivated non-action or oppositional behavior in response to demands that thwart a basic need for autonomy or relatedness. Each of these types of amotivation may have different durations and impacts, and each has unique determinants and dynamic implications (Deci and Ryan, 2012).

Extrinsic motivation is the actions taken to gain a reward or to avoid punishment (Noels et al., 2000). Rewards, in particular, are undeniably an effective way to control behavior, but they can also reduce the development of intrinsic motivation (Ryan and Deci, 2000). Extrinsic motivation, on the other hand, requires an instrumentality between the activity and separable outcomes such as tangible or verbal rewards, so satisfaction comes not from the activity itself but rather from the extrinsic consequences to which the activity leads (Ambrose and Kulik, 1999; Gagné and Deci, 2005). For example, a student who does his homework only because his parents want him to is extrinsically motivated. Extrinsic motivation is examined in four stages: external regulation, introjected regulation, identified regulation, and integrated regulation. External regulation is carried out to satisfy or achieve an external demand for behavior. Introjected regulation is acted upon by pressures such as guilt, anxiety avoidance, and pride. Identified regulation means that the individual recognizes the personal importance of a behavior and therefore accepts self-regulation of that behavior. Integrated regulation, on the other hand, means that the individual internalizes the reasons for the action more and makes it compatible with his/her needs (Ryan and Deci, 2000).

Intrinsic motivation is an important source of energy for individuals. In the Self-Determination Theory, Ryan and Deci (2000) have defined intrinsic motivation as a prototypical expression of the active integrative tendencies in human nature. They characterize

intrinsic motivation as activities done "for their own sake" or for inherent interest and enjoyment. Intrinsic motivation serves as an example of behavior that is entirely self-motivated, without any connection to external incentives or pressures, expressing solely the individual's own satisfaction and joy (Ryan and Deci, 2020). When individuals are intrinsically motivated, they experience their interests and pleasures and feel competent and free. They internally perceive the cause of the behavior and have the opportunity to experience flow. We infer intrinsic motivation if a person performs an activity without any pressure or reward, that is, if the individual determines his/her own behavior (Deci and Ryan, 1985). It usually refers to the motivation to participate in an activity because it is enjoyable and satisfying (Noels et al., 2000), and it is seen as a psychological need (Ahmadi et al., 2023).

As mentioned above, motivation deals with the energization, regulation, and maintenance of behavior by examining why individuals act. This is particularly important in the areas of physical activity, exercise, and sports (Karataş, 2020). For example, the ability of an athlete to continue long and strenuous training sessions throughout the season with determination and motivation to participate in sports is considered to be the cornerstone of success and performance. Likewise, providing the necessary energy to participate in regular physical activity and exercise is seen as an essential element for lifelong well-being and health (Standage et al., 2019). In wheelchair basketball athletes, it is understood that the motivation that is effective in sports participation is primarily based on teamwork and the emotions derived through sports (Molik et al., 2010).

Wheelchair basketball is one of the most well-known adaptive sports, recognized not only by individuals with disabilities but also by those with typical development (Larkin et al., 2014). Wheelchair basketball players contribute significantly to the important phenomena within this sport. Understanding and interpreting the lived experiences they acquire through participation in this sport are deemed crucial. In this study, in this context, the experiences of wheelchair basketball athletes and the motivational factors within the scope of self-determination theory as a result of these experiences were tried to be understood in depth.

2 Method

2.1 Pattern of the research

This study was conducted in a phenomenological design, one of the qualitative research designs. Phenomenology investigates the lived experiences of the individual (Creswell et al., 2007) and tries to uncover the in-depth meanings of the experiences (Norlyk and Harder, 2010).

2.2 Study design

The study group of the research was determined using the criterion sampling method, which is one of the purposeful sampling methods. Criterion sampling can be determined in line with the criteria prepared by the criteria determined by the researchers (Patton, 2002; Yıldırım and Simsek, 2018). Accordingly, the research criteria were determined as follows.

- Participating in wheelchair basketball for at least 5 years,
- Participating in competitions in Turkey's top league for at least 3 years,
- 22 years of age and above.

In this context, thirteen (13) athletes participating in wheelchair basketball competitions constitute the study group of the research. Information about the study group is presented in Table 1.

When the information about the study group is examined, it is seen that the participants are between the ages of 22–48, have been

TABLE 1 Demographic characteristics of the study group.

Wheelchair basketball athletes							
Participant	Age	Gender	Marital status	Education status	Disability status	Year of sport	Classification (points)
P-1	35	Male	Married	High School	Amputation	12	4
P-2	48	Male	Single	High School	Paraplegia	22	1,5
P-3	29	Male	Married	High School	lymphedema	13	4
P-4	29	Male	Single	License	Amputation	12	3,5
P-5	22	Male	Single	High School	Paraplegia	5	2
P-6	27	Male	Single	High School	Paraplegia	10	2
P-7	25	Male	Single	License	Paraplegia	10	2
P-8	45	Male	Single	License	Paraplegia	23	1,5
P-9	25	Male	Single	License	Paraplegia	9	1
P-10	27	Male	Married	License	Amputation	5	3
P-11	48	Male	Married	High School	Paraplegia	22	1
P-12	25	Male	Single	Middle School	Paraplegia	5	3,5
P-13	40	Male	Married	High School	Paraplegia	13	1

practicing wheelchair basketball for 5–23 years, and train for an average of 10 h per week.

2.3 Data collection tool

2.3.1 Personal information form and semi-structured interview form

Within the scope of the research, a personal information form was prepared to collect demographic information about the participants. With the prepared form, it was aimed to collect information such as age, educational status, disability status, number of years of participation in wheelchair basketball, classification and similar information about the participants.

Within the scope of the research, a semi-structured interview form was prepared for in-depth interviews. In the process of preparing a semi-structured interview form, a literature review was conducted. In this direction, questions were prepared by addressing the motivation phenomenon within the self-determination theory, which is one of the prominent approaches in the study of motivation and was first developed by Braun and Clarke (2017, 2020)'s "*Self-Determination Theory's Taxonomy of Motivation.*" Clarke and Braun (2017) noted that in studies involving thematic analysis, a deductive approach can be used for theory-driven analyses. Similarly, in our research, the interview protocol within the scope of SDT was determined through a deductive method. The prepared questions were evaluated by an academician with qualitative research competence and the questions were finalized. Some examples of questions prepared in this direction are presented below.

- Please provide information about the difficulties you encounter in your participation in wheelchair basketball. (Amotivation)
- How do the opinions of the people around you affect your participation in sports? (Extrinsic Motivation)
- In general, how do your personality traits affect your participation in sports? (Intrinsic Motivation)

In line with the prepared semi-structured interview form, the participants were interviewed face-to-face and in a quiet environment. Before the interview, all athletes were informed about the research and permission was requested for voice recording based on voluntary participation. The interviews lasted approximately 30 min for each participant. In addition, notes were taken on the issues that the participants emphasized during the interview. After the interview, the audio recordings were computerized to prevent data loss.

2.4 Data analyses

The reflexive thematic analysis method was used to analyze the data in the study. Reflexive thematic analysis is a frequently used method for identifying patterns of meaning in the data. It is also commonly preferred in phenomenological studies (Sundler et al., 2019). Braun and Clarke (2019) outlined the stages of reflexive thematic analysis as follows, and these stages were followed in the analysis of the data in our study.

- Analyzing the data,
- Creation of the first codes,
- Searching for themes,
- Review of themes,
- Identification and naming of themes,
- It consists of the preparation of the report.

In this context, within the scope of self-determination theory by Ryan and Deci (2000), at the end of the interview, the data were analyzed and the first codes were created. After the codes were created, themes were searched and reviewed. As a result of this process, themes were found. In this context, 6 themes and 16 sub-themes emerged. After the emergence of the themes, a metaphorical title was determined and reported for each theme.

2.5 Credibility, transferability, consistency and verifiability

Validity and reliability in qualitative research are expressed in terms of credibility, transferability, consistency and confirmability (Lincoln and Guba, 1985; Creswell et al., 2007). In this context, the participants were informed before and after the study for the credibility and transferability. In order to ensure consistency, the research data were coded separately by an expert in qualitative research other than the researcher, and the codes were compared. In addition, quotations from the participant views were presented to the expert. Within the scope of the verifiability of the research, all transactions carried out during the research period were recorded and stored in a computerized environment (Figure 1).

3 Findings

Within the scope of the research, 6 themes and 16 sub-themes emerged. Figure 2 presents the emerging themes, sub-themes and codes.

3.1 Amotivation

3.1.1 Disadvantage of disability: constraints

Within the theme of constraints, 3 sub-themes emerge. These sub-themes are structural, health, and constraints during sports. In this direction, it is seen that wheelchair basketball athletes have more structural limitations. Participants especially emphasized the problems of accommodation, hall, lack of ramps, materials, transportation, and financial problems of the clubs. In this context, a participant said:

> "Sometimes I may have difficulties in transportation. When I come by bus and public transportation, I experience such difficulties" (P-9).

When participants are generally assessed, they indicate that one of the most significant constraints affecting participation is economic issues. It is understood that economic problems cause problems in terms of both training, equipment, salary, and travel to league competitions. One participant drew attention to the financial situation and material shortages:

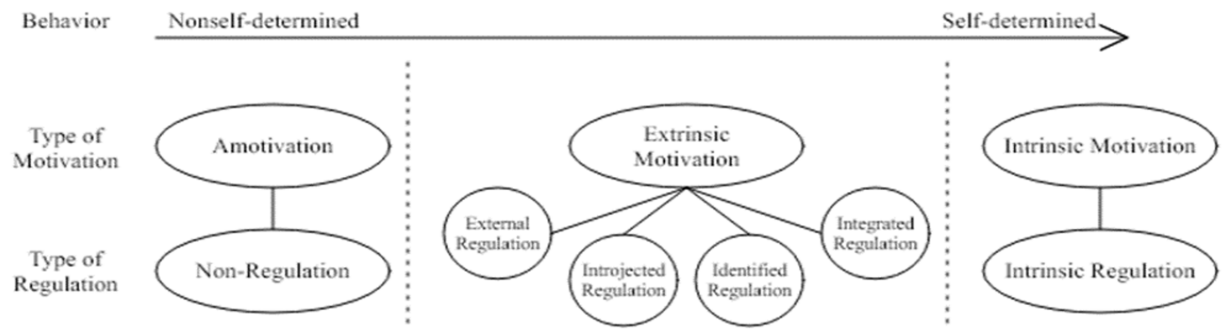

FIGURE 1
Self–determined: Adapted from Ryan and Deci (2000).

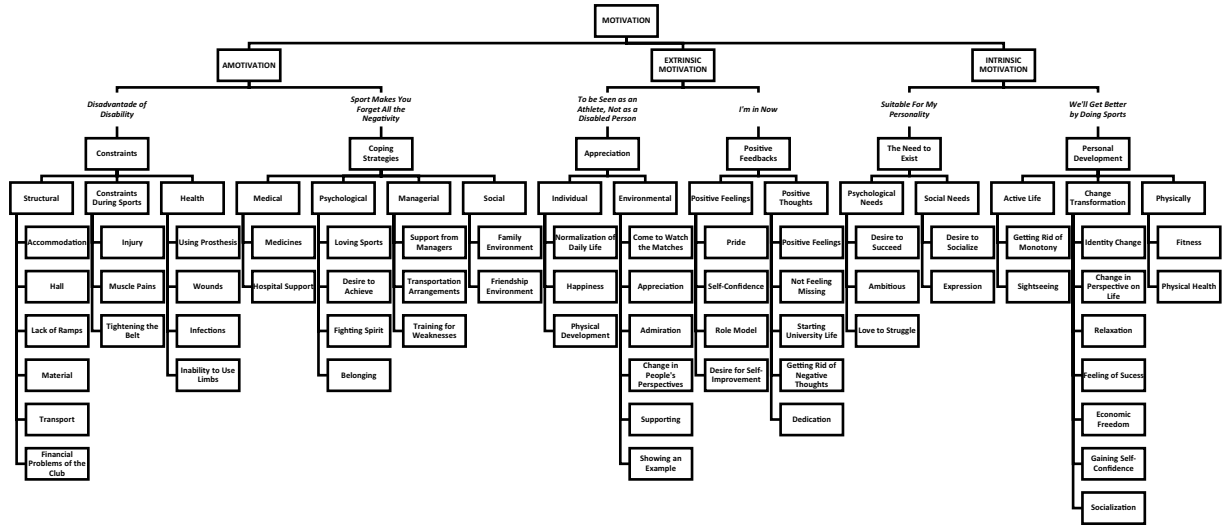

FIGURE 2
Emerging themes, sub-themes and codes.

> "Right now it's more economic. It's the economy of the team, of the club. We have difficulties in such situations, whether it is the issue of chairs or away trips" (P-12).

Within the scope of health limitations, it is understood that the use of prosthetics, in addition to the existing disability, leads to new wounds and infections. In this context, the participant shares their experiences regarding the use of prosthetics as follows:

> "We experience health problems the most. Regarding health, since we use prostheses, sometimes this happens in normal life, like electric shocks, tingling, pain, etc. It also happens in other parts of us, for example, many veterans have health problems such as blows to the arm, shoulder, or head during the injury" (P-1).

Another participant said:

> "...Of course, there are diseases, infections, sometimes we may have problems due to certain diseases due to disabilities. We get urinary tract infections, for example, not because of sports, but because we have paraplegia, so we use a catheter. That is why we often get infections, we sometimes have problems with this" (P-11).

On the other hand, it is stated that while practicing wheelchair basketball, they experience difficulties especially due to injuries, muscle pains and tightness of the wheelchair belt. In this direction, one participant said:

> "I mean, there is serious fatigue, muscle fatigue. We have muscle pains and injuries from time to time" (P-4).

The use of prosthetics due to existing disabilities in physically disabled athletes, as revealed by participant opinions, is understood to be a result of limitations in the use of body limbs, leading to challenges for athletes in this regard. On the other hand, a significant majority of the participants being paraplegic, and consequently experiencing issues related to inflection, emerges as a significant factor exacerbating existing difficulties.

3.1.2 Sport makes you forget all the negativity: coping strategies

Within the scope of coping strategies, psychological, managerial, medical, and social sub-themes emerged. It is emphasized that psychological factors are more prominent in coping with the difficulties faced by wheelchair basketball athletes. In this regard, one participant said:

> "The biggest thing is to love sports. You endure these constraints as you love sports. Also, setting a goal for oneself, aiming to be successful, wanting to be successful is the biggest help to cope with these difficulties, no matter which branch of sport one is in. Apart from the difficulties, you cannot cope with some constraints and you continue your sports with constraints. We have continued sports under these conditions until now..." (P-13).

On the other hand, it is emphasized that participants consider the support of team managers and coaches in every aspect as a crucial factor in overcoming challenges. A participant's perspective on this matter is as follows.

> "We are engaging when our coaches and managers provide us with these opportunities. It's not about individual struggle; when we work alongside our coaches and managers, many problems get resolved." (P-2).

Participants point out that one coping strategy is the creation of a social environment within the team, emphasizing its significance for them. Also, in coping with adversities, it is predominantly observed that athletes' affection for wheelchair basketball has a significant impact. The desire to succeed against all odds is recognized as a crucial precursor in the development of this sentiment, serving as a coping mechanism against encountered constraints. In addition to these, despite facing economic challenges, the strong support from team managers and coaches, especially at the managerial level, serves as a significant motivator for athletes. Furthermore, positive and supportive interpersonal relationships within the team are also considered another factor. In this regard, the support of athletes' families and peer groups is seen as an important strategy in overcoming encountered obstacles.

3.2 Extrinsic motivation

3.2.1 To be seen as an athlete, not as a person with a disability: appreciation

In terms of how the participants are perceived and reacted to by the individuals around them, it is emphasized that they generally attribute meaning to the fact that they are valued. In particular, it is emphasized that the participants received positive feedback such as admiration, appreciation, and being shown as an example, which prevented their disabilities. In addition, it is underlined that there is a change in the perspectives of the individuals around them due to the fact that they are athletes. For example, one participant expressed his views on this issue as follows:

> "People's perception of me has also changed. They saw them as human beings, not as people with disabilities. They were more cordial. My friends' thoughts changed, they saw that I was able to achieve something. They saw what a person with a disability can achieve, what I can achieve..." (P-5).

Another participant said:

> "Of course, perspectives change a lot, I mean, being a national athlete is exhibited as an attitude of being pointed at in the family environment and in the environment of relatives. They say I am an athlete, they say I am in the national team. Of course, it motivates, being pointed out among people, being shown with something to be proud of has a positive effect. You get more attached to what you do, you realize that what you do is important" (P-7).

On the other hand, participants emphasize that their physical development, happiness, and the normalization process in their daily lives serve as a source of motivation. For example, a participant expresses,

> "This sport keeps us in shape. My purpose for engaging in sports is entirely in this direction to be fit, that is, for the body to be fit. For instance, they say, 'You are taking care of yourself, you are doing sports,' because they know I engage in sports. I receive positive feedback in that regard." (P-1).

In this context, it can be said that it is more effective for athletes to be perceived more as 'athletes' rather than emphasizing the obstacles. Particularly, it is emphasized that they faced more attitudes focused on hindrance in their lives before becoming athletes, but this situation changes with participation in sports. This becomes a significant source of motivation for athletes.

3.2.2 I'm in now: positive feedback

It is seen that the positive feelings and thoughts arising from the fact that the individuals in the environment are athletes increase the motivation of the participants. In this context, the participants stated that the perspectives of the individuals around them created positive emotions such as pride, self-confidence, and not feeling deficient. One participant emphasized self-confidence as:

> "Their opinions gave me more self-confidence. From the very beginning, I did not feel that I was lacking in any way. It increased my motivation, had a more positive effect on my performance and my sports life, and thanks to that" (P-8).

Another participant also supported these views:

> "Being successful somewhere, being praised by someone else, boosts your self-confidence. This also boosts our self-esteem in a positive way. It's like this because now I'm in it, I'm an athlete, I can achieve things too" (P-13).

Additionaly, participants frequently highlight the positive impact of individuals in their surroundings, particularly when they exhibit a positive attitude. This includes fostering positive emotions such as not feeling inadequate, overcoming negative thoughts, and generating a sense of completeness. In this regard, a participant expresses themselves as follows:

> "People's perspective has changed. They appreciated the sport I engage in, gave me extra value, and truly made me feel valuable." (P-8).

Athletes emphasize that being seen as athletes rather than as disabled individuals and the development of positive attitudes toward them by individuals in their environment serve as a source of motivation for them in terms of building self-confidence, achieving success, and being appreciated.

3.3 Intrinsic motivation

3.3.1 Suitable for my personality: the need to exist

The findings revealed that personality traits of wheelchair basketball athletes in general increase their motivation to participate in sports. In this direction, the fact that the participants have the desire to succeed, are ambitious, and love to struggle is the most important factor in practicing this sport. For example, one participant expresses himself in this regard as follows:

> "I am ambitious, I cannot tolerate losing" (P-7).

In this direction, another participant expressed her feelings as follows:

> "Basketball is a sport that fits my personality. It's a challenging sport, that's how it is in life. I want to take part in a sport where there is extreme struggle, where there is a real war inside, plus the ambition to win, the desire to win, this is also in people's daily lives. The same is true in basketball" (P-8).

Another factor is that participants emphasize the significance of wheelchair sports as a motivation for their desire to socialize and express their emotions. A participant shares,

> "Sometimes, when people mention it, they laugh. Before getting into sports, before the injury, my circle of friends was so rare. Seeking dialog with people, even trying to integrate into the environment, was a challenging task. However, this situation turned out to be a blessing. Thanks to the team, thanks to the community, my circle of friends has expanded so much that sometimes I think to myself, 'I'm glad I faced this constraint, I'm glad I reached this point.' Not only has my circle of friends expanded, but also my social activities have increased. When people say, 'Let us go, let us do it,' this time, people include me in their plans. It's a benefit of sports." (P-10).

It is emphasized that the most crucial factor in ensuring intrinsic motivation is psychological factors. Particularly, in the development of this condition, it is understood that athletes' general personality traits, such as being resilient, ambitious, and intolerant of losing, play an effective role. In addition, it is observed that through sports, they spend more time in social environments and engage in settings that provide participants with the opportunity to express themselves better.

3.3.2 We will get better by doing sports: personal development

It is seen that there are many positive changes in the lives of the participants in wheelchair sports and these changes increase their motivation to participate in sports. Especially in this regard, it is emphasized that identity change occurs and that they gain self-confidence. Participants also reported that their perspectives on life changed, a social environment was provided, and there was a physical change and transformation. Participant views on this issue are given below:

> "It gives you an athlete identity, if nothing else, it gives you an athlete identity. Athlete identity is not something that everyone can easily do nowadays" (P-1).

> "Sports gave me self-confidence, it gave me the ability to fight with life. I actually learned that I can overcome difficulties. I mean, it activated me, quite frankly, against life. Sports has given me a lot. Power, thought, freedom, in other words, activism, that is, a lot of things related to life" (P-12).

> "I am an active person. I enjoy having fun and entertainment. I prefer group settings more and do not like being alone. I can say that wheelchair basketball has been quite supportive for me in this regard." (P-6).

In this context, within the framework of participant opinions, it is observed that the emphasis is on engaging in wheelchair basketball to highlight the prominence of personal development through sports and the idea that we will get better by participating in sports.

4 Discussion

This study was conducted with the aim of determining the amotivation of wheelchair basketball players in their participation in sports, the factors affecting their extrinsic motivation, and how they provide intrinsic motivation within the scope of the self-determination theory put forward by Ryan and Deci (2000). The findings obtained in this context are discussed and interpreted below.

4.1 Amotivation

4.1.1 Disadvantage of disability: constraints

In the context of the findings, it is understood that wheelchair basketball athletes face many constraints. In a study conducted by Bentzen and Malmquist (2022), which employed the same theory as our research, the satisfaction of needs in physical education, organized sports, and self-organized physical activity among adolescents with disabilities compared to their peers without disabilities over a three-year period was examined within the framework of SDT. The study concluded that adolescents with disabilities have lower participation, especially in physical education and partially in organized sports activities. In this context, it was emphasized that the suitability of structure is crucial for reducing constraints. In this regard, Argan et al. (2021) concluded in their research that there are structural barriers especially due to transportation and access. The research emphasizes that there are significant difficulties, from transportation to facilities to accessibility to halls and halls and lack of ramps. Similarly, Jaarsma et al. (2014) state that wheelchair athletes have difficulties accessing facilities and materials compared to other physically disabled athletes. On the other hand, it is also seen that athletes have health problems due to disability and difficulties they experience while playing

basketball. Esatbeyoğlu and Karahan (2014) state that especially people with physical disabilities face more constraints in participating in sports than those with hearing and visual impairments. When the literature on this subject is examined, it is seen that the problems of wheelchair basketball players are divided into diseases that are not related to basketball sports and injuries experienced while playing basketball (Sá et al., 2022). As a reason, it is stated that the pain in the spine area, especially in the lower back, is high as a result of overload, especially in those who use wheelchairs continuously (Curtis and Black, 1999; Wilroy and Hibberd, 2018; Sá et al., 2022). In the scope of our research, it is understood that there are more limitations related to structural factors based on the acquired data. Primarily, the construction of a structure specific to the current disability conditions of disabled athletes is emphasized. It is believed that the facilitation of individuals' inclusion in activities will be enhanced within this facilitative context. Additionally, it is considered crucial to take precautions to prevent the occurrence of secondary disabilities alongside their existing disability conditions. The findings suggest that the disability level varies for each disabled athlete in the teams, and their changing needs in this context should be taken into account.

4.1.2 Sport makes you forget all the negativity: coping strategies

It is seen that psychological factors are especially at the forefront in coping with these negativities faced by wheelchair basketball athletes (Perreault and Vallerand, 2007; Martin et al., 2015). It can be said that performing the best performance under pressure, concentration, self-confidence, the ability to set goals for oneself, as well as believing that one can be trained and having a positive relationship with oneself are effective in coping with difficulties (Perreault and Vallerand, 2007). In this regard, Lundberg (2006) examined the sports participation and subjective well-being of individuals with spinal cord injuries within the scope of SDT. The research concluded that providing additional sports opportunities for individuals with spinal cord injuries, especially in the post-treatment period, is effective in enhancing their psychological strength. Also, Erdemir et al. (2009) state that physical disabilities do not constitute a constraint to playing basketball; on the contrary, they are important in terms of showing that they are a part of society and that they see basketball as a joy of life. In this context, it can be said that sports make people forget the difficulties and troubles they experience. Within the scope of the obtained findings, it is possible to discuss some psychological issues caused by the existing constraints of wheelchair basketball players. However, it is observed that individuals create an outlet for themselves in terms of factors such as performing well in sports, the desire for success, and concentration. In this context, it can be said that individuals are 'better' both physically and psychologically. Therefore, basketball has been adopted as an important 'coping mechanism' for wheelchair basketball players.

4.2 Extrinsic motivation

4.2.1 To be seen as an athlete, not as a disabled person: appreciation

According to the findings of the study, it was determined that wheelchair basketball athletes were appreciated, shown as an example, and looked at with admiration by the individuals around them. Perreault and Vallerand (2007) define extrinsic factors as a significant variable within the scope of SDT when individuals participating in adapted sports explain their involvement in their respective sport. In this direction, they see being seen as an athlete, not as a person with a disability, as an important source of extrinsic motivation for them. Kumcağız and Çayir (2018) emphasize the importance of family members, friend groups, coaches and state support. They reported that this motivated them and helped them to cope with difficulties. In this regard, Ramsden et al. (2023) underlines that being in a sports environment changes attitudes toward people with disabilities. It is reported that not only intrinsic motivations are not sufficient for the participation and encouragement of individuals with disabilities in sports, but also extrinsic reasons should be taken into account (Perreault and Vallerand, 2007). In this direction, it can be said that the fact that wheelchair basketball athletes are valued by the individuals around them is an important motivational factor for them to be seen as an athlete, not as a person with a disability. The obtained findings indicate that wheelchair basketball serves as a means for disabled athletes to be appreciated and, in fact, accepted within society. In reality, extrinsic factors seem to be crucial for disabled athletes, and the opinions of external factors (*family, friends, neighbors,* etc.) impact and add meaning to their lives.

4.2.2 I'm in now: positive feedback

It is seen that these positive attitudes of the individuals in the environment toward wheelchair basketball athletes positively affected the participants. In this regard, in studies conducted in a similar field, SDT-based physical activities were seen to enhance individuals' participation in physical activity, their quality of life, and their levels of happiness (Ghaneapur et al., 2019). Accordingly, McLoughlin et al. (2017) concluded that the social support perceived by athletes with physical disabilities is effective in their motivation to participate in sports. Again, it has been determined that the social support received by athletes with physical disabilities from the individuals around them positively affects participation in sports (Wessel et al., 2011). Jeffress and Brown (2017) stated in their study that individuals with physical disabilities are accepted and respected by society regardless of their physical abilities. It is reported that this situation leads to an increase in the self-efficacy beliefs of the participants, thus enabling an increase in the quality of life of individuals with physical disabilities. In this context, it can be said that the positive social support that individuals with disabilities receive directly or indirectly is important in their motivation to participate in a physical activity (Durmuş et al., 2021; Olsen et al., 2023). Within the scope of the research findings, it can be stated that increasing encouraging factors for the participation of disabled athletes in sports and promoting their participation could enhance their respective motivations. This situation is thought to be achievable by increasing the visibility and awareness of wheelchair basketball and other disabled sports, both as a sport and its athletes, in society. It can be said that any form of positive feedback serves as a significant motivational source for disabled athletes, empowering them through such encouragement.

4.3 Intrinsic motivation

4.3.1 Suitable for my personality: the need to exist

According to the research findings, it is concluded that the intrinsic motivation of wheelchair basketball athletes affects their participation and enthusiasm in sports. Accordingly, Banack et al. (2011) examined the relationship between Paralympic athletes' perceptions of autonomy-supportive coach behavior, basic psychological needs, and intrinsic motivation to know, accomplish, and experience stimulation within the framework of SDT. The study emphasizes the significance of the alignment of factors influencing athletes' intrinsic motivation. It can be said that, through this alignment, athletes with disabilities can be successful. Also, it is seen that the fact that they have an ambitious and combative structure is a factor in this situation. Sports is seen as one of the most effective factors that increase the fighting spirit of individuals with disabilities to survive and hold on to life despite all the difficulties of life (Soyer et al., 2013; Gürkan et al., 2021). The fact that athletes with physical disabilities love competition and have the desire to achieve goals positively affects their motivation to participate in sports (McLoughlin et al., 2017). It is stated that the motivation of individuals with physical disabilities to participate in physical activity is influenced by the desire to achieve performance, the desire to succeed, and the spirit of competition (Mindrescu, 2022). In this direction, it can be concluded that the participants have a personality trait compatible with wheelchair basketball sport. According to the obtained data, it can be said that the desire for success and the combination of competitive elements increase the intrinsic motivation of wheelchair basketball players. In this context, it is considered important for them to choose a sports branch that suits their personalities, allowing them to express themselves in society. Additionally, it can be stated that the participants' choice of wheelchair basketball is influenced by their ambitious and competitive identities.

4.3.2 We will get better by doing sports: personal development

Participants stated that experiencing positive changes in their participation and continuation in sports supported them internally. For example, Çil et al. (2023) stated in their research that individuals with physical disabilities who do sports have an increase in positive thinking skills compared to those who do not do sports. Likewise, in their study on wheelchair basketball athletes, Fiorilli et al. (2013) stated that individuals who participate in basketball sports have more psychological well-being and social skills than those who do not. Ramsden et al. (2023) state that the establishment of friendships and belonging to a community are important for participation in wheelchair basketball. Again, in a study conducted by Tekkurşun-Demir and İlhan (2020), it was concluded that athletes with physical disabilities minimize their sports inadequacies and encounter more limitations than other disabilities. In our research, it can be said that wheelchair basketball players not only engage in sports but also make an effort to find the meaning of life through this branch. Through participation in sports, individuals are seen to push their existing potentials to the highest level. It can be stated that individuals also improve their quality of life through participation in sports. This situation is considered to be effective in athletes having a more optimistic/positive outlook on the future.

5 Conclusion

The aim of this study is to determine the motivational factors in the participation of wheelchair basketball players in sports according to the Self-Determination Theory. Within the scope of the findings obtained, it can be concluded that the most significant constraints for wheelchair basketball players arise from structural limitations such as financial difficulties, equipment, transportation, and accommodation issues faced by clubs. On the other hand, the use of prosthetics, infectious diseases related to disability, and difficulties in using limbs can be considered as disadvantages of the disability. Wheelchair basketball players' desire to overcome these challenges and constraints, along with psychological factors such as the will to succeed and a fighting spirit, together with managerial support and the club environment being a family atmosphere, are identified as the most important coping strategies.

Another result obtained in the study is that wheelchair basketball players are externally motivated more by positive attitudes and behaviors from their surroundings. In the formation of this situation, the recognition, exemplification, and support of athletes by individuals in their environment, such as family, friends, and neighbors, play a crucial role. Internally motivating factors are primarily driven by the athletes' existential needs and the desire for self-improvement. In this regard, the most important factors contributing to these aspects are identity change, a shift in perspectives on life, and an increase in quality of life.

6 Strengths and limitations

This research's strengths lie in examining the factors influencing wheelchair basketball players in overcoming obstacles and using qualitative research methods within the framework of the Self-Determination Theory (SDT). In this regard, it aims to provide detailed and in-depth information that will enable a comprehensive understanding of the behaviors of wheelchair basketball players in overcoming obstacles and the processes of change in their sports lives, within their own context. It is also believed that the study can contribute significantly to the relevant literature with the existing information. The limitations of the research include the difficulty in generalizing the results, as the data were collected from a limited number of participants.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

HS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Empowerment and social inclusion through Para sports: a qualitative study on women with physical impairments in Saudi Arabia

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Background: Participation in sports represents a potent means of empowerment and social inclusion. Nevertheless, women with physical impairments encounter specific challenges in accessing Para sports. The main aim of this study is to present the experiential participation and achievements in sports of women with physical impairments in Saudi Arabia.

Methods: Twenty women athletes with physical impairments who engaged in competitive Para sports in Saudi Arabia were interviewed. Interpretive phenomenological analysis was employed to extract themes elucidating the experiences of women athletes with physical impairments in Para sports.

Results: Four dimensions were identified: (i) Exploring participation in sports; (ii) The positive impact of participation in sports; (iii) obstacles in participation in sport; and (iv) hopes and aspirations to improve participation in Para sports.

Conclusion: In Saudi Arabia, participation in Para sports functions as a powerful tool for empowering and socially integrating women with physical impairments. However, these women encounter challenges in accessing sports. Achieving empowerment in Para sports necessitates the establishment of an inclusive ecosystem that celebrates diversity and equality. Collaborative efforts from governments, sports organizations, communities, and individuals are indispensable in creating an environment where women with impairments can flourish in sports.

KEYWORDS

social inclusion, women Para-athletes, disability, physical disability, Saudi women

1 Introduction

The World Health Organisation defines disability as an umbrella term for impairments, activity limitations, and participation restrictions that indicate the negative aspects of the interaction between an individual (with a health condition) and that individual's contextual factors (environmental and personal factors) (World Health Organization, 2011). It is estimated that there are 1.3 billion people in the world who experience a significant disability (World Health Organization, 2023, March 7). Notably, the prevalence of disability tends to

be higher among women than men, with the average prevalence of women aged 15 years and older is 18%, compared to 14.2% for males (World Health Organization, 2022). This means that about 1 in 5 women have a disability. Women with disabilities are a diverse group with a wide range of experiences, abilities, and needs, as well as unique challenges and opportunities. However, it is apparent that women with disabilities experience greater challenges and have considerably poorer experiences than their male contemporaries, facing greater barriers to access and participation (Emmett and Alant, 2006). Wickenden (2023) described disability, like other identities, as socially constructed, subject to misrepresentation, and frequently isolated from other issues and experiences.

Sports are a social activity that provides a platform for societal activity engagement, allowing for a sense of individual and collective self, meanings, and participation through social interaction (Svanelöv et al., 2020). Para sport refers to the athletic activities that are engaged in by individuals who have a qualifying physical, visual, or intellectual impairment, as governed by the International Paralympic Committee and its member organizations (Vanlandewijck and Thompson, 2011). Active participation in sports plays a vital role for people with disabilities in shaping their athletic sense of self, improving both physical and mental well-being, and significantly enhancing the overall quality of life (Ruddell and Shinew, 2006; Martin, 2013; Diaz et al., 2019; Martin Ginis et al., 2021). Para sport is a dynamic and inclusive arena within the athletic landscape that celebrates the athletic abilities and achievements of people with disabilities (International Paralympic Committee, 2023). It gives athletes with disabilities a stage to demonstrate their ability, determination, and tenacity, inspiring others and breaking down preconceptions while promoting equality and inclusion. Para sports not only redefine athleticism but also develops a sense of empowerment and camaraderie among participants and spectators. There are local and various international competitions for athletes with disabilities, including multi-sport and multi-disability competitions (e.g., Paralympic Games) and single disability competitions (e.g., Deaflympics and Special Olympics World Games). Along with competing in multi-sport events, disabled athletes also take part in a plethora of world cups and championships, including but not limited to the UCI Para-Cycling Track World Championship, the INAS World Football Championship, the IPC Powerlifting World Championship, the World Para Table Tennis Championship, and so on.

Although women athletes with disabilities have made great advances in recent years, they still face challenges such as unequal media coverage, limited participation opportunities, issues of intersectionality, insufficient financing, and a need for increased activism (DePauw, 2000; Roy, 2011; Moodley and Graham, 2015; Kirokosyan, 2021; Weiller-Abels et al., 2021; Alhumaid et al., 2022). To properly empower and celebrate women athletes with disabilities, it is critical to address these concerns and work toward a more inclusive and equitable sports scene where their accomplishments are recognized and celebrated in the same way as those of all other athletes. Empowerment, as defined by Kosciulek and Merz (2001), is the result of a combination of internal factors such as a sense of control, competence, responsibility, commitment, and future orientation, as well as situational factors that encompass social elements like control over resources, interpersonal skills, work, organizational skills, and social skills. These qualities contribute to enhanced community inclusion, empowerment, and overall well-being for individuals with disabilities (Kosciulek and Merz, 2001).

However, the participation of women with disabilities in sports is complex, and affected by the intersectionality of gender and disability. It is important to consider not only the specific nature and severity of the disability but also the specific sports they pursue (Emmett and Alant, 2006; Kirokosyan, 2021; Ballas et al., 2022; Olasagasti-Ibargoien et al., 2023; Richard et al., 2023). Kirokosyan (2021) noted that fewer women than men participate in Para sports, and the causes for this disparity are compounded by various factors, including gendered power dynamics, societal and cultural barriers, belief systems, and women's personal decisions. These variables, alone or in combination, may influence the women's participation in sports and potentially hamper efforts to raise awareness of the issues distinctive to female athletes with disabilities (Seal, 2012; Moodley and Graham, 2015; Kirokosyan, 2021). DePauw (2000) observed that despite being a smaller group compared to male athletes with disabilities, women have actively engaged in Para sports since the early 1920s. However, women athletes with disabilities aiming for high-level sports competition often confront dual discrimination rooted in both their gender and disability. More than three decades ago, Wendell (1989) remarked that women with disabilities face dual challenges: they grapple with the subjugation associated with being women in predominantly male-dominated societies and also contend with the oppression stemming from their disabilities in societies largely dominated by individuals without disabilities.

In Saudi Arabia and other arab countries, women athletes with disabilities face a unique set of challenges and barriers in the realm of sports. According to Alhumaid et al. (2022), the challenges faced by female athletes with disabilities in Saudi Arabia can be exacerbated by cultural, religious, and gender-specific issues as well as a lack of awareness and representation. Traditional gender roles and societal attitudes toward women in Saudi Arabia can create barriers for women athletes with disabilities. Stereotypes and biases may discourage their participation in sports and limit their access to training and competitive opportunities (Mohamed et al., 2020; Zahra et al., 2022). Some families and communities may discourage or even prohibit women, particularly those with disabilities, from engaging in sports. As a result, female athletes with disabilities generally find themselves little known or visible in Saudi Arabia. This lack of representation can contribute to the marginalization of these athletes and hinder their recognition and support from the wider society.

Nevertheless, the research on the quality of involvement of women with disabilities in the Arab region remains reduced in both quantity and quality. Further investigation is required to fully comprehend the extent of involvement among these women in society, taking into consideration ethnic diversity, cultural factors, and geographical location (Gharaibeh and Remaih, 2022). It is also unclear how the impact of the interplay between individuals and their surroundings on participation is essential for fostering full engagement in Para sports. Additionally, there is a research gap regarding gender equity in sports specific to Saudi Arabia, the broader Middle East, and other countries of the Arabic region (Alruwaili, 2023).

The main aim of this study is to present the experiential participation and achievements in sports of women with physical

impairments in Saudi Arabia as physical impairment is the most common disability in the country (Unified National Platform, 2023). The current study delves into their participation in sports, both recreationally and competitively, exploring the benefits and challenges they face. It also discusses the influence of traditions, cultural norms, and expectations on women with physical impairments in the context of sports. Furthermore, it addresses the future development of Para sports and the processes that have impacted the inspiration and empowerment of women with physical impairments. This study represents a new transformative, focusing on recent advancements in sports for women with physical impairments in Saudi Arabia.

2 Materials and methods

2.1 Procedure

After receiving ethical approval from the Research Ethics Committee at King Faisal University (KFU-REC-2023-JUN-ETHICS1091), women with physical impairments who were actively engaged in sports in Saudi Arabia were invited to take part in this qualitative research project. Participants were recruited through sports associations for persons with physical impairments in Saudi Arabia. Those who were willing to participate were sent an information sheet detailing the study's objectives and purpose, along with an informed consent form for them to sign. As the participants resided in different cities across Saudi Arabia, all interviews were conducted via telephone and no incentives were given for participation. The interviews, typically ranged from 25 to 30 min in duration, were audio-recorded with permission from participants and subsequently transcribed verbatim.

2.2 Participants

Saudi Open Data Portal (2023) reported that there were 53 Paras ports clubs associated with the Saudi Arabian Paralympic Committee, as stated by the Ministry of Sports. These clubs focus on 23 specific parasports and include a total of 3,682 athletes, with the majority being male. Out of all the clubs mentioned, only 7 of them have women's teams that participate in 4 distinct parasports, resulting in a combined total of 54 athletes. The sports comprised of deaf bowling with a participation of 2 athletes, 4 track and field clubs with a total of 45 participants, weightlifting with 4 athletes, and table tennis with 3 players.

A total of 34 athletes were contacted by our research team, and out of these, 20 agreed to be interviewed. Potential participants were required to satisfy the following inclusion criteria: (a) be at least 18 years old, (b) be currently engaged in sports, (c) have a physical impairment. The participants were between the ages of 19 and 50 ($M = 36.3$ years; $SD = 8.62$ years). All participants reported that they receive attendant care; when asked to self-rate their health status, more than half (65%) described their health as 'Good'; the remaining participants reported being in 'Excellent' health. Most of the participants (75%) had an acquired disability, while others had had a disability since birth. Demographic information of participants is shown in Table 1.

2.3 Measures

In order to investigate the participants' experiences, viewpoints, and attitudes toward participation in sports in Saudi Arabia, comprehensive individual interviews using a guided approach were carried out. This involves basing the interview topics on the interviewees' respective backgrounds to enhance the thoroughness and precision of multiple interviews (Patton, 1990). Following McGrath et al.'s (2019) recommendation, the interviews began with relatively straightforward warm-up questions to establish rapport between the interviewer and the interviewees. Subsequently, the questions then moved to more specific topics to elicit the participants' experiences, perspectives, and views on sports in Saudi Arabia.

The interview questions covered various topics, including the psychological, physical, and social impacts of sports participation, as well as the challenges and barriers encountered by the participants in relation to their involvement in sports. Below are some examples of the interview questions:

1. What do you think of the sports program that you participate in?
2. What do you like most about playing the sport?
3. Do you feel any changes (physical, mental) in yourself after playing the sport? If yes, can you describe these changes?
4. Do you face any issues related to your participation in sports?
5. What do you think would encourage more women with physical impairments to participate in sports?

The interviews were concluded once data saturation was achieved, indicating that no new themes or significant information were emerging from the interviews. However, to ensure thoroughness and confirm the absence of any overlooked themes, three additional interviews were conducted. These supplementary interviews served as a precautionary measure to validate the completeness of the data and ensure that all possible themes had been adequately explored and captured (Jassim and Whitford, 2014).

2.4 Data analysis

To explore the experiences, perspectives, and opinions of women with physical impairments engaged in sports in Saudi Arabia, an interpretive phenomenological analysis approach was utilized (Smith et al., 2009). Rather than simply aiming to confirm or reject a specific hypothesis, interpretative phenomenological analysis entails researchers endeavoring to organically capture and explore the meanings that participants ascribe to their encounters with the subject of investigation (Reid et al., 2005). In this particular case, the focus was on the experiences of women with physical impairments participating in sports in Saudi Arabia. These meanings were subsequently categorized into distinct themes to offer a comprehensive overview of the subject under investigation (Braun et al., 2016).

In the present study, we used a five-step process to identify and categorize the principal themes. First, we thoroughly read and reread the interview transcripts to become familiar with the content. Second, we sought to identify recurring patterns, both common and less common, that yielded valuable insights into the participants' viewpoints, perspectives, and experiences related to participating in sports in Saudi Arabia. Each distinct theme was assigned a unique

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TABLE 1 Demographic profile of participants.

Variable	Categories	Number (%)
Age	19–30 years old	5 (25)
	31–40 years old	7 (35)
	More than 40 years old	8 (40)
Education level	Middle school	1 (5)
	High school	7 (35)
	Diploma	2 (10)
	Bachelor	10 (50)
Occupation	Unemployed	7 (35)
	Student	2 (10)
	Athlete	1 (5)
	Self-employed	1 (5)
	Government employee	3 (15)
	Private sector employee	6 (30)
Marital status	Single	11 (55)
	Married	5 (25)
	Divorced	4 (20)
Years living with disability	<5	4 (20)
	5–10	1 (5)
	11- < age	9 (45)
	Since childhood	6 (30)
Sport participation level	District	4 (20)
	Club	10 (50)
	International	6 (30)
Years of playing sports	1–2	13 (65)
	3–4	1 (5)
	5–7	5 (25)
	8–9	1 (5)
Type of sports	Athletics	14 (70)
	Table Tennis	3 (15)
	Bowling	1 (5)
	Weightlifting	2 (10)
Self-rated physical activity	Moderately active	6 (30)
	Active	12 (60)
	Highly active	2 (10)
Time of play sports (days/week)	3	5 (25)
	4	4 (20)
	5	5 (25)
	6	6 (30)
Time of play sports (hours/day)	2	9 (45)
	3	6 (30)
	4	4 (20)
	5	1 (5)
Achievements	None	9 (45)
	Medal(s) in local championships	7 (35)
	Medal(s) in the national championship	2 (10)
	Medal(s) in the international championship	2 (10)

code. Third, we inductively determined and organized these emerging codes (Saldaña, 2013) to formulate preliminary themes. Fourth, these preliminary themes were clarified and labeled. Finally, in the fifth step, the preliminary themes were organized into the overall themes (dimensions).

2.5 Trustworthiness

Trustworthiness of the findings was ensured using two methods: member checks and peer review. First, member checks were employed to enhance the credibility of the findings. The interview transcripts were returned to all participants to validate, rectify, deny, or elaborate on the information they provided during their interviews. Second, peer review or debriefing, as an external assessment of the data (Lincoln and Guba, 1985; Creswell, 2007), involved an experienced qualitative researcher who is an associate professor in the field of teaching methods at a Saudi university. With 10 years of experiences in qualitative research, the peer reviewer evaluated the integrity of the study. The peer reviewer also collaborated with the coders during the five-step process to identify and categorize the main themes.

2.6 Reflexivity

Reflexivity plays a pivotal role in qualitative research, serving as a mechanism for researchers to critically examine their own assumptions, biases, and beliefs that could influence the research process and outcomes (Creswell and Miller, 2000). In this study, reflexivity was integrated into the research design to inform both data collection and analysis (Tracy, 2010). To minimize potential biases, the authors conducted a bracketing interview, creating a structured platform for introspection and reflection on theoretical assumptions and biases. Following this initial step, collaborative team discussions were conducted to delve deeper into these identified biases and assumptions, ensuring a thorough exploration and effective mitigation of their potential impact on the study's findings. Furthermore, the research team for this study comprises individuals with physical/mobility disabilities, who are also former Paralympian and research sport psychologist, alongside academic experts in the fields of adapted physical activity and sport, as well as sport sociology, particularly in the area of disability sport. This diverse composition brings a unique perspective and depth to the research process, enriching the study's overall rigor and validity.

3 Results

The interpretative phenomenological thematic analysis (Reid et al., 2005) revealed four main dimensions that the 20 participants associated with their experiences as women with physical impairments participating in sports in Saudi Arabia. These dimensions were extracted from the 50 most frequently occurring themes and sub-themes drawn from the raw data; these were organized into 12 first-order sub-themes and 9 s-order sub-themes These first- and second-order themes are presented and exemplified by representative interview extracts (see Table 2). The four main dimensions are as follows: (i) *Exploring participation in sports*, (ii) *The positive impact of participation in sports*, (iii) *The challenges of participating in sports*, and (iv) *Motivations to participate in sports*.

3.1 Exploring participation in sports

This dimension provided evidence about how the participants had become involved in sports. Specifically, several participants reported that they had initially been introduced to sports through colleagues and friends. As one participant mentioned, '*… it was by my friend. I wasn't aware that there was a club for people with disabilities that offered sports and exercises. However, my friend informed me of its existence and recommended that I go, so I did.*' Social media also provided a useful way for participating to discover opportunities to participate in sports. One participant mentioned, '… it was by chance, while browsing a social networking site, I came across video clips of Saudi girls with physical impairments participating in a local tournament. This ignited my desire to join in.' In addition, various sports clubs, associations, and organizations for those with disabilities emerged as a factor in attracting the participants to become involved in sports. As one participant stated:

> *'There was an event at the club for people with disabilities, and during the event, a coach approached me and invited me to participate in a game. After being tested, I signed a contract with XX club, and now I am part of the national team.'*

3.2 The positive impact of participation in sports

The positive impact of participation in sports, rooted in theoretical perspectives such as social capital theory and psychological well-being frameworks, is a central theme that emerged from the analysis of 30 raw data themes. Before delving into the description of each second-order sub-theme, it is essential to provide a comprehensive understanding of the overarching concepts that underpin this theme. In this section, we will explore the various *health benefits*, *key factors that contribute to sport participation*, and *social benefits* associated with engaging in sports activities. By examining these dimensions, we aim to shed light on the multifaceted positive impact that sports participation can have on women with physical impairments.

3.2.1 Health benefits

The health benefits of participation in sports emerged as a key theme across various health dimensions, including psychological, physical, and medical. To illustrate this, numerous participants highlighted the positive psychological impacts of participating in sports including feelings of psychological comfort, positive energy, alleviating stress and negative emotions, and providing a purpose in life. Specifically, one participant mentioned, 'I feel a sense of happiness during and after playing group games with individuals who share the same disability and level of thinking, which generates positive energy and overall happiness.' Additionally, another participant expressed that:

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TABLE 2 Participants' experiences of participating in sports.

Raw data themes	1st order subthemes	2nd order subthemes	Dimensions
Introduced by friends and colleagues ($n = 9$) Explored by social media ($n = 4$) Introduced by associations and organizations for people with disabilities ($n = 5$) Introduced to clubs for people with disabilities ($n = 5$)	Introduction to sports	Exploring participation in sports	Exploring participation in sports
It is a great feelings ($n = 9$) Feelings toward sports changed from negative to positive ($n = 7$) Improved mental health ($n = 3$) Psychological comfort, positive energy, and getting rid of stress and negative energy ($n = 17$) Improvement in concentration, reflexes, and responsiveness ($n = 6$) My outlook toward myself and people with disabilities has become more positive ($n = 2$) I feel like I have a purpose in life ($n = 1$) For a more useful and enjoyable life ($n = 9$)	Psychological effects of sports participation	Health benefits	The positive impact of participation in sports
Improving physical health ($n = 3$) Losing weight ($n = 6$) Increasing physical activity, strengthened muscles, physical fitness, healthy body ($n = 12$) Strengthening muscles through movement, activity, vitality, health and fitness ($n = 6$) Moving with the wheelchair and moving has become faster and easier than before ($n = 11$) Improvement in balance ($n = 6$) My body has become stronger and more flexible ($n = 17$)	Enhanced physical health and fitness		
Reduced pain and dispensing with medical treatments ($n = 3$)	Medical impact		
Time management ($n = 15$) Family support ($n = 3$) Paying attention to nutrition ($n = 1$) Intensive camps and ongoing coaching support ($n = 3$) The coaches are at a very high level and efficient ($n = 18$) Availability of devices and equipment ($n = 7$) Like the exercises and training program ($n = 14$) Love of sports ($n = 2$) The program supports and encourages women with disabilities to participate in sports ($n = 4$) Excellent, enjoyable, stimulating ($n = 17$)	Key factors that contribute to sports participation	Key factors that contribute to sports participation	
Building friendship and social relationships ($n = 2$) Like the social aspect and exchange of experiences with others ($n = 14$)	Enhanced social connections	Social benefits	
Encourage friends and others to do sports and join the sports clubs ($n = 15$) Invite women with disabilities to participate in the experience ($n = 5$)	Promoting Para sports		
Exercising and training result in increased physical effort and psychological stress ($n = 4$)	Negative effects of training	Health impacts	Challenges in participation in sports
Transportation issues ($n = 8$) Financial issues ($n = 3$) Difficulty obtaining assistive devices ($n = 1$)	Logistical challenges	Logistical challenges	
Changing society's perception and attitudes toward disability and people with disabilities ($n = 1$) Improving social awareness in society of people with disabilities and their rights ($n = 3$)	Promoting awareness and changing societal perceptions of disabilities	Social awareness	Motivation to participation in sports
Determination and persistence to achieve goals ($n = 2$) To make sporting achievements ($n = 6$) To represent the country in international Paralympic competitions ($n = 12$) Become a world-class Paralympian ($n = 11$) To become an assistant coach ($n = 1$) Continuing sports and striving to make achievements ($n = 5$) To be an active, an effective member, and a role model in society ($n = 2$)	Personal motivation – intrinsic and extrinsic	Personal motivation – intrinsic and extrinsic	
Paying more attention to sports clubs for people with disabilities ($n = 3$) Providing social and psychological specialists ($n = 1$) Empowering Saudi female coaches ($n = 2$)	Future development	Future development	

> *'Undoubtedly, my life has undergone significant changes after engaging in sports, and my perspective on life has evolved. Previously, I held the belief that individuals with disabilities lacked purpose, but after experiencing sports, my viewpoint completely transformed. Now, I recognize that individuals with disabilities can pursue meaningful careers and achieve their goals.'*

Meanwhile, several participants mentioned the noticeable improvement in their physical well-being. For instance, one participant asserted that she has become swifter and lighter in her movements and that her mobility has improved because of her participation in sports. Besides, another participant expressed, *'Participating in sports has brought substantial changes to my life. My physical fitness has improved, making it easier for me to maneuver my wheelchair with greater agility and speed.'* Reduced pain and the need for medical treatments were also cited as significant benefits of participating in sports, as one participant asserted, *'Not only has my pain subsided, but I have also been able to avoid surgeries related to my scoliosis and reduce the number of medical treatments I require due to my engagement in sports.'*

3.2.2 Key factors that contribute to sport participation

Several factors significantly contributed to the participants' involvement in sports and had positive impacts on their overall experiences. One of the key factors was the development of effective time management skills. Participants emphasized that effective time management and organization of daily tasks played a vital role in enabling their continued sports participation. As an illustration, one participant noted, *'I would ensure that I completed all my household duties early in the day, allowing me more time to go to the club.'* This highlights how efficient time management facilitated their commitment to sports and created opportunities for dedicated practice and engagement.

Moreover, participants highlighted the importance of coaches' professionalism and consistent dedication to athlete development and performance enhancement. The unwavering support and guidance these coaches provided significantly enhanced the participants' participation in sports. Participants noted that their coaches were understanding, cooperative, and patient, going above and beyond to help each athlete improve. One participant reported, *'Our coach is incredibly supportive, even when unexpected circumstances arise. He is understanding, cooperative, and patient, often repeating exercises to help each athlete improve.'* Relatedly, another participant expressed that:

> *'The coaching staff displays exceptional character. One coach has been with me since 2018, and he is incredibly motivating. Before each training session, he thoroughly assesses the athlete's needs, considering their physical condition and specific disabilities. This personalized approach by the coach greatly boosts our enthusiasm for training, as they tailor exercises to suit both our health condition and disability type.'*

In addition to effective time management and supportive coaches, strong and continuing family support emerged as a crucial factor in encouraging participation in sports. Participants expressed gratitude for their families' genuine passion for sports and training, which played a pivotal role in their ongoing sports engagement. One participant emphasized:

> *'My entire family shares a genuine passion for sports and training. Their unwavering support has been instrumental in my ongoing sports participation. I have even introduced my daughter to the world of sports, and my son is the reigning champion in Romanian wrestling in our country. Our household is a sports-oriented family that values athletic achievements.'*

This illustrates how family support creates an environment that fosters and nurtures sports participation, contributing to the participants' positive experiences and achievements. To end, these factors, including effective time management skills, coaches' professionalism and dedication, and strong family support, play a critical role in enhancing participants' sports participation. They contribute to positive outcomes such as personal growth, skill development, and enjoyment. Understanding and addressing these key factors are essential for comprehending the overall positive impact of sports engagement. By acknowledging and incorporating these factors into sports programs and interventions, it is possible to create an environment that maximizes the benefits and positive experiences derived from sports participation.

3.2.3 Social benefits

The findings also revealed that participating in sports provides numerous social benefits for individuals with disabilities. Such benefits include building relationships, improving communication skills, increasing awareness, and fostering a sense of belonging. The participants mentioned several social benefits that resulted from participating in sports; these included enhancing social connections and promoting the role of sports for individuals with disabilities within the community. For instance, one participant shared:

> *'It [participation in sports] has also had a significant impact on the social aspects of my life. It has allowed me to connect with individuals who have disabilities, enabling us to exchange experiences within the club. This exchange occurs not only among individuals with similar disabilities but also among those with different disabilities. It has allowed us to share our experiences and strategies for overcoming challenges.'*

Another participant emphasized the social benefits she experienced:

> *'The social aspect should not be underestimated, as it has a profoundly positive psychological impact on us as individuals with disabilities. We were once confined to our homes, with limited interactions within our families. However, now we have cultivated relationships and acquaintances that extend beyond our immediate family and relatives.'*

Moreover, the participants unanimously agreed that participating in sports is crucial for fostering better interpersonal relationships and friendships. For example, one participant asserted that participating in sports had significantly improved her social relationships and friendships as she had become more confident in asking her peers about unfamiliar sports-related matters and seeking guidance from

more experienced peers––especially as she is new to the club––as well as providing opportunities to meet others who share the same disability. In addition, the participants strongly emphasized promoting involvement in sports for women with disabilities, particularly those with physical impairments. For example, one participant, who works at a Saudi university, stated:

> *'Since I began my involvement in sports, I've been actively working to invite, encourage, and engage women with disabilities to participate in sports activities at our club. I've organized various events and friendly tournaments within the University, along with awareness campaigns to highlight the availability of sports for individuals with disabilities, regardless of the severity of their condition. These efforts have successfully encouraged numerous women to join and engage in sports. I take great pride in these endeavors and remain committed to this cause.'*

3.3 Challenges in participation in sports

The findings in this dimension highlighted the participants' experiences related to the challenges they face due to their participation in sports, including *health impacts* and *logistical challenges*.

3.3.1 Health impacts

The first challenge mentioned by the participants related to the physical and psychological impacts associated with rigorous physical training and involvement in sports. For instance, as one participant, a shot-put athlete, mentioned, '*…some exercises require intense physical effort, which can create psychological pressure…, I understand that these exercises are for the benefit of the athlete, but they can be mentally challenging.*' Another shot-put athlete mentioned that she experienced negative impact because of the high-intensity training in internal and external local and international sports camps.

3.3.2 Logistical challenges

The second challenge mentioned by several participants was the logistical difficulties they encountered when participating in sports, which sometimes affected their performance. For instance, one participant mentioned the transportation-related difficulties when going to her sports club, highlighting that the effort involved in arriving on time often leads to psychological pressure. To address this issue, another participant suggested, '*We need to reconsider transportation because our wheelchairs require a hoist to be loaded into a vehicle. Therefore, dedicated transportation solutions are necessary.*'

Participants also raised concerns about financial sufficiency and the lack of provision of assistive devices for sports participants with disabilities. In particular, they asserted that greater attention and support are needed from relevant organizations to enable clubs to support athletes financially to enable them to feel more secure about attending training and competitions and potentially attract more individuals with disabilities to participate in sports. Access is a frequently mentioned obstacle in para sport and is connected to several factors (Jaarsma et al., 2014; Conchar et al., 2016; Diaz et al., 2019). Initially, there is a substantial financial investment required to engage in adaptive sports. The cost of adaptive equipment is high, and it is typically customized for everyone, which makes it challenging to share among numerous participants. Regular gyms frequently lack access to this equipment, or they are not designed to cater to certain requirements due to disarray and other inadvertent circumstances. While the prevalence of adaptive sports leagues is increasing, they are not universally available and may necessitate substantial travel time for participation.

The limited availability of opportunities is particularly pronounced for female participants, as most adapted sports leagues are predominantly male dominated (Yoh et al., 2008). Transportation options may be restricted for individuals in this demographic due to their inability to operate vehicles, necessitating dependence on others or public transportation (Martin Ginis et al., 2012). Jenkins (2002) affirmed that the significance of sporting equipment extends much beyond its basic functionality. It is a crucial component of an athlete's performance, ensuring their safety and adherence to sport-specific regulations. Nevertheless, the economic significance of sports should not be undervalued, especially in terms of the equipment requirements of individuals aspiring to achieve the remarkable accomplishments of Paralympic competitors. Racing wheelchairs and other sports-specific mobility technology are costly and are generally not covered by health insurance. A significant number of individuals with disabilities are required to combine their financial resources to cover the expenses associated with their daily healthcare needs. Moreover, the exorbitant costs of adaptive sports technology serve as a barrier, restricting the number of individuals who may pursue their aspirations as athletes.

3.4 Motivation to participate in sports

Motivation to participate in sports, rooted in theoretical perspectives such as self-determination theory or achievement goal theory, provides valuable insights into the factors and processes that drive individuals to engage in sports activities. It serves as a central theme that emerged from the analysis of 12 raw data themes and their respective 3 s-order sub-themes, namely *social awareness*, *personal motivation (intrinsic and extrinsic)*, and *future development*. Motivation, within the context of sports participation, refers to the intricate psychological processes and factors that initiate, guide, and sustain individuals' engagement in sports activities. By understanding motivation, researchers and practitioners gain a crucial understanding of why individuals choose to participate in sports and what factors contribute to their continued involvement.

The three sub-themes further enrich the understanding of motivation in sports. Social awareness encompasses the influence of social interactions, norms, and support systems on an individual's motivation to participate in sports. Personal motivation, comprising intrinsic and extrinsic aspects, delves into the internal desires and external incentives that drive individuals' engagement in sports. Future development explores the aspirations, goals, and personal growth that individuals seek through their sports participation.

By comprehensively examining these sub-themes and their interrelationships, the conceptual framework provides a holistic understanding of motivation in sports participation. It elucidates how social factors, personal motivations, and future aspirations collectively shape individuals' engagement and commitment to sports activities. This framework is a valuable tool for researchers and practitioners to analyze and interpret motivational processes, design targeted

interventions, and optimize sports experiences for individuals involved in sports.

3.4.1 Social awareness

Some participants expressed that their key motivations for participating in sports were to change the social perceptions surrounding people with disabilities being involved in sports and raise awareness about people with disabilities and their rights. The participants emphasized that increasing social awareness about the rights of individuals with disabilities was a crucial motivation for becoming involved in sports. For instance, one participant expressed her desire to contribute to raising social awareness and improving policies related to people with disabilities in sports and their rights. Another participant elaborated:

> *'…I aim to alter society's perception of individuals with disabilities. In the past, there was a prevailing belief that individuals with disabilities were incapable of achieving anything – a misconception I personally experienced both in school and elsewhere. Through my involvement in sports, I aim to challenge this perception and demonstrate that disability is not a limitation of the body, but a misconception held by society… As a result of my efforts, I became the first Saudi woman to qualify for the 2020 Tokyo Paralympic Games, achieving a global sixth-place ranking…'.*

According to participants, the following factors increase athletes' chances of successfully resolving social problems: (1) trust in athletes, (2) trust in supporting organizations, (3) awareness and willingness to respond to problem development, and (4) credibility and admiration for athletes as role models in their field. These characteristics are common among these athletes, who can deal with the challenges their country faces while maintaining high standards. Saudi athletes are very sensitive to social issues due to their daily encounters with disability-related challenges and barriers, their extensive knowledge of regional issues, and their potential to effect change in their country beyond the promotion of sport.

3.4.2 Personal motivation – intrinsic and extrinsic

Various intrinsic and extrinsic motivations played significant roles in inspiring the participants to become involved in sports. One of the principal motivations was the participants' aspirations to represent Saudi Arabia on the global stage at international Paralympic competitions. For instance, as one participant emphasized, '*… my most cherished goal is to elevate Saudi Arabia's reputation on the international stage through winning championships. I'm dedicated to achieving this goal with unwavering determination.*' Several participants cited their driving motivation for participating in sports in terms of their desire to become active and exemplary members of society. For instance, as one table tennis athlete articulated, *'I embarked on my sports journey with the motivation to contribute to society as an active member and serve as a positive role model for others.*'

3.4.3 Future development

During the interviews, several participants provided suggestions and recommendations to enhance and promote sports participation among individuals with disabilities in Saudi Arabia, especially women. For instance, one participant emphasized the importance of the Saudi Arabian Ministry of Sports and relevant committees making increased efforts to improve participation in sports among people with disabilities by providing better facilities and the necessary equipment and supplies. In addition, participants called for female Saudi coaches to be given opportunities to obtain comprehensive sports qualifications and extensive training similar to those available to male sports coaches. Furthermore, one participant highlighted *'It is a necessity to have female psychologists and social workers available to assist athletes in coping with the psychological and social challenges that may negatively affect their athletic performance.*'

4 Discussion

The primary aim of this paper is to investigate the involvement and achievements of women with physical impairments in sports in Saudi Arabia. It aims to explore their participation, challenges, and cultural influences that shape their involvement. The paper examines the impact of societal expectations on their engagement in sports while also discussing the future of Para sports and empowerment for these women.

4.1 Exploring participation in Para sports

The research on sport socialization focuses on understanding how individuals become involved in the world of sports and how their beliefs and values become intertwined with it. Sport socialisation involves the adoption of attitudes, values, knowledge, and behaviors associated with sports participation (Svanelöv et al., 2020). Differentiating between being introduced to sports and learning values through sports provides a deeper understanding of why people engage in sports. This socialisation process is influenced by a combination of external factors such as location, culture, and available sporting opportunities, as well as internal factors including self-perception, life stage, learning processes, perception, motivation, attitude, and physical traits (Mullin et al., 2000; Ruddell and Shinew, 2006; Seal, 2012; Sales and Misener, 2021; Alhumaid et al., 2022; Chen et al., 2024).

This study explores the process of including women with physical impairments into Para sports in Saudi Arabia. In this study, participants recounted their introduction to Para sports, highlighting the role of societal unawareness. Their involvement stemmed from various factors such as friends' influence, invitations to social events to join sports clubs, and information shared on social media platforms. Ruddell and Shinew (2006) identified several key factors in the socialisation of individuals with disabilities into sports, including family, school, peers, and the community. However, additional agents such as therapists, peers with disabilities, or coaches of the Para sport may also play crucial roles in introducing them to sports. Given the limited awareness about Para sports movements in Saudi Arabia, those in direct contact with individuals with disabilities, such as peers or professionals in the field, become increasingly influential in shaping their engagement in sports activities. While these factors initially prompt women with physical impairments to participate in sports, studies have shown that implementing a more structured approach is crucial to attracting and recruiting a greater number of potential women athletes with physical impairments across the country (DePauw, 2000; Ruddell and Shinew, 2006; Kirk et al., 2021).

This study also documented the process of socialisation through sports. Participants describe how engagement in Para sports had positive outcomes in their lives, such as reshaping their self-perception, bolstering confidence, cultivating a more positive outlook on life, and expanding their social connections. Previous studies have also noted that engaging in physical activity and sports contributed to psychological advantages for individuals with disabilities, enhancing their self-esteem, autonomy, goal attainment, and personal growth (García and López., 2012; Muñoz et al., 2017; Diaz et al., 2019; Aitchison et al., 2022). Involvement in Para sports enabled these women to focus on their identity, abilities, and accomplishments (Svanelöv et al., 2020; Weiller-Abels et al., 2021; Wickenden, 2023). Additionally, participants expressed their ability to inspire and motivate more women with physical impairments to participate in Para sports. Participants also mentioned how their health improved through sport, including enhanced physical fitness, reduced pain, and improved wheelchair maneuverability and mobility (Aitchison et al., 2022; Ballas et al., 2022; Ascondo et al., 2023; Zabala-Dominguez et al., 2023).

4.2 Challenges to participation in Para sports

The Middle East nations is working toward achieving a higher level of gender equality in the region, demonstrating a national commitment to women's empowerment in both the public and private sectors with the advancement of policies for gender equality (Gharaibeh and Remaih, 2022). While positive advancements have been made, numerous challenges persist, impacting the involvement of women with disabilities in sports in Saudi Arabia. Understanding these barriers is crucial in fostering an inclusive and empowering environment for women with disabilities in sports.

Studies have shown that stereotypes and stigmas regarding gender and disability can lead to limited opportunities and expectations for women in sports (Coleman et al., 2015; Moodley and Graham, 2015; Weiller-Abels et al., 2021; Richard et al., 2023). In this study, participants highlighted the frequent challenges they face due to socio-cultural barriers deeply rooted in societal perceptions of individuals with disabilities, particularly women with physical impairments. As a result, the cultural and religious emphasis on doing good deeds, caring and looking after the welfare of certain groups in the community, such as orphans, the elderly, and people with disabilities has positioned these individuals as recipients of welfare outreach. For women with physical impairment, this perception clouded the opportunity of being viewed as potential investments for their development in Para sports. The results of this study align with Nagata's (2008) assertion that the cultural perspective prevalent in the Middle East, which views efforts related to disabilities as a welfare obligation, may not be conducive to the sustainable development of Para sports. Women with physical impairment in Saudi Arabia are also faced with cultural boundaries, such as the freedom to engage in physical activities (Alhumaid et al., 2022). In addition to this, prevailing misconceptions about the capabilities of women athletes with physical impairment can hinder their access to sporting activities which include the lack of female coaches and personnel in Para sports.

Participation in Para sports can provide alternative experiences and increase visibility for women with disabilities, thereby creating greater awareness of the importance of Para sports for women athletes with physical impairments. However, participants in this study highlighted the limited funding and a lack of sponsorship opportunities often discourage them from engaging in sports, primarily due to the high costs associated with adaptive and specialized training equipment. These challenges were also highlighted in a systematic review by Olasagasti-Ibargoien et al. (2023), which examined barriers to physical activity for women with physical impairments. The study revealed that women with physical impairments encounter numerous and complex challenges. These include inadequate accessibility or adaptations in sports centers, transportation limitations to sports facilities, insufficient communication among professionals, and subpar organizational management. Furthermore, the limited space and equipment that fail to accommodate mobility restrictions hinder their ability to fully utilize exercise equipment and available space. Addressing these multifaceted barriers is crucial for creating an inclusive and supportive environment that encourages women with disabilities to actively participate in sports and physical activities.

4.3 Improving participation of women with physical impairments in Para sports

Participation in sports has long been recognized as a powerful tool for empowerment, confidence-building, and social inclusion (Ashton-Shaeffe et al., 2001; Pensgaard and Sorensen, 2002; Nzeyimana, 2019). However, for women with physical impairments, engaging in sports and athletic activities often comes with challenges. There is a growing recognition of the importance of inclusivity in sports, particularly in creating opportunities for women with disabilities to participate and excel in Para sports (Ashton-Shaeffe et al., 2001; Ascondo et al., 2023). Improving participation for these women in Para sports is not just about creating avenues for physical activity and sport; it is about fostering inclusivity, breaking barriers, and empowering individuals.

One of the challenges reported by the participants in this study to actively engage in sports is the lack of accessibility to suitable sporting facilities, adaptive equipment, and specialized coaching for women athletes with physical impairment. This finding were also reported in previous studies (DePauw, 2000; Nzeyimana, 2019; Sales and Misener, 2021; Olasagasti-Ibargoien et al., 2023). Most of the participants in this study commented that many sports facilities are not adequately equipped to accommodate them for training. Addressing this issue requires a concerted effort to create universally accessible environments that cater to the specific needs of women with physical impairments. This includes not only physical accessibility but also the provision of adaptive equipment and knowledgeable coaches who understand the nuances of training women athletes with physical impairment. Empowering women with physical impairments in Para sports goes beyond merely providing opportunities; it involves creating an inclusive ecosystem that celebrates diversity, recognizes individual capabilities, and promotes a culture of equality (Nagata, 2008; Chen et al., 2024). This study supports the study by Olenik et al. (1995) that identified the underrepresentation of women in Para sports, both as athletes and in administrative roles, remains a significant barrier to raising awareness about the unique challenges faced by women athletes with physcal impairments.

Societal perceptions and stereotypes about women with disabilities often act as barriers, limiting their participation in sports. These stereotypes can result in a lack of encouragement, support, media coverage, and opportunities for women with disabilities to engage in sports activities (Hamdy et al., 2011; Parsons et al., 2017; Canton et al., 2023). In this study, participants noted the absence of women with disability as role models, and that few of the participants are inspired and motivated to be role models for society through their performance in Para sport. According to Ballas et al. (2022), empowering these women requires challenging societal norms, advocating for inclusivity, and creating awareness about the capabilities and potential of individuals with disabilities in sports. Fostering a supportive and inclusive community plays a pivotal role in encouraging women with physical impairments to participate in sports. Creating networks, support groups, and mentorship programs can provide a sense of belonging, encouragement, and motivation. These platforms offer emotional support and allow sharing of experiences, strategies, and successes, inspiring others to pursue their athletic aspirations.

In addition to the physical and societal challenges, participants in this study also mentioned financial constraints as the significant barriers to participation in Para sports for women with disabilities. The cost of specialized equipment, training, and participation in sporting events can be excessively high. To encourage greater participation, it is essential to develop sustainable financial support mechanisms, scholarships, and sponsorships tailored specifically for women with physical impairments, ensuring that financial limitations do not discourage their engagement in sports.

To truly support these athletes, governing bodies within the Para sports movement must be sensitive to financial, time, and cultural constraints that specifically affect women with disabilities, who often lack institutional or interpersonal support (Alhumaid et al., 2022). Consequently, failing to sustain the involvement of today's women athletes with disabilities will inevitably lead to a decline in participation in the future. Empowering these athletes to advocate for Para sports is challenging without opportunities for them to come together, exchange experiences, and validate each other's journeys (Bundon and Clarke, 2015; Silva and Howe, 2018). It's crucial to create accessible channels for women athletes to communicate their concerns to decision-makers, fostering a unified political front representing all women athletes, irrespective of their disability or sports affiliation (Powis, 2018).

Key components of organizational capacity, deemed crucial, encompass financial resources, personnel, infrastructure, operational procedures, interpersonal connections, networks, and strategic planning and advancement (Breuer and Wicker, 2014; Misener and Darcy, 2014). To encourage more participation of women with physical impairment in Para sport, requires collaborative efforts from governments, sports organizations, communities, and individuals to break down barriers and create an environment where women with disabilities can thrive in sports. Improving participation for women with physical impairments in sports in Saudi Arabia calls for a multi-faceted approach. It necessitates accessible infrastructure, awareness campaigns to challenge stereotypes, a supportive community, and financial assistance (Bundon and Clarke, 2015; Powis, 2018; Alhumaid et al., 2022). In addition, special attention should be placed on providing a women-friendly environment, such as designated women-only facilities and training arrangements. By actively addressing these challenges and promoting inclusivity, we can create a more equitable and empowering environment where women with disabilities can fully embrace the transformative power of sports, fostering their physical well-being, confidence, and sense of belonging in society (DePauw, 2000; Chen et al., 2024).

Silva and Howe (2018) commented that collectively, the Para sport community should foster a culture of multicultural exchange, welcoming diverse perspectives and innovative thinking. This approach should aim to empower individuals socially, acknowledging and celebrating the wide spectrum of human experiences. Given the tendency to overlook athletes with high support needs and exclude them from mainstream Paralympic events, it is imperative to focus on expanding opportunities and promoting inclusivity for these athletes. Additionally, heightened awareness is needed regarding the compounded challenges faced by women with physical impairments (Silva and Howe, 2018).

Participation in Para sports is not only a testament to human resilience but also a reflection of intrinsic and extrinsic motivational factors that drive individuals with disabilities to engage in athletic pursuits. These motivators play a pivotal role in inspiring and empowering individuals to overcome challenges and actively participate in sports, fostering personal growth, and contributing to the wider community.

5 Study limitations

It is important to acknowledge the limitations of this study's design when interpreting its findings. First, the reliance on participants' self-reported answers to posed questions introduces the possibility of "social desirability bias." This bias occurs when participants feel compelled to conform to societal expectations or endorse decisions that support Para sports for women with disabilities in Saudi Arabia. However, the study implemented measures to mitigate this bias, including confidentiality assurances and a purely scientific objective. Second, the study's small sample size focused exclusively on individuals with physical impairments. While this choice was based on the prevalence of physical impairments among Saudi women who engage in physical activities and sports, it is not possible to generalize these findings to all individuals with physical impairments. In other words, the current study's findings may not represent the overall reality of sports for people with disabilities, including those with physical impairments, in Saudi Arabia. Nevertheless, the study's results have provided valuable insights and recommendations that can significantly enhance the effectiveness and success of Saudi women with disabilities in engaging in physical and sporting activities. To gain a more comprehensive understanding of the experiences and challenges faced by individuals with disabilities in sports, future research could assess any changes or improvements over time, providing a more nuanced understanding of the dynamics of sports participation among Saudi women with physical impairments. Finally, the study has one last limitation, which is the distinction between the participants involved in individual Para sports and those engaged in team Para sports. Therefore, future research should

consider this aspect, as the circumstances and nature of participation in individual sports and team sports differ.

6 Conclusion

Participation in sports is a powerful avenue for empowerment and social inclusion. However, women with physical impairments face unique challenges in accessing sports. Women with physical impairments in Saudi Arabia encounter challenges due to inadequate facilities, equipment, and coaching. Creating universally accessible environments with specific equipment and knowledgeable coaches is pivotal in addressing this issue. Additionally, creating a sporting environment that encourages women to participate in sports is also important, such as women only training schedules, and more certified women coaches or team managers for women athletes with a physical impairment. Financial constraints also pose significant obstacles in Para sport. Developing and providing financial support mechanisms ensures that women with disabilities can overcome these barriers and engage fully in sports. Participation in Para sports is not only a testament to human resilience but also a reflection of intrinsic and extrinsic motivational factors that dritve individuals with disabilities to engage in sports. These motivators play a pivotal role in inspiring and empowering individuals to overcome challenges and actively participate in sports, fostering personal growth, and contributing to the wider community. Empowerment in Para sports necessitates an inclusive ecosystem that celebrates diversity and equality. Collaborative efforts from governments, sports bodies, communities, and individuals are essential in creating an environment where women with disabilities can thrive in sports.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Research Ethics Committee at King Faisal University in Saudi Arabia (Protocol code: KFU-REC-2023-JUN-ETHICS1091). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

MMA: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. YA: Conceptualization, Data curation, Investigation, Methodology, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. MS: Formal analysis, Investigation, Methodology, Resources, Validation, Visualization, Writing – review & editing. MAA: Data curation, Investigation, Resources, Validation, Visualization, Writing – review & editing. SK: Conceptualization, Investigation, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Enriching the lives of children with acquired brain injury and their caregivers: experiences from peer mentorship sports camps

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Peer-based community interventions have shown promise in improving health management and fostering coping skills and psychosocial functioning among individuals with a disability. Active Rehabilitation camps are examples of peer-based community interventions that provide structured, time-limited peer mentorship in conjunction with sports and leisure activities. These camps hold potential benefits for individuals with acquired neurological injury. However, the specific impact of Active Rehabilitation camps on children or individuals with acquired brain injury remains unexplored. In this longitudinal, qualitative study, we explored children with an acquired brain injury and their caregivers' experiences with an Active Rehabilitation camp in Norway through observations and interviews with nine children and ten caregivers. Using an abductive thematic analysis, we identified an overarching theme: Active Rehabilitation peer mentorship camps enrich the lives of children with acquired brain injury and their caregivers. The theme contains three sub-themes: (1) Interacting with peers made me wiser, (2) Nudging from peer mentors made me feel better, and (3) A sense of companionship through meeting peers. Peer mentorship, sports and leisure activities, and the safe camp atmosphere benefitted children with acquired brain injury and their caregivers. The children gained knowledge, motivation, and self-worth, and their caregivers had greater impetus to prioritize their children's independence. Meeting peers and peer mentors led to friendships and sustained social connections. The Self-Determination Theory was of assistance in explaining the informants' experiences. Active Rehabilitation camps provide children with acquired brain injury and their caregivers with an opportunity to develop better coping skills, improve psychological functioning, and build more robust social networks.

KEYWORDS

peer mentorship, peer support, acquired brain injury, sports camp, Active Rehabilitation, qualitative study, children, caregivers

Abbreviations
ABI, acquired brain injury; ADL, activities of daily living; AR, Active Rehabilitation; BCY, Brain Camp Yng; SDT, Self-Determination Theory.

1 Introduction

The United Nations Convention on the Rights of Persons with Disabilities states that peer support should be provided to help individuals with disability achieve full inclusion and participation in all aspects of life (1). Additionally, the World Health Organization (WHO) recommends integrating peer support into time-limited self-management courses to enhance the health management skills of people with disability (2). Time-limited peer-based community interventions for individuals with acquired brain injury (ABI) or spinal cord injury can improve coping skills and psychosocial functioning (3), which aligns with the WHO's goal of enhancing community-based rehabilitation for people with disability (4).

ABI is an umbrella term for various brain injuries, whether traumatic or non-traumatic (5–8). Related impairments may be severe, persistent, and sometimes life-long and may affect neurocognitive, psychological, and physical functioning (5, 9–13). Age at injury plays an essential role in how the individual is affected. When damage occurs in childhood and adolescence, the brain development process may be disrupted (14), and the child's ability to learn new skills may be impacted, leading to difficulties functioning at home, at school, and in their local community (15). Hence, an ABI affects the child and their family (5).

Active Rehabilitation (AR) is a global community, peer-based rehabilitation model developed in Sweden in the late 1970s (16). Training camps are the most common activity among AR organizations (16). These camps are structured and time-limited, leveraging sports and leisure activities to enable individuals to realize their full potential in skill development and participation by enhancing independence in their daily lives and boosting self-esteem (17). Peer mentorship, defined as intentional, purposeful, and unidirectional peer support provided by designated peer mentors (18, 19), is an essential element of AR camps (16). Further, a peer mentor "possesses experiential knowledge of a specific behavior or stressor and similar characteristics as the target population" (20).

Implementing theoretical frameworks in research on peer support interventions may help explain and synthesize results across studies (18, 21). Self-Determination Theory [SDT; (22)] is among several motivational theories suggested as suitable for research on peer support interventions (3, 23–25). SDT is an organismic approach to understanding how biological, social, and cultural conditions promote or hinder inherent capacities for psychological growth, commitment, and wellness (22). According to SDT, humans are viewed as active and growth-oriented, seeking the necessary nutriments to integrate themselves into their surrounding social structures and experience a fuller, more enduring, and profound sense of well-being (26).

As a meta-theory encompassing several mini-theories (22, 27), three specific mini-theories are particularly relevant to the current study. These include the Basic Psychological Needs Theory (26), Organismic Integration Theory (28), and the Relationships Motivation Theory (29). Basic Psychological Needs Theory identifies three basic psychological needs: autonomy, competence, and relatedness, which are the core of SDT (22, 26). The satisfaction of these needs is crucial for individuals to achieve eudemonic well-being (22). SDT also discusses a continuum of motivation and regulatory styles, where Organismic Integration Theory outlines different types of external motivation, ranging in various levels of autonomy. In summary, the higher the autonomy, the more likely the individual is to experience well-functioning (22, 28). In Relationships Motivation Theory, SDT further discusses essential elements of high-quality relationships, such as mutual involvement and being oneself (29). SDT's philosophy aligns well with the aims of AR camps and can, therefore, assist in explaining the findings of research on these camps.

While there is emerging evidence of AR camps' effects on adults with spinal cord injury (30–33), there is no evidence of AR camps' impact on children or individuals with ABIs (3). Furthermore, the caregiver's perspective concerning participation in AR camps has never been explored. Hence, we aimed to explore the experiences of children and youths and their caregivers participating in an AR camp for individuals with ABI. More specifically, the current study aimed to explore the following questions:

1. What are children's and youths' experiences with AR camps?
2. How do caregivers perceive their children's experiences with AR camps?
3. What are the caregivers' experiences with AR camps?

2 Materials and methods

2.1 Study design

This qualitative, longitudinal study was approved by the Norwegian School of Sport Sciences' Ethical Committee (Ref. no 229–160622) and the Norwegian Centre for Shared Services in Education and Research (Ref. no 521550). The study's conduction and reporting were informed by guidelines from Tracy (34) and the consolidated criteria for reporting qualitative research (COREQ) (35).

2.2 Methodological orientation

This study takes a critical realist approach that integrates a realist ontology (the belief in a real world existing independently of our thoughts and perceptions) and a constructivist epistemology (the idea that our understanding of the world is constructed from the researchers' and the study participants' perspectives and standpoints) (36, 37).

2.3 Setting

The Sunnaas Foundation is a Norwegian non-profit organization that runs AR camps in Norway (38). The Sunnaas Foundation's AR camp for children with ABI is called Brain Camp Yng [BCY; (39)]. Initiated in 2019 and run annually (38),

the camp is free of charge and hosts self-referred mentees (39). The staff comprises peer mentors and non-disabled assistants, the latter being primarily healthcare professionals. BCY aims for children to challenge themselves in sports and leisure activities with peers and peer mentors, learn from each other, and build a network of peers (39). A description of BCY following the Template for Intervention Description and Replication [TIDieR; (40)] can be found in the Supplementary Material S1.

BCY 2022 took place in August, and 13 children and youths (mentees) with ABI attended. Usually, family members do not attend AR camps, but BCY allows each mentee to bring a caregiver. Hence, 13 caregivers (parents and grandparents) participated in BCY 2022. The mentees were divided into a children's group (6–12 years) and a youth group (13–16 years). Each was matched with a peer mentor based on their goals for camp (e.g., practice using the affected hand), shared experiences related to their impairment(s) (e.g., sensitivity to noise and light, fatigue), or difficulties encountered in their local community (e.g., school settings, friendships; personal communication with Brain Camp Project Coordinator, June 2023). BCY 2022 adhered to the ten key elements of AR camps [Table 1; (16)].

TABLE 1 Description of the 10 key elements of Active Rehabilitation camps in relation to Brain Camp Yng 2022.

10 key elements of Active Rehabilitation camps	Description of Brain Camp Yng 2022 (BCY 2022) in relation to the 10 key elements of Active Rehabilitation camps
(1) Peer mentors	At BCY 2022, nine persons with ABI (17–33 years) were enrolled as mentors. Except for one mentor, all had participated as mentors in one or more previous camps. One mentor was part of BCY's organizing committee and oversaw the mentors. Each mentor (together with a non-disabled assistant) was assigned to one or two mentees.
(2) Non-disabled assistants	In total, 15 non-disabled assistants with healthcare backgrounds (six physical therapists, one occupational therapist, four sports therapists, two nurses, one medical doctor, and one psychologist) were present throughout the camp, many of whom had experience working with individuals with ABI. The non-disabled assistants did not receive specific training before attending the AR camps. Two had not previously participated in AR camps. Most non-disabled assistants (and the mentors) were assigned to one or two mentees throughout the camp, forming groups of three or four, including a mentor, a non-disabled assistant, and one or two mentees. Furthermore, the non-disabled assistants were assigned to the children or youth group, and one was part of the BCY's organizing committee.
(3) Activities of daily living and skills training	Training in activities of daily living (ADL) was not part of the formal schedule but was adapted to the needs of each mentee. In these sessions, the mentees received help and guidance in ADL from mentors and non-disabled assistants. Caregivers were encouraged to limit their assistance in ADL during the camp. ADL training may include getting dressed, showering, eating, planning the equipment needed for the activities, transfers, and walking.
(4) Sports and leisure activities	In BCY 2022, the following activities were included: water acquaintance/swimming, kayak/canoe, stand-up paddling, archery, boxing/self-defense, cycling, orienteering, yoga, air pistol shooting, fishing, virtual reality (VR) games/art, overnight camping (youth group only), art sessions (children group only), and meeting alpacas (children group only). Each session lasted about 1.5–3 h, with two to five sessions offered per day (Supplementary Material, S2). External professional instructors led most activity sessions in close cooperation with the mentors. The daily program started at 8 am with a camp dance and finished around 9:30 pm. The caregivers had a different schedule and occasionally participated in activities with their children.
(5) Education	In BCY 2022, the children and youth groups engaged in sessions with the psychologist and mentors to discuss coping strategies. Caregivers participated in three sessions: two with the psychologist and medical doctor and one with the mentors. The topics of the sessions with the psychologist and medical doctor included "getting to know each other" by sharing their children's history and "coping strategies." In the mentor session, the mentors told their stories and the caregivers could ask questions.
(6) Training environment	BCY 2022 was based at Vestre Kjærnes Gård (kjaernes.no), a conference center on a farm southeast of Norway. It is a rural location with a lake nearby, facilitating water sports activities. All camp attendees were accommodated at the farm: children shared a room with their caregivers, youths shared a room with another mentee, and the youths' caregivers had private rooms. All meals were served in the barn, where three tables were set up: one for the children group, one for the youth group, and one for the caregiver group, encouraging discussions and interactions. Mentors and non-disabled assistants joined the groups to which they were assigned. In one corner of the barn was a small area for relaxation, comprising two sofas and a table with drawing and art material and board games. Most sports and leisure activities were held in the outdoor area surrounding the farm. The yoga, VR, and education sessions were held in a meeting room and the farm's living room.
(7) Admission criteria	The admission criteria for BCY 2022 were as follows: children and youths between 6 and 16 years old, diagnosed with ABI, and able to walk or use a manual wheelchair (sunnaasstiftelsen.no). Eligible first-time mentees were prioritized. Three mentees at BCY 2022 had attended previous camps.
(8) Setting goals, initial and final assessment	The organizing committee contacted mentees before the camp to learn about their needs and camp goals and provide camp information. The information received from the mentees and their caregivers was used to customize the camp experience. During camp, staff meetings for the mentors and non-disabled assistants were held each evening. Mentees' progress, daily routines, and logistics were discussed in these meetings to prevent mistakes and adjust the support provided to mentees. At BCY 2022, there was no initial or final assessment.
(9) Training of peer mentors	The eight mentors in BCY 2022 applied to the Sunnaas Foundation to participate, seven of whom had attended the Sunnaas Foundation's Peer Mentor Training Program (Sunnaasstiftelsen, n.d.). This program consists of four courses per year, each lasting three to four days, covering topics such as defining the mentor role, setting goals, motivation, and communication.
(10) Duration of AR camps	BCY 2022 lasted six days, from July 31st to August 5th. Mentors and non-disabled staff arrived one day before the mentees to become acquainted and finalize the camp program's organization.

ABI, acquired brain injury; AR, Active Rehabilitation; ADL, activities of daily living.

2.4 Study participant selection

We invited all mentees and their caregivers to participate in this study if BCY 2022 was their first AR camp experience. Before BCY 2022, camp organizers contacted mentees and caregivers and informed them of the study on behalf of the research team. Upon arriving at camp, the mentees and caregivers interested in the study could discuss it further with the first author (PW) and provide informed consent. Caregivers consented for themselves and their children. The project information offered to eligible study participants was age-adapted.

2.5 Data generation

2.5.1 Observations

SM and PW participated in the camp as non-disabled assistants, which enabled them to perform field observations and discuss these observations daily. SM followed the children's group all week, while PW moved between groups and participated in part of the caregivers' schedule (see Supplementary Material S2, for BCY's schedule). Digital recordings were made recurrently using a cell phone throughout the day and transcribed each night. The template used for the field observations was based on Lareau's (41) guidelines. Field notes were not analyzed separately, but PW used this information when interviewing mentees and caregivers after camp. Attending the camp as staff also enabled PW to build rapport with the study participants before the interviews, as recommended by Eder and Fingerson (42) and Boylan et al. (43). Furthermore, by attending the camp, SM and PW could observe how mentees were affected by their ABI.

2.5.2 Interviews

We used semi-structured interview guides (Supplementary Material S3) pilot tested on children within the age range and mentees and caregivers from previous camps. This approach allowed us to investigate central themes of BCY's focus areas, such as self-esteem, activity, participation, and relationships, and delve deeper into the study participants' psychological needs fulfillment as suggested by SDT. Incorporating the principles of SDT into our interview guides not only enriched our study with a theoretical framework but also allowed us to capture the unique experiences of our study participants. PW conducted all interviews, either in-person or digitally, according to guidelines for conducting interviews with children and adolescents (42, 43). Mentees and caregivers were interviewed twice, first immediately after the camp and again after approximately six months. Mentees and caregivers decided the time and place of the interviews (see Table 2 for information about the interviews). In the interviews, PW used pictures from the camp as prompts and picture cards in case mentees struggled to describe situations or feelings. Six mentees chose to have their caregiver(s) present, which was optional, as were any breaks needed during the interview. Hence, some caregivers attended four interviews: two with their child and two alone. The caregivers provided all injury-related information in the first interview, and a log was recorded after each interview. The interviews were recorded digitally and transcribed verbatim by PW. All mentees and caregivers were offered to review their transcribed interviews, with only one caregiver choosing to do so.

Table 2 Information about study participants and interviews.

	Mentees (n = 9)	Caregivers (n = 10)
Personal characteristics		
Gender	2 girls/7 boys	5 females/5 males
Age (years)		
Range	7–16	31–70
Mean (SD)	12 (3)	47 (10)
Median (Q1–Q3)	11 (10–13)	48 (41–50)
ABI characteristics		
Etiology	3 traumatic, 6 non-traumatic (incl. encephalitis, stroke, cancer)	
Age at injury (years)		
Range	0–15	
Mean (SD)	7 (5)	
Median (Q1–Q3)	6 (3–10)	
Time since injury (years)		
Range	1.5–11.1	
Mean (SD)	5.2 (3.1)	
Median (Q1–Q3)	4.0 (3.5–6.5)	
Interviews (first/second)	n = 9/8	n = 10/9
Place of interviews ($1^{st}/2^{nd}$)		
Interviewees' home	9/6	8/6
Official meeting room	0/1	0/1
Digital	0/1	2/3
Time of interview after camp ($1^{st}/2^{nd}$)	1–13 days/5.5–7 months	1–13 days/5.5–7 months
Length of interview ($1^{st}/2^{nd}$) (minutes)		
Range	17–49/6–17	23–50/12–32
Mean (SD)	28 (10)/10 (4)	35 (9)/19 (5)
Median (Q1–Q3)	24 (20–34)/9 (7–11)	31 (28–44)/19 (18–20)

ABI, acquired brain injury; SD, standard deviation; Q, quartile.

2.6 Analysis

We analyzed the data using an abductive thematic analysis (44, 45). Our understanding of abduction is that prevailing theories (i.e., SDT) partly influenced our foci in the semi-structured interview guides and, more so, our interpretation of the results. In the analysis, we followed the eight steps outlined by Thompson (44): (1) PW transcribed all interviews verbatim, and FEA and PW familiarized themselves with the data through multiple transcript readings. (2) Using semantic codes, PW performed the initial inductive coding in MAXQDA 2022 (46). The coding was done inductively, trying to bracket our knowledge of SDT. Still, this knowledge may have influenced the coding process. (3) PW and FEA then discussed the different codes' meanings and situations for use. (4) PW and FEA used a

TABLE 3 Overview of themes, categories, and codes.

Overarching theme	Sub-themes	Categories	Codes
Active Rehabilitation peer mentorship camps enrich the lives of children with ABI and their caregivers.	Interacting with peers made me wiser	Managing fatigue	Fatigue
			Pain
			Epilepsy
		Gaining valuable insight	Sports technique
			Assistive devices
			Challenges of ABI in adolescence
			Adapted sports
			Variations of ABI
	Nudging from peer mentors made me feel better	Motivation	Physical activity
			Becoming a peer mentor
			Camp participation
			Local support systems
			Independence in ADL
		Mastery and confidence	Physical activity
			Self-esteem
			Self-confidence
			Social confidence
	A sense of companionship through meeting peers	Interacting with peers	Friendship
			Network of peers
		Interacting with peers and peer mentors	Relatedness
			Feelings of trust, honesty, comradery, understanding, support, acceptance
			Nuanced perspectives/normalization of the situation
		Interacting with peer mentors	Promote openness about ABI
			Hope

ABI, acquired brain injury; ADL, activities of daily living.
Color codes: Yellow = mentees, Blue = caregivers, Green = mentees and caregivers.

code matrix to gather codes into categories and possible themes. The entire research team further reviewed the codes, categories, and themes and examined the relationships among these to ensure essential data were captured. The transcripts, initial codes, categories, and themes were discussed among the research team several times to ensure rigor. (5) We drew on our knowledge from similar studies and theoretical motivational frameworks, such as SDT, when discussing the results. (6) The research team explored similarities and differences within and between the mentee and caregiver groups. (7) The research team attempted to display visually how the themes were derived from the initial codes and categories (Table 3). (8) The write-up included a description of the method, study participants, setting, and results with illustrative quotes and a discussion. Quoted mentees and caregivers were identified by "Child_no", "Youth_no", or "Caregiver_no" for identity protection. Because many of the younger mentees struggled to express themselves and give thick descriptions, we deemed it necessary to paraphrase and summarize many of their quotes to describe their experiences better. Hence, most quotes are from the caregivers.

Tracy (34) advocates honesty and transparency concerning researchers' biases to improve the quality of qualitative research. As such, this study's research team consisted of three physiotherapists (two female and one male) and one sports psychologist (male), three of whom had experience with AR camps within or outside Norway. After BCY 2022, SM became head of research at the Sunnaas Foundation. PW and SM were among the staff at BCY 2022, and PW had attended two BCY camps before 2022 and several other AR camps in Norway. Spending time with all mentees and caregivers during BCY 2022 allowed her to build rapport with study participants. Hence, when the interviews started, she was already familiar with them, potentially rendering mentees' and caregivers' camp experiences more accessible. PW's and SM's camp experiences may have affected their data interpretation. However, the research team was mindful of this possibility and thoroughly discussed codes, themes, and analyses to ensure rigor and credibility.

3 Results

This section will share information about the study participants and their camp reflections. An overarching theme evolved through iterative analyses of the mentees' and caregivers' reflections and discussions among the research team: Active Rehabilitation peer mentorship camps enrich the lives of children with ABI and their caregivers. The overarching team was created from three sub-themes: (1) Interacting with peers made me wiser, (2) Nudging from peer mentors made me feel better, and (3) A sense of companionship through meeting peers. Each sub-theme consisted of two or more categories (Table 3).

Throughout our analysis, we highlighted similarities and differences within and between the mentee and caregiver groups and noted changes between the first and second interviews. A peer is often defined as someone of equal standing to others, whether in, i.e., age or experience. Therefore, within the context

of BCY, the mentees' peers were both fellow mentees and peer mentors. The caregivers' peers were the other caregivers.

3.1 Description of study participants

Nine of ten eligible mentees and all ten eligible caregivers accepted the invitation to participate in the study (see Table 2 for study participants' characteristics). During the second interview, one mentee and one caregiver from the same family could not participate due to health issues. While most mentees exhibited minimal visible physical impairments, they faced challenges with fatigue, memory, concentration, epilepsy, and sensitivity toward noise and light.

3.2 Interacting with peers made me wiser

This sub-theme describes how interactions with peers and peer mentors assisted mentees and caregivers in developing better insight and establishing management strategies for fatigue and other ABI consequences.

3.2.1 Managing fatigue

Many mentees struggled with fatigue due to their ABI, and both mentees and caregivers were given information and gained a better understanding of fatigue at camp. Mentees discussed fatigue during a session with the psychologist and peer mentors and had the opportunity to observe the peer mentors and fellow mentees managing their fatigue during camp. Many learned about different ways and the importance of rest, as reported by one mentee: "I learned sometimes to take breaks, even when I want to continue to do something" (Child_9, second interview). Gaining more information about fatigue and participating in the intensive camp schedule led one mentee to challenge their physical limits and taught them that physical exhaustion is not a matter of worry. Having discussed fatigue with the peer mentors, one mentee expressed the intent to adjust rest habits upon returning home, acknowledged the significance of informing their local community about their need for rest, and felt empowered to start a dialog with their school about how to accommodate their need:

> Hmm, it is very important to inform those closest to me, like at school, to inform the teachers that I sometimes need breaks. "Sometimes you guys need to help me decide when I should rest because sometimes, I struggle to figure it out myself." Uh, I had a meeting with the school yesterday, and we decided that initially, it's thirty minutes on and thirty minutes off, and then we can gradually increase or decrease it. […] And I have never really considered informing others about the issues I'm dealing with, but when they [peer mentors] mentioned it, I realized how important it is for them to know why I might need to take a break during class. And I told my teacher and asked him to inform all the teachers and all the students about it. (Youth_3, first interview)

In the follow-up interview, some mentees said they managed their fatigue better and incorporated better rest routines at home. One youth described using physical activity as a respite from the headaches suffered as a consequence of ABI. Caregivers confirmed that their children had developed a more profound comprehension of fatigue by observing fellow camp attendees:

> He may have learned to take a short break beforehand […], and it's vital that he sees that others also need a break. I think it's very important for him to see that it's not just him who needs breaks. (Caregiver_4, first interview)

The caregivers did not have a dedicated session to discuss fatigue, but many reported gaining knowledge of the importance of rest and how to help their children rest. Some found it beneficial to observe how other caregivers carefully structured their days to manage their children's fatigue, having received little assistance from their local community in dealing with this issue. Others reflected on difficulties differentiating their children's fatigue and lack of motivation, well described by one caregiver: "What is fatigue and what is just being a normal child who doesn't want to go on a hiking trip?" (Caregiver_3, first interview).

Many caregivers were initially concerned about the busy camp schedule, as they were explained the importance of rest upon their children's initial injury. However, as the camp progressed, they noticed their children coping well and realized they could push them further:

> Hmm, we have definitely learned and seen how important rest is and how it's something everyone needs. […] Although we've been told it's a common need, and we see it in [child's name], it's kind of reassuring to know that there's some truth to it for the broader group of brain-injured individuals. Um, so that's one thing, and on the other hand, it's also good to push a little too, uh-huh. […] We have noticed at the camp that pushing a little can be helpful too. (Caregiver_1, first interview)

During the initial interview, some caregivers intended to prioritize a balance between activity and rest for their children. During the follow-up interview, many reported successfully maintaining this focus. At camp, some caregivers learned that high physical activity levels could positively impact secondary impairments such as pain and epilepsy. Despite encountering challenges in achieving the right balance between rest and activity and differentiating fatigue from physical exhaustion and lack of motivation, they felt less anxious about their children's activity level after the camp.

3.2.2 Gaining valuable insights

In addition to knowledge about secondary impairments, some mentees claimed to have learned about the variety of ABI, how to perform sports activities, and how sports can be individually adapted to their needs.

According to the caregivers, their own and their children's understanding and awareness of ABI improved after meeting

peers and peer mentors. Many emphasized the significance of the peer mentors sharing their experiences regarding potential challenges during adolescence, and some gained advice from other caregivers about handling challenging situations, useful devices (e.g., noise-canceling systems), and appropriate physical activities for their children. Further, some caregivers elaborated on how they acquired a better understanding of variances that exist across the nation in local support systems. After learning more about ABI, some caregivers recognized that their responses and feelings toward the injury were reasonable, given the circumstances. Others posited that this newfound knowledge of ABI inspired them to exercise more patience with their children. During the subsequent interview, some caregivers verified that they had indeed become more composed and understanding with their children.

> Um, it has probably influenced me a little. Specifically, in those situations where things are moving slowly or when [child's name] forgets things, it's like, I don't get frustrated with the situation; it's okay, that's just how it is. Yeah, I think it is a part of it [ABI], and I've become a bit calmer about, you know, things will be okay eventually, yeah. (Caregiver_1, second interview)

3.3 Nudging from peer mentors made me feel better

This sub-theme describes how nudging from peer mentors and engaging in sports and leisure activities increased mentees' and caregivers' motivation and mentees' confidence and sense of mastery.

3.3.1 Motivation

Just over half of the mentees were physically inactive before attending the camp, and many expressed interest in attempting new sports and leisure activities. Mentees mentioned their fun trying various activities when asked what they remembered best from the camp. They expressed a desire to try more activities in the future, with some sharing specific activities they wanted to pursue. The caregivers confirmed this desire to continue certain sports and leisure activities, and a few made detailed plans. Others said their children were already engaged in physical activities and thus refrained from making further plans. In the follow-up interview, some mentees previously uninvolved in sports or regular physical activity stated they had either begun participating in planned sports or increased their physical activity.

Some mentees expressed being motivated by their encounters with peer mentors, with whom they could relate and compare themselves. One youth expressed that it was comforting and motivating to know that one peer mentor also had a paralytic arm and added that having someone who could relate to their condition was helpful and inspiring. After attending the camp and bonding with the peer mentors, some youths endeavored to become peer mentors themselves, and one even disclosed having enrolled in a peer mentor training program. The motivation was to support and encourage other children and youth who had experienced ABI. Almost all mentees were inspired to participate in more camps, and all stated they would recommend BCY to other children with ABI.

A few caregivers observed that the children displayed increased motivation to improve their independence in ADL after interacting with peers and peer mentors:

> He learned something from them [peer mentors]. He understood that you can be really ill, but through training and dedication, you can manage to live an independent life. That's what he sees, and that's his goal. And in a way, it gives him a little push forward. (Caregiver_2, first interview)

Some caregivers admitted being overly protective of their children, hoping to prevent further hardships or challenges. They realized that although their intentions were good, this approach could harm their children's growth and development and hamper mastering activities. The caregivers explained that at camp, they discovered their children's potential to become more independent in ADL, with the camp's focus and peer mentors gently pushing mentees being essential to this increased awareness. Several caregivers expressed a desire to expand their children's independence and set higher expectations upon returning home:

> Ever since we returned from camp, I have, in a way, let go a little. I can't be such a helicopter mom. I have to, and of course, [child's name] enjoys it when Mom serves and helps and follows him around the room and all those things, but maybe I've become a bit more like, "No, [child's name], you have to do it yourself" [laughter]. Of course, if he's tired, I still do those things, but maybe I've picked up some tools from the peer mentors and staff about the importance of training independence. And you don't achieve that without doing things yourself. So yes, from personal care to moving around the house, we encourage [child's name] to master it himself, uh-huh. (Caregiver_2, first interview)

While not universally reported in follow-up interviews, some caregivers noted that their children had become more independent.

Many caregivers reported difficulties collaborating with their children's schools and local support teams for the necessary help and adaptations. They explained that interactions with the other caregivers and peer mentors at camp motivated them to persist in ensuring optimal outcomes for their children.

3.3.2 Mastery and confidence

Many mentees expressed a sense of mastery when discussing various activities. This experience brought them joy and a valued feeling of accomplishment:

> And knowing that even though you have a brain injury, it doesn't mean that you are incapable of doing most things.

> You can do almost anything anyone else can do. This is a valuable lesson to keep in mind. (Youth_3, second interview)

In the follow-up interview, one youth reported feeling empowered to try new activities at home after mastering new skills at camp. The peer mentors' encouragement to try the various camp activities was well-received by mentees, who appreciated the peer mentors' ability to understand their limitations and when to push them. Some mentees also noted a shift in their self-esteem, self-confidence, or social confidence following camp, with one explaining that it was easier to talk to people and that they had become more outgoing after camp.

Many caregivers hoped their children would gain mastery during camp and reported success. They credited the mentees' mastery to the peer mentors' gentle encouragement and support, instilling belief in the mentees' abilities:

> And that's the take-home message: how skilled the peer mentors are in getting the mentees not just to believe that they can do things on their own but also proving it to them. I think that's super important, and I would have liked to have more examples. But it's like, "Oh, am I going kayaking?" "Oh no, can I row without that floater on the kayak?" "Yes, you can!" And they [peer mentors] take you, they give you that little push, which is so valuable, and you bring that confidence with you. In that sense, their role is absolutely priceless, right? Because they [peer mentors] know, they know that they [mentees] can do it because they have been in the same position. They [peer mentors] know that the kids have much more capacity than they believe. (Caregiver_2, first interview)

The caregivers appreciated the so-called "you can do it" attitude at camp and believed the camp had positively influenced their children's self-esteem and confidence. They attributed the changes to interacting with and feeling acceptance from peers. They explained these positive changes could be observed in the mentees' attitudes, moods, and postures:

> I can tell that he is, how should I put it, much happier now. Um, yes, towards the end of the camp, I noticed that he was walking with an upright posture, whereas he usually walks like this [demonstrates a stooped posture], slightly leaning forward, looking down, and hesitant to make eye contact with people. It seems like he's now talking to people and laughing. (Caregiver_4, first interview)

3.4 A sense of companionship through meeting peers

This sub-theme describes how mentees, caregivers, and peer mentors connected at camp, how these meetings with peers and peer mentors were perceived, and what thoughts and feelings were facilitated by these meetings. Before attending camp, few mentees and caregivers had individuals with ABI in their network. Some caregivers felt isolated in their communities and feared their children struggled with loneliness.

3.4.1 Interacting with peers

The primary camp goal for many mentees and caregivers was for mentees to connect with peers and form friendships. Virtually all mentees expressed gratitude for meeting new people at camp and making friends. With these interactions, they felt enjoyment, alleviation of their loneliness, that they were not alone in their struggles, and that having an ABI was not something abnormal. The fellow mentees were perceived as being understanding. Moreover, the mentees appreciated not having to explain the injury and its consequences repeatedly and enjoyed meeting someone in whom they could see themselves:

> They [peers] understand a bit better and things like that, I think, uh-huh […] Yes, uh-huh. I don't have to explain about fatigue and things like that. […] It made a difference to be at a camp with people who have brain injury compared to a camp where nobody has brain injury. There's quite a big difference […] because they are, like, similar in a way, there are people who resemble me, who also have injuries. (Youth_1, second interview)

Connecting with other mentees was challenging for some due to age differences, but most expected to stay in touch after the camp. The youth group established a social media group, and follow-up interviews revealed that the group persisted, though involvement varied. Some of the children communicated with one another, either via phone or online gaming.

Most caregivers perceived their children had a positive experience meeting peers at the camp. They believed their children had felt accepted and included, made new friends, and received encouragement from the group. For some, this contrasted with their home situation, where the children struggled to maintain friends post-injury. The caregivers related this to the children's behavioral change after the ABI, which friends found difficult to handle. Some caregivers said that their children constantly compared themselves with their schoolmates at home, diminishing their self-esteem. Hence, introducing the children to others with ABIs was beneficial for their comparative behaviors. According to the caregivers, the children gained insight into how others handled similar situations, became more comfortable discussing their condition and difficulties, and developed a more nuanced perspective of a typical child's daily life. Some caregivers observed that their children encountered difficulties engaging with other mentees due to their varying levels of physical impairments.

Several caregivers expressed an interest in attending the camp to establish connections with other caregivers. Following the camp, many maintained these relationships. Some caregivers noted that while they did not frequently utilize this network, they viewed it as an easily accessible resource when needed. Upon meeting fellow caregivers at camp, they quickly noted a strong sense of trust and honesty within the group. The

caregivers also expressed feelings of support, camaraderie, and a sense of belonging to a community. They described the camp as a safe place to be vulnerable, where it was effortless to share experiences of having a child with an ABI. Further, they valued encountering others who could empathize with their situation rather than offer unsolicited advice.

> It has been a week of real highs and lows; there has been joy and tears and the opportunity to talk with others who understand what you're talking about instead of sitting there with your friends and trying to wrap your thoughts in a certain way. The opportunity to talk with other parents and just open that lid and know that they truly understand the emotions you've been dealing with or the thoughts you have, right? To gain an understanding that, as my child puts it: "you are not alone". It's a different kind of understanding, you know. (Caregiver_8, first interview)

3.4.2 Interacting with peer mentors

The children perceived the peer mentors as friendly and supportive but were unsure of their specific roles. The children's caregivers confirmed this lack of awareness but also claimed that their children had positive experiences with and quickly formed bonds with the peer mentors. Some caregivers perceived that when meeting peer mentors who could relate, their children were encouraged to be open about their injuries, participate more, and take on challenges during camp activities.

The youths perceived the peer mentors as individuals who motivated them to participate in various activities, educated them on how to manage living with an ABI, and assured them through their expertise and experience:

> You don't feel different because there are people who either struggle with the exact same thing or face similar challenges. And it provides a sense of security, knowing they have experiences and knowledge that can make you wiser. (Youth_3, second interview)

In addition, a few mentees noted that the peer mentors were present not out of obligation but because they genuinely wanted to assist.

The youths' caregivers perceived that their children admired the peer mentors. In addition, the caregivers believed the peer mentors encouraged the youths' independence, had faith in their abilities, comprehended their daily challenges, and assisted them in recognizing that their experiences and reactions were typical for their circumstances.

Caregivers commended the peer mentors for their credibility, uniqueness, and importance in enhancing the camp experience. They described the peer mentors' encounters as inspiring, impressive, and motivating and reported the belief that peer mentors genuinely cared about their children. The caregivers listened attentively to the peer mentors' narratives and valued their candidness and transparency regarding their harsh experiences with ABI. When asked about their interaction with the peer mentors, one caregiver expressed their appreciation:

> I thought it was really nice. They [peer mentors] truly gave of themselves despite their challenges and tough lives. It was truly, perhaps, the most wonderful experience […] because they could articulate their struggles and show their emotions. But still, they persevere and share so much. Um, I saw that there were a lot of tears and painful emotions but also many beautiful things. So, I think it must have been quite exhausting and tough for them as well. (Caregiver_1, first interview)

When asked if camp participation affected the caregivers' outlook for their children's future, some identified no change, either due to already existing high expectations or to challenges related to their children's diagnoses. Others said that when their child suffered the ABI, they felt all plans and visions for their child's future crumble. Thus, interacting with the peer mentors and observing how they managed life with an ABI instilled hope for and a more optimistic perspective of their children's future: "When I see the peer mentors, it feels good, it is perhaps easier to see a future for my child" (Caregiver_4, second interview). By interacting with the peer mentors, the caregivers also accepted that having an ABI did not mean their children's lives would be less, as expressed by one caregiver when asked what they had learned: "Well, it was never to give up or underestimate yourself. Life isn't over even though you struggle with fatigue or have a disability. Yes, I experienced the joy of life being with them [the peer mentors]" (Caregiver_2, second interview).

4 Discussion

This longitudinal, qualitative study explored the experiences of children with ABI and their caregivers who participated in a structured, time-limited peer mentorship sports camp. To our knowledge, this is the first qualitative, longitudinal study exploring these individuals' experiences with an AR camp. From the analyses, we constructed three sub-themes: (1) Interacting with peers made me wiser, (2) Nudging from peer mentors made me feel better, and (3) A sense of companionship through meeting peers, from which an overarching theme was constructed: Active Rehabilitation peer mentorship camps enrich the lives of children with ABI and their caregivers.

In this overarching theme, we emphasize the peer mentors' essential role in supporting mentees and caregivers by listening, encouraging, prompting, and empathizing. Moreover, we found that by interacting with peers and peer mentors, mentees and caregivers gained more insight and knowledge of ABI and its consequences, changing their behavior and everyday lives to improve coping. Mentees gained mastery through activities and developed motivation for physical activity and participation, and caregivers also noted a positive shift in mentees' self-esteem and self-confidence after the camp. Caregivers increased their desire to focus on improving their children's independence in ADL,

with some managing to maintain this focus and improve their children's independence after camp.

Mentees and caregivers built relationships with peers during camp, which continued after the camp. They expressed gratitude for meeting people who shared their experiences and truly understood their situations, as these connections enabled camaraderie and belonging among mentees and caregivers and helped ease feelings of isolation. Due to these interactions, caregivers also reported greater optimism about their children's futures. Further, the camp's sports and leisure activities, the safe social atmosphere, and the "you can do it" attitude adopted at BCY facilitated and enforced mentees' and caregivers' experiences.

4.1 Increased insight and overprotective caregivers

The mentees and their caregivers gained valuable insights about ABIs and related impairments at camp, which corresponds with other studies on structured, time-limited peer mentorship activity camps for individuals with acquired neurological injuries (47–50). In BCY, caregivers were encouraged to allow their children to manage ADL (such as meals) independently, and the children often participated in camp activities without their caregivers present. According to Grolnick and Apostoleris (51), when parents experience uncertain environments (e.g., their children having an ABI), they tend to become more controlling. Moreover, caregivers may be overprotective of and indulge their children due to the fear and relief associated with the child surviving a life-threatening injury or accident (8). Similarly, the caregivers in our study explained that their inclination toward overprotection stemmed from a desire to prevent undue hardship for their children. Several caregivers commented that increased knowledge of ABIs changed their behavior toward their children. They became more patient and understanding, provided less assistance in ADL at home, and paid greater attention to structuring daily schedules to accommodate their children's fatigue.

According to Organismic Integration Theory, the continuum of extrinsic motivation ranges from external regulation, through introjected and identified, to integrated regulation (28). Within the introjected regulation type, behavior is not entirely externally motivated but regulated by internal pressure, such as feelings of contingent self-worth (22). Ryan and Deci (52) discuss how parents might undermine autonomous motivation, increasing the introjection regulation of anticipated behaviors (i.e., through guilt and shame). The data in the current study do not indicate parental pressure; instead, they suggest a tendency toward minimal exposure to choices and challenges by being overprotective. Significantly, during camp, caregivers acquired a deeper understanding of ABIs, developed a heightened awareness of their children's capabilities, limitations, and requirements, and became more adept at discerning appropriate moments for encouragement and boundary establishment (possibly reflecting caregivers' need for competence satisfaction). By enhancing caregivers' understanding and knowledge of ABIs through the camp, basic psychological needs were met, leaving caregivers more inclined to give children greater freedom and allow them to explore and develop autonomy.

4.2 Sports and leisure activities as a facilitator

A lack of role models, assistive equipment, and facilities hinders physical activity among children with disability (53). Hence, attempting sports and leisure activities at camp with peers and peer mentors, combined with the opportunity to use suitable adaptive equipment and techniques, offered new experiences and enhanced the likelihood of mentees engaging in sports and leisure activities upon returning home.

Children with chronic illness sometimes cannot enroll in summer camps due to their impairments or because they need close medical attention (54). In BCY, healthcare professionals are among the camp staff, enabling children needing close medical attention (e.g., due to epilepsy) to participate in activities without a caregiver. Many camps for children with disability aim to allow mentees to play and be "normal" children (55). Our finding corroborates this, as mentees shared that they were given respite from managing the injury at camp.

The fun activities were central to both the children's and youths' positive camp experiences, a finding supported by other studies exploring diagnosis-specific camp experiences (47, 56–58). This perception of fun may have supported the mentees' tolerance for the intense camp schedule. SDT describes engaging in activities out of pure joy as an intrinsic motivation, which depends on experiences of autonomy, competence, and relatedness (22, 59). Ryan and Deci (22) state that the experience of competence satisfaction depends on positive feedback and optimal challenges, which is "the match of persons' abilities with task demands" (22). Hence, although identifying ideal camp activities and adapting these to a broad range of ages and impairments can be challenging (47, 56), it is vital for competence satisfaction and to ensure a reasonable challenge for everyone. Feedback focusing on competence is more likely to support intrinsic motivation, while feedback leading the person to feel critiqued or controlled can reduce intrinsic motivation (22). Moreover, verbal persuasion from significant others and vicarious experiences are sources of self-efficacy (60, 61), acted upon by the peer mentors at BCY by gently nudging and persuading the mentees to try activities, praising them for their efforts, and showing joy when the mentees partook in activities. Furthermore, the peer mentors demonstrated how they, with their impairments, completed tasks related to ADL and sports throughout camp. Mentees' experiences of mastery in the sports and leisure activities at camp may have motivated them to continue physical activity engagement after camp.

Children and youths with ABIs may experience low self-esteem (8, 62), and sports activities and peer interaction at camp seemed to boost their self-worth. A sports setting, such as the sports and leisure activities at BCY, may be considered a "natural context" and hence facilitate conversations between peer mentors and mentees (42) about complex topics, such as their injuries,

impairments, and social lives. Thus, sports and leisure activities may facilitate personal growth.

4.3 Networks and the need for relatedness

Meeting peers, whether other children, youths, caregivers, or peer mentors, was an essential part of our study participants' camp experience. As confirmed in our study, difficulties in establishing and sustaining friendships and loneliness can occur after an ABI (8). We believe the goal of making friends at camp and achieving this reflects the need for and satisfaction of relatedness, as described in SDT (22). In SDT, relatedness concerns feeling socially connected and is experienced when one feels part of a group, cared for, and important to others (22, 29). Mentees in the present study described that at camp, they felt they belonged to a group that understood their struggles, made friends, and were seen, looked after, and cheered on by peer mentors, experiences supported by Analytis et al. (47).

In the present study, contact within these networks of peers was somewhat limited after camp. However, some caregivers explained that even though they did not use the network much after camp, they still felt part of a group that cheered them on and argued this network would be easy to reach out to. This perception of available support may lead to a more positive assessment of stressful events and better coping skills (63).

According to Relationships Motivation Theory, high-quality relationships are facilitated by autonomous motivation, i.e., the willingness to participate in the relationship (29). Similarly, mentees and caregivers perceived that the peer mentors participated in the camp because they wanted to help. Moreover, they were genuinely happy for mentees when they mastered activities or social settings during camp. Furthermore, experiencing oneself contributing to others is essential to satisfying the need for relatedness (22). Hence, the autonomous motivation in these relationships between mentees and peer mentors may satisfy the need for relatedness and enhance the well-being of both parties.

Differences in age and injury impairment and trajectories were perceived to hamper bonding within the camp's mentee and caregiver groups and with the peer mentors. Matching mentees with mentors based on personal and injury characteristics were some of the matching criteria used in BCY 2022 and is common in peer mentorship interventions (64–66). However, Standal (67) argues that pure mirroring of injuries or demographics is insufficient to facilitate peer mentorship, as the empathy required of a peer mentor is more related to the ability to place themselves in the mentee's position. Furthermore, a supportive environment is, among others, characterized by "effectance supporting" (22). Hence, if mentees feel that peers or peer mentors are too well-functioning compared to themselves, they will not experience a sense of mastery, and competence will be thwarted. Our findings argue for condition-specific camps with a broad range of impairments and ages among mentees and peer mentors. Moreover, it seems essential that peer mentors manage their injuries well enough to motivate caregivers and mentees to continue facing their challenges and, simultaneously, are not perceived as super-humans.

4.4 Study strengths and limitations

Rather than relying solely on adult perspectives to understand the lives of children and youths, it is recommended to incorporate their voices in research concerning ABI to provide a platform for their thoughts and interpretations (42, 43). While following guidelines for interviewing children with ABI (43), we encountered challenges related to both ABI-related impairments and general interactions with children.

To establish rapport, study participants were free to select the interview locations (68), and children and caregivers chose interview times, sites, and attendees. Most opted for home interviews, enabling a familiar environment, but this choice brought distractions from siblings, family members, and pets. Caregivers were present in some children's interviews, aiding responses with prompts, but some children deferred to caregivers, leading to lessened engagement. Further, in three caregiver interviews, the children were present, potentially inhibiting open sharing.

Camp attendance by PW and SM helped build rapport and an understanding of how the children's impairments might implicate the interviews. However, building rapport with children takes time (68), and although PW comprehended the mentees' impairments, an even more profound level of familiarity would have been helpful.

To address fatigue, we kept sessions concise and provided breaks, including activities like games and sports, to maintain rapport. In alignment with guidelines (43), PW allowed the children control of the recording equipment to foster trust and used visual aids, including pictures, to address verbal comprehension and memory issues. Yet, although such prompts are recommended to enhance comprehension (43), we occasionally found that the children failed to concentrate on the questions and became more interested in looking at the people in the pictures. Although open-ended questions are advised when exploring peoples' experiences and perceptions (69), children might prefer closed-ended questions due to verbal limitations (68). Our comfort-led conversations yielded brief answers, subsequently relying on caregivers' insights.

Incorporating children, youths, and caregivers enabled a diverse experience exploration, and analyzing within and across groups strengthened the study's results. Study participant recruitment was exhaustive, and data saturation was not addressed due to study constraints.

Methodological orientations and the context bound our findings. Qualitative research offers context-rich knowledge that is transferable via analytical generalization (70, 71), and our study may benefit similar peer mentorship camps for various conditions. In addition, quantitative approaches to complex interventions, such as peer mentorship camps, are challenging due to ethical and logistical reasons and to ensure measuring the right outcomes (54, 72). Instead, we employed a qualitative design supported by a longitudinal format. It is possible that an extended follow-up period and inclusion of study participants who attended more than one camp would have revealed additional behavioral changes or offered insights into cumulative effects. Finally, exploring peer mentors' perspectives and age-based mentee differences could further enrich our understanding of AR peer mentorship camps.

4.5 Conclusion

Despite the short duration, participating in BCY seemed to contribute to valuable knowledge and experiences gained by children and youths with ABI and their caregivers. The overarching theme, "Active Rehabilitation peer mentorship camps enrich the lives of children with ABI and their caregivers", reflects peer mentors' essential role at BCY in facilitating knowledge gain, personal growth, and network building. Furthermore, this theme incorporates the sports and leisure activities offered at the camp and the safe and encouraging atmosphere, which appear vital to the mentees' and caregivers' experiences. The mentees expressed that they encountered a supportive environment that fostered enjoyment, mastery, motivation, and self-worth, all central facets of SDT (22). By connecting with peers and peer mentors, mentees learned to manage their ABI while forging meaningful friendships.

In addition, caregivers found great value in the support network formed among themselves, offering them a deeper understanding of ABIs and valuable perspectives on the experiences of those affected. Their newfound insight spurred positive changes in their parenting approaches, including increased patience, reduced assistance with ADL, and a more structured daily routine to accommodate their children's fatigue. Furthermore, meeting peer mentors gave them a more positive outlook on their children's future. The enhanced confidence of caregivers in their children could potentially foster a more autonomy-supportive parenting approach. Over time, this could nurture the children's need for autonomy and, perhaps indirectly, their need for competence as the increased trust in their abilities is demonstrated.

According to Ryan and Deci (26), individuals who prioritize meaningful relationships, personal growth, and community contribution—all linked to basic psychological needs—tend to experience greater eudemonic well-being. Therefore, by providing a safe and supportive camp atmosphere that fosters friendships, an increased understanding of ABIs, and self-worth, mentees and caregivers may be inspired to make positive changes in their daily lives and engage more fully with their local community in pursuit of eudemonic well-being.

Data availability statement

The datasets presented in this article are not readily available due to data protection regulations in Norway. Our research data falls under a category that requires strict confidentiality and cannot be openly shared. However, we have taken measures to fully anonymize the interview transcripts to ensure the privacy and anonymity of the participants. These anonymized transcripts can be made available upon request to the corresponding author.

Ethics statement

The studies involving humans were approved by This qualitative, longitudinal study was approved by the Norwegian School of Sport Sciences' Ethical Committee (Ref. no 229–160622) and the Norwegian Centre for Research Data (Ref. no 521550). The process and reporting of this study were informed by guidelines from Tracy (34) and the consolidated criteria for reporting qualitative research (COREQ) (35). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

PW: Conceptualization, Formal Analysis, Investigation, Project administration, Writing – original draft, Writing – review & editing. SM: Conceptualization, Formal Analysis, Investigation, Supervision, Writing – original draft, Writing – review & editing. AD: Conceptualization, Formal Analysis, Supervision, Writing – original draft, Writing – review & editing. FEA: Conceptualization, Formal Analysis, Project administration, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fresc.2024.1285742/full#supplementary-material

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Case study: Evaluating deep-water start techniques and training demands in seated slalom waterskiing for an athlete with paraplegia

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Purpose: Recreational and competitive slalom waterskiing is increasingly popular among individuals with spinal cord injuries (SCI), particularly for those with paraplegia using sit-skis. A key component of slalom skiing is the deep-water start (DWS), yet little is known about the physiological and physical demands of this activity when the athlete is seated. This study aims to fill this gap by focusing on the training requirements for a seated slalom athlete.

Materials and methods: Focusing on a young male athlete with paraplegia, this case study evaluates the effectiveness and efficiency of traditional (TDWS) and alternative (ADWS) DWS techniques during seated slalom waterskiing sessions. It assesses internal training load (TL) through heart rate (HR) zones and session rating of perceived exertion (sRPE), alongside pre- and post-session handgrip strength measurements to gauge peripheral muscle fatigue.

Results and conclusions: Performing the ADWS, achieving a full success rate, proved more effective but slightly more time-consuming than TDWS, which had limited success. HR during DWS maneuvers ranged from 63.2 to 81.3% of maximal HR, with most sessions occurring below the ventilatory threshold, thus perceived as hard effort. A moderate yet non-significant correlation was found between HR and sRPE-based TL. A significant reduction in handgrip strength post-session underscores the activity's demands. These insights illuminate the technical, physiological, and physical challenges in mastering DWS for seated slalom athletes with SCI, providing valuable guidance for the development of tailored training programs and techniques in this sport.

KEYWORDS

water sports, disability impairment, heart rate, perceived exertion, training zones

1 Introduction

In recent decades, Para athletes have gained greater prominence and have increasingly participated in a wide range of events (Baumgart et al., 2022). Therefore, there have been growing concerns about the necessity for advanced physical fitness and comprehensive training technique knowledge to optimize performance in athletes with physical impairments (Gee et al., 2021; Rodríguez Macías et al., 2022). Although contemporary studies have explored training methods for wheelchair sports (Simim et al., 2017; Baumgart et al., 2018), research has remained limited on competitive sporting disciplines outside the context of the Paralympic Games (Lexell and Frontera, 2023).

In this regard, waterskiing, a popular towed water sport activity, has provided leisure opportunities for individuals with spinal cord injury (SCI) (Urbański et al., 2021); and caters to various ability levels, including those who cannot stand (Suárez-Iglesias and Villa-Vicente, 2017). In the discipline of slalom, whether for athletes in the seated division or those able to stand, success hinges on mastering a repeatable technique that reduces load during the deep-water start (DWS) and on executing DWS with precision (Bray-Miners et al., 2012). This process entails navigating a sharp increase in tow rope tension, which can surge to 2.0–2.5 times an athlete's body weight (Keverline et al., 2003; Runciman, 2011). Lighter athletes may face even higher relative peak tensions, with skill level additionally influencing this tension (Suderman et al., 2023; Lance, 2024). Overcoming this significant initial tension requires considerable upper-body strength and endurance, especially for seated slalom athletes who primarily rely on their upper-body muscles to transition from water to a seated skiing position (Suárez-Iglesias et al., 2019b). To mitigate grip force and fatigue that may arise from maintaining the connection to the boat and control of tension on the line (Woodgate et al., 2021), various DWS methods are employed, including instructor-assisted starts and specific learning aids (USA Water Ski Level 1 Instructor's Manual, 2012).

However, research on the experiences of seated slalom athletes with the DWS has been limited. For the development of an effective and efficient DWS, incorporating sport science principles that address the physiological processes activated during exercise is crucial (Hoffmann et al., 2014). Collecting data on the physical workload of seated slalom athletes may potentially enhance coaches' ability to individualize training programs. This targeted approach could lead to more precise management of an athlete's physical workload, potentially aiding in the effective monitoring and development of the athlete. Such an approach might also contribute to improved sports performance and could possibly reduce the risk of injuries and illnesses (Stieler et al., 2023).

In this context, recent studies have specifically investigated the experiences and physiological impacts on athletes engaged in seated slalom waterskiing. The first study, involving three males with paraplegia, found that recreational seated slalom waterskiing generally entailed moderate intensity, with an average heart rate (HR) reserve around 45% (Suárez-Iglesias et al., 2019a). The second study engaged five adults from a rehabilitation center with various physical impairments in a beginner's seated slalom waterskiing course, and explored participants' perceptions of wellness, learning, and enjoyment. It reported that session intensity varied from "fairly light" to "somewhat hard" on the original Borg Rating of Perceived Exertion (RPE) scale 6–20 (Suárez-Iglesias and Villa-Vicente, 2017). While these studies employed HR and RPE metrics— common tools in athletic performance monitoring for wheelchair sports (Simim et al., 2017) —their focus diverged from typical performance evaluations in practices, where HR and RPE-based training zones are benchmarks for coaches to assess and monitor athletes' seasonal progress (Rodríguez-Marroyo et al., 2012; Yanci et al., 2015). Instead, these studies have highlighted broader aspects, such as the health benefits and inclusivity of participating in seated waterskiing for leisure.

Furthermore, tailoring training to an athlete's stress levels, as indicated by grip force, can enhance training outcomes, according to Sahar et al. (2022). Handgrip strength, a common indicator of physical performance in adaptive athletes (O'Connor et al., 2022), warrants close attention, particularly in seated slalom athletes. Supporting this observation, research including a study with four males at a national championship revealed that seated slalom waterskiing significantly reduced handgrip strength. Notably, the degree of this reduction varied according to each athlete's level of competition and overall fitness (Suárez-Iglesias et al., 2019b). Consequently, these findings suggested that monitoring handgrip strength could be instrumental in customizing training programs to optimize the performance and wellbeing of seated slalom athletes.

In light of the scenario previously outlined, this case study addressed the need for specialized training programs and an in-depth understanding of the physiological demands in seated slalom waterskiing. This research is centered around a young male athlete with SCI. It is methodically structured with a threefold objective: first, to quantitatively evaluate the efficacy and efficiency of both traditional and alternative DWS methodologies tailored to his specific condition; second, to analyze his exertion levels using HR zones and session-RPE (sRPE) for a comprehensive assessment of TL; and third, to assess his peripheral muscle fatigue, emphasizing handgrip strength measurements.

2 Method

2.1 Participant

This case study involved a 28-year-old male athlete with T5 complete paraplegia (ASIA Impairment Scale A) (Kirshblum et al., 2011), resulting from a motor vehicle accident 7 years prior. He was 1.77 meters tall and weighed 55.0 kg. With 3 years of experience in seated slalom waterskiing, he primarily trained at a cable park and on a reservoir, adopting a position with his knees above his hips and using an 18.2-meter tow rope. Identified as an intermediate-advanced athlete (Runciman, 2011; Bray-Miners et al., 2012), he often found it challenging to get out of the water independently, which usually led to failed or exhausting attempts. To overcome this, he undertook training in a new DWS technique. He was fully briefed about the study and provided his informed consent. The study received ethical approval from the University of León, Spain, and was conducted in accordance with the Declaration of Helsinki.

2.2 Procedure

2.2.1 Seated slalom waterskiing program

The program comprised six seated slalom waterskiing sessions, spanning three sessions per week over two consecutive weeks, focused

on learning, practicing, and refining two DWS techniques. The traditional technique involved the athlete sitting in the water and being pulled up onto the surface by the towboat without assistance (Bray-Miners et al., 2012). In contrast, the assisted alternative employed "the boom" (a training bar) attached to the port side of the towboat (Kegel, 1985), with a short rope gradually extended to align the seated slalom athlete centrally behind the towboat.

Each session began with a standardized 5 min warm-up consisting of mobility exercises on the towboat, followed by the introduction of the alternative technique for water-based training. After successfully completing a DWS, the athlete engaged in typical activities, predominantly slalom runs (Suárez-Iglesias et al., 2019a). These runs alternated between open water and an adapted slalom course, referred to as the inner-slalom course, with buoys set 6.4 meters from the course axis (International Waterski & Wakeboard Federation, 2023). In the event of a fall, the athlete was required to perform a DWS and restart the practice, incorporating a rest period for coaching feedback. The program was conducted at a reservoir in Northern Spain.

Special precautions were taken for the participant due to his SCI at T5, which increased the risks of hypothermia and autonomic dysreflexia. These included: (a) emptying the bladder or urine collection bag before each session; (b) wearing a wetsuit as a preventative measure; (c) ensuring the participant had free access to fluids at all times; and (d) avoiding prolonged rest periods in the towboat with wet clothes (Willis et al., 2018). Weather conditions varied, with air temperatures ranging from 20 to 32°C, wind speeds from 12 to 37 km/h, and water temperatures between 14 and 16°C. Waterskiing occurred in sheltered reservoir areas to minimize wind exposure and ensure smoother water conditions, away from other boat wakes. The athlete wore a waterskiing vest for safety (Loughlin, 2013). To control for variables that might affect outcomes, all sessions were conducted at similar times from 11:45 a.m. to 2:15 p.m., using the same towboat and experienced driver, with speed controlled by PerfectPass (PerfectPass Control Systems Inc., Dartmouth, NS, Canada), on the same inner-slalom course, and without altering the tow rope length.

2.2.2 Data collection

2.2.2.1 Content of seated slalom waterskiing sessions

An expert observer quantified characteristics and events during the sessions, making detailed written records of their nature, duration, and towboat speeds (Traceable manual digital chronometer VWR, Pennsylvania, United States). Activities were categorized into four broad groups based on their nature (see Figure 1). Within the *deep-water start* category, further differentiation was made to distinguish between two phases, when the seated slalom athlete performed *alternative* (ADWS) and *traditional* (TDWS) techniques (for further details, see Supplementary material).

2.2.2.2 Effectiveness and efficiency of deep-water starts

The same expert recorded the number of attempted ADWS and TDWS maneuvers. To evaluate effectiveness, the number of errors committed during these maneuvers was noted, while efficiency was assessed based on the time taken to complete each maneuver (Mohanraj et al., 2023). In terms of effectiveness, errors were categorized as falls, in line with the official rules for a seated slalom athlete (International Waterski & Wakeboard Federation, 2023). A fall is defined as occurring when the athlete: (a) loses possession of the tow line; (b) fails to maintain possession of the skiing device; or (c) is not predominantly supported by the skiing device and cannot regain a seated position. Conversely, a successful DWS attempt is characterized by the athlete adopting a seated position, which includes maintaining possession of the tow line, riding forward or backward on the skiing device, and having their weight fully supported by the skiing device or being able to ultimately regain control. For efficiency analysis, the time from the start of a successful ADWS or TDWS attempt until the athlete achieves a seated position was measured.

2.2.2.3 Internal training load

The exercise demands were quantified based on HR and RPE (Foster et al., 2001; Rodríguez-Marroyo et al., 2012). Heart rate was recorded every 5 s during each training session using the Polar Team System 2 (Polar Electro Oy, Kempele, Finland). After the sessions, HR data were downloaded to a computer using specific software (Polar Pro Trainer 5, Polar Electro Oy, Kempele, Finland). The participant's cardiorespiratory fitness was evaluated via a laboratory test performed prior to the start of the seated slalom waterskiing program (Suárez-Iglesias et al., 2019a). Based on the HR values obtained from this test, HR responses were categorized into three distinct intensity zones. These zones were defined in relation to the ventilatory threshold (VT) and respiratory compensation threshold (RCT): zone 1 (low-intensity exercise) was below VT; zone 2 (moderate-intensity exercise) was between VT and RCT; and zone 3 (high-intensity exercise) was above RCT (Rodríguez-Marroyo et al., 2012). These zones were used to calculate the TL by multiplying the time spent in zones 1, 2, and 3 by the constants 1, 2, and 3, respectively. The TL score was obtained by summing the results of the three phases. The intensity of seated slalom waterskiing sessions was evaluated using Borg's category-ratio (0–10) RPE scale, known as Borg-CR10; collected approximately 30 min after each training session (Foster et al., 2001). The participant was already familiar with this scale, having used it routinely to control training intensity during the year prior to the study. The sessions were categorized into three intensity levels based on the RPE values: moderate (RPE < 5), hard (RPE 5–6), and fairly hard (RPE > 6) (Rodríguez-Marroyo and Antoñan, 2015). Moreover, the TL was calculated using the sRPE, by multiplying the RPE value by the duration of the training session (Foster et al., 2001).

2.2.2.4 Handgrip strength

Handgrip strength was measured using a digital dynamometer (Takei TKK 5401 Grip-D, Tokyo, Japan) immediately before and after each seated slalom waterskiing session. The participant adopted a standardized testing position according to the guidelines of the American Society of Hand Therapists (ASHT), sitting in the towboat with the elbow bent at 90 degrees (Sisto and Dyson-Hudson, 2007). The participant selected the handgrip position on the dynamometer that allowed for maximum force exertion (Boadella et al., 2005). Peak force was recorded in kilograms over a 5 s period; three consecutive maximal repetitions were conducted for the dominant hand, with 60 s rest intervals between each repetition. The highest value from the

Deep-water start, included the proper position of the body while sitting in the water to start from a resting position until the skier planed on top of the water and began a run


Open-water practice, recorded from the time the skier started to being pulled behind the towboat, immediately after the DWS, to the moment the skier fell, released the tow rope handle, and sank into the water, or effectively entered the inner-slalom course


Inner-slalom course practice, recorded from the time the skier began waterskiing through the course to right before he either fell or went back to open waterskiing


Rest period, considering all situations in which the skier was stationary on the water receiving coaching feedback or recovering and getting back on the sit-ski after falling


FIGURE 1
Main activities during seated slalom waterskiing sessions.

three repetitions was used for analysis. The strength decrement index for each session was calculated as follows: 100% × (Initial Max – Final Max) / Initial Max (Reuter et al., 2011).

All measurements were conducted by the same researcher, who was experienced in the procedures for evaluating physical fitness in individuals with physical impairments.

2.2.3 Statistical analysis

Data were presented as mean ± standard deviation (SD). Normality was assessed using the Shapiro–Wilk test. The relationship between HR-based and sRPE-based TL methods was determined using Pearson's correlation coefficient (r). The magnitude of the correlation was classified as: trivial (< 0.1), small (0.1–0.3), moderate (0.3–0.5), large (0.5–0.7), very large (0.7–0.9), and nearly perfect (> 0.9) (Hopkins, 2002). A p-value of <0.05 was considered statistically significant. Pre- and post-session handgrip strength values were compared using a paired student's t-test. Statistical analyses were performed using SPSS version 24.0 (Chicago, Illinois, United States).

3 Results

3.1 Content of seated slalom waterskiing sessions

Key characteristics of the seated slalom waterskiing sessions are summarized in Table 1. The average session duration was 30 ± 7 min. The ADWS phase constituted 8.4 ± 5.2% of the total session time, TDWS 5.5 ± 4.4%, *open-water practice* 48.3 ± 23.6%, *inner-slalom course practice* 16.3 ± 16.5%, and *rest periods* 21.5 ± 13.7%. Towboat speeds ranged from 31 to 43 km/h.

3.2 Effectiveness and efficiency of deep-water starts

During the 6-day seated slalom waterskiing program, the participant executed a total of 23 DWS, comprising 13 ADWS attempts and 10 TDWS attempts (Table 1). In terms of effectiveness, the ADWS method achieved a 100% success rate, with each attempt resulting in the athlete adopting a seated position. In contrast, the TDWS method had a lower success rate of 20%. Regarding efficiency, the ADWS method averaged 74 s per attempt, totaling 16 min and 6 s, while the TDWS method was quicker, averaging 61 s per attempt, totaling 10 min and 13 s.

3.3 Internal training load

Physiological demands experienced by the seated slalom athlete are detailed in Table 2. Analyzed as percentages of maximal HR (%HR_{max}), the average HR during ADWS phases was 70.8 ± 6.3% HR_{max}, and during TDWS phases, it was 69.6 ± 4.5% HR_{max}. The overall average intensity across all seated slalom waterskiing sessions was 71.8 ± 4.4% HR_{max}. Time distribution across the intensity zones was 76.7 ± 15.3% in zone 1, 21.7 ± 14.2% in zone 2, and 1.7 ± 1.6% in zone 3. The mean RPE was 4.7 ± 1.6. The mean TL, assessed using HR and sRPE, was 39.6 ± 3.1 and 151.6 ± 61.1 arbitrary units (AU), respectively. A moderate positive correlation ($r = 0.45$, $p = 0.37$) between HR-based TL and sRPE-based TL was found, though it was not statistically significant.

3.4 Handgrip strength

Pre- and post-session handgrip strength values are presented in Table 2. The mean post-session value (43.7 ± 4.9 kg) was significantly lower than the pre-session value (49.8 ± 2.0 kg) ($p = 0.024$). The mean strength decrement index, indicating the proportionate deterioration from pre-session values, was 12.2 ± 9.2%. Strength decrement index values exceeded 20% in the first and fourth seated slalom waterskiing sessions.

4 Discussion

This case study contributes valuable perspectives on seated slalom waterskiing training for athletes with physical impairments, specifically focusing on an individual with paraplegia. It explores the potential effectiveness and efficiency of various DWS techniques, both

TABLE 1 Summary of data for the seated slalom waterskiing sessions.

Seated slalom waterskiing session	1	2	3	4	5	6
Total duration (min:s)	34:33	27:43	29:50	40:46	28:31	20:00
Alternative deep-water start	03:19	01:26	05:10	04:16	01:05	00:50
Traditional deep-water start	03:25	–	02:46	00:55	02:37	00:30
Open-water practice	17:05	26:17	11:31	14:29	08:47	08:05
Inner-slalom course practice	03:44	–	–	06:20	08:58	08:00
Rest period	07:00	–	10:23	14:46	07:04	02:35
Towboat speed (km·h^{-1})	31	34	34	34	34–43	37–40
Alternative deep-water start						
Number of attempts	2	1	5	3	1	1
Number of successful attempts	2	1	5	3	1	1
Traditional deep-water start						
Number of attempts	2	–	2	2	3	1
Number of successful attempts	0	–	0	2	0	0

TABLE 2 Percentage of maximal heart rate during deep-water starts and percentage time spent in each training zone, session rating of perceived exertion, training load, pre- and post-training values on handgrip strength measurements and Strength Decrement Index during the seated slalom waterskiing sessions.

Training session	1	2	3	4	5	6
Percentage of maximal HR						
Alternative deep-water start	75.3	81.3	68.1	64.3	68.1	67.6
Traditional deep-water start	70.9	-	75.3	63.2	67.6	70.9
Time spent in the training zones						
Zone 1 (%)	82	55	83	99	76	65
Zone 2 (%)	16	41	17	1	21	34
Zone 3 (%)	2	4	0	0	3	1
RPE (Borg-CR10 score)	5.0	3.5	2.0	5.5	6.5	5.5
sRPE-based TL (AU)	172.8	97.0	59.7	224.2	185.4	170.5
HR-based TL (AU)	41.5	41.3	34.9	41.2	36.2	42.2
Handgrip strength						
Pre (kg)	49.1	52.0	50.7	51.8	46.9	48.3
Post (kg)	36.5	49.3	48.5	40.4	43.1	44.6
Strength decrement index (%)	25.7	5.2	4.3	22.0	8.1	7.7

Borg-CR10, category-ratio (0–10) RPE scale; RPE, rating of perceived exertion; sRPE, session rating of perceived exertion; HR, heart rate; TL, training load; AU, arbitrary units; Pre, before training; Post, after training.

traditional and alternative. Additionally, the study assesses impacts on internal TL, and handgrip strength during DWS and ongoing seated slalom activities.

In waterskiing, which demands considerable physical fitness and advanced skills (Mullins, 2007; Woodgate et al., 2021), the current study's comparison of ADWS versus TDWS offers insightful observations, especially for coaches and athletes with SCI in seated slalom waterskiing programs. The analysis of effectiveness and efficiency suggests that ADWS, achieving a 100% success rate, may provide greater reliability and control – essential in this complex maneuver, especially when using adaptive equipment in extreme sports (Allen et al., 2021). Conversely, despite being faster, TDWS shows a lower success rate of 20%, potentially leading to athlete frustration, interruption of practice continuity, and a heightened risk of energy depletion and injury. These findings could inform training strategies that prioritize a balance between performance, safety, and technical skill (Gunderson, 1991; Suárez-Iglesias et al., 2019b), while acknowledging the sport's challenging learning curve, the need for mastery over specialized equipment, adaptability to various environments, and the diverse components and time management within both standing and seated slalom waterskiing sessions (Thye and Rokosz, 1991; Bray-Miners et al., 2015; Suárez-Iglesias et al., 2019a).

Regarding HR monitoring for gauging exercise intensity, the current research found the participant primarily engaged in aerobic metabolism during seated slalom waterskiing sessions, evident from the predominant time spent in HR zones 1 and 2, similar to standing slalom waterskiing (Mullins, 2007) and paralleling findings in Para alpine skiing (Goll et al., 2015). Such data suggest moderate physical strain in seated slalom waterskiing, consistent with prior research in this discipline (Suárez-Iglesias et al., 2019a). This pattern can likely be attributed to the intermittent nature of the sessions, which, in both previous and current studies, involve seated slalom waterskiing sessions exceeding 10 min but interspersed with *rest periods* and varied training components, such as *open-water practice* and *inner-slalom course practice*.

In addition, this research records for the first time %HR_{max} values during DWS, ranging from 63.2 to 81.3%. These reflect slalom waterskiing's high static and low dynamic demands (Mitchell et al., 2005) and are comparable to HR patterns reported in Para alpine skiing athletes (Goll et al., 2015). The comparable short duration of these activities, akin to the 55 s Para alpine skiing giant slalom runs, may explain these figures. Moreover, the similarity in HR responses between the seated slalom athlete during DWS and athletes in wheelchair tennis or basketball (Roy et al., 2006; Barfield et al., 2009; Croft et al., 2010; Sindall et al., 2013) further highlights the shared intermittent nature of these sports.

This investigation is the first to explore RPE in seated slalom waterskiing. The findings showed that the intensity of seated slalom waterskiing sessions ranged from moderate to fairly hard, according to the RPE categories defined by Rodríguez-Marroyo and Antoñan (2015). These RPE values, exceeding 5 on several occasions, suggest that the participant found the activity to be quite challenging. This contrasts with a study on elite wheelchair tennis athletes who reported lower RPE during singles matches (Sánchez-Pay et al., 2016), possibly due to differences in skill and experience levels. Evidence in the literature supports these findings, showing that perceived exertion can be influenced by skill level, as seen in recreational alpine skiers with advanced abilities reporting lower exertion (Scheiber et al., 2009).

It is now well established that TL monitoring is crucial for understanding an athlete's adaptation to training and assisting coaches in program design (Halson, 2014; Simim et al., 2017; Rodríguez Macías et al., 2022; Stieler et al., 2023). The present study revealed differing TL scores when using HR and sRPE-based methods. The TL values obtained in this study were lower than those reported for wheelchair basketball athletes during small-sided games (55.3–67.5 AU) (Iturricastillo et al., 2017) and notably less

than TL reported in elite wheelchair rugby athletes (247 ± 74 AU) using the same HR-based method (Paulson et al., 2015). These differences may stem from the distinct intensities and activities in wheelchair sports, characterized by high-intensity, intermittent wheelchair use, and varying eligible impairments (with wheelchair basketball encompassing diverse physical impairments and wheelchair rugby often involving athletes with cervical SCI). The sRPE-based TL values from this study were higher than those in wheelchair basketball for small-sided games (99.3 ± 26.9 AU) (Iturricastillo et al., 2017) but lower than in wheelchair rugby practice (934 ± 359 AU) (Paulson et al., 2015). These variances emphasize the need for cautious interpretation, considering differences in participant characteristics, activities, and training session durations across studies.

The intersection of objective and subjective measures in TL assessment for athletes with physical impairments is a topic warranting further exploration. The current research noted a moderate, yet non-significant, correlation between HR and sRPE-based TL ($r = 0.45$; $p = 0.37$) underscores the nuanced nature of seated slalom waterskiing's static demands, particularly for individuals with paraplegia. In such instances, HR typically shows modest increases during fatiguing isometric exercises, a response linked to central factors (Petrofsky, 2001). Besides, the sRPE scores in this study, encompassing both central and peripheral inputs (Borg, 1982), might have been influenced by these factors. Firstly, the repetitive nature of DWS and the prolonged duration of seated slalom waterskiing sessions, often surpassing the typical 15 min waterskiing times on slalom courses (Mullins, 2007), could have resulted in heightened central fatigue in the participant. Secondly, the requirement for meticulous force adjustments and reactions to external disturbances in seated slalom waterskiing could have additionally contributed to peripheral muscle fatigue (Ferguson, 2010). The findings of this study are consistent with research indicating small or trivial correlations between HR and sRPE-based TL in wheelchair basketball (range $r = -0.30$; ± 0.27 to 0.26; ± 0.28; $p > 0.05$) (Iturricastillo et al., 2017) yet they diverge from studies showing stronger correlations in wheelchair basketball matches ($r = 0.63$–0.65, $p < 0.001$) (Iturricastillo et al., 2016) and wheelchair rugby training sessions ($r = 0.81$) (Paulson et al., 2015). These variations might arise from differences in functional abilities among participants or diverse settings (e.g., small-sided games, training sessions, matches) in different studies.

The present research observed a significant decline in handgrip strength post-session, likely due to the intense engagement of finger flexors and forearm extensors required in tow rope handling (Mullins, 2007). This finding echoes a previous study (Suárez-Iglesias et al., 2019b), which showed an 18.5% average decrease in maximum handgrip strength among four seated slalom waterskiing athletes with SCI after 14 waterskiing sessions, typically after about 20.5 min of grip time. Comparable reductions are noted in judo, which similarly demands extensive use of these muscles (Bonitch-Góngor et al., 2012). In slalom waterskiing, gripping technique also influences forearm muscle load (Rosa et al., 2016); thus, we recommend coaches prioritize optimal upper limb positioning to improve neuromuscular performance in seated slalom waterskiing. Specifically, the ADWS technique, starting with a parallel grip on "the boom," may offer advantages over TDWS tow rope handling from the outset of the maneuver. Future research should encompass a broader group of athletes across multiple seated slalom waterskiing sessions, focusing on a detailed comparison of grip strength pre- and post-successful DWS using both ADWS and TDWS.

Despite its contributions to research for sports for people with physical impairments (Liu et al., 2022), the study is not without limitations. Primarily, the reliance on a single participant restricts the generalizability of the findings to the broader population of athletes with SCI (Rayes et al., 2022). It is important to acknowledge that the limited participation of athletes with SCI in research inherently restricts the breadth of training recommendations, which often rely on the anecdotal experiences of coaches, athletes, and scientists (Perret, 2017). Additionally, the lack of a time-motion analysis, which would provide external training load metrics like distance, speed, and duration (Stieler et al., 2023) limits a more holistic understanding of the participant's TL.

For intermediate-advanced seated slalom athletes with paraplegia, initially focusing on ADWS, despite being slightly more time-consuming than TDWS, provides a reliable foundation that leads to a higher number of successful water exits. This allows coaches to allocate more time to other essential waterskiing skills, such as those typically practiced during open-water skiing and navigating the inner-slalom course (e.g., crossing the wake and making precise turns). Once athletes are consistently successful with ADWS, coaches can gradually incorporate TDWS into their training sessions, as it is the DWS required for sanctioned events. This balanced approach, involving both DWS techniques and comprehensive training in all technical aspects of waterskiing, facilitates continuous and holistic athlete progression towards the competitive level.

Future research should investigate the long-term effects of integrating ADWS before transitioning to TDWS on seated slalom athletes with paraplegia. Evaluating key performance indicators such as skill acquisition speed, maneuver completion rates, athlete confidence, and injury incidence can provide valuable insights. This research could optimize training protocols, enhancing both the efficiency and safety of athlete development in competitive seated slalom waterskiing.

In conclusion, this study sheds new light on seated slalom waterskiing by comparing two DWS techniques for an athlete with SCI. The findings suggest that ADWS, with its full success rate, appears more effective but slightly more time-consuming than TDWS, which presented more challenges and fewer successes for the participant. The moderate TL during seated slalom waterskiing was perceived as a hard effort by the athlete with paraplegia, and the significant reduction in handgrip strength post-session underscores the discipline's grip strength requirements. These insights enrich understanding of the technical, physiological, and physical demands in mastering DWS in seated slalom waterskiing, offering valuable guidance for coaches and athletes in creating specialized training strategies and techniques.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Comité de Ética de la Universidad de León. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

DS-I: Conceptualization, Data curation, Funding acquisition, Investigation, Visualization, Writing – original draft, Writing – review & editing. CA: Supervision, Writing – original draft, Writing – review & editing. AG-F: Formal analysis, Writing – original draft, Writing – review & editing. JV-V: Conceptualization, Data curation, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. JuR-M: Writing – original draft, Writing – review & editing. JoR-M: Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2024.1363544/full#supplementary-material

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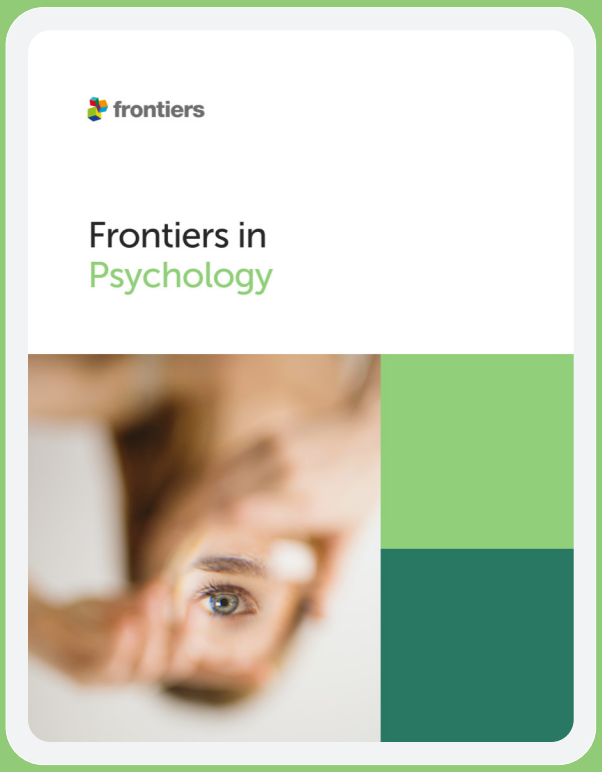

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