

Connecting the dots in physiotherapy: reframing the role of the profession in the anthropocene

Edited by

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Connecting the dots in physiotherapy: reframing the role of the profession in the anthropocene

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Editorial: Connecting the dots in physiotherapy: reframing the role of the profession in the anthropocene

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Editorial on the Research Topic

Connecting the dots in physiotherapy: reframing the role of the profession in the anthropocene

This Research Topic is the first comprehensive issue regarding the role that physiotherapists can play in the face of current environmental challenges, but also to recall the roots of the profession, linked to the environment in many diverse ways. It adds new data to the current debate about how to introduce planetary health and sustainability in healthcare education and practice (1). It shows that today's physiotherapists can be at the forefront of addressing the health impacts of climate change, advocating for sustainability and implementing a fundamentally revised vision of physiotherapy. Interdependence is a key concept for understanding how health, environment and society are interconnected across all levels and systems; it involves acknowledging complex planetary relationships, the situatedness of experience, and the partiality of knowledge (2). In this context, local nature-based interventions can be viewed as part of a global effort to enhance planetary health, with equity, sustainability, and transdisciplinary collaboration serving as guiding principles for action (3). Many other interventions can be developed from the various areas in which physiotherapists are involved, including research, education or management, requiring substantial policy changes at global, regional, national and local levels of a broader scope than the education or health sector (4). Physiotherapists around the world must take up the challenge to become sensitive and action-driven agents to address current environmental and social needs (5).

Higher education institutions are called to be active stakeholders regarding the Global Action Plan on Climate Change and Health approved at the Seventy-eighth World Health Assembly (6). Regarding physiotherapy, they should provide support for researchers, educators, students and clinicians to engage in sustainability initiatives, discover mentors in their area of interest, and receive funding for environmental physiotherapy projects. Physiotherapy leaders should promote sustainable practices to show that it is possible to minimize environmental impact, instill hope for present and future generations and engage with community partners in local and global initiatives. Physiotherapy students should have access to educational opportunities and pedagogical approaches to better understand the complex and multifactorial interactions between health and the environment (7). For this to happen, physiotherapy curricula should be framed within a broader awareness

of the interdependent social and ecological drivers of planetary health, facilitating novel ways of promoting population health while considering environmental integrity (8). Voices from outside academia, such as those from vulnerable groups, rural partners, community organizations, and indigenous or native populations, should be heard as an integral part of this co-creation process in research (9), education (10), management and practice (11).

The Research Topic comprises nine contributions from authors affiliated with higher education and research institutions located in eight countries. These articles cover themes applicable to education, research and practice, questioning current knowledge, posing novel perspectives, raising conceptual analysis and illustrating the possibilities for transferability to different contexts.

Regarding physiotherapy education, the work developed by Stone et al. describes the integration of environmental physiotherapy education into the physiotherapy curricula with the aim of developing holistic healthcare perspectives in students that will strengthen future physiotherapy practice. The article authored by Fradejas et al. clarifies how physiotherapy students involved in intergenerational service-learning programs benefit by promoting physical activity, wellbeing and social interaction within the community. The research by Swärdh et al. highlights the perspectives of physiotherapy educators, indicating that a disconnection remains between educational attitudes and actions. A key priority, then, is to offer new perspectives on professional identity and continuing professional development within the context of sustainable development. The proposal by Paz-Lourido and Ribeiro-Chaves emphasizes the need for the regeneration of the educational curriculum in physiotherapy to facilitate a better alignment between planetary health and service-learning as a pedagogical approach.

Still connected to education, but moving toward practice, the work done by Ólafsdóttir and Petursdóttir highlights the potential for physiotherapists to make significant contributions to the healthcare sector's sustainability goals, not only by contributing to reducing the healthcare sector's carbon footprint but also by promoting sustainable health behaviors. In turn, Persson et al. argued that multidisciplinary teams are essential for achieving sustainability, optimizing patient functioning, and preventing disease, promoting patient empowerment, implementing lean pathways, using low-carbon alternatives, and ensuring efficient resource use. The article by Doran-Sherlock et al. highlights some of the key challenges in the nature-based health and therapy literature, stating that the quality of many studies in the broader nature-based health and therapy literature is poor so far and has often been conducted within a reductionist biomedical framework. A list of considerations is provided to remedy this status quo and advance nature-based health and therapy.

The review by Svensson et al. mapped existing research comparing physiotherapy to pharmaceuticals, with a specific focus on whether these studies address aspects of sustainable development. It shows that studies are lacking that evaluate outcomes from a sustainable development perspective which could contribute to knowledge about how physiotherapy can be a low-carbon, resource-efficient alternative to pharmaceuticals. Finally,

the perspective raised by Sturm et al. points to the need to move beyond an isolated profession-centric approach when tackling the existing, concerning issues in child health worldwide. It demonstrates how physiotherapists can contribute to improved child health by incorporating risky play into physiotherapy theory and practice.

In the light of these works, it is urgent to connect the dots and reframe physiotherapy education, research and practice. This means embedding planetary health and considering research from various epistemological traditions, promoting innovative experiential pedagogies and strengthening community engagement in physiotherapy. This would facilitate entirely novel professional perspectives, and create spaces for future studies, theoretical frameworks and practical guidelines. It is necessary to address the barriers of lack of knowledge, material resources, and funding, and potentiate motivators such as education and guidance on the environment, physiotherapy and health.

Author contributions

BP-L: Methodology, Validation, Conceptualization, Writing – original draft, Supervision, Writing – review & editing, Investigation, Formal analysis. FM: Conceptualization, Validation, Writing – review & editing, Formal analysis, Supervision, Writing – original draft, Methodology.

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High consciousness—low application: sustainable development and sustainable healthcare in undergraduate physiotherapy education in Sweden

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Background: Swedish undergraduate physiotherapy education lacks comprehensive integration of sustainable development in curricula. Factors related to educators' perspectives in preparing future physiotherapists for sustainable development and sustainable healthcare may shed light on this shortcoming.

Aim: This study aims to describe Swedish physiotherapy educators' (i) consciousness of sustainable development and its inclusion in teaching and learning activities, (ii) ecological worldviews, (iii) attitudes toward sustainability and climate change in physiotherapy, (iv) perceptions of education for sustainable development and sustainable healthcare and (v) examine the relationship between ecological worldview and attitudes toward sustainability and climate change in physiotherapy.

Method: A cross-sectional, descriptive study was performed using a digital survey to collect data from educators within undergraduate physiotherapy education at five higher education institutions in Sweden. Data was collected using the Sustainability Consciousness Questionnaire, the New Ecological Paradigm Scale, the Sustainability Attitudes in Nursing Survey 2, and questions related to knowledge, attitudes, and self-efficacy for education for sustainable development and sustainable healthcare.

Result: Most, but not all, of the 72 educators, (76%) were aware of Agenda 2030 and the sustainable development goals, and 17% included perspectives related to sustainable development in teaching and learning activities. The educators endorsed an eco-centered ecological worldview and had largely positive overall attitudes toward sustainability and climate change within physiotherapy. However, almost one-third (28%) disagreed that issues about climate change should be included in the physiotherapy curriculum. Most agreed about having content knowledge on climate and health (81%), while a smaller part agreed on having pedagogical content knowledge regarding how to inspire or educate for sustainable development (17–28%). There was also a wide variation in perceived self-efficacy in education for sustainable development and sustainable healthcare.

Conclusion: Despite the endorsement of eco-centered ecological worldviews and a rather high consciousness of sustainable development as an overall concept, there remains a disconnect to educational attitudes and actions among Swedish physiotherapy educators. This points to the need to explore the narrative of sustainable development within physiotherapy in Sweden rooted in broader concept understanding, ethics, and reflective practice for sustainable development. A key priority should be to offer new perspectives on professional identity and continuing professional development within sustainable development.

KEYWORDS

survey, educators, higher education, new ecological paradigm scale, sustainability consciousness questionnaire, sustainability attitudes

Introduction

Sustainable development is essential for the well-being of both current society and future generations. To address the global challenges and foster resilient, thriving societies, the United Nations' Agenda 2030 and its sustainable development goals underscore the interconnectedness of economic growth, social inclusion, and environmental stewardship (1–3). Further, the nested dependency model of sustainable development (4) highlights the environment as the fundamental base supporting human society and economic systems. The concept of planetary boundaries (5) reinforces the environmental limits within which human development must operate. Consistent with this perspective, it is crucial to emphasize that environmental sustainability issues have become an urgent global health concern (6–10). The adverse health effects associated with negative exposure to environmental determinants of health place increasingly high demands on health care (11). At the same time, healthcare services in itself have a role in further contributing to negative health effects by generating emissions that lead to climate change and other environmental impacts such as air- and water pollution (12). While healthcare providers, including physiotherapists, are often less prepared to identify or respond to sustainability issues including environmental threats (13–15), the rising generation of health professionals is increasingly expecting their education to prepare them for building a sustainable future (16, 17). Accordingly, the undergraduate education for the next generation of physiotherapists must be significantly shaped by this concern and prepare students to work for and within a sustainable healthcare system.

International educational agreements urge universities to adopt sustainable practices across teaching and learning and have formulated policies focused on education for sustainable development, particularly the United Nations Decade of Education for Sustainable Development (18). These directives emphasize that education for sustainable development should be integrated into all university programs regardless of academic discipline rather than being limited to sustainability-focused courses. Within health care, the International Association for Health Professions Education, in 2021, provided a consensus statement (19) including a vision for educating a healthcare workforce that can deliver sustainable healthcare and promote planetary health, i.e., that our health depends on our environment. Sustainable healthcare refers to a comprehensive approach to health services that optimally balances the delivery of high-quality care, efficient resource use, and minimal environmental impact while

ensuring long-term economic and social viability (20). Three overarching learning outcomes for education for sustainable healthcare have been suggested; “describe how the environment and human health interact at different levels, demonstrate the knowledge and skills needed to improve the environmental sustainability of health systems, and discuss how the duty of a health care professional to protect and promote health is shaped by the dependence of human health on the local and global environment” (21).

Several calls to action for the physiotherapy profession and physiotherapy education to advocate for sustainable health care and planetary health have also been put forth by researchers from primarily the global north, highlighting the need for new ways to think and practice physiotherapy (22–25). Physiotherapy certainly plays a significant role in sustainable healthcare practices by using non-pharmacological and non-invasive treatments that empower patients to manage their own care in promotion, prevention, and rehabilitation (26, 27). Thus, physiotherapy can reduce the need for other more resource-intensive care solutions (24). However, physiotherapy also must reduce its carbon footprint through improvements in clinical practice by reducing waste, recycling, and promoting socially just and eco-friendly interventions for health behaviors such as zero-emission transport and a healthy diet within planetary boundaries in relevant contexts (28, 29), as well as focusing on evidence-based practice and lean service delivery. In addition, physiotherapists can also be involved in the preservation and renewal of ecosystems by engaging in the creation of public health initiatives for nature-based health (30). Physiotherapy educators therefore need to strive to integrate environmental sustainability into undergraduate physiotherapy curricula.

This study is situated within the context of Sweden, a country in the Global North where healthcare accounts for 4.5 percent of the national carbon footprint (31). The discourse on sustainable development in Sweden, much like in many other countries, has been shaped largely by Western paradigms that prioritize economic growth, environmental protection, and social equity (32). These pillars often focus on balancing the three dimensions of sustainable development rather than recognizing the interdependence and potential limits of growth. The governance of higher education in Sweden reflects an interplay between strong state regulation with a civic mission, institutional autonomy, and broader neoliberal trends (33). Academic freedom is explicitly protected by law within research while there is no equivalent explicit legal protection in teaching (34). Since 2006, the Swedish Higher Education Act has stated that higher education should promote sustainability in its activities (35). However, in 2017, the Swedish Higher Education Authority which monitors compliance

with laws and regulations found that six of eight universities providing undergraduate physiotherapy education require further development in their work on sustainable development within education (36). Since then, most universities in Sweden have become signatories to the Climate Framework (37), committing to ambitious climate action and integrating sustainability into all aspects of their operations. Thus, this legal and institutional framework reflects Sweden's broader commitment to sustainable development. Still, up to now, only 3% of all learning outcomes are sustainability-focused in Swedish undergraduate physiotherapy education, when explored through the lens of including all three dimensions of sustainable development (38).

For the successful implementation of both education for sustainable development and education for sustainable healthcare into undergraduate physiotherapy education, it is crucial for educators to comprehensively understand and embrace their role in preparing students for a sustainable future. This level of understanding necessitates that educators recognize sustainable development as a concept, as well as education for sustainable development and sustainable healthcare, but also know how to incorporate it into their teaching and learning activities. While some studies have shown that educators and healthcare professionals are not always sufficiently equipped to tackle sustainability challenges (39–42), a study on Swedish nurses and physicians has shown that they tend to endorse a rather eco-centric perspective in their ecological worldview (43). People with this perspective see humans as part of a broader ecological system, rather than as separate or dominant over nature (44), and are also more likely to engage in individual behaviors that help protect and sustain the environment (45). So far, we lack an understanding of how this translates to health profession educators, particularly educators within physiotherapy.

The aim of this study is therefore to describe Swedish physiotherapy educators' (i) consciousness of sustainable development and inclusion of sustainable development in teaching and learning activities, (ii) ecological worldviews, (iii) attitudes toward sustainability and climate change in physiotherapy, and (iv) knowledge, attitudes and self-efficacy in education for sustainable development and sustainable healthcare, as well as to (v) examine the relationship between ecological worldview and attitudes toward sustainability and climate change in physiotherapy.

Materials and methods

Research design and context

This cross-sectional, descriptive study focused on educators in undergraduate physiotherapy programs in a Swedish higher education context. As part of the adaption to the Bologna Process, the Swedish national study program in physiotherapy at first cycle level comprises 180 European Credit Transfer System credits or 3 years of full-time studies and is offered by eight different higher education institutions across Sweden. All programs adhere to the Qualification descriptor for Bachelor of Science in Physiotherapy (46). In addition to campus-based education, clinical practice is an important part of the education. Clinical practice is an educational experience under the supervision of a qualified physiotherapist in a clinical setting. For example, this could be inpatient care, primary care, or various forms of accommodation and treatment homes within municipal activities. The students in Sweden will complete approximately 1,000 clinical practice

hours of a total of 4,800 educational hours during their education. Educators within undergraduate physiotherapy education in Sweden consist mostly of physiotherapists and other professionals such as physicians, psychologists, physiologists, and behavioral scientists. Most educators have their primary employment at a university but some within healthcare. In Sweden, the proportion of women among employed physiotherapists is about 75 percent (47). Of the total number of employees at Swedish higher education institutions with research and teaching duties, irrespective of profession, 47 percent are women and 53 percent are men (48).

Participants and data collection

Five out of eight higher education institutions providing undergraduate physiotherapy education in Sweden accepted the invitation to participate in the study (Karolinska Institutet, Linköping University, Lund University, Mälardalen University, and Uppsala University). Data were collected from educators teaching or supervising, part-time or full-time, in a campus-based or clinical practice course in an undergraduate physiotherapy program in Sweden. The program directors, or equivalent persons in charge of each undergraduate physiotherapy program sent out information about the study and an invitation to participate to a total of 201 campus-based educators. Coordinators for educators in clinical practice were approached at all five programs, and three of these programs sent out the invitation to participate. Details on the exact number of educators in clinical practice who received the invitation could not be obtained due to logistic problems with duplicates of invitations from different coordinators and a lack of information on reach. Data was collected anonymously through a digital survey consisting of self-reported questions. The educators were provided with a link to the survey through the invitation letter, and it took approximately 10–15 min to complete. Three reminders were sent out to the campus-based educators, but none to the ones within clinical practice. Data was collected from March to May 2023.

Measures

Demographic characteristics included participants' sex, age, higher education institution, primary employment, profession, working title/position, participation in the program, and years of teaching/supervising. Other data was collected using other measures: the Sustainability Consciousness Questionnaire–short version (49); ecological worldviews including the New Ecological Paradigm Scale (44), attitudes toward sustainability and climate change in physiotherapy including the adapted Sustainability Attitudes in Nursing Survey 2 (50), and questions of education for sustainable development and sustainable healthcare.

Consciousness of sustainable development

Consciousness of sustainable development included knowledge of Agenda 2030, the sustainable development goals, the inclusion of sustainable development content in teaching and learning activities, attendance in courses/seminars on sustainable development in the past year and was collected through questions specifically designed for the present study as well as the Sustainability Consciousness Questionnaire

(SCQ-S). The SCQ-S is a valid and reliable measure developed to assess consciousness regarding sustainable development (49). The SCQ-S includes 27 items within three domains: economic, social, and environmental, and further assesses consciousness toward these domains in terms of three psychological factors: knowingness (recognition of the importance of sustainability), attitude (the attitudes toward sustainability), and behavior (the willingness to act toward a sustainable future). The items are rated on 5-point Likert scales, (1 = totally disagree to totally agree = 5, with a neutral option in the middle), with higher scores indicating high sustainability consciousness (min 1-max 5). The total SCQ-S score for the psychological factors within each domain is divided by the number of items to give a mean total SCQ-S score for each domain (min 1-max 5). The researchers have permission to use the Swedish version of SCQ-S in this study from the rightsholders (49). The item interrelatedness (Cronbach's α) of the measure was 0.845 for the total score.

Ecological worldviews

The revised New Ecological Paradigm Scale (NEP) is a widely used, valid, and reliable measure developed to assess people's beliefs and attitudes toward ecological issues, and their views on the balance between human activities and the natural world, i.e., ecological worldview (44). The NEP is constructed of 15 items around five aspects, namely: 'human domination over nature, human exceptionalism, the balance of nature, the risk of an eco-crisis and limits to growth'. The items are rated on 5-point Likert scales. Agreement with items with odd numbers and disagreement with the even-numbered items indicate pro-environmental responses, i.e., the scale for even-numbered questions: 1 = strongly agree, 2 = mildly agree, 3 = unsure, 4 = mildly disagree, 5 = strongly disagree; and thus, with a reverted scale for odd-numbered questions. The NEP reflects either an eco-centered (nature-centered) perspective; a high NEP score identify more closely with concepts that see humans as part of natural systems and emphasize the intrinsic value of nature, or an anthropocentric (human-centered) perspective; a low NEP score identify more closely with concepts that place humans apart from, or above, natural systems and the prioritizing of human needs. The total NEP score for all items is divided by the number of items to give a mean total NEP score (min 1-max 5). The researchers have permission to use the Swedish version of NEP in this study from the rightsholders (43). The item interrelatedness (Cronbach's α) of the measure was 0.727 for the total score.

Attitudes toward sustainability and climate change in physiotherapy

The Sustainability Attitudes in Nursing Survey 2 (SANS-2) is a valid and reliable measure developed to assess nurses' attitudes toward sustainability and climate change (50). SANS-2 broadly asks respondents to indicate whether they agree/disagree with the importance of climate change and sustainability in nursing and their inclusion into nursing education, and therefore, may be applicable to various other groups. The measure has been adapted and used in a nursing faculty setting (43, 51) as well as among paramedic students (52). Further, it was adapted for use in the present study by exchanging the word nursing to physiotherapy. The item interrelatedness (Cronbach's α) of the measure was 0.776 for the total score after changing the word nursing to physiotherapy. It comprises five items assessed on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), with higher scores indicating more positive attitudes toward

sustainability and climate change (min 1-max 7). The total SANS-2 score for all items is divided by the number of items to give a mean total SANS-2 score (min 1-max 7). The researchers have permission to use the Swedish version of SANS-2 in this study from the rightsholder (53).

Education for sustainable development and sustainable healthcare

Fourteen questions on knowledge, attitudes, and self-efficacy related to education for sustainable development and sustainable healthcare are informed by a previously published study, and the researchers have permission to use these questions from the rightsholder (54). One question related to education for sustainable development and the requirement for specific pedagogical approaches is specifically designed for the present study. The 15 questions are divided into three sections (knowledge, attitudes, and self-efficacy) and each question is rated on a Lickert scale (strongly disagree to strongly agree). The item interrelatedness (Cronbach's α) of the measure was 0.897 for knowledge items, 0.748 for attitudes items, 0.884 for self-efficacy items.

Data analysis

All data were analyzed using descriptive statistics of frequencies, mean, standard deviation, and percentiles. The assumption of a normal distribution was evaluated using the Kolmogorov-Smirnov test. The item interrelatedness of the respective measures was calculated using Cronbach's α which is based on the degree of association between the item responses obtained on a single administration of the measure to a group of people. Cronbach's α is commonly interpreted using a rules-of-thumb threshold for acceptable interrelatedness of α value of at least 0.70 (55). The Pearson correlation coefficient was calculated for the correlation. The cutoff value for the strength of the correlation used was high ($r = > \pm 0.7$), moderate ($r = \pm 0.5-0.7$), low ($r = \pm 0.3-0.5$), and negligible ($r = < 0.3$), and the level of significance was set at $p = 0.05$ (56). The statistical software, SPSS version 28.0.1.1 was used in the analyses.

Results

Participants

The survey was completed by a total of 72 educators (76% females, $n = 55$) from undergraduate physiotherapy programs at five higher education institutions in Sweden. However, 50% of the educators came from one of the higher education institutions. The educators were within the age groups 20–30 years (7%, $n = 5$), 31–40 years (15%, $n = 11$), 41–50 years (32%, $n = 23$), 51–60 years (33%, $n = 24$), 61–70 years (11%, $n = 8$), and 71–80 years (1%, $n = 1$). Fifty-three percent, $n = 38$ assigned their primary employment to the university, 33%, $n = 24$ to health care, 1%, $n = 1$ to shared employment, and 13%, $n = 9$ to another employer. Eleven of the men (64%) and 27 (49%) of the women were employed at a university, and four (23%) of the men and 20 (36%) of the women within health care. The vast majority were physiotherapists by profession (86%, $n = 62$), 4%, $n = 3$ were either medical doctors, psychologists, or physiologists, and 10%, $n = 7$ had

other professions. The larger part of the educators (59%, $n = 42$) had a teaching position, while 29%, $n = 21$ were educators within clinical practice, and 12%, $n = 9$ held another position. Five (29%) of the men and 16 (29%) of the women were educators within clinical practice. The educators were active as educators in years 1, 2 and/or 3 of the education, and their years of experience as an educator varied from 1–5 years up to 31–35 years.

Consciousness of sustainable development

The educators' consciousness of sustainable development was high, with 76% reported being aware of Agenda 2030 and the sustainable development goals, and the total mean score of the Sustainability Consciousness Questionnaire for the participants was 4.49 (SD 0.34; [Table 1](#)). However, 17%, ($n = 12$) had included, content or perspectives related to sustainable development, either explicitly or implicitly, in their teaching and learning activities during 2022 or 2023, and there were various reasons for not doing so ([Table 2](#)).

Ecological worldview

The total mean score of the New Ecological Paradigm Scale for the participants was 4 (SD 0.41), indicating an eco-centered ecological worldview. The 25th, 50th, and 75th percentiles were 3.8, 4, and 4.33, respectively. Statement 10, 'The so-called "ecological crisis" facing humankind has been greatly exaggerated', showed the highest score (mean 4.61). On the contrary, the lowest score (mean 2.49) was

attributed to statement 14 'The earth has plenty of natural resources if we just learn how to develop them'. The items and responses in the New Ecological Paradigm Scale are summarized in [Supplementary material](#).

Attitudes toward sustainability and climate change in physiotherapy

The mean total score of the Sustainability Attitudes in Nursing Survey 2 for the participants was 5.49 (SD 0.99), with the 25th, 50th, and 75th percentiles at 4.85, 5.6, and 6.15, respectively, indicating rather positive overall attitudes toward the relevance of the topics of sustainability and climate change within physiotherapy. The larger part of the participants agreed (5–7 on a Lickert scale) that sustainability is an important issue for physiotherapy (86%) and that it should be included in the curriculum (82%). However, the attitudes toward including climate change in the physiotherapy curriculum were less positive, with one-third of the participants (28%) disagreeing (1–3 on a Lickert scale) that it should be included in the curriculum. The items and responses in the Sustainability Attitudes in Nursing Survey 2 are summarized in [Table 3](#).

Correlation between ecological worldview and attitude toward sustainability and climate change within physiotherapy

The correlation between ecological worldview (New Ecological Paradigm Scale) and attitudes toward sustainability and climate change (Sustainability Attitudes in Nursing Survey 2) was low ($r = 0.356$) and statistically significant ($p < 0.002$).

Education for sustainable development and sustainable healthcare

The larger part of the participants agreed or strongly agreed, (81%) about having content knowledge on climate and health, and half of the participants agreed or strongly agreed, (54%) about having content knowledge on sustainable health care. A smaller part of the participants agreed or strongly agreed, (17–25%) about having pedagogical content knowledge on education for sustainable development (items 3–5). A moderate to large part of the participants (56–88%) agreed or strongly agreed with the significance of health professionals and healthcare for sustainable development (items 6–10). Approximately half of the educators (51%) were unsure whether education for sustainable development requires specific teaching approaches. There was a wide variation in how participants perceived their self-efficacy in education for sustainable development and education for sustainable healthcare. The items and responses are summarized in [Table 4](#).

Discussion

To our knowledge, this is the first study to describe physiotherapy educators' overall consciousness of sustainable development,

TABLE 1 Educators' consciousness of sustainable development ($n = 72$).

Awareness of Agenda 2030 and the global sustainable development goals, Yes/No, n (%)	55/17 (76/24)
Attendance in seminars or courses on sustainable development and/or climate change in the past 12 months, Yes/No, n (%)	23/49 (32/68)
Consciousness of sustainable development, min-max: 1–5, m (SD), $n = 67^*$	
Total score of the Sustainability Consciousness Questionnaire	4.49 (0.34)
Knowingness	4.36 (0.52)
Economic	4.35 (0.61)
Social	4.61 (0.50)
Environmental	4.11 (0.73)
Attitudes	4.74 (0.36)
Economic	4.71 (0.41)
Social	4.78 (0.38)
Environmental	4.73 (0.44)
Behaviors	4.36 (0.41)
Economic	3.76 (0.75)
Social	4.77 (0.44)
Environmental	4.55 (0.46)

*5 participants had an incorrect questionnaire completion on the Sustainability Consciousness Scale with 1–3 questions in total with missing values.

TABLE 2 Reasons* for not including content or perspective of sustainable development in teaching and learning activities within undergraduate physiotherapy education ($n = 72$).

Reasons	n, (%)
Not included in the learning outcomes	34 (47%)
Not relevant to my teaching topic	21 (29%)
Do not know <i>what</i> to teach	34 (47%)
Lack of knowledge	31 (43%)
Do not know <i>how</i> to teach	22 (31%)
No space for it in the course	18 (25%)
Lack of time	18 (25%)
Lack of pedagogical support	8 (11%)
No support from the management	5 (7%)
Do not think students are interested	3 (4%)
Disagree with colleagues	1 (1%)

*Each participant could provide more than one reason.

ecological worldviews, attitudes toward sustainability and climate change in physiotherapy, as well as views on education for sustainable development and sustainable healthcare in physiotherapy undergraduate education. Our findings indicate an overall high consciousness but a rather low application of sustainable development in teaching and learning among educators in Sweden. An interesting finding was that although the educators demonstrated a rather high endorsement of eco-centric ecological worldviews and fairly positive attitudes toward sustainability in physiotherapy, attitudes toward including climate change in the physiotherapy curriculum were less positive. The findings also indicated a low correlation between educators' ecological worldviews and their overall attitudes toward sustainability and climate change in physiotherapy. Furthermore, less than 20 percent of the educators had included content or perspectives related to sustainable development in their teaching and learning activities.

The educators in the present study demonstrated somewhat stronger eco-centered ecological worldviews than the general population in Sweden and other high-income countries (57, 58). It was also slightly stronger than among nurses and physicians in Sweden (36) but somewhat weaker than among environmentalists in the United Kingdom and Norway (58, 59). The findings of less positive attitudes toward including climate change in physiotherapy education give rise to a question of whether or not educators endorse an eco-centric perspective privately but adopt a more anthropocentric perspective in their professional roles. While there is limited research on this phenomenon within the framework of the New Ecological Paradigm Scale, previous research indicates that healthcare professionals take more action in their personal than professional lives to protect the environment, particularly those with strong professional identities (60). This aligns with findings that pro-environmental behavior does not easily transfer between personal and professional contexts (61, 62). However, difficulties implementing issues related to sustainable development and climate change at work within healthcare or higher education might also be due to work culture, established policies, or attitudes of the staff or leadership (63). There is also growing recognition that the traditional model of sustainable development may be insufficient to address the scale and complexity of the ecological crises (64–66). The eco-centric worldview that most of the educators in this study hold, challenges the anthropocentric

assumptions often embedded within the discourse on sustainable development, where environmental actions are sometimes justified solely as means to ensure human survival rather than as ethical imperatives to protect the inherent worth of the natural world.

In healthcare, the focus is often on immediate patient needs, with professional identity often tied to an anthropocentric perspective, where human individual health is the primary concern. Consistent with previous research (13, 41, 67), educators within physiotherapy in Sweden understood the effects of climate change on human health and that healthcare is part of the sustainability problem. However, increasing emphasis is also being placed on the critical role of health professionals as leaders, educators, and advocates in addressing environmental deterioration such as climate change (39, 68–71). To address this, frameworks like sustainable healthcare practices (20) and learning outcomes for sustainable healthcare (21) need to be integrated into physiotherapy education, practice, and research in Sweden (26, 72). Making sustainable healthcare “business as usual” in healthcare, with organizational support for climate-resilient services (73), might be crucial for fostering future physiotherapists equipped to navigate this transition. As noted by the Swedish National Council on Medical Ethics (74), healthcare professionals must contribute to climate action due to its profound public health impact. Educators must, therefore, embrace moral courage, speak up when ethical values are compromised (75) by reinterpreting the principles of *primum non nocere* (first, do no harm) and recognizing the vitality of the planet as the fundamental foundation for human health (76). World Physiotherapy's Position Statement for Climate and Health provides a pathway to promote and incorporate environmental sustainability into practice (77). The statement emphasizes the importance of physiotherapists acknowledging and addressing the health consequences of climate change, which highlights the growing expectation for higher education to prepare healthcare professionals for sustainability challenges.

The less positive attitude toward integrating climate change in physiotherapy education may also partly stem from political discourse, which can influence how it is approached in professional contexts. In Sweden, where climate activism is highly visible, eco-centric ecological worldviews may be privately supported, but there may also be perceptions that discussing climate change in education is risky or inappropriate, especially if seen as controversial (78). A large global survey of health professionals showed that 16% were hesitant to communicate about climate change due to concerns about controversy and 14% due to professional risk (41). How this dynamic plays out in Sweden's higher education remains unclear, but by framing education for sustainable development and sustainable healthcare through the lens of health consequences (79, 80), educators can create space for these discussions without falling into political traps. Leadership from national organizations like the Swedish Association of Physiotherapists (81) might play a pivotal role in reshaping professional norms within physiotherapy. By integrating sustainable development within planetary boundaries into the profession's core identity, physiotherapists can be positioned as key actors in addressing both human and planetary health. The Swedish Society of Medicine and the Swedish Society of Nursing have already set guidelines for their respective professions to adopt sustainable and climate-conscious healthcare practices (82, 83). This momentum should inspire the physiotherapy profession in Sweden to similarly advance and keep pace with this transition.

Nearly half of the educators who did not teach for sustainable development referred to the absence of relevant learning outcomes or uncertainty about what to teach. While they rated their content

TABLE 3 Sustainability and climate change attitudes among physiotherapy educators ($n = 72$).

SANS* items	Strongly agree 7	6	5	4	3	2	Strongly disagree 1	Mean (SD)
	N (%)	n (%)	n (%)	n (%)	N (%)	n (%)	n (%)	
1. Climate change is an important issue for physiotherapy.	20 (27.8)	10 (13.9)	20 (27.8)	12 (16.7)	7 (9.7)	2 (2.8)	1 (1.4)	5.19 (1.51)
2. Issues about climate change should be included in the physiotherapy curriculum.	12 (16.7)	9 (12.5)	18 (25)	13 (18.1)	13 (18.1)	5 (6.9)	2 (2.8)	4.60 (1.62)
3. Sustainability is an important issue for physiotherapy.	31 (43.1)	17 (23.6)	14 (19.4)	7 (9.7)	3 (4.2)	0	0	5.92 (1.18)
4. Sustainability should be included in the physiotherapy curriculum.	27 (37.5)	15 (20.8)	17 (23.6)	7 (9.7)	3 (4.2)	1 (1.4)	2 (2.8)	5.63 (1.48)
5. I apply sustainability principles at home.	30 (41.7)	23 (31.9)	15 (20.8)	4 (5.6)	0	0	0	6.10 (0.92)

*The Sustainability Attitudes in Nursing Survey 2.

knowledge of sustainable development as relatively high, they were unsure about how to teach or inspire students on this topic. When educators are tasked with a teaching and learning topic in which they might not have been formally trained or have limited practical experience, it can pose significant challenges. This can lead to ambiguity regarding the purpose of learning, resulting in a focus on learning *about* sustainability rather than a clear emphasis on learning *for* sustainability, even if its exact meaning within the field remains emergent. This situation might necessitate a transformation not only for the educator but also for the education itself (84). What is meant by development in physiotherapy? what should be learned and unlearned within physiotherapy? and how can physiotherapists contribute to shaping peaceful, just, and sustainable futures? According to Sterling (85), education should not be confined to “doing things better” or simply “doing better things.” Instead, it should aim for a deeper level of change, known as transformative learning. This approach encourages a fundamental shift in perspective, enabling individuals to see and understand the world, for example, the role of physiotherapy, in entirely new ways (86). The educators’ uncertainty may also reflect the challenge of applying all dimensions of sustainable development or sustainable healthcare in educational practice. Cotton et al. found substantial variation in how sustainability was understood by lecturers from different disciplines within higher education, with a notable tendency to focus more on environmental issues than on social and economic dimensions of sustainability (87). This could also be valid for physiotherapy educators in Sweden, who might use a single dimension of sustainable development in their teaching and learning activities or unconsciously educate about or for sustainable development without explicitly using the framework. This study explored educators’ consciousness, attitudes, and knowledge of sustainable development and sustainability without providing a specific model or definition to the educators. However, a definition of sustainable healthcare was provided: “Sustainability in healthcare means designing and providing care that uses resources in a way that does not negatively affect future health and well-being.” Thus, educators could have conceptualized sustainable development without

any framework or with different sustainability lenses such as through weak sustainability approaches, i.e., the three-pillar model (88), or Venn diagram (89), or a stronger sustainability approach, i.e., the nested dependency model (4). Education for sustainable development has been criticized for its perceived vagueness and the challenge of integrating its principles across educational contexts (90–92). The broad and often abstract nature of sustainable development can lead to superficial integration within curricula, where the focus may be more on rhetoric than on substantial changes in educational practices. Thus, adopting a vision for sustainable development in physiotherapy practice in Sweden involves not only paradigmatic changes in education but also in the operational and policy frameworks guiding healthcare delivery, since part of undergraduate physiotherapy education also occurs within clinical practice. In 2018 a number of Swedish key stakeholders in local authorities and regions described major variations in how they viewed the meaning of the concept of sustainable development and its implications for the work of healthcare. Few used the term sustainable healthcare and none mentioned an environmental dimension of sustainability (93). Undergraduate physiotherapy education and educators can thus play a pivotal role by broadening curricula and the understanding of the concept by implementing sustainable development rooted in a variety of cultural traditions, including ecological Indigenous health knowledge (94). This would foster a new generation of physiotherapists who might appreciate and use alternative health knowledge systems when creating future health solutions (95).

Educators were also uncertain if specific teaching methods were needed for education for sustainable development, perhaps reflecting a tendency in academia to discuss issues based on one’s own conceptual understanding and not based on practical application. Similar gaps have been identified in nursing education, where environmental issues are treated conceptually rather than with hands-on engagement (96). Previous research on education for sustainable healthcare has also shown that it often has single-session designs and is primarily theory-based where implication for clinical practice is lacking (40). However, several pedagogical approaches can

TABLE 4 Physiotherapy educators self-reported knowledge, attitudes, and self-efficacy related to education for sustainable development and education for sustainable healthcare ($n = 72$).

	Strongly agree n (%)	Agree n (%)	Unsure n (%)	Disagree n (%)	Strongly disagree n (%)
Knowledge					
1. I can list a few examples of direct effects of climate change on human health	27 (37.5)	31 (43.1)	11 (15.3)	3 (4.2)	0
2. I know what healthcare professionals in my field can do to take action to reduce negative environmental impact	4 (5.6)	35 (48.6)	23 (31.9)	5 (6.9)	5 (6.9)
3. I know how to best explain what sustainable development means for healthcare professionals	5 (6.9)	13 (18.1)	31 (43.1)	14 (19.4)	9 (12.5)
4. I am aware of how to best teach my students about the importance of sustainable development issues for their future work	3 (4.2)	9 (12.5)	31 (43.1)	18 (25)	11 (15.3)
5. I know how best to inspire my students to be interested in sustainable development issues	3 (4.2)	15 (20.8)	27 (37.5)	14 (19.4)	13 (18.1)
Attitudes					
6. The healthcare sector is part of the sustainability problem	29 (40.3)	29 (40.3)	11 (15.3)	3 (4.2)	0
7. Sustainable development should be the core business for healthcare professionals	11 (15.3)	29 (40.3)	14 (19.4)	14 (19.4)	4 (5.6)
8. Healthcare professionals have a critical role to play in achieving sustainability	9 (12.5)	32 (44.4)	24 (33.3)	5 (6.9)	2 (2.8)
9. Healthcare professionals should be equipped to advocate for change for sustainability	29 (40.3)	32 (44.4)	6 (8.3)	4 (5.6)	1 (1.4)
10. All health professions students should learn about sustainable development	34 (47.2)	29 (40.3)	4 (5.6)	4 (5.6)	1 (1.4)
11. Education for sustainable development requires specific pedagogical approaches	2 (2.8)	15 (20.8)	37 (51.4)	14 (13.9)	11 (11.1)
Self-efficacy					
12. I am confident in expanding my students' awareness of the concept of sustainable development	7 (9.7)	28 (38.9)	25 (34.7)	8 (11.1)	4 (5.6)
13. I am confident in explaining the relationship between sustainable development and my teaching content	3 (4.2)	21 (29.2)	36 (50)	9 (12.5)	3 (4.2)
14. I am confident in teaching how the healthcare sector affects the environment	6 (8.3)	24 (33.3)	28 (38.9)	3 (4.2)	11 (15.3)
15. I am confident in teaching effective ways of implementing sustainable development practices at work	5 (6.9)	18 (25)	32 (44.4)	8 (11.1)	9 (12.5)

effectively foster sustainability competencies with a focus on action competence (97, 98). There are also numerous resources and frameworks to facilitate the implementation of sustainable development and sustainable healthcare into curricula across health professions (99–101). The concept of planetary health offers a meaningful framework for operationalizing an eco-centric worldview within education (102). Such an approach extends beyond the traditional pillars of sustainable development, emphasizing the need for transformative change in societal values and behaviors to realign human activities within the Earth's ecological limits. Revising or adding learning outcomes at an overall local program level could also provide clearer direction for involved educators at the course level. This includes strategic and role-modeling leadership that engages and empowers educators to drive the development of education for sustainable development and to take responsibility for acting as stewards of the planet (103). Thus, it seems as if there is a strong need for continuous professional development among educators within physiotherapy in Sweden to prepare future physiotherapists for evolving environmental and healthcare challenges. A national discussion on how physiotherapy in Sweden should embrace sustainable development as well as education for sustainable development and sustainable healthcare is also essential. This could facilitate the transition toward a more comprehensive paradigm that also embraces the educators' eco-centered ecological worldview. Such a discussion can also draw attention to the challenges of sustainable development as a concept that can be selected, misunderstood, and misplaced in education due to ambiguity, with the consequence that the topic can be perceived as meaningless, reducing its potential to create change. Further exploration of educators' perceptions of education for sustainable development in physiotherapy would also provide valuable insights into how teaching and learning activities may be organized to support students learning for sustainable development within planetary boundaries.

Some strengths and limitations of the present study must be acknowledged. The survey was based on self-report, which may have resulted in socially desired answers. This is an inherent limitation in most surveys and while it was ensured the data collection was anonymous, self-reports are never free from bias (104). It is also possible that the study attracted those already interested in sustainable development, and that educators who responded to the survey differed from those who did not, which may have resulted in selection bias. However, the inclusion of educators from both campus and health care and other professional backgrounds than physiotherapy strengthens the findings' transferability to educators both within clinical practice and interdisciplinary educators alike. It should also be noted that the overall response rate could not be calculated, as the exact numbers of educators within the undergraduate physiotherapy education could not be retrieved. Further, the measures included in the survey did not answer the educators' positionality on sustainable development, i.e., preferred definition or if a weak or strong sustainability approach was used when answering the survey. The inclusion of different concepts in the survey, such as Agenda 2030, the sustainable development goals, sustainable development, and sustainable healthcare may also have contributed to ambiguities for the educators. The Sustainability Attitudes in Nursing Survey 2 only covers one part of the triple planetary crisis (105), namely climate change, but not pollution and loss of biodiversity. However, at the time of the development of the Sustainability Attitudes in Nursing Survey 2 (50), this concept was not

popularized and officially introduced to the healthcare community. The Swedish versions of the New Ecological Paradigm Scale and Sustainability Attitudes in Nursing Survey 2, as well as the questions on education for sustainable development and sustainable healthcare, had not been validated in physiotherapy settings prior to the use in this study, representing an additional limitation of this study. However, they have been used in several studies in other healthcare contexts with satisfying results. Further, even though the item interrelatedness for all measures was within the commonly used rule-of-thumb for acceptable value, the use of this cut-off value has been criticized for the risk of the researcher's efforts to increase alpha above a certain level by adding or deleting items (106). However, all items in the Sustainability Attitudes in Nursing Survey 2, the New Ecological Paradigm Scale, and the Sustainability Consciousness Questionnaire were used as in the original versions of the measures. One question was added to the previously published questions on education for sustainable development and sustainable healthcare, which in fact decreased the Cronbach's α value within attitudes.

Conclusion

Despite the endorsement of eco-centered ecological worldviews and a rather high consciousness of sustainable development as an overall concept, there remains a disconnect between educational attitudes and actions among Swedish physiotherapy educators. This points to the need to explore the narrative of sustainable development within physiotherapy in Sweden rooted in broader concept understanding, ethics, and reflective practice for sustainable development. A key priority should be to offer new perspectives on professional identity and continuing professional development within sustainable development. Educators might need support in translating their general consciousness into valuable applications within their professional roles.

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 requirement of ethical approval was waived by the Swedish Ethical Review Authority (Dnr 2022-07327-01). The study was conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ES: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. NB: Conceptualization,

Methodology, Writing – review & editing. APA: Conceptualization, Methodology, Writing – review & editing. APE: Conceptualization, Methodology, 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/fpubh.2024.1509997/full#supplementary-material>

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Integrating environmental physiotherapy into New Zealand undergraduate education: exploring current practice

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This paper describes the integration of environmental physiotherapy education into the physiotherapy curriculum in a New Zealand university in response to the environmental physiotherapy agenda and the University of Otago Sustainability Framework. We describe and discuss three learning activities, the associated challenges and lessons learnt, and the current position. Given the encompassing nature of environmental and health interactions, we aimed for multilayer immersive experiences using a range of pedagogical approaches. The first learning activity example exemplifies embracing and threading Aotearoa New Zealand's indigenous knowledge and practices throughout our BPhty curriculum. The second example demonstrates how environmental physiotherapy can be made explicit within a delineated learning activity. In the third example, we describe a clinical placement learning activity that occurred in our student-led private practice. Recent full accreditation of the curriculum by the New Zealand Registration Board and positive student evaluations and feedback demonstrate that this integrated holistic curriculum is both acceptable and enjoyable. Frequent and rapid curriculum modifications in response to the COVID19 Global pandemic's impact on teaching and learning have however prevented full formal curriculum evaluation at this stage. We envisage that this educational approach be an ongoing process of review and restructure. Aligned with global trends toward sustainability in healthcare, our goal is to prepare students to address the growing environmental influences on public health. By integrating environmental physiotherapy philosophy into the undergraduate physiotherapy curriculum, we aim to develop holistic healthcare perspectives in students that will strengthen future physiotherapy practice in New Zealand and internationally.

KEYWORDS

environmental sustainability, undergraduate education, physiotherapy, curriculum, holistic health, indigenous health

1 Introduction

1.1 Environmental physiotherapy

Planetary health is defined as “the health of human civilization and the state of the natural systems on which it depends” (1) pg. 1978, providing an overarching paradigm of the interdependence of human health with all elements of the ecosphere. Such a definition signifies the importance of inter-professional healthcare to address the intersecting global ecological crisis at play; this we acknowledge. In this paper, however we take a specific focus on Environmental Physiotherapy and entry-level physiotherapy education.

Environmental Physiotherapy is an emerging field within physiotherapy that focuses on the reciprocal relationship between human health and the environment. It emphasizes the impact of environmental factors such as air quality, access to green spaces, and climate change on individuals' physical well-being and promotes an inclusive, more holistic view of physiotherapy within the umbrella concept of planetary health. Environmental Physiotherapy promotes social activism for sustainable healthcare that upholds environmental justice, considers multispecies impact and recognizes the symbiotic relationship of all life on the planet. This branch of physiotherapy recognizes that environmental factors can both positively and negatively influence health outcomes and aims to integrate environmental considerations into all aspects of the physiotherapy discipline (2, 3).

By incorporating environmental awareness into their practice, physiotherapists can provide more comprehensive care that addresses not only the immediate presenting issues but also the environmental factors that contribute to or influence them. Such an approach may be challenging to many physiotherapists as worldwide, current physiotherapy practice still largely subscribes to a reductionist, mechanistic biomedical / colonial model of health care (4). There is however progress toward more encompassing holistic viewpoints embracing concepts such as person-centered care (5) and bio-psycho-social approaches (2, 4). While critical physiotherapy philosophizes advanced by progressivist physiotherapy scholars are also, albeit reticently, being embraced by some in the profession (4), an ecological viewpoint that is more connected, dynamic and explores relationships beyond that of humanistic conceptions is still far from accepted usual practice (6).

Physiotherapy, as a health discipline, is well placed to become an essential component of world environmental health movement. Physiotherapists are trained to assess and treat the physical effects of environmental factors on individuals, including the health issues resulting from poor environmental sustainability. For example, managing respiratory conditions exacerbated by air pollution (7) or providing rehabilitation after injuries sustained during natural disasters (8–11), physiotherapists frequently work to mitigate the health impacts of environmental challenges. Physiotherapy interventions often involve promoting physical activity and outdoor exercise, which not only contribute to physical and mental health but also environmental stewardship (2, 12, 13). The move by the profession toward more holistic forms of healthcare that address not only the physical but also the social, emotional, and mental aspects of health, could make the intricate link between health and the environment more apparent. By including environmental awareness and reasoning into their practice, physiotherapists can promote preventive measures, support sustainable health and recovery, and mitigate environmental risks (14).

Although in its infancy, Environmental Physiotherapy (12) is now an accepted branch of physiotherapy that is becoming increasingly more influential in promoting increased education and environmental practice within the profession internationally. The Environmental Physiotherapy Association (EPA) was the first international network of likeminded physiotherapy clinicians, academics, students and supporters to focus specifically on advancing the field. The EPA provide resources and education, including guidelines for educators and institutions, as well as facilitating international collaborative research on planetary health and the role of physiotherapy

practitioners in addressing environmental issues and planetary health (15).

The EPA introduced the Environmental Physiotherapy Agenda 2023 in 2020 with the unassuming goal:

To ensure that every student beginning entry-level physiotherapy education from 2020 onwards will have education regarding the relationship between the environment, human health and functioning, and how this pertains to physiotherapy as part of their programme (3) pg. 4.

1.2 Environmental physiotherapy education

Education that embodies sustainability, that teaches expectation of change and facilitates potential and capacity is essential (6). The foundation to instilling a sense of responsibility toward sustainable healthcare practices within the profession, probably lies at the stage of entry-level physiotherapy training. An ecological viewpoint and promoting environmental consciousness among physiotherapy students may pave the way for the next generation of physiotherapy practitioners to become holistic environmental champions and leaders of change.

Environmental Physiotherapy varies across cultures and countries, reflecting diverse environmental challenges and healthcare systems. For instance, in countries like Sweden, Norway and Denmark where access to nature is deeply ingrained in the culture, environmental physiotherapy emphasizes the therapeutic benefits of outdoor activities and wilderness rehabilitation (16–19). In contrast, in densely populated urban areas, environmental physiotherapy might focus on mitigating the health impacts, for example addressing the effects of air, water, noise and/or light pollution and promoting green infrastructure in urban planning (7, 20). Regardless of the context, integrating Environmental Physiotherapy education globally ensures that future physiotherapists are equipped to address environmental health challenges and advocate for sustainable solutions in their communities (21).

At time of writing, about 90 universities from across the globe have begun to integrate Environmental Physiotherapy into their programs, reflecting the growing international recognition for the need to address planetary health (3, 22, 23). The introduction of key concepts within environmental physiotherapy including, but not limited to, integrating indigenous knowledge, health equity, green space exposure and activity prescription, minimizing carbon footprints, exploring the United Nations Sustainably Development Goals (SDGs) and specific environmental factors (e.g., pollution and chronic obstructive airways disease) are underway (13, 23). The evidence showing that the profession and the educators are building momentum for change can be seen in websites, blogs and online activities (24, 25). For some key concepts, such as indigenous health and equity, details of how these are integrated into physiotherapy curricula are under investigation and emerging (26–28). However, for the larger field of environmental physiotherapy, curricula specific details are limited. Although examples can be seen on the EPA website as to how various universities are implementing environmental physiotherapy, they show minimal details. For example, Charles Sturt University (Australia) has integrated sustainability into its year 1, 2 and 4 courses, through scholarly review case-based scenarios and

group work; and Neotia University (India) had integrated environmental physiotherapy throughout their year 4 curriculum. Cardiff University (Wales) website reports embedding sustainability into the physiotherapy curriculum with lectures, reflective learning and working groups including interdisciplinary collaborations (29) and the Monash University (Australia) website offers short courses in sustainable healthcare practice as the “first-of-its-kind...” (30). A review of Swedish higher education institutions that teach physiotherapy found that two of the eight institutions had yet to develop learning objectives that were sustainability focused. Only one institution had more than 5 % of their learning outcomes focused on sustainability and of the 1,255 total intended learning outcomes identified, only two were sustainably focused and related to hands on competencies (31).

While universities across the globe appear to be embracing Environmental Physiotherapy within their curricula, descriptions of how they are doing this, and the accompanying learning objectives and/or outcomes are not detailed or have yet to be published within the academic and peer-reviewed literature.

The purpose of this paper is thus to describe, at a granular level, the implementation of environmental and sustainable education into the physiotherapy curriculum in an Aotearoa New Zealand (NZ) university, the University of Otago. In this paper, we detail three examples of learning activities we have embedded into our entry-level Bachelor of Physiotherapy curriculum.

2 Environmental physiotherapy education within a New Zealand bachelor of physiotherapy curriculum

2.1 Background

At the University of Otago, School of Physiotherapy, we strive to prepare physiotherapy graduates that are not only prepared for current clinical practice in NZ but can be agile to respond to the future health needs of our population and future physiotherapy practice. We thus have a goal of ensuring our curriculum is forward-focused, exemplify contemporary teaching, and reflects our NZ indigenous identity. Traditionally our physiotherapy curriculum, like elsewhere in the world, was strongly influenced by the biomedical model, a model framed within scientific objectivity and reductionism (2). We have embraced in the last decade, the bio-psycho-social model. Influenced by the critical physiotherapy debate and our obligation and responsibility to NZ's Te Tiriti o Waitangi, we are slowly progressing to post-colonial philosophies, including elevating Māori and Pacific People's models of health and environmental health.

In the context of the current paper, we believe that physiotherapists need knowledge and skills to understand how environmental factors, such as pollution and climate change affect our patients' health and recovery. By recognizing the importance of planetary health and demonstrating our commitment to holistic and sustainable healthcare, we aim to ensure that our curriculum is relevant and that our graduates lead the way in integrating environmental consciousness into patient care. Further to this, our University recently updated its *Ti Kōuka: the Sustainability Strategic Framework* (32). One pillar of this framework is *Te puaka ti, he tohu Raumati - Education for sustainability*. The whakatauki (Māori symbolic proverb) gifted for

this pillar is “The flowering of the ti kōuka in spring is said to foretell the type of weather in the summer to follow.” This alludes to the importance of equipping our students and staff with the skills, understandings and values required to be more sustainable in their lives and work. It is how they act which will determine the sustainability of our long-term future.

Indigenous health philosophies can substantially contribute to the environmental health discussion. As a bicultural society, in NZ, significant value is gained from understanding Māori perspectives. In Te Ao Māori world view, there is no separation of the health (Hauora) of the whenua (land) and the health (Hauora) and wellbeing of humans. There is an intertwined, reciprocal relationship here. The Hauora of the whenua or papatūānuku (our mother) is carried with a strong sense of responsibility. We care for our mother, and she nurtures and provides for us. We do not own our mother; instead, we carry the responsibility of looking after the whenua for the perpetuation of our very existence as a species. Thus, good health comes from guardianship and nurturing of the whenua and waterways. Positive health and wellbeing are obtained and maintained from living off and with the provisions the natural world provides. In a practical sense, this includes maintaining healthy whenua and waterways as part of healthy exercise, therefore, ensuring that we are drinking and eating food, which is produced from healthy, sustainable environments. Thus, it is easy to understand the negative effects of colonialism and segregation from the environment has had on Hauora Māori.

Traditional Māori healthcare practices include Rongoā, a practice that incorporates the healthy balance of the mauri (the networks of the life forces found in the natural world). Knowledge of the balances that exist within the harmony of the natural world is encompassed with mātauranga Māori (Māori science/knowledge); the natural world balancing ecologies for supporting healthy life on earth are observed and described (33). Rongoā rākau, the use of herbal medicines from trees and plants is also well understood within mātauranga Māori. Māori have uncovered many natural medical properties, which are now being proven with western science techniques. This includes but not limited to, antibiotic properties in Manuka (34) and anti-inflammatory properties in Manu Titi (mutton bird) spew (35).

In a country such as NZ, with a binding treaty between colonizers and indigenous peoples as a founding document (Te Tiriti o Waitangi), there is a responsibility to incorporate indigenous perspectives into health curricula and a physiotherapy registration requirement specifically addressing cultural safety and competency. As education providers, therefore, we have a duty of care to our people (tangata), our land (whenua) and for future generations. Māori perspectives of kaitiakitanga are understood as being related to guardianship and protection of the environment. These are intimately entwined with wellbeing and longevity and the responsibility to establish good governance and continue this for future generations. This responsibility is specifically related to the health of the whenua and waterways. Culturally this connection is inseparable and is connected with the health of a person. For example, with water, Māori may ask who you are: “Ko wai koe?” (“What waters are you?”). This has many meanings; the waters of parents, the fact we are mostly water, what waters were your tupuna (ancestors) drinking and how healthy were they? The reference to water is deep throughout Māori philosophies and sense of identity. For example, the word for water spring, te Pū, and pool of water, Puna, are found in words for relations, such as

mokopuna (grandchildren) or tūpuna (ancestors). Thus, environmental sustainability is an integral element when addressing physiotherapy approaches from a te Ao Māori perspective in NZ.

2.2 Pedagogical framework

In NZ and Australia, entry-level physiotherapy education is designed to produce competent, autonomous physiotherapists. The physiotherapy programs rely on Competency-Based Education and are designed to meet the competency standards set by regulatory bodies. In NZ, the registration authority is the Physiotherapy Board of NZ (PBNZ). The Physiotherapy practice thresholds describe the threshold competence required for initial and continuing registration as a physiotherapist in both Australia and NZ (36). To pass all prescribed courses and graduate with a Bachelor's degree, we must evaluate that students meet these PBNZ set threshold competences. The curricula in physiotherapy programs in Australia and NZ, all of which are different, incorporate a mix of theory, knowledge, practical skills, and clinical experience to enable students to reach the threshold competencies for entry level registration. Whichever model/s of health each program subscribes to, physiotherapy is learnt experientially by active participation in learning activities that are underpinned by clear theoretical concepts (37).

The “Physiotherapy practice thresholds in Australia and Aotearoa New Zealand” were launched in 2015, with the thresholds competencies reflecting contemporary (at that time) physiotherapy and healthcare practice in Australia and NZ. The threshold competencies were arranged under key competencies within seven integrated roles of physiotherapy practice: (1) Physiotherapy practitioner, (2) Professional and ethical practitioner, (3) Communicator, (4) Reflective practitioner and self-directed learner, (5) Collaborative practitioner, (6) Educator and (7) Manager/leader. The thresholds have recently been updated and now stress the importance of cultural considerations and holistically delivered care, free of bias, discrimination and racism. Of relevance to this discourse, is that one threshold competency is:

“Plan and implement an efficient, effective, culturally safe and responsive and client-centred physiotherapy assessment,” of which one enabling component is “recognise and evaluate the social, cultural, personal and environmental factors that may impact on each client's functioning, disability and health.”

The University of Otago's Physiotherapy entry level program (BPhty), a four-year Bachelor's degree program was revised from 2015 to 2018, guided by the Eberly Center framework for curriculum review and revision (38). This revision was in response to the 2015 launched registration threshold competencies as well as to the demands of the changing health service needs, government initiatives, and society demands. The aim was a curriculum that reflected and integrated NZ healthcare policies and prepared students for future practice and changing models of healthcare. NZ healthcare policies are increasingly focussed on person-centered and inter-professional care, equity and diversity, wellness, and management of individuals presenting with complex multi-morbidity (39). The curriculum revision resulted in an integrated curriculum, moving away from teaching content within the traditional siloed physiotherapy

disciplines of neurology, cardiorespiratory and musculoskeletal, to an integrated multi-physiotherapy-disciplinary teaching approach (see Table 1). There was an emphasis on student centered learning, employing methods such as problem-based learning, case-based learning, reflective practice and self-directed learning (40).

Our BPhty program also includes an Interprofessional Education component, aimed at familiarizing students with collaborative working, with ~900 students from nine health professional programs from the University of Otago and the Otago Polytechnic engaged at years 2 and 3, and multiple smaller groupings across the country working together clinically in their final years (41). Students learn alongside students from other health professions, an approach that prepares future health professionals for interdisciplinary healthcare delivery and thus overall improved health outcomes (42).

2.3 Incorporating environmental physiotherapy education

Our new curriculum design enabled incorporation of Environmental Physiotherapy learning objectives and activities, which we are gradually progressing. In addressing the aim of this paper, below we describe three examples of how we have done this to date. The first example exemplifies embracing and threading indigenous knowledge throughout our BPhty curriculum. The second example demonstrates how environmental physiotherapy can be made explicit within a delineated learning activity. In the third example, we describe a clinical placement learning activity that occurred in our student-led private practice.

2.3.1 Authentic teaching of the Hauora Māori curriculum

Education about threshold competencies that enable effective and respectful interaction with Māori are incorporated at all levels of our BPhty curriculum. We endeavor to thread Hauora (health) Māori and the Principles of te Tiriti o Waitangi knowledge throughout the curriculum. We describe below the learning activities specific to the Hauora Māori curriculum as examples of how indigenous health and biculturalism can be included, recognizing that culturally, health of people (tangata), land (whenua) and waterways are inseparable.

In year 2 of the BPhty program (see Table 1), the teaching year starts with the module “Foundations to Physiotherapy Practice.” In unit 2 of this module is “Understanding People and Self,” and this unit includes the following learning outcomes:

Understand cultural safety in NZ:

- Self-awareness and self-reflection of impacts of practitioner cultural lens.
- Cultural knowledge and skill in cross cultural interaction.
- Understand and implement NZ policies that address equity (such as te Tiriti o Waitangi; He Korowai Oranga (Māori Health Strategy); He Kawa whakaruruhau ā matatau Māori (PBNZ's Māori cultural safety and competence standard); and the United Nations Declaration of Rights of Indigenous People.)”

To enable authentic teaching, the Hauora Māori learning activities are delivered for a full day at the Ōtākou Marae (the local meeting grounds, the focal point of the local Māori community. Māori see their

TABLE 1 Outline of curriculum at a year 2 and 3 level: University of Otago physiotherapy specific papers taught as part of the BPHTY program.

Semester 1					
Year 2			Year 3		
Phty 254: Physiotherapy rehabilitation science 1		Phty 255: Physiotherapy clinical practice 1	Phty 354: Physiotherapy rehabilitation science 2		Phty 355: Physiotherapy clinical practice 2
Module 1 Foundations to physiotherapy practice	Unit 1: Welcome to the physiotherapy profession & to our program (Week 1)	Supervised clinical practice Integrated case studies Clinical Research	Module 1	Understanding Context Weeks 1 and 2	Supervised clinical practice Integrated case studies
	Unit 2: Understanding people and self (Week 2 to Week 3)				
	Unit 3: Understanding movement (Week 4 to Week 6)		Module 2	Prevention, Health/Wellness Week 3	
Module 2 Measurement and assessment	Unit 4: Understanding measurement (Week 7)				
	Unit 5: Understanding patient-centered assessment (Week 8 to Week 9)		Module 3	Primary care Weeks 4–13	
	Unit 6: Assessing posture and activity (Week 10)				
	Unit 7: Assessing body structure and function (Week 11 to Week 13)				

Semester 2						
Phty 254 Physiotherapy rehabilitation science 1		Phty 256 Physical activity in physiotherapy practice	Phty 255 Physiotherapy clinical practice 1	Phty 354 Physiotherapy rehabilitation science 2		Phty 355 Physiotherapy clinical practice 2
Module 3: Fundamentals of physiotherapy interventions	Unit 8: Basic / generic physiotherapy interventions (Week 1 to Week 5)	Topics covered: Importance of physical activity for health Tangata whenua approaches to physical activity Physical activity for Pacific populations Skills for teaching exercise Designing exercise programs Pharmacology - exercise	Supervised clinical practice Integrated case studies	Module 5	Tertiary care Weeks 1–5	Supervised clinical practice Integrated case studies
	Unit 9: Basic rehabilitation interventions (Week 6 to Week 9)	Exercise for balance strength, flexibility, aerobic function for clinical populations Contextual factors for physical activity participation Functional/Task orientated exercises		Module 6	Rehabilitation & community care Weeks 6–10	
	Unit 10: Principles of physiotherapy management (Week 10 to Week 12)	Biological adaptations to exercise Exercise induced hypoalgesia Exercise prescription following injury		Module 7	Professionalism & business Weeks 11–12	
	Unit 11: Clinical reasoning (Week 13)	Physical activity across the spectrum: Tertiary and secondary care; Primary care and community; Children; Older adults Hydrotherapy Strategies to promote physical activity uptake & motivation		Module 7	Module 7: Putting it all together and preparation for 4th year Week 13	

*Year 1 = First Year Health Sciences at University of Otago; Year 4 = a full-time clinical year plus research project; students also take papers in anatomy, physiology and pathology.

marae as their tūrangawaewae - their place to stand and belong). The students learn about the Pōwhiri process (the formal welcome ceremony onto the marae) and tikanga (Māori custom and protocols), history and current application of the principles of te Tiriti o Waitangi and the impact of colonization on current Māori health status, Māori models of wellness and how to incorporate them into provision of physiotherapy services, importance of te reo Māori (Māori language), and the process of mihimihi statement of identity (who a person is: their mountain, river and people).

In the fourth module of the year 2 course (“Assessment and measurement”) in unit 4 “Understanding patient-centered assessment,” all students, irrespective of culture, are taught the Whakaaro Pōkare Visual Tool (see Figure 1) developed by Pōtiki Bryant and Tikao to aid their patient interview process (43, 44). In the figure, the Pool signifies the patients’ life. Te Pū is the spring from the origin, signifying the patient (their essence). The lines signify the ripples of effect the patient has on their life. The pentagon shape reminds us that when we talk about life and wellness, there are many different aspects that make us well. The closer the aspects are to the source, the more important they are to the patient and their wellbeing. The visual model is laminated to enable white board markers to be used to record patient perspectives, which can then be photographed and wiped away at interview conclusion so that the laminated tool can be reused for another interview. Having the printed model laminated also provides an effective method for encapsulating a clear, visual depiction of the information from the patient, allowing the participant to see, manipulate and alter written information accordingly (43).

In year 3 of the BPhy program, the curriculum scaffolds onto intercultural competence and engagement with communities. Learning is via lectures, and workshops with activities with the following objectives:

- (1) Intercultural competence: (i) Review the value and relevance in the physiotherapy context, (ii) Conduct a self-reflection

exercise on own cultural background, and (iii) Consider how strategies for inter-cultural communication can be implemented.

- (2) Engaging with communities: (i) Consider what constitutes ‘community’ and ‘engagement’, (ii) Consider effective engagement using community centered approaches and importance for physiotherapy within NZ, and (iii) Review outcomes of successful and poor community engagement.

In year 4 all students have a visit to the local marae at the city center in NZ they have been allocated to for their final year, a year mostly comprising supervised clinical practice. Marae visits include undertaking the pōwhiri process in a healthcare setting, and learning Māori movement practices in rehabilitation, Rongoā, and Taurite Tū (a Māori strength and balance exercise program).

2.3.2 The Dragon’s Den physiotherapy Aotearoa - developing a modified business plan for a physiotherapy practice with a social mission

In the “Business module” of the Year 3 paper (see Table 1), students work in groups on an assignment “*The Dragon’s Den Physiotherapy Aotearoa - Developing a modified business plan for a physiotherapy practice with a social mission.*” Each group must develop a modified business plan for a new physiotherapy practice which has at its heart a social mission. Groups are allocated the location (i.e., a NZ region or town) for their new practice. Each group then sell their idea to the “Dragons” in the “Dragon’s Den Physiotherapy Aotearoa” session. Among several objectives of this assignment are the following: (i) understand local responsibility for contributing to global and local sustainable development; (ii) apply the concepts of professional duty and social responsibility; and (iii) apply basic principles of private practice management, including the development of business plans, sustainability, equity, diversity, accessibility and marketing services. During their “Dragon’s Den” styled presentation, groups are marked on their proposed physiotherapy practice’s social mission and vision, plans to enable equity of service and accessibility for all, and how they intend to offer sustainable physiotherapy (in the context of climate change). Students have preparation lectures on “The Application of Sustainability” and the United Nation’s Sustainable Development Goals (SDGs), and are directed to explore the Environmental Physiotherapy Association website¹ and the University of Otago’s Sustainability Framework (32).

2.3.3 Student-led clinics

In the final clinical year of the BPhy program many students are placed in one of the two School of Physiotherapy primary care private practice student-led physiotherapy clinics. These clinics offer physiotherapy services to the public, allowing fully supervised physiotherapy students to provide physiotherapy services while completing clinic placement and learning pseudo-autonomous practice. With the help of students and staff, the smaller of these facilities began the process of critically examining their processes and functions in line with the SDGs. Postgraduate students, undergraduate clinic based students and all staff in the School of Physiotherapy ($n = \sim 90$) were

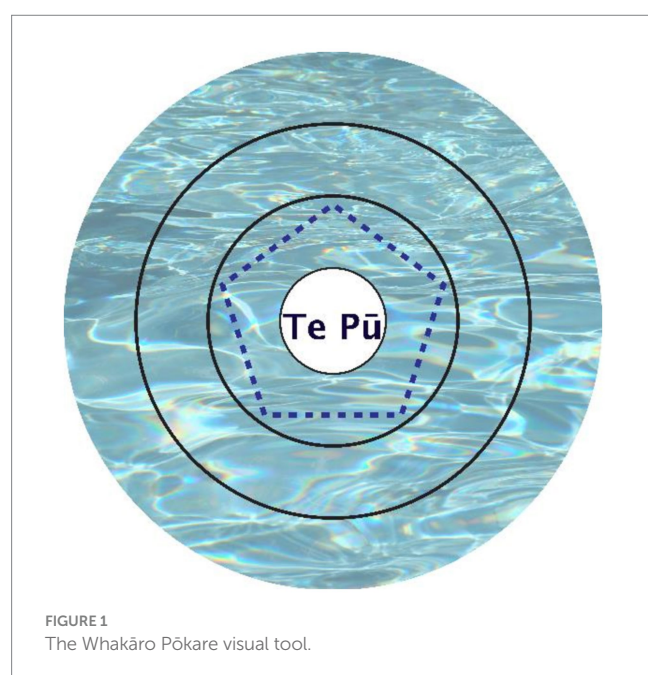


FIGURE 1
The Whakaaro Pōkare visual tool.

¹ <https://environmentalphysio.com>

invited, via email, to provide feedback on “what concepts, thoughts or philosophies spring to mind when considering the SDGs,” to assist with inspiration for building a starting platform. They were provided with a description of each SDG and asked to record thoughts and ideas relating to physiotherapy and specifically to “think of the SDGs as inspirations...” Collectively we received more than 100 responses with least one idea was raised for each of the SDGs, the five most popular SDGs producing more than 50 suggestions (see Table 2). These data were then later shared in as an education session with staff. While primarily used as a student learning activity, a secondary objective was to guide the clinical facility to become a more sustainable healthcare practice and an immersive student experience. Many current clinic protocols were identified as already addressing SDGs and new protocol ideas generated. Following this exercise, multiple new initiatives and modifications were introduced, with many proving to be more efficient than current practices (see Table 3 for detail).

3 Reflection and discussion

In this paper, we approach planetary health with a simplistic view, of encompassing the health of our planet, including human civilization, and the complex, interdependent interactions between the two. We consider Environmental Physiotherapy a focused subset of planetary health that explores the specific role of the physiotherapy profession within this broader concept. While our paper focuses specifically on Environmental Physiotherapy, we recognize that meaningful, sustainable change in this area cannot occur within a single profession and thus effective responses to planetary health challenges require interprofessional collaboration. While interprofessional education is a core part of all health professional programs at the University of Otago, as mentioned earlier, this paper was limited to describing the integration of Environmental Physiotherapy into our BPhty program, illustrated by the description of three novel learning activities.

Although we successfully incorporated Environmental Physiotherapy learning activities into our revised BPhty curriculum, we unfortunately have not been able to formally evaluate the outcomes of these initiatives. In revising our curriculum, we initiated the Continuous Feedback model (40) as a means of ongoing evaluation and refinement, but this process was disrupted by the COVID pandemic. Due to the pandemic, the curriculum underwent multiple adaptations to respond to the NZ government's many, and often prolonged, mandated lockdowns over a two-year period. Adaptions included changing the sequence of delivery of the curriculum (e.g., teaching all the theoretical components online for about 10 weeks and then teaching the in-person practical and workshop components in the subsequent semester of 13 weeks with strategies for social distancing and smaller classes, using telehealth in clinical placements). As the students moved up a year, the curriculum had to again be adapted to cover what had/had not been taught in the previous year. This caused a major disruption to the sequencing of our revised curriculum, and it became impossible to compare data from subsequent years. Further, due to the financial recession caused by both the COVID Pandemic and the two devastating cyclones that hit NZ in 2023 (45), the smaller clinic was closed and the immersive experience ceased before we were able to review and assess the outcome. Our curriculum was however reaccredited in 2023 by the PBNZ and gained full accreditation with no conditions for 7 years,

indicating that our curriculum and approach to teaching (including our novel environmental learning activities) were acceptable and our new graduates able to automatically register to practice physiotherapy in NZ and Australia. Anecdotal evidence suggests the students liked the Dragon's Den initiative and presented innovative ideas for physiotherapy private practice. The marae visits to in years 2 and 4 usually gain favorable student evaluations. Students also enjoyed the sustainable clinic concept (always keen to pick up new ideas, e.g., no more plastic cling wrap at lunch) and were passionate about sharing their ideas for improving the sustainability via the drop box located in the clinic reception. Perhaps future educational endeavors could use the PIER (Planning, Implementation, Program Evaluation, Program Revision) Framework to evaluate the integration of environmental physiotherapy teaching activities into the clinical practice setting (46). Evaluating outcomes of such endeavors probably leans toward qualitative methodologies to enable a deeper, more nuanced understanding of success and ways to improve than would blunt instruments such as surveys or student grades.

3.1 Practical implications, objectives and lessons learned

Incorporating environmental health and sustainability into the competency standards is a step toward preparing future physiotherapists to address environmental determinants of health. Providing a learning environment that allows students to experience integrating sustainable practices into simulated or real clinical care is logical and congruent with international movements and calls to action (2, 20). Environmental Physiotherapy teaching activities can easily be incorporated into theoretical and practical components of the curriculum, and many resources are readily available, although can have a substantial step-up cost, such as telehealth (47).

When, in early 2020, NZ went into lockdown during the first wave of the COVID-19 pandemic, telehealth facilities in our School's clinics became not only the primary source of patient interaction but also how the students were taught during their clinical placements. A global pandemic exemplifying the impact of nature on humanity also inadvertently supported the telehealth integration into teaching. For the first time, students completed entire six-week clinical placements, working with patients and supervisors without ever leaving their homes. The same software (Zoom Videoconferencing Software) that allowed physiotherapists to treat their clients online also allowed students to see their patients with supervisors actively involved in and controlling the teleconference clinical sessions. Initially an initiative aimed at allowing equitable access for those patients who could not attend the clinics, it became the only available option, thus validating its importance. With video communication, teleconferencing and mobile phones now common place globally, this is recognized as a cost-effective initiative for the client.

In our experience, integrating new sustainable technologies with existing healthcare infrastructure can be complex and costly, as can ensuring compatibility between old and new systems. For example, the equipment (technology) required to reduce our clinic's paper consumption, such as log-in facilities on new smart printers, tablets, and tablet accessories like digital pens, are all expensive items. It is reasonable to expect that most clinical environments would need to introduce such measures gradually due to inhibitory costs.

TABLE 2 Top five sustainable development goals (SDG) to improve the clinical teaching facility as suggested during consultation of staff and students ($n = \sim 90$).

		SGD	Examples of suggestions
Ranked according to number of suggestions	1	Goal 3: Ensure healthy lives and promote well-being for all at all ages	“Free online classes that do not require any equipment. Promoting exercise in outdoor environments...” “More funding for pediatric physios, increase screening of children” “Health promotion events such as cross-generational activities – promote walking routes that are accessible to all...”
	2	Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	“Providing easily accessible, free content related for the general public to empower them to look into questions they may have themselves.” “Educating patients to self-manage and understand own condition”
	3	Goal 1: End poverty in all its forms everywhere	“Provide telehealth options as a full-time service for those who struggle to access due to cost of travel, time off etc.” “More subsidies for low-income families to attend physio.”
	4	Goal 5: Achieve gender equality and empower all women and girls	“Content for women led by women. Making all genders aware of common problems they and other genders may face. Including all genders not just the stereotypical two. Multi-gender facilities for the community to use in practice.” “Giving all students equal opportunities, regardless of gender and/or background.” “Addressing/ acknowledging unconscious bias” “Encourage inclusiveness of gender diversity at all levels of university including admission to courses, research, and other university policies”
	5	Goal 6: Ensure availability and sustainable management of water and sanitation for all	“Water bottle filling stations and water filtering stations.” “Water cooler in the clinic, a few sanitary supplies in bathrooms” “Minimize unnecessary water use”

Surprisingly, the amount of printing significantly declined with the required log-in alone.

Finding sustainable alternatives that meet healthcare standards can be difficult. Additionally, sustainable products may have higher costs or limited availability. For example, on a very basic level, biodegradable cups from sustainably harvested forests are inevitably more expensive than regular plastic cups. Alternatives like glass cups, although slightly more expensive initially, are reusable. However, in a healthcare setting, considerations about sterilization, made more prominent during the COVID pandemic, can be equally frustrating. The balance between maintaining infection control and implementing eco-friendly practices is at the forefront of our planning.

While the transition to sustainable healthcare systems is essential, the economic, technological, and logistical complexities are challenging; we found a focus on continuous improvement and stakeholder engagement to be a valuable resource in our sustainability

efforts. Unfortunately, the unforeseen closure of the facility prevented us from empirically assessing the efficacy of the protocols introduced in this initiative. Nevertheless, the process effectively served as a pilot study.

Given the strong acceptance of the sustainable initiatives introduced in the student-based clinic, we believe many of these practices could feasibly be expanded across the entire School of Physiotherapy. We recommend starting with smaller, manageable goals, such as discouraging the use of soft plastics in lunches and waste by encouraging staff to adopt renewable, reusable containers. Additional steps could include ensuring only reusable cups and utensils in the staff room and promoting “walking meetings” to further integrate sustainability into daily routines.

Due to the smaller size of the clinic, we had the opportunity to implement targeted initiatives that resulted in tangible, immediately noticeable changes for both students and staff (Table 2). In contrast, larger institutions, forced to cover a much wider scope (such as

TABLE 3 Protocols used within the clinical teaching facility.

Initiative or modification	Status	Description and/or points of interest	Applicable SDG
Unisex toilets	Existing	Toilets and showers were non-gendered. Allowing access to all.	5, 10, 16
Provision of fresh drinking water	Existing	Filtered water was provided to all staff and visitors.	6
Biodegradable cups, made from sustainably harvested forests	New	Although the capacity to have reusable cups existed, concerns over infection control during the COVID 19 Pandemic and increase in use detergent and electricity meant we changed to sustainable biodegradable cups.	12
Students were surveyed for sustainable suggestions	New	In the initial stages, this was to engage students in the change process and elicit sustainable critical thinking.	11, 12, 13
“Green” suggestion box was placed in the waiting room for feedback from staff, students and public.	New	Most comments related to transport to and from the physiotherapy service, which we were unable to address at the time. Namely, the provision of safe bike stands and most consistently that people would pay for parking, if the money raised was used to plant trees to combat the environmental cost of using motor vehicles.	11, 12, 13
Plants	Existing	Students seemed to enjoy the environmental theory as a result they presented the clinic staff with additional plants to “green the space” upon finishing their placements.	3, 15
Introduction of Telehealth	Existing	Telehealth is known to address inequities by promoting access.	3, 10, 12
Introduction of card access photocopying	New	This significantly decreased the paper consumption. Potentially due to the extra time required and number of steps involved. E.g., Staff preferred to read from screens rather than log in and select options to print and then, having walked to the copier, potentially waiting in line to log in to the printer, then again selecting options before collecting their printing.	12
Introduction of digital signing of client/health paperwork.	New	This enabled forms to be completed without printing paper (the majority of which had been later scanned back to digital form and shredded)	12
Digitisation of student paperwork	New	All paperwork was digitized, and a new shared secure server was set up so that all paperwork could be completed and accessed by staff and students electronically. This increased efficiency within the clinic.	12
Lamination of all required non-digital paperwork	New	Laminated paper can be digitised for storage after use, and then wiped clean for the next user.	12
Ensure the clinic was ethnically inclusive			3, 10
Bilingual signage	Existing	e.g., directions within the facility	3, 10
Atmosphere	Existing	Inclusion of culturally significant indigenous items: e.g., the clinic hung Māori flax weavings that had been created by university staff and were part of the clinic heritage.	3, 10
Interpretation services	Existing	Interpretation services were accessible via a telephone service.	3, 10
Removal of unnecessary linen	New	The cost environmentally of cleaning sheets, pillowcases and towels after each client, in energy consumption and chemical waste was considerable. Instead, disinfecting the surfaces between clients proved not only more effective as we approached the COVID pandemic, but also financially astute.	12
Encouraging outdoor exercise	New	The teaching facility, although located in the CBD was less than 50 m from a riverbank. Staff and students were encouraged to take their clients outside were appropriate for assessment and/or treatment.	3, 15
Encouraging walking meetings	New	Where feasible, staff and students were encouraged to undertake “walking meetings.” This was the preferred option for all one to one meetings or meetings perceived to be more stressful or requiring privacy. E.g., providing feedback on student performance.	3, 15
Lunchboxes	New	Staff and students were asked to bring their food renewable receptacles, to minimize food wrapping waste.	12

teaching hospitals and universities), often need to begin with broader, more abstract measures, such as forming committees, developing policies, or drafting charters (32, 48, 49).

Our School's acknowledgement, and weaving in, of Hauora Māori and the Principles of te Tiriti o Waitangi knowledge throughout the curriculum is a work in progress as our levels of understanding of what this means in Physiotherapy and for the health outcomes of the people of NZ deepens. This is compulsory education for all healthcare professionals in NZ. Cognisance must all be given to Māori students' knowledge, as this is their heritage and way of being, and thus we must strive to extend their knowledge and practice. We continue to promote the understanding that the client / patient belongs to a whānau, community, culture and respect the connection between physical, mental, spiritual, and environmental health. Ultimately, we need to constantly work toward a shift from a colonial style of teaching and the exploitation of people and nature and environmental degradation (50). As health professionals, we must promote a move away from the degradation of culture and our living environment that impacts on all species especially humans. This logic has started conversations and debate about underpinning from the start, our BPhy curriculum with the knowledge and understandings of Hauora Māori and Māori models of healthcare. Then only later in the program introducing concepts developed in other parts of the world, such as the International Classification of Functioning, Disability and Health, to enable global citizenship. This example, while directly relating to NZ, gives food for thought to other nations on how they can adapt their physiotherapy curricula to their indigenous philosophies.

3.2 Looking forward

With the need for sustainable healthcare urgent and the global impact of health care being a significant contributor to environmental degradation, further ways of how to integrate planetary health and environmental sustainability into physiotherapy curricula are undoubtedly forthcoming. Until such a time we can endeavor to:

To inspire multi-level leadership and collaboration; empower and privilege students' voice; develop a curriculum framework with a planetary health lens, provide professional development for educators... and finally integrate [Sustainable Healthcare Education] into course accreditation standards... (51) pg. 331.

World Physiotherapy's Physiotherapist Education Framework notes that a graduate should be competent to practice "independently, in a safe, effective, equitable, accessible, sustainable and ethical manner" (52), although it does not directly address environmental sustainability. World Physiotherapy's Guidance Document for the development of physiotherapy curricula, however notes that a curriculum "should be situated within a broader context such as human rights, Sustainable Development Goals (SDGs), climate crisis, public health, and health promotion" (53).

As an international profession, we should aim to model a more holistic approach with greater understanding and collaboration from indigenous cultures that have sustainably maintained land and ecosystems. It is important to emphasize evidence-based practice in environmental health to ensure that students are capable of critically evaluating and researching the health impacts of environmental

factors, likely to become more prominent in future healthcare. The movement toward sustainability must be supported by educational institutions and applied homogeneously across all levels from top academics to first year students (54, 55) so that all health practitioners, both established and future, innately advocate for sustainable practices in their professions. Educational policies and frameworks, and institutional directives that command these are difficult to influence and difficult to change (56). With persistence, however, the planetary health and sustainable healthcare movement is gaining traction and integrating sustainability into healthcare education is happening across the globe (56, 57). We hope this paper has provided some tangible ways of how to incorporate such education into entry-level health professional programs.

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

OS: Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. KB: Writing – original draft, Writing – review & editing. LH: Conceptualization, Writing – review & editing, Methodology, Writing – original draft.

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Applying a sustainability perspective in the literature on physical therapy in relation to pharmaceuticals: a scoping review

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Introduction: Physical therapy encompasses a broad range of treatment options, often utilized in clinical settings where pharmaceutical interventions are standard. The potential for physical therapy to contribute to sustainable healthcare by reducing environmental impact, while maintaining the quality of care, remains underexplored. This study aimed to map existing research comparing physical therapy to pharmaceuticals, with a specific focus on whether these studies address aspects of sustainable development.

Methods: A scoping review was conducted, systematically searching the PubMed, Cinahl, and Pedro databases using keywords related to physical therapy, pharmaceuticals, and comparative studies. Two assessors independently reviewed and selected relevant studies, followed by data extraction and summarization of results.

Results: A total of 27 studies were included, varying in design, population, and healthcare context. The most commonly addressed conditions were osteoarthritis and musculoskeletal pain, with analgesics being the most frequently studied pharmaceutical interventions. While several studies touched upon economic and social dimensions of sustainable development, none examined environmental sustainability. This highlights a critical gap in current research.

Discussion: Future studies are needed to assess how physical therapy, when compared to pharmaceutical treatments, can contribute to sustainable healthcare by offering a low-carbon, resource-efficient alternative without compromising social sustainability through adverse effects. This knowledge could be instrumental in guiding healthcare systems toward more sustainable practices.

Systematic review registration: A study protocol was registered in Open Science Framework 2023-03-31 (Available from: <https://osf.io/we58g>).

KEYWORDS

physical therapy, physiotherapy, sustainable development, triple bottom line, scoping approach

Introduction

Healthcare accounts for a significant share of global greenhouse gas emissions, i.e., carbon footprint, and the largest share is due to the production, transport and consumption of goods and services such as pharmaceuticals and other chemicals, foods and medical equipment (1, 2). Thus, healthcare has a responsibility to actively participate in the transition towards sustainable development (2), defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs', involving economic, environmental and social sustainability (3). A sustainable healthcare builds on the three dimensions of sustainable development (2, 4), and is defined as a system that maintains and improves the health of current generations while minimizing damage to the environment and ensuring health for future generations (4). Four key elements have been identified to enable sustainable healthcare (5): disease prevention and health promotion to reduce the need for healthcare; self-management and empowerment of patients to take a greater role in managing their own health and healthcare; lean service delivery and; prioritizing low carbon alternatives (2).

The three dimensions of sustainable development are further described in the business framework the Triple Bottom Line (6). This framework argues that for a business to be sustainable, it needs to consider not only the economic aspect, but also the environmental and social aspects of operations. In other words, it must consider for example air pollution and greenhouse gas emissions, and the health and wellbeing of employees and clients (6). Triple Bottom Line has since its' introduction been employed in studies (2, 4, 7). The Triple Bottom Line has been found particularly interesting in healthcare since health is directly and indirectly determined by ecological and social aspects (8).

From the perspective of physical therapy (PT), individuals have inherent resources to maintain or improve their health on their own or with the facilitation of others (9). In PT, support for behavioral change, maintenance and resumption of activities, function and abilities, and the promotion of patient empowerment are central concepts (7). The concept of empowerment is based on the idea that people themselves have the ability and resources to define their own problems and devise action strategies to deal with them. Behavior change is an important part of health promotion and disease prevention (10), together with patient education and rehabilitation (10). The fact that PT is a treatment option without the direct environmental impact of, for example, pharmaceuticals (11) implies PT is key for sustainable healthcare.

Pharmaceutical care is the responsible provision of pharmaceuticals (e.g., drugs, medicines) for the purpose of achieving outcomes that improve a patient's quality of life (12). Pharmaceuticals affect physiological processes in the body, usually by binding to various proteins (13). Pharmaceuticals are usually chemically stable substances, allowing them to withstand a certain passage through the body before they reach their area of action (13). These properties and ways of acting in pharmaceuticals are primarily intended to promote treatment outcomes, but they can also have negative effects through various adverse effects in the user as well as a negative impact on the environment (13).

The adverse effects of pharmaceuticals can vary in severity and depend, among other things, on the substance used, who is

using them, and in what dose (3). Side effects of pharmaceuticals have a major impact on society, leading to high costs, increased morbidity requiring care, and risk of death (12). The production and consumption of pharmaceuticals contribute to a global problem of pollution in water and soil (5, 6). These pollutants affect human health and the lives of plants and animals and have been identified as major problems in several countries (14–16). The groups of pharmaceuticals most abundant in the environment are analgesics, specifically Non-steroidal Anti-Inflammatory Drugs (NSAIDs) (17).

The use of pharmaceuticals leads to negative environmental impact and possible negative side effects for the individual. PT as a treatment has been shown to have an effect in several areas where pharmaceuticals are commonly used, such as high blood pressure, depression, diabetes, and osteoarthritis (11, 18). However, there is a lack of collective knowledge about the areas in which PT could influence pharmaceutical use. This is an important area, as this knowledge could contribute the transition to sustainable healthcare. The aim of this study was to investigate what research, in form of scientific articles, is available that study PT in relation to pharmaceuticals. The aim was also to investigate whether this research relates their results to sustainable development regarding environmental-, social- or economic aspects.

Methods

Study design

This study utilized a scoping review methodology to investigate the extent and type of available research. The methodological framework proposed by Arksey and O'Malley (19) was followed, with some additions from Levac et al. (20). A study protocol was registered in Open Science Framework 2023-03-31 (Available from: <https://osf.io/we58g>) and the PRISMA ScR Checklist was used when reporting the results (21).

Research questions

The research questions guiding this scoping review were formulated as follows:

1. What research exists that compares PT and pharmaceutical treatments, or that assesses pharmaceutical use/prescription as outcomes from PT?
2. To what extent are aspects of sustainable development addressed, in articles on PT in relation to pharmaceuticals?

Literature search

A comprehensive literature search was conducted on 2023-02-20 to identify relevant studies. PubMed, Cinahl, and PEDro databases were searched using combinations of keywords related to PT, pharmaceuticals, and comparative studies, with no limitation on the date (Table 1). The search strategy was adjusted based on sample searches, and consultations with a librarian, to optimize search results.

TABLE 1 Overview of the search strategy.

	Search	Hits
PubMed	(physical therapy modalities OR physical therapy specialty OR physiotherapy) AND (pharmaceutical preparations OR pharmaceutical intervention OR drugs) AND (comparative study) NOT (animals OR animal experimentation)	771
Cinahl	(physical therapy modalities OR physical therapy specialty OR physiotherapy) AND (pharmaceutical preparations OR pharmaceutical intervention OR drugs) AND (comparative study) NOT (animals OR animal experimentation)	229
PEDro	physi* pharmaceutical* compar*	63
	physi* drugs* compar*	191

Study selection

Based on the following inclusion and exclusion criteria, studies were selected from the search result:

Inclusion Criteria:

- Original articles and study protocols that in some way compare PT and pharmaceuticals as treatment options, with PT explicitly mentioned as PT by the authors, or interventions performed or supervised by a physical therapist, or performed in a PT clinic.
- Studies that evaluate pharmaceutical consumption as an outcome measure via either intake or via prescription, or by evaluating a pharmaceutical treatment as an intervention.

Exclusion Criteria:

- Articles involving animal studies.
- Articles not available in English.

The selection process was performed by two assessors independently (PS and MJ), with the help of Rayyan.ai software, and started with screening of titles and abstracts. Relevant articles were further assessed by reading their full texts. Inclusion and exclusion criteria were applied individually by the authors. The selection was based on agreement and discrepancies were identified and resolved through discussion within the author group, until consensus was reached.

Data charting

Data from the included studies were extracted and organized into a table. The collected information included author details, year of publication, study location, study design, intervention type, study population, research purpose, methodology, outcome measures, significant results, and aspects of sustainable development.

Collating, summarizing, and reporting the results

The included articles were analyzed and presented in relation to the research questions, in terms of their characteristics, physical therapy interventions, types of pharmaceuticals, pharmaceutical consumption as an outcome measure, and discussions related to sustainable development. The scoping review aimed to provide an overview of the available research rather than conducting a synthesis of the evidence.

Results

The search in PubMed, Cinahl and PEDro resulted in 1254 articles (Figure 1) of which 45 duplicates were detected and deleted, leaving 1,209 unique articles for title screening. Out of 1,209 articles, 68 were selected for further review of abstract after the title screening based on the study's inclusion- and exclusion criterium. The abstracts were then reviewed, and 66 studies were selected for full-text review. Finally, 27 articles (22–48) were included after the study selection process, the most common reason for studies not being included was that they did not address PT explicitly as treatment (Figure 1).

The included studies (22–48) were published between 1998 and 2022 and conducted in 15 different countries, with the most studies conducted in Turkey (23, 37, 39–41, 47, 48) and the USA (24, 25, 34, 46) (Table 2). Most of the studies (17 out of 27) were randomized controlled trials (23, 24, 28–31, 35, 39–42, 44–48), and another four had a randomized design (26, 27, 37, 38), three of the studies where retrospective (25, 34, 36), one was a prospective observational study (43), one was an open-label alternate patient treatment allocation study (33) and two were study protocols (27, 32). The most common diagnoses in the included studies were osteoarthritis (OA), back pain and shoulder pain. The other studies

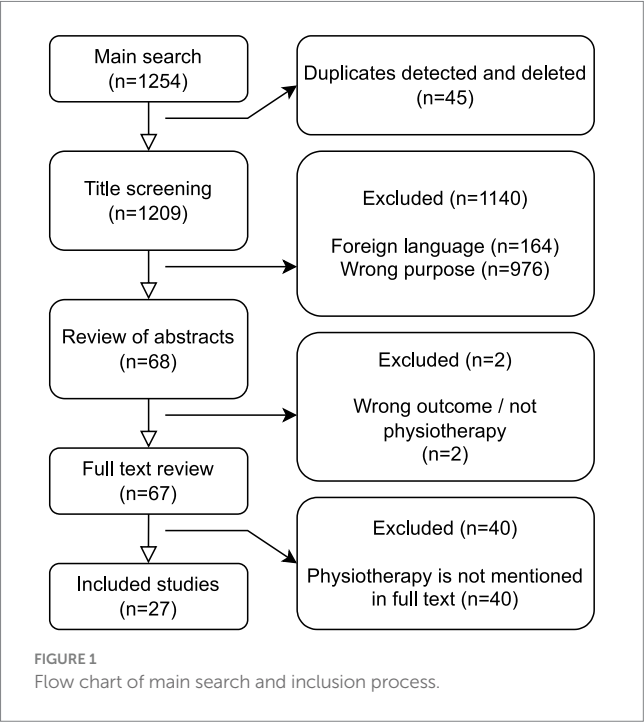


TABLE 2 Characteristics of included studies.

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
Uygur, E. et al. (2019), Turkey (48) Randomized controlled trial	To compare dry needling with cortisone injection as treatment for plantar fasciitis.	96 patients with plantar fasciitis that required continued treatment after 3 weeks of initial treatment. 66% female. Mean age $\approx$ 49.6.	Dry needling in the plantar fascia 2 times per week on 5 occasions.	Corticosteroid containing: Methylprednisolone acetate; Bupivacaine. 1 injection into the plantar fascia.	Pain, Proms function	Positive effects in favor of dry needling, when compared with injections after 6 months.	Environmental: no Economic: yes Social: no
Deyle, Gail D. et al. (2020), USA (46) Randomized controlled trial	To examine differences in treatment effectiveness for pain and physical function in the short and long term regarding injection and PT.	156 patients with knee OA. 48% female. Mean age $\approx$ 56.1.	Passive joint mobilization and strength training $\leq$ 8 sessions over 4–6 weeks +1–3 sessions at the time of the 4-month and 9-month reassessments	Glucocorticoid steroids containing: Triamcinolone acetate; Lidocaine. 1–3 injections.	Proms function, Health economics, Functional tests	Positive effects on pain and physical function in favor of PT, when compared to injections after 12 months.	Environmental: no Economic: yes Social: no
Bakilan, F. & Ortanca, B. (2021), Turkey (37) Non-randomized controlled trial	To compare the patient satisfaction and pain relief firstly between patients who received pharmacological treatment and non-pharmacological treatment.	109 patients with chronic low back pain. 65.14% female. Mean age $\approx$ 47.9.	Hotpack; Therapeutical ultrasound; TENS	NSAID; Myorelaxant; Lidocaine	Pain, Proms satisfaction	Positive effects on pain and satisfaction in favor of PT, when compared to pharmaceutical care.	Environmental: no Economic: yes Social: no
Bisset, L. et al. 2006, Australia (22) Randomized controlled trial	To investigate the efficacy of PT compared with a wait and see approach or corticosteroid injections over 52 weeks in tennis elbow.	198 adults with a clinical diagnosis of tennis elbow $\geq$ 6 weeks, who had not received any other active treatment by a health practitioner in the previous 6 months. 35% female. Mean age $\approx$ 47.6.	8 sessions of elbow manipulation and therapeutic exercises over 6 weeks + home exercise with resistance exercise band. Patient education to all participants.	Corticosteroid containing: Lidocaine; Triaminolone acetate. 1–2 injections. Patient education to all participants.	Pain, Proms function, Function tests, Assessor rating of severity	Positive effects in favor of CSI, compared with PT after 6 weeks. Positive effects in favor of PT at long time assessment when compared to CSI.	Environmental: no Economic: no Social: no
Hamzat, Talhatu K. et al. (2011), Nigeria (38) Quasi-experimental study	To determine the respective and combined effects of NSAIDs and PT in management of pain and reduced functional limitation among patients with concurrent hypertension and knee OA.	33 patients with both high blood pressure and knee OA of which 29 completed the study. 65.52% female. Mean age $\approx$ 65.7.	TENS; Strength training 3 times per week 8 weeks treatment period.	Anti-hypertensive drugs; NSAID 8 weeks treatment period.	Pain, Proms function	No significant differences between groups.	Environmental: no Economic: yes Social: yes

(Continued)

TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
el Refaye, G. E. et al. (2019), Egypt (45) Randomized, single-blind, controlled trial	To determine which is more effective in alleviating primary dysmenorrhea: PEMF or diclofenac drugs.	50 females with regular menstruation. Mean age $\approx$ 21.88.	PEMF on the pelvic region. 3 occasions per menstrual cycle during 3 cycles	Diclofenac when in pain during 3 menstrual cycles.	Pain, Blood test, Proms symptoms	Positive effects on all outcomes, in favor of PT, when compared to pharmaceuticals.	Environmental: no Economic: no Social: no
Gür, A. et al. (2002), Turkey (47) Randomized, single-blind, placebo-controlled study	To examine the effectiveness of low power laser and low-dose amitriptyline therapy and to investigate effects of these therapy modalities on clinical symptoms and QoL in patients with fibromyalgia.	75 patients with fibromyalgia. 80% female. Mean age $\approx$ 30.	Laser therapy. Every weekday for 2 weeks.	Amitriptyline daily for 8 weeks.	Pain, pain assessment, proms symptoms, proms QoL and mental health	Positive effects on pain and fatigue, in favor of PT, when compared to pharmaceuticals. Positive effects on mental health, in favor of pharmaceuticals, when compared to PT.	Environmental: no Economic: no Social: yes
Koc, Z. et al. (2009), Turkey (39) Randomized, single-blind, controlled trial	To compare the effects of epidural steroid injections and PT on pain and function in patients with LSS.	29 patients with lumbar spinal stenosis. 72.41% female. Mean age $\approx$ 59.1.	Ultrasound; Hot pack; TENS 5 times per week for 2 weeks; All participants: home-exercise for 6 months, diclofenac for 2 weeks.	Steroid containing: Triamcinolon acetoneide; Bupivacaine hydrochloride; Physiologic saline. Epidural injection. All participants: home-exercise for 6 months, diclofenac for 2 weeks.	Pain, functional tests	No significant differences between groups.	Environmental: no Economic: no Social: no
Atamaz, F. et al. (2006), Turkey (40) Randomized, single-blind study	To compare the effects of PT and two different intra-articular hyaluronan drugs (sodium hyaluronate (NaHA) and hylan G-F 20) on knee OA.	82 patients with knee OA. 81.71% female. Mean age $\approx$ 60.	Infrared; Short-wave diathermy pulsed patterns; Interferential therapy.	NaHA containing: 15 mg Sodium hyaluronate and 9 mg Sodium chloride. Hylan G-F 20 containing: 8 mg HA, 0.16 mg Sodium chloride and 0.04 mg Sodium dihydrogen phosphate hydrate. Intraarticular injection.	Pain, functional tests, Proms function, Proms QoL	Positive effects on pain and QoL, in favor of PT, when compared to injections. Positive effects on mental health, in favor of Injections, when compared to PT.	Environmental: no Economic: yes Social: yes

(Continued)

TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
Paker, N. et al. (2006), Turkey Prospective Randomized Study	To investigate the efficacy of TENS and of intra-articular hylan G-F 20 injection in terms of pain, functional status, and QoL parameters in patients with knee OA, and to monitor effects of treatment over a 26-week follow-up period.	52 patients with knee OA. No information regarding gender. Mean age $\approx$ 58.92.	TENS 20 min 5 times per week for 3 weeks.	Hylan G-F 20 3 intraarticular knee injections once per week.	Pain, Functional tests, Proms function, Proms QoL	No significant differences between groups.	Environmental: no Economic: no Social: no
Sadeghifar, Amirreza et al. (2022), Iran (36) Retrospective comparative study	To evaluate the efficacy of Subacromial CSI, HA injection and PT in patients with SIS to determine which treatment is most effective.	88 patients with subacromial impingement syndrome. 53.41% female. Mean age $\approx$ 43.	Stretching exercises; Specific strength training for shoulder muscles; Hot pack; TENS; Ultrasound. 3 sessions per week for 3 weeks followed by home exercises for 1 month	Triamcinolone; HA 2 CSI with 2 week interval.	Pain, Proms function	Positive effects, in favor of CSI, when compared to PT at 3 and 6 months.	Environmental: no Economic: no Social: no
Arslan, S. & Celiker, R (2001), Turkey (23) Randomized controlled trial	To compare the efficacy of local steroid injection and PT measures for treating adhesive capsulitis.	20 patients with shoulder pain and limited ROM. 50% female. Mean age $\approx$ 56.	Hot pack; Ultrasonic therapy; Passive glenohumeral joint stretching exercises; Specific shoulder exercises such as wall climbing	NSAID; Steroid containing; Methylprednisolone acetate. Local CSI.	Pain, ROM	No significant differences between groups.	Environmental: no Economic: no Social: no
Naikmasur, V. G. et al. (2009), India (42) Randomized controlled trial	To assess the effectiveness of PT methods in myofascial pain patients and to compare with pharmacotherapy comprising of a combination of muscles relaxants and NSAID.	40 patients with myofascial pain of masticatory muscles. 57% female. Mean age $\approx$ 34.76.	TENS; Ultrasound; Helium-neon laser	Ibuprofen; Paracetamol; Chlorzoxazone. 2 times per day for 5 days	Pain, pain assessment, Functional tests, Proms function	Positive effects on pain and function, in favor of PT, when compared to pharmaceutical care.	Environmental: no Economic: yes Social: yes

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TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
Lahti, M. et al. (2008), New Zealand (26) Pilot randomized trial.	To assess the ease of the day-to-day running and to review the implementation of the trial protocol. The secondary objective for the pilot study was to compare the treatments, that is, the primary objective for the main study.	57 female with predominant urge urinary incontinence experiencing at least monthly leakage. Mean age $\approx$ 55.	Bladder retraining therapy containing: Patient information and education; Pelvic floor muscle training. 3 months.	Anticholinergic drug: Oxybutynin; Tolterodin 3 months.	Proms QoL, Proms symptoms	No significant differences between groups.	Environmental: no Economic: yes Social: yes
Galán-Martín, Miguel A. et al. (2019), Spain (27) Study protocol for a randomized, multicenter clinical trial	To evaluate the effectiveness and cost-effectiveness of a program based on active coping strategies that include Pain Neuroscience Education and physical exercise by means of a randomized clinical trial compared to usual care in primary care PT.	Patients with non-specific back pain of ≥ 6 months. Age 18–70 years.	Pain neuroscience education program in 6 sessions (10 h) + group exercise 18 sessions led by physical therapist; Usual primary care PT consisting of 15 sessions of analgesic electrotherapy, thermotherapy and standardized physical exercise.	-	Pain, pain assessment, Proms QoL, Proms symptoms, Satisfaction, Pharmaceutical use.; Health Services visits;	Not applicable (study protocol)	Environmental: no Economic: yes Social: yes
Henderson, J. et al. (2020), Australia (43) A prospective observational study	To identify if a collaborative care ED PCP after-hours service would result in improvements in ED treatment times for musculoskeletal and simple orthopedic presentations compared with patients managed under a secondary contact model of care. Secondary aims to identify if there were differences in orthopedic, follow-up plans on discharge, and analgesia prescriptions.	1,640 patients in ED setting. No information regarding gender. Age ≥ 16 years.	Primary or secondary contact for patients in ED	Analgesics	Mean treatment time, orthopedic or GP referrals, Prescribed analgesics	Positive effects on referrals, prescriptions and early discharge, in favor of primary contact PT, when compared to secondary contact PT.	Environmental: no Economic: yes Social: no

(Continued)

TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
den Hertog, A. et al. (2012), Germany (28) Randomized prospective clinical study	To investigate fast-track rehabilitation concept in terms of a measurable effect on the early recovery after TKA.	147 patients that had underwent TKA surgery. 70.75% female. Mean age $\approx$ 67.	Fast-track rehabilitation: Group therapy; Early mobilization and individual PT. Standard rehabilitation: Individual postoperative care according to existing protocol.	Analgesics	Proms function, Length of hospital stay, Consumption of analgesics	Positive effects on function, Consumption of analgesics, and length of stay, in favor of Fast-track rehabilitation, when compared to standard rehabilitation.	Environmental: no Economic: yes Social: no
Rhon, Daniel I. et al. (2014), USA (24) Randomized controlled trial	To compare the effectiveness of 2 common non-surgical treatments for SIS.	98 patients with subacromial impingement syndrome. 31.63% female. Mean age $\approx$ 41.	Joint and soft-tissue mobilizations; Manual stretches; Contract-relax techniques; Reinforcing exercises directed to the shoulder girdle or thoracic/cervical spine	Triamcinolone acetonide. CSI.	Pain, Proms function, Shoulder-related health care use, Number of additional injections	Positive effects on health care use, in favor of PT, when compared to CSI. No significant differences between groups in pain and function.	Environmental: no Economic: yes Social: no
Brose, Steven W. et al. (2019), USA (25) Retrospective analysis	To determine the success of a multidisciplinary project to manage chronic pain while reducing reliance on opioids in a population of patients with spinal cord injury.	Individuals with spinal chord injury receiving outpatient care.	Exercises.	Opioids	Opioid prescription rate; Number of patients receiving opioids; Equivalent morphine quantity	Positive effects on opioid prescription rate and number of patients receiving opioids, in favor or the multidisciplinary project, compared to previous care.	Environmental: no Economic: no Social: yes
Gallefoss, F. (2004), Norway (35) Randomized controlled trial	To explore the effects and health economic consequences of patient education in patients with COPD in a 12-month follow-up.	62 patients with mild to moderate COPD. 50% female. Mean age $\approx$ 58.	Patient education regarding breathing and coughing, exercising and management of attacks.	Beta2-agonist inhalation; Ipratropium bromide; Salbutamol	Number of GP consultations; Proportions in need of GP consultations; Utilization of rescue pharmaceuticals; Patient satisfaction	Positive effects on GP consultations, in favor of patient education, when compared to a group with no education.	Environmental: no Economic: yes Social: no
van Baar, M. E. et al. (1998), Netherlands (30) Randomized, single-blind, clinical trial	To determine the effectiveness of exercise therapy in patients with OA of hip or knee.	201 patients with osteoarthritis of the hip or knee. 78.11% female. Mean age $\approx$ 68.	Exercise therapy from physical therapist. 12 weeks	NSAID; Paracetamol	Pain, Functional tests, Proms effect, ROM, Pharmaceutical use.	Positive effects on pain, function and pharmaceutical use, in favor of PT, when compared to treatment as usual.	Environmental: no Economic: no Social: no

(Continued)

TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
van Baar, M. E. et al. (2001), Netherlands (29) Randomized, single-blind, clinical trial	To determine whether the effects of exercise therapy in patients with OA of hip or knee are sustained after 6 and 9 months' follow up.	183 patients with osteoarthritis of the hip or knee. 85.79% female. Mean age $\approx$ 68.	Exercise therapy from physical therapist. 12 weeks	NSAID; Paracetamol	Pain, Functional tests, Proms effect, ROM, Pharmaceutical use.	Positive effects on pain, in favor of PT, was found at 24 weeks, but no differences remained at 36 weeks.	Environmental: no Economic: no Social: no
Hay, E. M. et al. (2006), UK (31) Pragmatic multicenter randomized clinical trial.	To compare the clinical effectiveness, in primary care, of enhanced pharmacy review or community PT with that of a control intervention (advice leaflet reinforced by atelephone call) in the treatment of adults aged 55 years and over consulting their GP with knee pain.	325 adults with knee pain. 64.33% female. Mean age $\approx$ 67.7.	Patient education about the safety and importance of exercise, pacing, pain relief, and coping strategies; Individualized exercise program.	NSAID; Analgesics	Pain, Proms function	Self-reported use of NSAID and simple analgesia was significantly lower in the PT group compared to the control group. For the pharmacy group, the use of NSAID was significantly lower and the use of simple analgesia significantly higher compared to the control group.	Environmental: no Economic: yes Social: yes
Clausen, B. et al. (2014), Denmark (32) Study protocol for a randomized, single-blind, controlled trial	To compare the efficacy of a specific neuromuscular exercise program with optimized analgesics and anti-inflammatory drug use on knee loads, as well as pain and physical function in people with mild to moderate medial tibiofemoral knee OA.	100 patients with knee OA. Age 40–70 years.	Exercises to improve balance, muscle activation, functional alignment, and functional joint stability.	NSAID; Acetaminophen	Pain, Functional tests, QoL, Pharmaceutical use.	Not applicable (study protocol)	Environmental: no Economic: yes Social: yes
Joshi, M. N. et al. (2009), India (33) Open-label alternate patient treatment allocation	To compare the performance of PT and amitriptyline for disability reduction in patients with fibromyalgia. To determine which clinical features at baseline would predict benefit with either therapy.	156 outpatients with fibromyalgia syndrome. 96.15% female. Mean age $\approx$ 39.	Specific exercises; Relaxation; Stretching; Strength training	Amitriptyline; Tramadol	Proms function, Pharmaceutical use (tramadol).	No significant differences between groups.	Environmental: no Economic: yes Social: yes

(Continued)

TABLE 2 (Continued)

Author, year, country, study design	Objectives	Population (age, diagnosis, sex, number)	Physical therapy	Pharmaceuticals	Outcomes	Overall results	Sustainable development perspective
Gagnon, R. et al. (2021), Canada (44) Randomized controlled trial	To compare the effects of direct-access PT to usual care provided by an emergency physician for patients presenting to the ED with a MSKD.	78 patients with minor MSKD. 44% female. Mean age $\approx$ 40.2.	Direct access to physical therapist in the ED including: Physical examination; Patient education; Interventions based on the clinical analysis and physical therapists diagnosis (technical aids, imaging, prescribed or over-the-counter medication, consults with other health care professionals)	Opioids; Over-the-counter drugs	Pain, Utilization of services and resources at ED; Health care professionals consulted; Imaging tests recommended	Positive effects on clinical outcomes and utilization of services and resources, in Favor of the direct access PT, when compared to usual care after discharge and 3 months later.	Environmental: no Economic: yes Social: yes
Kim, Howard S. et al. (2019), USA (34) Retrospective cohort study	To compare analgesic prescribing among ED visits for back or neck pain receiving PT versus usual care.	464 patients with back pain visiting ED. 59% female. Mean age $\approx$ 48.2.	Physical examination of patient; Guidance on activity progression; Home exercises; Patient information and education	Benzodiazepine; Other opioid drugs	Pain; Prescription of opioids or benzodiazepine at discharge	ED back and neck pain visits receiving PT were no less likely to receive an opioid prescription and were more likely to receive a benzodiazepine than visits receiving usual care.	Environmental: no Economic: yes Social: yes

OA, osteoarthritis; TKA, Total knee arthroplasty; ROM, Range of motion; COPD, Chronic obstructive pulmonary disease; ED, Emergency department; MSKD, Musculoskeletal Disorders; LSS, Lumbar spinal stenosis; SIS, Subacromial impingement Syndrome; PCP, Primary Care Provider; NSAID, Non-Steroid Anti-inflammatory Drug; PT, Physical therapy; PEMF, Pulsed Electromagnetic Field Therapy; TENS, Transcutaneous Electronic Nerve Stimulation; HA, Hyaluronic acid; GP, General Practitioner; Proms, Patient reported outcome measures; QoL, Quality of Life; BMI, Body Mass Index; FIQ, Fibromyalgia Impact Questionnaire; WOMAC, The Western Ontario and McMaster Universities Arthritis Index; VAS, Visual Analog Scale; SPADI, Shoulder Pain and Disability Index; GRC, Global Rating of Change; NPRS, Numeric Pain Rating Scale; CSI, Corticosteroid injections; AKSS, American Knee Society Score; HRQoL, Health-related Quality of Life; SF-12, 12-Item Short Form Survey; SF-36, 36-Item Short Form Survey.

commonly included musculoskeletal diagnoses, but also respiratory and gynecological diagnoses.

In the included studies, many different types of PT interventions were described, comprising various exercise interventions (20 of 27) (22–36, 38, 42–44, 46) and interventions where the patient passively received treatment (15 of 27) (22–24, 27, 36–42, 45–48) (Table 2). Other interventions found in the included studies were patient education (22, 26, 27, 31, 34, 35) and organizational health care changes (Table 2) (34, 43, 44).

Of the pharmaceuticals that appeared in the studies, the most common type was analgesics; primary NSAIDs, followed by cortisone or other injections, muscle relaxants, and pharmaceuticals for depression and anxiety. Other pharmaceuticals that occurred were blood pressure lowering substances, anti-choleric, and pharmaceuticals to facilitate breathing (Table 2).

Twelve of the studies (24, 25, 28–35, 43, 44) had pharmaceutical use- or prescription as an specified outcome measure. Of these studies, nine compared PT with treatment as usual (25, 27–30, 34, 35, 43, 44), one study compared PT with pharmaceutical review (31) and two studies compared PT with pharmaceutical interventions (32, 33). Of the studies that compared PT with usual treatment, three (34, 43) compared PT at the ED with either no-PT ED care or PT at a later stage. Two studies (29, 30) compared PT with standard treatment by a physician, one with standard treatment by physical therapist (27), one compared fast-track rehabilitation with rehabilitation according to routine (28), and two studies (25, 35) compared multimodal therapy and educational programs containing PT with treatment as usual and routine PT.

Fifteen studies compared PT interventions, without pharmaceutical treatment, with pharmaceutical interventions but did not specify pharmaceutical use as a direct outcome measure (22, 23, 26, 36–42, 45–48). In one of these studies the participants still reported their pharmaceutical intake, which was presented in the results (22). Of the 15 studies, nine compared PT with some type of injection (22–24, 36, 39–41, 46, 48) (cortisone, hyaluronic, NaHa, or steroid). The types of pharmaceuticals in the other six studies were: anticholinergics (26), NSAIDs or other analgesics (37, 38, 42, 45), muscle relaxants (37, 42), blood pressure lowering pharmaceuticals (38) and antidepressants (47).

None of the included articles discussed sustainable development, and none performed evaluations from a Triple Bottom Line since environmental aspects of sustainable development were not addressed in any study. Eight of the studies did not address any aspect of sustainable development (22, 23, 29, 30, 36, 39, 41, 45). Economic aspects of sustainable development related to costs and healthcare utilization, were discussed in 17 of the included studies (24, 26–28, 31–35, 37, 38, 40, 42–44, 46, 48). Six of those studies compared costs and utilization between their intervention and control groups (2, 24, 27, 28, 35, 44). One study (26) suggests for future studies that cost analyses should be carried out. Social aspects of sustainable development were addressed in 12 of the included studies (25–27, 31–34, 38, 40, 42, 44, 47). One study (33) addresses poverty, education level and unequal access to care. Quality of life or physical and mental health were included as outcome measures in eight studies (26, 27, 31–33, 40, 44, 47), but they were not discussed from a sustainable development perspective. Three studies discussed patient abilities and active participation in care (31, 42, 44) and two discussed risks to patients, such as overmedication (25, 34). In one study, TENS was suggested as an alternative for pain management if

pharmaceutical treatments where contraindicated (38). Negative effects of prolonged NSAID use, and the positive effects on coping through active patient engagement in PT were highlighted (42). Empowerment and self-management was discussed as possible reasons for lowered use of health care services and resources in PT treatment (44).

Discussion

This scoping review found that investigations on PT in relation to pharmaceuticals as treatment hold a variation of characteristics with different study designs, study samples and in a range of areas within healthcare. The perspective of sustainable development was not applied in any of the included studies, and environmental aspects were not considered at all. However, several studies did consider economic or social sustainability to some extent.

Among the 27 included studies, many different types of interventions were described as PT. Physical exercise in different forms, was the most frequent type of PT treatment in the studies and TENS was the second most frequent form of PT intervention. In most of the included articles PT was referred to as specific rehabilitation exercises (22–36), in some it was referred to as TENS (36–43) and, in one study, PT was referred to as electromagnetic field treatment (45). These examples mirror the diversity of interventions within the PT discipline, highlighting the importance to mention PT in the title, abstract or keywords when addressing an intervention within the wide scope of PT, when applicable. Nevertheless, to describe an intervention solely as ‘physical therapy’ would not be of sufficient detail (49). Thus, we argue that a clear description of the intervention, including if it is delivered within the PT discipline is necessary to facilitate systematic study of interventions delivered within the PT profession.

None of the included studies were found to address all three dimensions of sustainable development, i.e., the Triple Bottom Line. That absence of evaluations regarding environmental sustainability in any study, can be considered a missed opportunity as the high carbon footprint and pollution from pharmaceuticals is a well-known problem where an effective PT alternative could pose an important contribution to sustainable healthcare. The environmental impact of PT on for example facilities and water use should not be ignored, but could be considered minor compared to the total emissions from health care, especially when compared to pharmaceuticals (2). However, some studies did discuss economic and social aspects of sustainable development. Economic evaluations mainly concerned costs and utilization of health care resources where evaluations of social aspects involved patient participation and empowerment as means for reduced healthcare utilization over time. The importance of patient empowerment for sustainable healthcare has been recognized by the WHO and is proposed by the Centre for Sustainable Healthcare as a cornerstone for sustainable healthcare (2, 4). Another aspect of sustainability that was addressed in the included studies was over medication (25) and the negative consequences from side effects were discussed in another (38). In line with this, the inconvenience of side effects from pharmaceuticals compared with PT interventions has been described previously in research of pain management (50), and patients have previously been found to prefer non-pharmacological pain management over opioids as treatment (51). Hence, increasing societal knowledge and

awareness of PT as a non-pharmacological, non-invasive pain treatment is essential (52). Evaluation from the triple bottom line has been suggested in PT research (53). For such evaluations, cooperation between physical therapists, environmental scientists and economists could be of great value for assuring that all parts of the triple bottom line are considered in a holistic perspective on sustainable healthcare.

A strength of our study is the systematic methodology and following the stepwise process described by Arksey and O'malley with additions by Levac et al. (19, 20). Combining these two when conducting a scoping review is recommended for a structured methodology (54). The choice of study design was appropriate to be able to chart in which areas comparisons of PT and pharmaceuticals exist, in order to address gaps in knowledge and identify areas where systematic reviews would be possible. There have also been at least two reviewers of all articles at all stages. Making the selection of studies in a team is something recommended by Levac et al. (20).

One limitation of this study is that grey literature was not included. The primary reason we only searched databases is because we were mainly interested in scientific sources. This could have led to publications bias and a possible lack of included studies with non-significant results. Another limitation is only including articles in English, which may have meant that we missed interesting research that could have contributed to our results; the reduction in linguistic and cultural variation could have led to lower generalizability. The result could also be limited due to the choice to only include three databases in the search strategy, as well as the specific choice of databases. Further, the decision to only include studies that used certain terminology concerning PT, it was noted during the exclusion process that many potentially interesting studies were to be excluded. By only including studies where PT was mentioned explicitly, many studies that involved exercise interventions, TENS, acupuncture, and other interventions that may well be referred to as PT were excluded. This is problematic since similar interventions would be stated as PT in the included studies but were excluded due to the lack of mentioning of PT. However, it would not have been appropriate to define PT by naming all possible interventions, considering the wide range shown already in this study. Therefore, we emphasize the importance of carefully consider terminology in studies evaluating PT interventions, to facilitate future systematic research in the field of PT.

Conclusion

There is a need for further research on the role of PT interventions in relation to pharmaceuticals as treatment. Studies are lacking that consider sustainable development, and studies comparing PT and pharmaceuticals that evaluate outcomes from a perspective of sustainable development could contribute with knowledge about how PT can be a low-carbon, resource efficient alternative to pharmaceuticals, without their negative impact on social sustainability in terms of adverse effects, and thus contribute to sustainable healthcare.

Data availability statement

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

Author contributions

PS: Conceptualization, Data curation, Project administration, Formal analysis, Investigation, Methodology, Software, Writing – original draft. MJ: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Writing – original draft. AP: Conceptualization, Supervision, Validation, Writing – review & editing. EL: Conceptualization, Supervision, Writing – review & editing, Data curation, Project administration.

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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.

Generative AI statement

The authors declare that Generative AI was used in the creation of this manuscript. During the preparation of this work the authors used OpenAI in order to edit language. After using this tool, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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Advancing sustainable healthcare through multidisciplinary stroke team rehabilitation

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Empirical studies evaluating stroke team rehabilitation interventions from a sustainability perspective are scarce. This paper highlights the significant role of multidisciplinary stroke team rehabilitation in promoting sustainable healthcare by applying principles of sustainable healthcare. Climate change and air pollution are significant risk factors for stroke and other cardiovascular diseases. Healthcare contributes to 5% of global CO₂ emissions, exacerbating the disease burden associated with climate change. The vulnerability of individuals with disabilities to climate change has been highlighted, calling for global collaboration to address climate justice and health equity. This paper argues that multidisciplinary stroke team rehabilitation is essential for achieving sustainable stroke care, optimizing patient functioning, and contributing to all principles of sustainable healthcare: prevention, patient empowerment, lean pathways, low carbon alternatives, and efficient resource use. Timely assessments and dose-specific interventions are crucial for successful outcomes, providing significant co-benefits for healthcare resource use. Enhancing self-management and patient empowerment reduces healthcare utilization without compromising health outcomes. Telerehabilitation increases accessibility to healthcare services, particularly where transportation is challenging, and complements hospital-based procedures. Preventive healthcare activities, with their low carbon footprint, offer strong incentives for optimizing secondary prevention in stroke. Overall, multidisciplinary stroke team rehabilitation aligns with all sustainable healthcare principles, reducing overall healthcare consumption through optimized functioning and health. Increased investment in rehabilitation resources leads to better quality of care and reduced long-term resource use. By integrating sustainable practices, stroke team rehabilitation can significantly contribute to sustainable healthcare, addressing both human and planetary health.

KEYWORDS

planetary health, carbon footprint, rehabilitation, sustainable healthcare, sustainable development, environmental sustainability

Introduction

Empirical studies evaluating stroke team rehabilitation interventions from a sustainable healthcare perspective are lacking. To our knowledge, only one study in stroke rehabilitation has included evaluation of environmental, economic and social aspects of sustainability (Mortimer et al., 2018). This paper argues that multidisciplinary stroke team rehabilitation is a crucial component of sustainable healthcare, aligning with key principles of prevention, patient empowerment, lean pathways, low-carbon alternatives, and efficient resource use.

Climate change and health in stroke—Call for action

Interventions to mitigate climate change and reduce environmental pollution are a high priority in stroke prevention and care, as stated in the European Stroke Organization (ESO) Action Plan (Norrving et al., 2018), due to the increasing evidence of climate change and air pollution as significant risk factors for stroke and other cardiovascular diseases (Bejot et al., 2018; Cohen et al., 2017; Ljungman et al., 2019; Verhoeven et al., 2021; Yuan et al., 2019). Climate change, biodiversity loss, and pollution of air, land and water are consequences of human activities that fundamentally undermine the environmental conditions that support human life on earth (Watts et al., 2015). Further, International Society of Physical and Rehabilitation Medicine (ISPRM) has emphasized the explicit impacts of climate change in persons living with disabilities, acknowledging their specific vulnerability to the consequences from climate change, both concerning the ability to manage acute climate related catastrophes as well as to manage rehabilitation and health in a changed climate. The ISPRM call for rehabilitation providers to collaborate globally to address climate justice and health equity [(The International Society of Physical and Rehabilitation Medicine (ISPRM), 2023)]. At the same time, healthcare is a major contributor of air- and water pollution as well as greenhouse gas emissions, producing up to 5% of the total CO₂ emissions globally, in parity with the emissions produced by the world's largest countries (Karliner et al., 2019), thereby exacerbating the disease burden associated with climate change (Chen-Xu et al., 2024).

The 2030 Agenda for Sustainable Development, which includes the Sustainable Development Goals, was adopted by all UN member states in 2015, calling for the mobilization of all countries, all stakeholders, and all people to work toward a more sustainable future (Jha et al., 2016). In this mobilization, healthcare has an important role to play, and 50 countries so far have committed to creating climate-resilient, low carbon, sustainable health systems, including 14 countries that have set a target date of reaching net zero emissions from healthcare by not later than 2050 (NHS England, 2020; Wise, 2021). In response to the 2030 Agenda, the World Health Organization (WHO) acknowledges the increasing demands for rehabilitation services to meet the current trends of aging populations and increasing number of people living with disability (World Health Organization, 2019).

While climate change is the largest health threat of this century, it also presents the greatest opportunity for healthcare professionals and departments to drastically reduce carbon use, whilst meeting equity targets and improving health outcomes, for the sake of present and future health of patients and populations (Hamilton et al., 2021).

Stroke team rehabilitation starts in the stroke unit. Stroke unit treatment increases survival and optimizes level of functioning after acute stroke (Stroke Unit Trialists, 2013). At a stroke unit, the multidisciplinary stroke team provides coordinated treatment, care and rehabilitation based on current evidence and best practice, corresponding to the needs of the patient (Langhorne et al., 2020). The multidisciplinary stroke team includes all disciplines required for acute stroke management, including radiology, and has been found to lead to a more efficient and rapid management (Norrving et al., 2018). Functioning is a key indicator for rehabilitation and has been suggested as a third health indicator, complementing the established indicators of mortality and morbidity (Stucki and Bickenbach, 2017). Further, it is argued that a focus shift toward functioning in health evaluations in the global health community could enable the attainment of sustainable development goals for health and wellbeing (Boggs et al., 2021).

Sustainable healthcare provides high-quality healthcare to meet the present needs of patients and populations without compromising the ability to meet future needs (Mortimer et al., 2018). Sustainable healthcare involves a holistic strategy for health services that effectively balances high-quality care, efficient use of resources, and minimal environmental impact, while ensuring long-term economic and social viability (Mortimer, 2010). Efforts to reduce the negative contribution of healthcare activities to climate change, and to create resilience to respond to the worst impacts of a warming climate, also offers an unprecedented opportunity to protect the health of patients, populations, and the planet (World Health Organization, 2015). A useful tool for clinicians is the sustainable value equation, that weighs patient outcomes against a “triple bottom line” of financial, as well as environmental and social impacts in their clinical decisions (Mortimer et al., 2018). Financial impact can be calculated by asking whether the desired outcome is affordable in the present as well as in future (Cadilhac et al., 2020). Environmental costs attempt to measure and internalize the impact on the natural environment from healthcare activities (Taylor and Mackie, 2017). Social impacts consider whether the intervention is accessible to all and consider whether hospital activities that help individual patients also facilitate or undermine the health of families, carers, staff, the local community, and vulnerable groups (Mortimer et al., 2018). Mortimer et al.'s (2018) model (Figure 1) for a transformation of clinical practice offers five principles for planning interventions in sustainable healthcare practice. This model emphasizes the importance of integrating environmental sustainability into clinical decision-making and highlights the role of healthcare professionals in promoting sustainable practices. By adopting these principles, multidisciplinary teams can enhance the overall sustainability of healthcare systems, ensuring that interventions are both effective and environmentally responsible. In this perspective

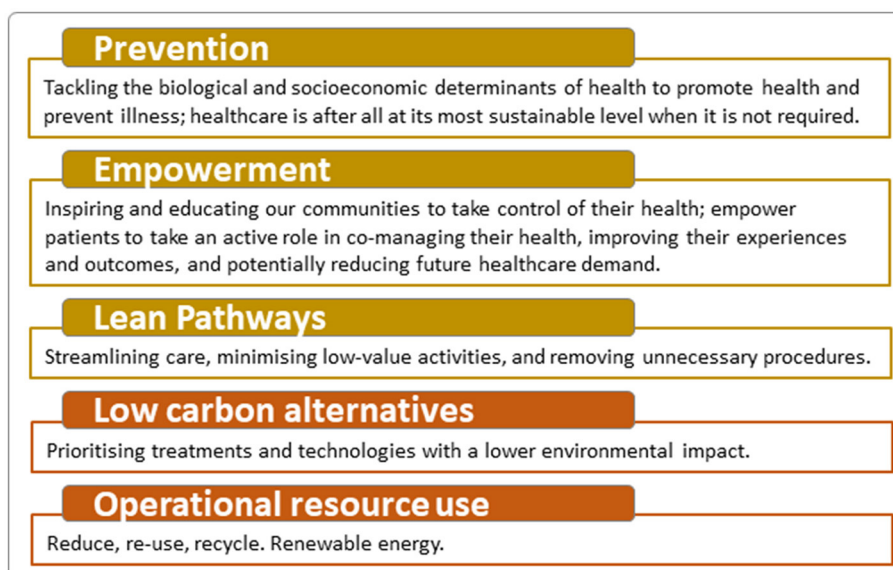


FIGURE 1
Principles for sustainable healthcare. Modified with permission from Mortimer et al. (2018).

paper, these principles are used as a framework to identify contributions of multidisciplinary stroke team rehabilitation to sustainable healthcare.

The role of multidisciplinary stroke team rehabilitation for sustainable healthcare

We identified four central aspects in which stroke team rehabilitation contributes to principles of sustainable healthcare: *the provision of timely and dose specific interventions optimize functioning, team rehabilitation supports self-efficacy and empowerment, telerehabilitation as a low resource delivery mode, and secondary prevention and health promotion minimize need of care* (Figure 2).

The first central aspect of how multidisciplinary stroke team rehabilitation contributes to sustainable healthcare is through timely and dose specific interventions that optimize functioning. One example is early supported discharge (ESD) from hospital (Langhorne et al., 2017), where the stroke team provides rehabilitation at the patient's home. The ESD can decrease the length of hospital stay (Jee et al., 2022) and be a cost-effective alternative to in-hospital stroke rehabilitation (Anderson et al., 2002; Candio et al., 2022). Although not evaluated in research on stroke rehabilitation, the reduced need for in-hospital care means a decrease in environmental impact from healthcare since in-hospital care produces a high carbon footprint (Rodriguez-Jimenez et al., 2023). ESD is also shown to be beneficial regarding the patients' functioning, in terms of independency in daily activities early after stroke (Bjorkdahl et al., 2023). Thereby, ESD contributes to three principles of sustainable healthcare; lean pathways in that it involves effective rehabilitation and is resource saving, and empowerment and prevention in that ESD

implements rehabilitation strategies applied by patients directly in their home environment, which also involves preventive strategies to reduce future healthcare consumption (Figure 2). Another example is the use of exoskeletons in upper limb rehabilitation, highlighting the need for sustainability evaluation due to the particularly high monetary costs of the equipment (Pinelli et al., 2023). The authors propose the usefulness of a sustainability evaluation including economic, social and environmental values as a framework to ensure sustainability in clinical decision-making in stroke rehabilitation (Pinelli et al., 2023). When it comes to the importance of dose specific rehabilitation, it has been found difficult to achieve the intervention dose needed to improve functioning, for example in upper limb rehabilitation after stroke (Hayward et al., 2021). This implies that an insufficient dose of rehabilitation could be a waste of valuable resources, hence not contributing to sustainable healthcare. Rather, an adequate rehabilitation dose is essential for achieving sustainable healthcare.

The second key aspect of how multidisciplinary stroke team rehabilitation contributes to sustainable healthcare is through the support of self-efficacy and patient empowerment. Stroke team rehabilitation interventions focusing on self-management, such as training in activities of daily life (ADL) or other task-oriented interventions, have been found not only to increase self-efficacy but also to be beneficial for quality of life and health status after stroke (Jones and Riazi, 2011). Self-efficacy shapes health behaviors by influencing the goals that individuals set, the effort they put into achieving those goals, and their perseverance in the face of challenges or setbacks (Dixon et al., 2007). By nature, rehabilitation involves empowerment of patients for strengthening of capacities and promoting self-management. This directly supports the principle of *empowerment* but also aligns with all other principles of sustainable healthcare. It aids in *prevention* by equipping patients with tools to maintain their health status, promotes *lean pathways* by reducing the need for additional

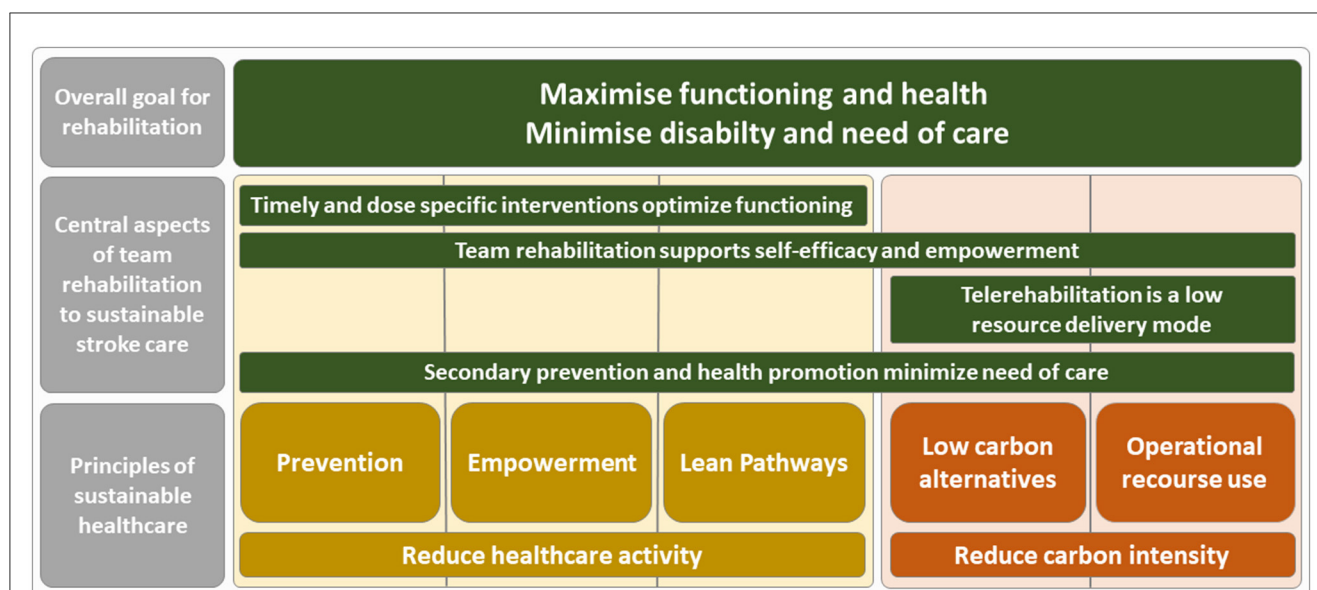


FIGURE 2

Aspects where multidisciplinary stroke team rehabilitation contributes to principles of sustainable healthcare.

healthcare interventions, and supports *low carbon alternatives* and *operational resource use* due to its resource efficiency (Figure 2).

The third significant aspect of how multidisciplinary stroke team rehabilitation contributes to sustainable healthcare concerns the use of telerehabilitation as a low resource delivery mode. Digital health involves using digital technologies to enhance health, including telerehabilitation, which delivers rehabilitation through information and communication technologies (World Health Organization, 2021). Telerehabilitation interventions have been shown to be cost-effective (Jiang et al., 2019) and could also be considered a *low carbon alternative* with a *low operational resource use* (Figure 2) compared to clinical visits, as a means for reducing the environmental burden of healthcare, where substituting clinical visits with digital health could lead to fewer transports and hence less vehicle emissions (Masino et al., 2010; Purohit et al., 2021). Telemedicine has been found to significantly reduce carbon emissions, with savings ranging from 0.70 to 372 kg CO₂e per consultation, primarily due to reduced travel, while the systems themselves produce minimal emissions (Purohit et al., 2021). A review found moderate evidence for the effectiveness of digital health on motor function, activities of daily living, independence, satisfaction and quality of life in patients with stroke (Appleby et al., 2019). However, telerehabilitation requires resources and infrastructure which need to be considered (Purohit et al., 2021), and the accessibility to technology in patients should be considered when using telerehabilitation in stroke team rehabilitation.

The fourth crucial aspect of how multidisciplinary stroke team rehabilitation contributes to sustainable healthcare involves secondary prevention and health promotion, which minimize the need for additional care. After a first stroke or Transient Ischemic Attack (TIA), effective secondary prevention could reduce the burden of stroke by almost 25% (Hankey, 2014). Secondary prevention is therefore an important part of stroke management and important for sustainable stroke care, including the work

conducted by all team members. Ten modifiable risk factors cause 90% of stroke incidences, there among physical inactivity, hypertension, unhealthy diet, smoking, and excessive alcohol intake (O'Donnell et al., 2016). Therefore, addressing modifiable risk factors for stroke is key in secondary prevention, commonly including counseling, patient education, risk factor management, and supervised exercise provided by health professionals in the stroke team (Liljehult et al., 2020). Improved health behavior is widely recommended to be included in secondary prevention (Kernan et al., 2014) and modifiable risk factors need to be managed not only with pharmacological treatment, but also with health behavior change (Boehme et al., 2017). Interventions focusing on secondary prevention in stroke through health behavior change have found effects on behavioral risk factors, blood pressure, as well as cardiovascular events (Liljehult et al., 2020). Clearly, secondary prevention contributes to the first principle of sustainable healthcare, which is *prevention*, but it also supports all other principles. It *empowers* patients by providing them with knowledge and tools for self-management to maintain their health and prevent further disease. Additionally, secondary prevention promotes *lean pathways* by reducing the need for additional healthcare resources through disease prevention. Moreover, preventive strategies for stroke are *low in carbon emissions* and *operational resource use* compared to the resource-intensive care required during stroke treatment, thereby helping to reduce the carbon intensity of care.

Path forward

Multidisciplinary stroke team rehabilitation is not only considered best practice in stroke care but is also essential for achieving sustainable stroke care. It optimizes functioning which has numerous co-benefits for healthcare resource use and contributes to all principles for sustainable healthcare;

prevention, patient empowerment, lean pathways, low carbon alternatives and efficient operational resource use. First, timely assessment and dose specific interventions are essential for successful stroke rehabilitation outcomes and are a central focus of the multidisciplinary stroke team rehabilitation aimed at optimizing patient functioning. Providing team rehabilitation at the right time and in the right dose to the patients who benefit most will optimize functioning and, in addition, yield important co-benefits for sustainable healthcare. Achieving beneficial rehabilitation outcomes hinges on providing an adequate dose, which can be challenging in a clinical setting. Nevertheless, investing in a sufficient intervention dose is crucial to avoid wasting valuable patient and staff resources. While this may require greater short-term resource allocation, it will ultimately lead to optimized functioning, improved quality of care, and reduced overall healthcare resource use, thereby contributing to sustainable healthcare.

Second, self-efficacy and patient empowerment are recognized as core values in rehabilitation relating to patient autonomy. By enhancing self-management and empowering patients, healthcare utilization can be reduced without compromising health outcomes (Panagioti et al., 2014), thereby contributing to more sustainable healthcare over time. Third, telerehabilitation, as an alternative to physical healthcare visits, holds great potential for people with stroke, particularly in increasing accessibility to healthcare services where transportation is challenging. The benefits of telerehabilitation extend beyond reduced travel, offering increased access to neurorehabilitation by complementing hospital-based procedures with telerehabilitation (Brennan et al., 2021). Last, preventive healthcare activities make a dual contribution to sustainable stroke due to their very low carbon footprint compared to more resource-intensive healthcare activities such as hospital or ambulatory care (Pichler et al., 2019). But foremost, there are vast social, environmental and economic benefits from stroke prevention relating to the potential decrease in years lived with disability caused by stroke (Cieza et al., 2021) along with the tremendous resources used in hospital care due to stroke (Lekander et al., 2017; Strilciuc et al., 2021) and the environmental impact from hospital emissions (Rodriguez-Jimenez et al., 2023). These aspects combined provide a strong incentive for optimizing secondary prevention in stroke. Additionally, health behavior changes often have environmental co-benefits; for example, dietary changes that are beneficial to health also have a lower carbon footprint (Crippa et al., 2021). Similarly, integrating more physical activity into daily life can lead to reduced greenhouse gas emissions due to decreased transportation needs (Quam et al., 2017). The significant contribution of secondary prevention to sustainable stroke care should be acknowledged, as it reduces stroke recurrence and thereby minimizes the need for care.

As demonstrated, multidisciplinary stroke team rehabilitation aligns with all principles of sustainable healthcare. Utilizing a sustainability framework to analyze healthcare activities allows us to identify both sustainable and less sustainable practices (Mortimer et al., 2018). Generally, striving for sustainable healthcare involves reducing healthcare activities (Mortimer et al., 2018). However, in the case of stroke team rehabilitation, the opposite is true. Increased investment in rehabilitation resources leads to lower overall healthcare resource use. This is because

rehabilitation interventions typically have a low carbon footprint and result in optimized functioning and health, thereby reducing overall healthcare consumption over time.

Future directions

Evaluations of stroke rehabilitation interventions that consider environmental, economic, and social aspects of sustainability are scarce. We strongly recommend that future evaluations of stroke rehabilitation interventions incorporate sustainable development perspective. This approach will uncover the contribution of multidisciplinary stroke team rehabilitation to sustainable healthcare.

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

HP: Conceptualization, Visualization, Writing – original draft, Writing – review & editing. MR: Writing – original draft, Writing – review & editing. EL: Writing – original draft, Writing – review & editing. SB: Writing – original draft, Writing – review & editing. AP: 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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Analysis of an intergenerational service-learning experience based on physical exercise in a community setting: a mixed-method study

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Introduction: Physical activity offers numerous benefits that improve psychological well-being, reduce dependency, and foster intergenerational relationships. Universities play a key role in promoting the health of students by proposing actions that contribute to a sustainable future, fostering a mature society and reducing ageism. This service-learning project aimed to assess the impact of an intergenerational cane-walking program on older adults and physiotherapy students in a community setting. The project focused on promoting health and fostering intergenerational relationships.

Methods: A concurrent, nested mixed-methods design was used for the intervention, involving intergenerational group walks during the 2022–2023 academic year. The program was designed and supervised by faculty members and three fourth-year fellows. Data collection was based on adherence to the intervention, the Behavioral Regulation in Exercise Questionnaire (BREQ-3), interviews with older adults and feedback questionnaires completed by them and participating students.

Results: Satisfactory adherence was evidenced among older adults, with 65.79% of participants who completed the project and 72% who adhered to the intervention, although there were no statistically significant differences in terms of motivation to exercise taking that adherence into account. The project's ability to foster intergenerational relationships was rated by the seniors at 9.50 ± 0.6 , and 100% answered affirmatively about its capacity of contribute to improving their health and well-being. Student feedback also reflected high scores for fostering intergenerational relationships, with scores of 10 (fellows), 8.7 ± 1.2 (third-year students), and 8.27 ± 1.2 (second-year students). The project's contribution to skills development was rated positively by 100% of the fellows, 88.6% of the second-year students, and 74.1% of the third-year students. In the nested study, three key themes related to exercise emerged by older adults: (1) perceptions of exercise, (2) barriers to exercise and (3) motivations for exercise. Regarding satisfaction with the program, three main themes emerged: (1) intergenerational relationships, (2) strengths of the program and (3) suggestions for improvement.

Conclusion: The program appears to improve the well-being of older adults and provide valuable experiential learning for students. Thus, service-learning projects could effectively promote sustainable health practices, highlighting the important role of universities in community health initiatives.

KEYWORDS

service-learning, intergenerational relations, exercise, aged, community participation

1 Introduction

Demographic trends are changing worldwide, leading to an aging population. In 2050, the world's population aged 60 and over will be 2.1 billion (1). In recent years, the concept of “Healthy Aging” has emerged as the optimal biological, sociological and physiological development throughout life (2). The Healthy Aging Strategy takes a life-course approach that aims to maximize the health and well-being of all older people (3).

Physical activity (PA) offers numerous benefits for aging at different levels. It has been proven that the combination of PA and spending time outdoors has a great impact on human health (4). Thus, in 2003, the concept of “green exercise” was born, which is any PA that takes place outside the home (4). When these activities are promoted in groups in the natural environment, functional and psychosocial benefits can also be achieved, fostering social relationships (5). Furthermore, some studies have concluded that motivation is an important aspect of practicing PA, with both instructors or healthcare professionals and positive reinforcement being essential (6). This is crucial to create a feeling of empowerment and enjoyment, in addition to the benefits of the PA itself, which also promotes adherence. The literature has shown that community-based group exercise programs for older people, especially in a natural environment, appear to promote both motivation and adherence over time (7). However, we must not overlook the barriers that are closely related to motivating older people, such as health problems, family responsibilities or education about the benefits and recommendations of PA, among others (8).

On the other hand, the mission of universities relates to the development of service to the community (9), in addition to the classic work of teaching and scientific research. Thus, universities must play a key role in promoting global health, proposing actions that contribute to a sustainable future, and promoting a mature society led by socially responsible professionals with ethical values and less ageism. Higher education institutions are also committed to meeting with the Sustainable Human Development (SHD), in which the paradigm of sustainability is a central concern for human existence, considering aspects such as development, cooperation, health, ecology, ethics, or global citizenship (10).

Higher education programs such as Service-Learning (SL) are being developed to build skills focused on community engagement at the university while supporting the achievement of several Sustainable Development Goals (SDGs) (10). In terms of methodological approach, a reciprocal relationship between service and learning is achieved, as SL combines service to the community with academic and experiential learning. In this way, SL enables students to approach their professional future through the development of social skills (11). Within SL, intergenerational SL involving students and older people is a valid option that enables health and social issues to be addressed.

In these SL projects, in addition to the specific interventions of the service, a real interaction is created in which experiences from the daily lives of all participants are shared (12). In this way, a bidirectional befriending approach is created, which is particularly relevant to reduce ageism by students (13, 14).

Considering the need to support adherence to exercise among the older adult population and prepare future physiotherapists for the demands of an aging population, the aim of this SL project was to evaluate the impact of an intergenerational walking program developed in a community setting on a group of older adults (OAs) and students.

2 Materials and methods

2.1 Design

An experimental study was developed involving an intergenerational SL experience based on PA in a community setting.

A concurrent, nested, mixed-method design was selected for this study. It was conducted in accordance with the Declaration of Helsinki and following the guidelines of the Mixed Method Article Report Standards (MMARS) (15). The quantitative approach followed was a quasi-experimental design. Besides, a qualitative descriptive approach was explored using content analysis.

This study has been approved by the University Ethics Committee of León (ETICA-ULE-049-2022), ensuring participant privacy per Organic Law 3/2018 of December 5. The SL project is supported within the framework of the cooperation agreement signed between the Social Service of the Junta de Castilla y León, the University of León and the city councils of León and Ponferrada (Spain).

2.2 Participants and setting

The project included participants divided into two study groups, OAs and students, who signed the subsequent informed consent after agreeing to participate in the project, clearing all their doubts and accepting their participation in the focus group by recording their voice.

The initial sample of OAs, which consisted of 38 participants, was linked to the SL project thanks to an *Intergenerational Approach Program*, funded by the Social Services of the regional government, and developed in collaboration between the University and the local Council's Department for Senior Citizens and Citizen Participation. This fact facilitated the project's alignment with the SDG-17 (Partnerships for the Goals). Inclusion criteria for OAs were: (1) the

ability to walk independently, (2) over 55 years of age, (3) no difficulty in performing moderate physical activities assessed with the Physical Activity Readiness Questionnaire (PAR-Q), (4) participation in practical walking training with canes and (5) the ability to read and complete questionnaires in Spanish language. Exclusion criteria were cardiovascular diseases that were incompatible with PA, which was determined by completing the PAR-Q.

The student sample included 71 participants: 27 third-year physiotherapy students as one of two possible activities within the continuous assessment of the subject “Specific methods in physiotherapy I” (Group A) and 44 s-year students as a compulsory activity within the face-to-face placements of the subject “Public health, health law and community physiotherapy” (Group B) at a Spanish university. Inclusion criteria were students enrolled in one of the two subjects associated with the SL project. In addition, 3 fourth-year fellows participated, one during the first and two during the second four-month period of the course, who were selected for the project following a selection process. Thus, a total of 74 students formed the posterior group of analysis.

2.3 Procedure

This SL project was integrated throughout the academic year 2022–23 into two subjects with learning competencies related to the field of health promotion within the physiotherapy degree program and took place over two consecutive semesters. The objectives, timetable and process of the project are described in [Appendix](#).

With regard to the group of OAs, within the timeline, it is worth mentioning the participation in a specific three-hour training session on walking with canes by an instructor paid for the city council of Ponferrada (Spain). This happened after the research group had verified the absence of exclusion criteria and the informed consent, the protection of images and other questionnaires described below (sociodemographic data, chronic comorbidity information and Spanish Behavioral Regulation in Exercise Questionnaire-3) were completed.

On the students’ side, the SL project started in the first days of the two semesters with the recruitment of the fourth-year fellows and the holding of information sessions for all students involved on the main objectives we sought to promote: intergenerational relationships and development or reinforcement of competences, such as settlement in knowledge, and guidance to older participants, of the technical pillars of cane-walking and exercise plan with canes, respectful treatment and leadership capacity.

After reinforcement (Group A) or initiation (Group B) of training in walking with canes by the professor in charge, the students were divided into groups of 3 to 4 people and assigned to a single outing with OAs. During these outings, the students guided the seniors in performing a warm-up exercise ([Figure 1A](#)), followed by training in proper cane technique and a short strength training exercise in the middle of the route ([Figure 1B](#)). These exercises and the route ([Figure 1C](#)) were carefully planned by fourth-year students, who provided detailed information and explanatory pictures to the other students via email a week before the outing. The SL project was developed in the city of Ponferrada (Spain), which has 52,963 inhabitants, a sub-humid continental Mediterranean climate and an abundance of peri-urban green areas. The outings alternated

between urban ([Figure 1D](#)) and peri-urban areas, which were carefully selected to provide novel and challenging environments to encourage engagement and participation. The intergenerational outing itself, along with the time spent on the dynamics of the SL project and learning walking technique with canes, was validated as a computable activity as part of a compulsory continuous assessment in Group A or with 5 h of a mandatory personal practicum (3 h for learning the technique of walking with canes and 2 h for the outing) in Group B.

Questions about the routes, the correct cane techniques, or the exercises were answered by the professor on the morning of the outing, during which practice canes were also distributed. The approximately two-hour walks were conducted from October 4, 2022, to May 22, 2023, on Monday afternoons (16:30–18:30). Before each session, the fourth-year fellows or professor checked the attendance list of the students and the OA and divided the seniors into small groups led by students. During the session, the teacher in charge assessed compliance (achieved or not achieved) with three basic aspects: appropriate guidance/instruction during the outing regarding technical aspects (such as cane walking pillars and exercise table), respectful interaction with older adult, and taking the leadership role.

Of the 27 outings initially planned, 22 were completed, but 5 had to be canceled due to inclement weather.

2.4 Outcome measurements

Sociodemographic data and chronic comorbidity information were collected at baseline as part of the initial screening process for OA participants ([Table 1](#)).

Throughout the project, adherence to the intervention was measured by two aspects postulated in the general exercise literature (16): the permanence in the project until its completion and the fidelity of the participants in the planned outings.

In addition, the motivation of OAs who completed the program was assessed using the Spanish Behavioral Regulation in Exercise Questionnaire-3 (BREQ-3) (17). This is an extended BREQ-2 questionnaire comprising 23 items with 6 subcategories to measure the behavioral regulatory styles: four for intrinsic regulation, based on questions about how they perceive PA in their daily life; four for integrated regulation, to find out if PA is part of their identity and if it is fundamental to them; three for identified regulation, where they evaluate the benefits and advantages of PA; four for introjected regulation, asking questions about guilt for not exercising, four for external regulation, where the respondent’s opinions influence the practice of PA; and four for amotivation, where motives for PA are not present (18–20). A five-point response scale was used to rate the items, ranging from 0 (not true for me) to 4 (very true to me). The score for each dimension was determined as the average value of items that constituted each subcategory.

The SL project’s ability to promote intergenerational relationships (0–10 Likert scales) was evaluated among the OAs who completed the project via an *ad hoc* opinion questionnaire, as well as a question on their perception (yes/no) of the project’s ability to improve their health and well-being. The last question sought to analyze the effectiveness of the intervention in terms of achieving SDG-3 (good health and well-being).

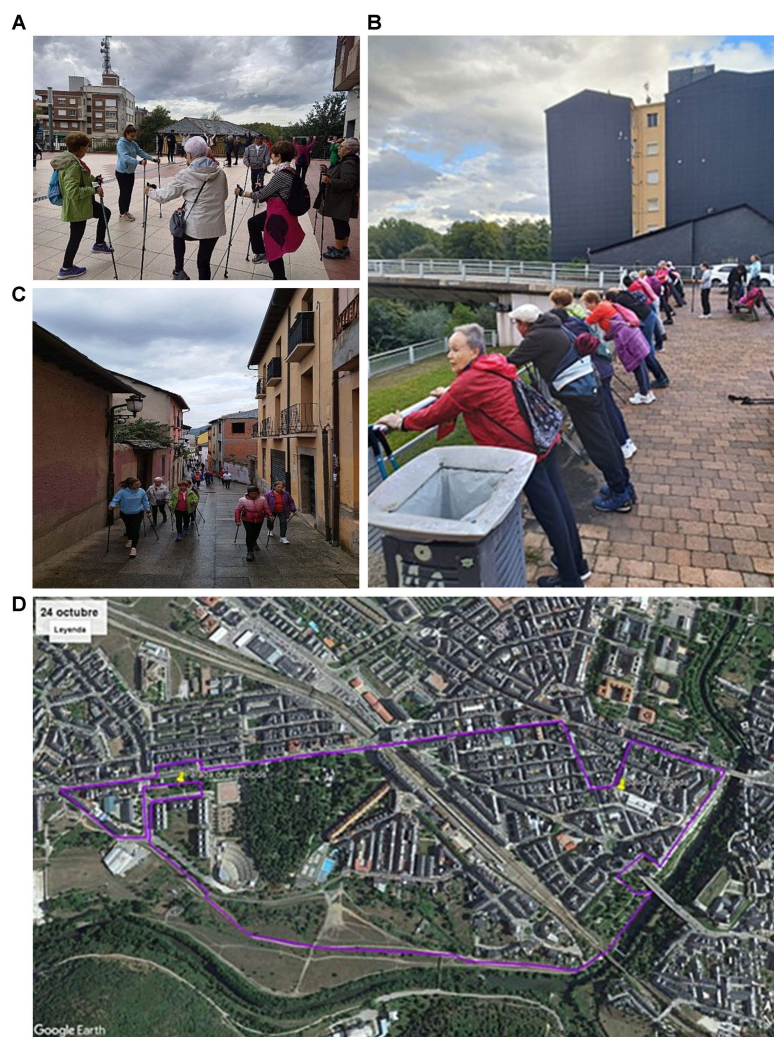


FIGURE 1

Intergenerational walking project photographs. (A) Intergenerational Walking Project 1 © 2022 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>. (B) Intergenerational Walking Project 2 © 2022 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>. (C) Intergenerational Walking Project 3 © 2022 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>. (D) Intergenerational Walking Project 4 © 2022 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

At the end of the study, the opinions of all student participants were also analyzed. An ad-hoc opinion questionnaire with a Likert scale from 0 to 10, was used to assess the effectiveness of the project in fostering intergenerational relationships and its usefulness in developing skills and abilities. These questions aimed to evaluate the impact of the intervention on the promotion of quality education, which is in line with the objectives of SDG-4 (Quality Education). In addition, an open-ended question was included to allow students the opportunity to provide highlights, suggestions for improvement or criticism of the project.

2.5 Nested qualitative study

For the qualitative study component, after the last walk with the students, the OAs were contacted and asked if they were interested in participating in a focus group. Three semi-structured focus group

interviews were conducted on May 29 and 30, 2023 by R.L., C.J. and S.C., three experienced qualitative researchers. Each focus group interview consisted of 7–8 OAs and lasted one and a half hours, until reaching data saturation when participants added no new information to answer the questions. The semi-structured interviews were based on a predefined interview guide (the question guide is shown in Table 2).

2.6 Quantitative analysis

Due to the exploratory nature of the study, no sample size planning was done prior to the study.

Quantitative data analysis was carried out using the statistical package IBM SPSS for Windows, version 28 (IBM Corp, Armonk, NY, USA).

For the descriptive analysis, the mean and SD or the median and interquartile range and numbers (percentages) were used. The

TABLE 1 General characteristics of older adults ($n = 38$).

General characteristics	Values
Age (mean $\pm$ SD)	72.00 $\pm$ 5.13
Gender [n (%)]	
Male	6 (15.79)
Female	32 (84.21)
Educational level [n (%)]	
No education. But I can read and write	7 (18.92)
Incomplete Primary (school)	3 (8.11)
First grade	1 (2.70)
Second grade/First cycle	10 (27.03)
Third grade/Second cycle	10 (27.03)
University	6 (16.22)
Civil status [n (%)]	
Single	2 (5.26)
Married	16 (42.11)
Widower	15 (39.47)
Divorced	5 (13.16)
Employment situation [n (%)]	
Active	2 (5.26)
Retired	36 (94.74)
Lives alone	20 (52.63)
Chronic disease	19 (50.00)
Type of chronic disease [n (%)]	
Arterial hypertension	7 (18.42)
Arthrosis	7 (18.42)
Diabetes	5 (13.16)
Others	6 (15.79)
Health perception [n (%)]	
Excellent	2 (5.26)
Very good	4 (10.53)
Good	27 (71.05)
Regular	5 (13.16)
Weekly physical exercise (mean $\pm$ SD) minutes	430.26 $\pm$ 213.42

SD, Standard deviation. General characteristics of older adults ($n = 38$) © 2023 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

Shapiro–Wilk test was used to determine the normality of the quantitative variable. The Mann–Whitney U test was used for between-group comparisons. Statistical analysis was carried out at a confidence level of 95% and a statistical significance of $p < 0.05$ for all comparisons.

2.7 Qualitative analysis

Qualitative data was analyzed through content analysis. Audio-recorded focus group interviews were transcribed verbatim and

pseudonymized. After that, transcriptions were reviewed by one researcher for accuracy. Two researchers independently read and coded the meaning units from the transcriptions using Atlas Ti 24. The codes were then grouped into categories, and these were condensed into themes. To ensure trustworthiness, codes, categories and themes were discussed reflectively between both researchers until reaching an agreement, a third independent researcher reviewed the themes and related narrations to confirm the analysis.

3 Results

3.1 Results of the quantitative study

3.1.1 Quantitative results in older adults

The initial sample of OAs consisted of 38 participants, with the following characteristics (Table 1). The average age was 72 years, with a predominance of women of 84.21%; the distribution by educational level showed a higher frequency of 27.03% for second grade/first cycle and the same percentage for third grade/s cycle, followed by 18.92% with no education but with literacy, 16.22% for university and 2.70% for first grade. The participants were predominantly married (42.11%) or widowed (39.47%); 94.74% were retired, while 52.63% lived alone. Regarding the presence of chronic disease comorbidities, 50% of participants had at least one comorbidity; the most common comorbidities included hypertension (18.42%) osteoarthritis (18.42%) and diabetes (13.16%). When the participants were asked about their perception of their state of health, the results were 5.26% excellent, 10.53% very good, 71.05% good and 13.16% fair.

The intervention demonstrated satisfactory adherence among the OAs, as indicated by the percentage of participants who completed the project—65.79% (25 out of 38)—and those who adhered to the intervention (Figure 2), defined as participants who completed at least two-thirds of the 22 outings (72%). On an individual level, the high adherence of three participants stands out, as they attended 100% of the sessions in the first semester, and two participants did so in the second semester.

The reasons given by participants who dropped out of the program ($n = 13$) were illness or serious injury ($n = 6$), prolonged absence from the city ($n = 3$), overlapping with other activities or family or personal problems ($n = 3$) or because they were unable to participate in the final assessment ($n = 1$).

The main reasons reported for absenteeism among the 25 participants who completed the intervention included caring for family members, attending medical appointments, and dealing with their own health issues.

When comparing the regulation of exercise behavior at the end of the intervention based on the adherence of the participants, no significant differences ($p > 0.05$) were found for the different BREQ-3 dimensions analyzed (Table 3). However, motivation scores for the final sample of OAs were more positive in the adherent group than in the non-adherent group, with intrinsic, integrated and identified regulation of PA close to the maximum score for all participants. In contrast, introjected regulation and external regulation scored low in both groups after the intervention. The amotivation dimension revealed favorable results in both groups.

TABLE 2 Guide of questions for the focal groups in older adults.

1. What type of physical exercise do you do in your daily life, taking into account the last week?
2. What motivates you to exercise?
Do you consider exercising pleasurable/satisfying? Do you think that physical exercise is part of your daily life? Do you consider practicing physical exercise beneficial/important? At what level do you think it is beneficial? How do you feel when you do not do physical exercise/when you do not attend sessions? Do you think that the people around you influence you to exercise? How? What demotivates or limits you from exercising?
3. Have you been surprised by your physical ability?
When students prepare routes, they assume that being older adults they will have a lower capacity and then the students are surprised.
Do you think that your physical capacity has been undervalued and that you could have done more than what was proposed? Has the group helped you to improve and surpass the physical capacity that you started with?
4. Do you think your satisfaction with life/happiness is different since you have participated in the cane-walking program? in what sense, what has changed?
5. Opinion questionnaire
What experiences and/or relationships have been maintained with the students during the sessions? What do you think about the participation of the students in the development of the project? Overall, do you think the project has helped foster intergenerational relationships? Do you think the program has been adapted to your needs? Would you change anything about the program?

Guide of questions for the focal groups in older adults © 2023 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

General opinion of the SL projects was evaluated among the subjects who completed the intervention ($n = 25$) using an ad-hoc opinion questionnaire (Table 4), which showed scores of 9.50 ± 0.6 about ability to foster intergenerational relationships. 100% of the sample answered in the affirmative to the question of whether the project was able to contribute to improving their health and well-being (SDG 3).

3.1.2 Quantitative results of the students

Table 4 also shows the results of the ad-hoc student opinion questionnaire, including a final open-ended response given to 74 participants. The data contained therein, as well as the quick compliance notes made by the professor in charge, show that the majority of the main objectives of the activity (appropriate guidance/instruction for the older adult, respectful interaction and leadership role) were met. Regarding the open-ended question, one third-year student noted in an open-ended response that his participation in the project “helped develop communication skills with future patients.” In addition, several second-year students emphasized that they found the “conversations with the seniors” and “the opportunity to learn from them” to be the most enjoyable aspects of the experience. However, some students suggested that a greater number of outings during the course could further enhance the program.

3.2 Results of the qualitative study

For the qualitative analysis 25 OAs (average age 72 years) participated in the focus group interviews.

The qualitative analysis of the OAs in relation to PA, revealed three main themes that complement and enrich the quantitative results: perceptions of PA, perceived barriers to regular participation in PA, and underlying motivational factors for PA. These themes not only support the questionnaire’s findings, but also provide a more nuanced understanding of the reasons behind the responses.

3.2.1 Perceptions of PA

This theme emerged from the synthesis of OAs’ narratives related to their perceptions when performing PA.

The first category of this theme is titled “Type of PA they usually do,” and in it they explained the physical activities they usually did, most of them were very active and the most usual exercise for them was walking: “Me, walk, walk, walk, walk. I also do gymnastics for a couple of days (...). Well, I did Taichi too, but this season my life got a little complicated and I have not been able to go.” (P29, non-adherent).

The second category found in this theme is the OAs’ self-efficacy for PA. One of them explained that she was able to do more PA than they previously thought: “Now I dare to do everything after not trusting myself in the first long runs and seeing that I did them perfectly. Now I dare with everything.” (P18, adherent).

On the other hand, other participants explained their difficulties when doing PA: “I have my difficulties walking, sometimes I cannot give more of myself because my leg does not allow me, so I cannot. Maybe at first, I run a lot and go among the first ones, but then I leave. Of course, because I cannot take it anymore. I have given so much of myself that I cannot take it anymore.” (P34, adherent).

The last category of this theme synthesizes the narratives related to how the OAs felt when they did not exercise. They explain that they know how important PA is in their lives and that they feel bad when they do not exercise. “If we want to grow old, we have to walk or do something. It’s just that if you do not exercise, you are missing something.” (P17, adherent).

3.2.2 Barriers to exercise

In this theme, the OAs expressed their perception of which elements prevented them from doing PA. This theme is composed of four categories.

The first category refers to health problems. The most common health problem was musculoskeletal pain: “This year foot surgery has limited me.” (P33, non-adherent).

The second category grouped the OAs’ narratives about how the COVID-19 pandemic restricted them to do exercise: “Because I used to go to the gym, I went every day for 5 h, every day, before COVID pandemic.” (P31, adherent).

Another common issue related as barriers to exercise was described in this third category: weather inclemency. The OAs explained that some weather conditions discouraged them to do PA: “The activity of walk forces you to go out a little bit. Otherwise, you would not go out 1 day because it’s raining, another day because it’s cold, another day...” (P10, non-adherent).

In a fourth category, the family burden is described: “If I have to pay attention to something, I do exercise anyway because I try to do it

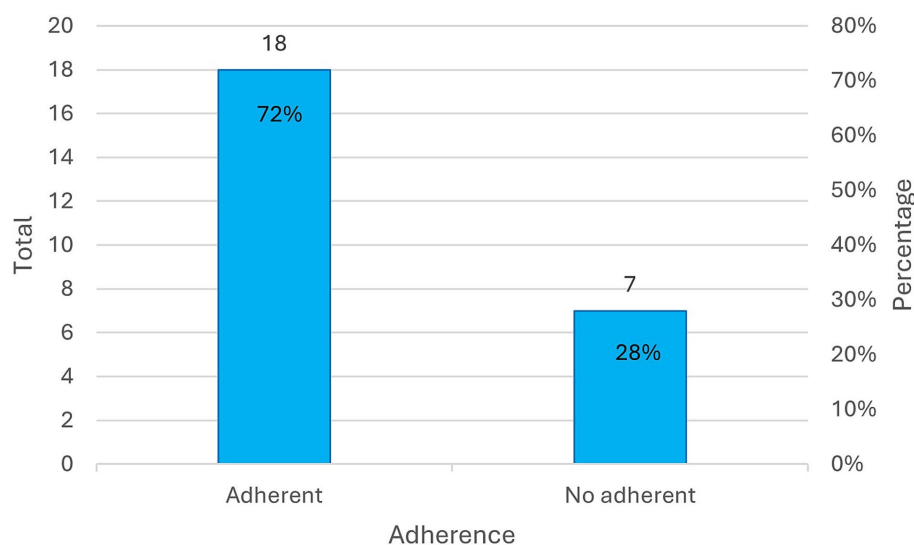


FIGURE 2

Distribution of the older adult participants according to adherence at the end of the intervention. Distribution of the older adult participants according to adherence at the end of the intervention © 2023 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

TABLE 3 Motivation results according to the BREQ-3 questionnaire considering adherence after completion of the intervention.

BREQ-3 Subcategory	Adherent (n = 18)	Non adherent (n = 7)	p-value
Intrinsic regulation	3.67 ± 0.62 4 (0.31)	3.36 ± 0.67 3.5 (1.25)	0.357
Integrated regulation	3.38 ± 0.94 3.88 (1.06)	3.11 ± 0.96 3 (2)	0.534
Identified regulation	3.78 ± 0.41 4 (0.33)	3.57 ± 0.46 3.67 (1)	0.297
Introjected regulation	1.28 ± 1.10 1.38 (2.25)	1.36 ± 0.99 1.5 (1.5)	0.883
External regulation	0.38 ± 0.81 0 (0.75)	0.21 ± 0.30 0 (0.75)	0.883
Amotivation	0.44 ± 0.67 0(0.81)	0.54 ± 1.12 0 (0.75)	0.701
Mean ± SD			
Median (Interquartile range)			
Using Mann–Whitney U test			

Motivation results according to the BREQ-3 questionnaire considering adherence after completion of the intervention. © 2023 by Beatriz Alonso-Cortés Fradejas is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>.

beforehand. But if I have to take care of someone, then I do not go out exercising. For example, when I accompany my husband, it is the only thing that limits me." (P36, adherent).

3.2.3 Motivations for exercise

The last theme that emerged deals with the motivations of OAs for exercise. This theme is composed of three categories.

The first category refers to the OAs' well-being, considering physical, mental, and physical appearance dimensions: "You get less tired. Yes, yes. You have different energy. Above all, the psychological

thing (...) Not only the physical aspect of exercising but the psychological aspect (...) It clears your head." (P15, adherent).

The second category of this theme synthesizes the OAs' feelings about their motivation in relation to other people, on the one hand, they highlighted the pleasure of socializing with people from the walking group: "We are a family. Even though we do not know each other's names." (P33, non-adherent).

Besides, they also explained the role of their relatives, who encouraged them to exercise: "My children, they have encouraged me to walk. Yes, at first, I fell, and everything was so clumsy. And it was very good for me because I was also lazy and they told me come on, go out and go out. And I later became a widow, I also did not feel like going out. And if it wasn't because of them, I would not go out and I'd be home all day. And my children come on, come out, it's going to be well for you." (P25, adherent).

The last category, related to motivations for exercise concerns the routine of exercise in their daily life, in which the OAs explained how a planned PA in their daily life makes it easier for them to exercise: "So, since I started, this is what you already have as a routine, you already say well, well now it's over, but let us see, for next year you have to sign up." (P13, adherent).

The qualitative analysis of the OAs' general satisfaction revealed three main themes that complement and enrich quantitative results: intergenerational relationships, strengths of the PA program and suggestions for improvement.

3.2.4 Intergenerational relationships

This theme emerged as a result of the representation of the OAs' perceptions about the relationships that developed during the walking sessions with the young people.

The first category of this theme is related to breaking prejudices, where OA explained how young people had previous concerns about them: "They said that they had been surprised by the physical condition we had (...). They thought we were going to be clumsier." (P18, adherent).

TABLE 4 Students and older adults ad-hoc opinion questionnaire.

	Second-course students $n = 44$		Third-course students $n = 27$		Scholarship students $n = 3$		Older adults $n = 25$			
Do you think the project has helped to foster intergenerational relationships?										
0 Nothing	1	2	3	4	5	6	7	8	9	10 Very high
Mean $\pm$ SD	8.3 $\pm$ 1.5		8.7 $\pm$ 2.3		10		9.92 $\pm$ 0.40			
In general, the project has helped you to:										
1. Learn or fix some knowledge.	Yes: 84.1% No: 15.9%		Yes: 81.5% No: 18.5%		Yes: 33.6% No: 76.3%		Improve health and wellbeing		Yes: 100% No: 0%	
2. Develop, enhance or become aware of skills and abilities.	Yes: 88.6% No: 11.4%		Yes: 74.1% No: 25.9%		Yes: 100% No: 0%					
3. Develop, enhance or become aware of personal values.	Yes: 90.9% No: 6.8%		Yes: 88.9% No: 11.1%		Yes: 100% No: 0%					
Comment on what you liked the most and the least, as well as any ideas that we can include in future intergenerational projects to improve:										

Besides, they also realized that they had a conceived idea of young people (“reverse ageism”): *“it often helps you change a little the idea you have about young people. Yes, because you have a preconceived idea and then you see them and say well, they are responsible. And they have concerns. Well, that contact makes you see it. Yeah.”* (P37, adherent).

Another category on this theme concerns the students’ perception of the support provided by the OAs. The OAs talked about how the students took care of them during PA sessions: *“They always accompany us, always, from the first in the group to the last. They always go with us, they do not leave anyone behind, they always go with us.”* (P17, adherent).

The last category of this theme deals with interpersonal relationships, in which the OAs reported on exchanges with young people: *“They seem interested in the things that I have done, for example, the Camino de Santiago and I have been explaining things about the route and they are very receptive and ask me and tell, oh, well, I want to do it. Very good.”* (P23, non-adherent).

3.2.5 Strengths of PA program

This theme, which emerged during the analysis, represents the OAs’ thoughts on the benefits obtained during PA activity.

The first category of this theme related to the participants’ enjoyment during the program, with the OAs talking about the places they had discovered during the walk and the strength of the group: *“It is very well programmed. They are talking to you about all the things you see along the way. It becomes very enjoyable.”* (P15, adherent).

The second category or theme concerned participants’ satisfaction with the activity, with OA making the following comments: *“Well, you can say that it was a success. (...) Rating 10/10.”* (P34, adherent).

3.2.6 Suggestions for improvement

On this theme, the OAs expressed their suggestions for improving the program for future editions. The first category related to organizational aspects, such as the location where the walks took place: *“The only thing I would ask for is to be more countryside than asphalt.”* (P27, adherent) or the best time to do the activity: *“Well, with*

the hour change perhaps the departure time in the afternoon, then it should also be delayed by an hour like the daytime, I think, especially in May.” (P21, adherent).

The second category concerned the desire for an extension and continuity of the activity: *“We want it to continue.”* (P14, adherent).

The last category refers to the development of aspects that are more related to the methodology of walking with canes: *“I would like to advance in the theory of walking with canes. Someone should come 1 day and tell us to improve more or to level up.”* (P20, non-adherent).

4 Discussion

This study provides evidence of the impact of the intergenerational PA program in terms of adherence and satisfaction among OAs. In addition, positive motivation scores were found in relation to intrinsic, integrated and identified regulation, particularly among the participants who adhered to the program. For students, the program played a critical role in developing essential skills, and both OAs and students emphasized its effectiveness in fostering intergenerational relationships. The qualitative data further revealed an increased sense of empowerment through PA, highlighting the significance of these findings. This underscores the program’s broader benefits, not only in promoting physical well-being but also in enhancing emotional and social connections across generations.

To our knowledge, the present study is the first study to explore the effects of a PA intervention including cane walking conducted in OAs and students in the context of a SL project using a nested, mixed-method design.

Furthermore, it is worth mentioning that the intervention has achieved effective alignment with the proposed SDGs, in particular Goal 3 (Good Health and Well-being), Goal 4 (Quality Education) and Goal 17 (Partnerships for the Goals).

Satisfactory compliance with the intervention was noted for the OAs, which was reflected in the high completion rates and continued

participation of those who remained engaged. This approach to measuring adherence, considering both the percentage of participants who completed the project and the attendance rate of participants, aligns with the framework proposed by Martin and Sinden (21). They suggest that adherence should be assessed by the number of sessions attended and the proportion of participants who completed the program, taking into account the duration and intensity. Furthermore, Hawley-Hague et al. (22) emphasize that compliance should not only be measured by the number of dropouts, but rather by a comprehensive evaluation of participant's engagement throughout the intervention.

It is also worth noting that this higher adherence was achieved despite the considerable total duration of the project (27 weeks), which, according to Vseteckova et al. (23), is a presumed handicap because poorer adherence results were achieved in a long-duration exercise programs compared to a short-duration. The results of the present study, which showed a dropout rate of 34.21%, are not consistent with the data of Sluijs et al. (24), who found that long-term exercise programs can reach a level of 70% poor compliance.

The remarkable adherence reached in both at the level of the individual periods counted and at the total level, is of particular interest because it has been achieved in a population with a special idiosyncratic population (mainly older adult women), given their frequent dedication to tasks such as caring for others and medical surveillance of their own health. Engberg et al. (25) found that OAs perform less PA than would be desirable due to the simultaneity of events in their lives. However, evidence suggests that enjoyment plays a critical role in promoting adherence to PA programs (26). In this context, the high adherence observed in our study may be attributed to the participants' enjoyment of intergenerational interactions. Notable behaviors such as smiling, laughing, maintaining eye contact, and participating in dynamic conversations with younger individuals likely contributed to the social and emotional appeal of the program, thereby fostering sustained engagement (27).

It is also possible that greater PA enjoyment influenced individuals' self-reported ability to engage in regular PA (28). This increase in self-efficacy observed in the qualitative analysis of OAs may have helped to reduce barriers to PA and promote adherence. Self-efficacy is closely related to overcoming barriers and is an important predictor of PA participation (29–31). Our results support this relationship and show that OAs were able to engage in more PA than they had previously thought possible.

In fact, it is important to note that in this study, the participants in the group that adhered to the program showed more positive motivation scores than those that did not adhere to the program. This suggests that the participants who remained engaged were generally more motivated. However, as the qualitative findings indicate, absenteeism from some sessions in both groups was justified by unforeseen factors such as attending medical appointments, which led to absenteeism and subsequently reduced adherence in some participants, or other external barriers such as family burden, physical health problems, unfavorable weather conditions or even the ongoing effects of COVID-19, which were possibly the main barriers to their further participation, more than the motivation itself. These findings are consistent with Lees et al. (32), who also identified lack of time and health-related problems as two of the most significant barriers to participation in PA among the OAs included in its study. This is also in line with what is postulated by Camp et al. (33), who reported that the dependence on health factors increases with age and

that the ability to adhere to exercise is influenced by several psychological constructs.

In agreement with Gladwell et al. (4) and Hanson and Jones (5), performing cane walking in natural outdoor environments may have provided some of the best health benefits for participants by improving their PA levels, restoring mental fatigue and improving mood and self-esteem. These findings are supported by the qualitative results about exercise motivation. In addition, “the group” promotes the social aspect that some people crave, and which may also have facilitated the observed adherence. Regarding outdoor and indoor exercise, a systematic review found no greater benefit of outdoor exercise compared to indoor exercise, although there was evidence that participants reported greater active valence and enjoyment of exercise (34). On the other hand, a recent review concluded that there is low-certain evidence that home-based exercise programs could provide benefits for OAs (35). Future studies comparing intergenerational indoor and outdoor exercise programs through SL would be needed.

Regarding motivation for the PA, positive motivation scores were found in relation to intrinsic, integrated and identified regulation particularly for the adherent group. This is in line with the study by Jofré-Saldía et al. (36) in which a multicomponent progressive training program for OAs was compared with no training program, showing improvements in the dimensions of the intrinsic and identified regulation BREQ-3 in favor of the training group. Furthermore, these findings aligned with the work of Picorelli et al. (37), who emphasize the importance of positive environmental factors and support systems in fostering motivation. Additionally, Cohen-Mansfield (38) highlight the motivational benefits of structured intergenerational programs, which enhance compliance and promote long-term participation. This intrinsic regulation is largely driven by the pleasure that the individuals derive from learning, with this enjoyment serving as the primary motivator for their actions (39). This is also supported by the qualitative data in which OAs suggested improvements to the program, reflecting a desire for progress that acts as a powerful motivator for continued participation.

Our findings highlight the complex interplay of motivational factors that influence participation in intergenerational PA programs among both older and younger participants. In the Cohen-Mansfield (38) study on - Motivation to participate in intergenerational programs - it was reported that older adults often reported motivations related to life circumstances, such as seeking support, companionship, or filling available time, whereas younger participants were driven by altruism, a sense of obligation, or perceived occupational value. Of particular note is that common motivations such as intergenerational interaction, enjoyment and friendship developed into enduring drivers over the course of the programs. This is consistent with the concept of identified regulation, which received higher scores in our study. Participants began to internalize the importance of the activity and embed it into their personal goals and values. This motivates them to engage in the activity, even if it is not inherently enjoyable (40). By identifying with the activity, individuals consciously integrate it into their value system, thereby enhancing their perceived autonomy (41, 42). Furthermore, the dynamic nature of the observed— motivations - in which intrinsic motivators such as satisfaction increased in importance over time — underscores the importance of a program design that fosters fun and meaningful connections. Future research should examine how these shifts in motivation influence long-term outcomes while identifying strategies to maintain engagement in different settings.

Quantitatively, this study found that the OAs in the adherent group scored slightly better than those in the non-adherent group in terms of identified regulation and slightly lower in terms of amotivation. These results are in line with those of Teixeira et al. (43), who suggest that integrated regulation is crucial for maintaining behavior over time, particularly when obstacles interfere with behavioral regulation or when activities become more difficult. A person who is motivated in an integrated way is more likely to exercise in the rain than a person who only exercises for pleasure (intrinsic reasons). On the other hand, high amotivation scores are associated with less exercise and reduced self-control, suggesting potential non-compliance with structured exercise interventions, as was the case in our study, in which the group that did not adhere to the program scored slightly higher on amotivation (33). These findings are supported by the perceptions and motivations for exercise reported qualitatively by OAs who have made PA a commitment and routine due to its multiple benefits. They also indicated that they are often encouraged to exercise by their children or other family members, which reinforces their commitment to PA.

Regarding SL projects, one of the main results found in this study, was the usefulness of an intergenerational experience based on SL methodology and the practice of a healthy habit to foster relationships between OAs and students of different levels. This is also reflected in the qualitative data that also demonstrates this strong relationship. The high score in promoting intergenerational relationships and the general satisfaction of both OAs and students suggest that the program has successfully created a supportive and enjoyable environment. The qualitative data revealed that satisfaction resulted, not only from the PA program, but also from discovering new people or places during the walks, having a scheduled PA in their daily life which facilitates them to exercise, and the power of the group, all of which contributed to the positive experiences. These findings are consistent with the Cohen-Mansfield study, which emphasized that motivation is often driven by positive intergenerational relationships and enjoyment. They concluded that activities that focus on a broader range of topics could encourage greater participation among older adults. And that incorporating intergenerational programs into diverse settings and promoting these programs as opportunities to support and interact with others could be an effective motivator for younger participants (38). Other studies have also found effects of a SL program among students and OAs, highlighting the intergenerational component as an essential element in reducing the gap between generations (12, 44).

In terms of the impact of the intervention on intergenerational relationships, some OAs in the focus groups emphasized that the program had helped them recognize the initial underestimation of students' ability to exercise. This is consistent with previous literature that has documented evidence of ageism against older exercisers (45), which is also highlighted in the Global Report on Ageism (46). To address this public health issue, the report recommends intergenerational interventions, such as those undertaken in this study, as a key strategy alongside policy changes and educational initiatives. However, this project found not only discrimination against OAs, but also the so-called "reverse ageism," which according to Raymer et al. (47) is due to the fact that the hype about generational differences gives credence to reverse-ageist ideologies, and that such ideologies engender reverse-ageist discriminatory behaviors directed at young professionals.

The positive feedback from students regarding the project's ability to foster intergenerational relationships and develop valuable skills

underscores the importance of SL programs in higher education. These findings are supported by Dauenhauer et al. (48) and Canedo-García et al. (49), who emphasize the educational and social benefits of intergenerational activities.

Another significant achievement of our research is the intervention's success in enhancing the skills and abilities, demonstrating the fulfillment of SDG-4 (Quality Education). This finding aligns with Dauenhauer, Steitz, Aponte, and Faria (2010) (48), who argued that relationships established with OA in SL through PA, have a strong educational component. Furthermore, studies on intergenerational SL conclude that students who participate in such programs not only feel more competent in interacting with OAs, but also develop skills that are important for their future careers (14, 50).

Other studies concluded that students who develop SL considered themselves more competent in their interactions with OA after interacting with them (14) and even develop their future professional skills (50). Building intergenerational relationships has the potential to promote healing and growth and enable engagement for mutual benefit.

The main limitations of our study are the small sample size and the convenience random selection. Although authors such as Jansons et al. (51) and Allen et al. (52) argue that voluntary participation in studies, as was the case in our study, favors adherence, this may have led to biases in the proportions and main themes identified in the focus groups. Besides, the questions asked in the qualitative design are closely related to the quantitative data collection, this could bias the perspectives of the OAs.

We believe that future research on intergenerational PA practices should further analyze into the capacity of such interventions to reduce ageism among all the groups involved, as well as negative attitudes toward aging and reverse ageism.

5 Conclusion

The intergenerational walking program showed remarkable benefits for both OAs and students. The OAs' adherence to the program was featured despite the handicap of its long duration. The OAs reported high satisfaction, highlighting the program's effectiveness in promoting physical activity and well-being. It was also found that the motivation scores for intrinsic, integrated and identified regulation were more positive in the adherent group than in the non-adherent group. Students also expressed positive feedback regarding the development of skills and intergenerational relationships, supporting the value of SL programs in higher education.

Future programs should continue to leverage the benefits of intergenerational activities and consider the motivations and barriers identified in this study to foster supportive environments and healthier and more engaged communities. Furthermore, the integration of SL into higher education curricula represents a challenge for the future, as it ensures the acquisition of professional and experiential skills for students and promotes the development of social sustainability within the community.

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 the Universidad de León Ethics Committee (ETICA-ULE-049-2022). 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

BAC-F: Writing – original draft, Writing – review & editing, Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Validation. RL-U: Conceptualization, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing, Validation. SC: Conceptualization, Supervision, Validation, Writing – original draft, Writing – review & editing. MF-G: Supervision, Validation, Writing – review & editing. JLP-L: Supervision, Validation, Writing – review & editing. CJ-S: Conceptualization, Formal analysis, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2024.1509016/full#supplementary-material>

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Challenges in nature-based health and therapy research and critical considerations for application in musculoskeletal health

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Nature-based health and therapy (NBHT) is a term incorporating a broad suite of practices that focus on engagement with the natural world and nature-rich spaces for potential physical and mental health benefits. As healthcare professions such as physiotherapy and osteopathy move away from biomedical/reductionist models of care for complex conditions towards approaches which take into account social and environmental determinants of health, NBHT may become part of clinical interventions and public health messaging. However, there are multiple challenges in aspects of NBHT research and application, from methodological issues in the primary research base, to questions of environmental injustice and access inequalities in many areas. In addition, engaging with natural environments which are vulnerable to the entwined threats of climate change and biodiversity collapse requires consideration of the effects of ecological disturbance and the underlying anthropocentric/utilitarian view of the natural world. In this perspective, we outline a critique of NBHT literature and offer positive suggestions for how better-quality research can be conducted and implemented by focusing on local environmental, social, and political factors. We conclude by outlining a set of critical considerations that healthcare professionals might use to develop and implement NBHT programmes in their specific regional contexts.

KEYWORDS

nature-based therapy, nature-based interventions, planetary health, physical health, musculoskeletal health

Introduction

Nature-based health and therapy (NBHT) refers to a wide range of practices involving engagement with nature-rich spaces or stimuli to elicit potential mental and physical health benefits (1). The individual practices which comprise NBHT can vary from *Shinrin yoku* (forest bathing), a form of structured relaxation in a forested environment first developed in Japan in 1982 (2), to gardening/horticulture (3), or wilderness exploration (4). Without adapting a specific interventional label, spending time in urban greenspace (parks, woodlands, etc.) is increasingly considered an important aspect of public health, and ensuring equality of access is considered to be a social justice issue (5). Research into this subject has been growing, with multiple systematic reviews now published focusing on the potential impact of NBHT on issues ranging from physical health conditions (6), to depression (7) and stress (8).

Although the field is relatively novel, there have been calls to develop the research base and implementation of NBHT based programmes in public health and planning policy (9), while health bodies such as the United Kingdom's National Health Service have committed to further implementing NBHT in social prescription (10).

Three theories have been frequently cited as underpinning the potential health benefits of NBHT: Attention Restoration Theory, a cognitive model in which natural spaces reduce the demand on voluntary attentional control mechanisms (11), Stress-Reduction Theory (SRT) in which experiences with nature are believed to trigger emotional and physiological changes (12), and the Biophilia Hypothesis (13) which posits that humans have an innate attraction towards living entities and processes (14). While these theoretical frameworks are subject to debate based on their evolutionary assumptions and purported mechanisms (15–17), epidemiological data suggests that exposure to natural environments is associated with positive health outcomes. Systematic reviews have linked greenspace with increased levels of physical activity, improved mood, and decreased overall mortality (5, 18), but most studies which comprise this research involve cross-sectional designs limiting the ability to infer causality. Research on blue spaces (rivers, lakes, shores, etc.) reveals similar trends, with positive associations between proximity to blue space and levels of physical activity (19), mental health metrics (20), and a negative association with all-cause mortality (21). Although individual effect sizes are generally small (21), and spatial factors such as accessibility, usability, visibility and ecological quality are not sufficiently accounted for (5, 22, 23), the literature is broadly consistent in showing statistically significant positive health outcomes with green/blue space exposure. Structuring this exposure through NBHT is a potential avenue for health interventions by multiple specialities.

Healthcare professions such as physiotherapy and osteopathy, for whom musculoskeletal (MSK) issues are a central focus, have traditionally based their practice on biomedical models of health and disease (24, 25). The traditional biomedical perspectives viewed biological or anatomical factors as determinants of the development of pathology or disease (26, 27). In recent decades, research has challenged these models, as complex conditions that fall under the professional scope of practice, such as persistent MSK pain, are poorly explained or treated by reductionist approaches (28–30). To address the multifactorial and interrelated nature of pain, the biopsychosocial (BPS) model has been used as a framework to understand complex conditions as emergent states arising from the interaction of biological, emotional/psychological, and social domains (31, 32). While the BPS model has led to promising developments in research and practice (33), it has also been argued that the general understanding and implementation of the model remains reductionist and particularly social and environmental factors are not yet considered sufficiently (34–36).

The role of environmental factors, defined as the external factors constituting the physical, social and attitudinal environment influencing the experience and management of a health condition, has been emphasised by the World Health Organisation (37) in The International Classification of Functioning, Disability, and Health Framework. Somewhat in line with this, Lehman et al. (38) have argued for the need to emphasise the role of contextual dynamics play in the BPS model because environmental factors have significant positive (e.g., natural spaces facilitating movement/

exercise) and negative (e.g., air pollution) influences on health. Because of the limited theoretical foundations and problematic applications of the BPS model, others have argued for an enactive-ecological model that more clearly advances an understanding of the body as inseparable from its social and ecological environment (34, 36, 39). Insofar the external environment is an important factor in either of these frameworks, environmental interventions such as NBHT may modify BPS model stressors or offer affordances for salutogenic behaviours. As such, healthcare practitioners and organisations engaging with people living with complex conditions may want to consider their potential role in prescribing, designing, facilitating, or lobbying for NBHT programmes. In doing so, it is important that individuals and organisations are cognisant of some inherent challenges to research and application of this field. The purpose of this perspective paper is to outline some of the key challenges while offering a set of critical considerations to aid in the design of NBHT interventions across a range of ecological and social contexts.

Challenges in NBHT research

While the field of NBHT is growing, many of the primary studies are of poor methodological quality, and as such, it is important to be cautious about any stated benefit arising from nature interaction [e.g., (6, 7)]. While most systematic reviews found a small but statistically significant impact of NBHT on mood and stress, improved study protocols are necessary to reduce uncertainty in this field (8, 40). Several factors contribute to this uncertainty – studies with high risk of bias, small sample sizes, heterogeneity of study design, etc. – and a major limitation for generalising the results is the frequent use of self-referred subjects who may be recruited due to a pro-nature disposition (8). Additionally, many studies measuring psychological outcomes are focused on asymptomatic populations (40), making extrapolation to people with specific diseases and disorders difficult.

In addition to the latter, the challenges of studying complex conditions and complex interventions must also be considered. Many of the conditions that NBHT seeks to impact (depression, anxiety, pain, stress, etc.) may be best understood within the context of the BPS model (38, 41). As such, research that attempts to establish a causal relationship between the dose of NBHT and response (e.g., symptom modification) may be overly reductive in its assumptions about the condition.

It could also be argued that NBHT is a complex intervention (42), as it entails multi-sensory stimuli, multiple potential mechanisms of action (43), and psychosocial moderators and mediators of effect (44). The challenges of studying complex interventions for multifactorial conditions are not trivial, and NBHT may have similar issues to address as more widely used MSK interventions like manual therapy and exercise (45, 46). Hansen et al. (47) and Doran-Sherlock et al. (7) identified a lack of qualitative and mixed-method studies in this field, and future corresponding research may help to illuminate how NBHT can be applied for distinct individuals and groups. Although improved methodological standards and a wider research framework are essential, following the BPS model and enactive-ecological models, it is also important to consider that the intrinsic, non-linear coupling between the body, brain, and external world (41, 48) can be a barrier to quantifying individual outcomes from NBHT.

Challenges in the implementation of NBHT

While addressing issues with the methodological and theoretical quality of the research base, it is important to consider how and why NBHT can produce varying effects on individuals and communities. Some data suggests that greenspace exposure may moderate income-related health inequalities (49, 50), but inequality of access to nature could exacerbate these differences (51–53). Addressing these barriers to access would, therefore, be an essential aspect of developing successful NBHT interventions, and doing so will involve taking into account highly localised factors ranging from transport inequality (54) to the politics of land ownership and access rights (55).

For example, in a European context, there exists a wide spectrum of legal frameworks for access to natural areas (56). Although improving access is an important goal in regions with poorer access rights, in colonised regions such as Australia and Canada, improving access to land under the stewardship of Aboriginal peoples must be done under the leadership of and with deep sensitivity to First Nations practices and knowledge (57, 58) or run the risk of perpetuating a form of eco-colonialism (59). Nicholls (60, 61) has cautioned that the movement towards the BPS model and enactive models in MSK care could perpetuate the entrenched tendency in neoliberal politics towards promoting individual responsibility over state or collective action. Developing or promoting NBHT interventions without these political or social considerations for disadvantaged people may reflect this, while lobbying for public transport options and access rights could address these inequalities.

On an individual level, the relationship between people and nature is subject to influences ranging from cultural values and norms (62) to psychological traits such as nature connectedness (63), and these are likely to influence outcomes arising from interactions with natural spaces. One of the purported goals of NBHT is to increase nature connectedness due to an associated increase in pro-environmental behaviour (63). Nature connectedness may be seen to increase with both repeated nature engagements (64) or a singular meaningful experience (65). While high levels of nature connectedness may result in a more positive response to natural environments, nature connectedness may also be associated with eco-anxiety, which can indicate poorer mental health (66, 67). Although there is nuance about how eco-anxiety may be constructive or unconstructive with regard to pro-environmental behaviours (68, 69), it is important to acknowledge that the psychological effects of NBHT are likely to be highly variable even amongst those with a pro-nature disposition (70, 71).

New directions and considerations

Meaning in nature connection

While there is a low proportion of high quality primary studies in the field, NBHT programmes are being developed, promoted, and integrated into health management by governments, local communities, and healthcare providers (9). More granular data may suggest how NBHT could improve health outcomes in specific populations and contexts, but the inherent uncertainty of the BPS/enactive models and the highly personal relationship which people have with the natural world make it difficult to predict or quantify outcomes for individuals. However, patient values are considered to be of significant importance

in contemporary MSK research (30, 72), and NBHT may offer an opportunity for patients to engage in valued nature-based activities. Although MSK professionals may be more comfortable exploring nature-related values with patients from the perspectives of potential biomedical benefits, changing contextual factors in the BPS model, or enactive-ecological opportunities for behavioural change, it is important to be able to explore the roles of personal meaning and connection with nature. A relationship with nature can bring people closer to their ‘inner world’ (73) and may be a means of attuning to the processes of life in various philosophical, spiritual, or religious traditions (74, 75). NBHT programmes that approach this subject from a pluralistic perspective will allow more space for individuals and groups to explore their relationship with nature in a manner connected to their respective frames of understanding.

Ecological disturbance

One issue which has not been addressed in the NBHT literature is the potential risk of ecological disturbance. Engaging with natural spaces is framed as a positive action, but research in the field of ecotourism is showing that human interactions motivated by a desire to connect with biodiverse spaces can have adverse effects (76–78). Particular species and ecosystems may be more vulnerable to ecological disturbance than others (79–81), and it is important to consider whether NBHT interventions could exacerbate or mitigate this. For NBHT programmes to benefit both people and wildlife, management strategies informed by local ecological knowledge and adapted from the related field of ecotourism (78) can help to minimise disturbance to non-human species via strategies ranging from education initiative to community outreach programmes (82, 83).

Anthropocentrism

Although NBHT may have significant potential for human health and carry-potential co-benefits for the environment through a variety of pathways, it should also be noted that it carries the risk of perpetuating anthropocentrism due to its principal focus on human health. Primary concern for human interests and benefits has been extensively criticised as one of the root causes of environmental degradation since colonial ages. To counteract this tendency in recent developments across planetary health, One health, and even conservation, the argument is made that a stronger concern for the environment, acknowledging the intrinsic value of non-human existence and seeing humans not as dominant but part of nature, needs to ground all initiatives, from local actions to global policy (60, 84–88). To this end, the development of NBHT should, at a minimum, always be reflective of its understanding of nature and the human-nature relationship, and strive to produce ecological surplus value beyond narrowly defined human health interests.

Critical considerations for NBHT programming and prescription

To help aid the development of NBHT programmes by healthcare professionals, the following is a provisional set of critical considerations that may help in designing, implementing, and prescribing interventions that align with the evidence and help to

address some of the challenges outlined in this perspective. These values are not exhaustive, nor are they likely to be universally applicable. It is the intention of the authors that these values are continuously updated to reflect the growing evidence and theoretical base of NBHT, and are adjusted and tailored to focus on the reality of a given social, environmental, cultural and political context.

1 Locality

NBHT should ideally be based on what is most local, minimising transport emissions, while maximising the opportunities for people to develop relationships with their environment.

2 Social and economic

The social and economic challenges faced by an individual/community should be taken into account when developing/prescribing NBHT programmes.

3 Benefits and outcomes

Claims in relation to benefits and outcomes must be aligned with the evidence base – it is especially important that studies on asymptomatic populations are not extrapolated to those with clinical conditions.

4 Shared multidisciplinary ecological knowledge

In order to minimise ecological disturbance, NBHT programmes should seek the knowledge of environmental/conservation groups to establish a balance between access to sites and potential disturbance of sensitive ecological processes.

5 Access and activism

Healthcare professionals may need to leverage the power of their communities, professional bodies, etc., to lobby for sustainable transport options for potential NBHT programmes and/or democratic engagement when land-use and ownership is a barrier to access of suitable natural sites.

6 'Leave no trace'

The roll-out of NBHT programmes must be accompanied by the promotion of codes of ethical and behavioural conduct to respect non-human life in a given setting.

7 Respecting indigenous peoples

In areas of historical or ongoing colonialism, respect for local knowledge and the leadership of local communities should be an absolute prerequisite for NBHT programme development, grounded in efforts to return respective regions to their pre-colonial owners and, therewith, indigenous stewardship.

8 Pluralism

The beliefs, psychological traits, and cultural values through which people relate to nature are highly varied, and NBHT programmes should seek to be cognisant of this.

9 Training and education

An introduction to NBHT application and prescribing can be developed in undergraduate and postgraduate MSK education.

Conclusion

In this paper, we have outlined some of the key challenges in the research, application, and theoretical underpinnings of NBHT. The quality of many studies is poor and has often been conducted through a reductionist biomedical frame. NBHT may have significant effects on conditions better understood through the BPS model or enactive-ecological models of health and disease, but as a complex intervention, it requires a nuanced understanding of how it may apply to a given individual or group. Health professionals such as physiotherapists, osteopaths, occupational therapists, etc., may be ideally suited to develop

NBHT programmes in their localities and communities as part of an effort to improve and connect public and planetary health. Doing so requires sharing multidisciplinary knowledge that addresses barriers to nature access and engagement and prioritising the concomitant protection/expansion of ecological processes and the non-human world. We conclude by offering a set of critical considerations aimed at helping healthcare professionals navigate the complexity of developing NBHT programmes that consider the best interests of people and nature in a range of social and environmental contexts.

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

RD-S: Conceptualization, Writing – original draft, Writing – review & editing. PS: Conceptualization, Writing – original draft, Writing – review & editing. NS: Writing – original draft. FM: Writing – review & editing.

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Conflict of interest

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Environmental pediatric physiotherapy and risky play: making the case for a perfect match

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Environmental physiotherapy is epistemologically anchored in the critical recognition that physiotherapeutic practice is fundamentally embedded within a planetary ecological framework, demanding a holistic, systemically integrated approach to professional practice. This perspective article highlights and underscores the value of risky play for child health and the commonalities with environmental pediatric physiotherapy. The article starts with a discussion of current challenges in child health around the globe, often resulting from a lack of physical activity of children, and claims finding new, promising and sustainable ways that are able to attract children and their parents to playfully increase the time that children are physically active. Followed by an overview of physiotherapists' roles and responsibilities in child public health, the authors point to the need to move beyond an isolated profession-centric approach when tackling the existing, concerning issues in child health worldwide. Foundational information about risky play underpinned with scientific results and its acknowledgment by other health professions is then presented. By including a perspective of what children want, the authors identify a gap between the world's children's actual needs and current societal offers. The benefits of risky play for child health are presented in detail, along with a discussion of various considerations pertaining to child safety. Concluding, this perspective article demonstrates how physiotherapists can contribute to better child health by including risky play in physiotherapy theory and practice.

KEYWORDS

physiotherapy, environmental, child health, public health, risky play, physical therapy, pediatric

1 Introduction

About 80% of the world's youth does not meet the recommendations of the World Health Organization (WHO) to be physically active for at least 60 min per day (1, 2), contributing to a global pandemic of physical inactivity, which is considered to be a major cause of global mortality (1–4). According to the WHO, in 2022, 37 million children under the age of 5 and 390 million children between 5 and 17 years old were overweight or obese, with increasing numbers in high-, middle- as well as in low-income countries (4, 5). One of the multifactorial reasons for this unfavorable development is insufficient levels of physical activity in children and adolescents (6), an accelerant for an early onset of non-communicable diseases (NCDs) such as diabetes type 2, cardiovascular diseases, neurological and mental health disorders, cancers, chronic respiratory diseases, or eating disorders (5, 7). Children with disabilities are even more predisposed to developing secondary health conditions (8).

Physical activity is clearly related to better health outcomes and recognized to be one of the most efficient ways to enhance a person's overall health across their lifespan (9–12). A decrease of 15% in physical inactivity worldwide is targeted by the WHO Global Action Plan on NCDs, by 2030. However, the implementation of physical activity on national levels is still insufficient (13). Although there is enough research proving the health benefits of physical activity, conducted over decades, the number of NCDs still increases, and rates of physical activity are changing slowly. Do we miss something important? Of course, better infrastructures, more resources for physical activity, as well as effective coalitions of multiple sectors are important for achieving more meaningful results (1, 14). But considering the huge amount of children and adolescents identified as being physically inactive around the globe (15), new, effective, and low-threshold strategies of health promotion are required to address these concerning developments in child health. It has been identified as a worldwide priority to develop approaches to target these concerning issues that are accessible, acceptable, cost-effective, culturally adaptable, feasible and to ensure an optimal compliance—of course fun (3, 16–19).

There is a tendency for physical activity and sedentary behavior habits learned during childhood to persist into adulthood (20). This highlights the importance to find joyful and meaningful ways for children, at an early age, to bodily movement and being physically active. Children with disabilities and of course also those without disabilities experience physiotherapy more positively when it is engaging, fun and pleasurable (21). Promoting physical activity in children should enable a broader health experience, including a lively child-environment interaction (22), which contributes to satisfaction, enjoyment, perceptions of social inclusion, and self-efficacy (23). Playful physical activities are promising to reach a large group of children, allowing them to explore, develop and enhance their physical abilities, motor and social skills, sense of belonging, self-efficacy and self-awareness, as well as to playfully integrate and overcome their fears. Not only is a child's right to play enshrined by Article 31 of the United Nations Convention on the Rights of the Child (24), play is necessary for child development. It is considered to be therapeutic, an instinctive mode of self-directed learning and efficient means of teaching and guidance, and a contribution to and enactment of health and wellbeing (25). Interestingly, the UN's general comment on the fulfillment of Article 31 has identified an increased safety focus and a lack of access to nature as threats to children's free play (26).

Physiotherapists are well-situated to mitigate these threats impacting child health. They are autonomous experts (27), tailoring individualized activity programs aligning with each child's unique motor developmental profile and functional capabilities (28). Physiotherapists engage with children and their families during developmental stages when health-related behaviors are amenable to intervention and modification and are expected to actively advocate for innovative strategies that foster health prevention and physical well-being among children throughout their lifespan (28–30). They work interdisciplinary in clinics, schools, communities, early childhood centers and hospitals, provide child and family-focused education, and identify and connect families with resources for health promotion and motor skill acquisition (28). Physiotherapists play an active role in bringing the United Nation's Agenda 2030 Sustainable Development Goals (SDGs) into life (31–34), create effective interdisciplinary coalitions to implement the WHO Global Action Plan on NCDs (1) and transcend biomedical perspectives

on child health and disability into holistic perspectives by applying the WHO's International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) (22, 35, 36). In this perspective article, we aim to highlight both, the value of risky play for child health and the worth of including this pedagogical stance into the provision of physiotherapy services. Contributing to this special issue on reframing the role of the physiotherapy profession in the Anthropocene, we will put weight on outdoor risky play during early childhood. We outline the well documented benefits of risky play for child health and overall development, and claim more and broader recognition of these benefits by the physiotherapy profession. Additionally, we advocate for future research investigating the interplay of physiotherapy, risky play and child health and the inclusion of knowledge about risky play in physiotherapy curricula to support contemporary pediatric physiotherapy.

2 Risky play

Risky play is defined as thrilling and exciting forms of play that involve a potential risk of injury (37), with ambiguity and uncertainty being understood as important characteristics (38). Risky play can happen indoors but is most common in outdoor settings where children are allowed to play freely (39, 40). Eight categories of risky play (see Table 1) have been identified through observations and interviews with children and adults (41, 42). Most of the research on children's risky play has been situated within the context of early childhood education, focusing on 1 to 6-year-olds. Children seek thrills and risks in their play and on a level that suits their individual competence and courage (43–45). Research shows that risky play is a common type of play both among girls and boys and across ages in the early years (39, 41, 42). Taking risks in play is also strongly connected to children's risk management skills. Research identifies how children are aware of the risk they are taking and how they mitigate or increase the risk according to their own skills and how they experience the situation (46, 47), and in addition, how risky play contributes to increased risk assessment skills (48).

In children with disabilities, the understanding of risk-taking and risky play is wider and more inclusive and does not contradict the original intention of the concept of risky play as being unstructured, child-driven activities (49). In a recent position statement, the Canadian Pediatric Society underscored the value of risky play for children's healthy physical, mental, and social development (50) due to its potential to prevent injuries (51, 52) by children learning how to manage risks and tackling health problems such as poor development of motor functions, obesity, anxiety, and behavioral issues (9, 50, 53–56). Research showed that physical activity is 2.2 to 3.3 times higher when children are playing outdoors than indoors, independent of different age groups, sexes, and contexts (16). Children spend significantly more time being active in adventurous environments than where structures are pre-fabricated (55). Furthermore, natural environments provide the ideal conditions for children, regardless of varying developmental levels, to engage in challenging and exciting forms of playful physical activity (38, 57–59). Unfortunately, children's opportunities to play freely outdoors are decreasing. The reasons for this can be grouped into four categories: time (nature-starved curriculum, time-poor parents, lack of time for free play), fear (stranger danger, dangerous streets, risk-averse culture); technology (rise of screen time); and space (vanishing green space) (60). Recently, the negative consequences of the rise of social media have been discussed in depth, pointing to risky play as an

TABLE 1 Eight categories of risky play, including related risks and sub-categories.

Category	Risk	Sub-categories
A: Great heights	Danger of injury from falling	Climbing Jumping from still or flexible surfaces Balancing on high objects Hanging/swinging at great heights
B: High speed	Uncontrolled speed and pace that can lead to collision with something (or someone)	Swinging at high speed Sliding and sledging at high speed Running uncontrollably at high speed Bicycling at high speed Skating and skiing at high speed
C: Dangerous tools	Can lead to injuries and wounds	Cutting tools: knives, saws, axes Strangling tools: ropes, etc.
D: Dangerous elements	Where children can fall into or from something	Cliffs Deep water or icy water Fire pits
E: Rough-and-tumble	Where the children can harm each other	Wrestling Fencing with sticks, etc. Play fighting
F: Disappear/get lost	Where the children can disappear from the supervision of adults, get lost alone	Go exploring alone Playing alone in unfamiliar environments
G: Play with impact	Where children are crashing—either themselves or an object—into something	Throw themselves onto a mattress Crash their tricycle into a fence
H: Vicarious risk	Where the risk is only observed by the children	Watching other children's risky play for a length of time

Over the years, eight categories of risky play have been identified. By investigating various kinds of risky play through interviews and observations of preschoolers and staff in Norway, Sandseter (41) identified six categories of risky play (A–F). Kleppe et al. (42) identified two more categories of risky play of toddlers aged 1–3 years (G, H).

effective way to ensure ideal childhood development for current and future generations (61). Within the physiotherapy profession, the Australian Physiotherapy Association (APA) advocated for risky play as a response to school lockdowns during the COVID-19 pandemic (62), and an online course for rehabilitation professionals has been released to highlight the benefits of risky play for child health (63).

2.1 What children want

Children prefer playing with natural materials and in natural environments over screen time (25, 38). If children have the

opportunity to experience nature, they develop a sense of care and a desire to conserve it (64). The experience of fun has been identified as a central experience for children, found within all physical and social environments. Children seek intense play experiences, want to make their own choices about what to play, and want to belong to their playgrounds (57). Obviously, what children around the globe mostly want and long for, differs more and more from what the societies they live in offer them: car-oriented, urbanized and increasingly highly digitalized, rather risk-averse societies as well overprotective environments, resulting in social encounters which rather isolate from each other than bringing communities actively together (61, 65), further contributing to nature-deficit disorders (66). Current generations of children spend less time playing outside and do so less frequently compared to their parents' generation (64, 67, 68). There is a shift in children's physical activity away from unsupervised and unstructured outdoor play toward structured and supervised activities that are primarily performed indoors (16, 18).

2.2 Why is risky play so important for children?

Engaging children in risky play is one of the best ways of injury prevention because their experiences lead to the ability to manage risks (52, 53). Children acquire coping mechanisms to handle risky situations by engaging in playful methods to evaluate and conquer risks, adapting to failure and adverse outcomes of their choices, leading to resilience and self-sufficiency (69). Risky play is naturally not only observed in children of all cultures but is found in many mammal species, representing an adaptive function (53, 54) by supporting the offspring in developing cognitive, emotional, motor, functional and social abilities. Playing freely plays an important role in the neurophysiological maturation of the prefrontal cortex, which influences self-regulation of behavior and impulsiveness and encourages self-reflection (56, 70–72). Risky play is considered to have an anti-phobic effect on a child's physiological development, where a child will first show normal adaptive fears, which protect it against various risk factors. Risky play is a stepwise fear-reducing behavior. Hindering children from taking part in age-adequate risky play may result in increased neuroticism or psychopathology in society, as the fears may continue despite being no longer relevant due to a child's physical and psychological maturation, possibly even turning into anxiety disorders (56).

The rising anxiety about children's safety has been described as a common feature of modern societies. Besides overprotective parenting, also the conception of childhood has changed (65). The understanding of a child as resilient and capable shifted to the picture of a vulnerable child who needs continuous safeguarding, although this may not be true for all children and societies (73). Physiotherapists invest a great deal of time and effort by educating patients and the public to combat such misleading beliefs that can influence an individual's lifestyle choices and quality of life (74, 75). Indeed, research shows that toddlers have the ability to assess and manage potential risks when they play outside in natural environments. Even 4 to 5-years old children were reported to be able to balance their risk-taking decisions between their evaluation of positive and negative

outcomes of the play (76). Toddlers' engagement in risky play promotes a sense of belonging through shared engagement in risky play experiences and by developing a personal connection with the place. Furthermore, social belonging to the group becomes evident when children demonstrate care and support towards each other when children's peers stumble and fall whilst navigating through challenging environments (77).

Preschoolers spend up to twice as much time being sedentary indoors than when they are outdoors. The longer the time that children are outside, the more active they are (16). Natural landscapes play a significant role in the motor development of children, as gross motor functions such as running, jumping, throwing, climbing or crawling are predominant when children actively play in nature (78). Outdoor activity in children is related to lower diastolic blood pressure and to greater aerobic fitness (16). Additionally, nature-based activities in early childhood increase the diversity of children's gut microbiome (79, 80), potentially reducing the risk of several immune-mediated diseases such as allergies, asthma, and type 1 diabetes (80), increase connectedness to nature, and may decrease perceived stress and anger frequency (79). Children with greater independent mobility meet more often to play with their peers, schoolmates and neighbors than children with less independent mobility (risky play category disappear/get lost, see Table 1). Physical activity outdoors also includes active transportation to commuting to school or other places (81), either by walking or riding a bike. The percentage of children using active transportation to get to and from places differs greatly between and among countries. The more developed the countries are, the lower they score in active transportation of children. In developing countries, active transportation may be the result of a lack of access to public transport and motor vehicles, but highly developed countries scoring high in active transport of children provide both infrastructure and policy to support active transportation (15). Rough and tumble play (see Table 1) is associated with higher interpersonal cognitive problem-solving in boys, but not with increased aggression (55). And, while we are on the subject of misleading convictions: the assumption that leaving children indoors is safer than outdoors may be wrong considering the potential harms of the internet including online-violence, cyber-bullying, pornography or image based sexual abuse (82), increased sedentary time and unnecessary incidental eating (18). These facts—both the encouraging and concerning ones—call for action.

What can physiotherapists do that current and future generations of children—the world's later adults—are able to live how they wish, to gain the experiences that they need, and can build nourishing relationships with their bodies, their peers, their neighborhood, and their natural environment?

3 How physiotherapists can contribute

Restricted opportunities for outdoor and risky play were discussed as having a potentially negative impact on children's physical activity behavior (55). Therefore, increasing the amount of time children spend outdoors seems to be a promising strategy to increase their physical activity levels and to promote healthy, active lifestyles (16) that persist into adolescence and adulthood. Physiotherapists are

equipped with essential knowledge about both optimal childhood development and how various pediatric conditions can affect a child's growth across multiple domains—including motor function, sensory processing, cardiorespiratory function, cognitive skills, and socio-emotional wellbeing (30). They are trained to autonomously choose and use a range of assessment approaches and therapeutic interventions, tailored to the child's age and stage of development, and provide guidance to caregivers on how to create safe(-as-necessary) environments for their children (19, 29, 83). Therefore, physiotherapists are predestined to spread the word about the benefits of risky play for optimal child development and health prevention, and tackling existing health issues (84) by including elements of risky play (see Table 1) into pediatric physiotherapy interventions, where appropriate.

Around the globe, physiotherapists are well-situated in reaching out to large groups of children and their caregivers, serving diverse communities including minority cultural groups, immigrants/refugees, persons living with disabilities, and gender-diverse communities. They can translate elements of risky play into various environments and cultures (69, 85), contributing to justice (86, 87) and pleasurable, positive experiences and achievements, which are valued by children and their caregivers (21). The International Organization of Physical Therapists in Pediatrics (IOPTP) firmly recommends that pediatric physiotherapy education programs include content focused on health promotion, injury prevention and physical fitness (30)—all realms positively influenced by risky play. In some countries, due to legal regulations or a culture of litigation, supervising adults are concerned about potential lawsuits, when stretching their own limits pertaining to risk-taking in child play (69, 88). Working collaboratively with caregivers, educators, and other health professionals, as well as policymakers, legislators, and other stakeholders in child health and safety, physiotherapists can inform about the benefits of risk-taking in physical activities, to change the negative perception of risk in children's play (see Table 2) (83, 84, 89). For example, the promotion of better public understanding of risky play's importance for children's health and development can be done through public talks, conferences, and interdisciplinary discussions, helping society to better understand why risky play matters and by advocating for environments and conditions that support it.

Physiotherapists can initiate multidisciplinary research collaborations to investigate the health benefits of risky play in various community settings, environments and cultures, raising meaningful questions to find solutions for today's burning questions in child health. To list only a few suggestions, future research could explore the perceptions of risky play among physiotherapists and allied health professions. The effects of risky play on children's motor skills development and fitness levels could be compared to more traditional pediatric physiotherapy interventions by using randomized controlled trials. At times, pediatric physiotherapy interventions need to be provided from infancy through adolescence and even into adulthood. Not all interventions chosen are appreciated by children and their families, but sometimes perceived being boring or dull (21). In this light, it might be valuable to study children's and their families' adherence to and satisfaction with physiotherapy, when including risky play interventions.

Physiotherapy and risky play are environmentally friendly (90), safe, low-cost and effective ways (91, 92) to improve children's

TABLE 2 Risks vs. hazards.

Risk in the context of risky play is understood as a situation whereby a child can recognize and evaluate a challenge and decide on a course of action how to respond to the challenge. The negative interpretation of risk led to a view of risk and hazard as being synonymous (53). A risk is not necessarily just negative. It can also be defined as situations in which we have to make choices among alternative courses of action without knowing the outcome (53). The presence of adults supervising children decreases injury rates. By enabling children to make choices that entail a risk of injury, while a caring adult helps to explore potential outcomes, their comprehension of the functioning of the world expands, fostering their development into independent and capable decision makers (55, 94).	A hazard is understood as a danger in the environment that could seriously injure or endanger a child and is beyond the child's capacity to recognize (53). Considering the developmental and physical literacy skills of children engaging in risky play, risks that may pose hazards are eliminated from the play environment, taking into account the child's age (53). Sometimes a hazard cannot be removed. In some regions of the world, children grow up in war-zones, where land-mines could be a severe threat to their lives, or they live in regions where encounters with wild or venomous animals are common. Extreme weather events such as heat or cold, long-term health risks of sun-exposure, or air pollution may impact a child's ability to play outside without restrictions. Depending on the society one lives in, both high levels of traffic, or even violence, can contribute to an unsafe environment for a child to freely play outside.
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health and well-being. Pooling both fields' strengths can help to increase children's awareness of the wonders of nature and life and to prepare them to accept future responsibilities towards communities, their personal health as well as planetary health (93). Nourishing a sense of belonging and connectedness (93), and reflecting on positive, playful ways of how we can build relationships and shape environments such as educational and health institutions, neighborhoods and playgrounds would be a good starting point for a healthy future worth living for humans and all other species (87).

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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

AS: Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing. EBHS: Writing – original draft, Writing – review & editing. BS: Funding acquisition, 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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Environmental physiotherapy: knowledge, attitudes, and practices among physiotherapists in Iceland

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Introduction: With growing concerns about climate change and the healthcare sector's carbon footprint, integrating sustainable practices into physiotherapy could not only reduce this impact but also enhance patient outcomes. This study explores the knowledge, attitudes, and practices of physiotherapists in Iceland regarding climate change and their role in promoting sustainability.

Methods: A cross-sectional survey was distributed to active members of the Icelandic Physiotherapy Association. A total of 114 physiotherapists participated (17.1% response rate). The survey, consisting of 21 questions across four themes—knowledge, attitudes, behavior, and obstacles—captured insights on respondents' understanding of climate change, their environmental practices, and the challenges they encounter.

Results: The results revealed a strong awareness of the relevance of climate change to health, though many respondents acknowledged limited knowledge on the topic. A majority expressed a sense of responsibility to mitigate climate change and reported taking actions such as reducing waste and promoting energy conservation. However, many identified a need for more guidance and training to integrate sustainable practices effectively. The primary obstacle was insufficient knowledge on implementing environmental strategies, with respondents indicating that education and resources would help overcome this barrier.

Discussion: This study highlights the potential for physiotherapists to contribute significantly to the healthcare sector's sustainability goals. The respondents' desire to enhance their environmental practices suggests an opportunity for professional associations and educational institutions to provide targeted training and support. By fostering greater environmental literacy, physiotherapists could not only contribute to reducing the healthcare sector's carbon footprint but also promote sustainable health behaviors in patients. Enhanced knowledge and support could help physiotherapists become key contributors to sustainability in healthcare.

KEYWORDS

climate change, physiotherapy, health education and awareness, environmental impact, health promotion

1 Introduction

The World Health Organization has identified climate change as the greatest health threat facing humanity (1). The connection between climate change and human health has been well-studied, revealing a dual challenge for healthcare systems. Firstly, rising temperatures and extreme weather events have been linked to various health issues, including respiratory and cardiovascular diseases, mental health disorders, and malnutrition with increased burden on healthcare systems (2). Secondly, the healthcare sector itself contributes significantly to environmental problems, accounting for up to 5% of global negative environmental impacts (3). Globally, it accounts for substantial greenhouse gas emissions, comparable to the emissions of 514 coal-fired power plants (4). Most of these emissions come from the supply chain, including the production, transportation, and disposal of medical goods and services.

A coordinated effort from all healthcare professions is essential to reduce the carbon footprint of the healthcare system (5). Physiotherapists can play a significant role, provided they have the necessary knowledge and understanding of how climate issues relate to their work (6). Physiotherapy inherently supports environmental sustainability through non-invasive treatments that can reduce the need for surgeries and medication (7, 8). Studies also suggest that encouraging active transportation among patients can simultaneously benefit their health and the environment (9).

International research indicates that healthcare professionals are generally aware of climate issues and their impact on health but often lack the detailed specific knowledge and practical tools needed to address these issues effectively (10–14). However, very few research have had specific focus on physiotherapists. A study from Spain (15) on physiotherapy students, indicated that the students were generally aware of climate issues and acknowledged their potential relevance to their future profession, but their knowledge was still somewhat lacking, and they did not perceive their studies to have adequately addressed the issue.

This study is the first to examine the knowledge, attitudes, and practices of physiotherapists in Iceland regarding climate issues, a topic largely unexplored in the field of healthcare. While previous research has highlighted the broader environmental impacts of healthcare systems, little attention has been given to the specific contributions and challenges within physiotherapy. This study is not only a contribution to fill this critical gap but also provides a unique perspective by focusing on Iceland—a country with a distinctive healthcare system and a strong commitment to sustainability. Furthermore, it explores how climate-conscious physiotherapy practices can positively impact public health by promoting environmentally sustainable healthcare delivery. By addressing these under-researched intersections, the study provides novel insights that not only advance physiotherapy practice but also align with global efforts to mitigate climate change and enhance population health outcomes.

Our aim is to answer the following research questions:

- What is the level of awareness among physiotherapists in Iceland regarding the health impacts of climate change?
- How do physiotherapists in Iceland perceive the relevance of climate change to their professional roles and responsibilities?
- What eco-friendly practices have physiotherapists in Iceland adopted to address climate issues in their work?
- What barriers and facilitators influence the integration of climate issues into physiotherapy practice in Iceland?

2 Methods

2.1 Study design and survey development

A cross-sectional survey was designed to gather data from physiotherapists in Iceland. The survey was developed and adapted from existing literature (10, 11, 13, 14) consisted of 17 questions divided into four main themes: knowledge, attitudes, behavior/practice, and potential obstacles and facilitators for eco-friendly practice.

1. Knowledge: Four questions aimed at assessing the respondents' understanding of climate change and its relevance to physiotherapy and health.
2. Attitudes: Seven statements focused on the respondents' beliefs about the role of physiotherapists in addressing climate change and their perceived importance of this issue. Participants were asked to express their attitudes toward these statements on a 5-point Likert scale.
3. Behavior/practice: Four questions on specific actions respondents were already taking to increase sustainability and reduce their carbon footprint in their professional practice as well as personal choices.
4. Obstacles and facilitators: Two questions on perceived obstacles respondents were facing in adopting eco-friendly practices and the types of support or incentives that would be most helpful in overcoming these barriers. Participants marked potential obstacles and facilitators from a list.

2.2 Participants

The survey was sent via email to all active members of The Icelandic Physiotherapy Association and was also promoted in a Facebook group for physiotherapists in Iceland. The background questions included questions on gender, age-group (10 years interval from 25 to 75 years old) and workplace setting, participants were informed about the study's purpose, their right to withdraw, and the confidentiality of their responses. Data was anonymized to ensure privacy.

2.3 Statistical analysis

Descriptive statistics summarized demographics, knowledge, attitudes, and practices. Chi-square tests and *t*-tests were used to examine associations between demographic variables and

respondents’ knowledge, attitudes, and practices. Thematic analysis (16) was used for qualitative data from open-ended responses.

(hospitals and rehabilitation centers), and around 12% work in teaching, research, or other fields.

3 Results

A total of 114 participants responded to the questionnaire. Most of participants were women, and the number was equal across all age groups from 25 to 65 years (Table 1). Approximately half of the participants worked in private clinics, little <40% in institutions

TABLE 1 Demography of participants.

		Number (%)
Sex	Female	93 (82.3%)
	Male	19 (16.8%)
	Other/prefer not to answer	1 (0.9%)
Age	25–35 years	31 (27.2%)
	36–45 years	26 (22.8%)
	46–55 years	24 (21.1%)
	56–65 years	28 (24.6%)
	66–75 years	5 (4.4%)
Workplace setting	Private clinics	57 (50%)
	Institutions	43 (37.7%)
	Teaching/research	2 (1.8%)
	Other, unspecified	12 (10.5%)

3.1 Knowledge of climate change and relation to health

Most participants (56.6%, $n = 64$) assessed their own knowledge of climate issues as intermediate. However, a total of 38.1% rated their knowledge as advanced ($n = 3$) or rather advanced ($n = 40$) and 5.3% ($n = 6$) rated their knowledge as rather little while no participant reported having very little knowledge.

There was a significant difference ($p < 0.001$) in how many considered climate change to affect people’s health in Iceland compared to other countries. In total, 84.1% ($n = 95$) of participants believed that climate change and its consequences affect people’s health in Iceland, either directly or indirectly while 97.3% ($n = 108$) believed the same applies outside Iceland. When asked, in an open question, how they believed climate change or its consequences affect people’s health, 84 participants wrote responses, from which several main themes were derived (Figure 1).

Air pollution and respiratory diseases were prominent in the responses, with many participants linking the two together and indicating that increasing air pollution negatively affects lung and respiratory function, potentially leading to an increased frequency of pulmonary and respiratory diseases. Consequences of climate change were also often mentioned, although not everyone connected them to health effects. References were made to pollution, changes in the Earth’s biodiversity and oceans,

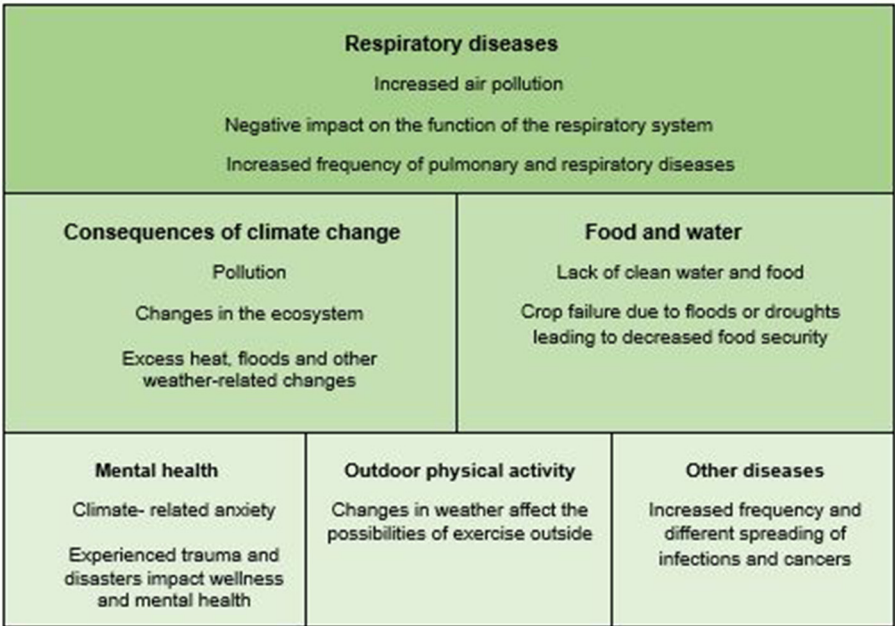


FIGURE 1
Themes on how climate change affects health.

heat, floods, and other weather-related changes, although it was not always clear how these changes would affect people's health. For example, one participant simply wrote: "air pollution, weather changes, ocean pollution" while another one gave a more detailed response:

"For example, water shortage, leading to crop failures, hunger, malnutrition, and death. More extreme weather resulting in damage to housing, increased risk of epidemics, disrupted transportation, and many people get displaced and suffer. Increased risk of floods and thereby destruction of valuables and crop failures. This, and much more, obviously has very negative effects on the health of those affected. Global warming and rising sea levels affect both marine and terrestrial ecosystems, which affects residents."

In some cases, accidents due to extremes in weather were also mentioned.

Many participants reported the effects on water and food supply, addressing both the lack of access to clean and unpolluted water and food as well as crop failures due to floods and droughts, which could affect food security. One participant wrote:

"Significant changes in the weather can cause crop failures and affect food security, which in turn can cause illness or even death. Water shortage or the opposite, floods, have very serious consequences, as many examples from the world in recent years show."

Mental health was also often addressed. This included discussion of so-called climate anxiety and concerns about the future. "Will it be habitable in the future, will my children or grandchildren be okay?" is an example of one participant's reflection. Additionally, the impact of experiencing natural disasters and traumas related to changing living conditions on mental wellbeing was also reflected. One participant mentioned "effects on the nervous system (e.g., stress, pressure from losing housing or family members)," while another noted that the

effects of climate change can "cause anxiety and insecurity, which leads to reduced quality of life regarding both mental and physical health."

Several participants mentioned the impact of weather changes on the ability to exercise outdoors. "Worse weather = less outdoor activity = less exercise," one participant simply stated. Another participant reported: "Extreme weather conditions, in either direction, make people potentially exercise less outdoors, with overall negative effects on their quality of life". Yet another pointed out the effect of limited outdoor activity on mental and physical health:

"People go outside less often if there is more extreme weather or precipitation due to climate change, which negatively impacts mental and physical health."

Finally, a few participants mentioned other diseases, such as the increased frequency and changing distribution of infectious diseases, cancer, and the impact of weather on the symptoms of individuals with arthritis, although it was not always clear in what way they believed climate change affected these factors.

3.2 Attitudes toward climate change and role of physiotherapists

Majority of participants (83%, $n = 88$) strongly agreed or agreed that the negative environmental impact of healthcare services needs to be limited, and similar number (80.5%, $n = 87$) agreed or strongly agreed that the negative environmental impact of physiotherapy services should be minimized (Table 2). Additionally, 78.7% of participants ($n = 85$) were very or somewhat concerned about climate change, while 8.3% ($n = 9$) were somewhat or strongly opposed to this statement. Most participants (87%, $n = 84$) were interested in learning more about how they could reduce environmental impacts in their work. In total, 66.7% of participants ($n = 72$) strongly agreed

TABLE 2 Attitudes toward climate change and role of physiotherapists.

Statement	Number (%)				
	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
It is necessary to limit the negative impact of healthcare services on the environment	47 (44.3%)	41 (38.7%)	13 (12.3%)	2 (1.9%)	3 (2.8%)
The negative impact of physiotherapy services on the environment must be limited	46 (42.6%)	41 (38%)	14 (13%)	2 (1.9%)	5 (4.6%)
I am concerned about climate change	31 (28.7%)	54 (50%)	14 (13%)	4 (3.7%)	5 (4.6%)
I am interested in learning more how I can reduce environmental impact in my work	53 (49.1%)	41 (38%)	10 (9.3%)	1 (0.9%)	3 (2.8%)
Physiotherapists should raise public awareness of the health impacts of climate change	21 (19.4%)	51 (47.2%)	21 (19.4%)	7 (6.5%)	8 (7.4%)
Physiotherapists should raise their clients' awareness of the health impacts of climate change	27 (25%)	45 (41.7%)	23 (21.3%)	8 (7.4%)	5 (4.6%)
Physiotherapy is inherently eco-friendly	29 (27.1%)	44 (41.1%)	29 (27.1%)	3 (2.8%)	2 (1.9%)



FIGURE 2
Examples on how physiotherapists can impact climate change.

or agreed that physiotherapists should raise public awareness of the health impacts of climate change. As many ($n = 72$) felt that physiotherapists should make their clients aware of the health effects of climate change, although a little more strongly agreed on that statement. Finally, a total of 68.2% ($n = 73$) strongly agreed or agreed that physiotherapy is inherently eco-friendly while 27.1% ($n = 29$) were neutral on the statement.

When asked whether participants believed that physiotherapists could have an impact (either negative or positive) on climate change within their professional field, most participants (79.6%, $n = 82$) agreed. A total of 60 participants responded to an open-ended question, providing examples on how they thought physiotherapists could reduce the impact on climate health within their workplace setting. Four themes were identified from their answers (Figure 2).

The first theme, and the most frequently mentioned, was active transportation and exercise. Participants primarily suggested that physiotherapists could encourage their clients to use active transportation instead of private cars to improve both their quality of life and health while reducing environmental impact. Additionally, participants highlighted the importance of being role models in this regard. One participant stated that physiotherapists could “encourage and set an example by using self-propelled transportation, such as choosing stairs over elevators, walking instead of driving, etc.” Exercise was also cited as an eco-friendly form of therapy.

The second theme focused on materials and supplies, with participants mentioning reducing the use of disposable products and paper and being selective with hygiene products and other equipment. One participant recommended “conscious use of equipment and supplies, such as choosing reusable over disposable items.” The third theme concerned waste sorting, specifically

referring to the waste generated at physiotherapy workplaces. One participant suggested that, for example, “each clinic could ensure it doesn’t use unnecessary amounts of paper, polluting cleaning products, sorts waste, etc.”. Finally, education was also frequently mentioned, mainly on dietary choices and eco-friendly lifestyles but also without further specification.

In addition, several participants took the time to respond even if they did not provide concrete examples. Their responses commonly reflected a belief in the profession’s ability and responsibility to make a positive impact, as two following quotes describe:

“Everyone need to make choices, and physiotherapists are often in key positions to influence their clients’ choices and their own.”

“If there is something we can do in our work or around our work that positively impacts climate change ... and everyone or most people participate, physiotherapists can certainly make an impact.”

3.3 Environmental behavior

Just over a quarter reported that there was no environmental policy at their workplace, and nearly a quarter were unaware of whether an environmental policy existed at their workplace or not (Table 3). A total of 74.8% of participants ($n = 88$) reported that they strive to limit environmental impacts in their professional work while 95.4% ($n = 103$) stated that they do the same as their personal choice ($p < 0.001$).

TABLE 3 Statements on environmental policy and behavior.

Statement		Number (%)
My workplace has an environmental policy	Yes	55 (50.9%)
	No	29 (26.9%)
	I don't know	24 (22.2%)
I strive to limit my environmental impacts in my work	Yes	77 (74.8%)
	No	26 (25.2%)
I personally strive to limit my environmental impacts	Yes	103 (95.4%)
	No	5 (4.6%)

Those who answered that they strive to limit environmental impact were given the opportunity to provide examples, and 63 participants took advantage of this. Three themes emerged from their responses (Figure 3).

Workplace/Operational practice was the most frequently mentioned theme and included various efforts to reduce waste. Participants described limiting the use of disposable items and packaging (such as paper towels, disposable sheets, plastic, and single-use packaging), reusing materials, conserving printing paper, and using energy, heating, and water efficiently. Many participants mentioned using sheet compartments to reduce laundry needs. Additionally, choices around purchasing, equipment use, and material selection were highlighted. For example, one participant stated:

“I use materials and equipment sparingly, encourage clients who need frequent or regular appointments to reuse the same sheet without washing it after each session, and maintain equipment so it lasts longer.”

Personal choice: This theme included two sub-themes. The first was waste sorting, mentioned in over half of all responses, and the second was transportation where participants reported using active transportation or electric vehicles themselves. One participant shared:

“I take the bus to and from work instead of using a private car, avoid plastic or reuse plastic bags, use stairs instead of elevators, and make full use of items (don't discard anything unnecessarily).”

Treatment approach was the least mentioned theme but advising clients on a healthy lifestyle and encouraging active transportation was mentioned. Two participants highlighted their choice of treatment methods, favoring exercise and education as primary treatment options over the use of electric devices or disposable equipment such as PEP devices.

3.4 Barriers and motivators for implementing eco-friendly practices

When participants were asked what they believed was potentially hindering them from adopting more eco-friendly

practices in their work, the most selected response was lack of knowledge, followed closely by lack of material resources (Table 4). Guidelines was the most frequently selected factor when participants were asked about what could make it easier for them to implement eco-friendly practices in their work. Education and a formal environmental policy from their workplace or professional association followed closely.

4 Discussion

The aim of this study was to explore whether practicing physiotherapists in Iceland have knowledge and interest in climate issues and their connections to physiotherapy and health, as well as to assess their attitudes, interests, and practices in this context. The results showed that although most participants rated their knowledge as intermediate, the majority agreed that climate change affects people's health, both within and outside of Iceland. Significantly more participants stated that they try to limit their environmental impact as their personal choice, than in their professional work and lack of knowledge and resources seem to be the most hindering factors for eco-friendly practices.

4.1 Knowledge of climate change and relation to health

Studies among healthcare professionals have shown a reasonable general knowledge of climate change, its consequences, and its effects on human health (10–14). The findings of our study appear to align with these results. Generally, the physiotherapists seemed aware of climate change and its impact on health, and basic understanding of the issue was evident in responses to open-ended questions. Icelanders perceive their own society to be at lower risk from the effects of climate change than other societies globally (17). This perspective is also reflected in our results, where more participants believe that climate change affects health outside Iceland than within the country.

Air pollution already has significant health impacts in Europe (18) and our participants seemed aware of this as many of them mentioned respiratory illnesses when asked about the health impacts of climate change. True to the physiotherapy profession, outdoor exercise was also top of mind for many, which is a less common theme in studies among healthcare professionals. This indicates the importance of exploring the unique perspective of physiotherapists and their role in reducing the climate impact of healthcare.

Interestingly, some participants listed diverse consequences of climate change, such as weather changes, pollution, and changes in biodiversity, without explaining how these factors impacted health. A few participants also mentioned changes in the spread and frequency of specific diseases without detailing how they related to climate change. These findings suggest that while participants recognize the health risks associated with climate change and can identify potential health impacts, their understanding of the underlying mechanisms may be limited. This highlights the need to enhance the education of future physiotherapists on the relationship between climate change and health outcomes.

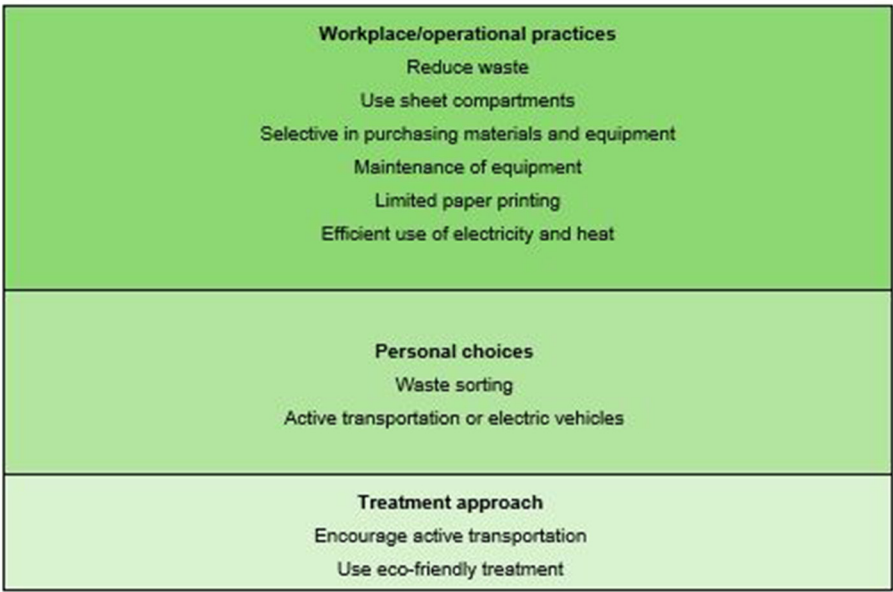


FIGURE 3
Ways to limit environmental impacts of physiotherapy.

TABLE 4 Barriers and motivators for implementing eco-friendly physiotherapy workplaces.

Barriers	N (%)	Motivators	N (%)
Lack of knowledge	57 (50%)	Guidelines	69 (60.5%)
Shortage of eco-friendly material/equipment	35 (30.7%)	Education on the relation between climate change, health and physiotherapy	53 (46.5%)
Lack of financial resources	22 (19.3%)	Formal environmental policy in workplace	53 (46.5%)
No environmental policy	19 (16.7%)	Formal environmental policy from IPA	52 (45.6%)
Lack of support from supervisors	13 (11.4%)	Support and encouragement from colleagues	47 (41.2%)
Too time-consuming	10 (8.8%)	Support and encouragement from supervisors	47 (41.2%)
Too much work	8 (7%)	Education resources for clients	30 (26.3%)
Lack of interest	3 (2.6%)	Evidence-based scientific articles	27 (23.7%)

IPA, Icelandic Physiotherapy Association.

4.2 Attitudes toward climate change and role of physiotherapists

In a study by Sambath et al. (12) among healthcare professionals in India, 43.9% of respondents expressed interest in learning more about the role of healthcare professionals in the context of climate change while 87% of participants in our study were interested in learning how they could influence climate change through their work. In a recent survey on the Icelandic public (17), 64% of participants expressed concern about climate change and environmental issues but in our study, over 80% of participants reporting concerns about climate change. One possible reason for the high level of concern in our study, is that women in Iceland seem to be more concerned about these issues (17) and most of our participants were women.

Most participants agreed that it was necessary to reduce the environmental impact of physiotherapy services and healthcare in general and nearly 80% indicated that physiotherapists could

have an impact on climate change within their field. Stanhope et al. (6) pointed out that educating patients to take advantage of green spaces and natural environments can enhance treatment outcomes by reducing pain perception and medication use. They also suggest that physiotherapists can play an active role in public health initiatives.

The Environmental Physiotherapy Association (19) has given some recommendations on how to make workplaces more environmentally sustainable, which include reducing the workplace’s carbon footprint, such as through waste sorting and selective use of materials and resources. These aspects were the most mentioned by participants in our study. Toner et al. (9) suggested that physiotherapists encourage patients to adopt active transportation as part of their treatment to enhance physical activity. Our participants also identified this opportunity, with many mentioning encouraging clients to use active transportation and incorporating physical activity as a therapeutic tool. Education was also frequently mentioned;

however, as previously noted, the content of this education was often not specified.

Physiotherapy is a noninvasive discipline, and it has been stated that physiotherapy is inherently eco-friendly, due to the emphasis on physical activity, touch and communication (7). Therefore, it has the potential to serve as an alternative to more resource-intensive interventions, such as medications and surgeries. Our participants identified physical activity and education as eco-friendly treatment options, and although not explicitly comparing physiotherapy to other treatments, nearly 70% agreed that physiotherapy is inherently eco-friendly. This perspective underscores the potential role of physiotherapists in reducing the environmental impact of the global healthcare system. If physiotherapy offers a more sustainable option compared to other treatments, its most significant contribution to minimizing healthcare's environmental footprint may lie in the effective practice of the profession. By promoting health, reducing the need for surgeries or medications, and fostering sustainable behaviors among clients, physiotherapists could play a pivotal role in advancing eco-friendly healthcare.

4.3 Environmental behavior

In a study by Kircher et al. (10) conducted among healthcare professionals in Minnesota, over a third of participants reported making no effort to reduce environmental impacts in their work, while in Lister et al.'s study (14) among healthcare workers in South Africa, 44% reported practicing sustainability in their work. Our study findings, however, show that most participants are already mindful of their environmental impact at work. Apart from some general actions, our participants mentioned using sheet compartments to save on laundry, and treatment-related recommendations and education on a healthy lifestyle, promoting active transportation, and choosing more eco-friendly treatment options.

It was interesting to observe that nearly all participants reported actively seeking to limit their environmental impact as their personal choice, a significantly higher proportion than those who said they did so at work. Moreover, nearly a quarter of respondents were unsure whether an environmental policy was in place at their workplace. This raises the question of why participants are less likely to demonstrate environmental responsibility at work compared to their personal choices. Prior studies among healthcare professionals show that a lack of knowledge about climate issues is often cited as a barrier (10, 11, 14). Therefore, it was not surprising that when asked about barriers in this study, lack of knowledge was the most frequently chosen response. Similarly, education and guidance on climate change in relation to physiotherapy and health were the most selected options when asked about potential motivators. These responses suggest that participants may want to improve their environmental efforts but are unsure how best to proceed. A lack of material resources was also frequently cited as a barrier, along with a lack of funding. This could indicate that in some cases, participants have ideas for solutions but lack the means or resources to implement them.

4.4 Strengths and limitations

This study is the first study to be conducted in Iceland among healthcare professionals, including physiotherapists, and their perspectives on climate changes and relation to health. Therefore, it is a foundational exploration of an unexamined topic in Iceland and a contribution to increasing awareness in research among physiotherapists elsewhere. True to the nature of foundational research, it raises more questions than it answers, highlighting opportunities for further research in this area. The main limitation of the study was the small size of the sample. Active members of the Icelandic Physiotherapy Association were 666 at the time of the survey, but only 114 responded, resulting in a response rate of 17.1%. It can be that physiotherapists who already had an interest in the topic were more likely to respond to the survey, despite efforts to appeal to all members during the study's promotion. Considering these factors, caution should be taken when generalizing the findings to all physiotherapists in Iceland. Nevertheless, the qualitative data from the open-ended questions and other results, can be useful in developing further research to gain deeper insights, capturing the unique perspective of physiotherapists in Iceland. This study is also a valuable input into global research in environmental physiotherapy.

5 Conclusions

This study is the first of its kind in Iceland to specifically highlight the perspective of physiotherapists, laying the foundation for ongoing research on climate change in relation to physiotherapy and health. The unique perspective of physiotherapists came through in the responses, revealing various opportunities connected to physical activity and outdoor engagement that have not been mentioned in other studies involving healthcare professionals. Call for guidelines on environmental physiotherapy and support for eco-friendly practice is evident. Further research should continue to explore this viewpoint, examining what role physiotherapists could play in public education and policy, what resources they feel are needed, and how they would prefer to increase their knowledge in this area.

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 approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

SO: Investigation, Project administration, Supervision, Writing – original draft, Writing – review & editing. LP: Formal analysis, Methodology, 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

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Regenerating physiotherapy curriculum in higher education: diving into planetary health and service-learning conceptual synergies

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The physiotherapy curriculum has been modified over the years to address patients, community and health care system needs more fittingly. Recent attention is being paid to the need for an eco-social transition of the profession. This article delves into conceptual frameworks that underpin the urgent need to regenerate the curriculum, fostering a vision of humanity and the planet as deeply interconnected and indivisible. This implies not only becoming aware of the environmental impact of educational and clinical physiotherapy practices but also to reframe education through the lenses of planetary health. This calls for active engagement, a solution-oriented approach to education, and a reimagining of humanity's relationship with the planet. Service-learning operates as an experiential critical pedagogy, blending hands-on engagement with reflective analysis to challenge students' assumptions and foster transformative learning rooted in social justice. This form of experiential critical pedagogy empowers students to learn while serving their communities in a range of areas—most notably in response to the urgent challenges of planetary health. By aligning planetary health with service-learning—an action-based pedagogy that cultivates student empowerment and civic responsibility—we can envision a regenerative transformation of the physiotherapy curriculum. This work's aim is to gain epistemological insight on the social-ecological complexity on this matter. The article discusses four rationales that permeate a framework for this regenerating purpose in the light of the Global Action Plan on climate change and health. It tackles planetary health, higher education, physiotherapy, and service-learning as a pedagogy orientated to action and critical reflection. All this opens the gate to rethink the role of physiotherapy education in the Anthropocene. Higher education needs to interconnect individuals, communities, and the natural world, promote shared governance and democracy, stimulate critical thinking and embrace diversity. Education in physiotherapy needs to underscore cognitions and academic proficiency, emotional intelligence, social consciousness, and ethical awareness, matchmaking learning experiences with local and global challenges. There is a need to advocate for pedagogical approaches that inspire hope and prepare students to contribute meaningfully to their communities, upholding principles of equity and intergenerational justice.

KEYWORDS

planetary health, physiotherapy, service-learning, higher education, curriculum

1 Introduction

For decades, physiotherapy's educational curriculum was aimed at training professionals to meet various individual needs linked to movement and functionality mainly focused on the specific competences (1, 2). Subsequently, the professional profile evolved, focusing on its potential to promote the health of the population from a public and community health perspective, understanding the social determinants of health, promoting interdisciplinary research, leadership and advocacy roles (3). This led to the need to expand the scope of the physiotherapy curriculum giving emphasis to transversal competences (4).

Over the last years, the biomedical perspective has permeated education and clinical practice, so that the evidence based on dominant research has also raised a growing concern about the loss of humanistic value and the lack of critical theoretical reflection in the profession (5). This evolution is not unique to physiotherapy and other health professions are going through a similar process reframing the curriculum to meet urgent global challenges. Currently, an eco-social transition of the profession is taking place, questioning the physiotherapy narratives that separate the foundations of the discipline from the Indigenous tradition, the uses of nature not as a resource but as constituent of the intrinsic good of the profession, and the participation of physiotherapists in the construction of more inclusive, supportive and environmentally responsible policies (6). Worldwide events such as the COVID-19 pandemic put the focus on physiotherapy as a crucial therapeutic strategy but also opened the discussion regarding the lack of consideration of the profession in international debates on how pandemics and chronic diseases are effects of the lack diversity, deforestation or pollution (7–9). The One Health initiative posed by the World Health Organization is only possible if there is a change in the way of understanding the health professions (including physiotherapy) and with it, the educational process for students to acquire the necessary skills. As will be seen later, conceptually One Health and Planetary Health are not the same, but both require competencies from physiotherapists different from those traditionally accepted as health practitioners. The physiotherapy profession has a growing interest and engagement in addressing climate change and its effects on health (10).

Ensuring equitable human development is important, but such development should be accomplished without further destabilizing the Earth's natural systems (11). As this is perhaps the greatest challenge of our time, people worldwide are increasingly facing the pressing challenges of today's interconnected environmental, social, and health crises. Academic and scientific personnel call for greater biodiversity and human health protection by preserving existing forests and improving the management of new or expanding ones (12). One way of navigating these seemingly opposing objectives is by detailing an understanding of the trade-offs and synergies between human progress and the development and environmental targets (13). That means designing a path to the future that offers sustainability and regeneration of the Earth's system, in which nature's benefits, risks, and responsibilities are shared fairly across the world (14). To transition into environmentally responsible and socially inclusive physiotherapy-care systems, universities should embed planetary health education and training across higher education curricula (15). It is at this point where experiential pedagogies such as service-learning have a great potential to change the positivistic university

inertias driven by institutional prestige and others, with impact in physiotherapy education (16). Moving away from predictive higher education, this work places an epistemological insight on the social-ecological complexity, valuing the expectations of each actor in physiotherapy education.

The article dives into concepts that could support a process of regeneration of physiotherapy curricula toward planetary health, based on a critical review and synthesis of existing literature, proposing innovative pathways for higher education. This implies not so much incorporating content on what planetary health is or is not, but how this can be embedded transversely and longitudinally into the curriculum in a normalized way, not as a fad. Studies on service-learning and planetary health are still very incipient, and inexistent (to the authors' knowledge) in their relationship with physiotherapy. So, this work also aims to contribute to the development of a comprehensive approach to how higher education and its surrounding communities can foster a regeneration of physiotherapy programs considering the WHO's Global Action Plan on Climate Change and Health (17).

The question that underlies this work is what rationales can be considered for the regeneration of the physiotherapy curriculum, how can they be articulated and what dimensions can emerge from that process. In this case, the pedagogical alignment includes four rationales: planetary health, regeneration of higher education, service-learning, and physiotherapy in order to propose a synergic path toward the regeneration of physiotherapy education.

2 The rationale for planetary health

Climate change poses a substantial threat to human health, leading to millions of additional deaths and illnesses due to increasingly striking extreme weather events (18). It especially affects the populations of low and middle-income countries (LMICs), owing to scarce resources, inadequate planning, and insufficient investment in health care, environment, and related sectors (19). Climate change is associated with negative health outcomes, increasing mortality and exacerbating cardiovascular and respiratory illness, mental health disorders, and other climate-sensitive health outcomes (20). These examples demonstrate the causal pathways that link the three global pressures of climate change, biodiversity loss, and infectious disease (21). This has attracted the attention of the different health professions, initially in its scientific performance but also in its educational, political advocacy and clinical roles.

Conceptual elements of planetary health have been discussed in the last years expanding on previous public health considerations (22). The Kuala Lumpur call to action (23) defines planetary health as a global movement, analytical framework and field of work what requires a solution orientated approach to promote a resilient and regenerative future for all. Institutions, educators, and learners that incorporate this framework would need to shift away from a business-as-usual, siloed approach to education (24). The São Paulo Declaration on Planetary Health (25) states recommendations for health practitioners, health sector, researchers and university to advance in the so-called Great Transition. This transition to a sustainable future requires reconciling the respect for the Earth limits with the justice principles reframing considerations as prosperity and progress (26). For institutions to adapt planetary health as a guiding framework for an institution-wide

approach, the issue of contextualization, transdisciplinarity, epistemological diversity, solution-oriented, action-based, and transformative approaches to education should be intentionally designed through strategic, logistical, and resource lenses (27, 28). All this would require inclusive relationships, thoughtful strategy, effective communication, and transformational partnerships (29).

Planetary health is distinct from One Health (30). While the first emphasizes the function of climate change, biodiversity loss, and environmental degradation on human health (31), One Health promotes integrative collaboration among multiple disciplines (32), reinforcing the disease control and global health security. While planetary health calls for systems thinking and complex interactions between ecological, social, and economic systems concerning human and ecosystem health to address global health challenges (33), the second emphasizes integrated surveillance, research, and policy to address shared health threats between humans and animals (34). In terms of resemblances, both recognize the interdependence of human, animal, and environmental health, emphasizing ecological interactions. Planetary health aligns with One Health in acknowledging the importance of ecosystems, climate change, and sustainability, and vice versa occurs in acknowledging the interconnectedness of health and ecosystems (35, 36). Both are highly complementary approaches based on transdisciplinary, multisectoral, and system-based approaches to health, but challenges remain when translating ideas into policy and practice (37). One Health and Planetary Health contribute to building a much stronger research community to collectively address public and global health challenges in an integrated way (38) pushing public health to evolve (39).

In any case, if we consider the frameworks used by the World Health Organization for the operationalization of the Global Action Plan on Climate Change and Health (17) one observes that four approaches are considered: (1) Sustainable Development Goals, (2) Health in All Policies, (3) One Health and (4) Planetary Health. These frameworks contribute to define the 15 key principles of this plan: Adaptability, Holistic approaches and collaboration, Community orientation, Human rights, Environmental justice, Innovation, creativity and technology-based, Evidence-based practice, Multisectoral partnerships, Financial efficiency, Social determinants of health, Gender equality/Gender inequalities and differences in needs and opportunities, Traditional and indigenous knowledge, Local and regionally led strategies, Vulnerable populations and Health equity. This plan brings implications for higher education and, therefore, for physiotherapy education.

3 The rationale for regenerating higher education

Regenerating physiotherapy curriculum is not possible without being framed in a broad higher education transformation. Higher education includes universities, universities of applied sciences and other forms of education considered to be the highest level of education in a given country. Its constitution has evolved since the first universities established in the Middle Ages in Europe and so has its purpose (40). According to the United Nations Educational, Scientific and Cultural Organization (41), higher education is a rich cultural and scientific asset that favors personal development and economic, technological and social transformations. It also stimulates

the exchange of knowledge, research and innovation, and equips students with the necessary skills to respond to the constant evolution of the labor market ensuring them economic security. But UNESCO (42) has claimed in the last years for renovated structures and procedures to ensure real transformations such as increasing its interdisciplinarity by focusing on and promoting the critical and active spirit of citizens, as this would contribute to sustainable development, peace, well-being and human rights.

Higher education plays a vital role in training future professionals to mitigate climate change and propagate social and governance measures to foster sustainability (43, 44). Unlike previous agendas, such as the Millennium Development Goals and Education for All, the Sustainable Development Goals, which make up the 2030 Agenda for Sustainable Development, explicitly refer to higher education as part of the vision of lifelong learning for all (45). Higher education is urgently required for sustainable development, innovating not only for individual impact in the classroom, but also to advance institutional change and decisively influence the teaching and learning discourse of higher education (46).

In terms of planetary health, contemporary universities could address diverse aspects of the problem. On the one hand, they must become carbon-neutral institutions by adopting low-carbon operating practices, and on the other hand, they must develop curricula and pedagogical approaches to educate students (and, by extension, communities) about the imperatives of climate change mitigation and adaptation. In addition, universities, as trusted organizations, must increase the evidence of the impact that different policies have to generate large-scale but context-sensitive changes (47). But since planetary health considers systematic feedback loops for causality (98), the same approach could be applied to higher education institutions: their actions influence the environment and the community, but also vice versa. Therefore, the role of higher education within the Global Action Plan on Climate Change and Health (17) could be also addressed by enhancing the so-called “third mission” of universities through community participation.

All the above bring several scenarios to the discussion. From the perspective of ecological justice (that is, with nature), the embedding of higher education with planetary health topics, would engage in more sensible discussions on climate change, addressing the disparities between official international climate policy and societal and ecosystem needs (48). Higher education would advocate strategies that could widen the investigation on local and regional political ecology (49). From the perspective of social justice, higher education would manage solidarity, collaborative and empowering relationships that could reduce social-economic inequality, social discrimination and oppression worldwide (50). From the perspective of cognitive justice, higher education would foster dialog between science and other understandings, which are essential to equality between inclusion and participation (51). Through the concept of learning together, higher education would engage in an ongoing reflexive praxis that would generate knowledge for participants within their communities while also generating knowledge about how we learn. From the perspective of historical colonialism justice, higher education would advocate broader recognition of how socially and regionally uneven concentrations of wealth, which have resulted in climate-changing emissions, were created in the first place (52). From the perspective of gender justice, higher education would recognize that gendered vulnerabilities require tailored adaptation measures (53).

For higher education to be able to effectively cope with these challenges and future scenarios, pedagogies that actively engage people in learning and behavioral change toward actions for sustainability will be required (54). Regenerative education is an emerging strand of educational theory and practice based on the way in which human communities and individuals relate to themselves and the environment (55, 56). That means valuing improved social-ecological systems for the purpose of mutually flourishing. The proposal for the regeneration of higher education implies the need for a far-reaching transformation, which pays attention to lived experiences, interpretation and co-construction of reality. From a socio-critical point of view, a real transformation of educational institutions requires educators to be more aware of their role, which can be enhanced through self-reflective and dialogic processes (25). Transdisciplinary research, teaching and learning will be necessary and possible by promoting a solution-oriented praxis based on epistemological diversity (57).

Regenerating education means enabling individuals to tackle complex and emotional topics related to planetary health without feeling overwhelmed. This would imply redesigning learning institutions by embedding climate change types of justice and planetary health education in curricula, across all levels, disciplines, sectors (geographies/indigenous/spiritual) and pedagogies (58). Technology would be used in each setting increasing adequate accessibility to resources for planetary health and civic engagement (59). Environmental health curriculum and communication skills would effectively advocate for climate leadership empowerment and workforce preparedness (60). The energy, awareness and ambition of youth would complement the authority and expertise of subject matter experts if the educational barriers to youth engagement in high-level decision-making are removed (61). That requires equipping and enabling learners to drive transdisciplinary and mutually reinforcing actions.

4 The rationale of physiotherapy

The Policy Statement of Climate Change and Health states that World Physiotherapy recognizes the existence of a climate change emergency as the greatest threat to human health in the 21st century (62). This statement should not be seen only as a starting point but as a further step in the expected growing interest of physiotherapy in recognizing roots in the profession that combine environmental awareness, clinical reflection and ethical thinking within a sustainability and patient safety context. It aligns with the International Classification of Functioning, Disability and Health (99) and recognizes the important role of the environment in people's functioning, ranging from physical factors (such as climate, terrain or building design) to social factors (such as attitudes, institutions, and laws). It also links with the ethical principles for individuals and physiotherapy organizations (63), since the health of people and communities is not disconnected from the environment. Previous works have claimed that there is a strong global call for the physiotherapy profession to take action to advocate for sustainable practice at individual and organizational spheres (10).

It has been stated that physiotherapists are at the forefront of tackling diseases and supporting people with disability and could advocate for practices addressed to sustainability and health promotion (6). Nature prescriptions have been integrated within

face-to-face therapies offered by physiotherapists, with emerging research highlighting nature's role as a non-pharmaceutical means of supporting rehabilitation (64). In interventions involving people with long-term health conditions spending time in parks, gardens, forest/woodlands and wetlands, improvements were reported in the participants' psychological, physical and social well-being (65). Harnessing nature can lay the foundations for more health equity and sustained behavioral change that extends beyond the clinical environment to everyday life and routines, which might not otherwise be achieved in tightly controlled indoor settings (66).

Embedding planetary health within physiotherapy education would support Indigenous and traditional knowledge, new voices to inform physiotherapy healthcare practice (67). It would discuss how promoting environmental sustainability in physiotherapy health care could support progress on social determinants of health, health equity, and respect for cultural diversity. It would favor the discussion of how physiotherapy health professionals should contribute to mitigation, adaptation, advocacy, and activism regarding sustainable development, and environmental stewardship (58). The redesign of urban areas toward health-promoting spaces, reducing pollution, increasing walkability, wilderness and green spaces through shared governance models would be a normalized area for physiotherapy education in health promotion and public health, since these are also possibilities for concrete nature-based actions with a local and global impact on planetary health (68).

In this sense, it is necessary to take into account existing initiatives in higher education such as the International Network of Health Promoting Campuses or the International Network of Sustainable Campuses, on which physiotherapy education can not only pivot but also propose innovative experiences. In relation to local communities, pedagogical approaches such as service-learning increase reciprocal relationships between academic and community partners. Considering the large number of organizations whose mission is aligned with environment, sustainability, climate change, and planetary health, service-learning could permeate physiotherapy faculties and departments in a more agile and effective way than other teaching methods.

5 The rationale of service-learning

Service-learning in higher education is an experiential educational pedagogy in which students engage in community service, reflect critically on this experience, and learn from it personally, socially and academically. The activities address human, social and environmental needs from the perspective of social justice and sustainable development, and aim at enriching learning in higher education, fostering civic responsibility and strengthening communities. It brings together students, academics and the community whereby all become teaching resources, problem solvers and partners. In addition to enhancing academic and real-world learning, the overall purpose is to instill in students a sense of civic engagement and responsibility and work toward positive social change within society. UNESCO (25) states that *"service-learning and community engagement soften the walls between classes and the community, challenge students' assumptions, and connect them to systems, processes, and experiences beyond their own experiences."* Although there are diverse considerations about the relevance of this pedagogy in higher education, the core principles are

clear. An authentic service-learning experience is designed in a way that engages students in learning experiences by addressing real needs through partnerships with community entities. In turn, community service activities are addressed to enhance students' learning. This "service" includes actions as direct service, indirect service, advocacy and research, which implies that higher education students (all levels) can develop actions ranging from direct interventions in the community to research-based advocacy reporting. So, the distinctive character of service-learning resides in the fact that students are focused on ensuring mutual benefits for themselves and the community, promoting otherness as a value, that is, encouraging recognition of difference and diversity, both in the personal and social spheres.

Critical reflection is essential and aimed to deepen student learning but also community-campus partnerships (69). This is why service-learning should not be confused with volunteering, internships, or fieldwork. Service-learning is a structured and balanced pedagogical approach that integrates academic learning with meaningful community engagement (100), its roots are experiential pedagogies based on "learning by doing" (70).

Prior studies show that service-learning can act as a catalyst for activating education for sustainable development in higher education (71). This is particularly important because there are significant psychological barriers that limit individual action in terms of climate change, including a lack of knowledge and feelings of uncertainty and disempowerment (72). Experiences include data collection as a part of service-learning partnerships applied as a tool to integrate climate change and sustainability concepts in the classroom (73). Service-learning has been used to provide students with an opportunity to directly engage with organizations grappling with climate change through the collection of data, the creation of models, and the application of those models to scenarios of climate change (74). Therefore, service-learning promotes students' ability to apply their newly acquired skills and knowledge to support partner organizations in understanding how to face and respond to climate change more clearly.

From the perspective of the faculty, students gain from service-learning experiences a deeper understanding of the impact of climate change on their discipline by allowing them to conduct real-world, applied work (75). Service-learning partnerships between students and scientists should be considered an important new avenue for updating education and practice, but also for promoting community science and planetary health advocacy. Finally, when referring to service-learning consideration should be given to the tendency of projects to evolve from simple experiences to complex, dynamic and long-term sustained collaborative projects based on strong partnerships. To facilitate this transition, the so-called "institutionalization of service-learning" allows the faculty and the university to be committed to this pedagogical approach in the long term, which also facilitates measuring its impact (76–79).

6 Discussing and proposing conceptual dimensions to regenerate physiotherapy higher education curricula

Contemporary higher education is called to align its purpose toward the Global Plan of Action on Climate Change and Health (17).

This plan is organized into three primary action areas: (PAA1) leadership, coordination and advocacy; (PAA2) evidence and monitoring; and (PAA3) country-level action and capacity-building. Each primary area is framed in a global target divided into objectives with specific actions addressed to members states, the WHO secretariat and stakeholders. To articulate the path of this discussion only one objective of each primary action areas will be selected, although all of them are interconnected. The Objective 1. C refers to "Empower, inform and effectively engage the health community to support climate and health action," the Objective 2. A is to "Strengthen the scientific and traditional knowledge evidence base through scientifically-sound research and empirical evidence on the connections between climate change, climate action and health," and finally, the Objective 3. E is to "Implement climate change and health interventions to increase climate resilience and reduce greenhouse gas emissions of health systems and facilities." In this sense, physiotherapy education will need to prepare future professionals to pursue these objectives and to come up with strategies for climate change mitigation and adaptation as part of their social role (80). There are six fundamental reasons to regenerate physiotherapy curricula. First, it would influence the design of transformative educational strategies that would integrate diverse ways of knowing and co-benefits for people, communities and the planet, as knowledge and spiritual traditions (81). Second, it would foster a social and ecological approach to health promotion and disease prevention and control, ranging from individual to population-level determinants of human, animal, and ecosystem health, and its underlying and mediating factors (82). Third, it would characterize the linkages between environmental changes and human health at different geospatial and temporal scales and would incorporate characteristics of complex adaptive systems (83). Fourth, it would promote equity and justice in the rights of humans and the rights of nature, giving all human populations and ecosystems, present and future, the opportunity to attain their full vitality (84). Fifth, systemic disparities would be reduced so that no population carries disproportionate burdens of environmental and health impacts while others can thrive (85). And sixth, education processes would acknowledge the structural inequities and historical and political injustices (83).

Service-learning emerges here as an experiential pedagogy, a useful approach to address new narratives regarding planetary health and climate change in higher education (54, 86, 87). As sustainability is a complex and sometimes vague idea (88), service-learning projects can intersect climate change and physiotherapy, acting as a concrete pathway for physiotherapy students to learn about and engage in their field of study. By integrating ecological awareness in service-learning projects through synchronicity with the planet's natural cycles and sources of life (water, air, earth, and sunlight), students would consider the present and future impact their thoughts and actions have on others and place (89). That would build a sense of reverence for themselves and their community, a sense of belonging that fosters complex relationships over time, for which intergenerational service-learning projects may be adequate. Planetary health sees women as keepers of cultural identity and caretakers of the natural environment, as vessels for strong communities and networks, bonding people, place and community. Service-learning in planetary health seeks to enhance collective vitality and well-being, reinforcing human relationships with the ecosystem. Students would learn to reconstruct the collective awareness of the interconnectedness that exists within

nature and re-gain ecologically bound cultural identity, pairing human relationship with their inner self and as part of nature systems. At a practical level, including nature-based physiotherapy practices in the curriculum would pose students closer to understanding the meaning of interconnectedness with nature, fostering comprehension on biological diversity recognition or eco-sustainable traditional practices. Service-learning projects can be developed to address local and global conservation goals, preserve native cultures and keep and communicate traditional knowledge, culture and sovereignty related to biodiversity preservation.

The regeneration of physiotherapy education via planetary health and service-learning means that higher education educators should make physiotherapy students more than observers, replicators and reproducers in the teaching-learning process. They should encourage students to actively participate in the “physical” world, opening the doors and windows of classrooms in their metaphorical and real sense. The description of the events linked to planetary health should go hand in hand with the self-reflection and interpretation since education is a socially constructed process. They can get inspiration from the fact that indigenous or traditional cosmologies position humans as inseparable from the Earth and all its inhabitants (58, 89). A greater connection with the rural world through community campus partnerships can also be a good

strategy to establish better connections with ways of life closer to the rhythms of nature, including the experience of its unpredictability. Such an approach sets the stage for complex thinking, non-linearity, transdisciplinarity and resilience. It provides a substantial theoretical basis for the inseparable understanding of physiotherapy as a phenomenon of research, practice and education, whose multidimensional nature can be fed back through pedagogies that stimulate co-creation instead of reproduction.

The application of the principle of inseparability implies that higher education physiotherapy curricula should embrace the fundamentals of planetary health not as a new fad or imposition but as a possibility of regeneration. This would make physiotherapy education more contextual, holistic, symbolic and relational, not limited by time. Since planetary health considers systematic feedback loops for causality this approach needs to be embedded in community-campus partnerships, for which service-learning is an appropriate pedagogical approach (Figure 1).

The complex notions of responsibility that involve service-learning through its co-created approach, means that students would learn and implement professional codes of conduct for maintaining a peaceful, thriving, and cooperative society grounded in love and reciprocity. The embedding of planetary health on physiotherapy

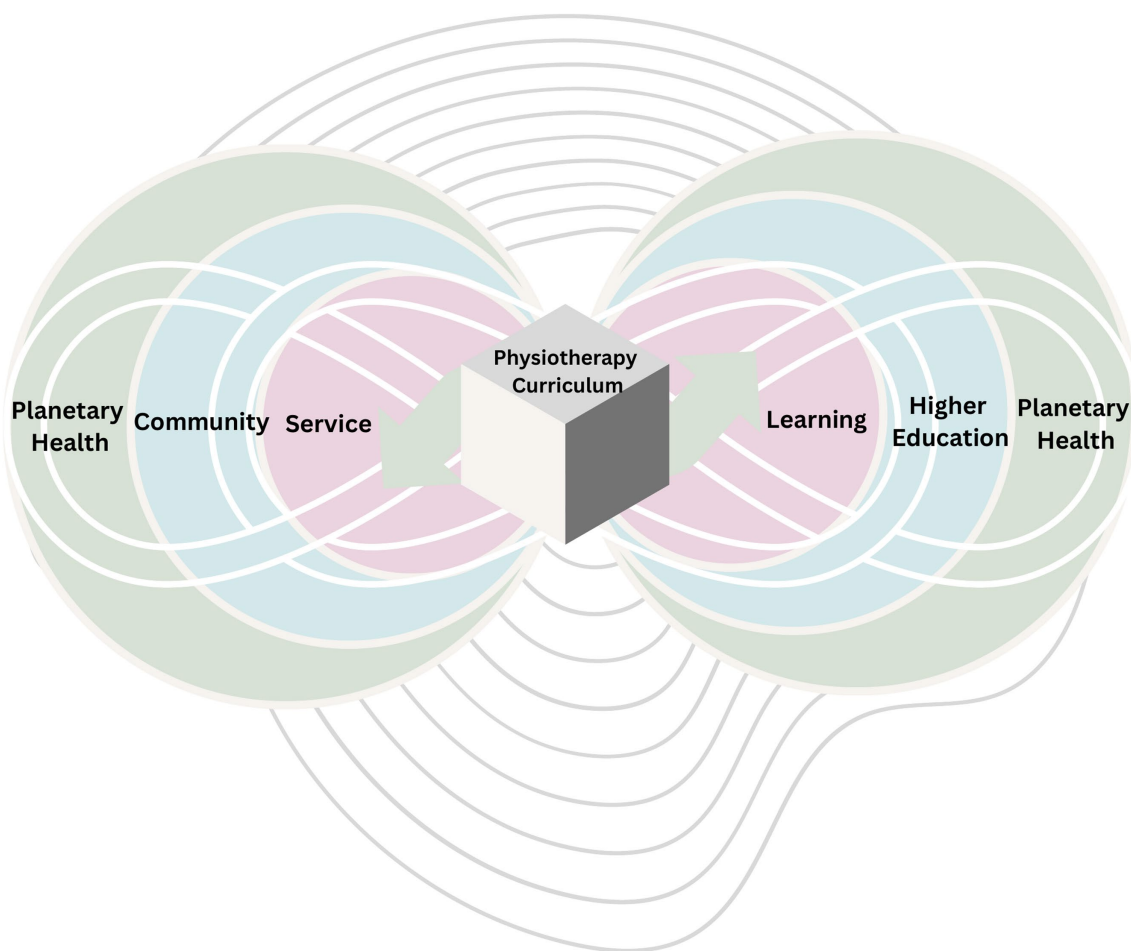


FIGURE 1
Systematic feedback loops in planetary health, physiotherapy and service-learning.

curricula through service-learning can be also a way of relating the rights and needs of people, of teaching the art of governing through negotiated instruments, and promoting otherness without compromising self-determination and dignity. Due to the nature of critical reflection involved in service-learning, gender inequalities or colonialism are among the issues to be addressed (90). Therefore, incorporating planetary health through service-learning into physiotherapy higher education curricula would require consideration of four domains (Figure 2). Domain I or domain of nature and social awareness: physiotherapy educators could empower students to make more complex and systematic decisions, such as in planning and co-designing projects with the community, locally or transnationally. Domain II or domain of abstraction: educators must seek the analysis of complex environmental concepts from a transdisciplinary perspective, their relationships and theoretical bases, as well as innovative positions to address environmental challenges. Domain III or domain of ethics: physiotherapy educators could strengthen ethical thinking promoting a critical reflection on equity and climate justice. Domain IV or content domain: Educators should deepen specific knowledge and skills about planetary health and other related approaches, including the selection, the production of evidence or the rescue of data for direct service, research or advocacy.

Physiotherapy curriculum should also consider the Primary Action Areas of the Global Plan of Action on climate change and health (PAA1, PAA2 and PAA3). The crossing point at the center of the curriculum (D) supposes the dialogic intersection of the strategic lines of action in the face of current eco-social challenges and the dimensions of service learning in planetary health. It is here again that service-learning must be seen not only as a pedagogical mediator but also as a curriculum regenerator, sustained by its profound capacity to stimulate critical thinking and reflection in and on action (91).

Service-learning is appropriate for *empowering, strengthening, and implementing* transdisciplinary initiatives related to change mitigation or adaptation but also for other forms of relating education and environment. Since service-learning is based on partnerships between

the community and the university, strengthening and sustaining those over time is essential to produce transformative inputs into the curriculum (92). This is facilitated by the institutionalization of service-learning, a multifaceted process aimed at promoting and normalizing service-learning in higher education. This process is usually initiated by key people who follow a bottom-up or top-down approach (93). In the first case, the process starts from individual projects that are transferred and expanded to other disciplines, requiring an institutional process to support them. In the second, less frequent, institutionalization is based on the impulse of the organization's leaders, who promote policies for the optimal development of service-learning throughout the organization. To this end, institutions must implement policies and management processes aimed at training educators in this pedagogy, empowering students, but also facilitating, promoting, and recognizing service-learning (76–78).

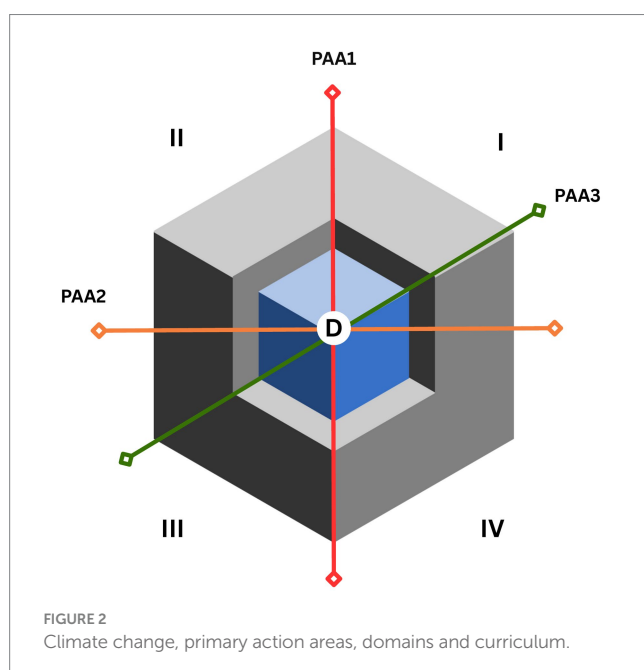
The future challenge for many faculties and schools is the development of matchmaking tools where educational needs are integrated and balanced with service requirements framed in planetary health. This can be particularly relevant to connect higher education with the rural world, establishing new formats of co-creation and collaboration based on reciprocity. Digital tools are helpful to enable physiotherapy students to document and showcase the skills gained through service-learning, making these competencies more visible, transferable, and meaningful to employers in order to continue transformations at workplace level. Another challenge refers to quality management and assessment procedures that accompany curricular transformations in physiotherapy. Qualitative data based on students' self-reflection and community partners feedback, should be particularly considered for this regeneration process.

By promoting service-learning, physiotherapy schools and faculties could be seen as living laboratories or communities of practice, proposing planetary health solutions. But there are no magic recipes here. It will be necessary to delve into the purpose of education and the uncertainty of everyday life, while still instilling hope in the current challenges. This will require a critical analysis of processes and products, avoiding sporadic experiences with no real meaning or purpose. The establishment of a community of practice in service-learning would facilitate mentoring, as well as the development of transdisciplinary projects with students and scholars from other disciplines. Finally, the improvement of physiotherapy education, research, and society's commitment to planetary health can be promoted through quality assurance procedures that recognize social motivations for cooperation, as is the case with service-learning projects (94).

In a way of reading the future, the challenge of regenerating higher education toward sustainability and planetary health will be permanent, because that is not a destination where once people arrive, they can sit back and relax. It will require continuous experimentation, learning, reflection, connection, questioning, and recalibration. This must be observed through the lens of real life, that is, from uncertainty, complexity, and ambiguity, taking risks, accepting failures, and promoting a hopeful vision of the future (95–97). Because this affects us all. Physiotherapists included.

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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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