ATTITUDE TO BODY-RISK FACTOR OR HEALTH FACTOR IN PSYCHOPATHOLOGY

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ATTITUDE TO BODY-RISK FACTOR OR HEALTH FACTOR IN PSYCHOPATHOLOGY

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Table of Contents

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Is Regular Physical Activity Practice During a Submarine Patrol an Efficient Coping Strategy?

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Introduction: A nuclear-powered ballistic missile submarine (SSBN) is a singular professional environment, exposing personnel to isolation and confinement amidst sophisticated technology for the duration of a mission. Submariners see their mood and cognition deteriorate as their mission progresses. With regard to the benefits of physical activity (PA) on mental health, this study evaluates the impact of regular PA on the maintenance of thymia and sensory functioning during patrols.

Method: This pragmatic exploratory cohort follow-up study included 29 volunteer submariners before, during and 1 month after return from patrol. PA practice was evaluated by a daily self-questionnaire. This allowed submariners to be classified into two groups according to the median of the total duration in minutes of a sport practiced during the patrol (PA practicing submariners and non-practicing). Changes in mood and psychological activation, health (including sleep), unipodal stability, and accommodation distances were compared between the two groups over the period of the patrol.

Results: Overall thymic functioning deteriorated during the patrol. Submariners who practice PA maintain a stable level of activation unlike non-practicing PA submariners, but they exhibited both worse general health and sleep at recovery. For these personnel, postural control is better at the end of the patrol and far visual accommodation tends to be preserved.

Conclusion: PA during patrol alone is not sufficient to compensate for the thymic dysregulation induced by the SSBN environment. Nevertheless, it seems to help in maintaining an exteroceptive functioning. This exploratory study suggests directions for possible future research on physical activity associated with sensory stimulation amongst submariners, and more generally amongst people working in isolated and confined environments.

Keywords: physical activity, military, thymia, exteroception, submarine patrol

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INTRODUCTION

In the distant past, our ancestors lived with nature as cultivators, hunters, and gatherers. As technology and society evolved, people became increasingly sedentary. Their level of physical activity decreased. Then, for political, economic and/or military reasons—reasons that today might even include tourism which offers the wealthiest the opportunity to stay on an orbital base—the problem of physical inactivity has become increasingly acute. This is especially true of the exploration of extreme environments. Indeed, from the depths of the oceans to the confines of space, man can now confront extreme, unusual, isolated or confined conditions whose dangers, limited resources and constraints on the possibility of communicating and interacting with others, push professionals to the limit of their human functioning (1).

The American College of Sports Medicine [ACSM; (2)] recommends more than 5 days per week of moderate-intensity physical activity (PA), or either a combination of moderate to high-intensity PA or else 3 to 5 days per week of moderate to high-intensity PA. It is clear however that modern living environments accentuate sedentary lifestyles and their attendant deleterious effects, such as cardiovascular, psychological, or sleep-related difficulties. Moreover, PA has been shown to have beneficial effects, notably on the mental health of individuals (3, 4), or on cognitive functioning (5). These in turn affect the quality of relationships, health, and/or performance (6). Consequently, the quality of life of individuals depends partly on the practice of PA. Indeed, the World Health Organization (WHO, 2014) states that the absence of PA or a sedentary lifestyle, is the 4th risk factor for mortality worldwide and is among the main causes of breast and colon cancer, diabetes, and ischemic heart disease (7). Physical inactivity is therefore expected to be one of the main causes of mortality. The effects are already being felt in populations that are both increasingly overweight and whose physical performance on standardized tests is deteriorating (8). These phenomena have increased during the period of confinement imposed due to the pandemic (9): adults have gained weight (10), as have both children and adolescents (11).

Practicing a profession in an extreme, unusual, isolated, and/or confined environment exposes individuals to physical inactivity and weight gain and ultimately to a deterioration in both physical and mental health and body functioning. The nuclear-powered ballistic missile submarine (SSBN) is a very particular professional context that exposes submariners to an isolated and confined environment (ICE) and highly technological surroundings in which to live, during a patrol which may last 2 months or even more. This environment may adversely affect human psychology and physiology. Studying the impact of the SSBN environment on individuals highlights multiple constraints (confinement, isolation, promiscuity, watchkeeping rhythm, absence of natural light, an artificial atmosphere, exposure to constant noise) and suggests how these affect mood and physical states. The consequences can be particularly deleterious, so it is advisable not only to prepare individuals prior to missions and to provide for recovery after, but also to consider countermeasures, including the possibility of PA on board the vessel. Based on the benefits of PA to health, this survey assesses whether regular practice over the patrol helps to cope with psychological and body functioning. What do these countermeasures consist of? Do they actually limit the effects of being sedentary on psychological and body functioning? To what extent? What effects would they be?

PA is defined as any movement produced by skeletal muscles that is responsible for an increase in energy expenditure above resting expenditure (12). This definition applies to physical activities associated with work, leisure, sports, housework, and other components of daily life. The WHO defines four main areas of PA: activities in daily life, occupational activities, leisure and sports, and travel. PA is therefore plural, as it can be carried out in different contexts (professional, leisure, family, competition) and for different reasons (leisure, work, travel, performance). It is not to be confused with physical exercise and even less with sport. For the WHO, the distinction lies in the level of sophistication of the practice. PA includes physical activity in everyday life, at home, at work, traveling between places, and in non-competitive recreation. In the constricted space of a submarine with no possibility of escaping elsewhere, it will be most likely that PA occurs with the option of weight training or the use of a home-trainer.

PA can be practiced at different intensities: low, moderate, and high. Intensity is measured in METs (1 MET corresponds to the basic metabolic expenditure per Kg per minute of a subject, awake, at rest and sitting; 1 MET 3.5 ml $O_2.kg^{-1}.min^{-1}$). According to the WHO, a moderate intensity PA (about 3-6 METs), requires a moderate effort and accelerates the heart rate (walking briskly, dancing, gardening, housework...). A high intensity PA (>6 METs) requires high effort, shortens the breath, and accelerates the heart rate considerably (running, swimming at a brisk pace, playing sports, and traditional games). It is important to note that the level of PA intensity, whether it is low, moderate, or high is really relative. That is, it is related to the abilities of people and the nature of their environment. The intensity depends on one's experience with PA, and one's physical condition. The crew members here are all in good health, practicing regular activity outside patrol periods. Of these, some continue to practice on board and some do not. In view of this, regular physical activity could be particularly beneficial on board an SSBN. This is a very special environment due to its recycled atmosphere and unusual, confined and isolated nature. During a patrol of several weeks underwater, as mentioned above, submariners operate in extreme and stressful surroundings. Their missions, or patrols, involve many unusual, often unnatural stimuli over a long period of time (13). Personnel are subjected to watches that disrupt the circadian rhythm (14). The environment is monotonous, and therefore provides a poverty of sensory modulations. A well-known effect of the patrols is the appearance of emotional and thymic disturbances. The work of Joly (15), Crosnier (16), and Lamour (17) on the adaptation of submariners to the constraints of an SSBN patrol describes the appearance of a syndrome of seasonal depression or "wintering" from mid-patrol. At the least there is an increase in negative and deterioration of positive moods, and a less restorative sleep (18). These effects

are deleterious to cognitive functioning (16). Although there is a lack of objective data, submariners describe a disappearance of these thymic symptoms in the weeks following their return from mission. Recent data in the literature suggest that mood disorders involve a deterioration in interoceptive functioning (19, 20). It is interesting to note that while interoception has been well-studied in mood disorders, exteroception has received less attention. Exteroception is mediated by our five senses and allows us to perceive the outside world. Impaired exteroceptive functioning may be especially implicated in ICE because of the sensory characteristics of these particular environments. Initial results show a degradation of interoceptive (21) and exteroceptive performance (visual accommodation, olfactory detection, proprioception) during patrols (22). These findings prompt reflexions as to the relevant countermeasures to be deployed during missions.

The benefits of PA which have already been mentioned are also widely described in many psychiatric pathologies, particularly in the prevention and curative treatment of depression and anxiety (23). In healthy subjects, when practiced regularly, it is a recognized mental health factor (24). People who practice PA voluntarily are less anxious, less depressed, less neurotic (25). It improves stress tolerance and helps maintain cognitive abilities, such as memory and learning (26). Its benefits with regard to depression could lead to an improvement in exteroceptive functioning (20). In fact, the practice of PA implies *per se* exterior stimuli, especially those that are proprioceptive. PA appears to be a countermeasure of interest, simply applied and acceptable to personnel on ICE missions. It should be stressed that beneficial effects derive from voluntary activity. In the case of imposed exercise or efforts that are too intense, the effects are less, or even adverse (27).

However, to date, no study has evaluated the benefits of regular PA during SSBN patrols. We wished to explore the issue in order to deploy this simple countermeasure during ECI missions. The main objective of this study is to evaluate the impact of PA practice on thymic regulation during an SSBN patrol. Its secondary objective is to evaluate the impact of this practice on certain senses (visual accommodation and proprioception).

MATERIALS AND METHODS

Design

Our study, a pragmatic exploratory cohort follow-up, was conducted on the crew of the SSBN *Le Triomphant* during an operational patrol in 2018. It was submitted to the South-East VI (Clermont-Ferrand) personal protection committee and received a favorable opinion on September 15, 2017 (study qualified as category 2: interventional research with minimal risks and constraints; IDRCB: 2017-A01329-44). An initial document was circulated to inform the personnel of the study to be conducted during the mission and its modalities. This document contained the regulatory aspects of the study as well as the contact details of both the promoter (Central Directorate of the Armed Forces Health Service) and the investigators. The ship's doctor then presented the study, its objectives and constraints during a briefing session with the crew. The different measures were planned over the duration of the mission (**Table 1**).

Participants

The population studied was that of the submariners of the SSBN *Le Triomphant*, red crew, scheduled for a 60-80-day patrol in the autumn/winter of 2017-2018 (the dates of SSBN missions are classified as defense secrets). The inclusion criteria are as follows: existence of an informed and written consent from the patient; affiliation to a social security system; subjects judged fit for underwater navigation according to the regulations in force within the Army Health Service (Ministerial Instruction n°500 on medical aptitude for underwater navigation). 29 volunteer submariners, all male, were included. Their average age was 29.8 years (SD: 6.45). Of these, 23 were living with a partner (76.67%) and 14 had at least one child (48.27%).

Professional Experience

The average length of service was 5,567 h on a nuclear attack submarine (NAS) (SD = 4,708) for the three submariners with NAS experience, and 6,835 h on an SSBN (SD = 6,505). The lowest work experience in the population was 0 h on NAS and 101 h on SSBN. The highest experience was 9,000 h on NAS and 25,000 h on SSBN. To illustrate what diving hours on an SSBN represent, an operational patrol corresponds to 2,000 h spent underwater. Three submariners from the population had never been on patrol on an SSBN before. For three other submariners, this was their last patrol.

Work Rate

In the population studied, eight submariners (27.6%) were on an "off-shift" schedule, working a day shift, with no night shift except for unforeseen interventions, and 20 (69%) were on a shift schedule (i.e., with a night shift every day) alternately between 8 P.M. and midnight, then between midnight and 4 A.M., and finally between 4 A.M. and 8 A.M. on the third night. One submariner did not specify his work rhythm.

Other Characteristics

Submariners reported an average weight before patrol of 75.96 kg [(60-97 kg); SD = 9.57]. Of 29 submariners, 24 (82.76%) were non-smokers. Two (6.89%) of the 29 submariners were left-handed.

Measures

Physical Activity

A homemade questionnaire was given to the subjects to provide daily information on their physical activity during the patrol. They were asked to mention their daily PA, its nature, and duration. The participants completed the following questionnaire for each week of the mission to record their level of physical activity (**Table 2**).

The descriptive statistics are presented in **Table 3**.

Emotions

The 12-item scale of positive and negative experience questionnaire [SPANE, (28)] was used to assess subjective

TABLE 1 | Planning of measures.

	Inclusion	Patrol		Recovery
	S1 or M1 (Baseline)	**S2 or M2 (J10)**	**S3 or M3 (J50)**	**S4 or M4 (back + 1 month)**
Information	X			
Inclusion and exclusion criteria	X			
Consent	X			
Sports Tracking Logbook				
Type of sport and duration of practice	Daily			
Self-questionnaires				
Socio-demographic data	X			
Emotional state (SPANE)	X	X	X	X
Physiological thymic state (Thayer)	X	X	X	X
Enteroception (MAIA)	X	X	X	X
Health (GHQ, LEEDS, appetite)	X			X
Exteroceptive Tests				
Visual accommodation	X	X	X	X
Tummy tuck	X	X	X	X
Monopodial support	X	X	X	X
Stabilometry	X			X

N = 29.

TABLE 2 | Frequency and type of Physical Activity week 1.

Your physical activity week 1			
	Physical activity	**Types of activities**	**Duration (min)**
D1 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D2 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D3 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D4 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D5 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D6 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		
D7 W1	Ergo cycle: ¨ Yes ¨ No		
	Other:		

feelings of well-being, based on how frequently they were felt over the previous week.

Activation/Deactivation

The Thayer activation/deactivation questionnaire (29), comprising 20 items which the subject rates on a four-point Likert scale (1 = disagree to 4 = extremely agree) was used. Two sub-factors are calculated on an activation/deactivation axis (general activation: active, energetic, dynamic, fit, and general deactivation: sleepy, tired, attentive, drowsy) and two sub-factors on the tension/relaxation axis (inner tension: uneasy, worried, irritated, tense, and inner relaxation: indifferent, calm, relaxed, quiet). In the study, the questionnaire focused on the week that had just passed.

Several health indicators were also measured, general health, perceived sleep quality, exteroceptive variables.

General Health

The 12-item General Health Questionnaire [Goldberg GHQ-12, (30)] was employed. This is a questionnaire that explores the subject's psychosocial state over the past few weeks in terms of somatic complaints (or somatization), anxiety and insomnia, social dysfunction, and depression. Each item is associated with four response modalities which the subject rates on a scale of 0 to 1 (0 = not at all/no more than usual and 1 = a little more than usual/much more than usual). The overall score reflects the intensity of psychosocial distress experienced by an individual (**Table 4**).

Perceived Quality of Sleep

The Leeds Sleep Evaluation Questionnaire (31) (LEEDS) with visual analog scales assessed four aspects of sleep evaluation: sleep quality and degree of sleepiness, sleep quality, wake quality, and post-wake quality, and performance. It makes it possible to monitor subjective changes in sleep with respect to usual subjective sleep. A low score indicates that sleep is worse than usual.

Exteroceptive Variables

Proprioception was assessed using postural stability tested with a stabilometric static platform (Stabilotest). Subjects were asked to stand for 1 min with their eyes open, and 1 min with

TABLE 3 | Psychological variables description (Mean; Standard Deviation).

	Baseline		D25		D55		Recovery	
	PA	**N-PA**	**PA**	**N-PA**	**PA**	**N-PA**	**PA**	**N-PA**
Thayer Questionnaire								
GA	10.20 (2.073)	10.21 (2.08)	8.79 (2.86)	8.15 (2.91)	6.88 (3.76)	6.88 (3.76)	11.43 (2.03)	10.10 (1.73)
GD	4.40 (2.13)	3.86 (2.38)	4.46 (2.37)	5.07 (3.00)	5.25 (2.26)	5.50 (2.78)	4.43 (1.95)	3.80 (1.99)
IT	3.47 (3.18)	3.64 (3.05)	2.50 (3.13)	1.66 (2.01)	1.75 (2.38)	1.75 (1.78)	2.14 (2.63)	1.00 (1.56)
IR	8.20 (2.04)	7.43 (3.16)	9.21 (1.88)	8.08 (2.63)	8.92 (1.24)	7.13 (3.04)	8.86 (1.23)	8.70 (2.91)
SPANE Questionnaire								
PE	3.99 (0.67)	4.08 (0.44)	3.37 (0.68)	3.31 (0.68)	3.24 (0.97)	2.93 (0.92)	3.88 0(.86)	4.10 (0.35)
NE	2.38 (0.58)	2.40 (0.7)	2.06 (0.53)	2.00 (0.70)	1.89 (0.63)	2.11 (0.46)	1.92 (0.52)	1.82 (0.52)
MAIA Questionnaire								
TS	25.23 (4.53)	23.84 (3.32)	23.72 (5.57)	23.07 (3.78)	21.76 (5.17)	21.44 (3.88)	21.90 (6.54)	21.66 (4.64)
NCS	3.23 (0.78)	3.06 (0.75)	3.20 (0.9)	3.30 (0.85)	2.90 (1.11)	2.56 (0.83)	3.02 (1.12)	2.93 (1.05)
NDS	2.84 (0.69)	2.28 (0.49)	2.38 (0.79)	2.24 (0.63)	2.11 (0.85)	1.92 (0.59)	1.80 (0.78)	1.90 (0.83)
NWS	3.82 (0.60)	3.69 (0.92)	2.87 (0.77)	3.03 (0.67)	3.18 (0.53)	3.36 (0.83)	3.21 (0.91)	3.07 (0.77)
ARS	3.09 (0.86)	2.82 (0.78)	2.81 (1.12)	2.52 (0.65)	2.46 (1.05)	2.35 (0.93)	2.82 (1.03)	2.33 (0.95)
EAS	3.24 (0.85)	3.12 (0.63)	3.28 (0.94)	3.10 (0.95)	3.09 (0.92)	2.63 (0.79)	2.97 (1.24)	3.04 (1.04)
SRS	2.98 (0.91)	2.71 (1.01)	2.98 (0.99)	2.67 (0.95)	2.82 (1.03)	2.63 (1.27)	2.63 (1.43)	2.60 (1.28)
BLS	2.33 (1.11)	2.13 (1.04)	2.20 (1.13)	2.14 (1.01)	1.96 (0.81)	1.78 (1.18)	1.90 (1.08)	2.20 (1.34)
TrS	3.69 (1.22)	4.03 (0.92)	4.00 (1.28)	4.08 (0.92)	3.24 (1.52)	4.22 (0.90)	3.56 (1.64)	3.60 (1.07)

PA, Physical Activity Group; N-PA, No-Physical Activity Group; SPANE, Scale of Positive and Negative Emotion; MAIA, Multidimensional of Interoception Awareness; GA, General Activation; DG, General Deactivation; IT, Inner Tense;IR, Inner Relaxation; TS, Total Score; NCs, Noticing Subscore; NDS, Not-Distracting Subscore; NWS, Not Worrying Subscore; ARS, Attention Regulation Subscore; EAS, Emotional Awareness Subscore; SRS, Self-Regulation Subscore; BLS, Body Listening Subscore; TrS, Trusting Subscore.

their eyes closed. Among the numerous metrics regularly used to characterize postural stability (32, 33) in the literature, we assessed the most frequent metrics: weight distribution between left and right foot, sway length, standard deviation along the sagittal (Antero-posterior) and frontal (Medio-Lateral) directions, 90 confidence elliptic area, and slope its principal axis, Center of pression (CoP) mean velocity, and its variance. Vision was assessed by the Parinaud scale (the French equivalent to the Jaeger chart), which measures the natural accommodation distance (from the tip of the nose to the reading surface, measured with a tape measure in cm) at which the subject holds a text to read it comfortably. Paragraphs of text are written in decreasing font size. The recommended reading distance to test visual acuity is 33 cm, with a tolerance ranging from 30 to 35cm. Luminance was controlled with a luxmeter to ensure that the lighting environment was the same for all subjects. Moreover, accommodation evaluation was assessed for natural accommodation, and both maximal and minimal accommodation. The measurement was made from the tip of the nose to the reading surface, using a tape measure. Individuals kept their glasses on if they usually wore them. Proprioception (32, 33), mediated by balance, was measured with the unipodal standing test (UPST), over three successive series by recording the maximum time of maintaining posture on the preferred foot, eyes open (EO) then eyes closed (EC). The average of the times and the best time achieved for each of the two situations were retained.

Experimental Procedure

The experimental design of the study is described in **Figure 1**.

Data were collected in four stages: before, during (D10 and D50 of the patrol) and 1 month after the return from the patrol, with the exception of the health variables collected before and on return from the patrol.

Data Analysis

Statistical analysis of the data set was carried out using IBM SPSS Statistics 25 software for some analyses). Data will be expressed in number and proportion (%) for the qualitative variables or modalities (stress events: yes/no) and in mean (M) and standard deviation (SD) for the quantitative variables. A categorization of the subjects according to the importance of physical activity was made on the basis of the median of the total duration in minutes of declared sports practice during the patrol whatever the nature of the PA. This categorization describes two groups: a group of so-called PA practicing submariners with a total duration of practice during the patrol greater than or equal to the median of the included population, and a group of so-called non-practicing submariners, with a total duration less than the median of the included population.

TABLE 4 | Health variables description (Mean; Standard deviation).

		Physical activity	Baseline M(SD)		Recovery M(SD)	
			PA	N-PA	PA	N-PA
GHQ			1.93 (2.97)	1.57 (1.87)	5.36 (5.85)	1.50 (2.84)
Sleep	GTS	Difficult/easy	2.60 (2.32)	2.70 (2.23)	0.23 (3.37)	2.36 (3.59)
		Slow/Quick	2.07 (2.34)	2.57 (2.68)	−1.31 (3.52)	1.91 (3.81)
		Sleepiness	1.60 (2.53)	2.07 (2.50)	−0.31 (3.17)	0.82 (3.09)
	QoS	Restless	−2.00 (2.42)	−2.57 (2.31)	−2.85 (1.34)	−3.55 (1.51)
		wakeful periods	−0.40 (2.85)	0.43 (3.18)	−0.46 (3.13)	0.43 (3.18)
	AFS	Difficult/easy	1.00 (3.12)	1.07 (3.25)	−0.62 (3.38)	0.55 (3.14)
		Slow/Quick	1.27 (3.22)	1.71 (2.76)	−1.08 (3.28)	0.27 (2.53)
	BFW	Fatigue when wake up	1.93 (2.25)	1.71 (2.09)	−1.08 (3.35)	0.73 (2.97)
		Tiredness now	2.00 (1.96)	2.57 (1.83)	−0.62 (3.69)	2.36 (2.91)
		Balance and coordination	2.07 (2.25)	4.00 (0.78)	−0.08 (4.31)	1.91 (3.65)
Food attitudes	Sensation of appetite		3.80 (0.94)	4.29 (0.73)	3.92 (0.49)	4.09 (0.54)
	Enjoy food		4.07 (0.59)	4.21 (0.43)	4.15 (0.55)	4.18 (0.60)
	Hunger when time to eat		3.80 (0.77)	4.14 (0.77)	3.62 (0.65)	3.91 (0.70)
	Satiety after eating		3.87 (0.52)	4.07 (0.47)	4 (0.10)	4.09 (0.30)
	Hunger between meals		2.80 (0.56)	3.36 (0.93)	3.77 (0.44)	3.64 (0.50)

PA, Physical Activity Group; N-PA, No-Physical Activity Group; GHQ, General Health Questionnaire; GTS, Getting to sleep; QoS, Quality of Sleep; AFS, Awake Following Sleep; BFW, Behavior Following Wakening.

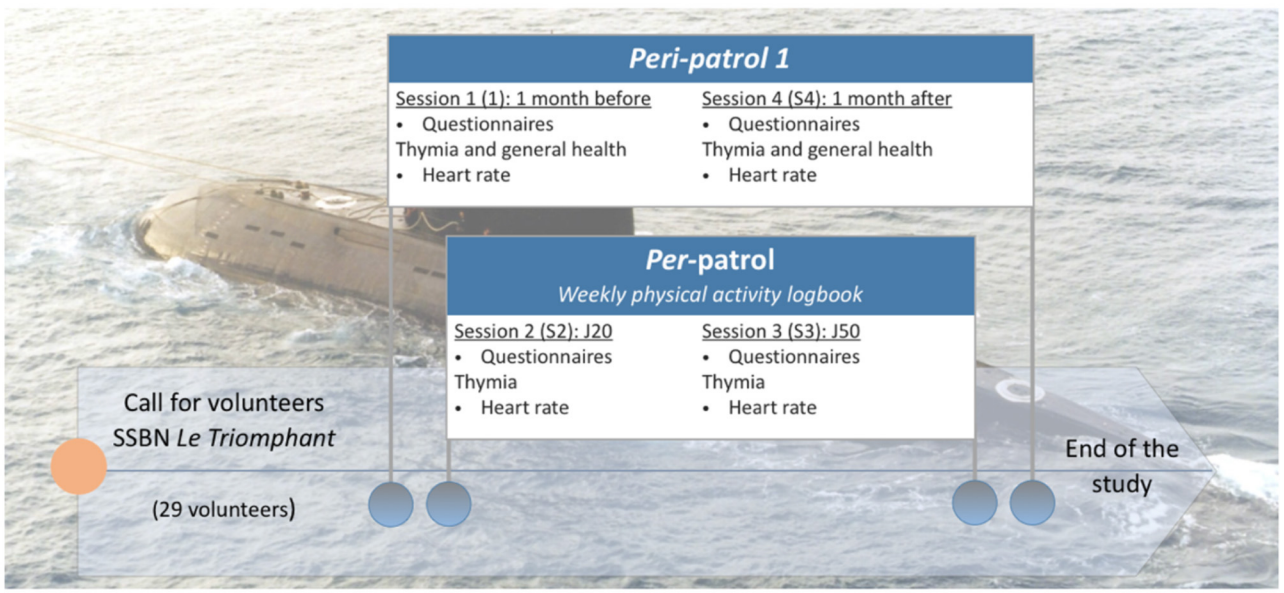

FIGURE 1 | Proposed experimental design according to operational constraints. The indiced collection times, day 10 and day 50, are approximations.

For the pre-departure collection, the percentages between the two groups were compared using the Chi-2 Test and Fisher's Exact Test when the Chi-2 conditions were not met. Group means were compared using the Student's *t*-test for independent samples (PA and non-PA status) when the variables in the samples compared followed a normal distribution. For the evaluation of the impact of the patrol on the two groups (sport and non-sport status), analyses of variance (ANOVA) on the variables collected during the four measurement sessions [S1 before, during (S2 and S3, D10 and D50 of the patrol, respectively) and S4 1 month after the return from the patrol] were performed. Tukey *post-hoc* tests were used when

TABLE 5 | Types of activities chosen and number of participants.

Type of activities	Number of participants
Sailors who prefer cycling	7
Sailors preferring to run on the treadmill	2
Other activities	17
Total	26

necessary. For the variables collected at the S1 inclusion and S4 recovery phases, the means of the before-and-after deltas were compared using the Student's *t*-test for independent samples when the variables of the samples compared followed a normal distribution. A difference was considered significant at $p < 0.05$. A trend toward a significant difference was noted when $0.05 < p \leq 0.10$.

RESULTS

Description of Physical Activities During the Patrol

Three types of sports, determined by the limited space available in the submarine, can be practiced during the mission: ergocycle, treadmill, and weight training (**Table 5**). Of the entire patrol, 6 submariners did <1 PA session per week, 10 did between 1 and 3 sessions, and 9 did more than 3 sessions. Two submariners stated that they did not practice any PA. One submariner did not fill in his PA record book. Over the first 60 days of diving analyzed, the average number of days of PA performed was 21.1 (SD = 17.5). Over the first 30 days, the average was 9.8 and over the next 30 days, 10.5. The average time spent on PA during the patrol was 1220.2 min (SD = 1560.8) with a median value of 620 min. Of the 28 subjects who filled in the PA logbook, 15 reported more than 620 min of practice during the patrol, one subject reported 620 min and 12 reported <620 min. Sixteen subjects were therefore considered to belong to the group of so-called PA practicing submariners. They reported an average of 34.33 days with PA (SD = 14.11). Their minimum number of days with PA was 16, and their maximum was 55. Non-practicing submariners reported an average of 5.93 days with PA (SD = 5.34). Their minimum number of days with PA was 0, and their maximum was 17.

Impact of Sport/Non-sport Status at Inclusion

The ship's doctor was in charge of all the measurements during the patrol in which the study was carried out, which limited the potential bias related to measurement errors that could have occurred if there had been several experimenters. Thus, the study protocol was scrupulously followed.

Socio-Demographics

There was no difference in age between the two groups ($t = -1.51$, $p = 0.14$). There was no difference between the PA/non-PA group in terms of family situation (single or couple; $p = 0.21$), reported stress event ($p = 0.55$), and smoking outside of patrol ($p = 0.56$). No difference was found in terms of professional experience ($p = 0.85$ and, $p = 0.18$, respectively, for patrol hours in NAS and SSBN). There was no difference between the two groups in terms of work rhythm on board, watch or off watch ($p = 0.28$).

Psychopathological Functioning

Concerning the thymic state, no difference was found between the two groups on the psychological variables collected in the Thayer and SPANE questionnaires. Concerning health, no difference in terms of weight, appetite or GHQ score was found between the two groups (respectively, $p = 0.48$ and $p = 0.69$). There was no significant difference in sleep between the two groups at inclusion, except for the higher sleep disturbance rating with respect to usual subjective sleep in PA practicing submariners (M = 2.07, SD = 2.25) compared to non-practicing (M = 4, SD = 0.78, $p = 0.01$).

Exteroceptive Functioning

Regarding visual accommodation, there was a difference in distribution between the two groups for the distance of accommodation before the patrol ($U = 6$; $p = 0.017$). Subjects in the non-PA group were distributed toward low values of the distribution interval of the "distance of distant accommodation," whereas subjects in the PA group were distributed toward high values. Regarding proprioception, no difference was found on the unipodal station test.

Impact of Patrolling on Psychological Functioning According to PA/Non-PA Status

The SPANE scores on the two subscales designed to assess positive and negative emotions were used.

There was an effect of the data collection session on the positive emotion subscale score ($p < 0.001$), with no effect of sport status ($p = 0.68$), nor interaction ($p = 0.14$) between the session and group factors. *Post-hoc* analyses showed that the positive emotion score was highest at the inclusion session (S1) and the recovery session (S4) compared to the per-patrol sessions at D10 (S2) and D50 (S3). The positive emotion score was higher at D10 compared to D50.

A session effect was also found on the negative emotion subscale score ($p = 0.01$), with no effect of PA status or interaction between session and group factors ($p = 0.92$ and $p = 0.86$, respectively). *Post-hoc* analyses showed that the negative emotion score was significantly higher at the inclusion session (S1) compared to the per-patrol sessions of D10 (S2) and D50 (S3) and recovery (S4). Negative emotion scores showed no difference between the per-patrol sessions of D10 (S2) and D50 (S3) and recovery (S4).

The Thayer questionnaire subscales were used to assess general activation and general deactivation in the analysis below.

A session effect and a PA status effect on the general activation subscore were found ($p = 0.005$ and $p = 0.001$, respectively), without interaction between the session-PA status factors ($F = 1.63$, $p = 0.20$). The PA practicing submariners

TABLE 6 | Analyses for the interaction between the variables and the condition, PA vs. Non-PA.

Variables x status	F ratio	p	Partial η^2	Alpha = 0.05
Thayer				
Activation	1.63	0.20	0.07	0.41
General deactivation	4.45	0.001	0.18	0.87
Internal tension	1.18	0.32	0.05	0.31
Relaxation	1.38	0.32	0.01	0.11
Monopodal stance	5.38	0.001	0.28	0.92

N = 29.

exhibited a higher activation level at each of the sessions (**Table 6**).

A session effect on the general deactivation subscore was found ($F = 8.51$, $p < 0.01$), and an interaction between the session-sport status factors ($F = 4.45$, $p < 0.001$). The general deactivation subscore deteriorated significantly during the patrol, with no effect of PA status ($p = 0.40$). *Post-hoc* analyses showed that the general deactivation score was highest at D50 for non-PA practicing compared to PA practicing ($p = 0.05$). A "session" effect on the internal tension subscore (Thayer questionnaire) was also found ($F = 4.54$, $p < 0.01$), with no effect of PA status ($p = 0.85$), nor interaction ($p = 0.32$). *Post-hoc* analyses showed that internal tension was highest during the inclusion session before the patrol compared to the levels at D10, D50 and after recovery (**Table 1**).

There was no session effect, no group effect, and no interaction for the relaxation sub-score.

Health

The results show a significant difference between the two groups on the delta recovery-inclusion GHQ scores ($t = -2.45$, $p = 0.02$). The PA practicing submariners had a higher GHQ score 1 month after the mission compared to inclusion ($M = +3.18$, $SD = 4.07$) whereas it decreased in the non-PA ones ($M = -0.2$, $SD = 1.62$). We also found a trend toward a difference between the two groups on the recovery-inclusion (delta) for the sleep length subscores of the Leeds questionnaire. The latter decreased in PA practicing men after recovery compared to inclusion in contrast to non-PA practicing ($p = 0.09$).

Exteroception

Regarding far accommodation, the analyses showed a trend toward a difference in position between the two groups 1 month after the end of the patrol (recovery) ($U = 6$; $p = 0.017$). As with inclusion, the non-PA group were distributed toward low values of the far accommodation distance, whereas subjects in the PA group were distributed over the whole range of accommodation distance distribution.

Regarding proprioception, there was an effect of session ($F = 6.24$, $p < 0.01$) on monopodal stance duration, but no effect of sport status ($F = 0.13$, $p = 0.73$). There was an interaction ($F = 5.38$, $p < 0.01$) between the session and group factors. *Post-hoc* analyses showed that the duration of monopodal support was higher in the non-sportsmen at the inclusion session, compared to the following sessions. There was no significant difference between sessions in the sportsmen.

DISCUSSION

As in previous studies evaluating the mood and health of submariners during an SSBN patrol, we found a deterioration in thymic functioning during the patrol. This was associated with a more or less complete recovery 1 month after return, depending on the variables and the sport group.

The results obtained do not allow us to confirm the main hypothesis of a positive impact of PA practice on mood. Although no difference was observed between the PA and non-PA practicing groups in terms of positive and negative emotions, the deterioration in the activation state during the patrol for the non-PA submariners suggests that the patrol is not subjectively experienced in the same way by the two groups. This result suggests that regular practice of PA while on patrol would allow for better vigilance, which is recognized as an important factor for boat safety.

These results should be considered in the light of the differences in subjective sleep quality and general health observed 1 month after the patrol between the two PA groups: compared to inclusion, the PA practicing submariners slept less and expressed a poorer general health functioning. Although these data alone are in agreement with existing studies (34), the results as a whole do not provide a clear answer to the hypothesis of better health maintenance in the broad sense for submariners who regularly engage in PA. It would be interesting to compare the two groups in terms of their personality profile and their strategies for dealing with stress. It has been observed that army soldiers, even with addictive behavior, practice PA more intensively in stressful situations. During a six-month projection in Afghanistan (raptor 201 mandate), PA was an effective means of adapting to operational stressors and managing situational anxiety (34). These data suggest that PA practicing submariners might use it cognitively as a way to better manage the stresses of patrol. PA could then be considered for sport submariners as an obligatory practice rather than an activity for pleasure. As far as humans are concerned, a compulsory PA practice is known to trigger a stress reaction (35, 36). During the patrol, physical practice for sport submariners could be a means to deal with anxiety and stress. Taking this status into account may be necessary when determining the training programs for regular sportsmen. It is important to emphasize that mindfulness-based interventions may reduce anxiety and render a given activity more pleasurable than under normal circumstances through the reallocation of attention toward bodily signals (37). Such an approach could also develop a desire for PA during patrol among non-athletic submariners.

Furthermore, unipodal stability data and its evolution suggest that PA and non-PA practicing submariners do not control their posture in the same way. Maintaining the standing position is

a biomechanical and neurophysiological feat for humans. The human body has developed a system of postural regulation, not only so as to stand upright despite external constraints (sloping or slippery ground, etc.) or internal constraints (breathing, blood circulation, etc.), but also to orient itself in space and prepare its movements with precision. This is particularly relevant in the environment of an SSBN on a mission. Our study shows that between PA and non-PA practicing subjects, it is only in non-PA submariners that unipodal stability deteriorates while on patrol. In addition, we found a distribution of remote accommodation distances around smaller distances. The interaction between these exteroceptive differences needs to be further explored: in submarines, where the viewing distance is limited, distant accommodation is very rarely used.

Further studies concerning the other exteroceptive sensors which are differently stimulated in a mission environment, would help to confirm our initial results.

This exploratory study has several limitations. Firstly, the low number of volunteers reflects a possible recruitment bias. Where results are borderline, they probably have minimal significance. Given the multiplicity of tests carried out, discussion may be needed to determine which of the observed results should carry weight. Secondly, the choice of psychological scales has been validated for the exploration of mood disorders, but there are other tests that focus more specifically on seasonal depression. These questionnaires are subjective and prone to self-measurement bias. Further complementary psychological assessments, including personality tests to determine an anxious-trait and coping profile, would have helped to describe better the impact of regular sport during a patrol. Finally, our study classifies practitioners according to a duration of PA while on patrol. However, we have no evidence that submariners practicing PA on board, practice it on land and vice versa. The classification into PA and non-PA practicing is contextual and does not necessarily reflect the PA level of an individual.

This study is one of the first to assess the role of PA in a confined and isolated environment, such as an SSBN. This is a very specific environment that seems ideal for exploring all the issues of individual adaptation in extreme and stressful surroundings. The interior of a submarine is a rigorous environment in which human error can jeopardize a mission and an entire crew. For this reason, submariners are carefully selected. They are all in excellent physical and mental health, which reduces confounding biases on the health status of individuals, but also makes it difficult to extrapolate the results to any other population. Nevertheless, it is conceivable that if differences are observed in this sample where differences between individuals are minimal, they would be greater in the general population. Finally, it should be noted that dividing the groups after the fact makes it possible to limit measurement bias. The daily filling-in of a diary limits the bias that having to recall details later would introduce.

CONCLUSION

Although regular PA is associated with better activation adaptation on an SSBN during a patrol, this countermeasure does not seem sufficient to limit the thymic and health impact on professionals of the constraints imposed by such an isolated and confined environment. PA could nevertheless play a role in maintaining exteroceptive sensory skills while on patrol. Enhancing it with artificially increased sensory stimulation might be more beneficial than mere practice alone. An implementation of pleasure practice could be useful for thymic regulation. It would be interesting to conduct a study on this subject so as to understand better the dissociation between the improvement in both physical functioning and activation, and the absence of benefits for thymia and health. It is possible to imagine that, in the long term, a crew member in charge of a specific role on board could be trained to propose physical activity programs dedicated to this population and this type of environment. Such programs remain to be imagined and their effects to be evaluated. In order to improve the efficiency of ships and to maintain the good health of those on board, it would seem necessary to evaluate other countermeasures to the psychic effects observed during SSBN patrols. The results of any such evaluations would be of great use to professionals working in extreme, unusual, isolated and/or confined environments such as space or polar stations.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because Confidential data linked to the Frenchs Forces. Requests to access the datasets should be directed to marion.trousselard@gmail.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité de Protection des Personnes sud-est VI (France) (IDRCB: 2017-A01329-44). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CM-K wrote the article, contributed to the data collection, and the methodological aspects. BL, AM, CP, JP, AV, and MT have made substantial contribution to the conception of the design of the protocol, gave feedback to the manuscript. BL particularly contributed to the data analysis and the redaction of the manuscript. AM, CP, and JP particularly contributed to the data collection. MT particularly contributed to the conception of the study's design, the data analysis, and the redaction of the manuscript. BL, AM, CP, JP, AV, and MT have read and approved the submitted version of the manuscript.

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Self-Representations of Military Veterans Suffering From Chronic Post-traumatic Stress Disorder: The Role of Sport

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Background: Post-traumatic stress disorder (PTSD) is a psychiatric illness that is very prevalent in both civilian and military environments. The clinical course, regardless of management, is chronic for a number of patients, especially veterans. Persistent PTSD symptoms interact with representations of the person and their body, and may negatively impact rehabilitation. Sport is known to help psychiatric patients such as those suffering from PTSD, as it improves the connection with the body, and supports physiological and emotional regulation. However, the impact of sport on self-representations has not yet been studied. The first aim of this study is to explore person and body representations in a population of military veterans suffering from chronic PTSD, as a function of clinical severity. Second, it aims to explore how a 9-day sport program, which includes an element of socio-professional rehabilitation, changes representations of the person and their body.

Methods: This exploratory qualitative study examined the self-representation of veterans with chronic PTSD before a sport rehabilitation program. Veterans were given the prompts "body" and "person" and asked to free associate. PTSD severity and the mind–body connection were assessed using the Posttraumatic Stress Disorder Checklist for DSM-5, and the Freiburg Mindfulness Inventory, respectively. Parasympathetic activity was recorded at rest. A subgroup of the population volunteered to participate in a post-program session to record the same semantic, psychological, and physiological variables.

Results: Although before the program, veterans gave more negatively than positively valenced words, no relation was observed between the overall number of negative words and PTSD severity. Post-program, changes were observed in terms of valence. Specifically, some negatively-valenced categories of words disappeared, and some positive categories appeared. At the same time, there was a fall in PTSD severity, an increase in the mind–body connection, and a decrease in parasympathetic activation.

Conclusions: This study highlighted that veterans with chronic PTSD have a negative representation of the self. A dedicated, 9-day program that included regular sport improved self-representations related to both the person and their body, and reduced PTSD symptoms. The findings underline the importance of ensuring that programs for patients suffering from chronic PTSD should include sporting activity, and highlight the benefits. Sport appears to be a path to the reappropriation of a positive image of the self, by improving the representation of the body. This relationship could be consistent with improved interoception, but our results need further investigation.

Keywords: post-traumatic stress disorder, veterans, body representation, person representation, sport, mind-body connection

INTRODUCTION

Post-traumatic stress disorder (PTSD) is an adaptive condition that can occur following one or more traumatic events that involve direct or indirect confrontation with death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence (1). According to DSM-5, patients with PTSD present four clusters of symptoms: reliving, avoidance, hyper-reactivity, and negative cognitions and affects (1). Moreover, there can be numerous comorbidities (2). In addition to their clinical and cognitive symptoms, PTSD patients can suffer from the changes in the perception of self (3), leading to the sense of lost identity (4–6) that further degrade their quality of life, and impair their ability to maintain social and professional relationships.

In the general population, the lifetime prevalence of PTSD ranges from 1 to 7%, depending on the sample (7) and, for some patients, the condition becomes chronic (8). While studies show that more than half of patients make positive progress (9), a relatively recent review highlights that clinical outcomes can be highly variable (10): in particular, only 18–50% achieve stable remission. These figures are similar for military veterans (11–14), although the prevalence is estimated to be around 20% in this population, depending on the nature of the mission (15, 16). Studies also point out that the disorder can take many different paths (13, 14). Overall, once established, PTSD is a complex clinical entity that evolves in a variety of ways, becoming chronic in many patients.

One of the many impacts of PTSD is to destabilize the individual's identity. Notably, it can "impact the resources a person brings to identity work" (17). Studies in military cohorts have consistently found an association between identity and poor mental health (18), and between military identity and poor psychological functioning (19). Identity disruption, understood as a loss of temporal integration following a trauma, has been associated with reintegration problems in veterans suffering from poor mental health (20) which is consistent with an interrelation between identity and social validation (21). Social identity resources have been described as "the social psychological capacities that flow from internalized group memberships such as support, solidarity and belonging" [(6); p. 312]. Although it is clear that each of the two constructs impacts the other, the intersection between PTSD and identity remains poorly understood.

One reason for this may be the lack of clarity regarding concepts related to identity. The idea of identity is closely related to that of appraisal or beliefs about the self and the world. Although identity and the self are closely-related concepts, identity is considered to consist of representations and feelings, while the self is considered as a purely cognitive concept, the "self-concept" (22), which is, first and foremost, situated within the body. Furthermore, the self-concept refers to a representation of the self that encompasses the ways in which people see themselves, while self-presentation focuses on the way in which people present themselves to others (21).

Whether it be the self-concept or the self-presentation, both are based on the self-referential processing (SRP). SRP is an embedded process that consists of relating information to the self (23, 24), which is also considered as the "experiential self." Frewen (25) considers that verbal SRP is a form of introspection that refers to the semantic self as the subject, while non-verbal SRP is a form of interoception that refers to the somatic self-object. Although both imply top-down and bottom-up controls, top-down control is tested using focused attention and executive tasks, while bottom-up control is mainly tested in a resting state using mind-wandering (for verbal SRP) and body-wandering (for non-verbal SRP) exercises.

To the best of our knowledge, little is known about the physiological correlates of SRP. At the same time, the physiological correlates of interoception are beginning to be described: the quality of interoception has been shown to be partly related to heart rate variability (HRV), notably high vagal tone (26–28). HRV has proven to be a reliable, non-invasive descriptor of the function of the autonomic/central nervous system, and is thought to reflect higher brain activities. In the case of PTSD, abnormalities associated with SRP have been clearly highlighted. Clinical symptoms are significant, as they are consistent with the negative self-referential and other-referential cognitive appraisals that a patient with PTSD suffers from. They include persistent and exaggerated negative expectations of oneself, as well as a distorted sense of self- or other-focused blame regarding the causes and consequences of the traumatic event (1). A patient with PTSD often experiences pervasive, negative emotional states, of which the most common are self-conscious,

internally-directed emotions such as guilt and shame (29, 30). Symptoms related to SRP abnormalities may play an important role in the maintenance or exacerbation of the symptoms of PTSD, and the development of comorbidities. Consequently, their identification during PTSD treatment is critical although, to the best of our knowledge, there is no consensus regarding an experimental task that could measure verbal and non-verbal SRP (25). The above observations suggest that notions of the self could provide a useful theoretical framework to study PTSD; such an approach would both deepen our understanding and enhance care.

In this context, a recent review (31) highlights convergent results which suggest that sport practice combined with other forms of treatment may reduce symptoms above and beyond standard treatments alone. Although data evaluating the benefits of sport practice on identity disruption and/or self are scarce, some exploratory results seem relevant. In a single case study of a war and torture survivor, practicing sport was found to not only have beneficial cognitive and emotional effects, but also enhance the sense of belonging. Other positive impacts were a better sense of body and self, and an improved ability to cope with pain (32). In their review of the impact of sport practice on the well-being of combat veterans suffering from PTSD, Caddick and Smith (33) noted that the evidence underlines the value of sport practice in well-being and rehabilitation. Among veterans, regular practice of elite sport has been found to support a reconnection with their previous identity and sense of self. In the military context, developing a sense of belonging with peers is highly valued, and may contribute to bringing personnel back to good health.

Finally, studies consistently report reduced HRV in people with PTSD. Such findings suggest autonomic inflexibility due to sympathetic overactivity and/or parasympathetic insufficiency (34, 35). These results once again raise the question of the benefits of sport practice on HRV regulation for patients with PTSD. It is well-known that athletic condition is an important variable that influences the autonomic control of the heart (36). It has also been shown that endurance sports increase parasympathetic modulation over a 24-h period (37). Although some data suggest the value of sport in supporting parasympathetic improvement, there is currently no data that demonstrates the benefits with respect to PTSD symptoms.

In response to the lack of knowledge about self in the context of PTSD, and the lack of validated interventions that aim to improve the self-image, this study is the first to evaluate the verbal valence and semantics that veterans use to talk about themselves and their bodies, as a function of PTSD severity. First, we hypothesize that we will observe a correlation between the number of negative words used in verbal responses related to both the person and his or her body, and the clinical severity of PTSD symptoms. Second, we evaluate the therapeutic effects and psychophysiological processes observed during a sport's program organized by the French Army for veterans with PTSD. Here, we hypothesize that practicing sport decreases the severity of PTSD symptoms, through processes that improve the person's self-representation, and an improvement in the psychophysiological mind–body connection.

MATERIALS AND METHODS

Participants

The population included in this exploratory study consisted of 47 veterans who had been on sick leave due to PTSD for over 6 months, between May 2018 and April 2021. This group had been enrolled on a professional reinsertion course following a recommendation regarding their suitability from their referring psychiatrist. These courses are organized by the French Army's wounded soldiers' unit (the *Cellule d'aide aux blessés de l'armée de Terre*). Five to six courses take place each year, with 8–12 participants. In addition to medical care, the aim is to support the recovery of psychologically injured soldiers, in order to facilitate their reintegration into civilian life. The program runs over a 9-day period, and is composed of group and individual physical activities, and professional exercises.

The study received prior approval from the Sud-Mediterranée III Personal Protection Committee (10 September 2018; NTC03995992). All subjects received information on the protocol, and gave written consent prior to participation.

Procedure

For the full cohort of 47 veterans, baseline semantic, psychological and physiological data were collected before the program began. A subgroup of 26 individuals volunteered to participate in an experimental session at the end of the program. For this group, semantic, psychological and physiological data were evaluated twice (pre- and post-program).

The program takes place either in a small village in the Écrins National Park in France, for multisport activities such as hiking, mountain biking, climbing, canyoning, and orienteering, or in the *Domaine les Gueules Cassées* (a recreational site located near the Mediterranean Sea, initially dedicated to the care of wounded soldiers), for water sports. The daily program consists of around 3 h of sporting activities, and one or two practical, individual and group workshops focused on PTSD information, or coaching in professional skills.

Whatever the multisport program or the water sport program, each sport activity is supervised by a qualified sports instructor and begins with an explanation of the session and a warm-up and ends with a debriefing on the session. The main goal of each session is to get in touch with the sensations of the body without the idea of performance. Concerning the multisport program, the first day is a 2-h walk of about 6 km to get back into shape. If the conditions are favorable, the schedule for the classic program is as follows. The veterans have a climbing session on the second and fourth days. The level of difficulty of the climbing routes is progressive from 4 to 5+ according to the International Union of Mountaineering Associations. For days 3 and 5, the activity is a mountain bike activity in the mountains. The last 3 days are organized with a canyoning activity lasting all the day, and according to the preferences of the veterans of the climbing or the mountain bike activity. The last day is reserved for the orientation race of about 3 h with a difference in altitude of 400 m. The water sport program combines the discovery of swimming with fins and scuba diving. In order to reduce, or even eliminate the anxiety that is described with diving because of the environment, and the

use of complex equipment, a very progressive training program was implemented with the recommendations of the Divers Alert Network. The protocol did not include any long dives at depths >20 m. The first two dives take place in a swimming pool. This make it easy to evaluate the level of anxiety of veterans, and to form homogeneous groups for dives in the sea. Throughout the course, the depths reached increased very gradually, and the ratio of veterans to monitors varies from two to one to one to one (for the most stressed individuals).

Professional activities focused on preparing a curriculum vita, coaching for professional resources and some role-playing for team building. During their free time, participants can join in group activities such as table soccer, pool, or other games, or simply relax. Civilian or military experts in human resources and social reinsertion conduct the workshops. A military psychologist is present at all times to provide support for symptoms of anxiety or substance dependence if one veteran asks for an emotional support during the 9-day program. There is no systematic psychotherapeutic treatment. All participants completed the full program.

Variables

Sociodemographic information included age, gender, social environment, and total number of major stressors encountered in either the professional or the personal environment.

Two self-report questionnaires were used. The PTSD Check List Scale (PCL5) (1, 38) was selected to assess PTSD severity. The patient is asked to rate the following four categories of symptoms: re-experiencing; avoiding situations that remind the person of the event; hyperarousal; and impairment to cognitive and emotional functioning. Each self-descriptive statement is evaluated using a 4-point Likert scale ranging from (2) "not at all" to (4) "extremely." Valid PCL-5 scores range 0–80 with higher scores indicating worse PTSD severity. Among the different thresholds that are proposed in the literature to diagnose PTSD, we chose the highest, as our aim was to identify a very specific group (1). Specifically, the cut-off point proposed by the National Center for PTSD—33—was selected.

The Freiburg Mindfulness Inventory-14 (FMI) was selected to assess the mind–body connection, as mindfulness has been consistently associated with higher interoceptive awareness (39). The FMI is a short form (14 item) self-report questionnaire that has been developed for people with no background knowledge of mindfulness (40, 41). It is considered to be a consistent and reliable scale for evaluating mindfulness, and is divided into two subfactors (42). "Acceptance" is the ability to embrace unwanted thoughts and "Presence" reflects a willingness to be present, characterized by a non-judgmental attitude to events that occur in the environment. Each self-descriptive statement is evaluated using a 4-point Likert scale ranging from (1) "strongly disagree" to (4) "strongly agree." Valid FMI scores range 14–56 with higher scores indicating high mindfulness disposition.

The free association method was used to record verbal representations reported by the individual about themselves and their physical body. This method was initially developed in the field of psychoanalysis, and has more recently been adopted by cognitive and social psychology (43). It is used to collect the content of the participant's representational universe. Participants were given two prompts (describe yourself; describe your body) and asked to respond with up to 10 words or expressions that spontaneously came to mind.

HRV was assessed during a 5-min period at rest by electrocardiogram (ECG) signals captured using the PHYSIONER system (CODESNA, France). This clinical and research device uses a 250 Hz sampling rate to accurately detect R-wave peaks. The R–R interval corresponds to the beat-to-beat interval of the instantaneous heart rate, and temporal, frequential or non-linear analyses can be used to extract HRV information. For clarity, we chose to use only one feature: RMSSD (the root mean square of successive differences between normal R–R intervals). The benefits of using RMSSD include: (1) its resistance to the influence of breathing frequency, which is a problem in frequential measures (44); and (2) its ability to capture levels of parasympathetic activity over a short period. A RMSSD score for each subject was calculated using KUBIOS HRV analysis software. The ECG was always performed between 14:00 and 18:00 to limit variation in circadian rhythm.

Statistical Analyses

Statistical analyses were performed using Statistica software (Statsoft France, Maisons-Alfort, version 7.1). Data are expressed as a number and percentage (%) for qualitative variables, and as the mean (M) and standard deviation (SD) for quantitative variables. The reliability of each psychological measurement (self-administered PCL5 and FMI questionnaires) was gauged by computing Cronbach's alpha (45). All were above 0.74, which indicates good reliability.

In the first step, we used the PCL5 median to categorize veterans into two groups: one where scores were above the median (the Severe PTSD Group), and another where scores were below the median (the Moderate PTSD Group). This qualitative inductive analysis used a manifest analysis with description of what the informants actually say with the objective to stay very close to the text, to use the words themselves, and to describe the visible and obvious in the text (46). First, words used to describe the person and their body were categorized into positive, negative and neutral valence, and counted. Second, the categorizing strategy was based on similarity-based relations that involve resemblances or common features. These two steps of valence coding as of categorization were carried out by three independent judges, who compared their own evaluations and reached a consensus.

Between-group comparisons of sociodemographic, psychophysiological, and semantic data were performed using Pearson's chi-square test for variables with several modalities, and either Student's *t*-test, or the non-parametric Kruskal–Wallis test for quantitative data.

The second step concerned subjects who had volunteered for the post-program session. Here, the aim was to evaluate the effects of the program on the words used to describe themselves and their body, with respect to their valence and semantic characteristics, PTSD symptoms, FMI scores, and RMSSD. A separate Wilcoxon non-parametric analysis was run, given the non-homogeneity of variance (Levene's test).

TABLE 1 | Psychophysiological characteristics of moderate and severe PTSD groups.

	Moderate PTSD (M; SD)	Severe PTSD (M; SD)	*t* or H (*p*)
FMI	32.20 (6.64)	30.87 (6.65)	*t*:0.63 (0.53)
FMI-P	14.90 (3.49)	14.52 (2.77)	*t*:0.38 (0.7)
FMI-A	17.30 (3.84)	16.35 (4.4)	*t*:0.73 (0.47)
RMSSD	0.1 (0.05)	0.08 (0.06)	H: 2.57 (0.1)

FMI, Freiburg Mindfulness Inventory; FMI-P, FMI-presence; FMI-A, FMI-acceptance; M, mean; SD, standard deviation.

In each step, Bravais-Pearson correlation analyses were used. The statistical threshold for significance was set at $p < 0.05$. A trend was considered to be present when $p < 0.10$.

RESULTS

Baseline Description of the Population

Four individuals were excluded from the analysis as they did not complete the questionnaires, leaving a total of 43 patients who had been suffering from PTSD for more than 6 months. The average duration of sick leave was 12 months (SD: 9.4). All of the population was male. Their average age was 33.95 years (SD: 6.02). Of these, 29 (67.44%) were living with a partner, eight (18.6%) were single, and six (13.95%) were divorced. Fourteen (35%) had at least one child. Mean number of major stressors encountered in either the professional or the personal environment was 3.3 (SD: 1.54) and 2.15 (SD: 1.49) respectively.

All subjects had a PCL5 score equal to, or above 33. Mean clinical severity (PCL5) was 61.42 (SD: 12.36). No correlation was found between the PCL5 score and the overall FMI score or its sub-scores, or between the PCL5 score and RMSSD.

The median PCL5 score for the group was 61. Twenty-one subjects were classified as suffering from moderate PTSD. The mean score within this group was 50.9 (SD: 5.6). Twenty-two participants were classified as suffering from severe PTSD, including one subject with a PCL5 score equal to the median. Here, the mean was 71.45 (SD: 7.71). There was no difference between the two groups in terms of age or duration of sick leave. RMSSD tended to be higher for the moderate group compared to the severe group, while no difference was observed for the overall FMI score, or its sub-scores, between the two groups (**Table 1**).

Baseline Free Association Results

As shown in **Table 2**, a total of 230 words were given by the 43 participants. Of these, 142 terms (61.7%) referred to the person, and 88 (38.3%) to their physical body. Of the 230 words, none were neutral, 76 (33.5%) were positive, and the remainder (66.5%) were negative. Overall, 36.95% of words were negative and referred to the person; 29.56% were negative words about the body; 24.78% were positive words describing the person; and 8.69% were positive words about the body. The distribution of words used to describe the person and their body differed between severe and moderate PTSD groups ($X^2 = 6.64, p = 0.01$).

Regarding the 142 words associated with the person, 39% were positive and 61% were negative. Patients in the severe group gave 78 words in reference to themselves, 37% of which were positive and 63% negative. Patients in the moderate group gave 64 words, 42% of which were positive and 58% were negative. No difference between groups was observed, either in terms of the total number of words, or in terms of the number of positive and negative words. Seven overall categories were identified, which were split into subcategories according to their positive or negative valence. These seven categories were: cognitive, behavioral, affective, volitional, moral, relational and identity (**Figure 1**).

TABLE 2 | Examples of positive and negative words for each category given by participants to describe their person and their body.

Category	Positive	Negative
Person		
Cognitive	*Perfectionist*	*Pessimistic*
Behavioral	*Athletic*	*Impulsive*
Affective	*Happy*	*Sad*
Volitional	*Competitor*	*No desire*
Moral	*Loyal*	*Evil*
Relational	*Smiling*	*Unbearable*
Identity	*Rather educated*	*Ambivalent*
Body		
Evaluation	*Protective*	*Disgust*
Vitality	*My body is alive*	*My body is sluggish*
Relaxed/tense		*Stressed*
Dys/functional	*My body is a tool*	*Damaged*
Physical image	*Thin*	*Overweight*
Pain		*Painful*

Regarding the 88 words associated with the body, 23% were positive and 77% were negative. Patients in the severe group gave 46 words in reference to their own body, 20% of which were positive and 80% were negative. Patients in the moderate group gave 42 words, 26% of which were positive and 74% were negative. In this case, the distribution of valences differed between groups ($X^2 = 3.96$, $p = 0.04$). Specifically, 42.05% of negative words were given by members of the severe group, compared to 35.22% for the moderate group. On the other hand, 12.5% of positive words were produced by the moderate group, compared to 10.22% for the severe group. Six overall categories were identified, and each was split into two subcategories according to their positive or negative valence. The six categories were: good or poor evaluation of the body, good or poor level of energy, relaxed or tense body, dys/functional, positive/ negative physical image, physical pain or not (**Figure 2**).

Table 2 provides an example of a positive and negative word for each category.

Post-program Description of the Population

The average age of the 26 volunteers who agreed to participate in the post-program sessions was 34.3 (SD: 6.51), and the mean PCL5 score was 58.56 (14.45). Pre-session, a moderate positive correlation was observed between the FMI-A score and RMSSD ($r^2 = 0.39$; $p = 0.09$) in this group.

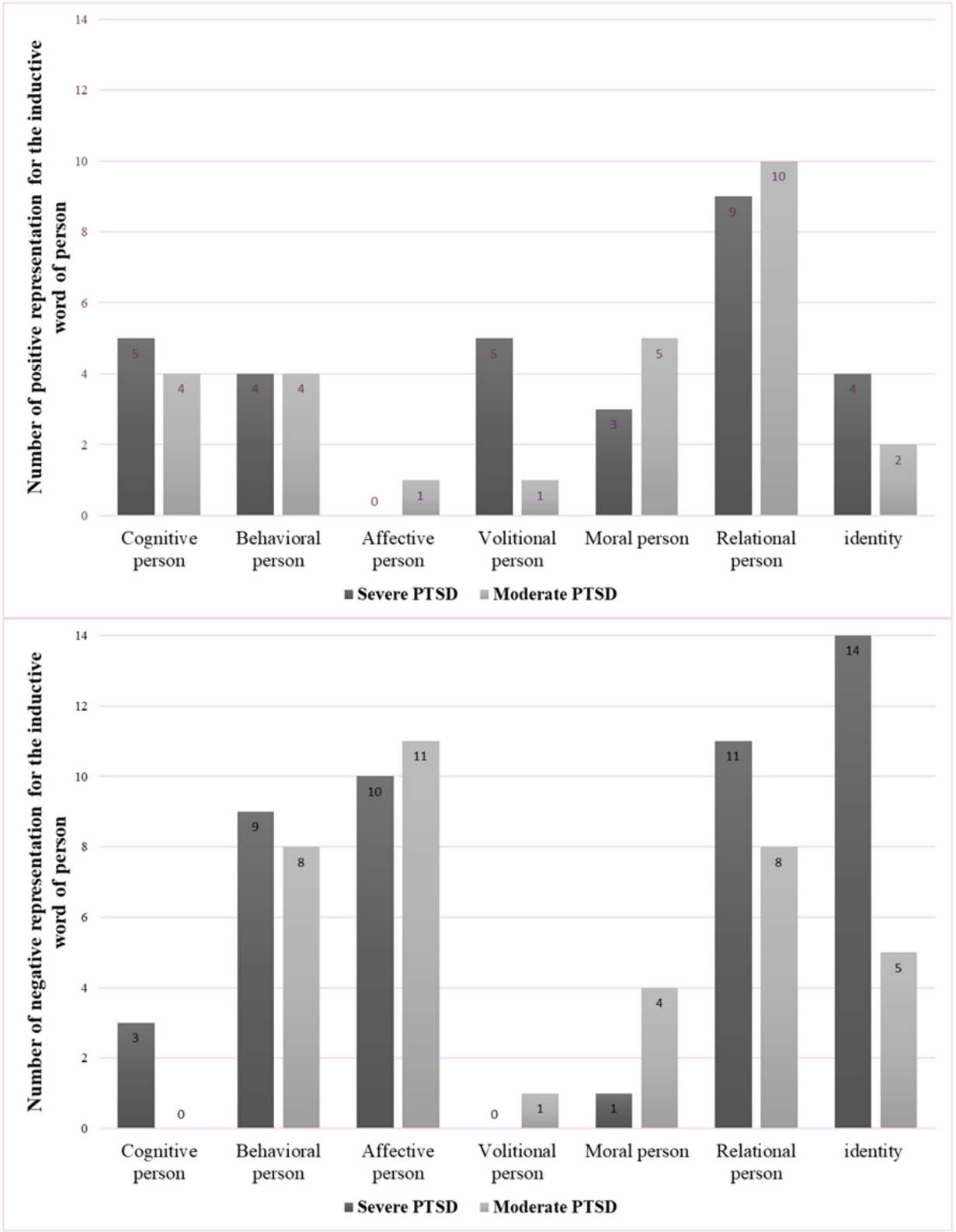
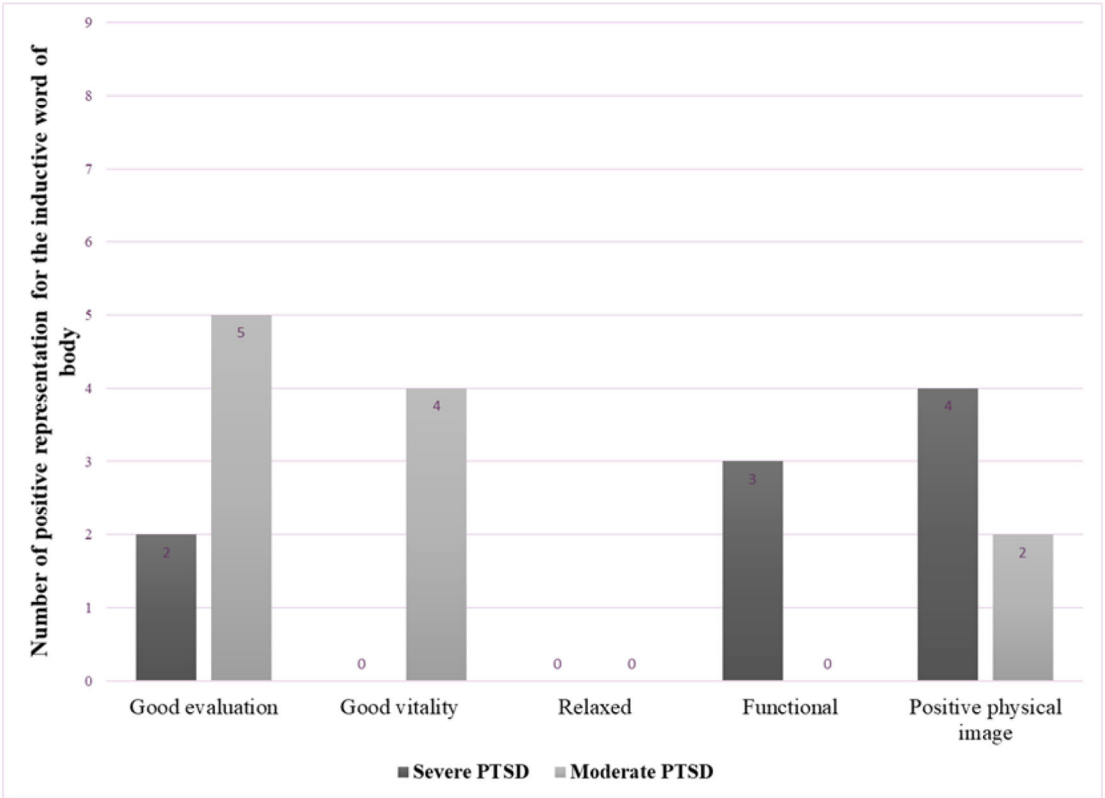


FIGURE 1 | Categories and numbers of positive (top) and negative (bottom) words referring to the person for severe and moderate PTSD groups.



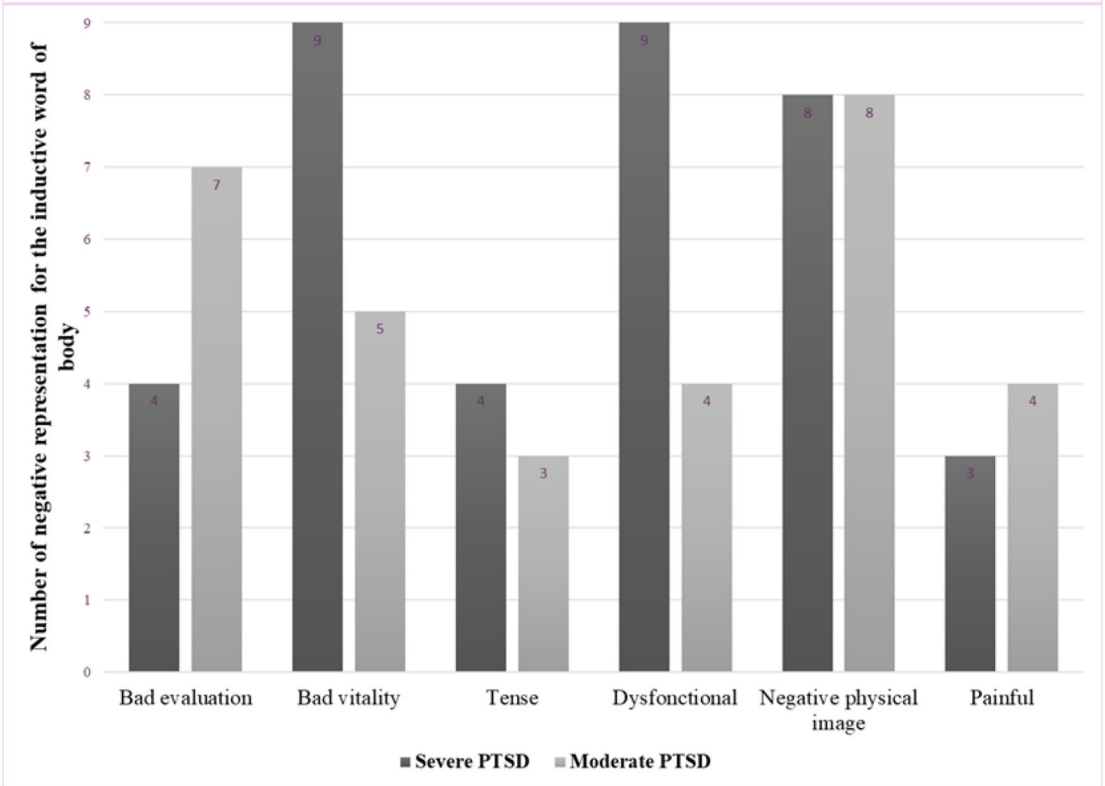


FIGURE 2 | Categories and numbers of positive (top) and negative (bottom) words referring to the physical body, for severe and moderate PTSD groups.

Following the program, the mean PCL5 score was 52.8 (14.54). A significant decrease was observed ($Z = 2.56$; $p = 0.01$). However, in only one case did the post-session score fall under the cut-off of 33. The decrease in the PCL5 score was associated with an increase in the mean overall FMI score ($Z = 3.07$, $p = 0.003$), the mean FMI-P score ($Z = 1.79$, $p = 0.074$), and the mean FMI-A score ($Z = 3.2$, $p = 0.002$). A decrease in RMSSD was also observed ($Z = 3.09$; $p = 0.002$). Strong positive correlations were observed pre- and post-session for the PCL5 score, the overall FMI score, and its sub-scores ($0.60 < r^2 < 0.90$; $0.0001 < p < 0.002$). No correlation was observed pre- and post-session for RMSSD. At post-session, a moderate positive correlation was observed between the overall FMI score and RMSSD ($r^2 = 0.41$, $p = 0.08$).

Pre-session, participants gave 127 words to describe themselves and their body; of these, 37.8% were positive, and 62.2% were negative. Post-session, 111 words were given; none of these were considered neutral, 59.45% were positive, and 40.54% were negative. The analysis of the valence of these words found an increase in the total number of positive words (both referring to the person and their body) between pre- and post-session ($X^2 = 10.29$; $p = 0.001$).

Pre-session, participants gave 76 words to describe themselves; of these 46% were positive, and 54% were negative. Post-session, 66 words were given; 68% were positive, and 32% were negative. The analysis found a significant increase in the number of words with positive valence ($X^2 = 6.16$; $p = 0.01$). **Figure 3** shows the number of words referring to the person as a function of the seven categories, pre- and post-session. It should be noted that the category of "moral" disappeared.

Turning to representations of the body, 51 words were given pre-session; of these, 25% were positive, and 75% were negative. Post-session, 45 words were given; of these, 47% were positive, and 53% were negative. The analysis identified evidence of a trend with respect to an increase in the number of words with positive valence ($X^2 = 3.8$, $p = 0.05$). **Figure 4** shows the number of words used to describe the body, pre- and post-session, according to the categories listed above. Three changes were observed: (i) the painful category disappeared; (ii) a positive word appeared in the relaxed/ tense category; and (iii) a new opening/ closing category emerged, with one positive word used to describe the body.

DISCUSSION

This study examined a population of military veterans with chronic PTSD, who had been on sick leave for more than 6 months.

The overall analysis of verbal descriptions of the self- found several differences with respect to the valence and semantic characteristics of words used to refer to the body and the person. The identified categories are part of the cognitive-behavioral theoretical approaches. There is no single definition of cognitive-behavioral theory because there are so many different cognitive-behavioral theories. However, all cognitive-behavioral theorists value the role that cognitions play in the development and maintenance of psychological problems (47). Targeted categories, namely semantic categories, may offer therapeutic approaches to the management of PTSD in veterans. In absolute terms, the biggest category was negative representations of the person; this was followed by negative representations of the body, positive representations of the self, and finally, positive representations of the body. On a semantic level, descriptions of the person could be divided into seven categories: cognitive, behavioral, affective, volitional, moral, relational and identity. Most positive representations fell into the relational category, while only one positive word was classified as affective. Negative descriptions were distributed across all seven categories, but behavioral, affective, relational and identity were particularly important.

Representations of the body were divided into six categories: good or bad evaluation, good or bad vitality, relaxed/tense, dys/functional, physical image, no/pain. The "relaxed/tense" category was the only one that did not contain a positive word (indicating a relaxed state). These representations provided an insight into SRP among veterans.

Our overall population was divided into two groups consisting of those with either severe or moderate PTSD. Between-group comparisons were carried out at the vagal level, and with respect to the mind–body connection, as both are known to be related to interoception. The analysis showed that those with moderate PTSD tended to have a higher level of parasympathetic functioning, but that this was not associated with differences in terms of the mind–body connection. Further comparisons of representations of the self-showed that, contrary to our hypothesis, those in the severe group did not produce more negative words than those in the moderate group. We conclude that the self-representation appears to be independent of PTSD severity for veterans who have suffered from PTSD for at least 6 months. With regard to interoception, no connection could be identified between the introspective evaluation of the self, and the psychophysiological evaluation of interoception.

For subjects who participated in the post-program session, the analysis found that participation in the course was associated with a decrease in clinical PTSD severity, and an increase in the mind–body connection, notably the acceptance dimension. Although RMSSD decreased post-session, we found no relationship with the pre-session level. However, a moderate positive correlation was found between post-session RMSSD and the mind–body connection. Thus, we conclude that the main effects of the sports program related to subjective evaluations of PTSD severity, and mind–body functioning. However, our results are too tenuous to draw any conclusions in terms of interoception improvement.

In accordance with our second hypothesis, the benefits of the program were associated with a positive change in the self-representation. First, we observed a general increase in positive representations, for both the person and their body. While both increased, the increase was higher for the person than the body. Second, the categories changed. For person representations, the category of "negative moral" disappeared. For body representations, the "painful" category disappeared and a positive word appeared in the

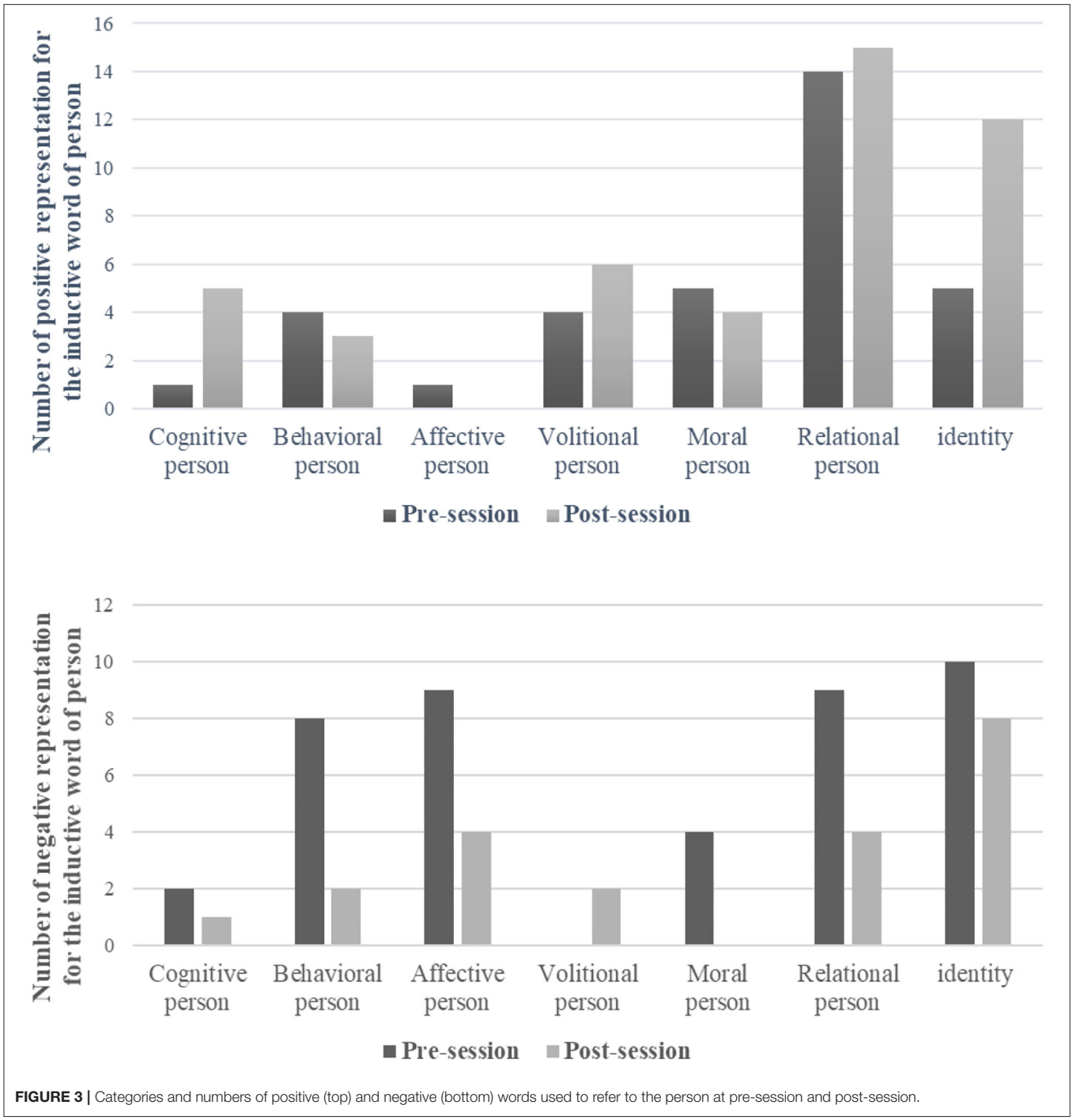


FIGURE 3 | Categories and numbers of positive (top) and negative (bottom) words used to refer to the person at pre-session and post-session.

"relaxed/tense" category. Furthermore, the opening/closing body category emerged, and one word was classified as positive (opening).

These positive changes appeared at the end of the 9-day sports program, and suggest that these veterans may have reconnected with aspects of their previous identity and sense of self. They also appear to have a more positive relationship with their body, suffer less pain, be more relaxed, and be more dynamic. However, here again, the introspective evaluation of the self through the analysis of words could not be related to an improvement in variables related to interoception, especially as post-program, parasympathetic activity decreased. This decrease in RMSSD at the end of the program appears to be inconsistent with the observed clinical improvement, the better body–mind connection, and the emergence of a more positive self-representation.

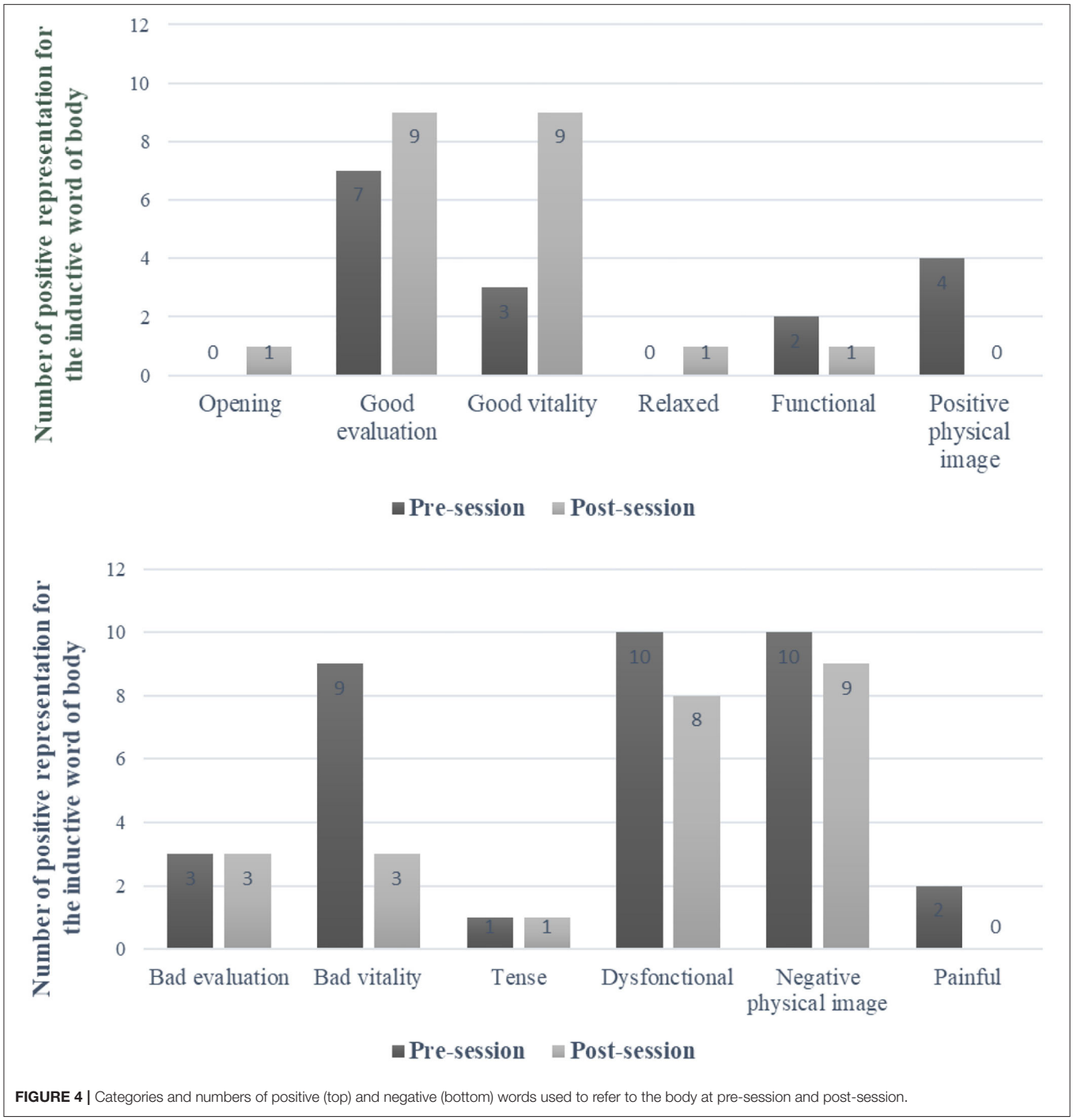


FIGURE 4 | Categories and numbers of positive (top) and negative (bottom) words used to refer to the body at pre-session and post-session.

HRV is a widely-accepted indicator of psychological stress (48). However, stress is known to be consistent with a wide range of individual differences in the autonomic response—from sympathetic activation to vagal withdrawal, or a reciprocal pattern of autonomic response (48). On the one hand, the observed post-session decrease in parasympathetic tone at rest suggests that the program as a whole, including the workshops, sports activities and life outside the home, disrupt homeostatic processes (49). Each activity is a challenge for the veterans. Participants describe themselves as very tired at the end, especially as many have resumed physical activity after a long pause during their sick leave. On the other hand, the concomitant improvement in clinical symptoms, and the mind–body connection, suggests that the program may constitute a positive challenge that contributes to the recovery of the self. Only a further long-term assessment can answer this question.

Finally, the rest condition used in the vagal assessment is currently recognized as insufficient. There is a need to assess the three systematic levels of cardiac vagal control (resting, reactivity, and recovery) in order to fully evaluate how efficiently self-regulatory resources are mobilized and used (50).

This exploratory study has several limitations. The first is the population, which is only composed of male veterans. This implies that any generalization to other populations must be undertaken with caution. Second, the small number of subjects means that the analysis lacks statistical power. Third, several limitations relate to the evaluation of interoception. In this study, we indirectly assessed interoceptive sensitivity, which refers to the degree to which the individual feels engaged by interoceptive signals, with a mind–body connection scale. Our subjective measure of interoceptive sensitivity needs to be supplemented by a behavioral task in order to complete the assessment. This is all the more important given that subjective sensitivity to interoceptive signals does not account for cerebral activation. The latter observation makes any interpretation of the relationship between the benefits of the program for interoception, and improvements in the self-representation, questionable. Turning to the physiological interoception assessment, RMSSD was only recorded at rest, and this measure should be supplemented with measures of vagal reactivity and recovery. Finally, three limitations come from the protocol. The effects of the 9-day program on self-representations and symptomatology are not controlled. The program included both workshops and sports, the observed benefits could be attributed to the workshops, the sporting activities, or both. Self-selection bias could be due to the post-program sample. These three methodological limitations make any generalization of the results questionable.

CONCLUSION

This exploratory study aimed to provide an insight into how military veterans evaluate their self. Most representations of the self, notably the person and their body, are negative, illustrated by the violence of some of the words used by the cohort of veterans. At the same time, the negativity of these words was found to be unrelated to clinical PTSD severity. Sport could be a way to reappropriate a positive image of the self. The findings of this study suggest that sport could be used to improve the individual's representation of the person her or himself, by improving the representation of the body. Although this relationship could be consistent with better interoception, our results are inconclusive on this point.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

This study received the agreement from the Sud-Mediterranée III personal protection committee before the start of inclusions, 10 of September 2018 (NTC03995992). All the subjects received information on the protocol and gave their written consent prior to their participation. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MT designed the study. AB, AD, CM-K, DL, GL, SJ, and MT planned and participated in word and statistical analyses. CB, GL, AB, SJ, and MT recorded the data. CB, CM-K, DL, and MT participated in all stages of writing and proofreading. All authors took an active part in the process and read and approved the final manuscript.

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Attitudes Towards Appearance and Body-Related Stigma Among Young Women With Obesity and Psoriasis

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The goal of this study was to investigate the role of the subjective assessment of one's body image in the relationship between objective indices of appearance and perceived stigma in young women affected by obesity and psoriasis. These are chronic diseases that decrease one's physical attractiveness and are associated with stigmas related to body defects. A total of 188 women in early adulthood took part in the study (M = 25.58; SD = 2.90), including obese women (n = 54), women suffering from psoriasis (n = 57), and a control group (n = 77). The participants completed the Multidimensional Body-Self Relations Questionnaire, Perceived Stigmatisation Questionnaire, and a socio-demographic questionnaire. Anthropometric data were gathered using a body composition analyzer. Objective parameters of body shape were calculated (WHR and ICO). Subjective assessment of one's body and attitudes towards one's body were found to influence perceived stigma, independently of the condition causing the stigma and of the objective appearance of the participant. This study did not support the existence of a relationship between parameters regarding body shape and sense of stigma, even when subjective body assessment acted as a moderator. At the same time, body mass was a strong predictor of levels of perceived stigma. Women affected with obesity perceived a higher level of stigma than the other groups. The severity of psoriasis did not impact the perceived stigma. Moreover, women with psoriasis assessed their health—as a part of the assessment of their bodies—the highest, which may explain the lower perceived stigma in this group.

Keywords: body attitude, body image, body stigma, obesity, skin disease

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INTRODUCTION

Body image, assessment of one's body, and attitudes towards one's body are important elements of the development of the "self" (1). Research suggests that how we perceive our body is more important for our body image than its actual appearance (2, 3). This is important, because one's body image and sense of attractiveness are strongly associated with self-esteem (4, 5), well-being (6), happiness (7, 8), life satisfaction (9), and it influences health-related quality of life (10–12). Our attitudes towards our bodies are shaped and change throughout the different stages of our lives. Assessment of one's body decreases significantly during adolescence and early adulthood—mainly because of judgement from one's environment (13–15)—increases slowly during mid-adulthood (16), and then rapidly drops when one reaches old age (17, 18). People tend to be most critical of their bodies during adolescence and young adulthood (19), and the imperfections typical of

teenage bodies are often used by peers as a source of mockery or rejection (20, 21). The shaping of one's body image is influenced by attitudes and beliefs regarding one's body (subjective opinions and perceptions, such as satisfaction or dissatisfaction with one's looks), physical factors (objective body measurements, proportions, body mass, height), interpersonal factors (opinions from one's environment; e.g., family members, peers), and cultural factors (e.g., from the media) (1, 22). The latter have a huge influence over the "ideal" an individual tries to attain, because they play a significant role in the acceptance and construction of standards for bodies (23). Western culture promotes body ideals characterised by tall, slim female bodies (24, 25), with constant breasts-to-waist ratio and a low hip-to-waist ratio (26, 27), while perfect male bodies are muscular and mesomorphic (V-shaped, with broad shoulders and a narrow waist) (28, 29).

Thus, the way a person views their body depends not only on their culture (30–33) and age (16, 17), but also on their gender (34). Body image is a much more important part of the "self" for girls and women than it is for men, and thus it directly and strongly shapes their overall levels of self-esteem (35, 36). In comparison to men, women are more prone to negative body-image evaluations and pay more attention to their looks (37); furthermore, they are subject to greater pressure from the media regarding their body shape (31). Physical attractiveness also influences the way that an individual is treated. The so-called "halo effect" is when a person who possesses one positive feature is perceived as therefore having other positive features (38). Thus, individuals who would be considered unattractive or physically ugly are more likely to be perceived as having negative features. Even in children's stories, ugliness or a visible disability is often a marker of evil (39–41).

Fear of being unattractive, not fitting into the norms, or even being rejected due to one's looks may lead to serious mental disorders. Attitudes towards one's body are an important element of disorders such as anorexia and bulimia nervosa (42) as well as body dysmorphic disorder (43, 44). Shame and the sense of humiliation associated with the perception that one's environment can see one's flaws—skin problems, for example—and the fear of being rejected or isolated by "healthy" individuals may lead to mental health problems such as depression, addiction, or anxiety disorders (45). Individuals suffering from depression tend to focus more on their body mass and they may ruminate about their extra weight (46). There also exists a relationship between increased body mass and decreased mental health (47). Moreover the difference between actual ("real self") and idealised ("ideal self") body shape among young women increases emotional discomfort, anxiety, fear, and internal tension (48) Unattractive looks that do not "fit the norm" may thus be a major source of stigma (49).

A feature, mark, or social attribute may be the cause of deep stigmatisation. People suffering from such stigmas may be perceived as different, lesser, or even dehumanised (50). Unattractive looks and body imperfections (such as pimples, being too tall, too short, too fat, too skinny, etc.) are one of the most important sources of stigma, alongside character imperfections (laziness, mental illness, dishonesty) and identity (attached to identification with a particular race, ethnicity, religion, ideology, etc). Certain bodily imperfections (e.g., chronic skin diseases or prosthetic limbs) can be hidden, not immediately visible, and thus discreditable. In such situations, a person may decide whether and under what circumstances they will disclose their imperfection. A visible feature that cannot be disguised, such as height, obesity, or skin colour, is discredited because of its being clearly visible (51, 52). Someone who is thus stigmatised often experiences exclusion or rejection and their imperfection can become their defining attribute (53).

The difference between discredited and discreditable stigmas means that the assessment of attractiveness and the level of stigma differ depending on the context. Dermatological conditions and obesity are chronic health problems that impact one's sense of attractiveness, significantly lowering one's physical attractiveness and influencing quality of life (11, 54–58). However, a person with a visible skin condition (e.g., psoriasis or atopic dermatitis) is perceived differently than are obese ("fat") individuals: the environment "blames" an individual for being obese (11). Psoriasis or atopic dermatitis are genetic conditions whose occurrence is outside the control of the person affected (59, 60). Psoriasis is a chronic disease that may undergo periods of remission, during which the condition improves and the associated problems may even disappear completely; however, it is impossible to completely cure it and prevent relapse (45). Obesity is a chronic disease characterised by the ratio between one's body mass and height squared being above 30 (61), and an individual's choices can play a role in the aetiology of the condition (it is commonly perceived that one can change their looks/body mass through exercise, diet, medication, or, in the most serious cases, by surgery). Thus, the stigma around obesity is two-fold: both the appearance (bodily imperfection) and character imperfection are stigmatised (49, 52).

Therefore, the goal of the current study was to investigate the role of subjective assessment of one's body in the relationship between objective indices of one's looks (body shape, body mass, presence of a skin condition) and the sense of stigma among young women.

To this end, the following hypotheses were formulated:

1. The level of perceived stigma will depend on the type of stigma: young women who are obese will experience the greatest sense of stigma due to being affected by a double stigma; the lowest levels of stigma will be experienced by the women in the control group.
2. Attitude towards one's body will be a moderator of the relationship between the objective parameters of the stigma-causing condition and the sense of stigma.

MATERIALS AND METHODS

Participants

A total of 188 young adult women took part in the study (age: $M = 25.58$; $SD = 2.90$; min = 19, max = 30); we chose a young study group on purpose, as this is a developmental period in which body image is very important and assessments thereof are the most critical (19). We selected two groups of women who

have conditions that affect how one looks: obesity and psoriasis. Despite the fact that these conditions often co-occur (62), we focused on groups of women with only obesity [as per WHO BMI $\geq$ 30, $n = 54$; (61)] or psoriasis (the inclusion criteria were at least 1 year having elapsed since diagnosis and visible skin lesions; $n = 57$). In order to assess whether the investigated phenomena occur only for the group with the visible stigmatising conditions, women with normal weight and no skin conditions were also included in the study (control group; $n = 77$). None of the study participants underwent bariatric surgery or laser skin therapy.

Procedure

The recruitment procedure had two stages. During the first stage, females participating in a larger project, described elsewhere (63), who met the inclusion criteria for this study were recruited. During the second stage, females who met the inclusion criteria for this research project were asked to invite acquaintances to participate—i.e. a non-random method of sample selection ["snowball sampling technique"; (64)]. A total sample of 188 females was recruited for this study. Data were collected between 2018 and 2019.

Participants completed the following questionnaires: *the Perceived Stigmatisation Questionnaire, the Multidimensional Body-Self Relations Questionnaire,* and a short survey to collect medical and sociodemographic variables. These questionnaires were completed during a visit to a dietician, dermatologist, or psychologist, or at home (in this case, participants had 2 weeks to complete the questionnaires). Additionally, we collected objective body measurements: body mass, height, and sizes of individual body parts. This allowed us to calculate anthropometric indices for all participants, such as Body Mass Index (BMI), Index Of Central Obesity (ICO), and Waist-to-Hip Ratio (WHR). Moreover, the objective body parameters connected with body mass were controlled using a body composition analyzer. The data used for this study were part of a larger survey and the questionnaires that formed this study took around 25 min to complete.

The protocol of this study was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdansk, Poland (decision no. 12/2018).

Multidimensional Body-Self Relations Questionnaire

We used the Multidimensional Body-Self Relations Questionnaire (65), in its Polish adaptation (66), to measure the participants' body-image. This questionnaire is composed of 69 statements that assess the participants' attitudes towards their body's appearance. The scale has 10 subscales clustered into four areas: Appearance—*Appearance Evaluation* (AE), *Appearance Orientation* (AO), and *Body Areas Satisfaction* (BAS); Fitness—*Fitness Evaluation* (FE) and *Fitness Orientation* (FO); Health—*Health Evaluation* (HE) and *Health Orientation* (HO); *Illness Orientation* (IO); and Body Weight—*Overweight Preoccupation* (OP) and *Self-classified Weight* (SCW). Participants give their responses on a five-point Likert type scale ranging from 1 (*definitely disagree*) to 5 (*definitely agree*). The indicators are slightly different for some items: 1 (*never*), 2 (*rarely*), 3 (*sometimes*), 4 (*often*), and 5 (*very often*).

Perceived Stigmatisation Questionnaire

The Perceived Stigmatisation Questionnaire was used to assess sense of stigma in the young women (67). The questionnaire is composed of 21 items that form 3 subscales: *Absence of Friendly Behaviour*, *Confused/Staring Behaviour*, *Hostile Behaviour*, and *Total Score*. Participants assess on a five-point Likert-like scale how often people behave in certain ways around them, where 1 indicates *never*, 3 indicates *sometimes,* and 5 indicates *always*. In order to develop a Polish version of the PSQ, the questionnaire was translated into Polish independently by an interpreter and a psychologist with the author's consent. After selecting the best Polish version, it was back-translated into English by a native speaker. Then, the quality of translation was assessed by comparing the back-translation with the original questionnaire.

Sociodemographic Questionnaire

The sociodemographic questionnaire was composed of questions about age, height, marital status, place of residence (city, town, village), concomitant diseases, the diets one follows, as well as visits to specialist physicians and dieticians. With regards to dermatology, we asked about the severity of the condition and methods used to conceal or treat the visible skin lesions. In the part regarding body mass and shape, we used the body measurement data to calculate anthropometric indices.

Body Composition Analyzer

In order to measure the objective dimensions of the body and its components, we used the Segmental Body Composition Monitor–Tanita BC-601, produced by Tanita Corporation, Japan. BMI was calculated only as an inclusion criterion for the obesity group. The importance of body composition and visceral fat levels is increasingly emphasised (68, 69), which is why BMI was not used in further analyses. For adults, the analyzer allows the measurement of indices of obesity level adjusted for muscle mass content, fat percentage (%BF), recommended daily energetic intake, basal metabolic rate, metabolic age, bone mass, and visceral fat content (70).

Anthropometric Indices

Indices related to body shape were calculated based on a questionnaire prepared for the purposes of this study.

Index of central obesity (ICO): the ratio between waist circumference and height. This allows the assessment of the ratio between visceral fat and the total fat content. It is a more precise parameter for gauging one's health, because it takes visceral fat levels into account. It is also important for the parameters of one's body shape (71).

We also calculated the *Waist-to-hip ratio (WHR*), which is an index of body shape. It usually takes values between 0.6 and 1.0—the lower the index, the slimmer the waist in comparison to the hips (hourglass figure; (26, 72).

Statistical Analysis

The analyses were performed in Python 3.8.5 programming language (Python Software Foundation, USA, 512 Lafayette

TABLE 1 | Anthropometric differences between the groups.

Anthropometric parameters	Control group ($n = 77$)		Women with obesity ($n = 54$)		Women with psoriasis ($n = 57$)		ANOVA			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2	*DIFF*
Body mass	61.07	6.00	98.17	15.14	60.92	7.90	267.72	<0.001	**0.07**	O >C; O > P
BMI	21.74	1.64	35.01	4.14	22.04	2.21	442.46	<0.001	**0.08**	O >C; O > P
WHR	0.79	0.07	0.89	0.08	0.81	0.09	26.62	<0.001	**0.02**	O >C; O > P
ICO	0.45	0.04	0.63	0.07	0.47	0.05	221.03	<0.001	**0.07**	O >C; O > P
%BF	28.56	3.75	43.44	4.91	27.23	6.07	193.88	<0.001	**0.06**	O >C; O > P
Visceral fat	1.86	0.79	8.62	2.47	2.07	1.19	352.18	<0.001	**0.08**	O >C; O > P
Age	25.56	2.81	26.19	2.62	25.04	3.18	2.22	0.11	**0.02**	_
High	167.52	6.07	167.37	5.36	166.00	5.45	1.31	0.27	**0.01**	_
Disease severity	1.01	0.72	1.02	0.84	5.51	1.73	303.75	<0.001	**0.07**	O > C; P > O; P > C

C, Control Group; O, Women with obesity; P, Women with Psoriasis; η^2, magnitude of effect.

Boulevard, Suite 2, Fredericksburg, Virginia 22401) programming language, using JupiterLab 2.2.6(Open Source Software) as the computation environment.

The following python libraries were used:

- pandas 1.1.3 (Open Source Software);
- scipy 1.5.2 (Open Source Software);
- numpy 1.19.2 (Open Source Software);
- pingouin 0.3.9 (Open Source Software).

Test data were contained in pandas.DataFrame. DataFrame is a two-dimensional, size-mutable, potentially heterogeneous tabular data type. Its structure contains labelled axes (rows and columns). Arithmetic operations align on both row and column labels. It can be considered a mathematical database. This study used DataFrame to index and align data. Each row contained all data collected from a single participant.

Wilk-Shapiro test was performed using scipy.stats.shapiro function. One way Anova test was performed using pingouin.anova function. Kurskal test was performed using scipy.stats.kruskal. Spearman's Rho correlations were calculated using scipy.stats.spearmanr function. Pearson's Rho correlations were calculated using scipy.stats.pearsonr function. Z-Score was calculated by executing pandas.DataFrame.apply(numpy.mstats.zscore). Moderation was calculated using python implementation of prof. Hayes, A. F. PROCESS macro. Wilk-Shapiro test was used to verify parametric assumptions on data used in the document.

As a result, non-parametric variables were found: Absence of Friendly Behaviour, Appearance Orientation (AO), Fitness Orientation (FO), Health Orientation (HO), Illness Orientation (IO).

For parametric variables, the validity of group selection was determined by using mean analysis, ANOVA, and Dunn's multiple comparison test. For non-parametric variables, the validity of group selection was determined by using mean analysis, Kruskal-Wallis *H*-test, and Tukey's range test.

Pearson Rho correlation ware calculated for parametric variables, between groups for Anthropometric Indices, PSQ, and MBSRQ while Spearman Rho correlations were calculated for non-parametric variables.

Bias-correct, no-nparametric, bootstrap PROCESS MACRO moderation was used to determine the relationship of Anthropometric Indices, and PSQ with MBSRQ as relation moderator.

RESULTS

Objective Body Dimension Differences

First, we assessed whether groups had been selected appropriately. Their characteristics and anthropometric differences are presented in **Table 1**.

The collected data indicate that the groups were selected appropriately. The groups differed in terms of the parameters that were key to the sampling process. Parameters regarding body mass and BMI were the highest in the group of women affected with obesity (Dunn *post hoc* analysis: $p < 0.001$), while those regarding the phase and the severity of disease were highest in the group affected by psoriasis ($p < 0.001$). The groups did not differ in terms of age and height.

Participants' Attitudes Towards Their Own Body and Their Perceived Stigma

Attitudes towards one's own body differed between the groups (**Table 2**).

Women affected by obesity had the lowest satisfaction with their bodies (Tukey comparison with psoriasis: $p > 0.002$; and the control group: $p = 0.001$) and the lowest assessment of their looks (Dunn *post hoc* analysis: $p > 0.001$). It is not surprising that this was associated with the assessment of one's body mass (*post hoc* Tukey: $p > 0.001$) and with being preoccupied with one's weight as an aspect of the assessment of one's appearance (Dunn *post hoc* analysis: $p < 0.001$). Health, understood as an aspect of one's attitude one's own body, was assessed the highest by women with psoriasis (*post hoc* Tukey: $p = 0.01$).

TABLE 2 | Differences in the assessments of one's body (MBSRQ) between the groups.

MBSRQ		Control group ($n = 77$)		Overfat group (n=54)		Skin disease group ($n = 57$)		ANOVA			
		M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2	*DIFF*
Appearance	Appearance evaluation (AE)	21.62	3.10	19.26	4.62	21.60	3.47	19.10	<0.001	**0.01**	-
	Appearance orientation (AO)	39.61	4.85	38.67	6.04	39.51	5.24	2.76	0.25	**0.01**	O > C; O > P
	Body areas satisfaction (BAS)	31.21	5.61	26.69	5.80	30.47	5.94	20.40	<0.001	**0.10**	C > O; P > O
Fitness	Fitness evaluation (FE)	15.27	2.99	13.81	3.78	14.96	3.36	7.13	0.03	**0.03**	-
	Fitness orientation (FO)	35.04	3.48	35.69	5.40	35.04	4.22	0.43	0.65	**0.01**	-
Health	Health evaluation (HE)	18.95	2.31	18.57	3.21	19.65	2.13	6.57	0.04	**0.03**	C > O
	Health orientation (HO)	35.40	4.65	35.37	5.79	35.23	5.40	0.02	0.98	**0.01**	-
	Illness orientation (IO)	12.74	2.53	12.69	3.39	13.09	3.46	0.29	0.74	**0.01**	-
Body *Weight*	Overweight preoccupation (OP)	9.82	2.80	13.96	3.73	10.11	6.15	16.76	<0.001	**0.15**	O > C; O > P
	Self-classified weight (SCW)	6.30	1.36	9.31	0.86	6.05	1.67	101.09	<0.001	**0.05**	O > C; O > P

C, Control Group; O, Women with obesity; P, Women with Psoriasis; η^2, magnitude of effect.

TABLE 3 | Differences in perceived stigma between the groups.

PSQ	Control group ($n = 77$)		Women with obesity ($n = 54$)		Women with psoriasis ($n = 57$)		ANOVA			
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	η^2	*DIFF*
Absence of friendly behavior	2.24	0.39	2.19	0.45	2.08	0.47	5.25	0.07	**0.02**	P > C
Confused/staring behavior	1.70	0.37	1.97	0.62	1.64	0.43	7.75	<0.001	**0.08**	O > C; O > P
Hostile behavior	1.42	0.37	1.88	0.83	1.59	0.50	10.15	<0.001	**0.10**	O > C
Total score	1.84	0.29	2.03	0.49	1.79	0.35	6.27	0.002	**0.06**	O > C

C, Control Group; O, Women with obesity; P, Women with Psoriasis; η^2, magnitude of effect.

Some statistically significant differences were also observed for perceived stigma (**Table 3**).

Overall sense of stigma was greater in women affected by obesity than those affected by psoriasis ($p = 0.012$) or the control group ($p = 0.044$). Further analyses did not reveal any differences between women with psoriasis and women from the control group ($p = 0.493$).

Objective Body Dimensions and Perceived Stigma

In the next step, we investigated the relationships of anthropometric indices and body dimension with perceived stigma. There was a surprising lack of relationship between perceived stigma and objective indices regarding body shape (WHR, ICO) as well as the severity of psoriasis (Disease Severity). However, there were correlations between sense of stigma and parameters associated with body mass and fat levels (**Table 4**). The greatest number of significant correlations were observed in the group of women affected by obesity. Interestingly, significant relationships revealed in the psoriasis group were negative, which means that the higher one's body mass, the lesser the perceived stigma (provided one does not reach the threshold of being overweight).

Moderating Role of the Body Image for Perceived Stigma

Moderation analysis was performed in order to investigate the role of subjective assessment of one's body in the relation between objective body measurements and perceived stigma (**Figure 1**).

No moderation effect was observed in the relation between objective indices regarding body shape (WHR and ICO) as well as the severity of psoriasis (Disease Severity) and perceived stigma. *Health Evaluation* was the most common moderator associated with the subjective attitude towards one's own body

in the relationship between body dimensions (body mass, %BF, and visceral fat) and perceived stigma. It is worth noting that this was the only moderating factor in the group of women with psoriasis, while it did not moderate any of the relationships in the case of women with obesity. Interestingly, in the group of women affected with obesity, attitude towards one's own body significantly influenced the sense of being stared at and the experience of hostile behaviours in social relations when body mass or body fat levels were higher.

TABLE 4 | Correlation between body dimension and perceived stigma.

PSQ	Group	Body dimension		
		Body mass	%BF	Visceral fat
Absence of friendly behavior	Control group ($n = 77$)	−0.22*	−0.31**	−0.16
	Women with obesity ($n = 54$)	0.06	0.10	0.08
	Women with psoriasis ($n = 57$)	−0.24	−0.24	−0.05
Confused/staring behavior	Control group ($n = 77$)	−0.07	−0.29**	−0.30**
	Women with obesity ($n = 54$)	0.40**	0.33*	0.39**
	Women with psoriasis ($n = 57$)	0.02	−0.08	0.16
Hostile behavior	Control group ($n = 77$)	−0.22	−0.24*	−0.12
	Women with obesity ($n = 54$)	0.48***	0.39**	0.36**
	Women with psoriasis ($n = 57$)	−0.31*	−0.18	0.00
Total score	Control Group ($n = 77$)	−0.22	−0.37***	−0.27*
	Women with obesity ($n = 54$)	0.41**	0.35**	0.36**
	Women with psoriasis ($n = 57$)	−0.21	−0.22	0.04

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

DISCUSSION

The main objective of this research was to verify the subjective role of the assessment of one's body in the relationship between objective indices of appearance and the perceived stigma among young women. The above-presented analyses largely supported the hypotheses.

Sense of Stigma Among Young Women With Conditions That Decrease One's Physical Attractiveness

We hypothesised that the level of perceived stigma would depend on the type of stigma. The fact of being chronically ill itself, irrespective of the type of illness, results in stigma (73). However, our study found that not every illness leads to the same levels of perceived stigma. In line with the hypotheses, obese women were more likely to have a sense of stigma than women in other groups. This agrees with our previous results: a study on a smaller number of women (11) found that obese women were more likely to experience hostility as part of their stigma than women with skin conditions or those without an objective stigma. Lin et al. (74) asked 464 teenagers who were either overweight or non-obese about depressive symptoms, perceived stigma associated with body mass, and internalised stigma; they also measured actual and perceived weight status. They concluded that weight-related self-stigma is a problem even for people who are not overweight, because perceived weight stigma was associated with weight-related self-stigma regardless of body mass status. Strong associations between perceived weight stigma and weight-related self-stigma have been observed. In a study by Vartanian et al. (75), with 598 participants, pictures of women who were either obese

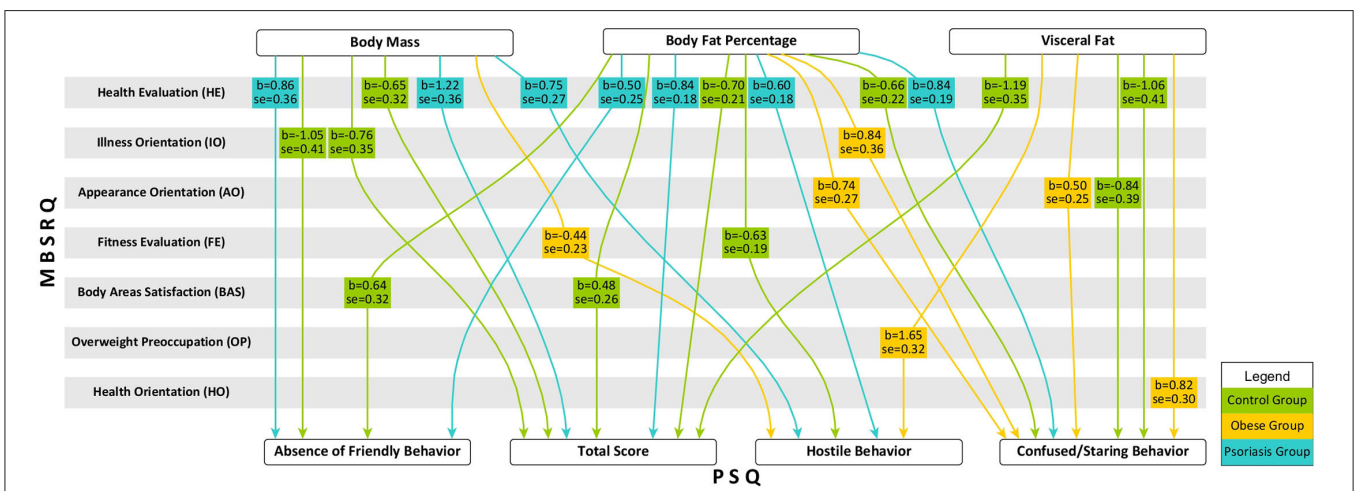

FIGURE 1 | Moderation effect of body image on relation between objective body dimension and perceived stigma.

or non-obese were shown to the participants, who assessed them with regards to emotions, attitudes, stereotypes, or desire for social distance. Images of obese individuals inspired more disgust and negative attitudes and stereotypes as well as greater desire for social distance. The researchers concluded that disgust plays an important role in prejudices and discrimination towards obese individuals and that it may partially explain prejudice against overweight people.

We also hypothesised that women affected with psoriasis would differ from the control group in terms of their perceived stigma; however, this hypothesis was not supported by the collected data. Moreover, the severity of the disease, its phase, and the size of affected skin surface also did not impact levels of perceived stigma. This is in line with the research by Rzeszutek et al. (76), which showed that some people affected by psoriasis do not differ in their attitudes from healthy individuals. Moreover, higher satisfaction with their own body and resources allows individuals with psoriasis levels of life satisfaction similar to those of the general population This is also in line with the research by Sakson-Obada and Wycisk (77), who found that accepting one's illness and positive body image and body experiences decreased the negative impact of psoriasis. Thus, positive body image may also facilitate more successful coping with physical symptoms of psoriasis and increase the well-being of patients (78), thereby decreasing perceived stigma.

Interestingly, women who were not overweight and did not suffer from any skin condition, even those with high body fat levels, did not perceive a lack of positive behaviours towards them or lack of compliments. This is in line with previous research (79) that found that women who were not overweight did not associate increased body mass or body fat with lack of friendly behaviours towards them. Contrasting results were observed by Lipowska et al. (33), where lack of perceived friendly behaviours was deemed an important component of stigma and compliments played an important role in building the body esteem of the young female participants, independently of their body mass.

The Role of Attitudes Towards One's Body in the Relationship Between Objective Body Measurements and Perceived Stigma

We hypothesised that the attitude towards one's body would be a moderator of the relationship between the objective parameters of the stigmatising illness and perceived stigma. Attitudes towards one's body are developed from the earliest years of life, starting with the stage of getting to know one's own body. After that, these attitudes are shaped and internalised through comparisons with people around us, their opinions, and attitudes towards us. For girls and women, body image comprises a much bigger part of the "self" than is the case for men, and it strongly influences their overall self-esteem (35, 36). From the earliest years of life, women experience stigma and negative judgements associated with increased body mass. One study on a group of children aged 3 to 7 (80) in which participants were asked to describe their preferences for the appearance of playmates as well as to ascribe features attributed to normal and overweight figures revealed that girls are more strict in their judgements of overweight individuals than boys. As per Carof's report (81), despite the fact that European countries vary in their cultures' approaches to overfat and obesity, attitudes towards excess body mass are generally negative and are also often associated with moral judgements of the individual. This is why it is worth emphasising that our results indicate that body mass and its components (fat percentage and visceral fat) play an important role in the relationship with one's own body and perceived stigma. Independently of the objective stigma and body shape (proportions), preoccupation with one's body mass and control over it is a factor that influences one's body image and perceived stigma. Moreover, preoccupation with one's appearance was stronger in the group of obese women than in the remaining groups, and it played an important role in the relationship between objective body dimensions (body fat, visceral fat) and the sense of being stared at because of one's appearance. It can be thus supposed that weight is an important factor in determining to what extent a woman feels attractive, what attitudes she has towards her own body, and whether she perceives weight-related stigma. This is in line with the research of Tovée et al. (82), according to whom body weight explained as much as 53% of the variance in attractiveness among women, while in the case of men it was only 13%. Interestingly, according to the Faries and Bartholomew (83) study, fat percentage seems to be a strong indicator of attractiveness, and the influence of WHR and BMI on attractiveness is partially dependent on it. Despite the fact that multiple studies indicate that women are more preoccupied with their weight than are men (84) and women with higher body mass are more dissatisfied with their appearance (85–87), dissatisfaction with one's appearance and body mass appears to be a universal phenomenon for women (88). Similar results were observed in a study in which all female participants, independently of their body mass and body fat levels, expressed dissatisfaction with their body mass and a desire to reduce it (79). Interestingly, in the study Blodorn et al. (89), women with higher weight, when they were to describe during the study why they would make a good date, and their potential partner would see or hear their recording, felt greater expectations of social rejection when weight was seen (vs. unseen). Experimental studies (90) additionally revealed that showing women who are initially dissatisfied with their bodies images of a very slim "perfect" body significantly increased their levels of dissatisfaction, and led them to judge themselves more harshly. This effect was not observed in women who were initially satisfied with their bodies. Body weight is therefore one of the strongest predictors of satisfaction with one's appearance in women - the lowest level of satisfaction is shown by people with the highest body mass (91).

Moreover, our analyses did not support the existence of a relationship between parameters related to body shape and perceived stigma when the subjective assessment of one's body was tested as a moderator of this relationship. Similar results were observed for a group of Polish and Vietnamese young people (33), for whom objective body measurements did not influence sense of stigma among women. No relationship between anthropometric indices and assessment of one's own body was observed and waist to hip ratio was associated with

one's satisfaction with body mass and physical fitness. Moreover, in Polish women, BMI had little influence over assessment of their bodies. This again supports the claim that body mass and its components, and not body shape, influences our attitudes towards our own bodies, and whether we perceive stigma related to our appearance.

A surprising result of the presented study was the positive assessment of one's own health by women affected with psoriasis. This positive assessment seems to lower the levels of perceived stigma, even when body mass or body fat levels are higher. This is in line with the results of a study by Alexandrova-Karamanova (92), who found that young people who assessed their health positively also exhibited more positive feelings and attitudes towards their bodies and appearance. This is even more surprising because psoriasis significantly impacts one's sense of physical attractiveness and acceptance of one's own body (77). A completely different approach towards one's own body and stigma was revealed in the case of obese women. It is likely that women do not treat obesity as an illness *per se*. Obesity is associated with a number of consequences for one's physical health (93–95); however, these medical conditions are often not directly associated with obesity (in the sense that people not affected by obesity also suffer from these conditions). Thus, it is possible that an individual does not perceive such diseases as associated with obesity, but rather as conditions independent of their appearance, which is why they assess their health differently and pay less attention to the evaluation thereof in the context of their appearance or stigma. Skin conditions require treatment on many levels, such as taking good care of one's skin, alleviating itchiness, regular visits to a specialist, and concealing the affected areas (96, 97). In the case of psoriasis, believing that one has internal control over one's health is associated with the acceptance of the condition, which facilitates adherence to guidelines given by specialists, which, in turn, allows for relatively successful treatment of symptoms (98). Thus, a positive assessment of one's health may allow one to better cope with the physical symptoms of psoriasis and helps reduce stress (which exacerbates the condition) (99).

CONCLUSION

Summing up, the main conclusion of our study is the fact that subjective assessment of one's body and attitudes towards one's body influence perceived stigma, independently of objective body shape or the type of condition causing the stigma. At the same time, body mass is a strong predictor of perceived stigma for all women.

Levels of perceived stigma differ between women with psoriasis and women affected by obesity. Obese women feel stigmatised more strongly than the rest of the group. Patients suffering from psoriasis assessed their health as most inportnant element of body evaluation, which may result in a lower sense of stigmatisation in this group. Therefore, perceived stigma should be taken into account when working with obese individuals and actions could be taken to help improve their body image. Furthermore, social programmes should take the necessary steps to reduce stigma related to body mass, through prophylaxis in the field of health, sugar and lipid economy, physical activity as well as psychological and medical support. When working with stigmatised women, it is also worth focusing on their resources and skills, which will increase their self-esteem and self-efficacy. At the same time, as long as the media portrays very slim female bodies with smooth skin as desirable, comparing one's own body to that model will lower body satisfaction and foster eating disorders.

LIMITATIONS

Our research involved young women who are particularly vulnerable to social disapproval and criticism for having an unattractive appearance and appearance that does not meet age norms. Moreover, as we mentioned, body image is a much more important element of "Self" for girls and women than for men. At the same time, it would be worthwhile to also study young men affected by obesity and psoriasis in order to assess the role that gender plays in these phenomena. This will broaden our understanding of the role of body image in the sense of stigma in those affected by appearance-related diseases. Another limitation is related to the selection of participants based on just two medical conditions: it is possible that extending the study to other visible conditions that may cause stigma could reveal more general tendencies regarding the relationship between one's body, attitudes towards one's body, and perceived stigma.

The sample size is another limitation of our study. Despite the fact that both excess body mass and skin conditions affect a large number of women, not all the women who were invited to take part in the study agreed to the collection of anthropometric data (e.g., stepping on the scale). Therefore, the results of our study cannot be generalised to all women with obesity and psoriasis. The sample size also limits the number and depth of analyses that could be conducted. While we can correlate anthropometric variables with sense of stigma, a longitudinal study would allow us to better determine causality. It would be worthwhile to extend the study to see whether similar results can be observed in a bigger sample. The way that participants were recruited (deliberate sample selection) may also be a limitation. Moreover, place of residence, marital status, and parental status were not taken into account in the study, thereby limiting the possible analyses. It may be that pregnancy or place of residence influence the perceived stigma or the attention paid to particular body imperfections.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdansk, Poland (decision

no. 12/2018). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

NM and ML: conceptualisation, methodology, writing—original draft preparation, and writing—review and editing. JK: software and validation. JK and ML: formal analysis. NM: investigation, data curation, and project administration. ML: supervision and funding acquisition. All authors contributed to the article and approved the submitted version.

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Predictive Role of Body Image in Bulimic Behaviors Among Obese Patients Qualified for Bariatric Surgery

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Bulimic behavior and the associated experience of one's own body are of great importance in the course of surgical treatment for obesity. This study determined the predictive role of multidimensional body image on bulimic-type eating behaviors among individuals scheduled for the surgical treatment of obesity. This study was conducted in a clinical setting on a group of 100 obese patients who were treated at the Centre for the Surgical Treatment of Obesity at the University Hospital in Krakow (Poland) and were qualified for bariatric surgery. Body image was examined with Cash's Multidimensional Body-Self Relations Questionnaire (MBSRQ) and bulimic behavior with David M. Garner's Eating Attitudes Test (EAT-26). Part A of the EAT-26 focused only on the bulimia and food preoccupation scale. Part B included sex, age, and body mass index (BMI) in the predictive model. A stepwise multiple regression analysis was conducted to assess psychological predictors of eating behavior. For binary variables, a logistic regression analysis was conducted for the whole group and for the women's group alone. Owing to the small sample size of men, regression analyses were not conducted. Higher values were observed in the Appearance Orientation dimension among women when compared to men. Appearance evaluation and age were found to be significant predictors for bulimic behaviors in the whole group. In regression models for behavior in the last 6 months, the predictors were found to be Health Evaluation and Appearance Orientation for laxative use, and Overweight Preoccupation for vomiting for weight control. Health-promoting behaviors in obesity treatment were conditioned as follows: for exercise, the predictors were sex and Fitness Orientation and for weight loss, they were Overweight Preoccupation and Body Areas Satisfaction. Our study shows that different bulimic behaviors are variously conditioned by body image dimensions, some of which are predictors of behaviors that are risk factors for obesity and poor outcomes of bariatric treatment, whereas others increase the chance of pro-health behaviors among obese individuals.

Keywords: body image, obesity, bariatric treatment, bulimic eating behavior, MBSRQ Cash, EAT-26 Garner

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INTRODUCTION

Obesity is a major health problem worldwide, as reflected by its steadily increasing prevalence in the adult population (1–3). A WHO report shows that 39% of the global adult population was overweight in 2016, and that 13% suffered from morbid obesity (1). A body mass index (BMI) above 30 kg/m^2 indicates clinical obesity and its diagnosis is associated with a higher risk of numerous somatic health consequences like cardiovascular disease, hypertension, type 2 diabetes (4), and respiratory diseases (5) including asthma (6). Obesity is a risk factor for cancer (7) and also leads to disturbances in psychosocial functioning. Multiple experiences of discrimination as a result of increased body weight imply lower quality of life scores (8), reduced body satisfaction, lower self-esteem, a tendency to experience negative emotional states, and poor cognitive functioning (9).

With the increasing prevalence of obesity, more radical forms of combating the problem are gaining recognition, such as bariatric surgery, which is currently the most effective and durable treatment for morbid obesity (10). This type of surgery provides significant weight loss and helps treat over 40 obesity-related conditions (11, 12). However, a comparative analysis of the durability of bariatric treatment outcomes shows a marked variability in distant outcomes regardless of the type of surgical procedure (10, 13). It is important to identify variables with predictive value for the outcome of the surgical treatment of obesity (14).

A literature review indicates that a multiplicity of psychological factors are significant in the development of obesity, in the course of its treatment and the post-operative outcomes (15, 16).One of the most significant psychological factors among people with obesity is the presence of pathological eating patterns (eating disorders or ED), which is defined as persistent, abnormal eating behaviors over time that result in altered food intake or consumption leading to impaired physical health and/or psychosocial functioning (17). The American Psychiatric Association's classification of mental disorders (Diagnostic and Statistical Manual of Mental Disorders—DSM-5) includes a group of non-specific eating disorders in addition to anorexia nervosa (AN) and bulimia nervosa (BN). It includes, among other things, binge eating disorder (BED), which is characterized by recurrent episodes of overeating accompanied by anxiety and a feeling of lack of control over eating despite the absence of physiological hunger. Eating large amounts of food at a time, eating faster than usual, eating alone out of embarrassment, and feelings of shame and guilt or lowered mood after a binge are the characteristic features of BED. Episodes of overeating must occur at least once a week for at least 3 months (17). In contrast to bulimia nervosa, binge eating is not followed by compensatory behaviors like provoking vomiting and/or using laxatives. Co-occurrence of eating disorders, especially BED, is reported in the obese population. Over half of the people with clinically diagnosed BED have a BMI that corresponds to being overweight or obese (18). BED is highly prevalent among patients who participate in conservative obesity treatment (19) and who are qualified for bariatric treatment; it affects up to 27% of them (20). In a longitudinal study involving a 7-year follow-up of patients treated surgically for obesity, Lavender et al. (13) demonstrated that the greater the severity of an eating disorder (eating pathology), the poorer the effect of bariatric treatment. Eating behaviors with bulimic features affected ∼40% of patients before bariatric surgery, and 24% of them reported overeating at least once a week (21). After the treatment, a lower severity of this type of eating behavior was observed (22–25).

Bulimic eating behavior is closely related to the experience and image of one's own body (26, 27). According to Thomas F. Cash's theoretical model of multidimensional measurement of body image, this attitude includes both the perceptual and the behavioral dimension of one's own corporeality. Body perception includes satisfaction or dissatisfaction with one's appearance, one's own health and physical condition. The behavioral dimension includes actions aimed at improving the appearance and attractiveness of one's body and its physical condition (28). It is important to identify how a person perceives their body image as it can be a predictor of compulsive and bulimic disorders (29), which, in turn, may be relevant to the treatment of obesity (22, 30–32).

Dissatisfaction with one's body and disturbances in body image perception can take many forms and occur regardless of sex, age, or ethnicity. They affect both normal weight individuals and those belonging to extreme categories in terms of BMI (underweight and morbid obesity) (33). No research model has created or used a uniform definition of body image among obese people. However, a review of the literature by Ivezaj et al. (16) shows that body image dissatisfaction among people with obesity is common and associated with various aspects of biopsychosocial functioning, including eating behavior. Individuals with a higher BMI estimate body shape more adequately than do thin and overweight individuals with bulimic behavior or symptoms of binge eating, but individuals after bariatric surgery with comorbid eating disorders overestimate the size of their bodies (16). Geller et al. (22) noted the mediating role of emotional eating between body image dissatisfaction and levels of stress experienced among individuals undergoing treatment for obesity. A clear association of body image dissatisfaction with levels of anxiety, depression, and the occurrence of suicidal thoughts was indicated (31, 32).

Eating behavior and body image appear to play a key role in the long-term effectiveness of bariatric surgery for the treatment of morbid obesity. Research on the role of psychological factors in the effectiveness of these surgeries must seek to understand both the psychological mechanisms that are important for one leading a pro-healthy lifestyle, and the subjectively assessed quality of life after surgery. For example, impaired perception of body size (34) and the association of body image dissatisfaction with levels of stress experienced because of stigmatization (35) has been reported among obese individuals seeking bariatric treatment. De Panfilis et al. indicated that improvement in body image after bariatric surgery is not related to objective treatment outcomes, which is understood as the number of kilograms reduced (30). Bariatric treatment may be associated with the lack of acceptance of excess skin and general dissatisfaction with the appearance of one's

skin, which will generate persistent pre-surgical dissatisfaction with the body or particular parts of it. De Panfilis et al. indicated the importance of the modulatory role of eating disorders, including bulimic behavior, in predicting treatment outcomes (30).

In light of the problems described, we conducted this study to determine the predictive role of multidimensional body image on bulimic eating behavior in individuals scheduled for the surgical treatment of obesity. This is an important topic to address because of the role of bulimic behavior both in the development of obesity and its treatment (21, 23–25), and their determinants. The study also points out the need for the analysis of a multidimensional body image. Bertoletti et al. (36) postulated that future studies should analyse body image in the context of its functionality and impact on changes in the quality of life after bariatric surgery. Grilo et al. (37) conducted a review on body image in bariatric patients and highlighted the paucity of research on the multidimensional examination of body image and its importance in the treatment of people with obesity. We referred to the theory and psychometric measurement of multidimensional body image using the MBRSQ tool (28, 38). This tool measures both the level of satisfaction with one's body and aspects related to fitness and health. The issue analyzed has an implementation value, too. Bertoletti et al. (36) justified that treatment outcomes should be defined with the patient before surgical treatment, including the identification of body satisfaction indicators as an element related to the quality of life after surgery.

Owing to the exploratory nature of this study, research questions were formulated instead of hypotheses:

1. Are there differences between men and women in terms of multidimensional body image and bulimic behavior?
2. Are body image dimensions predictors of bulimic eating behavior among patients scheduled for bariatric surgery?

The research model assumed that the explanatory variables were body image dimensions, BMI value, sex, and age, whereas the response variables were indicators of bulimic eating behavior. The selection of the operationalizing variables presented above is consistent with the clinical and psychosocial characteristics of the study group. The results obtained attempt to answer the research questions posed. We predict that the analysis of the relationship between the multidimensional body image and bulimic behavior will have practical implications for the targeted planning of psychological interventions in this group of patients.

MATERIALS AND METHODS

Ethics Statement

All procedures followed were in line with the ethical standards of the responsible committee on human experimentation and the Helsinki Declaration of 1975, as revised in 2000. The Bioethics Committee of the Jagiellonian University has approved the study (Document No.: 1072.6120.16.2021, dated February 17, 2021). Informed consent was obtained from all participants included in the study.

Participants

This study was conducted between January and July 2021 at the Centre for the Surgical Treatment of Obesity at the University Hospital in Krakow. The inclusion criteria for the study group were follows: eligible for surgical treatment of obesity, primary surgery for the treatment of obesity, and the absence of a chronic, untreatable mental health disorder, which would make it difficult to maintain cooperation with the treatment team. The criteria for bariatric surgery for the treatment of morbid obesity followed the Polish Surgeons Society's Guidelines of The Section of Metabolic and Bariatric Surgery, which includes a BMI of 40 or 35 kg/m^2 with obesity comorbidities (39).

The study group included 100 patients (73 women and 27 men) aged between 21 and 64 years (mean age 39.25 years, $SD = 9.92$). Mean BMI = 44.42 ($SD = 6.52$, min. 33, max. 63). As many as 78, 20, and 2% of the subjects had class 3, 2, and 1 obesity, respectively. The patients were examined by a clinical psychologist after a surgical consultation, which indicated the need for bariatric surgery. The study was carried out in natural clinical conditions in a clinical application as part of the qualification procedure for the surgical treatment of obesity. Following the tests, the patients waited for the date of the procedure, which was not specified during the qualification period. Patients were informed about the objectives of the study in keeping with the guidelines of the Bioethics Committee of the Jagiellonian University.

Methods

Two tools were used in the study:

1. The Polish version of the Eating Attitudes Test (EAT-26) by Garner et al. (40) was used to study eating behavior (41). EAT-26 comprises of two parts, named A and B. The respondent assesses statements on a scale of 1–6, except for the last two questions, which are answered with "yes" or "no." Part A has 26 items and deals with eating behaviors and feelings in the following categories: dieting, bulimia, food preoccupation, and oral control. A score of over 20 on the total scale in this section justifies a clinical interview for an eating disorder. Section B refers to the frequency of behaviors that may be symptoms of an eating disorder in the preceding 6 months, such as overeating with the feeling of not being able to stop eating (EAT-B1), vomiting to affect one's weight or shape (EAT-B2), using laxatives, diet pills, or diuretics to control one's weight or shape (EAT-B3), exercising for more than an hour a day to lose or control weight (EAT-B4), losing 10 kg or more (EAT-B5), and information on treatment for an eating disorder ever (EAT-B6). In the Polish version, the application of the EAT-26 on a non-clinical sample indicated an overall Cronbach's alpha of 0.80 (41). The Bulimia and Preoccupation with Food Scale was used in this study. The sum of Part A and the Dieting scales and Oral control scales were not interpreted because they refer to behaviors that may be indicators of psychological eating disorders of the restrictive type, but in the group of people with obesity these behaviors manifest as positive changes in eating patterns. In using the EAT-26 questionnaire, summary scores from part A and two subscales

were not included because of the content of the Dieting and Oral Control scales, which represent strategies undertaken to initiate and perpetuate health-promoting changes in eating behavior in this group of patients. One example is the expectation of a weight reduction of 5–10% of initial body weight in preparation for the surgical treatment of obesity. Statements that indicate problems with anorexia or bulimia are favorable in this case, such as: "*I avoid food with sugar*," "*I eat diet food*," *and* "*I take steps to reduce my body weight*" in Part A of the questionnaire and an affirmative response to the questions: "*In the past 6 months, did you happen to exercise for more than 60 min a day to lose or control weight?*" *and* "*In the past 6 months, did you happen to lose 10 kg or more?*" in Part B of the questionnaire illustrate the strategies used by patients to reduce weight.

2. Rogoza et al.'s Polish adaptation (41) of the Multidimensional Body-Self Relations Questionnaire (MBSRQ) created by Cash (38) examined the assessment of the respondent's attitude toward their own bodies. In the Polish normative group, the exploratory factor analysis showed that factor structure of the MSBRQ was similar to that of the original version. Its internal reliability was assessed using the McDonald x factor and ranged from 0.66 to 0.91. The respondent referred to each of the 69 items on a scale that ranged from 1 to 5. The higher the score, the greater the satisfaction with the body areas and its functions. The test included the following scales: Appearance evaluation (AE), Appearance orientation (AO), Fitness evaluation (FE), Fitness orientation (FO), Health evaluation (HE), Health orientation (HO), Illness orientation (IO), Body areas satisfaction (BAS), Overweight preoccupation (OP), and Self-classified weight (SCW).

Medical history data included: sex (female-male), age, BMI, and comorbid psychiatric disorders.

Statistical Methods

The results were analyzed using the SPSS 27 package (42). The first step was to present the mean values of the variables in the research model. The differences between the mean intensity of the variables in the male and female groups were measured. The Mann-Whitney *U* and *chi*^{2} tests were applied at this stage. The strength of the association between the psychological response and explanatory variables was measured using correlation analysis. The stepwise multiple regression analysis was used to estimate the strength and direction of psychological predictors of eating behavior. Logistic regression analysis was used for binary variables for the whole group and the women's group alone. Owing to the small number of men, regression analyses were not performed in this subgroup.

RESULTS

Table 1 presents the descriptive characteristics of the body image and eating behavior variables.

Of those surveyed, 33% had lost more than 10 kg in the preceding 6 months and 26% had received treatment for an eating disorder in the past. To answer the first question on the differences between men and women in terms of multidimensional body image and bulimic eating behavior, the non-parametric Mann-Whitney *U*-test was used (**Table 2**). The choice of test was also made because of the large difference in the number of women ($n = 73$) and men ($n = 27$). In the analyses, higher values were observed only in the AO dimension among women when compared to men (AO—F: mean 3.47, $SD = 0.67$ vs. M: mean 3.11, $SD = 0.64$, $p = 0.017$).

TABLE 1 | Characteristics of psychological variables in the whole sample group (for continuous variables).

Psychological variables	M	*SD*	Min–Max
MBSQR			
AE—Appearance evaluation	1.90	0.72	1.00–4.00
FE—Fitness evaluation	2.19	0.79	1.00–40.0
HE—Health evaluation	2.91	0.67	1.26–4.50
AO—Appearance orientation	3.38	0.68	1.83–4.75
FO—Fitness orientation	2.77	0.52	1.33–4.08
HO—Health orientation	3.24	0.50	1.91–4.50
IO—Illness orientation	3.13	0.79	1.20–5.00
OWP—Overweight preoccupation	3.54	0.75	1.75–5.00
SCW—Self classified weight	4.74	0.63	1.00–5.00
BAS—Body areas satisfaction	2.24	0.55	1.00–3.77
EAT-26 (bulimia and food preoccupation)			
B—Bulimia and food preoccupation	2.10	2.77	0.00–12.0
EAT-B1 (overeating)	1.95	1.27	1.00–6.00
EAT-B2 (use of laxatives)	1.05	0.26	1.00–3.00
EAT-B3 (vomiting)	1.61	1.31	1.00–6.00
EAT-B4 (exercising more than 60 min a day)	1.79	1.23	1.00–6.00

The comparison of the values of binary variables relating to "yes" or "no" answers to the following questions, namely "B5: Have you lost 10 kg or more of weight in the past 6 months?" and "B6: Have you ever been treated for an eating disorder?" was conducted using the Chi^2 test (**Table 3**).

There were no statistically significant differences in the frequency of answering "yes" or "no" between men and women for B5 and B6. In the next step, a correlation analysis was conducted between the variables of body image and bulimic eating behavior (**Table 4**).

The dimensions of body image and dietary attitudes are correlated. The severity of the Bulimia dimension was associated with two body image scales: negatively with AE ($r = -0.34$) and positively with OP ($r = 0.20$). In terms of the dimensions in the second part of the questionnaire, B1 (overeating) was negatively correlated with variable AE ($r = -0.21$), Variable B2 (laxative use) was positively correlated with variable HE ($r = 0.25$). Variable B3 (vomiting) was negatively correlated with FE ($r = -0.21$) and positively with OP ($r = 0.25$). Variable B4 (exercising for more than 60 min per day) was positively associated with FO ($r = 0.22$). BMI severity was correlated poorly with HE ($r = -0.20$) and AO ($r = -0.22$).

The stepwise multiple and logistic regression analyses were used to answer the second question on the predictive role of body image dimensions for bulimic eating behavior in the study group.

TABLE 2 | Differences between men and women in the severity of psychological variables.

Psychological variables	Mean		*SD*		$t_{(98)}$	*p*
	F	M	F	M		
MBSQR						
AE—Appearance evaluation	1.94	1.81	0.72	0.73	0.84	0.404
FE—Fitness evaluation	2.20	2.16	0.77	0.85	0.27	0.791
HE—Health evaluation	2.95	2.78	0.64	0.75	1.16	0.248
AO—Appearance orientation	3.47	3.11	0.67	0.64	2.43	0.017
FO—Fitness orientation	2.80	2.68	0.49	0.59	1.09	0.277
HO—Health orientation	3.29	3.10	0.51	0.46	1.74	0.086
IO—Illness orientation	3.09	3.24	0.84	0.65	−0.87	0.387
OWP—Overweight preoccupation	3.62	3.32	0.75	0.73	1.78	0.078
SCW—Self classified weight	4.81	4.56	0.41	0.98	1.81	0.073
BAS—Body areas satisfaction	2.21	2.32	0.55	0.56	−0.93	0.357
EAT-26						
B—Bulimia and food preoccupation	2.04	2.26	2.70	3.01	−0.35	0.729
EAT-B1 (overeating)	1.90	2.07	1.26	1.33	−0.59	0.556
EAT-B2 (use of laxatives)	1.04	1.07	0.20	0.38	−0.56	0.578
EAT-B3 (vomiting)	1.63	1.56	1.35	1.22	0.25	0.802
EAT-B4 (exercising more than 60 min a day)	1.64	2.19	1.05	1.59	−1.98	0.051

TABLE 3 | Differences between men and women in terms of the frequency of responses given among the binary variables: EAT-B5 and EAT-B6.

Variables	Response	F		M	
		n	%	*n*	%
EAT-B5	Yes	27	36.99	6	22.22
$chi^2_{(1)} = 1.94$; $p = 0.163$	No	46	63.01	21	77.78
EAT-B6	Yes	18	24.66	8	29.63
$chi^2_{(1)} = 0.25$; $p = 0.615$	No	55	75.34	19	70.37

In addition to psychological predictors, BMI and the binary variables, namely and sex and age were included in the analyses. **Table 5** presents the stepwise multiple regression analyses across the group.

For the Bulimia and food preoccupation variable, the model indicated a negative effect of two predictors, namely AE and Age ($R = 0.42$; $p < 0.001$), explaining 8.03 and 6.04% of the variance. While assessing the severity of behavioral variables in the preceding 6 months, no predictive model was matched for variable B1 (overeating). In regression models for dependent variables B2 (laxative use), B3 (vomiting) and B4 (exercising more than 60 min a day), the variables correlated positively. For variable B2, HE and AO proved to be predictors ($R = 0.33$, $p = 0.004$), explaining 8.1 and 4.78% of the variance. OWP was a predictor for B3 ($R = 0.25$; $p = 0.012$), explaining 6.25% of the variance. The model match ($R = 0.31$; $p = 0.007$) indicated that B4 could be explained by FO and sex, explaining 5.86 and 4.90% of the variance, respectively.

Table 6 shows the multiple stepwise logistic regression for the EAT-B5 and EAT-B6 binary variables. The analysis indicated that Nagelkerke's R^2-value was 0.16 in the regression models for EAT-B5 and EAT-B6. The statistically significant predictors in multiple stepwise logistic regression for EAT-B5 (losing more than 10 kg in the past 6 months) were OWP and BAS. Both were positive, that is, as they increased, the probability of EAT-B5 increased (the odds ratios were 2.08 and 3.63, respectively). For EAT-B6 (treatment for eating disorders in the past), the predictor turned out to be HO (odds ratio 4.43), meaning that as it increased, the probability of EAT-B6 increased.

Table 7 presents the results of the stepwise multiple regression analysis for the female group. For the variable Bulimia and Food Preoccupation, the model ($R = 0.30$; $p < 0.001$) indicated an inhibitory role of AE, explaining 9.15% of the variance. As in the whole group, no regression analysis model was matched for B1, whereas positive correlations with explanatory variables were obtained for B2, B3, and B4. For B2 in the matched model ($R = 0.34$; $p = 0.013$), HO and BMI were predictive, explaining 6.91 and 5.11% of the variance, respectively.

The stepwise regression analysis on B3 ($R = 0.25$, $p = 0.032$) demonstrated the influence of the explanatory variable OWP with a coefficient of 6.33% of the variance. The last of the B4 variables—model match ($R = 0.23$; $p = 0.046$) indicated the influence of FO, explaining 5.48% of the variance.

Table 8 shows the multiple stepwise logistic regression for EAT-B5 and EAT-B6 in the female group. In the regression model for EAT-B5, Nagelkerke's R^2-value was 0.13. BAS was found to be a statistically significant predictor in multiple stepwise logistic regression for EAT-B5 (losing more than 10 kg in the preceding 6 months). This means that as they increased, the probability of EAT-B5 increased (odds ratio: 9.70). In the regression model for EAT-B6 variable (past treatment for eating disorders), Nagelkerke's R^2-value was 0.22. For this variable, the predictor turned out to be HO (odds ratio: 37.47), which means that as it increased, the probability of EAT-B6 increased.

TABLE 4 | Analysis of the correlation of predictors and dependent variables.

Psychological variables	Bulimia and food preoccupation	EAT-B1 (overeating)	EAT-B2 (laxatives)	EAT-B3 (vomiting)	EAT-B4 (exercising more than 60 min)
AE—Appearance evaluation	−0.34**	−0.21*	−0.01	−0.18	−0.06
FE—Fitness evaluation	−0.14	−0.01	0.02	−0.21*	0.05
HE—Health evaluation	−0.14	−0.09	0.25*	−0.09	−0.02
AO—Appearance orientation	−0.04	−0.02	0.17	0.10	−0.06
FO—Fitness orientation	−0.15	−0.15	−0.07	−0.03	0.22*
HO—Health orientation	0.01	−0.13	0.08	0.06	0.13
IO—Illness orientation	0.13	−0.05	0.18	0.05	0.02
OP—Overweight preoccupation	0.20*	−0.01	0.03	0.25*	0.09
SCW—Self classified weight	0.13	0.09	−0.04	0.01	0.01
BAS—Body areas satisfaction	−0.19	−0.16	0.17	−0.07	0.05

*$p < 0.05$; **$p < 0.01$.

TABLE 5 | Body image dimensions as predictors of eating behavior in the whole group.

Dependent variable	Predictors	*B*	*Beta*	r_{semi}	% of variance	*t*	*p*
Bulimia and food preoccupation	Constant	6.98				6.08	<0.001
$R = 0.42$; $R^2 = 0.18$	AE	−1.12	−0.29	−0.28	8.03	−3.08	0.003
$F = 10.38$; $p < 0.001$	AGE	−0.07	−0.25	−0.25	6.04	−2.67	0.009
EAT-B1 (overeating) $F = 1.14$; $p < 0.335$	–	–	–	–	–	–	–
EAT-B2 (use of laxatives)	Constant	0.43				2.35	0.021
$R = 0.33$; $R^2 = 0.11$	HE	0.11	0.29	0.28	8.10	2.97	0.004
$F = 5.92$; $p < 0.004$	AO	0.09	0.22	0.22	4.78	2.28	0.025
EAT-B3 (vomiting)	Constant	0.07				0.11	0.910
$R = 0.25$; $R^2 = 0.06$	OP	0.43	0.25	0.25	6.25	2.56	0.012
$F = 6.53$; $p < 0.012$							
EAT-B4 (exercising more than 60 min a day)	Constant	−0.59				−0.77	0.442
$R = 0.31$; $R^2 = 0.10$	FO	0.58	0.24	0.24	5.86	2.51	0.014
$F = 5.21$; $p < 0.007$	Sex	0.62	0.22	0.22	4.90	2.29	0.024

R, multiple correlation coefficient; R^2, multiple determination coefficient; F, F statistics for the analysis of variance for the whole model; p (at F), p probability for the model as a whole; B, partial regression coefficient; Beta, standardized partial regression coefficient; r_{semi}, semi-particle correlation coefficient; % variance, the percentage of the variance of the dependent variable explained by the predictor (calculated as the square of the semi-partial correlation multiplied by 100%); t, value of the Student's t-statistics for the given predictor; p, p probability for a given predictor.

DISCUSSION

Body image and bulimic eating behavior are associated with many aspects that are important in the process of qualification for bariatric surgery and in the evaluation of the effectiveness of this form of treatment for people with obesity (32, 37). Studies confirm body dissatisfaction among obese individuals both before and after bariatric surgery, and in a longitudinal study model, it was found that levels of body image dissatisfaction decreased after surgery (25, 31, 43). Body dissatisfaction depends on BMI (43), but weight loss after surgery is not sufficient to reduce psychological stress, which is associated with body image satisfaction and increased emotional eating (31). Meneguzzo et al. showed that patients who underwent bariatric surgery encountered more difficulties after undergoing surgery in assessing their body size with respect to BMI than overweight and obese people who did not undergo surgery (44). Given the validity of the body image construct and bulimic behavior, we thought it would be interesting to establish the predictive role of multidimensional body image in bulimic-type eating behavior among individuals scheduled for the surgical treatment of obesity. The authors are aware of the importance of longitudinal studies. This research is a part of an on-going longitudinal study model designed to monitor patients after bariatric surgery.

While attempting to answer the first research question regarding differences in body image between men and women with obesity, differences were noted only in the AO dimension, which refers to caring about one's appearance and taking actions aimed at improving one's attractiveness. The difference was found to be significantly more intense in the female group. The result obtained is consistent with empirical data that confirm that women, not only among those with obesity but also in general

TABLE 6 | Body image dimensions as predictors of eating behavior for EAT-B5 and EAT-B6 binary variables in the whole group.

Predictors	*B*	SE	Wald	*P*	OR	95% CI for OR	
EAT-B5							
OWP—Overweight preoccupation	0.73	0.33	4.89	0.027	2.08	1.09	3.98
BAS—Body areas satisfaction	1.29	0.45	8.34	0.004	3.63	1.51	8.72
Constant	−6.28	1.85	11.56	0.001	0.00		
EAT-B6							
HO—Health orientation	1.49	0.54	7.59	0.006	4.43	1.54	12.78
Constant	−2.90	2.23	1.69	0.194	0.05		

TABLE 7 | Body image dimensions as predictors of eating behavior in a group of women.

Dependent variable	Predictors	*B*	*Beta*	r_{semi}	% of variance	*t*	*P*
Bulimia and food preoccupation	Constant	4.25				4.83	<0.001
$R = 30$; $R^2 = 09$ $F = 7.15$; $p < 009$	AE	−1.14	−0.30	−0.30	9.15	−2.67	0.009
EAT-B1 (overeating)	–	–	–	–	–	–	–
$F = 64$; $p < 797$							
EAT-B2 (use of laxatives)	Constant	0.37				1.69	0.096
$R = 34$; $R^2 = 12$	HO	0.10	0.26	0.26	6.91	2.34	0.022
$F = 4.65$; $p < 013$	BMI	0.01	0.23	0.23	5.11	2.01	0.048
EAT-B3 (vomiting)	Constant	−0.01				−0.01	0.991
$R = 25$; $R^2 = 06$	OP	0.45	0.25	0.25	6.33	2.19	0.032
$F = 4.80$; $p < 032$							
EAT-B4 (exercising more than 60 min a day)	Constant	0.25				0.37	0.715
$R = 23$; $R^2 = 05$	FO	0.50	0.23	0.23	5.48	2.03	0.046
$F = 4.12$; $p < 046$							

R, multiple correlation coefficient; R^2, multiple determination coefficient; F, F statistics for the analysis of variance for the whole model; p (at F), p probability for the model as a whole; B, partial regression coefficient; Beta, standardized partial regression coefficient; r_{semi}, semi-particle correlation coefficient; % variance, the percentage of the variance of the dependent variable explained by the predictor (calculated as the square of the semi-partial correlation multiplied by 100%); t, value of the Student's t for the given predictor; p, p probability for a given predictor.

populations, attach greater importance to the appearance and shape of their own bodies regardless of age and across cultural groups than do men (45–48). In the remaining body image dimensions and in the AE scale associated with the construct of the general body dissatisfaction index, there were no significant differences between the female and male subjects. Women and men did not differ in terms of the severity of their bulimic behavior. In contrast, differences emerged in the predictive role of sex for exercise performed with a frequency of more than 1 h per day in the preceding 6 months (B4 EAT-26) indicating that men are more physically active before bariatric surgery. Duncan et al. (49) found that distorted body image, greater preoccupation with weight and body shape, and eating patterns that are more prevalent among women than men may negatively affect the uptake of healthy lifestyle activities such as physical exercise. Heinberg et al. (50) indicated that people with moderate levels of body image dissatisfaction were more likely to engage in changing their eating patterns and introducing physical activity, with better results in weight reduction and improved well-being.

Preparing for bariatric surgery includes making lifestyle changes not only in relation to nutrition but also in implementing other health-promoting behaviors. Originally, in the EAT-26 test, high intensity values of this variable were identified with restrictive behavior; however, in the case of the group studied, this is an incorrect interpretation as physical activity was indicated and considered important in the process of treating obesity (51). Patients who increased their physical activity in preparation for surgery rated the improvement in the quality of life after surgery higher when compared to those who did not change their level of physical activity in the preoperative period (52).

The second research question was concerned with the determinants of bulimic behavior, understood as body image dimensions, BMI, age, and sex in the study group of patients qualified for bariatric surgery.

A strength analysis of the associations between indicators of multidimensional body image and bulimic eating behavior confirmed the relationships between these variables. Greater bulimic behavior was associated with greater dissatisfaction with one's appearance (AE) and higher levels of fear of weight gain. Stepwise multiple regression analysis indicated that AE and age were significant predictors for bulimic behavior across the group, but that age was not significant in the female group. This

TABLE 8 | Body image dimensions as predictors of eating behavior for EAT-B5 and EAT-B6 for women.

Predictors	*B*	SE	Wald	*p*	OR	95% CI for OR	
EAT-B5							
BAS—Body areas satisfaction	1.28	0.51	6.42	0.011	3.60	1.34	9.70
Constant	−3.40	1.17	8.45	0.004	0.03		
EAT-B6							
HO—Health orientation	2.19	0.73	8.93	0.003	8.92	2.12	37.47
Constant	−8.60	2.59	11.00	0.001	0.00		

implies that body satisfaction and self-perceived attractiveness is a preventive factor in the occurrence of disordered eating behaviors, and that compulsive behaviors were more prevalent among people who were dissatisfied with their bodies. These results are consistent with empirical data presented in other studies in non-clinical (53) and clinical groups (37). Grilo et al. (37) indicated that body dissatisfaction, overvaluation of weight, preoccupation with weight, and fear of weight gain in a group of obese or overweight individuals with bulimic features or features of BED had significant effects on both the form of eating behavior and the frequency of its occurrence.

Preoccupation with weight and fear of weight gain (OP) significantly influenced eating behavior and was associated with vomiting for weight regulation (B3-EAT-26), both in the entire group and women's group alone. Similar weight control behaviors associated with laxative use (B2-EAT-26) were found to be conditioned in a sample of bariatric patients (female and male) by body image dimensions related to HE and AO. Those who rated their health better and placed greater importance on their physical appearance were more likely to engage in laxative behavior. Laxation was differently conditioned only in the group of women in whom a higher BMI and a higher level of HO, requiring adherence to a healthy lifestyle, induced laxative behavior. BMI severity was very weakly negatively associated with HE and AO, indicating that the more obese one is, the worse one feels and the less interest one has in their physical attractiveness. This result was consistent with studies that indicated that, compared to individuals with normal BMI, those with high BMI engaged in less health beneficial lifestyle behaviors (54). The severity of body dissatisfaction increased along with increasing BMI (43). Grilo et al. (37) studied groups of patients who were qualified for bariatric surgery (in a clinical sample that was similar to ours: predominance of women in the whole group, age, and BMI), and confirmed that as BMI decreases, satisfaction with body image increases. Geller et al. (31) showed that weight loss, however, is not sufficient after surgery to reduce psychological stress, which is related to body image satisfaction.

HO was a predictor of motivation to seek treatment for eating disorders. A quarter of the respondents indicated that they had been treated for this in the past. The analysis of the responses to this question did not differentiate between men and women. However, this result must be interpreted with caution, as there were respondents in this group who understood this question as referring to conservative treatment undertaken for obesity, rather than treatment undertaken for diagnosed, psychological eating disorders. This issue requires further research.

Weight preoccupation and fear of weight gain (OP) were significant predictors of behaviors related to weight loss by over 10 kg in the preceding 6 months (B5-EAT-26), but only in the general group. The effect of weight loss was determined by BAS in both the general group and the women's group alone. In our group, a third of the patients had reduced their weight by 10 kg or more in the preceding 6 months. However, patients qualified for bariatric surgery are advised to reduce between 5 and 10% of their initial body weight (55, 56), which, in clinical practice, means that some patients meet this criterion with a weight loss of <10 kg. These data can therefore be interpreted as favorable behavioral indicators of preparedness for surgical interventions and patient cooperation in treatments provided by multidisciplinary teams. Responses to the question on reducing 10 kg or more did not differ by sex. A weight reduction of 10 kg or more in the period before bariatric surgery was confirmed by 36.99% of women and 22.22% of men. Exercising for more than 60 min per day (B4-EAT-26) occurred at a higher frequency among men than among women, but these behaviors were also conditioned by the body image dimension of FO, that is, taking care of physical fitness as an important part of one's lifestyle. Both preoperative weight reduction through lifestyle changes (B5-EAT-26) and physical activity (B4-EAT-26) were desirable health-promoting strategies in the study group. Individuals are more likely to engage in changing their eating patterns and introduce physical activity, with better outcomes in weight reduction and improved well-being with moderate levels of body image dissatisfaction (50). Our study shows that these lifestyle behaviors (weight reduction and physical activity) are influenced by AE, OP, and FO.

The data obtained imply the importance of clinical assessment of body image dimensions in the context of qualification for bariatric surgery. The emergence of a group of patients with greater body dissatisfaction and excessive preoccupation with weight highlights the need for deeper psychological assessment for the presence of disordered eating patterns of the bulimic type. The identification of body image disorders and bulimic eating behaviors enables the application of specialized therapeutic procedures in preparation of a patient for bariatric surgery. The inclusion of the perspective of experiencing the body and its relationship with self-regulatory mechanisms related to eating is a valuable direction in psychological interactions, both before and after bariatric surgery (44, 57, 58). This may lead to better results in the surgical treatment of obesity, understood as the number of kilograms reduced in the long term, a reduction in unhealthy behaviors, and an improvement in the overall quality of life (59).

Limitations of the Study and Prospects

This study used self-report methods that are limited by the risk of biased responses from the subjects. The small sample of men did not allow an assessment of the relationship in this group. The project is ongoing and was designed as a longitudinal study to assess the influence of psychological factors on surgical outcomes. We continue to recruit participants to join the study group from among patients qualified for bariatric surgery and seek to monitor patients after surgery at the Centre for the Surgical Treatment of Obesity at the University Hospital in Krakow.

CONCLUSIONS

To contribute to the development of knowledge on the determinants of bulimic behavior and its relevance to the surgical treatment of obese patients, we focused on the determinants of these behaviors by analyzing multidimensional body image at the time of qualification for bariatric surgery. Despite the small number of men in the group, a clear difference between men and women emerged both in the context of body image and in the predictive role of sex in eating behavior. Our results showed that body image dimensions play a predictive role in various bulimic-type behaviors. On the one hand, AE, HE, OP, and AO are predictors for bulimic behaviors, whereas FO, BAS, and OP determine the treatment-promoting behaviors in a group of obese people. The results support the position that the patients' awareness of their body is important for the doctors to assess their psychological condition in the course of qualifying them for bariatric surgery. This is owing to the fact that some dimensions of body image are predictors of behaviors that serve as a risk factor for obesity and poor outcomes of bariatric treatment, whereas other dimensions increase the chances of pro-health behaviors among obese people.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

B-BK and BI designed the study. AĆ and B-BK drafted application to the bioethical committee from the Jagiellonian University Medical College with the contribution of PM. PM qualified patients for bariatric surgery. AĆ qualified patients for the group and conducted psychological tests, conducted literature searches and provided summaries of previous research studies, and wrote the first draft of the sections Introduction and Discussion. B-BK conducted, analyzed and interpreted the data, and drafted the grant proposals that secured financing for the publication. B-BK, BI, and A-SF revised the manuscript. A-SF prepared the text to be placed in the Frontiers system. All authors contributed to the article and approved the submitted version.

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SYSTEMATIC REVIEW
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Systematic Review of Literature on Eating Disorders During Pregnancy—Risk and Consequences for Mother and Child

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Background: Eating disorders (ED) are a diagnostic category that includes several nosological units such as anorexia nervosa (AN), bulimia nervosa (BN), or binge eating disorder (BED). This category most often concerns women, while the peak incidence falls on the reproductive age. Therefore the issue of ED during pregnancy is an interesting topic. Due to the creation of unrealistic ideal of "desired," slim figure both by the mass media and social media even during and right after gestation, more and more pregnant women introduce behaviours aimed at maintaining the "perfect" appearance. However in some cases it may have serious consequences for the health of both mother and child leading to the creation of the term "pregorexia" by the media to describe this issue.

Aim: The aim of this paper was to conduct a systematic review of the literature dealing with eating disorders in pregnant women, with particular emphasis on pregorexia.

Method: A systematic review of literature published within the last 5 years (2016–2021) in English or Polish and available through MEDLINE / PubMed, Google Scholar and Cochrane Library databases was conducted based on the previously assumed inclusion and exclusion criteria.

Results: Initially, 634 publications were obtained during the review, of which 55 papers were selected in the course of the title analysis. After further evaluation of abstracts, 28 papers were qualified for full text analysis. Ultimately, 10 papers were selected for the final analysis.

Conclusions: The issue of ED in pregnant women is a broad topic covering a heterogeneous group of women—both those with a previous history and those with the onset during pregnancy. The occurrence of ED symptoms during this period is associated with a high likelihood of negative consequences for both the mother and the child. The course of pregnancies and deliveries in these patients is more complicated. Therefore, it seems reasonable to develop a multidisciplinary screening strategy and standards of management and supervision over this group of patients.

Keywords: pregorexia, anorexia, eating disorders, pregnancy, bulimia nervosa

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INTRODUCTION

Eating disorders (ED) are a diagnostic category that includes several nosological entities such as anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED). AN is characterised by an increased fear of weight gain, a disturbed body image, an introduction of dietary restrictions, or other weight loss behaviours. Bulimia nervosa is characterised by episodic occurrences of binge eating and the introduction of compensatory behaviours—most commonly purging to prevent weight gain. In the case of binge eating disorder, fewer compensatory strategies are observed than in the case of bulimia nervosa (1).

Statistically, women suffer from eating disorders much more often—Keski-Rahkonen et al. (2) indicate that the prevalence of anorexia nervosa among women in the European population is <1–4%, bulimia nervosa <1–2%, binge eating disorders 1–4%, while amongst men the prevalence of eating disorders is estimated at 0.3–0.7%. Eating disorders most often appear in young women (3) while they are still in adolescence or early adulthood—which coincides with the beginning of the reproductive period in women. Resultantly, the relationship between eating disorders and reproductive health remains a thought-provoking issue, especially in the context of sexual dysfunctions and menstrual disorders observed in women with ED (4). Amenorrhea is, according to the latest diagnostic criteria, one of the elements of the clinical picture of anorexia. Approximately 68–89% of female patients with AN confirm its occurrence for at least 3 months during the disease period. These types of disturbances in the monthly cycle are the result of limited caloric intake and/or excessive exercise, which lead to endocrine disruptions. Changes in the anatomy and physiology of the female reproductive system in the course of AN have led to the hypothesis in the literature that anorexia at least significantly hinders conception. However, recent studies indicate that the fertility of women diagnosed with AN does not differ from the general population. Furthermore, studies also indicate that women with anorexia nervosa tend to be of a lower average age upon becoming pregnant and are subject to the risk of unplanned pregnancy that is twice as high as that of the general population (5).

The period of pregnancy and puerperium is a period of immense changes taking place in the woman's body—including the greatest changes in body appearance since puberty (6). The time of pregnancy is also a period of greater sensitivity to negative self-perception, which contributes to the deterioration of self-esteem (7). For women with already diagnosed eating disorders, the period of pregnancy is particularly difficult (8), especially in the early stages of pregnancy. During this early period patients' body undergoes changes, yet they are not yet pronounced enough to clearly indicate pregnancy—this proves to be a particularly difficult moment for women with ED (9). Therefore, the impact of pregnancy on both the course of ED and the effect of ED on maternal and foetal well-being ought to be considered an issue of great importance. Sebastiani et al. indicate that the prevalence of eating disorders in pregnant women may reach 5–7.5% (6) and that the occurrence of these disorders has undoubtedly adverse effects on the course of pregnancy, childbirth and the condition of the child after birth, which becomes a significant interdisciplinary problem and is of equal interest to researchers in fields of psychiatry, obstetrics and neonatology.

Bannatyne, in a 2017 publication, indicates that a distinction can be made between eating disorders occurring before pregnancy, exacerbated during pregnancy or occurring only during pregnancy (10). It is estimated that on average 54% of women with a history of eating disorders reported improvement or even remission of ED symptoms during pregnancy (11). However, studies can be found that show the deterioration or appearance of new symptoms during this period, especially in the case of binge eating (12). The post-partum period presents as a particularly high-risk period for exacerbation and/or onset of symptoms and body image deterioration for women with and without a history of ED (13).

This topic is also an area of media interest—in 2008, on Fox news and The Early Show, journalists used the new term pregorexia to emphasise the emergence of a phenomenon involving restrictive behaviours such as limiting calorie intake and intensifying exercise amongst pregnant women in order to maintain a perfect figure during pregnancy and immediately after birth (14).

The aim of the present study was to carry out a systematic review of the literature on body image changes in pregnant women, the prevalence and course of eating disorders during pregnancy, and to attempt to gather current knowledge on the subject. In addition, it was sought to determine whether the media term pregorexia is medically reflected in case reports or diagnostic categories.

METHODS

The literature available electronically for the period 2016-2021 was reviewed in the course of the study. In this paper, the authors presented the current state of knowledge on eating disorders in pregnancy and therefore decided to include papers from the last 5 years in the review. The papers selected for the review were written in Polish and English. Articles were obtained from electronic databases: MEDLINE/PubMed, Google Scholar and Cochrane Library. The selected person-centred studies were chosen by searching the keywords "eating disorders," "anorexia nervosa," "bulimia nervosa," "binge eating disorder," "disordered eating," "body image," "pregnancy," "pregorexia." Each author searched for papers separately and these were then chosen in the three stage classification process. Initially, the authors searched the above- mentioned databases and, after evaluating the titles and preliminary analysis of the abstracts, selected the publications that were most relevant to the subject matter of the review. Selection was conducted according to the established inclusion criteria:

- Published between January 2016 and January 2021.
- Published in English or Polish,
- Published as part of journals (book excerpts, for example, and were excluded),

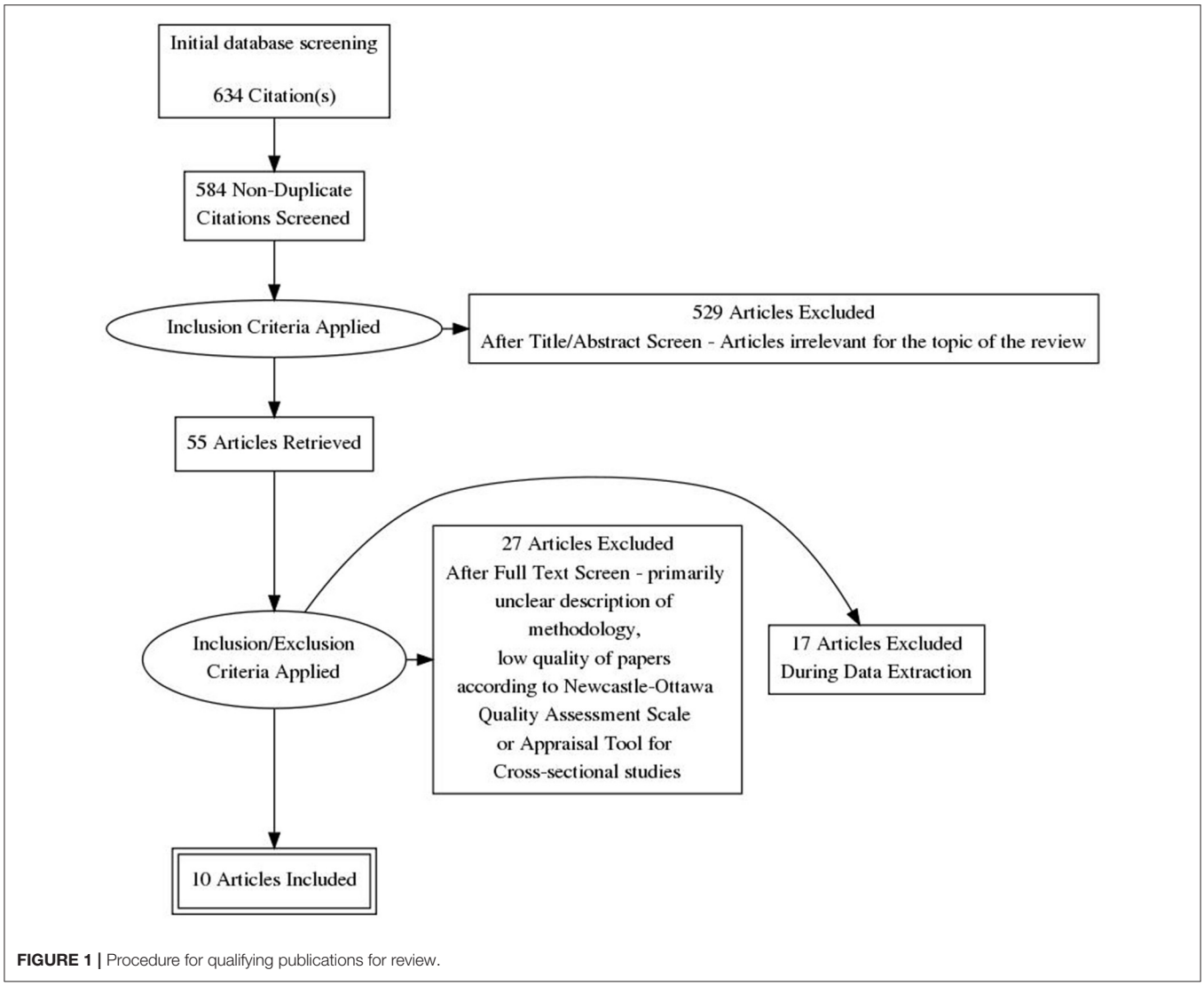

FIGURE 1 | Procedure for qualifying publications for review.

- Clear and comprehensive presentation of; the methodology (e.g., inclusion and exclusion criteria), demographic data of the participants and the process of diagnosis of the patients analysed.
- Good methodology was used including:
  - reliable research tools, validated for the target population,
  - clearly defined research hypotheses,
  - satisfactory description of the statistical methods used.

Quality assessment of eligible cohort studies was conducted with utilisation of Newcastle-Ottawa Quality Assessment Scale while evaluation of cross-sectional studies was based on the Appraisal tool for Cross-Sectional Studies. The first phase of the review involved searching for publications, and analysing their relevance to the subject matter of the review, as based on the title of the paper. In the second stage, the abstracts were analysed for compliance with the study inclusion criteria. The publications, which were shortlisted by each author for further analysis were cross-checked against each other and, after exclusion of duplicates, were subjected to a preliminary full-text analysis aimed at assessing compliance with the assumed inclusion criteria. An analysis of the bibliography of the included works was carried out as well. Initially, 634 publications were obtained, out of which 55 papers were qualified in the course of title analysis. After further evaluation of abstracts, 28 papers were selected for full text analysis. The 10 papers found to be most consistent with the subject matter of the review were finally screened based on established inclusion and exclusion criteria. **Figure 1** shows the procedure for qualifying publications for review.

RESULTS

Results are presented in the **Table 1**.

DISCUSSION

The authors of the reviewed papers indicate a great variety in the clinical picture of eating disorders and in the level

TABLE 1 | Analysis of publications used in the review.

	Title of the publication	References	Year of publication	Study group	Type of publication	Conclusions
1	Maternal eating disorders and perinatal outcomes: a three-generation study in the Norwegian mother and child cohort study	Watson et al. (15)	2017	70,881 grandmother-mother-child triads (dataset 1- eating disorders during pregnancy) 52,348 grandmother- mother-child triads (dataset 2- eating disorder status during the lifetime)	Cohort study	Children of mothers with eating disorders during pregnancy presented numerous abnormalities after birth, and the course of these pregnancies was also abnormal.
2	Waking up every day in a body that is not yours: a qualitative research inquiry into the intersection between eating disorders and pregnancy	Claydon et al. (16)	2018	15 pregnant women	Qualitative Descriptive study - analysis of the interview and blogs/journals	The information obtained from the study is a source of help in prenatal and postnatal care for women with eating disorders.
3	Adolescent pregnancy and eating disorders: a minireview and case report	Harrison et al. (17)	2017		Case study of a 16-year-old girl diagnosed with atypical anorexia nervosa	Healthcare professionals should diagnose pregnant teens for symptoms of an eating disorder to ensure they receive timely treatment. In people with remission of ED symptoms, pregnancy is a key period in developing a treatment plan to maintain disease remission after delivery.
4	Association of maternal eating disorders with pregnancy and neonatal outcomes	Hirschberg et al. (18)	2019	7,542 pregnant women with ED, 1,225,321 pregnant women without ED	Cohort study	Women with active or prior eating disorders, regardless of subtype, are at increased risk of complications during pregnancy and in the newborns
5	Eating disorder symptoms pre- and postpartum	Petterson et al. (19)	2016	426 pregnant women, 345 in the postpartum period	Survey questionnaire	Study using the optimised and shortened Eating Disorder examination questionnaire EDE-Q, 5.3% of pregnant women and 12.8% of women in the postpartum period (6–8 months after delivery) suffered from eating disorders
6	Striving for the thin ideal post-pregnancy: a cross sectional study of intuitive eating in postpatum women	Lee et al. (20)	2019	419	Cross-sectional study	Survey questionnaire using: IES, BSQ, EAT 26 MBSRQ EPSD Most women in the postpartum period are at risk of negative unhealthy eating behaviours directed at
7	The relationship between perfectionism and body image with eating disorders in pregnancy	Kiani-Sheikhabadi et al. (21)	2019	200 pregnant women	Survey questionnaire	Survey questionnaire using: Eat 26, Bardone-Cone and rezaei perfectionism questionnaire. The authors point to a clear positive correlation between negative perfectionism (pursuing extremely high unrealistic goals) and the symptoms of ED in pregnancy

(Continued)

TABLE 1 | Continued

	Title of the publication	References	Year of publication	Study group	Type of publication	Conclusions
8	Body dissatisfaction and Fat Talk during pregnancy: predictors of distress	Dryer et al. (22)	2020	408 pregnant women	Survey questionnaire	Questionnaire study using: body part satisfaction scale (BPSS), PERCEIVED SOCIOCULTURAL PRESSURE SCALE (psps), internalisation of the thin ideal, fat talk questionnaire, Edinburgh postnatal depression scale, pregnancy related anxiety scale, eating attitude test eat 26. Body dissatisfaction causes symptoms of depression in pregnant women, ED and pregnancy related anxiety disorder (PABD). 9.3% had sufficiently high scores - the cutoff point for a screening diagnosis of an eating disorder
9	Prevalence and clinical characterisation of pregnant women with eating disorders	Bye et al. (8)	2019	545 pregnant women	Cross-sectional study	Depression, anxiety disorders, self-harm and suicide attempts were more common in pregnant women with eating disorders.
10	Presence of eating disorders and its relationship to anxiety and depression in pregnant women	dos Santos et al. (23)	2017	913 pregnant women (in the 2nd and 3rd trimester of pregnancy)	Cross-sectional and prospective study	Statistical significance was found between eating disorders and the risk of anxiety and depressive symptoms in pregnant women

of severity of symptoms in a group of pregnant women. Claydon et al. (16) emphasise that pregnant women experiencing eating disorders can be divided into 3 groups: (1) those who improve during pregnancy and maintain improvement after childbirth, (2) those who improve only during pregnancy with secondary deterioration and symptoms intensification during the puerperium, and (3) women with active ED symptoms throughout pregnancy. Fogarty et al. (9) make further, more detailed distinction on the basis of the severity of ED symptoms during pregnancy. They distinguish between patients who (1) completely stop restrictive behaviour, (2) in whom a partial reduction in the severity of symptoms can be observed, (3) in whom symptoms remain at the same level as before pregnancy, and (4) a group of patients in whom symptoms worsen or possibly changes in the nature of symptoms develop—(e.g., from binge/purge type to binge-only type). For women who experience symptom reduction and health improvement in pregnancy, the desire to ensure the safety of the baby and a concern for the developing foetus constitute the protective factor (6). Claydon et al. (16) and Clark et al. (24) indicate that even foetal movements and kicks were protective factors against the negative body image. In their publication, Harrison et al. report that while eating disorder symptoms remit/weaken after pregnancy, their exacerbation can be observed after childbirth. Moreover, Lee et al. (20) indicate that changes in body appearance during pregnancy are more socially acceptable. What is more difficult to accept, however, is a woman's appearance after childbirth. During the post-partum period, women face pressure to return to their pre-pregnancy appearance and weight as quickly as possible, putting them at a greater risk of developing post-partum depression and anxiety disorders, especially in women with ED. These women are more likely to have problems adapting to their new role in life—being a mother—and show an increased risk of postnatal depression (19). dos Santos et al. demonstrated a statistically significant association between the presence of ED and the risk of anxiety disorders and depression (23). Bye et al. (8) indicate that psychiatric comorbidity is common in pregnant women with ED—these researchers also show that women with ED were more likely to suffer from depression and anxiety disorders. Moreover these women were more likely to have a history of self-harm and suicide attempts compared to women without a history of eating disorders.

At the same time, in patients with a history of eating disorders, the course of pregnancy, labour and puerperium is more often abnormal. In a 3-generation cohort study, Watson et al. (15) show that for mothers with eating disorders, the course of pregnancies was more often abnormal, and newborns presented numerous abnormalities after birth. Patients with BED faced an increased risk of gestational diabetes, pregnancy-induced hypertension and pre-eclampsia. Pregnant women with eating disorders were more likely to undergo caesarean section, induced labour, while the prolonged labour was more common. Their babies were born with lower.

APGAR scores, were more likely to require resuscitation and the incidence of perinatal death was more frequent. In addition, IUGR and smaller head circumference, microcephaly and low birth weight were more common. In their study,

TABLE 2 | Possible complications in pregnant women with ED and their newborns (5, 6, 15, 17, 18).

	Abnormalities during pregnancy and delivery, gynaecological complications:	**Complications in a child:**
Anorexia nervosa (AN)	Post-partum haemorrhage	Shorter birth length IUGR, SGA, low birth weight
Bulimia nervosa (BN)	Gestational diabetes, preeclampsia, more frequent abortions, PCOS, induced labour	Low APGAR score at 1 min
Binge eating disorder (BED)	Pregnancy-induced hypertension, gestational diabetes, preeclampsia, increased rate of miscarriages, longer duration of 1st and 2nd stages of labour PCOS	Longer birth length, LGA

Watson et al. indicate that infants of mothers with AN had shorter body length at birth, low birth weight, while infants of mothers with BED achieved greater length at birth (LGA). The causes of this phenomenon are not entirely clear, but may include malnutrition or overfeeding, increased stress reactivity, persistent residual ED symptoms, or symptom recurrence (15). In their study, Mantel et al. indicate that all subtypes of eating disorders were associated wub an increased risk of preterm delivery and an ∼2-fold increased risk of unrestrained purging. In contrast, women with present symptoms of anorexia nervosa showed a two-fold increased risk of anaemia during pregnancy and an increased risk of antenatal haemorrhage and instrumental delivery. In addition, newborns of mothers with ED were under an increased risk of microcephaly.

Arnold et al. (5) indicate a six-fold increase in perinatal mortality in newborns of mothers with ED. Bulik et al. (12) even discusses the risk cycle—mothers suffering from anorexia nervosa with low BMI give birth prematurely, which predisposes them to future onset of anorexia nervosa. Newborns exposed to perinatal complications are at a higher risk of developing symptoms of anorexia nervosa during adolescence and early adulthood (15).

The authors of this study did not encounter the term "pregorexia" in the analysed studies. None of the reviewed studies identified the group of women in whom the symptoms of eating disorders (i.e., restrictive behaviour—food restriction, intense exercise) were observed only during pregnancy and would disappear after delivery. Presently, the term "pregorexia" is not reflected in the current diagnostic categories.

Table 2 summarises possible complications in pregnant women with eating disorders and in their newborn children.

Explanation of abbreviations.

IUGR, Intrauterine Growth Restriction; IUGR, Intrauterine Growth Restriction; SGA, small for gestational age; LGA, large for gestational age; PCOS, Polycystic ovary syndrome.

In description of the case of a 16-year-old pregnant girl with anorexia nervosa, Harrison et al. (16) draw attention to the small amount of research on eating disorders in underage pregnant women—the main focus of majority of studies is adult mothers, while research indicates that up to 11% of children worldwide are born to underage mothers, and up to 7.5% of pregnant women may have some form of eating disorder.

CONCLUSIONS

The authors of the reviewed papers indicated that pregnant women with eating disorders constitute a heterogeneous group of patients. A distinction was made between women with ED onset before pregnancy and with ED onset during pregnancy. It was emphasised that pregnant women are sensitive and susceptible to external signals, which may result in them developing eating disorders, the symptoms of which persist beyond the pregnancy and the post-partum period.

However, the term "pregorexia," which is not currently included in any classification, did not appear in the studies, nor are the criteria that this disorder could meet specified. Moreover, in some patients with ED prior to pregnancy, symptomatic improvement was observed during pregnancy, while in some cases, on the contrary—deterioration was observed in the perinatal period. A systematic review of publications on eating disorders in pregnancy from the last 5 years uniformly indicated the occurrence of numerous complications in pregnant women with ED for the mother (both somatic and psychological complications), for the course of labour and the newborn. Therefore, it appears reasonable to observe all pregnant patients for occurrence of eating disorders and to intensify the supervision of those women in whom they have been confirmed.

For pregnant women with active ED symptoms or a history of ED and the children they give birth to, interdisciplinary collaboration between specialists in gynaecology, psychiatry, neonatology and paediatrics is required. Therefore, it is deemed necessary to develop new screening methods or to disseminate existing ones in order to improve the detection of ED in pregnant women. There is currently very limited literature on eating disorders in pregnant women, especially in adolescents, indicating the need for additional research in this area.

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

All authors made equal contributions to the idea, review, and preparation of the manuscript.

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The Associations Between the Anorexic Readiness Syndrome, Familism, and Body Image Among Physically Active Girls

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Introduction: *Anorexic Readiness Syndrome* (ARS) is a construct of prophylactic importance, useful in the selection of people showing a tendency to use restrictive diets and increased concentration on the body. The aim of the research was to verify the significance of the type of physical activity, body perception and familism for the development of ARS.

Material and Method: The research was carried out in the first half of 2021on a sample of 163 girls. It consisted of: (1) physically inactive girls ($n = 48$), (2) physically active girls in disciplines other than aesthetic ($n = 69$), (3) girls engaged in aesthetic physical activity ($n = 46$). The study used: *Anorexic Readiness Syndrome Questionnaire* (ARS-12), *Familism Scale* (FS) and *Body Image Avoidance Questionnaire* (BIAQ).

Results: The highest average ARS score was recorded in the group of girls engaged in aesthetic activity. A significant difference in the severity of ARS occurs between people who do not engage in activity and those who practice aesthetic activity. The severity of ARS rises as the difference between real and ideal body weight increases. People active in aesthetic disciplines who obtained a high score on the Respect scale (FS subscale) have a lower ARS score than those physically active in other disciplines who obtained low scores on the Respect scale. The higher the score on the Material success and achievement scale (FS), the greater the ARS intensity in all subgroups. What is much more important in shaping ARS is the perception of your body. The focus on eating and body weight and Clothing and appearance (BIAQ subscales) are relevant to the ARS and moderate the relationship between Material success (FS subscale) and anorexic readiness.

Conclusions: People engaging in aesthetic physical activity are more likely to suffer from ARS. The family can certainly prevent a child from developing anorexic readiness by shaping a sense of community and family identity, a clear division of roles, limiting the importance of materialism and competition in raising children. The prevention of ARS and eating disorders should also focus on strengthening the realistic assessment of body parameters and their acceptance, as well as promoting strategies for healthy weight control.

Keywords: Anorexic Readiness Syndrome, familism, body image, physical activity, body weight

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INTRODUCTION

Eating disorders are increasingly becoming a public health problem worldwide (1). For example, 9% of the United States population will have an eating disorder in their lifetime (2). One of them is anorexia nervosa, which occurs in all developed and in developing countries. It is estimated that anorexia nervosa occurs in 1.4% of women and in 0.3% of men (3). From 1990 to 2017, indicators of specific eating disorders increased systematically, and they were more common in the female population than in the male population (4). In 2017, the highest rates of eating disorders were observed in Australia, Western Europe, North America–in high-income countries, but the most significant increase was recorded in East and South Asia, as well as in Guinea, Bosnia and Herzegovina and China (4–7).

According to some researchers [cf. (8, 9)], certain groups of people are particularly prone to developing symptoms of anorexia nervosa (e.g., those who practice dancing, running, skating, gymnastics), especially girls aged 15 to 19, for whom a sense of physical attractiveness has a rewarding function (10, 11).

In 2000 (12) the term *Anorexic Readiness Syndrome* (ARS) was introduced. The creation of this construct was primarily prophylactic, serving the early recognition of anorexic tendencies in children and adolescents, because the effects of dietary restrictions and the use of restrictive diets without medical or dietary control may interfere with the proper development and growth of the body (cf. 13). We assume that ARS [cf. (13, 14)] is a set of indicators located primarily in the cognitive and behavioral sphere of the functioning of an individual, suggesting abnormalities in fulfilling the nutritional needs and attitude toward one's own body and internalizing media messages regarding physical attractiveness. In other words–people who show a high level of ARS: (1) display certain behaviors and thoughts in relation to the body and food, e.g., know and follow various restrictive diets, know and use various methods of weight control; (2) have strongly internalized standards of attractiveness, and maintaining / achieving physical attractiveness is of paramount importance to them. These main features of ARS are reflected in the two-factor test tool (ARS-12) used in this study, which consists of two subscales: (1) Anorexia Sentences and Tendencies (AST) and Internalization of attractiveness norms (IAN). We also assume that the determinants of ARS are multi-faceted, similar to anorexia nervosa [cf. (15)]. Thus, among a number of internal variables important for shaping irregularities in the sphere of eating, one can indicate, i.a., interest in the corporeality and its creation, normative for adolescence, and participation in mass culture among the external ones.

While the risk factors for anorexia nervosa are very often seen in the functioning of the family system (16), the protective role of the family in revealing abnormal behavior toward the body and eating is much less frequently indicated. However, one of the determinants strengthening human mental health is familism, i.e., strong identification with the family and attachment to it (17). So far, there are few studies regarding the importance of familism for protection against the development and strengthening of eating disorders, and the available ones concern mainly enculturation processes [cf. (18, 19)].

Familism is expressed in loyalty to family members, in showing them trust, positive feelings and mutual solidarity. Its intensity is evidenced by the strength of an individual's relationship with the family, measured in relation to the strength of a person's bond with other social groups (20). According to K. Walecka-Matyja (17, p. 803), "in times referred to as anxiety, instability, unpredictability, the concept of familism takes on a special meaning, as it is indicated by researchers as one of the most important factors protecting the state of mental health." At the same time, it seems that attention – through appropriate socialization, as well as social policy–to strengthen familism may contribute to limiting the development of mental health problems, including undertaking risky behaviors, especially in the population of children and adolescents (21, 22).

However, the matter seems much more complicated in relation to the issues related to the attitude of young people to the body and eating. As mentioned, the adolescence period is full of physiological and psychosocial changes that normatively change the perspective of young people in perceiving themselves and the world. Researchers from various regions of the world (Ukraine, Poland, the United States of America, South Africa, India) indicate that adolescents–despite different aesthetic standards in their indigenous environments–show preoccupation with a slim body and dissatisfaction with their own physicality (23–27).

Moreover, young people's involvement in popular culture, intensive use of social media, drawing inspiration from them in creating their own image, and giving physical attractiveness a superior value (28–31) make the adolescence of modern youth burdened with considerable risk. All the more so if young people are intensively engaged in physical activity, especially in the so-called aesthetic disciplines (e.g., dance, fitness) and/or those with weight categories or pressure to maintain a certain body weight. Although, on the one hand, regular physical activity may play a protective role for mental health (32), on the other hand, especially in disciplines requiring low body weight, it contributes to its deterioration, including the development of eating disorders (33–35) and the use of destructive weight control strategies (36, 37).

Attention should also be paid to gender differences in the formation and quality of the body image (38). In the case of boys, it is rather stable–it does not change significantly as a result of puberty, while in girls, along with psychophysical development, it usually changes to a disadvantage, causing a number of negative consequences (38). Cash and Pruzinsky (39) distinguish two groups of factors on which the development of body image depends. The first includes past events that cause an individual to have a specific way of thinking about oneself (e.g., the meaning given to an image by parents). The second consists of current events, especially those that force a person to pay attention to their own body and its appearance (e.g., puberty, sports activity) (40). Meanwhile, a high level of acceptance of one's body and image is desirable because it protects against distress associated with low self-esteem (41).

AIM OF THE RESEARCH

The main aim of the current research was to investigate the relationship between the Anorexic Readiness Syndrome, familism, and body image among physically active girls. At the same time, it was assumed that people who are physically active, especially in disciplines related to weight categories and/or in aesthetic disciplines (e.g., dance, artistic gymnastics), may exhibit more risky eating behavior in order to control body weight. However, if they have high results of familism, the risk of ARS is lower, even with a not quite positive body image (normative in the adolescent stage). Additionally, it was predicted that the form of activity (aesthetic) or the intention to undertake it (proportions correction, reduction of fat mass for the benefit of muscle) to control physical attractiveness, correlated to a greater extent with increased values of anorexic readiness than activity aimed at increasing endurance, strength, flexibility or serving health, etc.

MATERIALS AND METHODS

The study used a set of three self-report tests and an extended demographic record. The first is the inventory of the *Anorexic Readiness Syndrome* (ARS-12) developed by Ziółkowska and Ocalewski (14). It is designed to recognize attitudes toward eating and body and the internalization of the norms of attractiveness in both girls and boys. The tool contains 12 items, to which the participant responds by answering "YES" or "NO". Confirmatory factor analysis using the principal components method confirmed the assumptions concerning the content analysis and allowed to distinguish two factors: Anorexic sentences and tendencies (AST) and Internalization of attractiveness norms (IAN). The first of them concerns the so-called anorexic behaviors and beliefs about eating and the body, while the second–looking for inspiration in the virtual and social world to control one's attractiveness and patterns in this regard. The reliability of the tool was determined using the coefficient of internal consistency. Cronbach's alpha for the AST scale was $\alpha = 0.75$, and for the IAN scale it was $\alpha = 0.80$, while for the entire test it was $\alpha = 0.83$ (14).

In addition, the study used *the Familism Scale* [*Mexican American Cultural Values Scales for Adolescents and Adults*, MACVS; (42)] in the Polish adaptation by K. Walecka-Matyja (17). It consists of 44 items to which the respondents refer on a scale from 1 to 5, where 1 means "I strongly disagree" and 5–"I strongly agree." As a result of the exploratory factor analysis used in the adaptation process (17), five dimensions of familism were distinguished: (1) Respect (RESP), (2) Material success and achievements (MATSUC), (3) Individualism (IND), (4) Religion (REL), (5) Family support (FAM-SUP). The tool has satisfactory psychometric properties (the Cronbach's Alpha index value for individual subscales ranges from 0.91 to 0.63) (17).

The last of the tools used was the *Body Image Avoidance Questionnaire* (BIAQ) by Rosen et al. (43) in the Polish adaptation by Brytek-Matera and Rogoza (44). The BIAQ consists of 19 items, and the participant's task is to refer to them on a scale from 5 ("always") to 0 ("never"). This tool is used to assess the behavioral dimension of the body image, which is related to, i.a., avoiding situations that trigger anxiety about one's own appearance (44). BIAQ has a factorial structure: (1) Clothing and appearance (CLO-APP), (2) Social activity (SOC-ACT), (3) Concentration on food and body weight (FO-WEI), (4) Preoccupation with physical appearance (PHYS-APP). In Polish studies (44), the questionnaire showed excellent internal consistency (Cronbach's alpha = 0.89), and the test-retest ratio was 0.87.

The research material was supplemented with demographics concerning the age of the respondents, the BMI, the difference in the current and ideal body weight, physical activity–type and frequency, relationships with the family, and coexisting problems in the sphere of somatic and mental health.

The research–due to the epidemic situation–was carried out using a *Google* form. The authors obtained a positive assessment of the research project of the Committee for Ethics of Scientific Research at the Faculty of Psychology of the UKW (March 16, 2019). Subsequently, an electronic version of the form was developed and the link made available to those who met the inclusion criteria (female, age 16 to 21). Additionally, the authors used the criterion of physical activity, according to which three subgroups were finally selected: (1) lack of physical activity (apart from participation in physical education lessons), (2) systematic sports activity (regular classes in a sports club / class), (3) systematic sports activity in aesthetic sports disciplines, such as classical dance, modern dance, fitness, figure skating, ballet (regular classes in a club / sports class).

The research was conducted from January 15 to February 12, 2021. After the database of results was prepared, their statistical analysis was started. The collected data was examined and descriptive statistics were calculated in line with making statistical inferences. The statistical significance of the differences between the results obtained in particular groups was verified with independent samples test ANOVA. The *r*-Person's correlation tests were used. Aiming to investigate the relationship between the ARS, familism and body image we conducted a series of multivariate regression to maximize the percentages of the results' variance. Mediation analysis procedure was performed according to Baron and Kenny (45). The calculations were carried out with Statistica 13 software.

RESULTS

One hundred and sixty-three girls aged 16 to 21 participated in the study, 48 of whom declared not being engaged in any physical activity (No activity), 46 engaged in aesthetic sports activity, and 69 physical activity in other disciplines (Sports activity). The mean age of the respondents is 18 years. The mean body mass index (BMI) is 20.84, which accounts for normal weight. The girls from the study sample, however, declared that they would like to weigh on average 3.88 kg less than their current body weight. The largest mean difference between the current and ideal body weight was recorded in the No activity group (4.34 kg). The respondents spent an average of 4.11 h a week on physical activity, undertaking this activity about three

times a week (2.96). The most time for physical activity–about four times a week (3.87) was spent by girls from the Aesthetic sports activity group, which amounted to 5.86 h. About 40% of all respondents declared a burden of mental disorders other than eating disorders (e.g., anxiety, depressive disorders), about 14%–of eating disorders, and over 20%–chronic diseases (e.g., allergy, diabetes, Hashimoto's disease, cardiovascular diseases). There were no persons suffering from anorexia nervosa in the studied sample. The respondents (14%) declared symptoms of compulsive eating (it was not the same as the diagnosis of this disorder). Thirty percentage of the surveyed women come from single-parent families, and on average 62.58% indicate the problem of overweight or obesity in the family (**Table 1**).

Next, the differences in terms of the following variables were analyzed: *Anorexic Readiness Syndrome*, familism and body image between the compared groups: 1. No activity, 2. Sports activity, 3. Aesthetic sports activity. There were statistically significant differences in the Anorexic Readiness Syndrome measured by the ARS-12 questionnaire and its AST subscale between groups 1. No activity and 3. Aesthetic sports activity (*post hoc* LSD test (Last Significant Differences): ARS SUM–$p = 0.004$ (Bonferroni correction $p = 0.011$); AST –$p = 0.002$ (Bonferroni correction $p = 0.006$). However, there were no differences between groups 1. No activity and 2. Sports activity (*post hoc* LSD test:ARS SUM–$p = 0.294$; AST–$p = 0.132$; IAN–$p = 0.957$), and also between groups 2. Sports activity and 3. Aesthetic sports activity (*post hoc* LSD test: ARS SUM–$p = 0.033$ (Bonferroni correction $p = 0.099$); AST–$p = 0.048$, Bonferroni correction $p = 0.144$.; IAN–$p = 0.178$). Generally, there were no differences in the intensity of the IAN subscale, the scale of familism and the body image (**Table 2**).

The *r*-Pearson correlation analysis (**Table 3**) showed statistically significant relationships between ARS and all body image subscales (BIAQ): Clothing and appearance, Social activity, Concentration on food and body weight, Preoccupation with physical appearance. The greater the difference between current weight and ideal weight, the more important is the Preoccupation in body weight and physical appearance.

The analysis of empirical data shows that Internalization of the Standards of Attractiveness (IAN) correlates positively with Anorexic sentences and tendencies (AST), the Material Success and Achievement subscale (FS) and with all body image subscales (BIAQ). The significance level of these correlations was $p < 0.01$ and $p < 0.001$. **Table 3** presents detailed results of the correlation between all subscales.

In the next step, multiple regression analysis was performed to check whether the subscales of the *Familism Scale* are predictors of ARS. It turned out that the subscales: 1. Respect ($\beta^* = -0.24$; $p = 0.046$) and 2. Material success and achievements ($\beta^* = 0.24$; $p = 0.005$) are statistically significant predictors of *Anorexic Readiness Syndrome*. However, the other subscales of *Familism* are not statistically significant: 3. Individualism ($\beta^* = 0.04$; $p = 0.643$), 4. Religion ($\beta^* = -0.05$; $p = 0.586$), 5. Family support ($\beta^* = 0.21$; $p = 0.061$). The model accounted for 9% of the ARS variance [$F_{(5,147)} = 2.94$; $p = 0.015$]. It was also checked whether the BIAQ subscales are ARS predictors. Statistically significant predictors were the subscales: 1. Clothing and appearance ($\beta^* = 0.23$; $p < 0.001$) and 2. Concentration on food and body weight ($\beta^* = 0.51$; $p < 0.001$). The subscales: 3. Social activity ($\beta^* = 0.11$; $p = 0.138$) and 4. Preoccupation with physical appearance ($\beta^* = -0.03$; $p = 0.725$) were not statistically significant. The model accounted for 42% of the ARS variance [$F_{(4.158)} = 30.67$; $p < 0.001$]. The regression analysis of multiple variables was also performed for ARS: 1. Activity time ($\beta^* = 0.03$; $p = 0.724$), 2. Number of active days ($\beta^* = 0.33$; $p < 0.001$), 3. Mental disorder (without ED) ($\beta^* = 0.07$; $p = 0.394$), 4. Eating disorders (ED) ($\beta^* = 0.21$; $p = 0.006$), 5. An incomplete family ($\beta^* = 0.08$; $p = 0.252$), 6. Overweight/obesity in the family ($\beta^* = 0.00$; $p = 0.957$), 7. Difference between the current and ideal body weight ($\beta^* = 0.15$; $p = 0.042$). In conclusion statistically significant predictors were: the number of days of activity, eating disorders and the difference between ideal and real weight. The model accounted for 19% of the ARS variance [$F_{(7.154)} = 6.25$; $p < 0.001$].

Moreover, a mediation analysis procedure was performed [according to Baron and Kenny (45)] of the BIAQ subscale Concentration on food and body weight between Material success (FS) and ARS (**Figure 1**).

It turned out that with an increase in the intensity of Material success, the ARS increased ($\beta = 0.20$; $p = 0.012$), and with the increase in Concentration on food and body weight (BIAQ), the ARS increased ($\beta = 0.608$; $p < 0.001$). By inserting the ARS two predictors: Material success and Concentration on food and body weight (BIAQ) into the multiple regression analysis, the variable Material success ceases to be statistically significant for ARS ($\beta' = 0.08$; $p = 0.194$). Thus, a mediating role of Preoccupation with body weight was acknowledged between material success and ARS.

A similar statistical procedure showed a mediating role of the Clothing and appearance (BIAQ) subscale between Material success and ARS (**Figure 2**). By inserting the ARS two predictors: Material success and Interest in clothing (BIAQ) into the multiple regression analysis, Material success loses its statistical significance in relation to ARS ($\beta' = 0.11$; $p = 0.133$).

The moderating significance of the Respect (FS) scale for the severity of ARS depending on sports activity was proved (**Figure 3**).

People from group three. Aesthetic sports activity, who obtained a higher score than the arithmetic mean on the Respect scale ($M = 39.74$), had a statistically significantly lower ARS score than people from the same group who obtained a lower score than the arithmetic mean on the Respect scale. On the other hand, for people from group two. Sport activity, the results, depending on the intensity of Respect, were opposite. The size of the effect of the interaction between Respect and ARS, depending on sports activity, was $\eta^2 = 0.04$ [$F_{(1.104)} = 4.87$; $p = 0.029$].

DISCUSSION

The main aim of our research was: (1) to determine the intensity of ARS in the selected subgroups differing in physical activity, and (2) the relationship of the *Anorexic Readiness Syndrome* with familism and body image. It was assumed that the intensity of ARS would be significantly greater in the group of physically

TABLE 1 | Characteristics of the sample.

	Total *N* = *163*	**No activity (1) *n* = 48**	**Sports activity (2) *n* = 69**	**Aesthetic sports activity (3) *n* = 46**
Age [years; *M* (*SD*)]	18.75 (1.84)	18.88 (1.86)	19.04 (1.70)	18.20 (1.91)
BMI [kg/m^2; *M* (*SD*)]	20.84 (3.29)	20.75 (3.50)	21.04 (3.53)	20.62 (2.67)
Difference between current body weight and ideal body weight [*kg*; *M* (*SD*)]	−3.88 (5.69)	−4.34 (5.90)	−3.84 (6.32)	−3.44 (4.41)
Time of sport activity [*h/week; M (SD)*]	4.11 (4.11)	1.30 (1.90)	4.91 (3.82)	5.86 (4.78)
Number of active days [*no. of days/week; M (SD)*]	2.96 (1.68)	1.46 (0.92)	3.39 (1.53)	3.87 (1.48)
Mental disorders (excluding ED)	68 (41.71%)	22 (45.83%)	28 (40.58%)	18 (39.13%)
Eating disorders (ED)	23 (14.11%)	8 (16.67%)	8 (11.59%)	7 (15.22%)
Somatic diseases	37 (22.70%)	12 (25.00%)	19 (27.54%)	6 (13.04%)
Single-parent family	49 (30.06%)	17 (35.42%)	20 (28.99%)	12 (26.09%)
Occurrence of obesity/overweight in the family	102 (62.58%)	31 (64.58%)	46 (66.67%)	25 (54.35%)

N, the size of sample; M, mean value; SD, standard deviation value.

TABLE 2 | Differences between the compared groups with regards to: Anorexia Readiness Syndrome–ARS, familism and body image.

	Total *N* = *163*	**No activity (1) *n* = 48**	**Sports activity (2) *n* = 69**	**Aesthetic sports activity (3) *n* = 46**	**$F_{(2,160)}$ *for comparison (1–3)***
Anorexia readiness Syndrome-SUM	4.74 (2.31)	4.15 (2.13)	4.59 (2.19)	5.52 (2.49)	**4.53***
Anorexic sentences and tendencies	2.80 (1.57)	2.33 (1.36)	2.77 (1.54)	3.35 (1.68)	**5.21****
Internalization of the standards of attractiveness	1.92 (1.35)	1.81 (1.23)	1.83 (1.33)	2.17 (1.50)	1.13
Familism Scale-SUM	121.20 (20.71)	120.71 (19.07)	121.04 (21.34)	121.96 (21.80)	0.05
Respect	39.74 (10.48)	38.17 (10.01)	40.87 (10.97)	39.70 (10.21)	0.94
Material success and achievements	25.50 (6.35)	26.54 (6.81)	24.65 (5.51)	25.70 (6.96)	1.29
Individualism	20.02 (2.77)	20.54 (2.80)	19.52 (2.56)	20.22 (2.97)	2.11
Religion	14.88 (8.36)	14.92 (8.55)	14.55 (8.56)	15.32 (8.02)	0.12
Family support	25.57 (4.33)	24.96 (4.73)	26.04 (4.14)	25.50 (4.17)	0.90
Body image avoidance questionnaire					
Clothing and appearance	9.12 (2.49)	9.04 (2.66)	8.87 (2.31)	9.59 (2.56)	1.18
Social activity	2.20 (3.39)	2.19 (3.65)	2.03 (3.17)	2.46 (3.48)	0.22
Concentration on food and body weight	10.71 (4.21)	9.94 (3.58)	10.52 (3.98)	11.80 (4.97)	2.47
Preoccupation with physical appearance	10.83 (5.66)	12.06 (5.47)	10.32 (6.05)	10.30 (5.12)	1.63

*N, the size of sample. *sign to indicate statistical significance. *$p < 0.05$; *$p < 0.01$.*

active people than in the group of inactive people, especially in those teenagers who practice the so-called aesthetic disciplines. Moreover, it was assumed that a higher intensity of ARS would reveal itself in people who manifest lower body satisfaction and a lower level of familism. It was expected that familism could act as a protective factor for the development and manifestation of dissatisfaction with the body by adolescents and the use of practices aimed at controlling its parameters and mass. The inspiration for this assumption were, among others, research by Sanders (46).

The obtained results indicate that the intensity of ARS measured with the ARS-12 questionnaire and its AST[1] subscale in the studied sample is significantly different in physically inactive people and people who are active in aesthetic disciplines. In the group of people active in aesthetic disciplines, the AST subscale score is definitely higher than in physically inactive people. However, no such differences were observed between people practicing sports activities (excluding aesthetic disciplines) and physically inactive people. The AST subscale is concerned with revealing thoughts and behaviors that rely on disciplining the body, primarily to reduce its (fat) mass. Although there may be weight categories (e.g., martial arts), it seems that the importance of the figure is not as spectacular in aesthetic sports as it is in the other sports. Thus, the level of concentration on controlling the body in young people who are physically inactive and practice unsightly disciplines

[1]It should be added that in the reported studies, a new tool was used to assess the ARS (11), and the results of studies by other authors concerning the assessment of *Anorexic Readiness Syndrome*, which we cite, were obtained using the *Individual Attitude to Eating Questionnaire* (12).

TABLE 3 | r-Pearson correlation coefficient of the examined variables ($N = 163$).

Variables	Internalization of the standards of attractiveness	Anorexic sentences and tendencies	Familism scale	Respect	Material success and achievements	Indivi dualism	Religion	Family support	Clothing and appearance	Social activity	Concentration on food and body weight	Preoccupation with physical appearance
Anorexia readiness syndrome	**0.76*** **	**0.82*** **	0.03	0.06	**0.20***	0.09	0.18	0.02	**0.39*** **	**0.38*** **	**0.61*** **	**0.28*** **
Internalization of the standards of attractiveness		**0.25****	0.00	0.04	**0.21****	0.00	0.11	0.02	**0.22****	**0.26****	**0.39*** **	**0.31*** **
Anorexic sentences and tendencies			0.04	0.06	0.11	0.13	**0.16***	0.01	**0.39*** **	**0.33*** **	**0.56*** **	0.15
Familism scale				**0.87*** **	**0.38*** **	**0.12**	**0.71*** **	**0.72*** **	0.01	−0.11	0.04	**−0.20***
Respect					0.13	−0.08	**0.51*** **	**0.71*** **	0.07	−0.15	0.04	**−0.26****
Material success and achievements						**0.26****	0.07	0.00	**0.23****	0.09	**0.19***	0.09
Individualism							0.12	0.00	**0.24****	0.13	0.12	**0.22****
Religion								0.44***	**0.21****	−0.12	**−0.16***	**−0.24****
Family support									0.03	**−0.18***	0.06	−0.12
Clothing and appearance										**0.36*** **	**0.25****	**0.47*** **
Social activity											**0.39*** **	**0.52*** **
Concentration on food and body weight												**0.27*** **

*N, the size of sample; M, mean value; SD, standard deviation value; *p < 0.05; **p < 0.01; ***p < 0.001. *sign to indicate statistical significance.*

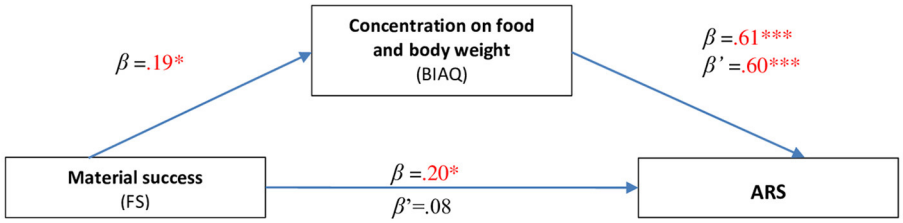

FIGURE 1 | Mediating role of the factor Concentration on food and body weight (BIAQ) between Material success (FS) and ARS.

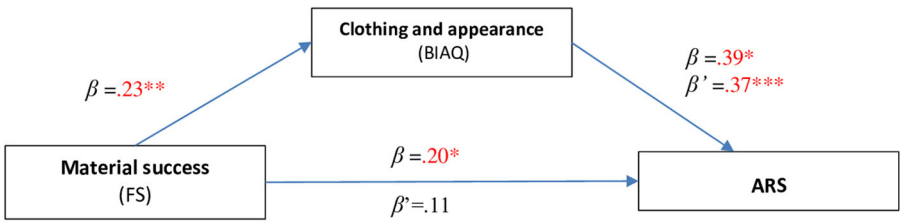

FIGURE 2 | Mediating role of the factor Concentration on food and body weight (BIAQ) between Material success (FS) and ARS.

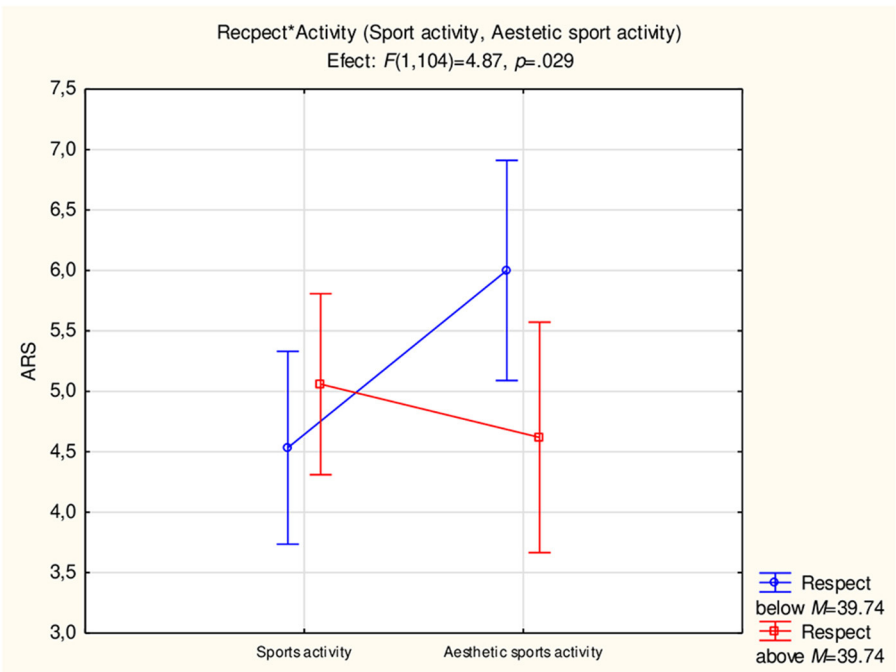

FIGURE 3 | Moderating role of the factor Respect (FS) for the severity of ARS depending on sports activity.

may be on a similar level. Moreover, the number of days of activity was a statistically significant predictor of ARS. This result is in line with the result obtained in the previous research conducted by the authors of the text (14) on a non-clinical sample of 116 people (girls−66%, boys−34%). The study included teenagers from general and sports schools. It turned out that people (interestingly–especially boys) involved in sport manifested significantly higher levels of ARS than the remaining participants.

Similar results were obtained by other researchers who verified anorexic behavior among female dancers (47). A greater severity of undesirable eating behavior was observed in this group compared to the control group. It was also shown that abnormalities in this area increase with the increase in

the severity of ARS. A few years later, Chalcarz, et al. (48) documented that every fourth active young woman from the studied sample showed a high intensity of ARS, declaring the intensification of physical exercise with a simultaneous tendency to limit food-intake, as well as the use of various methods of body weight reduction and significant nutritional knowledge about the calorific value of food products. Ołpińska-Lischka (49), in a study conducted on a sample of 156 German and Polish dancers, showed that most of them were diagnosed with moderate and high levels of ARS.

Our own study did not confirm any statistically significant differences in the intensity of familism and body image between the compared groups. Meanwhile, a review of reports from studies by other authors indicates that familism is a variable that favors involvement in physical activity. Pikó and Brassai (50) investigating the relationships between various variables related to values and taking up health behaviors by young residents of Hungary and Romania found that familism, as well as religiousness and collectivism, are important for revealing pro-health (physical activity) and anti-health (use of psychoactive substances) behaviors. Ramanathan and Crocker (51) assessed the relationship between personal, family and cultural attitudes and social norms with physical activity in a study conducted among Indian teenagers. It turned out that the level of familism in the studied sample was high, and the respondents felt that physical activity was important for their physical and mental health and for strengthening their relationships with the family. However, there is data indicating the negative role of familism in maintaining improper behavior related to health. For example: McLaughlin et al. (52) found that a high level of familism, a value that reflects commitment to the family that exceeds self-care, prevents weight loss in Mexican American women. Perhaps obesity, which is a family problem, co-occurring with a high level of familism, makes it difficult to change one's eating and activity habits. This could be interpreted as betraying the family or rejecting it. However, in a situation where the family models constructive behavior, familism as integration with the family and its values seems to protect young people against non-constructive forms of functioning.

A lot of empirical data confirm significant correlations between body image and physical activity, although the results in this regard are inconclusive. For example: Haugen et al. (53) conducted research in a group of Norwegian adolescents. The authors found out that people who undertake regular physical activity are more satisfied with themselves than those who are inactive. This satisfaction was mainly related to physical appearance and body. Brytek-Matera and Kozioł (54) examined people who regularly practice fitness. The authors proved a much more positive assessment of their own body and appearance in the group of physically active women as compared to those in the control group. However, they showed that they were more likely to undertake physical activity to correct their body shape and beauty than to improve their health condition and performance, and people with high scores of self-objectification were less satisfied with their appearance. Garstka (55) has empirically documented that women practicing recreational gymnastics are more satisfied with their figure and its individual parts and endurance. However, it should be emphasized that this benefit, resulting from taking up physical activity, is not always visible, as it depends on many other variables, including motives and type of activity. When an individual is influenced by media messages and when exercise causes an obsessive focus on appearance, they become a risk factor for a person's physical and mental health, and instead of improving body satisfaction, they may reduce it (56). This is confirmed by the research of Vartanian et al. (57). The authors proved that undertaking exercise and diet motivated by body correction is associated with a greater focus on the body image than when the above-mentioned behaviors are dictated by health reasons. Vartanian et al. (57) claim that training aimed at weight loss and improving the feeling of physical attractiveness increases concentration on appearance, the risk of disturbances in the body image and engaging in behaviors harmful to the health of the individual.

Meanwhile, Schiep and Szymańska (40) empirically documented that physically active youth had a more negative body image compared to people who did not declare it. Also Hupało and Głogowska (58), while studying junior high school students, 60% of whom declared practicing physical activity, showed that adolescents are generally dissatisfied with their bodies, reveal a low sense of attractiveness, and taking up physical activity is not related to their satisfaction with their body image.

Our own research also showed statistically significant relationships between ARS and all body image subscales: Clothing and appearance, Social activity, Concentration on eating and body weight, and Preoccupation with physical appearance. In the already cited research by Ołpińska-Lischka (49) it was proved that dissatisfaction with one's own body coexists with ARS, interestingly, it concerns not so much the entire figure, but the nose, face, breasts and physical condition. Research involving girls, including those manifesting SGA (59), document that their attitude toward their own body is changed under the influence of psychocultural factors, such as, for example, the internalization of norms regarding physical attractiveness. The results coinciding with those quoted were obtained by Izydorczyk et al. (60). The authors have proven significant relationships between the self-esteem of adolescents in the period of early adolescence and selected components of the *Anorexic Readiness Syndrome*, namely dissatisfaction with the body and perception of one's own attractiveness.

Moreover, our own research has shown that the greater the difference between the real and ideal body weight, the more important for a person the preoccupation with physical appearance. This result is consistent with a number of studies [cf. (61–64)] which proved that the greater the discrepancy between the current and ideal/expected body weight by the participants, the lower their satisfaction with it. However, this relationship is probably related to gender, as girls and women are subject to socio-cultural pressures to achieve and maintain a slim figure to a greater extent than boys and men (65). As a consequence, it is the female representatives who may experience dissatisfaction with their body significantly more often/intensely, especially when its weight differs from subjective standards. Moreover, in the case of men, overall body weight is built up to a large extent by muscle

mass, while in women, high body weight is usually equated with excess body fat, which results in a deterioration of the body image (66).

The presented study investigated that two subscales of familism–Respect and Material success–are significant predictors of ARS, the first of which plays the role of a destimulant, and the second–a stimulant. This means that the higher the Respect intensity, the lower the ARS intensity, and the higher the Material success intensity, the greater the ARS intensity. Due to the lack of data from other studies, it is not possible to compare them, but this result seems logical. The Respect subscale measures the need to maintain proper intergenerational relations and the importance of parents to children, e.g., in a decision-making situation. The material success subscale, on the other hand, concerns the importance of material achievements, earning money, and pursuit of achievement through competition (67). Experiencing respect in the family of origin, including the individual's physicality, may protect against initiating behaviors that are manifestations of ARS (e.g., undertaking restrictive diets, criticism of one's own attractiveness). Children growing up in families where the relations with their caregivers are correct, and they are treated by the children as significant adults, role models will be less prone to seek their attention or mark their presence by manifesting self-destructive behaviors (e.g., starvation). Moreover, the moderating role of the Respect scale for ARS severity depending on physical activity has been documented. People engaged in aesthetic activity, who obtained a higher score than the arithmetic mean on the Respect scale, showed lower ARS intensity than those with a lower score on this scale. At the same time, in the group of physically active people in other disciplines, the effect of the interaction between Respect and ARS was opposite. Probably the type of undertaken activity has a different function and allows for securing slightly different mental needs. On the other hand, materialism manifested in the family of origin, focus on objects and acquiring money, may deteriorate its functioning (68, 69), which will be felt especially by children who receive things more often than feelings and care from their caregivers.

At the same time, body image elements such as Clothing and appearance and Concentration on food and body weight were found to be predictors of ARS, with both subscales acting as stimulants for *Anorexic Readiness Syndrome*. This result is in line with other research results, including Kazmierczak et al. (70), conducted in the community of *pro-ana* people. It was found that higher ARS rates were revealed by people who were concerned about body weight, dissatisfied with their current weight regardless of its value, dissatisfied with their appearance, used food restrictions and focused on counting calories in meals. Similarly, Kozik (71), examining self-esteem as a risk factor for ARS, proved, among others, that a lower sense of physical attractiveness–an important dimension of self-assessment, predicts a higher intensity of ARS.

The authors' own research showed the mediating role of the subscales Concentration on food and body weight and Clothing and appearance (BIAQ) between Material success and ARS. This means that the higher the value of the indicated mediating variables, the higher the ARS value, regardless of the value of the Material success variable. The latter variable is associated with–as already mentioned–a greater tendency to accumulate goods, including objectification of the body by controlling its image. Material resources also favor greater availability of food on the one hand, but also weight control. Young people from families with lower economic status much more often have excess body weight and difficulties in controlling it (72).

CONCLUSIONS

- People who are physically active in aesthetic disciplines show a greater intensity of ARS than those who are physically inactive (sports active people do not differ from no active people and aesthetic sports people in terms of ARS).
- People with a lower body image have a higher ARS intensity; additionally, as the difference between the current and ideal body weight increases, the body image deteriorates (here: Concentration on food and body weight and Preoccupation with physical appearance).
- A predictive significance for ARS is given to body image (here: the Clothing and appearance subscales and Concentration on food and body weight) and familism (here: the Respect and Material success subscales).
- The mediators between Material success (familism) and ARS are Concentration on food and body weight and Clothing and appearance (body image).
- The Respect subscale (FS) has a moderating significance for the severity of ARS depending on the type of sports activity.
- It seems that continuation of research in the group of adolescents of both sexes may reveal additional differences in ARS, body image and familism depending on the type of physical activity. Additionally, in the group of boys, it would be worthwhile to introduce the category of strength sports (e.g., bodybuilding, calisthenics, crossfit) in order to assess their risk for taking up dietary restrictions and their attitude toward their own body.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Research Ethics Committee at the Faculty of Psychology of the UKW. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Revisiting the Postulates of Etiological Models of Eating Disorders: Questioning Body Checking as a Longer-Term Maintaining Factor

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Body checking (BC) is not only inherent to the maintenance of eating disorders but is also widespread among healthy females. According to etiological models, while BC serves as an affect-regulating behavior in the short term, in the longer term it is assumed to be disorder-maintaining and also produces more negative affect. The present study therefore aimed to empirically examine the proposed longer-term consequences of increased BC. In an online study, $N = 167$ women tracked their daily amount of BC over a total of 7 days: Following a 1-day baseline assessment of typical BC, participants were asked to check their bodies in an typical manner for 3 days and with a 3-fold increased frequency for 3-days. Before and after each BC episode, the impact of BC on affect, eating disorder symptoms, general pathology and endorsement of different functions of BC was assessed. Participants showed longer-term consequences of increased BC in terms of increased negative affect and general pathology, while eating disorder symptoms remained unaffected. In the case of typical BC, participants showed decreased general pathology and anxiety. Furthermore, the endorsement of a higher number of BC functions led to increased negative affect and an increased amount of typical BC. The findings support the theoretically assumed role of maladaptive BC in maintaining negative emotion in the longer term. However, though requiring replication, our finding of positive effects of typical BC calls into question the overall dysfunctionality of BC among non-clinical women who are not at risk of developing an eating disorder.

Keywords: body checking, emotion, shape and weight concerns, theory of eating disorders, body image

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INTRODUCTION

Body checking (BC) describes the repeated evaluation of one's own body (1). It occurs in several mental disorders such as body dysmorphic disorder [BDD (2)] or illness anxiety disorder (3), but is most commonly known in the context of eating disorders (EDs). Patients with EDs engage in BC to obtain information about their size, shape, and weight (4, 5). Etiological models of EDs assume a high relevance of BC, and empirical research has demonstrated that BC is a contributing factor to the development (6) and maintenance (7) of ED symptoms. In the context of ED pathology, BC

includes multiple strategies of monitoring one's general appearance in an idiosyncratic manner (8). Common strategies include repeated weighing or mirror gazing, measuring or pinching body parts, or trying the fit of clothes to assess one's body size (9). It may also involve other people, in terms of comparing one's appearance to that of others (10) or asking others for reassurance regarding one's appearance (11). With increasing digitalization, BC nowadays encompasses new types of behaviors such as taking selfies and repeatedly checking one's appearance in them (12), checking one's body parts in photos uploaded to social media [c.f. (13)], participating in social media challenges (e.g., "skinny check"), or comparing one's size, shape, and weight to other digitally posted bodies on social media platforms (14).

While the strategies used to check one's body vary, all have been found to be associated with greater ED pathology (5, 9, 15) such as body dissatisfaction (16), overvaluation of one's weight and shape (17), dietary restriction (18, 19), and negative treatment outcomes (20). Besides its prominence in EDs, studies have also shown that body-related checking is a generally normative behavior (5), which is likewise present in healthy individuals (6) who tend to apply similar BC strategies to those listed above for patients with EDs (7, 21). However, even among healthy females, participants with higher body dissatisfaction reported more BC of disliked body parts compared to participants with a rather positive attitude toward their body (22), suggesting a clinical significance of assessing one's shape, weight, and size through BC also in the non-clinical population.

Although research has demonstrated strong associations of BC with ED symptoms both in patients with EDs and in non-clinical participants, the distinct consequences of BC cannot be clearly derived (23). Generally, BC is classified as a dysfunctional safety behavior (24) and is linked to obsessive-compulsive disorder, in which checking behavior is the most frequently applied compulsion (25), to reduce unease and fear (26, 27). Transferred to body-related checking, BC is postulated to have an anxiolytic function by neutralizing the overconcern with one's shape and weight (9, 28). Adopting this notion, cognitive-behavioral theories of EDs emphasize two different functions of BC: an initial short-term relief from negative emotions (24), followed by a longer-term maintenance of negative emotions and ED pathology (29).

Describing the short-term function of BC, Williamson and colleagues (24) postulated that BC acts in the short term to help undo negative emotions that are triggered by distorted information processing concerning body stimuli (e.g., selective attention on negatively valenced body parts). With regard to the longer-term consequence of BC, Fairburn and colleagues (29) assume that over time, engaging in BC leads to increased arousal, which magnifies the selective attention on assumed bodily imperfections. This selective attention in turn increases the negative affect that the individual was seeking to alleviate in the short term through BC (4), thus reinforcing the patient's belief in the necessity and utility of BC to cope with upcoming negative emotions and to regain a perceived loss of control. Instead, the outcome is that BC itself increases anxiety and strengthens a negative body evaluation over time (24, 29). Through the creation of this vicious cycle, BC is not only activated by ED-specific thought processing (24) but also helps to maintain this way of thinking in the longer term (4).

With respect to the function of BC to reduce negative affect in the short term, only a small number of studies have empirically tested the model assumptions. Kraus and colleagues (30) assessed BC in patients with anorexia nervosa (AN) and bulimia nervosa (BN) in their natural environment by means of ecological momentary assessment. Contrary to the theoretical short-term effect described above, the authors found an increase in negative emotions and a reduction of positive emotions immediately after a BC episode (30). A laboratory study by Shafran et al. (31) in non-clinical women yielded comparable findings: In an experimental induction of BC, women in a "high body checking" condition did not show a reduction in body dissatisfaction, but rather showed increased body dissatisfaction, feelings of fatness, and negative self-critical thinking. However, in an online study by Hartmann and colleagues (32), patients with ED symptoms retrospectively reported a reduction of negative affect from immediately before to after a recalled BC episode. Other retrospective assessments also confirmed the postulated assumptions of reduced negative emotions after BC, with even stronger effects being reported in females with high body dissatisfaction (21, 33).

Hence, studies on the short-term function of BC have yielded inconsistent findings, which may be attributable to different measurement methods between retrospective assessments and assessments before and after actually performed BC. Besides this, the ambivalent results might be due to the different time intervals in which BC was assessed. In most experimental surveys, the emotional state after BC was gathered shortly after the respective BC episode [e.g., (31, 34)]. However, as the time course of BC consequences has not yet been determined, it is unclear whether the study findings describe the short-term relief or whether they already reflect the longer-term maintaining mechanism. For this reason, to the best of our knowledge, no research to date has formed distinct categories regarding the exact amount of time denoted by short-term, longer-term or even long-term effects of BC. Derived from the time course of the research above, we define short-term functions of BC as effects that are directly attributable to one specific BC episode [e.g., (34)], longer-term consequences of BC as effects that are due to multiple, repeated episodes in a defined time frame [e.g., (23)], and long-term consequences of BC as effects that are unlimited in time and occur after habitual performed BC [e.g., (35)].

As outlined above, most previous studies focused on short-term functions of BC. In terms of the longer-term maintenance of negative affect and ED pathology, one study examining longer-term effects (23) and two studies examining long-term effects (35, 36) revealed ambiguous findings. Bailey and Waller (23) examined BC in a 1-day interval in a naturalistic environment: Non-clinical female participants measured their wrist size every 15 min for 8 h on 1 day, and did not check the following day, in a randomized order. Contrary to the model assumption, the authors found no difference between the two conditions in terms of body dissatisfaction or general eating attitudes,

with the exception of an increase in the fear of uncontrollable weight gain in the BC condition. Likewise, regarding long-term effects, using ecological momentary assessment, Sala et al. (36) found that BC did not predict any ED pathology, such as body dissatisfaction or drive for thinness, in a sample diagnosed with EDs. By contrast, the other study focusing on long-term consequences, conducted by Zaitshoff et al. (35), found that typical engagement in BC predicted ED pathology 3 to 4 months later in a sample of college students, which is consistent with the proposed pathology-maintaining effect of BC. However, in contrast to the study by Sala et al. (36), the latter study relied on self-reported questionnaire data, and participants were not actually asked to check their body.

As evident from the reported literature, findings regarding short-term, longer-term, and long-term consequences of BC are inconsistent. However, the largest research gap can be found in the area of longer-term consequences. In the aforementioned study by Bailey and Waller (23), the engagement in BC was experimentally restricted as the authors only focused on one fixed BC behavior (i.e., checking wrist size), thus neglecting naturally performed BC behaviors. Furthermore, as previous studies have focused on ED symptoms, the proposed longer-term maintaining consequence of increased negative affect (24) has not yet been investigated.

Generally speaking, besides the effect of BC on ED symptoms and negative affect, subsidiary functions of BC have mainly been disregarded in previous research. However, BC is not the only strategy that presumably helps persons with ED to "undo" distress or that influences ED symptoms (9, 10). Patients with EDs show other compensatory strategies to cope with the fear of weight gain, such as purging in BN and restrictive eating in AN (4, 24). Moreover, some patients show the counterpart of body checking by completely avoiding confrontation with their shape or weight, namely *body avoidance* (5). Therefore, certain functions must be inherent to BC such that the behavior is maintained and is not replaced by other strategies that also aim to reduce negative affect. In a first analysis of individuals with a self-reported diagnosis of one of the mental disorders in which BC is usually performed (see above), participants rated their negative affect and their endorsement of functions of BC (32). Attainment of certainty was found to be the most relevant function. In particular, in those participants with a self-reported body image disorder (i.e., AN, BN, BDD), a characteristic function of BC was self-motivation (32). So far, data only exist on symptomatic women, even though non-clinical individuals also tend to perform BC on a daily basis (5). In healthy individuals, BC might serve different functions, as it assumed that in contrast to patients with EDs, they do not experience an attentional bias toward disliked body parts (37). Extensive functions of BC have not yet been examined in non-clinical participants, especially using longer-term assessments.

Based on the inconsistent findings on the functions and consequences of BC, the present online study empirically examined the postulated longer-term negative consequences of BC. Hence, we compared the impact of an experimentally increased frequency of BC (experimental condition) with the idiosyncratic typical amount of BC (control condition) within the daily life of non-clinical women. Participants took part in both conditions using a crossover design, with each condition running for 3 days. In order to identify the tipping point between the theoretically assumed functional short-term and dysfunctional longer-term BC (29), the first objective of the study was to examine the proposed longer-term consequences. We therefore hypothesized that in both conditions, BC episodes would lead to a longer-term increase in a trait-like battery of negative affect, in ED symptoms, and in general pathology (I).

The second objective was to identify distinct features of the (dys)functionality of BC in terms of the quantitative amount of BC. Based on the aforementioned findings by Bailey and Waller (23), we expected to find a stronger deterioration in the trait-like battery (see above) in the experimental condition than in the control condition (II).

The third and fourth objectives were to foster the understanding of the self-perceived functions of typical BC in non-clinical individuals, as previous studies only examined the different functions of BC in self-diagnosed patients in the short term. In line with Hartmann and colleagues (32), we also expected attainment of certainty and motivation to be the most relevant longer-term consequence of BC in non-clinical individuals (III). In addition, Wilhelm and colleagues (21) found that participants who endorsed a higher number of BC strategies generally showed greater body dissatisfaction. In the present study, we tested whether these findings can be transferred to the different BC functions. Thus, we assumed that a higher number of endorsed functions of BC would result in a higher likelihood of engaging in BC. Specifically, we hypothesized that a higher number of BC functions endorsed in preliminary questionnaires would predict increased body dissatisfaction, negative affect, and the amount of typical BC in the longer term, that is after an episode of typical BC (IV).

MATERIALS AND METHODS

Participants

As inclusion criteria, participants needed to identify as female, be aged between 18 and 65 years, and report no current or past mental disorders. Exclusion criteria were suicidal or self-harm behavior, acute intoxication by psychotropic substances or the use of psychiatric drugs. A total of $N = 427$ college students clicked on the link provided through the University mailing list, of whom $n = 324$ began the survey (75.8 %). Over the five time points of the survey (see **Figure 1**), a total of 138 participants dropped out. Of these, $n = 60$ dropped out at the first survey time point, $n = 20$ at the second, $n = 18$ at the third, $n = 20$ at the fourth, and $n = 20$ at the fifth time point. As the highest dropout rates occurred at the landing page for each time point ($t0$–$t4$), no systematic effects for dropout are assumed. Prior to the analysis, $n = 16$ data sets were excluded due to double participation. After completing the preliminary questionnaires, three participants were excluded as they did not meet the study criteria ($n = 1$ due to male sex; $n = 2$ due to the use of antidepressants). Hence, the final sample comprised $n = 167$ (39.1 %) females. Participants received course credit as reimbursement. The study was approved by the ethics committee of Osnabrueck University.

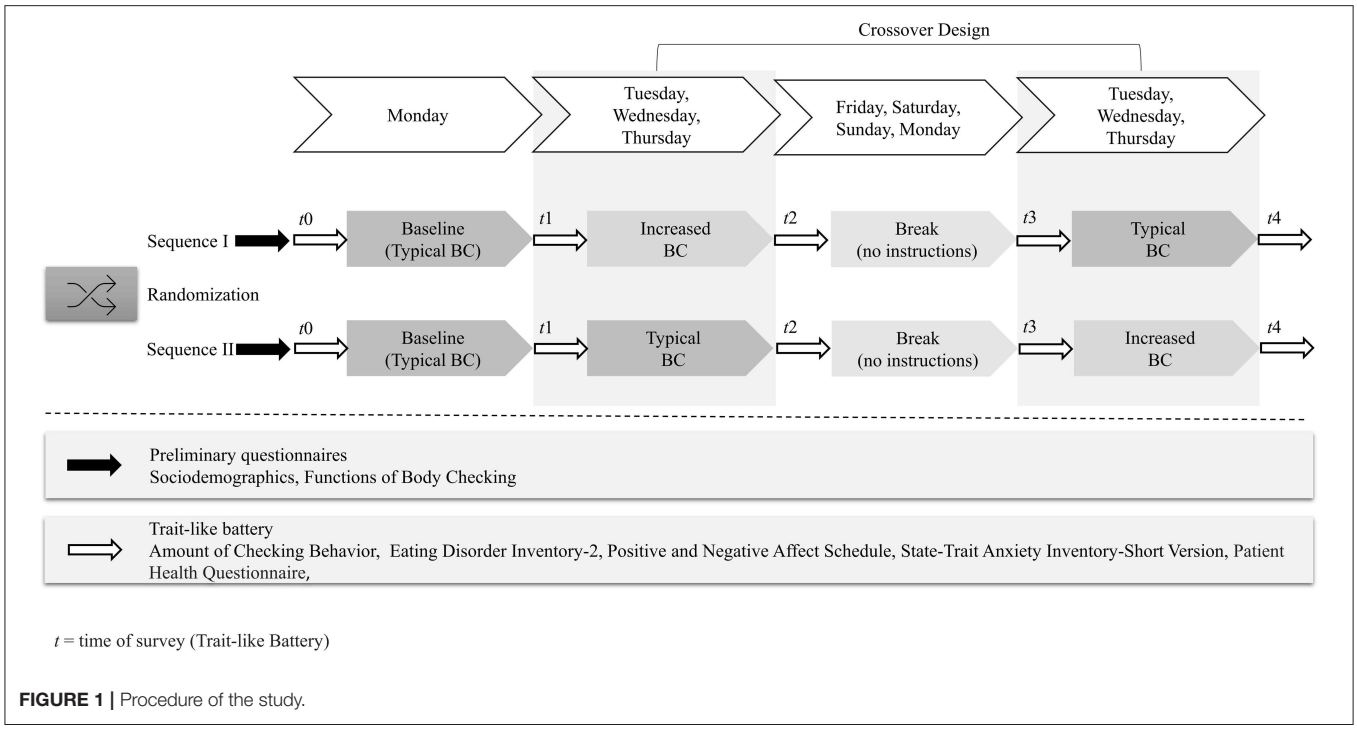

FIGURE 1 | Procedure of the study.

Measures

Assessment of Body Checking Behavior

On each separate day of the two 3-day conditions, participants self-reported the amount of performed BC by using a multicounter application on their smartphone. Participants were instructed to increase the counter by plus one (+1) each time they had performed BC in the time from 8:00 am until 8:00 pm and to start a new counter for each of the 7 days of assessment. After each 3-day episode, they received an E-mail invitation to enter the number of their daily BC on an online survey platform.

Functions of Checking Questionnaire

To assess the purpose of typical BC in non-clinical individuals, in a preliminary questionnaire prior to the experiment, the participants rated their endorsement of five specific functions of BC in the Functions of Checking Questionnaire (32) on a 5-point Likert scale from 1 = *not at all* to 5 = *very much*. The items comprise the following functions of BC: *Avoidance of Negative Consequences, Further Motivation, Estimating the Possibility of Concerns, Attainment of Certainty, Achievement of Control*. Following Hartmann et al. (32), the analyses were run on a single-item level. Therefore, no internal consistency score is provided. Moreover, due to the novelty of this questionnaire, we further cannot provide test-retest reliabilities from other studies.

Eating Disorder Inventory-2

The Eating Disorder Inventory-2 [EDI-2 (38, 39)] is a self-report questionnaire assessing ED pathology. In the present study, the following two subscales were used: The *Body Dissatisfaction* subscale assesses the degree of (dis)satisfaction with one's shape, abdomen, hips, buttocks, and thighs using nine items. The *Drive for Thinness* subscale assesses the desire to lose body fat and the preoccupation with one's own body. Items from both subscales are rated on a 6-point Likert scale ranging from 1 = *never* to 6 = *always*, with higher scores indicating greater symptom severity. In the present study, participants were asked to refer to the past 3 days (instead of the usual 28 days) in their responses, in order to cover potential changes in subjective body dissatisfaction due to the respective BC episode. In previous studies in healthy females, both subscales have shown excellent to nearly acceptable internal consistencies [*Body Dissatisfaction* $\alpha = 0.90$; (40); *Drive for Thinness* $\alpha > 0.58$; (41)]. In the present study, Cronbach's α can be rated as excellent for *Body Dissatisfaction* ($\alpha = 0.99$) and for *Drive for Thinness* Scale ($\alpha = 0.98$) at all time points. The test-retest reliability of the EDI-2 over a 7-day interval ranges from $r_{tt} = 0.86$ until $r_{tt} = 0.89$ (39).

Positive and Negative Affect Schedule

To evaluate the theoretically proposed longer-term consequences of BC on affect due to BC, we applied the self-report Positive and Negative Affect Schedule [PANAS (42, 43)]. As the instructions can vary according to study purposes (43), we asked the participants to consider the last 3 days when completing the PANAS, which corresponds to one BC episode. The PANAS encompasses 20 items as single adjectives that describe different perceptions and feelings, with 10 items corresponding to the broad dimension of *Negative Affect* and 10 items corresponding to *Positive Affect*. We utilized both dimensions, as previous studies on BC assumed that negative affect does not necessarily

equate to a lack of positive affect [e.g., (30)]. The items are rated on a 5-point Likert scale ranging from 1 = *not at all* to 5 = *extremely*. The PANAS has proven to be highly internal consistent for both subscales [*Positive Affect*: $\alpha = 0.88$; *Negative Affect*: $\alpha = 0.85$; (43)]. In the present study, internal consistency was likewise good (*Positive Affect*: $\alpha = 0.88$; *Negative Affect*: $\alpha = 0.91$). The test-retest reliability of the PANAS over an interval of 8 weeks was $r_{tt} \leq 0.66$ (42).

State-Trait Anxiety Inventory Short Version

Research has shown that a higher degree of BC is positively associated with anxiety in ED patients and non-clinical individuals (44). To retest this finding in the case of experimentally increased BC and typical BC, we assessed emotional anxiety in more detail using the one-dimensional State-Trait Anxiety Inventory Short Version [STAI-SKD (45)]. To cover anxiety within each BC episode, we instructed participants to reflect upon the last 3 days. The instrument comprises 5 items that are rated on a 4-point Likert scale ranging from 1 = *not at all* to 4 = *very much*. As in other research reporting good internal consistency [$\alpha = 0.81$ (32)], internal consistency was good in our sample ($\alpha = 0.89$ for all time points). Furthermore, no test-retest reliability is provided for the short version of the STAI. However, for the full version of the STAI, $r_{tt} = 0.97$ was reported for trait anxiety and $r_{tt} = 0.45$ for state anxiety in a student sample over an interval of 21 days (46).

Patient Health Questionnaire

The Patient Health Questionnaire [PHQ-9 (47, 48)] is a one-dimensional self-report screening instrument for major depressive disorder, which served as a measure of general pathology in the present study. In order to examine general pathology during BC episodes, we asked participants to respond to the 9 items referring to the last 3 days (instead of the usual 2 weeks). Items are rated on a 4-point Likert scale ranging from 0 = *not at all* to 3 = *nearly every day*. Internal consistencies in a non-clinical student sample were good [$\alpha = 0.85$ (49)]. In the present sample, internal consistencies can be rated as excellent ($\alpha = 0.96$ for all time points). A good test-retest reliability ($r_{tt} = 0.89$) was shown in the same non-clinical student sample reported above over an interval of 1 month (49).

Experimental Conditions

In a cross-over design (see **Figure 1**), participants completed two conditions (experimental and control condition), each lasting for 3 successive days. To avoid order bias, the order of each sequence (experimental or control condition first) was randomized. In the experimental condition, participants were asked to check their body at a 3-fold increased frequency, using their typical amount of baseline BC as a reference. In the control condition, participants were asked to stick to their typical BC. The first condition was followed by 4 days without guidance to avoid carry-over effects. Subsequently, participants underwent the task on the same days of the week as the previous condition. At the beginning of each condition, participants received a similar definition of BC, explaining that it entails the repeated inspection of one's body (1) in order to obtain information about size, weight and shape (4). Furthermore, with each condition, participants were asked to reflect upon and then perform their own natural, typical BC behavior, meaning that they were not given specific instructions on what to check on their body. For the purpose of inspiration only, they were given the following examples of BC: "weighing, mirror gazing, pinching body parts (9), comparing one's shape to others (10) or to posts including bodies on social media platforms (14)." After providing the definition and describing strategies, in the experimental condition, the instructions were phrased as follows: "We would like you to triple your BC for the next days (Tuesday to Thursday) and to count it separately for each day." In the control condition, we changed the instructions with regard to the amount of BC: "We would like you to stick to your typical BC behavior on a regular basis [. . .]".

Procedure

The data collection period of the online experiment covered 7 days, with an additional break of 4 days ("washing out") between the respective conditions. Once participants provided informed consent to the study goals and were informed of the voluntary nature of participation and the anonymized data storage, they were randomly assigned to one of the two sequence orders (see study procedure in **Figure 1**). To capture BC in daily life, the study began on a Monday for each participant. First, in preliminary questionnaires, the participants learned the definition and examples of BC (see above), provided demographic (age, gender, nationality), body-related (weight, height), and psychological data (use of drugs, physical illness, current or past therapeutic treatment), and indicated their endorsement of different functions of BC with the Functions of Checking Questionnaire (32). Following this, they completed the trait-like battery for the first time ($t0$), measuring ED symptoms with the EDI-2 (38, 39), affect with the PANAS (42, 43) and STAI-SKD (45), and general pathology with the PHQ (47, 48). Participants were then asked to complete a 1-day baseline from Monday until Tuesday by recording their usual daily amount of BC in a smartphone-based counting app. Next, on Tuesday, they were asked about the amount of their baseline BC from the day before, the trait-like battery was again administered ($t1$), and the participants started with one of the two BC conditions of typical BC or increased BC that lasted for 3 days each from Tuesday until Thursday. Additionally, they received an E-mail with a reminder to stick to their individual BC rate for the respective condition (baseline amount for typical BC and tripled baseline amount for increased BC). Before and after each 3-day episode of BC, subjects received an E-mail with a link to a survey in which they were asked to enter their daily recorded amount of BC for each of the 3 days separately and to again complete the trait-like battery ($t2$–$t4$).

Data Analysis

The statistical analyses were run using the software IBM Statistical Package for the Social Sciences [version 26; IBM, (50)], with the exception of the manipulation check of equivalence between the baseline and the typical BC condition, which was performed using jamovi [version 1.6 (51)]. In a first step, sociodemographic and health-related data were merged to *M*

(*SD)* and *Range*. To ensure a successful manipulation, we conducted 4 manipulation checks: First, the 2 sequences of typical and increased BC were tested for selection bias using analyses of variance (ANOVAs) with Bonferroni correction, with the within-subjects factor Condition (i.e., experimental, control) and the between-subjects factor Sequence (i.e., first typical BC or first increased BC). Second, *t*-tests for dependent samples were conducted to ensure the successful manipulation that participants actually increased their BC in the respective experimental condition. Third, to check for sequence effects, we conducted an ANOVA with the independent variable Sequence and the dependent variable Amount of BC. Fourth, to test for equivalence between the amount of BC at baseline and the amount of BC in the typical BC condition, two one-sided tests (i.e., TOST procedure) were used following Lakens et al. (52). The TOST procedure was calculated against the equivalence bounds stemming from the smallest effect size of interest of Cohen's $d = 0.5$, which is proposed by Norman et al. (53) for health-related outcomes. Equivalence between baseline BC and typical BC can be assumed if both of the one-sided *t*-tests for dependent samples are considered statistically significant (52).

To test the influence of BC on the trait-like battery as proposed in hypotheses I and II, we used repeated measures (multivariate) analyses of variance (rm-[M]ANOVAs) in a 2 × 2 design with the within-subjects factors Time (i.e., pre, post each checking episode) and Condition. To test for mean differences between typical BC and increased BC and for mean differences between pre and post 3-day BC episodes, we used single rm-MANOVAs for multifactorial measures, that is the dependent variables of ED pathology (EDI-2), and rm-ANOVAS for one-dimensional measures as the dependent variables of emotion (STAI-SKD, PANAS) and general pathology (PHQ-9). For the rm-MANOVAs, any significant effects were broken down into single rm-ANOVAs followed by pairwise comparisons. If the assumption of sphericity was not met for the dependent factors ($p < 0.05$ for Mauchly's test of sphericity), Greenhouse-Geisser-corrected degrees of freedom were applied. Effect sizes for the factor differences and interactions were reported using partial eta-squared (η_p^2). In accordance with Cohen (54), values are classified as small (0.01), moderate (0.06), and large (0.14). Regarding the functions of BC in hypothesis III, we descriptively examined *M* (*SD*) of single functions. To test the influence of the number of endorsed functions of BC in hypothesis IV, we used linear regression analyses with the number of functions assessed in preliminary questionnaires as the dependent variable and body dissatisfaction, negative affect, and the amount of BC as independent variables assessed after the typical BC episode.

RESULTS

Participant Characteristics

Participant characteristics are provided in **Table 1**, which reveals a mean BMI in the normal weight range (*Range* 18–34) and a mean age in the early twenties (*Range* 18–53). None of the participants exceeded the cut-off scores of the trait-like battery, which would have indicated a clinically severe level of symptoms, reflecting a level of body dissatisfaction in the sample which lies within the usual range for non-clinical subjects (55). Overall, the low prevalence of clinical symptoms indicates a healthy sample without eating disturbances.

Manipulation Checks

The manipulation was considered as successful. First, to rule out selection bias, regarding the equal distribution of participants across the two sequences (typical BC first or increased BC first), the ANOVAs showed no differences in the amount of typical BC at baseline [$F_{(1, 158)} = 0.734$, $p = 0.393$], in participants' sociodemographic characteristics, or on the trait-like battery (see **Table 1**). Second, regarding the amount of BC averaged over 3 days, the *t*-test for dependent samples indicated that participants performed BC significantly more often during the experimental condition than during the control condition [$t_{(144)} = 9.95$, $p < 0.001$]. However, while participants were asked to triple their BC in the experimental condition, mean comparisons indicated that they only doubled their amount of BC (typical BC: $M = 9.0$, $SD = 10.1$; increased BC: $M = 17.0$, $SD = 15.3$). **Table 2** shows the daily amount of BC in the typical BC and the increased BC condition. Third, there were no differences between the two conditions as a function of sequence for the typical BC [$F_{(1, 150)} = 0.893$, $p = 0.346$] or increased BC condition [$F_{(1, 148)} = 0.632$, $p = 0.428$]. Fourth, with respect to the test for equivalence between baseline and typical BC, the two one-sided *t*-tests were significant for the upper bound [Δ_U: $t = -7.09$ (149), $p < 0.001$] and for the lower bound [Δ_L: $t = 5.16$ (149), $p < 0.001$], depicting a 90 % CI [−1.19, 0.31], which lay between the bounds of −2.77 and 2.77 on a raw scale ($d = -0.5$–0.5). Therefore, baseline BC and typical BC can be considered as statistically equivalent. Exact BC rates of the experimental conditions are given in **Table 2**, and the checking rate for all participants from the 1-day baseline condition prior to the experimental manipulation lay at $M = 8.9$ times ($SD = 12.5$).

Hypothesis I and II: Effects Before and After Checking Episodes in Typical vs. Increased Body Checking

For the following results of the trait-like battery on ED symptoms, affect, and general pathology, *M (SD)* for the two conditions of typical BC and increased BC are presented in **Table 3**. All found main effects were of small effect size (54).

Eating Disorder Symptoms

No effects of BC on ED symptoms emerged in the present sample. When examining the EDI-2 subscales, the two-way interaction Time × Condition was not significant [$\Lambda = 0.99$, $F_{(2, 135)} = 0.78$, $p = 0.461$, $\eta_p^2 = 0.01$], nor were the main effects of Time [$\Lambda = 0.97$, $F_{(2, 135)} = 1.73$, $p = 0.181$, $\eta_p^2 = 0.03$] and Condition [$\Lambda = 0.97$, $F_{(2, 135)} = 1.96$, $p = 0.144$, $\eta_p^2 = 0.03$].

Affect

Regarding the emotional states of *Positive Affect* and *Negative Affect* within the PANAS, the two-way interaction Time × Condition [$\Lambda = 0.97$, $F_{(2, 134)} = 2.08$, $p = 0.129$, $\eta_p^2 = 0.03$] did not reach significance. However, the results revealed a significant

TABLE 1 | Means and standard deviations of demographic characteristics and trait-like measures.

Variable	Total sample ($N = 167$)		Sequence 1[a] ($n = 83$)		Sequence 2[b] ($n = 78$)		Statistics
	M	*SD*	*M*	*SD*	*M*	*SD*	
Age	23.8	6.5	23.3	5.7	23.9	6.6	$F_{(1, 159)} = 0.37$, $p = 0.542$
BMI[c]	23.3	10.7	23.9	14.2	22.7	5.4	$F_{(1, 159)} = 0.52$, $p = 0.472$
EDI-2 DT[d]	2.8	1.5	3.0	0.9	2.9	0.9	$F_{(1, 159)} = 0.09$, $p = 0.766$
EDI-2 BD[e]	2.9	1.3	3.1	0.4	3.0	0.4	$F_{(1, 159)} = 0.79$, $p = 0.375$
STAI-SKD[f]	1.5	1.3	1.6	0.6	1.7	0.6	$F_{(1, 159)} = 1.33$, $p = 0.251$
PANAS pos[g]	2.4	1.8	2.7	0.7	2.8	0.6	$F_{(1, 159)} = 0.93$, $p = 0.335$
PANAS neg[h]	1.2	1.8	1.4	0.4	1.4	0.6	$F_{(1, 159)} = 1.13$, $p = 0.289$
PHQ-9[i]	0.7	0.4	0.7	0.5	0.8	0.5	$F_{(1, 159)} = 0.52$, $p = 0.472$

To control for order effects, Statistics show results of the ANOVA between the two Sequences.
[a]First typical, then increased body checking. [b]First increased, then typical body checking. [c]Body Mass Index. [d]Eating Disorder Inventory-2, subscale Drive for Thinness. [e]Eating Disorder Inventory-2, subscale Body Dissatisfaction. [f]State-Trait Anxiety Inventory Short Version. [g]Positive and Negative Affect Schedule, subscale Positive Affect. [h]Positive and Negative Affect Schedule, subscale Negative Affect. [i]Patient Health Questionnaire-9.

TABLE 2 | Amount of checking in the typical checking and increased body checking condition.

Condition	Total sample				Sequence 1[a]				Sequence 2[b]			
	Typical[d]		Increased[e]		Typical[d]		Increased[e]		Increased[e]		Typical[d]	
	M	SD	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Day												
1	8.8	7.3	19.0	23.4	9.1	8.1	19.1	23.9	16.6	14.1	10.1	13.4
2	8.9	10.6	17.9	18.1	8.4	7.0	19.7	23.7	16.9	14.2	9.3	12.0
3	9.5	12.1	16.8	14.8	7.6	6.8	19.3	21.3	16.8	16.1	9.7	12.5
Day 1–3	9.0	10.0	18.0	19.0	8.4	6.8	19.4	22.6	16.8	14.4	9.7	12.4

[a]First typical, then increased body checking. [b]First increased, then typical body checking. [c]Body Checking Condition. [d]Typical Body Checking Condition. [e]Increased Body Checking Condition.

main effect of Time [$\Lambda = 0.95$, $F_{(2, 134)} = 1.85$, $p = 0.043$, $\eta_p^2 = 0.05$], but no significant main effect of Condition [$\Lambda = 0.99$, $F_{(2, 134)} = 0.57$, $p = 0.570$, $\eta_p^2 = 0.01$]. With regard to the factor Time, separate univariate *post-hoc* ANOVAs revealed significant main effects only for the subscale *Negative Affect* [$F_{(1, 135)} = 5.45$, $p = 0.021$, $\eta_p^2 = 0.04$] but not for the subscale *Positive Affect* [$F_{(1, 135)} = 1.49$, $p = 0.224$, $\eta_p^2 = 0.01$]. The mean values for *Negative Affect* were higher after each condition than before each condition, indicating an increase in longer-term negative affect after each 3-day BC episode. Regarding anxiety in the STAI-SKD, the interaction of Time × Condition was not statistically significant [$F_{(1, 136)} = 1.21$, $p = 0.273$, $\eta_p^2 = 0.01$]. However, the 2 × 2 rm-ANOVA yielded significant main effects of Time [$F_{(1, 136)} = 4.45$, $p = 0.037$, $\eta_p^2 = 0.03$] and Condition [$F_{(1, 136)} = 5.39$, $p = 0.022$, $\eta_p^2 = 0.04$]. *Post hoc* analyses revealed that the mean values for Time were lower after each BC episode than before each episode, suggesting a decrease in anxiety after each 3-day episode of BC. Moreover, a main effect of Condition emerged, insofar as participants in the increased BC condition generally showed less longer-term anxiety. Taken together, after a 3-day episode of BC, *Negative Affect* increased and anxiety decreased.

General Pathology

For changes in general pathology due to BC, the 2 × 2 rm-ANOVA for the PHQ-9 showed a significant interaction effect of Time × Condition [$F_{(1, 136)} = 0.97$, $p = 0.031$, $\eta_p^2 = 0.03$], revealing the pattern of an ordinal interaction: While participants in the increased BC condition showed increased general pathology, those in the typical checking condition showed fewer of these symptoms. Nevertheless, we found no main effects of Time [$F_{(1, 136)} = 0.20$, $p = 0.658$, $\eta_p^2 = 0.00$] or Condition [$F_{(1, 136)} = 0.98$, $p = 0.113$, $\eta_p^2 = 0.02$] in terms of general pathology.

Hypothesis III and IV: Functions of Checking

Regarding the endorsement of different functions of typical BC assessed in preliminary questionnaires, participants most often endorsed the function of attainment of certainty, followed by motivation, and the attainment of control. Exact means regarding the frequency of endorsement of all given BC functions are presented in **Table 4**. Regarding the number of endorsed functions of BC as a predictor of longer-term negative affect assessed after the 3-day typical BC episode, the multiple

TABLE 3 | Means and standard deviations for the respective conditions.

Condition	Time		EDI-2[a]		STAI-SKD[d]	PANAS[e]		PHQ-9[f]
			BD[b]	DT[c]		Positive affect	Negative affect	
Preliminary measures		*M*	3.10	2.90	1.68	2.71	1.39	0.76
		SD	0.46	1.10	0.57	0.68	0.48	0.48
Typical checking	Pre BC[g]	*M*	3.16	2.62	1.67	2.54	1.44	0.74
		SD	0.96	0.98	0.64	0.84	0.62	0.45
	Post BC[g]	*M*	3.18	2.61	1.54	2.56	1.54	0.70
		SD	1.00	0.96	0.59	0.81	0.43	0.47
Increased checking	Pre BC[g]	*M*	3.16	2.66	1.69	2.67	1.39	0.66
		SD	0.99	0.94	0.57	0.88	0.54	0.43
	Post BC[g]	*M*	3.19	2.63	1.58	2.60	1.53	0.69
		SD	1.02	0.82	0.58	0.87	0.44	0.42

[a]Eating Disorder Inventory-2, [b]Subscale Drive for Thinness, [c]Subscale Body Dissatisfaction. [d]State-Trait Anxiety Inventory Short Version. [e]Positive and Negative Affect Schedule, subscale Positive Affect and subscale Negative Affect. [f]Patient Health Questionnaire-9. [g]Body Checking.

TABLE 4 | Means (*M*) and standard (*SD*) Deviations of Functions of Body Checking.

Function of checking item	Frequency (*N* = 167)	*SD*
Avoidance of negative consequences	2.1	0.1
Further motivation	2.4	1.0
Estimating the possibility of concerns	2.1	0.9
Attainment of certainty	2.5	1.0
Achievement of control	2.3	1.0

correlation of $R = 0.25$ for the amount of typical BC and body dissatisfaction was found to be statistically significant [$F_{(1, 165)} = 10.88$, $p < 0.001$]. However, endorsement of a higher number of different BC functions did not lead to higher body dissatisfaction on the EDI-2 subscale ($ß = 1.62$, $p = 0.661$), but did significantly predict higher negative affect on the PANAS ($ß = 0.249$, $p < 0.001$) and a greater amount of typical BC ($ß = 0.261$, $p < 0.001$).

DISCUSSION

While many studies have investigated the short-term function of BC, that is to reduce negative affect, the proposed longer-term consequences of BC, to maintain negative affect and ED pathology (24, 29), have rarely been examined. Therefore, to confirm the longer-term maintaining consequence of BC, that is to increase negative emotions and eating-related cognitions, the present study investigated the course of affect, ED symptoms, and general pathology in non-clinical women over two 3-day BC episodes of unmanipulated typical BC and experimentally induced increased BC. Additionally, we were interested in further self-perceived functions of typical BC and in the extent to which the endorsement of a higher number of these functions predicted higher longer-term negative affect.

First, we hypothesized that in the longer term, engagement in BC would lead to an increase in negative affect, ED symptoms, and general pathology irrespective of the condition (i.e., typical BC or increased BC). As predicted, the performance of BC resulted in increased negative affect at the end of each 3-day BC episode compared to baseline, suggesting that BC behavior generally produces aversive emotions in the longer term. This is in accordance with theoretical assumptions of ED models [cf. (24)], which state that although engagement in BC relieves negative affect in the short term, it contributes to the maintenance of negative affect in the longer term. Contrary to expectation, anxiety, as a facet of negative affect, was lower in the longer term after an episode of BC compared with before the episode. This is in contrast to theoretical assumptions of a short-term decrease and a longer-term increase in negative emotions, which generally include anxiety. This discrepancy might be attributable to potentially different consequences in terms of anxiety between non-clinical individuals and patients with EDs. Studies in patients with EDs have shown that by engaging in BC, clinical samples become sensitized to the fear of uncontrollable weight gain (1, 56), likely because BC increases selective attention (57) toward disliked body parts (58). In turn, participants in the present non-clinical sample may have become habituated, rather than sensitized, to potential fear that is evoked by BC, as they do not experience self-devaluing thoughts (59, 60) and selective attention (37, 60) and show a rather balanced viewing pattern during BC (5, 61, 62). Thus, regarding the association between BC and affect overall, the present results suggest that although BC reduces anxiety for non-clinical subjects over time, the uncomfortable process of BC leads to a generally negative affect. Despite the ambiguity of our findings regarding anxiety, the longer-term increase in overall negative affect does indicate the predictive pathological value of BC, as proposed in etiological models [e.g., (29)].

Moreover, also contrary to expectation, we found no differences in ED symptoms between the beginning and end of a BC episode. Thus, participants' performance of BC did not lead to a longer-term change in concerns about size, weight, and shape. As such, our findings are not in line with theoretical assumptions that BC contributes to ED symptoms in the longer term (29). Likewise, the present results do not correspond to

other non-clinical research on short-term functions of BC, which reported a strong positive association between BC and eating pathology regarding ED symptoms (6), feelings of fatness (31), or body dissatisfaction (63, 64). Unlike the aforementioned research on short-term functions of BC that suggest an influence of BC on ED pathology, the one other study that examined longer-term consequences, by Bailey and Waller (23), also found no changes in weight and shape concerns in non-clinical women as a consequence of BC. Longer-term consequences of BC on the maintenance of ED pathology have been theoretically proposed (24, 29) but are yet to be empirically confirmed. Similarly, with regard to long-term consequences of BC, in an ecological momentary assessment study, Sala et al. (36) did not find that BC predicted ED pathology such as future bulimic symptoms, drive for thinness, or body dissatisfaction in a sample diagnosed with an ED. This suggests that the absence of effects on ED pathology that is shown in the longer term also continues in the long term.

While an integration of our longer-term findings into research that deviates from theory raises the question of consistency, a potential pattern emerges when examining the time ranges of measurements: In studies that reported short-term associations between BC and eating pathology, the changes were short-lived (18) and subsided after 10 (64), 15 (21), or 30 min (31). In the longer term and the long term, in studies in which participants actually checked their body in a naturalistic setting, no associations between BC and eating pathology were found 1 day (23), 3 days (i.e., our study), or 1 month (36) after BC episodes. Potentially, the influence of BC on ED symptoms therefore subsides in the longer term. Nonetheless, although no effects on ED symptoms emerged, the present results did reveal that BC increased negative affect. Therefore, the impact on eating pathology might be more time-sensitive than the impact on affect [cf. (65)]. The discrepancy between our findings and ED theory highlights the need for further research on the longer-term consequences of BC in order to clarify the impact of BC on ED symptoms.

Our second hypothesis examined the impact of frequency on BC. Specifically, we expected negative affect, ED symptoms, and general pathology to be higher in the experimental condition of increased BC than in the control condition of typical BC. While there were no differences between conditions regarding negative affect or ED symptoms, anxiety was even found to be lower in the increased BC than in the typical BC condition. This lends further credibility to the results from hypothesis I, indicating that BC has an anxiolytic function in non-clinical subjects in the longer term. Moreover, BC impacted general pathology insofar as the experimental condition was associated with greater general pathology. This corresponds to theoretical models on EDs which assume that a higher frequency of BC leads to a higher likelihood of ED maintenance (4). Our findings on the negative consequences of increased BC are complemented by previous research reported that a higher amount of BC negatively influences general mental health and quality of life (66) as well as symptoms of ED (5, 18). Further highlighting the pathological impact of a higher frequency of BC, questionnaire-based (7, 67) and retrospective (32) studies found that BC frequency was lower in non-clinical individuals than in patients with EDs, especially BN (7). Combined with the negative impact on increased BC found in our non-clinical sample, this leads to the assumption that the amount of BC can be taken as a broad indicator of the pathological significance of BC.

Besides the negative consequences of increased checking, we found an unexpected decrease in general pathology in the control condition, indicating that our non-clinical participants seem to have benefited from typical BC. This finding is in contrast to theoretical assumptions defining BC as a dysfunctional behavior that, regardless of frequency, contributes to the maintenance of EDs [(68), p. 104]. However, the positive impact of typical BC on general pathology found in the present study may stand to reason when considering BC as dimensional and when referring to the second safety behavior, namely body avoidance (28). Often, avoidance and checking are regarded as two opposite poles of safety behavior (5, 18) that may fluctuate and alternate (4) and that are therefore both theoretically regarded as disorder-maintaining (5). On the one hand, the mechanism of avoiding looking at certain body parts is seen as preventing confrontation with reality (27). On the other hand, the mechanism of increased checking is considered to magnify perceived imperfections (4). Consequently, along with increased BC, body avoidance is likewise regarded as dysfunctional. In view of the harmful nature of both high body avoidance and high BC, the present results on the potential helpfulness of typical BC suggest a "just right" amount, indicating that a healthy amount of typical BC might be a protective factor in the longer run.

It is therefore possible that our non-clinical participants naturally tended to check only up to their healthy limit, but not beyond this, which might explain why they only doubled their checking in the increased BC condition even though they were tasked to triple it. If replicated, this "just right" amount of BC may thus be a distinguishing factor between non-clinical and clinical individuals, according to which patients with EDs may have lost their sense of healthy typical BC. The assumed existence of a non-harmful amount of BC might further explain why non-clinical individuals also frequently scrutinize their bodies without developing clinical pathology (6, 9). Still, the assumed inverted U-shaped association of BC is not compatible with ED models and needs to be replicated and further examined by including clinical samples.

As expected in our third hypothesis, the attainment of certainty and motivation were the functions of highest relevance for our non-clinical population. This is in line with findings in patients with ED symptoms reported by Hartmann et al. (32). In the latter study, the authors reasoned that the importance of attainment of certainty was explained by the fact that patients with EDs often experience an intolerance of uncertainty. The concept of intolerance of uncertainty is related to checking (69) and indicates that a situation (e.g., not knowing how one looks in a mirror) is difficult to endure (70, 71), leading to reassurance behavior such as BC. However, intolerance of uncertainty likewise exists in healthy individuals (72–74). While our non-clinical women also seemed to engage in BC in order to attain certainty, intolerance of uncertainty might again be the leading motivator for the craving for certainty in this sample.

Given that both patients with ED and non-clinical women seem to strive to attain certainty, this function might be less of a distinguishing factor between the two groups. Instead, irrespective of population, intolerance of uncertainty might act as a negative reinforcer of BC, as is assumed by the theoretical models with respect to negative affect (29).

Likewise, in line with findings from patients with ED symptoms (32), to further motivate oneself was a second important reason for engagement in BC in our sample. However, motivation might be construed differently in non-clinical individuals and patients with EDs. In the clinical population, patients often pursue ambitious objectives regarding shape and weight (75), meaning that they might need BC to further motivate themselves to hold on to rather unintuitive compensatory strategies (e.g., restrictive eating). In our non-clinical subjects, by contrast, the motivation to check one's body might not originate from a dysfunctional pattern. In the case of a less pronounced drive for thinness (76, 77) and a lower attentional bias toward unattractive body parts (78), BC might motivate healthy individuals to keep on liking their body or to adopt a more balanced lifestyle through realistic feedback rather than further weight loss. Again, regarding the function of motivation from a non-pathological perspective, BC could be rather a protective factor for non-clinical women in the longer term.

In line with our fourth hypothesis, the endorsement of a greater number of BC functions predicted negative affect and the amount of typical BC, indicating that the number of functions of BC impacted mood and the typical rate of BC. This result might be interpreted in light of the findings of Wilhelm and colleagues (21), who reported that when participants endorsed a higher number of BC strategies, they tended to show greater body dissatisfaction. While our goal was to transfer the results found for BC strategies to BC functions, the present results support the suggestion that not only does an increased number of BC strategies lead to body dissatisfaction (21), but that an increased number of functions fulfilled by BC may also lead to negative affect. Yet, according to the present results from hypotheses III and IV, our non-clinical participants did not endorse different types of functions of BC than patients with EDs [cf. (32)]. However, the present results revealed that a higher number of endorsed functions of BC led to greater negative affect. It might be suggested that the reasons for and causes of BC may be less relevant than the amount of BC, which fosters the maintenance of ED pathology.

The present study was the first to examine longer-term consequences of BC in non-clinical females in a natural environment. Nevertheless, some limitations should be mentioned when interpreting the results. First, we did not monitor the participants' compliance with the BC instructions. As our BC conditions were implemented in participants' daily life and relied on self-disclosure, we were unable to verify whether BC was actually performed and if so, whether participants recorded it every time. Moreover, even if participants did perform BC as instructed, we still cannot rule out that they partially avoided checking their least-liked body parts and only concentrated on the liked ones. Furthermore, there is a risk of recall bias, as participants only rated their emotions every 3 days, after the interventions. However, this possibility may have been decreased by the real-time app-based tracking of the amount of BC and by the fact that the questionnaire instructions were modified to reflect emotions of the last 3 days. Nevertheless, to control for avoidance and reliability, we suggest the usage of ecological momentary assessment or E-mail/text message prompting [e.g., (79)], which monitors omissions, allows for time-based and event-based sampling plans, and enables compliance to be checked in the moment. In a potential study design with ecological momentary assessment or smartphone-based prompting, participants could therefore still check their body in an typical and in an increased manner, but instead of only covering affect and body dissatisfaction in a trait-like concept every 3 days, participants might provide a state-like response directly after performing BC. This might be useful to learn more about the time course of BC. Likewise, we recommend replications with psychophysiological assessments (80), eye-tracking [cf. (81)], and interview-based data (35).

Second, future studies should conduct adapted replications in diverse subsamples. Heterogeneity in our sample was lacking in terms of gender, age, and mental health status, as we only included non-clinical women who were mostly in their early twenties and in the normal weight range. Regarding gender, similar affective responses to BC have been previously demonstrated in males in the short term (65), but the transferability to longer-term consequences has not yet been examined. Furthermore, as shown in previous research, BC is even more evident in samples with body image disturbances (15). Therefore, the inclusion of an ED sample might have magnified the present results or revealed different longer-term effects. As a further limitation, we restricted BC in terms of ED pathology. However, checking behavior occurs not only in body image disturbances, but also in various psychological diagnoses such as obsessive-compulsive, illness anxiety or panic disorder [cf. (32)], the longer-term consequences of which have not yet been fully investigated.

Third, patients with EDs are often unaware of the degree to which repeated checking has increased [(68), p. 103]. It has not yet been examined whether non-clinical individuals are also usually unaware of their BC or potential fluctuations therein. Therefore, we cannot rule out that changes, especially in the typical BC condition, are caused not only by BC itself but also by participants' heightened selective attention on the subject of BC and thus also their body. In terms of the Hawthorne effect (82), this might have led to an overestimation of the frequency of BC behavior and an increase in negative valence on the employed measures. To reduce the likelihood of selective attention bias, we implemented a 1-day baseline before the experimental manipulation started, meaning that a potential peak caused by selective attention would have become visible at the baseline level, and used this as a reference for changes throughout the typical BC condition. With respect to the small effect sizes of all dependent variables, it is further possible that the effects may have been caused by usual test inconsistencies rather than by the manipulation. Therefore, we chose instruments with a high internal consistency and test-retest reliability and adapted the

time frame to reflect only about the last 3 days, corresponding to the time frame of the respective checking episode. Nevertheless, due to these limitations, our findings should be interpreted with caution, and need to be replicated in investigations employing longer BC episodes.

Fourth, regarding subsiding effects, the time course of functions of BC is vague, and research has not yet revealed when, exactly, BC leads to the proposed relief from negative affect in the short term and when it turns into the longer-term consequence of maintaining negative affect. Therefore, validation is needed to confirm the time frame within which longer-term consequences are attributable to multiple BC episodes. Additionally, a follow-up episode examining not only longer-term, but also long-term consequences should be considered in future research. Furthermore, we did not track the length of each individual BC episode. While some studies argue that BC is generally quite brief [i.e., < 2 min (64)], other authors assume it to be time-intensive [e.g., in BDD (83)]. Therefore, the length of an episode might be another potential influencing factor that needs to be examined prospectively.

Despite these limitations, the present study was the first to examine longer-term consequences of increased BC in non-clinical women. With respect to the postulates of models on the development and maintenance of EDs (24, 29), the present results suggest that the theories might be refined to include a detailed differentiation between concrete time periods that comprise short-term, longer-term and long-term consequences of BC. Furthermore, a specification of the potentially varying effect of a different frequency of BC is warranted, as we found a rather positive impact of typical BC but a negative impact of increased BC. Additionally, based on the present results, theories should consider adaptations to non-clinical populations, who – like clinical samples – tend to perform BC, but who possibly experience a more positive longer-term outcome after BC in terms of the motivation for healthy living instead of the motivation to continue with compensatory behaviors (e.g., dietary restriction).

Based on the present finding that BC leads to the maintenance of negative affect in the longer term, implications for therapy and preventive programs might be derived from our study. For patients with ED, the influence of BC on mood, which was even demonstrated in our non-clinical sample, suggests that treatment should encompass psychoeducation on the vicious cycle of BC [(68), p. 104]. Nevertheless, our findings suggest the benefit of a "just right" amount of BC. If our findings in non-clinical women are replicated and transferred to a clinical sample, the performance of BC should no longer be stigmatized as generally perilous [(68), p. 108], and its strict reduction should therefore not be aimed for in therapy. Instead, a balanced pattern of BC is potentially more helpful and protective. With respect to non-clinical or subclinical persons, low-threshold programs that detect a dysfunctional high rate of BC as an early warning sign for the development an ED may contribute to ED prevention.

CONCLUSION

This study was first to examine longer-term consequences of increased BC. It supports the findings of the one previous study on the long-term impact on BC (23) by revealing that the empirical transfer of etiological ED models on BC remains limited. We found that although the longer-term increase of negative affect due to BC was in line with the assumptions of ED models, eating pathology did not change in accordance with BC. Furthermore, contrary to the assumptions on BC proposed in ED models (24), BC appeared to have an anxiolytic effect in the longer term, and typical BC even had a positive impact on general pathology. Thus, the present findings suggest a healthy impact of BC in non-clinical persons. Increased BC, however, as is more pronounced in patients with EDs (15), led to higher anxiety and higher general pathology in the longer term, which indicates negative consequences of too much BC. As BC fulfills similar functions in ED patients and non-clinical individuals, the results hint at the role of quantity as a determining factor leading to (dys)functional BC. Derived from the present results, we propose adaptations of the ED theory for non-clinical samples, insofar as a balanced BC behavior might serve as a protective factor in non-clinical individuals and could be a treatment target in patients with body image disturbances (84).

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

AH and SV contributed to the conception and design of the study, which was elaborated with the assistance of VO and M-BV. VO wrote the first draft of the manuscript and collected and analyzed the data. All authors contributed to the revision of the manuscript and read and approved the submitted version.

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Patients With Super Obesity Do Not Perceive Themselves as Being at Higher Risk for a More Severe Course of COVID-19 Infection

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Background: The coronavirus disease 2019 (COVID-19) pandemic has led to major health-related concerns in the population. Several risk factors for a severe course of COVID-19 disease have been identified, with obesity taking an important role. However, it is unclear whether this association is only known in the expert world or whether individuals also experience themselves as risk patients due to their obesity and whether the desire for weight reduction may also be associated with a hoped-for risk reduction. These questions were addressed in a cross-sectional study of patients who have presented to an obesity center in order to lose body weight.

Methods: Patients ($n = 155$) of the obesity center were asked to complete an *ad hoc* questionnaire to assess whether the desire to lose weight is also associated with a hoped-for risk reduction with respect to COVID-19 disease during the middle of the pandemic in the period between October 2020 and April 2021. We additionally assessed their perceived general stress using the Perceived Stress Questionnaire (PSQ).

Results: In our explorative study, overall worries correlated significantly with worries about contracting COVID-19 ($r = 0.483$, $p < 0.001$). There has been an association with concerns about severe COVID-19 progression and psychological distress from the COVID-19 pandemic ($r = 0.543$, $p < 0.001$). In addition, a correlation was found between persons who worry about contracting COVID-19 and feeling like an at-risk patient ($r = 0.530$, $p < 0.001$). Interestingly, the higher the BMI (>50 kg/m^2), the lower were the worries in PSQ (ANOVA $p = 0.046$). However, COVID-19-related worry was nonetheless present in the higher BMI subgroups. The most intense worries were experienced by individuals with a BMI between 35 and 39 (PSQ worries 50.44), immediately followed by individuals with a BMI between 40 and 49 (PSQ worries 49.36).

Discussion and Conclusion: An increased risk for a more severe course of COVID-19 infection is not generally perceived by obese individuals. In particular, individuals with very high BMI (>50)—although being at very high risk for a severe course of the COVID-19 disease—do not display increased worries, which might point toward heightened denial.

Keywords: obesity, body perception, desire for weight reduction, risk factors, risk patients

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) was caused by a novel coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (1). The mild to moderate form of COVID-19 illness is associated with cough, fever, and fatigue. However, if a severe course of COVID-19 disease is present, it can lead to pneumonia, respiratory failure, multiorgan failure, and ultimately death (1, 2). The number of global deaths associated with COVID-19 disease increased to 4.86 million confirmed deaths by mid-October 2021 (3). In light of the ongoing COVID-19 crisis, studies have been initiated worldwide to investigate the severity of the disease and health risk factors. Some studies have already been able to identify confirmed risk factors that may cause COVID-19 disease to be life-threatening (4). Some research manifested that elderly patients and patients with chronic pre-existing conditions such as obesity, cardiovascular disease, diabetes, cancer, and chronic respiratory and renal diseases are vulnerable to severe COVID-19 disease (5–7).

There is no clear evidence of an increased risk of contracting COVID-19 due to existing obesity. On the other hand, it has undoubtedly been identified that obesity must be considered an underlying risk factor for severe COVID-19 disease progression. A recent study in England showed a linear increase of risk of severe COVID-19 starting from BMI $\geq$23 (7–9). Obesity as an important risk factor for a severe COVID-19 course is characterized by increased hospital admissions, intensive care, and ventilator requirement with fatality (10). This risk liability even emerges independently of age, gender, and comorbidities (7, 9). Thus, there is the worrying increased risk for severe COVID-19 progression in obesity and other chronic diseases that are often concomitant and secondary to obesity. For subjects with obesity, the COVID-19 pandemic therefore entailed enormous challenges.

The lockdown certainly had the potential to promote weight gain through social isolation, an accompanying lack of physical activity, and the swelling of the stress gamut that often accompanies increased consumption of unhealthy foods (11–13). Both depression and anxiety disorders can be severe psychological comorbid diseases, which can be aggravated by the above-mentioned COVID 19 consequences and accordingly promote the risk of a severe COVID-19 disease course (11). We examined whether subjects with obesity perceive themselves as being at-risk patients regarding a COVID-19 infection, and if so, whether they are afraid of an infection or willing to reduce weight because of this risk. Ultimately, we investigated whether the desire for weight reduction of patients with obesity may also be related to a hoped-for risk reduction for a COVID-19 disease.

METHODS

Procedure

We conducted an explorative cross-sectional online survey to assess whether the desire to lose weight is also associated with a hoped-for risk reduction with respect to COVID-19 disease course or progression. The study was carried out between October 2020 and April 2021 at the University Hospital in Tübingen. The patients who have presented to our obesity center in order to lose body weight have been examined at the psychosomatic outpatient clinic at the University Hospital in Tübingen from psychologists and psychosomatic doctors. All patients in the study period were offered the opportunity to participate in the survey. The patients, who had given their written consent after detailed information and explanation of the study, participated in the anonymous data collection. The questionnaire was handed out in digital form by email after each consultation. The study was approved by the local ethics committee (458/2020BO).

Sample

A total of 155 patients (113 female, 42 male) participated in the survey. We had to exclude one female and one male participant because of invalid data regarding weight and height (final n = 153). The following analyses are based on the descriptive and psychometric data collected using the online questionnaire.

Survey

In total, the questionnaire consisted of three subject areas:

- "patient characterization" with three nominally (patients' wish for obesity treatment, treatment received or current treatment, and month of appointment) and five metrically (age, sex, weight, height, and comorbidities) scaled items;
- "COVID-19-related concerns" with one nominally scaled item (COVID-19 infection in the past—yes, no) and nine items recorded on Likert scales (ranging from 0 = do not agree at all to 100 = agree fully—see **Table 1**); and
- the standardized questionnaire "Perceived Stress Questionnaire" (PSQ) (14). The "PSQ" encompassed 20 items recorded on a 4-point Likert scale with the categories "almost, never, sometimes, often, most of the time" and measures worries, tension, joy and demands on patients (15). Cronbach's alpha and split half reliability for subscales is >0.70.

Statistical Analyses

The analyses were performed using the statistical software IBM SPSS Statistics (version 27, IBM Corp, 2017). Sociodemographic characteristics were analyzed descriptively. After assessing normal distribution of data, differences were assessed using a t-test and χ^2-test. In addition, ANOVAs were used to test whether BMI (grouped) had an impact on COVID-19-related worries or general worries. Spearman correlation analyses were performed to examine associations, e.g., between COVID-19-related concerns and PSQ concerns. Because of the explorative manner of this study, we did not perform a power analysis and did not adjust for multiple testing.

RESULTS

Patient Characterization

The study population consisted of 153 patients (112 female, 41 male). The mean age was 43.0 years (range = 18–77 years, SD 12.8). BMI ranged from 31.2 to 61.7 kg/m^2, average 45.4,

TABLE 1 | COVID-19-related concerns.

Question	Average 0 (strongly disagree) to 100 (strongly agree)
Anxiety and worries	
(1) How much psychological distress do you feel as a result of the COVID 19 pandemic?	40.98 (SD 27.78)
(2) I am worried that I will get COVID-19 myself.	35.95 (SD 32.04)
(3) I am concerned that COVID-19 disease will take a severe course in me.	43.92 (SD 35.99)
(4) I am generally quick to worry or fret.	34.72 (SD 33.88)
(5) I have withdrawn socially because of my concern about contracting COVID-19.	33.64 (SD 34.74)
Risk perception	
(6) I feel like I am an at-risk patient because of my obesity.	48.48 (SD 39.27)
(7) Reducing the risk of getting severely ill with COVID-19 is an important motivation for me to reduce weight.	41.92 (SD 39.22)
Control	
(8) I have the feeling that the state and the relevant authorities have the situation regarding COVID-19 under control.	40.63 (SD 28.97)
(9) I feel sufficiently informed with regard to COVID-19.	59.66 (SD 32.70)

TABLE 2 | Patient characterization.

Characteristic	*n*	%
Gender		
Male	41	26.8
Female	112	73.2
BMI group		
BMI 30–34.9 kg/m^2 (group 1)	3	2.0
BMI 35–39.9 kg/m^2 (group 2)	30	19.6
BMI 40–49.9 kg/m^2 (group 3)	89	58.2
BMI >50 kg/m^2 (group 4)	31	20.3
Comorbid diseases		
Arterial hypertension	73	47.7
Hyperlipoproteinemia	28	18.3
Diabetes mellitus	30	19.6
COPD	3	2.0
Sleep apnea	44	28.8
Joint degeneration	73	47.7
Depression	43	28.1
Anxiety disorder	14	9.2
No comorbid diseases	30	19.6
Desired treatment		

	Conservative treatment (guided weight loss)		Bariatric surgery	
	n	%	*n*	%
BMI group 1 ($n = 3$)	0	0.0	2	66.7
BMI group 2 ($n = 30$)	20	66.7	15	50.0
BMI group 3 ($n = 89$)	28	31.5	78	87.6
BMI group 4 ($n = 31$)	3	9.7	29	93.5
			χ^2 (3) = 20.55 $p < 0.001$	

N = 153 subjects. Desired treatment: patients could choose multiple options; therefore, here the number exceeds n = 153.

SD 6.2. Two percent reported a BMI between 30 and 34.9 kg/m^2, 19.6% BMI 35 to 39.9 kg/m^2, 58.2% BMI 40 to 49.9 kg/m^2, and 20.3% had a BMI >50 kg/m^2 (**Table 2**); 77.1% reported one or more somatic comorbidities, and 31.4% reported psychological comorbidity (depression and/or anxiety disorder); 19.6% reported no comorbid diseases (**Table 2**). There has been no significant correlation between BMI and number of reported somatic as well as psychological comorbidities. Patients' desired treatment related to BMI groups shows an increase of desired bariatric treatment with higher BMI, while conservative treatment decreases [see **Table 2**, χ^2 (3) = 20.55, $p < 0.001$].

COVID-19-Related Concerns

A COVID-19 infection was reported by 3.3%. Patients' concerns related with COVID-19 have been moderate to medium. On average, patients stated that they feel like being an at-risk patient because of being obese with 48.5 on a scale from 0 to 100. Their motivation to reduce weight because of thereby reducing the risk of getting severely ill with COVID-19 has been 41.9 on average. Feeling sufficiently informed with regard to COVID-19 has been 59.7 on average (see **Table 1**).

Overall worries (question 4) correlated significantly with worries about contracting COVID-19 (question 2; $r = 0.483$, $p < 0.001$; **Figure 1A**) and the worries scale in PSQ ($r = 0.477$, $p < 0.001$; **Figure 1B**). We found significant positive but small correlation between BMI and motivation to reduce weight (question 7; $r = 0.195$, $p = 0.016$; **Figure 1C**) but no significant correlations between BMI and COVID-19-related concerns (e.g., question 3; $r = 0.021$, $p = 0.793$; **Figure 1D**). There was a medium to large significant correlation between feeling like an at-risk patient (question 6) and all questions about anxiety and worries (1–5, $r = 0.393$ to $r = 0.674$, $p < 0.001$; e.g., question 3; $r = 0.674$, $p < 0.001$; **Figure 1E**) as well as a small significant correlation with worries in PSQ ($r = 0.237$, $p = 0.003$; **Figure 1F**).

Patients seeking conservative vs. surgical treatment did not differ in COVID-19-related concerns (*t*-test) with two exceptions: Patients asking for bariatric surgery reported significant lower worries to get COVID-19 (question 2; mean ± SD: 33.03 ± 31.21 vs. 48.45 ± 33.07, $p = 0.019$) and lower worries in general (question 4; 31.94 ± 33.34 vs. 46.62 ± 34.15, $p = 0.035$).

PSQ

A significant effect was found in ANOVA related to the PSQ scale worries and BMI groups [$F_{(3,149)} = 2.74$, $p = 0.046$]. The patients with highest BMI (group 4, average value 35.70) reported significantly less worries than group 3 ($p = 0.031$; **Figure 2**). It should be noted that in the worries scale, BMI group 2 with the value 50.44 and BMI group 3 with the value 49.36 were above the

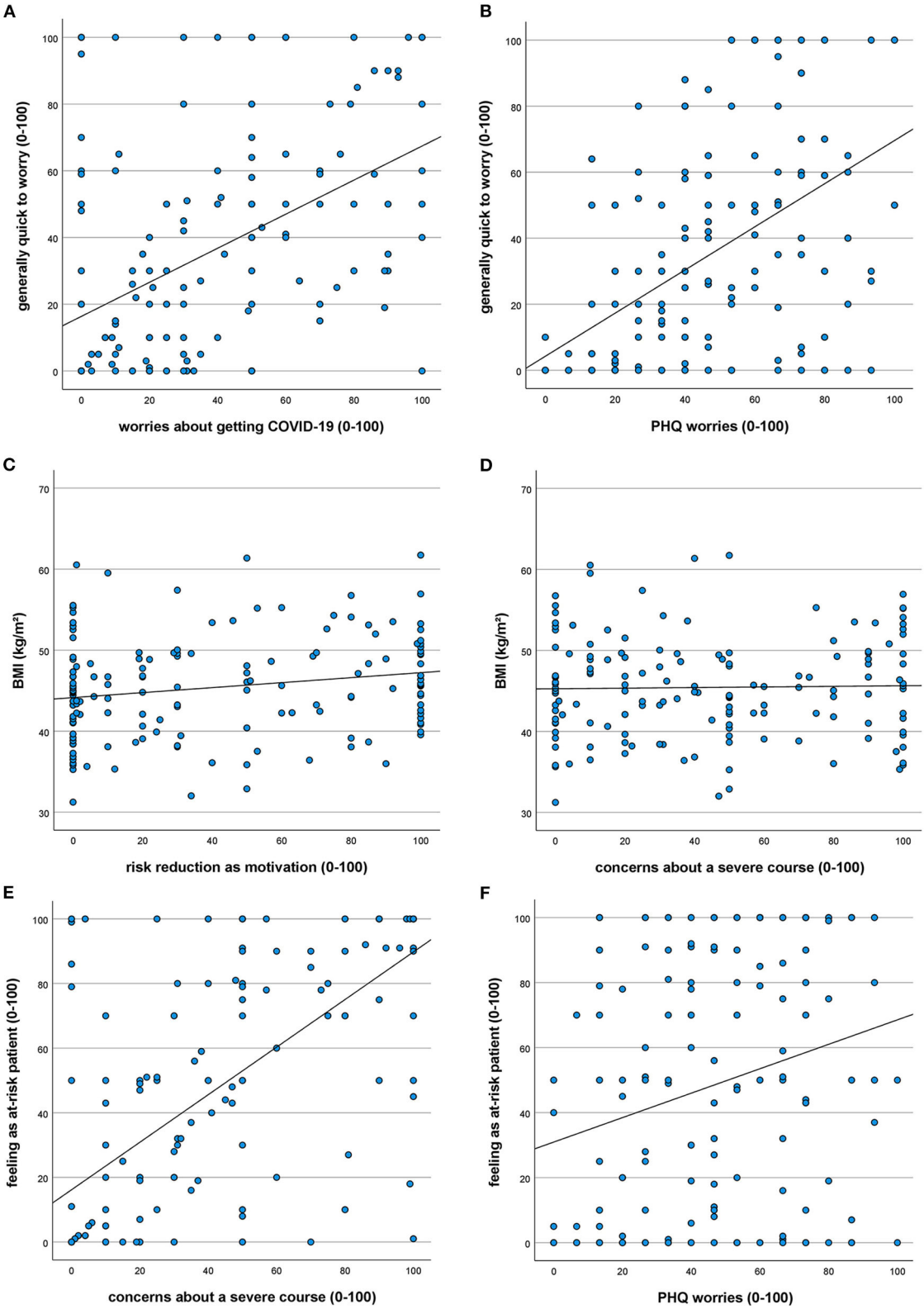

FIGURE 1 | Correlations regarding COVID-19-related concerns. **(A–F)** Data are displayed as scatterplots with fit line.

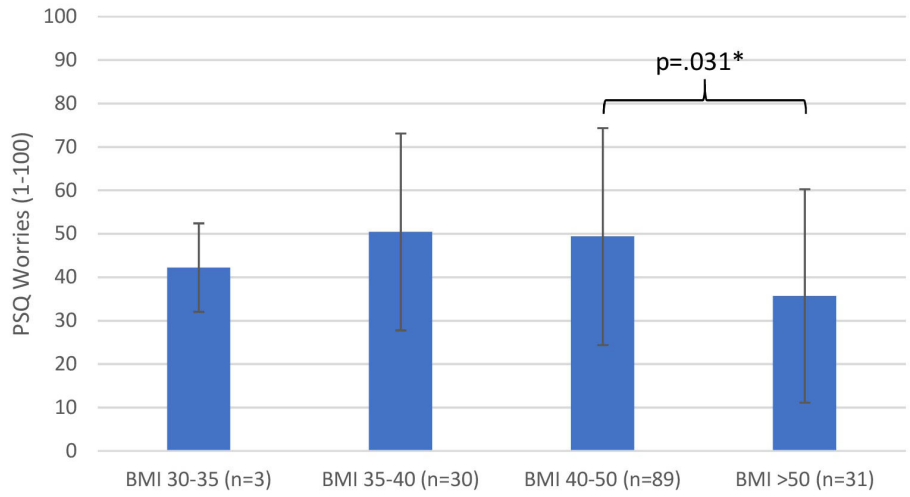

FIGURE 2 | PSQ scale worries. Data are displayed as mean ± SD. *$p < 0.05$ as assessed by ANOVA and Tukey *post-hoc* test.

TABLE 3 | Perceived stress questionnaire.

Perceived stress questionnaire	Average	SD
Worries		
BMI group 1 ($n = 3$)	42.22	10.18
BMI group 2 ($n = 30$)	50.44	22.67
BMI group 3 ($n = 89$)	49.36	25.00
BMI group 4 ($n = 31$)	35.70	24.56
	$F_{(3,149)} = 2.739$	$p = 0.046$
Tension		
BMI group 1 ($n = 3$)	46.67	13.33
BMI group 2 ($n = 30$)	58.22	21.65
BMI group 3 ($n = 89$)	53.63	25.00
BMI group 4 ($n = 31$)	45.81	25.22
	$F_{(3,149)} = 1.451$	$p = 0.230$
Joy		
BMI group 1 ($n = 3$)	37.78	26.94
BMI group 2 ($n = 30$)	44.00	21.63
BMI group 3 ($n = 89$)	45.84	23.43
BMI group 4 ($n = 31$)	52.47	20.78
	$F_{(3,149)} = 1.013$	$p = 0.389$
Demands		
BMI group 1 ($n = 3$)	51.11	13.88
BMI group 2 ($n = 30$)	51.56	23.35
BMI group 3 ($n = 89$)	44.57	22.60
BMI group 4 ($n = 31$)	38.71	18.57
	$F_{(3,149)} = 1.836$	$p = 0.143$
PSQ total		
BMI group 1 ($n = 3$)	50.56	12.29
BMI group 2 ($n = 30$)	54.06	17.87
BMI group 3 ($n = 89$)	50.43	19.75
BMI group 4 ($n = 31$)	41.94	18.50
	$F_{(3,149)} = 2.270$	$p = 0.083$

Differences between groups were assessed by ANOVA and Tukey post-hoc test.

cutoff value of the general population (cutoff value PSQ: worries 6.0–46.0). No significant differences have been found for total PSQ as well as the other subscales tension, joy, and demands among BMI subgroups (see **Table 3**).

DISCUSSION

In the present explorative study, we assessed COVID-19-related concerns and the related motivation to reduce body weight in a naturalistic setting in the middle of the pandemic using a population of subjects presenting to an obesity center with the aim to reduce body weight.

Using an *ad hoc* questionnaire, obese patients (BMI range 31.2 to 61.7) reported medium values for the feeling of being at-risk for a severe course of a COVID-19 disease. On the other hand, they reported values above average (59.66, 0–100) in feeling sufficiently informed with regard to COVID-19. The motivation to reduce weight because of thereby reducing the risk of getting severely ill with COVID-19 was scored at below medium levels. Interestingly, COVID-19-related concerns and BMI did not show a correlation, giving rise to the assumption that increasing BMI does not increase the perception/awareness of being at higher risk for a severe course of the COVID-19 disease. In addition, when clustering patients according to BMI groups, the group with the highest BMI (>50) even showed decreased levels on the worries scale of the Perceived Stress Questionnaire.

Although the risk factor obesity for a severe course of the COVID-19 disease is well known to medical professionals (7, 8, 16), this might not be true for the lay public. How can we communicate an elevated risk to at-risk patients in another way with encouraging character that helps them to care for themselves? Communicating worries and stirring up fears do not seem to work properly and may have unwanted side effects like stigmatization (17). In particular, obese patients who experienced an inability to reduce weight on their own in the

past could be in danger of giving up and denying the risk. This can be exacerbated by continuing to communicate only the risk, which can be overwhelming and forcing a respective denial. Therefore, the motivation to reduce weight should be separated from the communication of an increased risk due to obesity and should not be used as an argument when accompanying decision-making. When communication about a risk is combined with a choice of viable alternative actions to reduce it, self-efficacy can be increased—an important motivator for behavior change (18). Another reason for the observed low levels of worries in the group of highest BMI could be anxious components, which lead to increased apathy and less concern about contracting the virus. We did not measure anxiety in our study, which could be an interesting parameter for further studies.

One major strength of the study is that it has been conducted in the middle of the COVID-19 pandemic. Because of this and its naturalistic design, we think that it can contribute to the considerations on how obese patients could be motivated when communicating new risk information. Restrictions are the cross-sectional and self-reported design. As we only used a narrow psychometric test with PSQ, there could be confounders in our data that we did not detect and therefore cannot explain. Because of the explorative manner, the small sample size, and small correlations, our study cannot be generalized to the average population. Furthermore, it is limited to the assessed geographic region.

CONCLUSION

Our findings suggest that risk communication for obese patients in the context of COVID-19 did not work very well for all patients, especially for individuals with very high BMI (>50). We did not find a strengthened wish for reducing weight to reduce the risk for a severe course of COVID-19. Future studies in this area should focus on post-COVID-19 times and try to examine how risk perception of people with obesity changed. This could also have an impact on the desire for bariatric surgery or conservative treatment. They could also focus on the aspect of how to motivate obese people for weight reduction in the context of communicating risks for sequelae and take possible moderating demographic variables into account.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Committee of the University Hospital Tuebingen. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

NS and JL performed the data analysis and wrote the first draft of the manuscript. AS, NS, RA, IM, and SZ planned and initiated the study. AS conducted the data generation and gave critical input throughout the study. All authors finalized the manuscript.

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Social Network Site Appearance Comparison's Prediction of Anxiety Among Chinese Females: The Mediation Effect of Body Area Satisfaction, Overweight Preoccupation, and Self-Esteem

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Social network site appearance comparison refers to a tendency to compare the body image of one-self to others when using social network sites. It was found to be associated with negative emotions, for example, depression, among young females, and this association was mediated by body image and self-esteem. However, researches on the chain-mediating role of body image and self-esteem in anxiety had been limited. Therefore, the current study examined the chain-mediating role between social network site comparison and anxiety among 320 Chinese females, using the Social Network Site Appearance Comparison Scale (SNSACS), Multidimensional Body–Self Relations Questionnaire (MBSRQ), Self-esteem Scale (SES), and the anxiety subscale of Depression-Anxiety-Stress Scale (DASS). Results revealed that (1) SNSACS, SES, and DASS anxiety scores were significantly correlated with each other, and the scores of two MBSRQ subscale, that is, body area satisfaction and overweight preoccupation, were significantly correlated with SNSACS, SES, and DASS anxiety scores; (2) body area satisfaction and self-esteem played a chain-mediating role in the effect of social network site appearance comparison on anxiety; (3) overweight preoccupation and self-esteem played a chain-mediating role in the effect of social network site appearance comparison on anxiety. The findings may inspire new ideas for understanding how social comparison triggers anxiety and for developing methods to reduce anxiety derived from appearance comparison among Chinese females.

Keywords: social network site appearance comparison, multidimensional body-self relations, self-esteem, anxiety, overweight preoccupation, body areas satisfaction

INTRODUCTION

In today's society, the demands on women's body shape are getting higher and higher. An ideal female body is considered to be not only slim, but also in perfect proportion. These high standards make the idea of beauty less healthy and natural, as more women are using weight-loss drugs or taking cosmetic surgery. Besides, women are becoming increasingly vulnerable to weight and appearance anxiety, while internet media makes the situation even worse. Women are surrounded by Internet media and inevitably affected by the appearance standards it promotes and make comparison inadvertently, which often provokes anxiety.

Social network site appearance comparison referred to the process in which an individual compares with other website users, features such as appearance and body shape through selfies, videos, and other information displayed on social network sites (1). Fardouly et al. (2) developed the Social Network Site Appearance Comparison Scale (SNSACS) to investigate the extent one compared his/her appearance, body shape, and clothing with others on social network sites. Social network site appearance comparison was associated with mental health. For instance, Fardouly et al. (3) found that making fewer appearance comparisons was positively associated with preadolescents' mental health. Social network site appearance comparison was also found to be positively associated with depression (4, 5).

Social network site appearance comparison was also associated with body image concerns. Body image was defined as people's psychological feelings toward their own bodies, including the perception, imagination, emotion, and physical properties (6) and was considered to be highly correlated with social network site appearance comparison. For instance, Baker et al. (7) found that female college students reported dissatisfaction toward their appearance and frequent comparison about their looks or the number of likes with others. Cohen et al. (8) further found that the engagement of photo activities, rather than the general use, in Facebook and Instagram led to thin-ideal internalization, body surveillance, and drive for thinness. Rousseau et al. (9) found that more appearance comparisons on Facebook were associated with more body dissatisfaction. Besides, women with higher comparison tendency were found to be more susceptible to the impact of mass media on their body image (10) and that the tendency of social network site appearance comparison was related to body shame, restrictive diet, and cognitive bias of self-image among female college students (11, 12). Appearance comparison in social network sites was also found to mediate the effect of Facebook usage on body image concerns and self-objectification (2, 13).

Body image concerns were also associated with self-esteem and anxiety. For instance, adults who were satisfied with their appearance and weight often had higher self-esteem and life satisfaction (14). Teenagers who had social media–related body dissatisfaction would check social media more frequently and have higher rates of depression and online social anxiety than those who did not (15). Both body image disturbance and low self-esteem were associated with higher level of social anxiety in adolescents (16–18). Besides, individual's recognition of body image was found to affect their anxiety about building intimate relationships, whereas self-esteem played a partial mediating role (19). Using the Multidimensional Body-Self Relations Questionnaire (MBSRQ) developed by Cash (20), Zhang et al. (21) found that only body area satisfaction and overweight preoccupation subscales of MBSRQ were associated with anxiety, and these associations were mediated by self-esteem.

Peng et al. (22) examined the chain-mediating effect of body image and self-esteem on the relationship between social network site appearance comparison and depression. In their study, appearance comparison was found to have a direct effect on depression, while it also affected depression indirectly, through the mediating effect of either body image satisfaction or self-esteem, respectively, and the chain-mediating effect of body image satisfaction and self-esteem (22). High tendency of appearance comparison could cause dissatisfaction on one's body image and then lower self-esteem and trigger depression.

While social network site appearance comparison was associated with depression (4, 5), its relationship with other negative emotions, for example, anxiety, remained unknown. Besides, results of previous studies (16–18, 21) indicated that body image, more specifically body area satisfaction and overweight preoccupation, and self-esteem may play mediating roles in the relationship between social network site appearance comparison and anxiety. Therefore, the current study aimed to investigate the relationships between social network site appearance comparison, multidimensional body-self relations, self-esteem, and anxiety among a sample of Chinese females, and the hypotheses were as follows:

(1) Social network site appearance comparison, body area satisfaction and overweight preoccupation subscales of MBSRQ, self-esteem, and anxiety were correlated with each other.

(2) Body area satisfaction and self-esteem had a chain-mediating effect between social network site appearance comparison and anxiety.

(3) Overweight preoccupation and self-esteem had a chain-mediating effect between social network site appearance comparison and anxiety.

MATERIALS AND METHODS

Participants

A total of 359 female college students or graduates were recruited from an online survey platform (https://www.wjx.cn/jq/92808961.aspx), whereas 39 of them were excluded because of the following reasons: (1) 18 participants were excluded because they were male; (2) 7 participants were excluded because their answering times were <400 s; (3) 9 participants were excluded because they failed to respond correctly to one or more attention check question(s); and (4) 5 participants were excluded because they were older than 40 years. Therefore, 320 female participants were ultimately retained, whose ages ranged from 17 to 39 years, with a mean age of 21.6 ± 3.2 years.

Measurements

Social Network Site Appearance Comparison Scale

SNSACS, developed by Fardouly et al. (2), is a three-item scale measuring the extent one would compare his/her appearance, body shape, and clothing with others when using social network sites. The SNSACS used a 5-point Likert scale, where 1 refers to "strongly disagree" and 5 "strongly agree." Higher scores indicate that one was more likely to compare with others when using social networking sites. The Chinese version of SNSACS was translated by Peng (23) and had good reliability in the current study (item-total correlation = 0.879–0.911, Cronbach α = 0.879).

Multidimensional Body–Self Relations Questionnaire

The MBSRQ was developed by Cash (20) to measure one's attitudes toward his/her body image. The original questionnaire consisted of 69 items, using a 5-point Likert scale, where 1 refers to "definitely disagree," and 5 refers to "definitely agree." The MBSRQ measured 10 dimensions of body image, which were appearance evaluation (APPEVAL), appearance orientation (APPOR), health evaluation (HLTHEVAL), health orientation (HLTHOR), fitness evaluation (FITEVAL), fitness orientation (FITOR), illness orientation (ILLOR), Body Areas Satisfaction Scale (BASS), overweight preoccupation (OWPREOC), and self-classified weight (WTCLASS), respectively. Ma (24) translated and revised the Chinese version of MBSRQ, which retained the same 10 subscales but consisted of 93 items. The Chinese version of MBSRQ had fine internal consistency in its eight subscales (Cronbach α = 0.57–0.84), except for that in the FITEVAL (Cronbach α = 0.28) and HLTHOR (Cronbach α = 0.40) subscales. Besides, the test–retest reliability of the Chinese version of MBSRQ was 0.665 (24).

Rosenberg Self-Esteem Scale

The Rosenberg Self-esteem Scale (SES) (25) consisted of 10 items and evaluated one's overall attitudes toward his/her worthiness as a human being (26). The responses were recorded on a 4-point scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The Chinese version of SES was translated and revised by Ji and Yu (27), with the eighth item rewritten (28). Higher scores indicate a higher level of self-esteem. The Cronbach α of the SES in the current study was 0.902.

The Anxiety Subscale of Depression-Anxiety-Stress Scale-21

The Depression-Anxiety-Stress Inventory-21 (DASS-21) was developed by Lovibond and Lovibond (29), which consisted of three subscales: depression, anxiety, and stress. In the current study, only the anxiety subscale was used. The anxiety subscale consisted of seven items, which were rated on a 4-point scale ranging from 0 (never) to 3 (almost always). Higher scores indicate more severe anxiety symptoms (30). The simplified Chinese version of DASS-21 was revised by Gong et al. (31), and the Cronbach α of the anxiety subscale was 0.80.

TABLE 1 | Descriptive statistics of measures and their correlation coefficients.

	Mean	SD	SNSACS	SES	Anxiety
SNSACS	9.98	3.05			
SES	30.28	5.42	−0.138*		
Anxiety	12.62	8.71	0.140*	−0.413**	
MBSRQ					
Appearance evaluation	3.27	0.69	−0.079	0.491**	−0.274**
Appearance orientation	3.39	0.49	0.471**	−0.023	0.064
Fitness evaluation	3.16	0.9	−0.018	0.302**	−0.167**
Fitness orientation	3.41	0.65	−0.091	0.300**	−0.240**
Health evaluation	3.61	0.7	−0.04	0.381**	−0.421**
Health orientation	3.33	0.5	0.021	0.259**	−0.190**
Illness orientation	3.6	0.64	−0.003	0.292**	−0.131*
Body area satisfaction scale	3.24	0.75	−0.141*	0.505**	−0.256**
Overweight preoccupation	2.85	0.9	0.304**	−0.144**	0.168**
Self-classified weight	2.74	0.5	0.037	−0.063	0.052

*$p < 0.05$, **$p < 0.01$.

SNSACS, social network site appearance comparison scale; SES, self-esteem scale; MBSRQ, multidimensional body–self relations questionnaire.

Procedure and Data Analysis

The questionnaire was delivered online with a QR code through a social app named WeChat; once the participants scanned the QR code, they would jump to the web page of this questionnaire. The participants would carefully read the informed consent written by the researcher; only if they agreed with it could they go on to read the instructions written by the researcher in the questionnaire and fill the questionnaires in according to it. After filling in the questionnaires, all participants would receive 3 RMB as remuneration through WeChat in 3days.

Correlation analysis and chain-mediated analysis were performed on the collected data using SPSS 25.0 and the PROCESS macro for SPSS (version 2.16.3) developed by Hayes (32). The number of bootstrap samples was set at 5,000, and the confidence interval was set at 95%.

RESULTS

Correlations Among SNSAC, MBSR, Self-esteem, and Anxiety

Pairwise correlation analysis revealed the following: (1) social network site appearance comparison, self-esteem, and anxiety scores were significantly correlated with each other ($r = -0.138$, 0.140, and −0.413, respectively; all $p < 0.05$); (2) social network site appearance comparison was also significantly correlated with appearance orientation ($r = 0.471$, $p < 0.01$), body area satisfaction ($r = -0.141$, $p < 0.05$), and overweight preoccupation ($r = 0.304$, $p < 0.01$) subscale scores of MBSRQ; (3) except for appearance orientation and self-classified weigh subscales, scores of the other eight subscales of MBSRQ were significantly correlated with both self-esteem ($r = -0.144$ to 0.505, all $p < 0.01$) and anxiety ($r = -0.274$ to 0.168; all $p < 0.01$ except for that of ILLOR subscale, $p < 0.05$) scores. See detailed descriptive statistics and correlation coefficients among all measures in **Table 1**.

The Chain-Mediating Effect Analysis

The MBSRQ includes 10 dimensions, so there were a total of 10 underlying models that need to be analyzed. Because the premise of implementing mediating effect analysis was that there was correlativity among predictors (i.e., independent variables), mediating variables, and criteria (i.e., dependent variables), only 2 models met the correlativity in all pathways, which were as follows: (1) social network site appearance comparison was taken as the predictor, body area satisfaction and self-esteem were taken as the mediating variables, and anxiety was taken as the criterion, named as model 1 and (2) social network site appearance comparison was taken as the predictor, overweight preoccupation and self-esteem were taken as mediating variables, and anxiety was taken as the criterion, named as model 2.

The chain-mediating effect analysis of model 1 revealed the following: (1) the overall model was significant ($R^2 = 0.180$, $F = 23.147$, $p < 0.001$); (2) the direct effect between social network site appearance comparison and anxiety failed to reach a significant level (95% CI = −0.021 to 0.184), whereas the total mediating effect was significant (95% CI = 0.017–0.114); (3) social network site appearance comparison negatively predicted body area satisfaction ($\beta = -0.140$, $t = -2.532$, $p = 0.012$), body area satisfaction positively predicted self-esteem ($\beta = 0.502$, $t = 10.143$, $p < 0.001$), and self-esteem negatively predicted anxiety ($\beta = -0.375$, $t = -6.320$, $p < 0.001$); (4) the chain-mediating effect was significant (95% CI = 0.006–0.057). The results of chain-mediating effect analysis are shown in **Table 2** and **Figure 1**.

The chain-mediating effect analysis of model 2 revealed that (1) the overall model was significant ($R^2 = 0.186$, $F = 24.042$, $p < 0.001$); (2) the direct effect social network site appearance comparison effect on anxiety failed to reach a significant level (95% CI = −0.049 to 0.165), whereas the total mediating effect was significant (95% CI = 0.034–0.147); (3) social network site appearance comparison positively predicted overweight preoccupation ($\beta = 0.307$, $t = 5.694$, $p < 0.001$), overweight preoccupation marginally predicted self-esteem ($\beta = -0.112$, $t = -1.936$, $p = 0.054$), and self-esteem negatively predicted anxiety ($\beta = -0.393$, $t = -7.601$, $p < 0.001$); (4) the effect of social network site appearance comparison on anxiety was mediated by overweight preoccupation (95% CI = 0.001–0.068) and self-esteem (95% CI = 0.001–0.093), respectively; the chain-mediating effect was significant (95% CI = 0.0003–0.0324). The results of chain-mediating effect analysis are shown in **Table 2** and **Figure 2**.

DISCUSSION

In the current study, we examined the relationships between social network site appearance comparison, multidimensional body-self relations, self-esteem, and anxiety among a sample of Chinese female young adults. We found that social network site appearance comparison had significant positive correlations with anxiety. Moreover, the body area satisfaction and overweight preoccupation dimensions of MBSRQ and self-esteem were found to have a chain-mediating effect on the relationship between social network site appearance comparison and anxiety. Previous studies had revealed the effect of social network site appearance comparison on depression (4, 5) and the mediating role of body image satisfaction and self-esteem (22). The current study extended our understanding of the effect of social network site appearance comparison on anxiety and revealed chain-mediating effects of body image and self-esteem, which was consistent with previous studies (22). More particularly, by using a multidimensional measure of body image (i.e., MBSRQ), we found that two dimensions of body image, that is, body area

TABLE 2 | The mediating effects and proportions of chain-mediating models.

Model	Direct/indirect effects	Effect size	Proportion	Boot LLCI	Boot ULCI
Model 1: The chain-mediating model of SNSAC→ BASS→ self-esteem→ anxiety	Direct effect	0.082		−0.021	0.184
	Total mediating effect	0.060	29.70%	0.017	0.114
	SNSAC→ BASS→ anxiety	0.008	3.96%	−0.007	0.037
	Chain-mediating effect	0.026	12.87%	0.006	0.057
	SNSAC→ self-esteem→ anxiety	0.026	12.87%	−0.011	0.070
	Total effect	0.202			
Model 2: The chain-mediating model of SNSAC→ OWPREOC→ self-esteem→ anxiety	Direct effect	0.058		−0.049	0.165
	Total mediating effect	0.084	37.17%	0.034	0.147
	SNSAC→ OWPREOC→ anxiety	0.029	12.83%	0.001	0.068
	Chain-mediating effect	0.014	6.19%	0.0003	0.032
	SNSAC→ self-esteem→ anxiety	0.041	18.14%	0.001	0.093
	Total effect	0.226			

SNSAC, Social Network Site Appearance Comparison; BASS, Body Areas Satisfaction Scale; OWPREOC, overweight preoccupation; LLCI, lower level of confidence interval; ULCI, upper level of confidence interval.

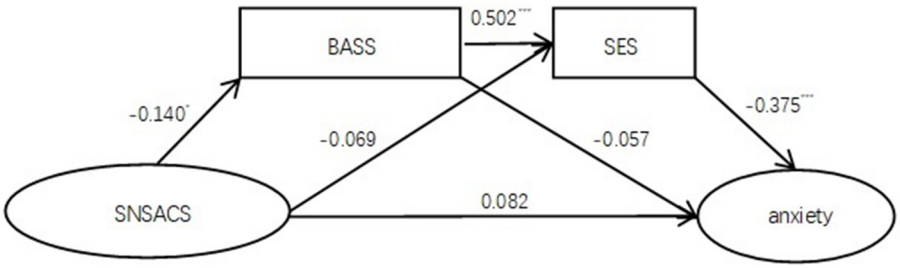

FIGURE 1 | The BASS and SES significantly played a chain mediating effect between SNSACS and anxiety. SNSACS, social network site appearance comparison scale; BASS, body areas satisfaction scale; SES, self-esteem scale. *$p < 0.05$, ***$p < 0.001$.

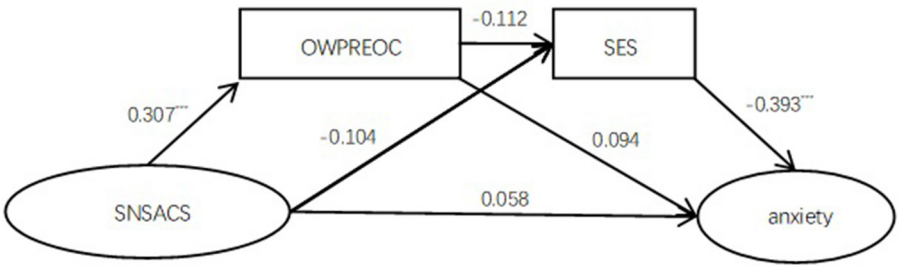

FIGURE 2 | The OWPREOC and SES significantly played a chain mediating effect between SNSACS and anxiety. Besides, OWPREOC and SES were found to have significant indirect effect, respectively. SNSACS, social network site appearance comparison scale; OWPREOC, overweight preoccupation; SES, self-esteem scale. ***$p < 0.001$.

satisfaction and overweight preoccupation, were most relevant to social network site appearance comparison, self-esteem, and anxiety. These two dimensions had been found to be associated with self-esteem and anxiety (21). These results contributed to our understanding of how different dimensions of body image vary on their associations with appearance comparison and anxiety. Comparing one's appearance on social network site among young females would provoke more anxiety, through lowering one's satisfaction with her own body parts and inducing more concerns about being overweight, which then lowered one's self-esteem.

The results of the current study may also have clinical implications. For instance, the results of the current study indicate that body area satisfaction and overweight preoccupation might have more to do in the relationship between social network site appearance comparison and anxiety, compared with other dimensions of body-self relations. These results may provide a preliminary empirical support for intervention target for the emotional problems caused by body image comparison. Future researches could further explore how to effectively intervene on appearance satisfaction, overweight preoccupation, and self-esteem, so as to achieve the purpose of promoting the emotional health of females.

The current study had several limitations. First, the researcher made a mistake and failed to collect data of item 18 of the appearance orientation subscale in the MBSRQ. This mistake might have an impact on the results of the current study; the interpretation of the results should also be treated with caution. Second, this study is a cross-sectional study; thus, caution should be taken when making inferences about causality between variables. Future studies can use the longitudinal study design method to explore the causal relationship between variables. Third, we mainly recruited female young adults in the current study. It should be noted that women of different ages may vary in social media use and in its impact on anxiety. Therefore, one should be cautious when generalizing the results of the current study to women of other age ranges.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

RH and YY conceived the study and drafted the paper. RH collected and analyzed the data. Both authors contributed to the article and approved the submitted version.

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The Mediating Effect of Negative Appearance Evaluation on the Relationship Between Eating Attitudes and Sociocultural Attitudes Toward Appearance

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Objective: Body-image disturbance and eating disorders are significant physical and mental health problems in China. Attitudes toward the body are thought to work in conjunction with other established risk factors for dietary pathology, which include body dissatisfaction, dieting, and negative effects. Negative appearance evaluation may be valuable for extending our understanding of measuring factors and potential causal relationships associated with body image and eating problems. Therefore, this study aimed to determine the association between negative appearance evaluation and a combination of eating attitudes and sociocultural attitudes toward appearance and the mediating effect of negative appearance evaluation on the relationship between eating attitudes and sociocultural attitudes toward appearance.

Methods: We invited 339 Chinese adults to undergo the Eating Attitudes Test (EAT-26), the Fear of Negative Appearance Evaluation Scale (FNAES), and the Sociocultural Attitudes toward Appearance (SATAQ-3) scale, and used AMOS 24.0 for model construction and mediating effects testing.

Results: There was a significant positive correlation between EAT-26 scores and FNAES ($p < 0.001$) and SATAQ-3 scores ($p < 0.001$), and all dimensions except internalization general were significantly positively correlated ($p < 0.05$). There was a significant positive correlation between FNAES and SATAQ-3 scores for all dimensions ($p < 0.01$). There was no significant direct effect of eating attitude on sociocultural attitude toward appearance; however, there was a significant mediating effect of fear of negative appearance evaluation.

Conclusion: Our results demonstrate that negative appearance evaluation fully mediates the relationship between eating attitudes and sociocultural attitudes toward appearance. An individual's attitude toward eating affects negative body perceptions and thus their perception of their own body shape. Our exploration of the specific effects of eating attitudes on body perception provides a psychological basis for guidance and developing interventions regarding attitudes toward the body.

Keywords: sociocultural influence, body image, EAT-26, FNAES, SATAQ 3

INTRODUCTION

An eating disorder is a type of mental disorder that is characterized by abnormal eating habits or a group of abnormal eating behaviors and negatively impacts physical and mental health (1, 2). Abnormal eating behaviors include reduced physical fitness, altered body weight and body fat percentage, and poor bone health (3). Moreover, eating disorders are a major cause of physical and mental health problems among young women (4). The main clinical manifestations are bulimia nervosa, anorexia nervosa, and binge-eating disorder, and the main subclinical manifestations are diet and bulimia (5, 6). Clinical eating disorders are relatively rare and primarily develop and evolve from subclinical eating disorders, which are highly common. Subclinical eating disorders affect 60% of girls and 30% of boys (7).

It has been shown that when individuals are faced with stressful events, have long-term distorted cognition of physique or body shape, or are affected by negative emotions, they are prone to abnormal eating attitudes, which often manifest as overeating, dieting, and other eating problems (8–10). Eating attitudes are a series of cognitive, emotional, and behavioral tendencies of individuals who consider eating as an object. In severe cases, these tendencies can develop into a clinical eating disorder, such as bulimia nervosa, anorexia nervosa, and binge-eating disorder (11). The Eating Attitudes Test (EAT-26) is a reliable and valid instrument that provides an objective measure of the symptoms of anorexia nervosa (12). Furthermore, the EAT-26 may be considered the most appropriate tool as an outcome measure for clinical groups or as a screening tool for high-risk groups for anorexia nervosa in non-clinical settings (13). It is influenced by external stimuli, situations, and the individuals themselves (14).

Individuals with eating disorders are prone to negative self-evaluation, which results in a deformed body image (15, 16). The most prominent psychological problems in individuals with eating disorders are related to their attitudes toward thinness and food. The heavier their weight, the stronger their desire to be thin, and the greater the difficultly in controlling excessive eating. However, underlying these specific attitudes toward body shape and eating, patients with eating disorders may also have other psychological problems, such as pursuing perfection and fear of growth and maturity (17, 18). According to Garner et al. (19), individuals with abnormal eating attitudes may have distortions in body image and inner feelings, which are accompanied by psychophysiological symptoms, such as negative body self, unreasonable eating, and irregular sleep. Previous research has shown that the total score of eating is positively correlated with the fat subscale score of the Negative Physical Self Scale, which indicates that individuals with a high eating attitude score are more likely to have an eating disorder and a more negative cognition of their body (20). Chen (21) showed that anorexia nervosa patients have negative cognitive eating disorders and body image disorders; they are not satisfied with their current body mass and may even have a cognitive bias toward their already low body mass index (BMI). However, patients with anorexia nervosa may overestimate their body weight due to visual distortions (22). Moreover, based on stereotypes about weight, people with eating disorders have double standards that lead to a distorted evaluation or characterization of their external image (23). Furthermore, personality types have been shown to influence individuals' perceptions of body satisfaction and body image (24). There is also evidence that overvaluation of low body weight and fear of weight gain cannot be explained by general cognition, rather, they require individual judgments (25). In other words, patients do not exhibit changes in physical representations in general; instead, they present with top-down cognitive-emotional distortions in evaluations of their own bodies (26).

In 1962, Bruch first proposed that anorexia nervosa patients have body-image disorder, and numerous reports have since reported similar findings. Body-image disturbances are usually associated with eating disorders (27). Body image disorder is a distorted understanding of one's image, which is caused by social, psychological, or biological factors (28). A disturbance in body image is an individual's cognitive maladjustment of their body, which usually leads to negative emotional experiences (29). Thompson et al. (30) proposed the definition, "a persistent report of dissatisfaction, concern, and distress that is related to an aspect of appearance... [and] some degree of impairment in social relations, social activities, or occupational functioning" (p. 11). Body-image disturbances are particularly prominent among female college students and include dissatisfaction with body shape, skin color, height, and other aspects (31), which leads to low self-esteem, anxiety, and depression due to public self-consciousness (32). The Fear of Negative Appearance Evaluation Scale [FNAES; (33)] is used to assess apprehension about appearance evaluation and determines the degree to which people experience apprehension at the prospect of being evaluated negatively for their appearance. It was developed by modifying items from the Brief Fear of Negative Evaluation Scale (34) and creating novel items that index apprehension toward a negative appearance evaluative experience.

Thomas et al. (33) and Leary (34) speculated that fear of negative appearance evaluation (FNAE) and fear of negative evaluation (FNE) are related to sociocultural factors. Various disparate influences have received attention in the field of body image disturbances and eating disorders, including interpersonal and sociocultural factors such as negative appearance-related feedback (teasing), modeling of dieting and body image concerns by parents and peers, elevated tendencies to compare one's appearance to others, sexual abuse, sexual harassment, and internalization of media images and messages (35, 36). Furthermore, investigating the more specific FNAE may be valuable for extending recent work regarding the identification of factors that are associated with, and potentially the cause of, body image and eating problems (49).

Appearance-ideal internalization and appearance pressures are empirically supported risk factors for body image disturbance and disordered eating in Western countries (37, 38). The sociocultural theory has been shown to be a useful framework for exploring how environmental influences contribute to body image concerns (30). The Sociocultural Attitudes toward Appearance Questionnaire (SATAQ-3) is used to document an

individual's recognition of their awareness of a societal influence, alongside the endorsement/acceptance of the prevailing message of an internalization of the touted standard (39). Research findings consistently support the strong relationship between sociocultural influences and body dissatisfaction (40). Several studies have shown that thin-ideal internalization and perceived appearance pressures are uniquely associated with and predict body dissatisfaction. Girard et al. (41) emphasized the usefulness of sociocultural models in understanding women's body image, which includes their drive for thinness and muscularity concerns. As Knauss et al. (42) expected, internalization, pressure, and BMI contribute to the prediction of body dissatisfaction in boys and girls; moreover, girls internalize media body ideals to a greater extent and feel more pressure from media to conform to this ideal than do boys. In the model by Lovering et al. (43), sociocultural pressure from the media, partners, and peer variables significantly predict body image and eating concerns through the mediating effect of the latent thin-ideal variable (i.e., internalization of the thin-ideal and appearance comparisons), and of the four pathways, the pathway between the media influence variable to the thin-ideal variable was the strongest (43). Exploring the Tripartite Influence Model of body dissatisfaction in postpartum women. There is strong evidence for significant relationships among the putative risk factors, mediators (internalization, comparisons, and peer suppression of feelings), and criterion variables (body dissatisfaction, drive for thinness, bulimic symptoms, and self-esteem) (44). Peer influences, body-image dissatisfaction, eating dysfunction, and self-esteem in adolescent girls. Appearance-ideal internalization refers to the acceptance of culturally endorsed appearance ideals (e.g., thinness for females and muscularity for males) as one's personal appearance standard (45), whereas perceived pressures can be defined as the feeling of being encouraged to modify one's physical appearance to reach such ideals (46). A meta-analysis revealed that the emphasis of mass media on the beauty of being slim is significantly related to body image disorder in college students (especially women) (47). In addition, other studies have found that the likelihood of females developing an eating disorder is positively correlated with the degree of recognition of social values (48).

In summary, this study hypothesized that there are two stages of the effect of dietary attitudes on sociocultural attitudes toward appearance. In the first stage, a disorder of dietary attitudes activates FNAE. In the second stage, FNAE eventually affects sociocultural attitudes toward appearance. Therefore, this study hypothesized that: (1) there is a relationship between negative appearance evaluation and sociocultural attitudes toward appearance, and (2) FNAE plays a complete mediating role in the influence of eating attitudes on sociocultural attitudes toward appearance.

MATERIALS AND METHODS

Participants and Procedure

Participants were 339 healthy people (176 female, 163 male) from various regions of China who were invited to complete the questionnaires. The average age of participants was 31.06 years (range = 18–72 years, standard deviation [SD] = 11.87 years), and mean BMI was 22.24 (range = 14.5–37.2, SD = 3.86). Inclusion criteria were: aged ≥18 years, Chinese nationality, residence in China, and no physical disability or somatic diseases that prevent physical activity. Criteria were verified according to responses to questions on sociodemographic data and health, which allowed for the determination of the exclusion factors.

During the data collection period, 632 participants completed the survey in Chinese. We excluded 201 returned questionnaires from the analysis because of errors in completing the questionnaires (incomplete data) and respondents who had a nationality other than Chinese. A further 92 questionnaires were excluded because the inclusion criteria were not fulfilled.

The procedure carried out in this study consisted of an online survey conducted as part of an international research project registered on ClinicalTrials.gov.[1] This study used data collected from a Chinese population between July 20, 2020, and November 24, 2020, during the period of the global pandemic situation. The work was carried out according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The protocol was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk, Poland (decision no. 33/2020). The questionnaires that formed this study took around 30 min to complete. All survey participants provided electronic informed consent before registration.

Instruments

Fear of Negative Appearance Evaluation Scale

The FNAES (49) was used to assess women's apprehension toward appearance evaluations. The FNAES contained six items (e.g., I'm worried about what people think of my appearance), which were scored on a five-point Likert scale, from definitely disagree to definitely agree. Higher scores indicated greater FNAE. Cronbach's alpha for the FNAES in the present study was 0.93.

The Eating Attitudes Test

The EAT-26 was used to assess subjects on their cognitive, emotional, and behavioral tendencies regarding diet (19). It comprised 26 items that measured three factors: dieting, bulimia, and food preoccupation (abbreviated as bulimia), and oral control. In this study, scale scores were calculated using screening scores. Questions 1 to 25 were scored as never/rarely/sometimes = 0, often = 1, usually = 2, or always = 3, and question 26 was scored in the opposite way. Higher scores represent more severe eating attitudes and behavioral problems. A total score ≥20 indicated the possible presence of an eating disorder. Cronbach's alpha for the EAT-26 in the present study was 0.72.

[1] https://clinicaltrials.gov/ct2/show/NCT04432038

The Sociocultural Attitudes Toward Appearance Questionnaire-3

The SATAQ-3 (46) was used to assess participants' sociocultural attitudes toward appearance. The SATAQ-3 is a 30-item measure comprising four subscales: internalization general, internalization athlete, perception of pressure, and information. Each item was scored on a five-point Likert scale, from definitely disagree to definitely agree.

The information subscale consisted of nine items, which were used to measure recognition of the social importance of beauty ideals in the media (e.g., magazine advertisements are an important source of information about fashion and "being attractive"). The pressure subscale consisted of seven items, which were used to measure perceived stress to meet the Western ideal displayed by the media (e.g., I've felt pressure from television or magazines to have a perfect body). The internalization general subscale consisted of nine items, which were used to measure the internalization of the thin ideal (e.g., I compare my body to the bodies of people who are on television, and I do not care if my body looks like the body of people who are on television). The internalization athlete subscale consisted of five items, which were used to measure the internalization of the sports ideal (e.g., I try to look like sports athletes and I wish I looked as athletic as sports stars). Previous studies have shown that the SATAQ-3 has high internal consistency in female college students and patients with eating disorders. Cronbach's alpha for the SATAQ-3 in the present study was 0.88.

Data Analysis

Data analysis was performed using SPSS 26.0 and AMOS 24.0. *T*-tests or one-way analyses of variance (ANOVAs) were used to compare scores between participants with different demographic information. Pearson correlation analysis was used to explore relationships between FNAES, EAT-26 (dieting, bulimia and food preoccupation, and oral control), and SATAQ-3 (information, pressure, internalization general, and internalization athlete) scores. In addition, AMOS 24.0 was used to clarify the influencing path of participants' eating attitudes and sociocultural attitudes toward appearance on external apprehension toward appearance evaluations. Bootstrapping was used to test the mediating effect of apprehension toward appearance evaluations on the relationship between eating attitudes and external sociocultural attitudes toward appearance. A $p < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows the differences between the selected demographic variable groups for the FNAES, EAT-26, and SATAQ-3 scores. The mean FNAES score was higher in females (17.37 ± 6.19) than in males (16.41 ± 5.67). Females scored lower than men on the EAT-26 for both total and all dimension scores. SATAQ-3 scores showed similar patterns as the FNAES and EAT-26 scores; however, there were no significant differences.

Pearson correlation analysis showed that FNAES score was positively correlated with the dieting ($r = 0.18$, $p < 0.01$), bulimia ($r = 0.18$, $p < 0.01$), and total score ($r = 0.19$, $p < 0.05$) of the EAT-26, and internalization general ($r = 0.30$, $p < 0.01$), internalization athlete ($r = 0.26$, $p < 0.01$), pressures ($r = 0.37$, $p < 0.01$), and information ($r = 0.31$, $p < 0.01$) of the SATAQ-3. In addition, the bulimia score was positively correlated with the pressures ($r = 0.11$, $p < 0.05$) and information scores ($r = 0.13$, $p < 0.05$), the oral control score was positively correlated with the information score ($r = 0.14$, $p < 0.05$), and the total score was positively correlated with the information score ($r = 0.16$, $p < 0.01$) (**Table 2**).

The structural equation models built using the EAT-26 score as the independent variable, SATAQ-3 score as the dependent variable, and FNAES score as the mediating variable (**Figure 1**) showed that the model had a good fit ($\chi^2/df = 2.831$, AGFI = 0.931, CFI = 0.945, GFI = 0.966, IFI = 0.946, RMSEA = 0.074, SRMR = 0.045, TLI = 0.915). Furthermore, the standardized path coefficients showed that the EAT-26 score significantly predicted the FNAES score ($\beta = 0.21$, $p < 0.01$), and the FNAES score significantly predicted the SATAQ-3 score ($\beta = 0.41$, $p < 0.01$) (**Figure 1**).

The results of the mediation effect indicated that the mediating effect was significant; however, the direct effect was not significant. Apprehension toward appearance evaluations played a complete mediating role between eating attitudes and sociocultural attitudes toward appearance, and the mediation effect accounted for 70.09% of the total effect (**Table 3**).

DISCUSSION

The present study examined the association between negative appearance evaluation and a combination of eating attitudes and sociocultural attitudes toward appearance. We also explored the mediating effect of negative appearance evaluation on the relationship between eating attitudes and sociocultural attitudes toward appearance. Overall, the data suggested that negative appearance evaluation is associated with sociocultural attitudes toward appearance. Specifically, those who report eating disorders demonstrated higher levels of sociocultural attitudes toward appearance. Negative appearance evaluation scores significantly mediated the relationship between eating attitudes and sociocultural attitudes toward appearance.

These findings both support and extend previous literature regarding the relationship between sociocultural attitudes toward appearance and adaptive eating patterns. Women are at higher risk of eating disorders, especially women in college, and have the highest prevalence of eating disordered behaviors (38, 50). The sex difference might be attributed to biological, psychodynamic, and sociocultural factors (51). However, there was no significant difference in eating attitudes between different BMI groups, except for bulimia and oral control subscale scores. Furthermore, those aged 25–34 years had the highest average score on this scale. Current research on eating disorders is focused on adolescents (7, 52–54), and there is a lack of large-scale cross-sectional studies on the age of onset of eating disorders, which may be a useful research direction in the future. This study showed that there was no significant difference in negative image ratings between

TABLE 1 | Participants' scores on the FNAES, EAT-26, and SATAQ scales.

Variables	Category (N)	FNAES	EAT-26				SATAQ			
			Dieting	Bulimia	Oral control	Total score	Internalization general	Internalization athlete	Pressure	Information
Gender	Male (176)	16.41 ± 5.67	6.49 ± 4.90	0.97 ± 1.78	2.14 ± 2.46	9.60 ± 6.54	25.93 ± 7.08	15.17 ± 2.47	20.68 ± 7.03	26.72 ± 5.14
	Female (163)	17.37 ± 6.19	4.94 ± 4.69	0.82 ± 1.31	1.60 ± 2.06	7.36 ± 5.99	24.55 ± 6.61	15.02 ± 2.84	18.99 ± 6.74	25.23 ± 4.88
	T-value	−1.50	2.97	0.87	2.16	3.27	1.85	0.51	2.25	2.72
	Cohen's d	0.16	0.32	0.10	0.24	0.36	0.20	0.06	0.25	0.30
Age	≤24 years (140)	18.37 ± 5.65^{a}	5.04 ± 5.28^{a}	1.02 ± 1.73	2.29 ± 2.45^{a}	8.35 ± 6.87^{a}	25.44 ± 6.71	15.28 ± 2.86	20.51 ± 6.55	25.4 ± 5.13^{a}
	25∼34 years (109)	17.06 ± 6.10^{ac}	6.99 ± 4.67^{bc}	1.05 ± 1.57	2.19 ± 2.32^{bc}	10.23 ± 6.55^{bc}	25.13 ± 6.25	15.34 ± 2.45	20.04 ± 6.87	27.54 ± 4.73^{bc}
	35∼44 years (42)	14.29 ± 5.36^{b}	5.86 ± 4.74^{ac}	0.52 ± 1.25	0.60 ± 1.17^{a}	6.98 ± 5.15^{a}	24.14 ± 7.64	14.14 ± 2.23	18.02 ± 7.81	24.21 ± 5.30^{a}
	45∼54 years (26)	14.77 ± 4.89^{bc}	4.73 ± 3.63^{a}	0.65 ± 1.44	1.65 ± 2.21^{ac}	7.04 ± 4.74^{a}	25.23 ± 7.97	14.65 ± 3.25	19.92 ± 7.93	26.19 ± 4.87^{ac}
	≥55 years (22)	13.82 ± 5.95^{b}	5.05 ± 3.20^{ac}	0.41 ± 1.05	0.41 ± 0.91^{b}	5.86 ± 3.34^{a}	27.05 ± 8.27	15.14 ± 1.81	18.45 ± 6.46	25.41 ± 4.31^{ac}
	F value	**7.00*** **	**3.02***	1.75	**7.90*** **	**4.05****	0.68	1.96	1.29	**4.59****
	η^2	0.08	0.04	0.02	0.09	0.05	0.01	0.02	0.02	0.05
BMI	≤18.4 Thin (40)	17.73 ± 5.44^{a}	4.33 ± 4.97	1.53 ± 2.48^{a}	3.90 ± 3.26^{a}	9.75 ± 7.20	24.30 ± 5.64	15.23 ± 3.31^{a}	22.00 ± 6.86^{a}	25.93 ± 4.40
	18.5∼23.9 Normal (206)	17.39 ± 6.04^{ac}	6.05 ± 5.03	0.92 ± 1.38^{bc}	1.97 ± 2.11^{bc}	8.94 ± 6.45	25.90 ± 6.72	15.41 ± 2.56^{ac}	20.65 ± 6.49^{ac}	26.55 ± 5.04
	24.0∼27.9 Overweight (63)	15.65 ± 6.23^{a}	5.75 ± 4.70	0.57 ± 1.42^{bc}	0.78 ± 1.44^{b}	7.10 ± 6.16	24.32 ± 7.48	14.52 ± 2.49^{a}	17.32 ± 7.48^{b}	25.02 ± 5.28
	≥28 Obesity (30)	14.77 ± 4.31^{b}	5.53 ± 3.42	0.60 ± 1.38^{bc}	0.90 ± 1.24^{b}	7.03 ± 4.26	24.2 ± 8.00	14.03 ± 2.24^{a}	17.03 ± 6.88^{b}	24.43 ± 5.16
	F value	**3.00***	1.43	**3.47***	**20.13*****	2.42	1.50	**3.65***	**7.00*****	2.60
	η^2	0.03	0.01	0.03	0.15	0.02	0.01	0.03	0.06	0.02

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$; ps valued smaller than 0.05 were bolded for clarity. And one-way analysis of variance tests (ANOVA) was used for analyses by age, residence, or BMI. abc the same letter means that there is no difference between pairwise comparisons within the group and different letters mean that there is a difference. (N = 339, Mean ± SD).

TABLE 2 | Correlation between FNAES, EAT-26, and SATAQ-3 scores.

	FNAES	Dieting	Bulimia	Oral control	EAT-26 (total score)	Internalization general	Internalization athlete	Pressure	Information
FNAES	1								
Dieting	**0.18****	1							
Bulimia	**0.18****	**0.37****	1						
Oral control	0.04	0.08	**0.27****	1					
EAT-26 (Total score)	**0.19****	**0.88****	**0.63****	**0.48****	1				
Internalization general	**0.30****	−0.04	0.08	−0.06	−0.03	1			
Internalization athlete	**0.26****	−0.01	−0.01	0.01	−0.01	**0.36****	1		
Pressure	**0.37****	−0.05	**0.11***	0.08	0.02	**0.68****	**0.46****	1	
Information	**0.31****	0.11	**0.13***	**0.14***	**0.16****	**0.55****	**0.32****	**0.54****	1

*$p < 0.05$, **$p < 0.01$; ps valued smaller than 0.05 were bolded for clarity.

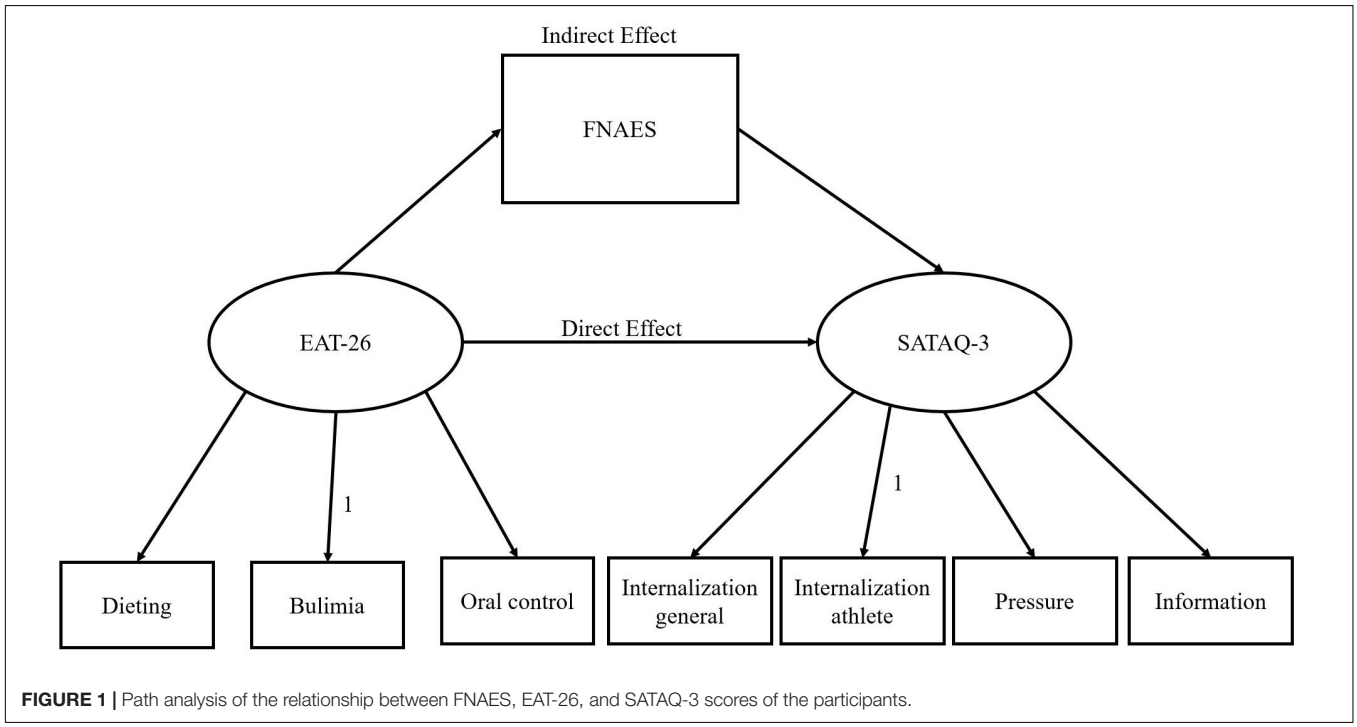

FIGURE 1 | Path analysis of the relationship between FNAES, EAT-26, and SATAQ-3 scores of the participants.

TABLE 3 | Bootstrap analysis of the mediation effect size and significance test of FNAES in EAT-26 and SATAQ.

Path	Standardized effect size (Effect)	Standard error (Boot SE)	Effect size (%)	p	95%CI
EAT-26→SATAQ (Direct effect)	0.04	0.12	29.91	0.40	[−0.19, 0.19]
EAT-26→FNAES→SATAQ (Mediation effect)	**0.08****	0.07	70.09	0.01	[0.01, 0.29]
EAT-26→SATAQ (Total effect)	**0.12***	0.09	100.00	0.04	[0.01, 0.38]

*$p < 0.05$, **$p < 0.01$; ps valued smaller than 0.05 were bolded for clarity.

men and women. However, there were significant differences in the evaluation of one's own image among different age groups; the perception of one's appearance and physique became more negative with age. As women approach midlife, the pressures that came from body monitoring and surveillance (55) begin prior to middle age. These pressures may become more salient during the aging process (56, 57). In addition to the social ideal of being beautiful and slim in women of all ages, middle-aged women also face age-related pressures, such as the need to avoid wrinkles and other visible signs of aging (58–60). These increasing pressures

may develop into concerns about appearance, which increases the fear of negative appearance judgment and results in greater dissatisfaction with their body (61). Scores differed significantly between BMI groups, whereby people with a lower BMI tended to have a more negative evaluation of their appearance. This was not consistent with the results of previous studies. Studies have found that the FNAES does not significantly correlate with BMI (49). This discrepancy may be due to cultural differences between China and the West; moreover, the pursuit of thinness for a prolonged period may lead people with a lower BMI to be less satisfied with their appearance. Notably, the impact of the coronavirus 19 (COVID-19) outbreak is a problem that cannot be ignored. The COVID-19 outbreak threatened public physical health while having a profound impact on the public's mental health (62, 63). Indeed, several self-reported studies have suggested that dietary restrictions or compensatory behaviors were further exacerbated during the outbreak (64). Moreover, recent questionnaire data suggests that the epidemic had a similar negative impact on people's diet under certain conditions, whereby symptoms became more severe in patients with eating disorders (65). In addition, under the strict control conditions of the COVID-19 pandemic in China, such effects may have been amplified, which likely affected individuals' perception of their external image. To some extent, this may have influenced a more negative view of their external image, which can lead to cognitive biases that are ultimately reflected in sociocultural attitudes.

This study also found a positive correlation between eating attitudes and FNAE, which is consistent with previous research. Several studies have investigated eating disorders in both men and women and found that those with eating disorders have a higher incidence of emotional disorders (66–71). Furthermore, satisfaction with body image is significantly different from that of the control group (51), demonstrating clear body dissatisfaction in this group (72, 73). FNAE, which is defined as social anxiety and distress due to their appearance negatively evaluated, has been found to be predictive of eating disorders above and beyond other body image variables (49). Patients with eating disorders may be more worried about their appearance being negatively evaluated. Indeed, clinical samples of women with eating disorders report higher levels of fear of negative evaluation than that of controls (74). Social appearance anxiety (i.e., fear of negative evaluation of one's appearance) and general fear of negative evaluation have each been proposed as risk factors for eating disorders. It is possible that treating FNAE may reduce eating disorder symptoms (75).

Fear of negative appearance evaluation scale was also associated with sociocultural attitudes toward appearance, and we observed a correlation between eating attitudes and information. Because of the cultural differences between the West and China, people have different sociocultural attitudes toward appearance, which affects the generalization of our results. Slimness is an ideal criterion for female attractiveness in China (76), and girls who do not conform to this philosophy are more likely to receive negative feedback, experience physical dissatisfaction, and perform inappropriate compensatory behaviors to reduce the difference between their own and the ideal body shape (76). Moreover, there is a stronger cultural premium on appearance and attractiveness as defining attributes of femininity in China (77). In Western culture, objectification theory (78) suggests that Western societies sexually objectify the female body, which leads women to feel as if they are constantly being valued (or devalued) according to their appearance. Internalization of media images and messages (35, 79) may lead to the onset and maintenance of body image disturbance and eating disorders (45, 80). The external pressure and information that constantly instill the concept of beauty may influence eating attitudes toward gaining social recognition of "beauty" through dieting and other behaviors.

Our findings contribute to evidence suggesting that the relationship between eating attitudes and sociocultural attitudes toward appearance is mediated by negative appearance evaluation. van den Berg et al. (81) reported that girls exhibit internalization of the ideal body and feel more pressure from the media than boys. When girls have a strong negative image of their bodies, there is a greater internalizing effect when they see "plus-size" models or "slim" pictures that suggest that slim models represent beauty, and a negative self-image reinforces this perception. The age range of participants in this study was largely focused on adolescence and the period of transition from adolescence to middle age. Body image concerns usually begin and increase during early adolescence and decrease in younger adulthood; thus, it affects mental health at different stages of life. The type and extent of body image disturbance vary with age, race, peers, family, and sociocultural influences. The development of negative body image disorders is considered to be the strongest determinant of sociocultural influences, and body dissatisfaction is considered to be a predictor of eating disorders because adolescents do not accept the "ideal body." Furthermore, current research suggests that body dissatisfaction is associated with an increased tendency to initiate unhealthy eating behaviors, for which girls are at higher risk than boys (82). Notably, the present study was conducted in adolescents without a diagnosis of eating disorders in a non-clinical setting. In an earlier study, Furnham et al. (83) observed that males and females had comparable levels of body dissatisfaction, but in opposite directions: 41% of males wanted to be thinner, whereas 22% of females wanted to gain weight. Thus, underweight men seem to be dissatisfied with their bodies, whereas underweight women seem to be very satisfied (84). Although both men and women desire physical perfection, gaining weight and attaining the ideal body should be achieved through exercise and weight training and not only *via* diet control (85). However, the idea of achieving the socio-cultural perception of a perfect body, combined with girls' dissatisfaction with their bodies, can exacerbate inappropriate eating behaviors and increase their risk of developing eating disorders (86). Many individuals with eating disorders are undiagnosed (87) and thus do not receive the necessary support and training. Adolescence is a time when individuals are highly vulnerable psychologically; therefore, it is important to provide the necessary support to enable them to develop into healthy adults. Adolescents require education around perceiving their bodies in a healthy way and how to filter messages in the mass media to prevent negative effects. In a previous study, Posavac et al. (88) observed that female students

with a negative self-image who received psycho-educational instruction in media analysis were less likely to make social comparisons and less vulnerable to the negative effects of "thin" images of beauty than students who did not receive such instruction. Individuals with a positive body image tend to filter and reject unrealistic images in the media to protect their body image (89).

The current study has several limitations worth noting. First, the age distribution of our sample was 18–34 years and is thus not representative of the general population; however, body image concerns are a key issue for this population, as eating disorders and associated pathology are common in this age group. In addition, the study design was cross-sectional; therefore, no longitudinal conclusions can be drawn about the relationships between these variables. These variables should be examined in the future using a prospective design to monitor sociocultural attitudes toward appearance and assess perceptions of eating attitude and negative appearance evaluation over time, particularly during the transition from adolescence to middle age. Despite these limitations, the current study provides useful insight into the relationships between eating attitudes, perceptions of one's own body shape, and the factors associated with this social context in the Chinese population. We found that differing perceptions of external body shape can be effective predictors of eating behavior and social perception. Overall, studies on diet and related body image factors (internalized and perceived body acceptance) should be continued to improve the health of Chinese populations and combat eating disorders and weight-related diseases.

CONCLUSION

Our results suggest that negative appearance ratings fully mediate the effect between dietary attitudes and sociocultural attitudes toward appearance. An individual's eating attitudes influence negative body perceptions, which in turn affects the perception of their body shape. Our findings on the specific effects of dietary attitudes on body perception provide a psychological basis to guide and develop interventions on attitudes toward the body. Given the current cultural climate in which women's and men's bodies are constantly being objectified and censored, and recognizing the social importance of media (e.g., magazines and advertisements) in determining the ideals of beauty, there is a crucial need to identify the factors that influence individuals' sociocultural attitudes toward appearance. In addition, studies using diverse age groups may help understand how these issues and behaviors manifest.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk, Poland. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HF, ML, MLa, BI, and YY: conceptualization. RW, ML, MLa, and YG: methodology. HF, JL, ML, MLa, BI, and SG: investigation. RW, YG, XW, and HF: writing – original draft preparation. RW, MLa, ML, BI, YG, XW, and HF: writing – review and editing. ML and MLa: supervision. ML: project administration. All authors contributed to manuscript revision, read, and approved the submitted version.

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ORIGINAL RESEARCH
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The Effect of Physical Activity on Neurotrophin Concentrations and Cognitive Control in Patients With a Depressive Episode

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Background: Cognitive deficits occur in most patients with affective disorders. The role of neurotrophic factors (e.g., BDNF) as modulators of brain plasticity affecting neurocognitive abilities has been emphasized. Neurotrophin concentrations may change under the influence of various interventions, including physical activity. Selected studies have shown that cognitive function may also be affected by exercise.

Aim: The aim of the study was to determine whether physical activity changes the concentration of neurotrophins and their receptors in patients with an episode of depression. It was also examined how one session of aerobic exercise affects cognitive control.

Methods: The study included 41 participants. The subjects were asked to exercise on a cycloergometer for 40 min with individually selected exercise loads (70% VO_2max). Before and shortly after the exercise blood samples were acquired to perform blood assays (proBDNF, BDNF, TrkB, NGFR). The participants also performed a Stroop test twice—before the exercise and 10 min after its cessation.

Results: The single bout of physical exercise did not cause any significant changes in the concentration of neurotrophic factors. The SCWT results: both the mean reading time (29.3 s vs. 47.8 s) and the color naming time (36.7 s vs. 50.7 s) increased. The patients made more mistakes after physical exercise, both in part A (0.2 vs. 1.5) and B (0.6 vs. 1.5). The so-called interference effect decreased—the difference between naming and reading times was smaller after exercise (6.2 s vs. 2.4 s). No significant correlations were found between the concentrations of the studied neurotrophic factors and the Stroop test results.

Conclusions: The results did not confirm changes in neurotrophin concentration under the influence of a single session of physical activity. The shortening of the interference time after exercise may be caused by practice effects. A significant limitation of the study is the use of the Stroop test twice in short intervals.

Keywords: neuroplasticity, BDNF, Stroop test, depression, exercise

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INTRODUCTION

Affective Disorders and Cognitive Impairments

Depression affects more than 300 million people worldwide (1). Bipolar disorder affects about 45 million people worldwide (1) and it consists of both depressive and maniac episodes separated by periods of normal mood. Affective disorders involve cognitive impairments. Depressed patients frequently report difficulties with concentrating their attention and experience problems with tasks requiring prolonged focus (2). The pace of work and the ability to learn deteriorate as well. Depression also negatively affects psychomotor speed (i.e., coordination, dexterity, acting with appropriate speed and force), which involves both cognitive and physical abilities (3, 4). For proper cognitive functioning, it is important that the course of executive functions (forming concepts, starting and continuing actions, understanding sets and selecting information depending on the situation, storing information about the criteria of current actions and switching to new rules of action, solving problems, and making decisions) remains undisturbed (5–7). In 20–30% of patients with depression, deficits have been described in this area as well (2, 5). Some papers draw attention to the fact that cognitive impairments (deficits in selective attention, working memory, and long-term memory) continue to persist during remission and that improvement in mood is not always accompanied by normalization of cognitive abilities (8). Data from meta-analyses confirm that patients with bipolar disorder also have neurocognitive dysfunction (9–11).

Neurogenesis and Neuroplasticity

The human brain retains plasticity as its nerve cells retain the ability to change both their structure and function throughout the life of an individual. Interactions with the environment cause existing neuronal networks to change, and new synaptic connections are formed. Modulation of neurogenesis is associated with numerous factors acting at different stages of neuronal formation and differentiation. The best known neurotrophins include nerve growth factor (NGF), brain-derived neurotrophic factor (BDNF), neurotrophin 3 (NT-3), and neurotrophin 4 (NT-4).

Brain-derived neurotrophic factor (BDNF) has been found in almost all brain regions of the adult central nervous system. Expression of BDNF and its receptor, TrkB (tropomyosin receptor kinase B), has been observed in skeletal muscles, cardiac muscles, liver, and fat cells (12). BDNF is released from the brain into the blood both at rest (13) and during exercise (14). Like other neurotrophins, BDNF is initially synthesized as a precursor protein (proBDNF). ProBDNF and mBDNF exert opposite biological effects by activating two distinct receptor systems (15). Activation of the TrkB receptor prevents apoptosis and neurodegeneration, whereas activation of the p75NTR receptor initiates cell death (16). It plays an important role in the modulation of synaptic transmission and plasticity, which determines the adaptation of the nervous system to constant environmental changes. It supports cognitive processes such as learning and memory by modulating long-term potentiation (LTP) and depression (LTD) in hippocampal synapses (17, 18). The p75NTR receptor, also known as the nerve growth factor receptor (NGFR), was the first discovered member of the tumor necrosis factor receptor (TNFR) superfamily, with low affinity for NGF. NGFR affects cell cycle regulation through its function as a suppressor of certain processes in progenitor and somatic cells (19, 20).

Neuroplasticity and the Role of BDNF in Affective Disorders

Depression may correspond to a significant slowing down or inhibition of neuroplasticity. Changes in the expression of genes regulating brain plasticity and reduced numbers of interneuronal connections have been observed; a decrease in *de novo* neurogenesis has also been postulated (21). It has been shown that the concentration of this neurotrophin in depressed patients differs from the healthy population both before treatment (effect size 0.91, 95% CI 0.70–1.11) and after treatment (effect size 0.34, 95% CI 0.02–0.66) (22). BDNF levels increase after treatment (effect size 0.62, 95% CI 0.36–0.88), and this increase correlates with improvement in depression scores changes ($p = 0.02$) (22). Plasma BDNF concentration is also lower in patients with bipolar disorder (Hedges' $g = -0.28$, 95% CI: -0.51 to -0.04, $p = 0.02$) (23).

Physical Activity in Affective Disorders

Physical activity has a positive effect on both the somatic and mental state. It reduces the risk of developing depressive disorders in all age groups. A meta-analysis by Schuch found that exercise has a large and significant antidepressant effect in people with depression (including MDD) (24). There are also contradictory results. No improvement in the quality of life, reduction in depressive symptoms or the relationship between exercise and achieving remission (25) was noted. It is not entirely clear how exercise could change the course of mental illness. One of the proposed mechanisms is change in neuroplasticity induced by physical activity. It was confirmed that both a single exercise and regular physical activity increase the concentration of BDNF (26, 27). The increase in BDNF levels after exercise was observed in a study conducted in young, healthy participants (28, 29). A significant increase in BDNF was found also in patients with depression (30, 31). It was noted that changes in the concentration of neurotrophins may be associated with changes in selected cognitive functions (32). However, some studies show that the level of BDNF under the influence of physical activity, especially in patients with depression, does not change significantly. In one meta-analysis (199 patients, only aerobic exercise of various duration), no significant change in BDNF concentration was observed after exercise ($p = 0.75$) (33).

The effect of exercise on cognition, especially among patients with depressive disorders, is inconclusive. A review of the available literature conducted by Brondino et al. (34) found no evidence for beneficial effects of physical activity on cognitive function. The authors found no change in either overall cognitive performance or its individual components (speed of processing, attention/vigilance, working memory, verbal and visual memory, and reasoning), regardless of the duration and

intensity of exercise. No significant effect of PA on cognitive performance was found, but the results pertaining to several neurocognitive functions (not including verbal memory and verbal fluency/working memory) appeared to be better among patients engaging in PA than in the sertraline group; however, they did not differ from the results achieved in the placebo group (35). One of the studies found that the aerobic training improved depressive symptoms and cognitive control processes in individuals with MDD (36).

Fewer studies are available on the impact of a single bout of physical activity on cognitive performance in depressed patients. One analysis (79 studies, 2,072 subjects) conducted by Chang showed that a single bout of exercise (aerobic, non-aerobic, and muscular resistance) had a positive effect on cognitive function, but the effects observed during the exercise, immediately afterwards, and at a later time were small (37). Improvements after a single session of exercise were observed, among others, in the TREAD (Treatment with Exercise Augmentation for Depression) study. High-intensity exercise was associated with improved spatial working memory, while other cognitive functions (including psychomotor speed, attention, visual memory, and spatial planning) improved regardless of task intensity (38). The authors postulated that physical activity may be a beneficial intervention in depressed patients complaining of cognitive decline, especially if the exercise regime conforms to WHO guidelines. Improvements in some cognitive functions, primarily related to the prefrontal cortex (i.e., working memory, verbal fluency, speed of information processing), were observed after a single session of high-intensity exercise (39).

Many studies linking physical activity and cognitive function have been conducted in healthy populations. Due to the physiological decline in cognitive performance that progresses with age, these experiments have often featured older adults. Physical activity has been found to primarily affect working memory and executive functions, with effects lasting up to ∼2 h after cessation of exercise (40). The most commonly used tools (tests) have been those that assess skills depending on the functioning of the prefrontal cortex (attention and perception tasks that focus on reaction time and on verbal and visual working memory). In a review conducted by Basso and Suzuki (40), the authors found that a single session of exercise primarily affects executive functions, including attention, working memory, problem solving, cognitive flexibility, verbal fluency, decision making, and inhibitory control. Selected publications have also made the suggestion that the intensity of the physical activity used may be a differentiating factor (41). The researchers concluded that an increase in BDNF after exercise is likely to be of peripheral (rather than central) origin, and they noted an association between the post-intervention BDNF levels and cognitive function. Acute changes in peripheral BDNF following physical exercise were demonstrated, and individuals with greater increases in plasma BDNF following physical exercise exhibited greater cognitive training gains, but only if the cognitive training session was preceded as opposed to followed by physical exercise (42).

TABLE 1 | Basic characteristics of the respondents ($n = 41$ participants).

	Mean ± SD
Age (years)	38.5 ± 13.3
BMI (kg/m^2)	25.8 ± 5.4
HDRS	19.2 ± 5.9
MMSE	28.9 ± 1.4

Aim

In the present study, we attempted to evaluate the effects of exercise on neurotrophic factor levels in depressed individuals. We examined whether a single session of aerobic exercise would change the levels of BDNF and other proteins (proBDNF, TrkB, p53). The influence of exercise on selected cognitive abilities (primarily cognitive control) of patients was also assessed using a Stroop test.

MATERIALS AND METHODS

Participants

Adult (18–65 years, both sexes: 24 women and 17 men) inpatients diagnosed with major depressive disorder (MDD) or a depressive episode in the course of bipolar disorder (BD) using semi-structured interviews based on ICD-10 (International Classification of Diseases) and hospitalized in a psychiatric clinic in Poznań were invited to participate in the study. The diagnoses were made by two psychiatrists. The severity of depression was assessed using the Hamilton Depression Rating Scale (HDRS). The exclusion criteria included the occurrence of an acute psychotic episode, a comorbid diagnosis of substance abuse during the previous 6 months, as well as severe cardiovascular and skeletomuscular disorders (constituting a contraindication to participate in physical exercise). All the patients were examined by a cardiologist before the study. They all provided their written consent after being informed about the study methods. The study was approved by the Ethical Committee of the Poznan University of Medical Sciences. The demographic characteristics of the participants are summarized in **Table 1** (Basic characteristics of the respondents).

Evaluation of VO_2max—Astrand-Ryhming Test

As the exercise load increases, the body's oxygen consumption increases proportionally until it reaches a certain value above which the oxygen uptake remains constant despite the increasing load. This value is called the maximal oxygen uptake or maximal aerobic capacity (VO_2max) and is expressed in liters/minute or milliliters/kilogram of body weight/minute. Aerobic capacity was assessed with a modified Astrand-Ryhming protocol for predicting VO_2max using a Kettler DX1 Pro cycloergometer (Ense-Parsit, Germany), and HR was monitored using a Polar A-5 pulse meter (Polar Electro Oy, Kempele, Finland). The participants were asked to maintain a constant cadence of 60 revolutions per minute. The trial was stopped when the patient reached the expected heart rate, and it remained stable between

130 and 170 bpm (the difference in heart rate was no more than 5 bpm). The predicted VO_2max was read from the nomogram or the accompanying tables (43) and multiplied by both the Astrand and the von Dobeln age correction factors. These two predictions in L/min were then converted to mL/kg/min.

Blood Assays—BDNF, proBDNF, TrkB, and NGFR

A 10-ml sample of venous blood was collected from each patient into an anticoagulant-free tube between 7:30 and 9:30 a.m. after overnight fasting. After 1 h of incubation, the serum was separated by centrifugation, aliquoted, and stored at −70 until the time when all the samples were analyzed. Another blood sample was collected 10 min after the completion of exercise and subjected to the same procedures. Enzyme-linked immunosorbent assay analyses were performed using DuoSet ELISA Development Kits (BDNF cat. no. DY248, proBDNF cat. no. DY3175, TrkB cat. no. DYC397-5, NGFR cat. no. DY367) from R&D Systems (Minneapolis, MN, USA) in accordance with the manufacturer's instructions (with minor modifications). The plates were coated with capture antibodies overnight at room temperature, then washed 3 times and blocked with 1% BSA/PBS for 3 h. The serum samples were diluted in ratios of 1:2 (proBDNF, NGFR), 1:40 (TrkB), and 1:100 (BDNF) in reagent diluent to fit the linear range of standard curves for each analyzed protein. The plates were incubated with 100 μL of samples or standards overnight at room temperature. All the samples and standards were run in duplicates. The detection steps were performed in strict accordance with the manufacturer's instructions. The standard curve ranges were 1,000–15.6 pg/ml (BDNF, TrkB), 3,000–46.8 pg/ml (proBDNF), 2,500–39.06 pg/ml (NGFR). The intra-assay and inter-assay coefficients of variability (CV) were <5 and <10%, respectively.

Assessment of Cognitive Control—The Stroop Color-Word Interference Test

The Stroop Color-Word Interference Test (SCWT) is often used in psychiatry and neurology to assess primarily cognitive control. The version of the test used in this study consists of two parts: A and B. In part A the participant is asked to read as quickly as possible a list of color names printed in black (achromatic color-word reading). In part B of the test, the participant is presented with the same words, but each word is printed in a color that is inconsistent with the word's meaning—the task is to name the font colors in which the individual words are printed (chromatic color-word reading). The test evaluates the time required to perform part A (treated primarily as a measure of reading speed) and the time required to perform part B—which is a value that takes into account both the speed of reading and the time necessary to activate complex mental processes, including cognitive control and inhibition of automatic verbal responses. Naming font colors that are inconsistent with the meaning of the printed words has been observed to take longer; this phenomenon is known as the Stroop interference effect (44). The number of errors, made primarily in the second part of the test, is also assessed. Each instance of beginning to utter an incorrect word is counted as an error even if the participant makes a self-correction immediately.

Testing Procedures

The tests were performed in an indoor gym with external stimuli reduced to a minimum (i.e., no music, no videos). A simple, standardized instruction was provided to each participant. The participants were requested not to eat, drink coffee, or smoke during 2 h before the test. They took their medication as usual. All tasks (with the exception of the Astrand-Ryhming test) were performed on the same day in standardized conditions. First, blood samples were acquired (between 7:30 and 9:30 a.m.). Ten minutes after the blood sample was acquired, each patient completed a questionnaire for mood assessment and completed a Stroop test, after which they started the main exercise. The exercise consisted of a 40 min ride on a cycloergometer (name) with the load set at a level of 70%VO_2 max, corresponding to the individual anaerobic threshold (AT). This value was determined individually for each patient during the exercise test, which determined the VO_2max value according to the adopted procedure (Astrand-Ryhming test). The initial load was 25–50W (warm-up); after 5 min the load was gradually (25W/min) increased to the target load, which was maintained for 30 min. The last 5 min of exercise was performed with a load of 25W (cooldown). As in the exercise test, the speed during the exercise session was maintained at 60 RPM. After the end of the exercise session, the patients again completed a mood assessment questionnaire and performed the Stroop test, and a second blood sample was collected after 10 min.

Anthropometric Assessments

Anthropometric measurements included body weight and height. Body weight was measured using a SECA beam balance scale. Height was measured using a SECA stadiometer. The body mass index (BMI) was then calculated (**Table 1**).

Medication Use

We recorded the use of antidepressants, mood stabilizers, and antipsychotics. The patients also used somatic medications. Participants taking beta-blocking agents were excluded due to the influence of these agents on heart rate (HR) response (see **Supplementary Material**).

Statistical Analyses

The distribution of the data was analyzed using the Kolmogorov-Smirnov and Lilliefors tests. Non-parametric tests were applied. The Wilcoxon signed-rank test was applied to analyze dependent variables (to check the significance of differences of the concentrations of BDNF, proBDNF, TrkB, NGFR, and the SCWT performance before and after exercise). Spearman's rank correlation coefficient was applied to test the correlation between measurable variables (the concentrations of BDNF, proBDNF, TrkB, NGFR, and the SCWT performance). The significance level was set at $p < 0.05$. The analyses were made using the STATISTICA 13.3 software (StatSoft, Kraków, Poland).

TABLE 2 | Protein concentrations (BDNF, proBDNF, BDNF, NGF, and TrkB) did not change significantly due to exercise.

	Before exercise	After exercise	Wilcoxon test T	*p*
BDNF (ng/ml)	14.84	14.48	378.00	0.67
proBDNF (ng/ml)	2.62	1.87	287.00	0.86
NGFR (ng/ml)	0.5	0.51	375.00	0.83
TrkB (ng/ml)	22.51	21.79	427.00	0.96

RESULTS

The study analyzed 41 patients (24 women and 17 men) aged 19 to 63 years (mean age: 38 years). Twenty seven patients were diagnosed with a depressive episode in the course of bipolar disorder, while the remaining (14 patients) had their first depressive episode or suffered from recurrent depressive disorder. The mean calculated value of BMI was 25.8 kg/m^2. The most common comorbidities included hypertension (7 participants) and hypothyroidism (5 participants). Previous pharmacological treatment was maintained during the study. Depression severity was assessed at baseline with the HDRS: the mean score was 19 points, the lowest score was 9 points, and the highest score was 34 points. Exercise load was determined individually for each patient (according to the protocol described in the methods section). The average exercise load was 109W, the minimum load was 50W, and the maximum load was 175W. No statistically significant changes were observed after the exercise sessions with regard to the concentrations of the analyzed neurotrophic factors (BDNF, proBDNF) or their receptors (NGFR, TrkB). The individual values are presented in **Table 2**.

Cognitive control was evaluated using the Stroop test. The SCWT assesses inhibitory control of a habitual response in a conflict situation (45) and the ability to switch to a previously unused response criterion (46). The primary indicator described in the Stroop test is the so-called interference effect, i.e., the increase in reaction time when the subject has to react according to a new criterion, different from the one used in the first part of the task. The SCWT evaluates working memory, the efficiency of concentrating attention, and the ability to maintain of executive control (equated with resistance to interference). The test was completed twice by 34 participants—immediately before ($SCWT_1$) and about 10 min after exercise ($SCWT_2$). Both the mean reading time (29.3 s vs. 47.8 s) and the color naming time (36.7 s vs. 50.7 s) increased. The patients made more mistakes after physical exercise, both in part A (0.2 vs. 1.5) and B (0.6 vs. 1.5). However, the so-called interference effect decreased—the difference between naming and reading times was smaller after exercise (6.2 s vs. 2.4 s). The results are presented in **Table 3**. No significant correlations were found between the concentrations of the studied neurotrophic factors and the Stroop test results. The correlations are presented in **Table 4** (before exercise) and **Table 5** (after exercise).

TABLE 3 | The table shows the time (in seconds) to complete the individual parts of the Stroop test (SCWT A—version A, monochrome and SCWT B—version B, color), the number of errors (in versions A and B), as well as the interference time (in seconds) before and after exercise.

	Before exercise	After exercise	Wilcoxon test T	*p*
SCWT A (time in s)	29.3 ± 9.3	47.8 ± 21.5	34.00	$p < 0.0001$
SCWT A (number of errors)	0.2 ± 0.6	1.5 ± 2.1	0.00	$p < 0.001$
SCWT B (time in s)	36.7 ± 15.6	50.7 ± 16.1	110.50	$p = 0.001$
SCWT B (number of errors)	0.6 ± 1.1	1.5 ± 1.7	37.50	$p = 0.004$
Interference time (s)	6.2 ± 13.2	2.4 ± 12.6	56.50	$P < 0.001$

The time of performing individual tasks and the number of errors made have increased significantly, while the time of interference has been significantly shortened.

TABLE 4 | The table shows correlations between the Stroop test results (SCWT A—version A, monochrome and SCWT B—version B, color) and the concentrations of the studied neurotrophic factors before exercise.

		Rs	*p*
BDNF	SCWT A (time in s)	−0.226	0.2065
	SCWT A (number of errors)	0.243	0.1728
	SCWT B (time in s)	−0.041	0.8229
	SCWT B (number of errors)	0.224	0.2095
	Interference time (s)	0.142	0.4302
proBDNF	SCWT A (time in s)	0.026	0.8975
	SCWT A (number of errors)	0.058	0.7752
	SCWT B (time in s)	−0.036	0.8570
	SCWT B (number of errors)	−0.087	0.6646
	Interference time (s)	−0.041	0.8404
NGFR	SCWT A (time in s)	−0.068	0.7063
	SCWT A (number of errors)	0.110	0.5410
	SCWT B (time in s)	0.101	0.5748
	SCWT B (number of errors)	0.216	0.2276
	Interference time (s)	0.272	0.1255
TrkB	SCWT A (time in s)	0.198	0.2618
	SCWT A (number of errors)	0.195	0.2695
	SCWT B (time in s)	0.312	0.0720
	SCWT B (number of errors)	−0.034	0.8498
	Interference time (s)	0.170	0.3364

No significant correlations were found.

DISCUSSION

Physical activity is used also as one of the strategies to maintain (or improve) cognitive function. Researchers continue to investigate the mechanism of this phenomenon. The impact of physical activity on the cognitive abilities of depressed patients is unclear. It has also not been clearly established whether a

TABLE 5 | The table shows correlations between the Stroop test results (SCWT A—version A, monochrome and SCWT B—version B, color) and the concentrations of the studied neurotrophic factors after exercise.

		Rs	*p*
BDNF	SCWT A (time in s)	0.235	0.1875
	SCWT A (number of errors)	0.250	0.1607
	SCWT B (time in s)	0.189	0.2930
	SCWT B (number of errors)	0.019	0.9166
	Interference time (s)	−0.070	0.6976
proBDNF	SCWT A (time in s)	−0.031	0.8774
	SCWT A (number of errors)	−0.045	0.8234
	SCWT B (time in s)	−0.214	0.2829
	SCWT B (number of errors)	−0.203	0.3093
	Interference time (s)	−0.126	0.5311
NGFR	SCWT A (time in s)	−0.298	0.0916
	SCWT A (number of errors)	−0.179	0.3185
	SCWT B (time in s)	−0.165	0.3588
	SCWT B (number of errors)	0.131	0.4683
	Interference time (s)	0.339	0.0536
TrkB	SCWT A (time in s)	0.084	0.6370
	SCWT A (number of errors)	0.081	0.6492
	SCWT B (time in s)	0.083	0.6392
	SCWT B (number of errors)	−0.203	0.2494
	Interference time (s)	−0.104	0.5600

No significant correlations were found.

single session of physical activity can change the concentration of neurotrophic factors.

As a result of the study conducted by our team, we did not observe statistically significant changes after exercise with regard to the concentrations of the analyzed proteins (BDNF, proBDNF, NGFR, TrkB). Similar results were obtained in some of the studies presented in the introduction. However, they mainly concerned the concentration of BDNF. According to the authors' knowledge, the available literature does not contain much data on the changes in proBDNF, TrkB and NGRF concentrations under the influence of physical activity in patients with an episode of depression. In our study, these values did not change significantly. However, many publications indicate that, under the influence of exercise, the concentration of BDNF increases (28, 29). This observation usually applies to healthy individuals (30, 31, 47).

Most of the research to date has focused on exercise programs consisting of multiple sessions. Regular exercise is likely to have a greater impact on neuroplasticity, which may also result in sustained improvement in cognitive function. Fewer studies are available on the impact of a single bout of physical activity on cognitive performance and change in the concentrations of selected neurotrophic factors in depressed patients. Contrary to our experience, some of them showed both an increase in the concentration of neurotrophic factors and an improvement in cognitive functions (32, 42). Studies linking physical activity and cognitive function have been conducted in healthy populations. The results indicate a positive effect of exercise on cognitive function. The less beneficial effect we observed among the depressed population may be related to several factors. Most often, these individuals have a sedentary lifestyle and are reluctant to engage in complex activities. The baseline BDNF level in patients suffering from depression was found to be lower compared to healthy subjects. In reviewed studies, men were often a significant proportion of participants, and a greater increase in BDNF was observed in the male population than in the female population. In our project, women, who are diagnosed with depression several times more frequently, were predominant.

The obtained results may also be related to the selected exercise intensity. The studies suggest that exercise load may differentiate the influence of physical activity on cognitive functions (38, 41). In many studies, however, a moderate intensity (this was used in our experiment) was enough to obtain the desired effects.

It is suggested that SCWT can assess various cognitive functions (48). The Stroop test measures primarily speed of visual search (part A—reading), working memory, and conflict monitoring (part B—naming colors) (49, 50). It is also used to measure other cognitive functions such as attention, processing speed, cognitive flexibility (51). As shown in previous publications, these functions in patients with depression are reduced compared to healthy subjects (2–7). In the study by Basso and Suzuki (40), they indicate that physical activity can affect attention, working memory, decision making, and inhibitors control, which contributed to the choice of SCWT in our study. The Stroop test was repeated twice in quick succession. Improvement in interference time that we observed may be due to practice effects. It is wondering, why the other variables (time and number of errors) would not also improve. It is possible that this is caused by fatigue after exercise.

Implications and Limitations of the Study

Our study has several limitations. It was conducted on a small group of participants. The study did not include a control group. It enrolled patients with both BD and MDD. It is believed that the baseline level of cognitive function and the concentrations of selected neurotrophic factors in both groups may differ significantly. In order to exclude significant cognitive deficits, the patients were examined by MMSE during recruitment, and they all scored above 27 points. It was not possible to confidently estimate the level of the subjects' physical activity before hospitalization; this estimation relied on the self-assessment of the participants (most declared a complete lack or low levels of exercise at least since the onset of depression). Differences in motivation and commitment to task performance were evident and attributable, at least partly, to the presence and severity of depressive symptoms. Notwithstanding, all participants were subject to the same procedures and verbal instructions and cues for each stage of the test. The influence of medication on both physical performance and neurocognitive abilities was not without significance. Blood sample acquisitions were performed at two time points. It is conceivable that a change in the concentration of the examined proteins would be observed during exercise or after a longer period of time after its

completion. For the assessment of selected cognitive functions, we used only the Stroop test, which measures specific abilities. This test was repeated twice in a short time, which could activate the so-called practice effect. In order to objectify the results, it is necessary to extend the battery of tests and include a control group. We believe that it would be worthwhile to continue the research in this area and to eliminate the limitations listed above.

CONCLUSION

No change in the concentrations of selected neurotrophic factors and receptors after a single bout of exercise was observed in this study. Neither were there any significant correlations between the concentrations of BDNF, proBDNF, TrkB, NGFR and the SCWT performance. The opposing results from previous studies indicate the complexity of the problem and suggest that the mechanism linking physical activity, depression, and cognitive function is a multifactorial one. Understanding it could contribute to the creation of a therapeutic exercise program whose effectiveness would be supported by scientific evidence.

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/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee of the Poznan University of Medical Sciences. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FR and AJ-M were involved in the conceptualization and design of the study, analysis, and interpretation of data. AJ-M, KDr, and KDo acquired data. AJ-M, KDr, KDo, MK, KJ, and GK were involved in the conduct of the study. MS performed protein determinations and statistical analysis. AJ-M wrote the first draft of the article. FR supervised the study and revised the manuscript. All authors contributed to the article and approved the submitted version.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.777394/full#supplementary-material

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