

RESEARCH ARTICLE

Acute physiological and mood changes associated with a single 60-minute Nirvana Fitness session in young women

Robert Podstawski^{1*}, Krzysztof Boryśławski², Bożena Hincza³, Attila Szabo⁴, Emilia Bałdyga¹, Anna Podstawska⁵, Aneta Omelan⁶, and Paweł Jastrzębski⁷

¹Human Wellness Research Laboratory, Department of Physiotherapy, Faculty of Health Sciences, University of Warmia and Mazury in Olsztyn, Olsztyn, Warmian-Masurian Voivodeship, Poland

²Faculty of Health Sciences, Angelus Silesius University of Applied Sciences in Wałbrzych, Wałbrzych, Lower Silesian Voivodeship, Poland

³Department of Physical Education and Sport, University of Gdańsk, Gdańsk, Pomeranian Voivodeship, Poland

⁴Department of Psychology and Health Management, Faculty of Health and Sport Sciences, Széchenyi István University, Győr, Győr-Moson-Sopron County, Hungary

⁵Psychotherapy, Prevention, and Addiction Treatment Clinic, Olsztyn, Warmian-Masurian Voivodeship, Poland

⁶Department of Tourism, Recreation, and Ecology, Faculty of Geoengineering, University of Warmia and Mazury, Olsztyn, Warmian-Masurian Voivodeship, Poland

⁷Department of Emergency Medicine, Faculty of Health Sciences, University of Warmia and Mazury, Olsztyn, Warmian-Masurian Voivodeship, Poland

***Corresponding author:**
Robert Podstawski
(podstawski robert@gmail.com)

Citation: Podstawski R, Boryśławski K, Hincza B, *et al.* Acute physiological and mood changes associated with a single 60-minute Nirvana Fitness session in young women. *Health Psychol Res.* doi: 10.36922/HPR026250134

Received: June 19, 2026

Revised: September 1, 2026

Accepted: September 4, 2026

Published online: October 19, 2026

Copyright: © 2026 Author(s). This is an Open-Access article distributed under the terms of the Creative Commons Attribution Non-Commercial 4.0 International (CC BY-NC 4.0), which permits all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Publisher's Note: AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract

Background: Evidence regarding physiological and psychological changes associated with Nirvana Fitness (NF) in women remains limited.

Objective: This study examined physiological responses and mood changes before and after a single 60-minute NF session in young women.

Methods: The study included 105 female university students aged 18.1–23.0 years (mean age, 20.07 ± 1.14 years). We assessed physical activity levels using the Polish short version of the International Physical Activity Questionnaire. We measured anthropometric characteristics and body composition using bioelectrical impedance analysis before the training session, and we evaluated mood states before and after the session using the Profile of Mood States questionnaire.

Results: Participants demonstrated moderate physical activity levels and normal body mass index values, although body fat percentage was close to the upper reference range. The session was characterized by low-to-moderate physiological intensity (mean heart rate, 112.4 bpm; estimated energy expenditure, approximately 376 kcal), with low estimated oxygen uptake and respiratory responses. Significant pre–post changes in mood states were observed, including reductions in emotional tension, depression, anger, confusion, and fatigue, and an increase in vigor (all $p < 0.001$).

Conclusion: Immediate changes in self-reported mood states were observed after a single NF session; however, the single-arm pre–post design does not allow these changes to be attributed specifically to NF. The findings should therefore be considered preliminary, and controlled studies are needed to determine whether NF

contributes to these changes in mood states in young women.

Keywords: Nirvana Fitness; Mood states; Physical activity; Young women; Physiological responses

1. Introduction

Nirvana Fitness (NF) is a training method that integrates low- to moderate-intensity physical activity, conscious diaphragmatic breathing, and coordinated movement sequences. This program combines movement with breath control, a combination the scientific literature has examined for its effects on the autonomic nervous system.¹ Although direct evidence on NF is limited, research on consciously regulated breathing provides relevant physiological context for understanding a key component of this method. Evidence from studies of controlled breathing suggests that consciously regulated, slow, deep breathing may alter sympathetic and parasympathetic nervous system activity, indicating its potential role in modulating physiological processes related to organismal homeostasis.² As one of the few autonomic functions subject to voluntary control, breathing is a key focus of interventions aimed at stress reduction and improved physiological regulation.³

Nirvana Fitness incorporates elements also found in other mind-body exercise modalities, particularly yoga and Pilates, but combines them within a structured format centered on rhythmic diaphragmatic breathing, prolonged exhalation, coordinated low- to moderate-intensity movement, and music. Unlike yoga, which encompasses a broader range of postures, breathing practices, and meditative techniques, and Pilates, which primarily emphasizes controlled movement, postural alignment, core stability, and muscular control, NF integrates breathing and movement into a continuous, music-supported exercise sequence. A central component of the training is conscious diaphragmatic breathing with a prolonged expiratory phase.¹ Research on slow, controlled breathing, rather than NF-specific studies, has linked this breathing pattern to modulation of autonomic nervous system activity, particularly increased parasympathetic activation, which supports restorative processes and regulates stress responses.⁴⁻⁶ Slower breathing with prolonged exhalation may also increase vagal nerve activity, which has been linked to reduced heart rate and changes in hemodynamic parameters, such as blood pressure.⁴ Furthermore, studies of controlled breathing have reported associations with improvements in heart rate variability, recognized as an indicator of autonomic adaptability and resilience to stress.⁷

Unlike traditional yoga, which is typically practiced in static postures and meditative settings without musical accompaniment,⁸ NF introduces “meditation in motion,” based on rhythmic activity performed in synchrony with music.⁹ Integrating mindful breathing with music is readily adaptable for Western populations, which may help explain the method’s growing global popularity. NF sessions typically last approximately 55 minutes and involve a sequence of simple, functional full-body exercises performed in synchronization with breathing rhythm and relaxation-oriented music. NF-related research describes this type of multisensory stimulation as potentially facilitating a “flow” state and supporting concentration and emotional regulation.¹ Although changes in mood-related neurophysiological processes have been discussed in the broader literature on physical activity and mind-body interventions, such evidence should not be interpreted as direct evidence of a specific NF mechanism. Accordingly, the potential contribution of breathing, music, movement, and relaxation to psychological responses observed during NF remains to be established.

Contemporary lifestyles promote persistent shallow, rapid breathing patterns characterized by a predominance of upper thoracic respiration, which may adversely affect alveolar ventilation efficiency and the body’s gas balance.¹⁰ Research on diaphragmatic and controlled breathing, rather than NF specifically, suggests that breathing training aimed at diaphragmatic activation may increase tidal volume and improve gas-exchange efficiency.¹¹ These changes have been associated with enhanced tissue oxygenation and improved functional capacity.⁴

Additionally, repeated breathing patterns, combined with movement, may contribute to a so-called conditioned relaxation response.¹² This concept, described in research on meditation, relaxation, and controlled breathing techniques, involves developing an automatic physiological response to specific respiratory stimuli and may be associated with reduced psychophysiological tension.¹³ Although these mechanisms are relevant to the breathing and relaxation components incorporated into NF, evidence directly demonstrating their occurrence during NF sessions remains limited. The techniques applied in NF share characteristics with approaches described in the literature on exercise physiology, psychophysiology, and respiratory

therapies and may therefore provide a theoretical basis for considering NF within preventive health strategies.¹⁴ This method exemplifies a holistic training approach that integrates physical activity with breathing regulation and elements related to autonomic regulation.

The available literature includes few studies that specifically examine NF, as well as studies involving related but distinct interventions using the BTS NIRVANA virtual reality system or mindfulness-oriented training. These studies should therefore be interpreted separately when considering the evidence relevant to NF.

The earliest studies associated with the NIRVANA name concerned the BTS-NIRVANA virtual reality system used in neurocognitive rehabilitation. Russo *et al.*¹⁵ investigated an eight-week neurocognitive rehabilitation program in 20 post-stroke patients, comprising 24 sessions conducted three times per week. The intervention was associated with improvements in visuospatial abilities and sustained attention, while the “body shadow” feature was reported to support body perception and self-identification. Subsequently, De Luca *et al.*¹⁶ compared an eight-week BTS-NIRVANA virtual reality training program with cognitive therapy in 12 post-stroke patients and reported greater improvements in cognitive functioning in the virtual reality group both immediately after the intervention and at one-month follow-up.

In contrast, studies specifically examining NF are more directly relevant to the present research. Solianik and Ivanova,¹⁴ investigating 20 women randomly assigned to an NF group ($n = 10$) or a control group ($n = 10$) and delivering two 50-minute sessions per week over eight weeks, demonstrated significant reductions in stress levels and improvements in inhibitory control and cognitive flexibility, although no changes were observed in working memory or spatial memory. In studies involving young women, Jankauskiene *et al.*¹ compared NF, functional training, and a control group (NF: $n = 21$; fitness: $n = 22$; control: $n = 47$) in an eight-week intervention conducted twice weekly. The results indicated improvements in selected aspects of body image, which were reported in association with the NF intervention and discussed in relation to enhanced mind–body integration and reduced excessive appearance monitoring. Notably, NF was associated with greater changes in psychological variables, whereas functional training was associated with greater changes in motor performance.

In a subsequent study by the same research group,⁹ changes in body appreciation following NF were assessed among 43 participants (NF: $n = 21$; control: $n = 22$). The findings demonstrated significant improvements in both groups, with a greater magnitude of change observed in the

NF group. Furthermore, changes in mindfulness, reduced body surveillance, and increased relational connectedness emerged as significant predictors of enhanced body appreciation. Complementary evidence from a related, but distinct, movement-based intervention was reported by Balciuniene *et al.*¹⁷ in a study involving 110 female university students (mean age 21.5 ± 3.5 years), in which an eight-week intervention combining elements of cognitive–behavioral therapy and movement-based sessions incorporating mindfulness components (30 participants in the intervention group and 80 in the control group) resulted in significant improvements in body image and reductions in the internalization of thinness ideals, thereby providing contextual evidence regarding psychological factors associated with body perception rather than direct evidence concerning NF.

A 2026 study included 48 young women (NF: $n = 16$, functional training: $n = 15$, control group: $n = 17$).¹⁸ The intervention lasted eight weeks and was conducted twice weekly as supervised group sessions. Measurements were performed before the intervention, immediately after its completion, and 12 months later. The findings demonstrated sustained improvements in positive body image and exercise motivation in the intervention groups compared with the control group one year after the intervention, while no changes were observed in appearance monitoring or recreational physical activity.¹⁸

The literature on NF remains limited and is based primarily on a small number of studies conducted by the same research group, involving short-term interventions implemented in relatively small samples. Although the available findings indicate potential associations with stress reduction, cognitive functioning, and body image, these results should be regarded as preliminary and require further empirical validation. At the same time, some publications referring to the term “Nirvana” concern distinct virtual reality-based interventions used in neurological rehabilitation, which are not equivalent to NF.

A growing body of evidence indicates that a single bout of exercise can induce transient improvements in affective states, although the magnitude of these effects may vary depending on the type and intensity of exercise. Early research showed that acute exercise can improve mood, while more recent meta-analytic evidence confirms that a single exercise session benefits general mood, anxiety, and depressive symptoms.^{19,20} Importantly, acute psychological responses are not limited to conventional aerobic or resistance exercise. Mind–body forms of physical activity that combine movement with controlled breathing, relaxation, and attentional regulation may also influence acute psychological and

physiological responses. For example, a single session of Pilates has been shown to produce favorable changes in selected mood states in young adult males,²¹ while a recent systematic review indicated that single sessions of yoga and meditation may influence stress reactivity.²² In addition, accumulating evidence indicates that controlled breathing and breathwork may influence both psychological and physiological functioning. A meta-analysis of randomized controlled trials reported beneficial effects of breathwork on stress, anxiety, and depressive symptoms,²³ whereas a recent systematic review and meta-analysis showed that slow-paced breathing can produce immediate effects on cardiovascular and emotional functioning, including reductions in heart rate and improvements in heart rate variability.²⁴ These findings suggest that exercise modalities incorporating movement, breathing regulation, focused attention, and relaxation may provide a relevant context for examining acute physiological and psychological responses.

Nirvana Fitness incorporates several of these elements by combining physical movements with controlled breathing, relaxation, focused attention, and music. However, compared with more extensively studied mind-body practices such as yoga, Pilates, meditation, and breathwork, empirical evidence concerning the acute physiological and psychological responses to a single NF session remains very limited. In particular, although evidence shows that acute exercise and related mind-body practices can influence mood, stress reactivity, and physiological responses, the specific acute physiological and psychological responses associated with a single 60-minute NF session remain poorly characterized. Therefore, the effects of such a session on physiological responses and mood states in healthy young women, while considering their anthropometric characteristics and habitual physical activity levels, remain insufficiently understood.

The rationale for the present study was the limited evidence on acute physiological and psychological responses to a single NF session. Although previous studies have examined NF in the context of longer-term interventions, including changes in stress, cognitive functioning, and body image, evidence concerning the immediate responses to a single 60-minute session remains scarce. Therefore, the present study examined physiological responses and changes in mood states before and after a single 60-minute NF training session in young women, while considering their anthropometric characteristics and physical activity levels. Based on the available literature on mind-body exercise interventions and the limited evidence regarding NF, we hypothesized that: (i) a single 60-minute NF session would be characterized by low-to-

moderate physiological responses, as reflected by heart rate and estimated metabolic parameters; and (ii) the session would be followed by changes in participants' mood states, as assessed using the Profile of Mood States (POMS) questionnaire.

2. Materials and methods

2.1. Participants

The study was conducted between May 3 and May 30, 2025 (summer semester) at the University of Gdańsk, Poland, and involved 105 female students aged 18.1–23.0 years (mean age: 20.07 ± 1.14 years). Participants were recruited using a purposive sampling approach and included all female students enrolled in the compulsory physical education (PE) program who had voluntarily selected NF as their preferred PE activity through the University's USOS registration system. All students attending these classes during the study period were invited to participate in the study. All participants were adults. Women engaged in competitive sports and those with previous experience in NF were excluded to minimize the influence of highly trained individuals and prior familiarity with the intervention on the study outcomes. Consequently, participants followed the same PE curriculum as their peers who were not recruited. To reduce potential variability associated with menstrual cycle phase, only women who self-reported being in the pre-ovulatory (follicular) phase of the menstrual cycle at the time of the study were included.^{25,26} Menstrual cycle phase was determined solely on the basis of participants' self-reported information; no hormonal assays, ovulation tests, or other biological methods were used to objectively confirm menstrual phase. Information regarding hormonal contraceptive use and menstrual irregularities was not systematically collected and therefore was not used as an additional criterion for menstrual phase classification. Potential participants were informed about the study aims during compulsory PE classes. A total of 105 eligible female students agreed to participate and were later informed by e-mail and text message of their final enrollment. Before the study, all participants underwent a medical examination performed by a physician, who confirmed that they were in good general health, were not taking medications or dietary supplements, had no history of hematological disorders or other medical conditions that could affect the measured variables, and had no diagnosed respiratory or cardiovascular disorders.

For quantitative analysis, participants' physical activity levels were assessed using the Polish short version of the standardized and validated International Physical Activity Questionnaire (IPAQ).²⁷ Before the study, participants reported the average weekly time (in minutes) spent

engaging in physical activity, with a minimum duration of 10 minutes per activity session. Energy expenditure associated with self-reported weekly physical activity levels was expressed in metabolic equivalent of task (MET) minutes per week.²⁸ MET represents the ratio of metabolic rate during physical activity to resting metabolic rate, where 1 MET corresponds to an oxygen consumption of approximately 3.5 mL/kg/min. Based on the self-reported frequency, intensity, and duration of physical activity (“how often, how much, and how long”), participants were classified into three categories: low physical activity (<600 MET-min/week), moderate physical activity (600–1,500 MET-min/week), and high physical activity ($\geq 1,500$ MET-min/week).

2.2. Ethical statement

The study was conducted in accordance with the principles and guidelines of the World Medical Association and complied with the policies of the Health Science Council. Ethical approval was granted by the Ethics Committee of the University of Warmia and Mazury in Olsztyn (Approval No. 39/2011; approval date November 24, 2011). This is a standing approval for non-invasive studies of healthy university students, under which several previous studies by this group have been conducted; the approval formally covered the procedures used for the present study and remained valid at the time of data collection in May 2025. Each participant received detailed information regarding the purpose of the study, potential risks, and the research protocol. The protocol included comprehensive information on the measurement procedures, which participants could review during NF sessions immediately before the study. All participants provided voluntary written informed consent prior to participation. The present study was not registered as a clinical trial because it was designed as an exploratory exercise intervention study evaluating acute physiological and psychological responses to a single NF session in healthy university students. The study did not involve a clinical population, therapeutic intervention, or treatment-related outcomes; therefore, clinical trial registration was not applicable.

2.3. Procedures, data collection, and equipment

Prior to the study, participants received detailed instructions on the use of heart rate monitors. They were instructed to consume at least 1 L of water on the day of testing and an additional 0.5 L approximately 2 h before the trial. Participants were asked to refrain from consuming any food or beverages until the final body measurements were taken at the end of the experiment. Anthropometric measurements were obtained before the NF training session. In addition, participants were instructed to avoid

strenuous physical activity on the day preceding the trial. The students also assisted the research team during the measurement procedures.

2.4. Nirvana Fitness intervention

The intervention consisted of a single 60-minute NF session conducted in a spacious exercise hall under standardized environmental conditions. The same certified NF instructor led all sessions to ensure consistency. Participants exercised in standardized groups of 25–30 women, which corresponds to the typical size of university practical classes.

The session followed the standard NF methodology and consisted of three phases: a 10-minute warm-up including breathing, mobility, and preparatory exercises; approximately 45 minutes of the main exercise phase comprising a sequence of dynamic and static movements inspired by yoga, Pilates, and functional training, performed with smooth, rhythmic transitions and continuous movement flow. The exercises progressed from simple breathing and mobility activities to more complex standing and floor-based movement patterns, then concluded with relaxation exercises. As in a standard exercise session, the main phase constituted the principal training component and was performed at a slightly higher intensity than the introductory and final phases.

Throughout the session, particular emphasis was placed on slow, controlled diaphragmatic breathing synchronized with body movements. Participants performed all exercises barefoot, following the instructor’s verbal and visual cues while adapting the movements to their individual physical capabilities. The session was accompanied by specially selected relaxing music designed to facilitate breathing rhythm, concentration, and relaxation. All participants completed the same standardized protocol, and physiological parameters were recorded continuously throughout the entire 60-minute session, including the warm-up, main exercise, and cool-down phases.

2.5. Assessment of well-being

Well-being was assessed using the Polish adaptation²⁹ of the POMS questionnaire. The instrument consists of 65 mood-related adjectives and evaluates six distinct mood dimensions: tension, depression, anger, fatigue, confusion, and vigor. The “tension” subscale reflects muscle tension and generalized discomfort, whereas the “depression” subscale assesses feelings of sadness accompanied by a sense of inadequacy and worthlessness. The “anger” subscale refers to irritability and hostility toward others, while “vigor” reflects readiness for action and a sense of vitality. The “fatigue” subscale measures tiredness and

reduced energy, while “confusion” describes mental disorganization and perceived ineffectiveness. The intensity of feelings experienced at a given moment is rated on a five-point Likert scale ranging from 0 (“not at all”) to 4 (“extremely”). Scores for each subscale were calculated by summing the responses to the corresponding items, with higher scores indicating greater intensity of the respective mood state. The total mood disturbance (TMD) score was calculated by summing the negative mood subscales (tension, depression, anger, fatigue, and confusion) and subtracting the vigor score. No constant was added so that TMD could be negative. The POMS questionnaire is a valid and reliable instrument for assessing both negative mood states, such as psychological distress, and positive mood states, including vigor,³⁰ in the context of physical activity interventions.³¹ The original POMS has demonstrated good psychometric properties, with Cronbach’s α coefficients generally exceeding 0.80 for most subscales, confirming satisfactory internal consistency and construct validity.^{32,33} The instrument has demonstrated an overall detection rate of 80%, with a sensitivity of 55% and a specificity of 84%.³⁴

2.6. Anthropometric measurements and body composition analysis

Body height was measured to the nearest 1 mm using a calibrated InLab S50 stadiometer (InBody, Republic of Korea) in accordance with standardized measurement guidelines. Body mass (to the nearest 0.1 kg), body mass index (BMI), and body composition parameters, including body fat percentage and skeletal muscle mass, were assessed using bioelectrical impedance analysis with the InBody 270 Bioelectrical Impedance Analyzer (InBody, Republic of Korea). The device uses a foot-to-foot, hand-to-hand, and hand-to-foot measurement system and includes two stainless steel footpad electrodes integrated into a platform scale, as well as a tetrapolar eight-point tactile electrode system with two stainless steel hand electrodes. Previous studies have shown that bioelectrical impedance analysis using the InBody 270 analyzer is a valid method for assessing body composition and yields results comparable to alternative techniques, including dual-energy X-ray absorptiometry.³⁵ The platform scale utilizes a single load cell to determine body mass and calculate BMI. Body fat percentage was estimated by aggregating segmental lean analysis results to determine total lean body mass, fat mass, and the proportion of fat mass relative to total body mass. Muscle mass percentage (M%) was calculated using proprietary equations based on assessments of body water distribution across body segments. Visceral fat level was estimated using regression equations provided by the manufacturer, reportedly derived from comparisons between visceral fat measurements obtained

from computed tomography scans and torso impedance assessments conducted during segmental lean analysis.

2.7. Measurements of physiological parameters

Physiological parameters, including heart rate (HR; minimum, average, and maximum values), as well as estimated values of energy expenditure, oxygen uptake (VO_{2avg} and VO_{2max}), excess post-exercise oxygen consumption ($EPOC_{peak}$), and respiratory rate (RR_{avg} and RR_{max}), were measured continuously during the 60-minute NF training session using Suunto Ambit3 Peak Sapphire heart-rate monitors (Suunto, Finland). Exercise intensity was classified into six heart rate zones defined as percentages of the reference HR_{max} of 162 bpm: zone 1 (<90 bpm; <55% HR_{max}), zone 2 (90–108 bpm; 55%–66%), zone 3 (109–125 bpm; 67%–77%), zone 4 (126–144 bpm; 78%–89%), zone 5 (145–162 bpm; 90%–100%), and zone 6 (>162 bpm; >100%). For the assessment of exercise intensity, a reference maximal heart rate (HR_{max}) value of 162 bpm was applied for all participants. This fixed reference value was adopted because, given the low-to-moderate intensity of NF, high heart rates were not expected during the session; it therefore served as a common reference for classifying exercise intensity within a relatively homogeneous group of young women rather than as an individually determined or age-predicted maximum. The Suunto Ambit3 Peak Sapphire monitors are widely used in these types of studies^{36,37} and have been shown to be accurate and reliable.^{38–40} Participants wore the watch unit on their wrist, and the heart-rate sensor was secured to their chest. Each device was programmed individually based on participants’ sex, year of birth, body mass, and physical activity level. Participants activated the monitor immediately before the 60-minute NF session. After the training session, participants deactivated the monitors, and the recorded data were saved via the Suunto Movescount application installed on their smartphones. Subsequently, the data were exported from the Movescount application and recorded in an Excel spreadsheet for further analysis. The physiological recording included the 10-minute warm-up phase of the NF session, comprising breathing, mobility, and preparatory exercises (Section 2.4); no separate warm-up preceded the measured session.

2.8. Statistical analysis

Basic descriptive statistics (mean, standard deviation [SD], and range) were calculated for each parameter. The normality of distribution was assessed using the Shapiro–Wilk test, and the coefficient of skewness (As) was also calculated. Differences between measurements obtained before and after exercise were evaluated using the paired-samples Student’s *t*-test. Additionally, Wilcoxon signed-

rank tests were performed as sensitivity analyses for the POMS subscales. Mean differences together with their 95% confidence intervals (95% CI) were calculated. Cohen's d for paired samples (mean difference divided by the SD of paired differences) was used as a measure of effect size. To account for multiple comparisons across the POMS subscales, p -values were additionally adjusted using the Holm–Bonferroni procedure. Because the sample size was fixed by the number of students enrolled in the NF PE classes, a sensitivity power analysis was conducted in place of an *a priori* calculation: with $n = 105$, $\alpha = 0.05$ (two-tailed), and power of 0.80, the design was able to detect a within-subject effect of $d_z \geq 0.28$. Statistical analyses were performed using Statistica v.13, and statistical significance was set at $\alpha = 0.05$.

3. Results

Table 1 presents the characteristics of the women included in the study, including their physical activity level, selected anthropometric characteristics (body mass), and body composition parameters. The participants demonstrated a moderate level of physical activity, averaging 1,110 MET-min/week. The mean BMI fell within the normal range, whereas the body fat percentage was located at the upper limit of the reference range, approaching 30%. The mean waist-to-hip ratio (0.87) was relatively high for women and may indicate a greater tendency toward central fat distribution. At the same time, visceral fat level (8.4) remained within the normal range. The mean overall body composition assessment score (InBody Score: 71.8 points on a 0–100 scale) was accompanied by relatively high body fat content and comparatively low skeletal muscle mass. The mean skeletal muscle mass value was 24.5 kg, which was relatively low compared with values typically observed in young women. This interpretation is partially supported by body composition control indices, which suggest that a reduction in body fat mass of more than 6 kg, alongside an increase in fat-free mass of approximately 2.2 kg, would be advisable (Table 1).

Table 2 presents the physiological parameter values obtained from women during the 60-minute NF program sessions. The mean heart rate ($HR_{avg} = 112.4$ bpm) was consistent with moderate-intensity exercise, whereas the maximum heart rate values ($HR_{max} = 138.3$ bpm) did not exceed the threshold for vigorous-intensity effort in women aged approximately 20 years. During the 60-minute training session, participants expended an average of approximately 376 kcal. Estimated values of VO_{2avg} , VO_{2max} , $EPOC_{peak}$, as well as RR_{max} , remained within a low range (13.5 mL/kg/min, 27.0 mL/kg/min, 15.8 mL/kg/min, and 28.1 br/min, respectively), while the mean respiratory rate (RR_{avg}) was 19 breaths/min. Exercise intensity analysis showed that the

60-minute NF training session was predominantly very low-intensity (zone 1, <90 bpm; 1,259 s) and low-intensity (zone 2, 90–108 bpm; 1,804 s), with most recorded exercise time occurring within these zones. The participants did not reach exercise intensity zones above 162 bpm, and the mean time spent in the 145–162 bpm zone was negligible (1.8 s) (Table 2).

Table 3 presents the differences in mood states before and after a one-hour NF training session, as assessed using the POMS questionnaire. The obtained results showed significant changes in several mood state dimensions following the NF training session. Emotional tension significantly decreased ($p < 0.001$), with lower post-session scores indicating reduced tension. Furthermore, significant decreases in depression and anger levels were recorded following the training session (both $p < 0.001$). Confusion also decreased to a similar extent, with lower post-session scores. Vigor increased significantly ($p < 0.001$) after the training session, indicating higher vigor scores. At the same time, fatigue decreased significantly ($p < 0.001$), with lower post-session fatigue scores. One hour of NF exercises was also followed by a significant reduction in the TMD index ($p < 0.001$; decrease from 42.99 to 14.63), reflecting lower overall negative mood disturbance scores after the session (Table 3).

4. Discussion

This study examined selected physiological responses and mood states before and after a single 60-minute NF training session in young women, accounting for their anthropometric profile and physical activity level. Interpreting the findings is challenging because few scientific publications on NF allow direct comparison of the effects observed in the present study with previous reports. Therefore, the discussion is situated within the broader context of research on physical activity among young adults, including interventions differing in exercise intensity and their effects on somatic and psychological parameters.

The women in the study had moderate physical activity, averaging 1,110 MET-min/week. The mean BMI (23.3 kg/m²) remained within the normal range; however, body fat percentage was relatively high (approaching 30%), while muscle mass proportion was low. This body composition profile shows that a normal BMI may coexist with less favorable body composition characteristics, with implications for health risk assessment and planning appropriate exercise interventions. Similar observations were reported by Jankauskiene *et al.*¹, who demonstrated that among young women, BMI values predominantly fell within the normal range (mean values of 23.4 ± 4.6 kg/

Table 1. Anthropometric and body composition parameters of women participating in the Nirvana Fitness session ($n = 105$)

Parameters	Mean	SD	Min	Max	Coefficient of skewness
Age (years)	20.07	1.14	18.1	23.0	0.098
PA (MET-min/week)	1,110.4	496.3	420	3,100	1.104
Body height (cm)	168.79	6.80	155.1	187.2	0.662
Body mass (kg)	64.80	12.03	46.3	115.9	1.542
BMI (kg/m ²)	23.33	4.14	17.5	40.2	1.619
TBW (kg)	32.72	3.69	26.0	47.3	0.945
Protein (kg)	8.78	0.99	7.1	12.6	0.873
Minerals (kg)	3.24	0.41	2.5	4.9	1.171
BFM (kg)	20.06	8.87	8.1	55.3	1.661
FFM (kg)	44.74	5.08	35.5	64.8	0.957
SMM (kg)	24.49	3.02	18.9	36.2	0.887
Body fat percentage (%)	29.91	7.48	13.2	52.0	0.679
InBody score	71.8	6.5	50	82	-1.441
Target weight (kg)	60.86	4.96	52.3	84.2	1.501
Body mass control (kg)	-3.94	9.64	-37.2	11.5	-1.375
BFM control (kg)	-6.12	8.46	-37.2	6.2	-1.652
FFM control (kg)	2.18	2.35	0.0	8.8	0.812
BMR (kcal)	1,336.4	109.88	1,137	1,771	0.962
WHR	0.87	0.06	0.75	1.04	0.695
VFL	8.4	4.5	3	24	1.580
Obesity degree	108.5	19.24	81	187	1.627

Abbreviations: BFM: Body fat mass; BMI: Body mass index; BMR: Basal metabolic rate; FFM: Fat-free mass; MET: Metabolic equivalent of task; PA: Physical activity; SD: Standard deviation; SMM: Skeletal muscle mass; TBW: Total body weight; VFL: Visceral fat level; WHR: Waist-to-hip ratio.

m² and 22.90 ± 4.41 kg/m² in separate analyses), although this did not preclude the coexistence of unfavorable body composition parameters. In turn, a study conducted by Omelan *et al.*⁴¹ among women practicing yoga revealed that although BMI values remained within the normal range and were slightly higher than those observed in the control group (women participating in Zumba classes), the yoga practitioners exhibited lower body fat content and a higher proportion of fat-free mass.

The mean waist-to-hip ratio (0.87) was above the commonly used reference threshold of 0.85 for women and may therefore indicate a greater tendency toward central fat distribution rather than a gynoid fat distribution pattern.

However, this finding should be interpreted cautiously, as the mean waist-to-hip ratio value does not mean all participants had increased central adiposity. According to WHO reference criteria, waist-to-hip ratio values above 0.85 in women are associated with increased risk related to central fat accumulation, while large prospective studies indicate that greater central adiposity, as assessed by waist-to-hip ratio, is associated with increased all-cause mortality risk.^{42,43}

Podstawski *et al.*,³⁶ in a study of female university students, found that martial arts, jogging followed by sauna (JFBS), and swimming were among the most effective forms of physical activity in this population. Students who

Table 2. Physiological responses during a 60-minute Nirvana Fitness exercise session

Parameter	Mean	SD	Min	Max	Coefficient of skewness
HR _{avg} (bpm)	112.4	4.9	104	130	1.052
HR _{min} (bpm)	72.4	8.9	57	98	0.633
HR _{max} (bpm)	138.3	10.7	119	162	0.716
Energy expenditure (kcal)	376.3	76.8	188	496	-0.233
VO _{2avg} (mL/kg/min)	13.5	4.3	6	24	0.456
VO _{2max} (mL/kg/min)	27.0	5.3	14	39	0.096
EPOC _{peak} (mL/kg/min)	15.8	9.8	2	47	0.802
RR _{avg} (br/min)	19.1	1.8	15	24	-0.075
RR _{max} (br/min)	28.1	4.5	23	43	1.585
Duration of exercise performed within a specific intensity zone (s)					
Zone 1 (<90 bpm)	1,259.1	537.9	140	2,894	0.131
Zone 2 (90–108 bpm)	1,804.4	584.4	371	2,812	-0.666
Zone 3 (109–125 bpm)	484.5	487.3	0	2,262	1.778
Zone 4 (126–144 bpm)	50.1	103.5	0	506	2.494
Zone 5 (145–162 bpm)	1.8	10.1	0	67	5.743
Zone 6 (>162 bpm)	0.0	0.0	0	0	0

Abbreviations: EPOC_{peak}: Peak excess post-exercise oxygen consumption; HR: Heart rate; RR: Respiratory rate; SD: Standard deviation; VO_{2avg}: Average oxygen uptake; VO_{2max}: Maximal oxygen uptake.

Table 3. Changes in mood states before and after Nirvana Fitness (*n* = 105)

POMS variables	Before			After			Mean difference	95% CI	Significance of differences				
	Mean	SD	Min–max	Mean	SD	Min–max			<i>t</i>	<i>p</i>	<i>Z</i>	<i>p</i>	Cohen's <i>d</i>
Tension	10.49	6.81	0–32	6.71	5.12	0–32	3.77	2.11–5.43	-4.50	<0.001	4.52	<0.001	0.44
Depression	14.26	12.83	0–57	6.54	10.08	0–52	7.71	4.56–10.87	-4.85	<0.001	5.12	<0.001	0.47
Anger	10.91	8.68	0–40	6.67	5.89	0–35	4.25	2.47–6.02	-4.75	<0.001	4.53	<0.001	0.46
Fatigue	11.87	7.38	0–28	5.90	6.02	0–26	5.97	4.01–7.93	-5.31	<0.001	5.39	<0.001	0.52
Confusion	8.77	5.56	0–42	5.33	3.67	0–22	3.44	2.17–4.71	-5.36	<0.001	5.23	<0.001	0.52
Vigor	13.30	6.65	0–29	16.53	6.39	0–27	-3.22	-4.95 to -1.49	3.69	<0.001	3.54	<0.001	0.36
TMD	42.99	38.01	-18–165	14.63	29.85	-13–159	28.36	19.08–37.64	-6.06	<0.001	5.65	<0.001	0.59

Notes: Lower TMD scores indicate improved psychological well-being; all statistically significant differences remained significant after Holm–Bonferroni correction for multiple comparisons.

Abbreviations: CI: Confidence interval; SD: Standard deviation; TMD: Total mood disturbance.

practiced martial arts or JFBS had relatively lower body fat levels, whereas women who swam had the highest body fat levels. Furthermore, the findings indicated that martial arts, JFBS, and swimming were the most physically demanding activities among female students, whereas golf was associated with the lowest level of physical exertion. In contrast, NF exhibits a different physiological load profile. Analysis of physiological parameters indicates that NF is a low- to moderate-intensity form of exercise, with the large majority of session time spent in the two lowest heart rate zones. The mean heart rate of approximately 112 beats/min indicates activity within a safe aerobic zone, without reaching high-intensity thresholds (no episodes above 162 bpm). The low-to-moderate respiratory rate ($RR_{avg} \approx 19$ breaths/min) suggests that this method's central component does not generate a strong cardiorespiratory stimulus, but instead supports exercise under relative hemodynamic stability and conscious breath control. The moderate energy expenditure (mean: 376 kcal) was consistent with a moderate energetic demand during the session and suggests that NF may represent a feasible form of physical activity, particularly for individuals for whom vigorous training is difficult to implement or sustain. At the same time, given the body composition profile of the women studied (high body fat percentage despite normal BMI), the NF characteristics observed in the present study may be considered when designing physical activity programs aimed at establishing regular exercise habits. However, to achieve meaningful improvements in body composition, NF would likely need to be complemented by resistance training or more vigorous physical activity.

The most pronounced changes following a single NF session were observed in the psychological domain. The TMD index decreased significantly from 42.99 to 14.63, indicating a marked improvement in overall self-reported mood following the session. Notably, perceived fatigue decreased while vigor increased, which is not a typical immediate response to exercise primarily aimed at improving physical performance, where transient fatigue is more common. Zaccaro *et al.*⁴ emphasized that conscious modulation of breathing, particularly slowing the respiratory rhythm and prolonging the exhalation phase, promotes activation of the parasympathetic branch of the autonomic nervous system, which may contribute to reduced physiological arousal and improved mood. In turn, Balban *et al.*¹² described the conditioned relaxation response, in which rhythmic movement and controlled breathing may trigger an automatic relaxation response in the body. Yoga, from which NF is partially derived, has also been shown to improve mood, as numerous studies have demonstrated, including those by Singh and Sharma,⁴⁴ Omelan *et al.*,⁴¹ and Vogler *et al.*⁴⁵ Similar findings have been

reported for Pilates, another foundational component of NF. The Pilates exercise system likewise integrates physical activity with controlled breathing, and scientific evidence has reported associations with improved mental health and well-being,⁴⁶ further supporting the potential relevance of breathing–movement interventions for psychological well-being. The present study found substantial changes in mood states following a single 60-minute NF session, thereby extending the findings of Solianik and Ivanova,¹⁴ whose work focused primarily on long-term adaptations.

From a practical perspective, NF may be of interest as a low-load form of physical activity that combines breathing and movement and may be perceived by participants as relaxing. The observed significant reduction in confusion was accompanied by lower post-session scores in this mood dimension, which may reflect changes in perceived cognitive clarity and broadly align with the improvements in inhibitory control and cognitive flexibility reported after an eight-week NF program by Solianik and Ivanova.¹⁴ However, it should be noted that the absence of a control group and the homogeneous sample selection (women in the follicular phase) limit the generalizability of the findings.

In summary, NF may represent a hybrid form of physical activity—characterized, on the one hand, by moderate energy expenditure and relatively low cardiorespiratory strain, and, on the other, by notable changes in self-reported mood states after a single session. Comparison with the findings of Podstawski *et al.*³⁶ highlights that different forms of physical activity may be associated with different physiological and psychological profiles: high-intensity activities may be particularly relevant for shaping somatic parameters, whereas NF may constitute a potentially useful form of activity for individuals seeking activities with a lower cardiorespiratory load and an emphasis on psychophysical well-being. The popularity of this activity may also be supported by its name, which is commonly associated with serenity, happiness, and inner peace. In the longer term, this approach may help individualize physical activity choices based on young women's needs, capabilities, and health priorities. Given the mood changes observed in the present study, particularly regarding mental well-being, NF warrants further investigation, especially in controlled, longitudinal studies, to determine whether the immediate mood changes are reproducible and whether they extend to longer-term psychological outcomes.

A major strength of the present study is that it is one of the few investigations to date examining the effects of NF on participants' well-being and, to the best of the authors' knowledge, the first to assess selected physiological responses during a single 60-minute NF session. Another

strength is the relatively large, homogeneous sample of healthy young women, which reduced inter-individual variability and increased the study's internal consistency.

Several limitations should also be acknowledged. First, this was an uncontrolled pre-post study without randomization or blinding; therefore, causal inferences cannot be drawn, and the observed changes cannot be attributed exclusively to the NF intervention. Expectancy or placebo effects cannot be ruled out. Second, the study population consisted exclusively of young female university students, which limits the generalizability of the findings to males, older adults, clinical populations, or individuals with different levels of physical fitness. Although only participants who self-reported being in the pre-ovulatory (follicular) phase were included, menstrual cycle phase was not objectively confirmed using hormonal assays or ovulation tests, and information on hormonal contraceptive use and menstrual irregularities was not systematically collected. Therefore, residual variability related to hormonal status cannot be completely excluded. Third, the study evaluated only the immediate effects of a single training session, and no follow-up assessments were performed; consequently, the persistence of the observed mood changes over time remains unknown. Mood was assessed using a self-report questionnaire and may therefore have been influenced by subjective perception. Importantly, perceived stress was not assessed using a dedicated validated stress instrument; therefore, the present study does not allow conclusions regarding stress reduction. In addition, autonomic nervous system responses were not evaluated using objective measures such as heart rate variability, which could have provided additional information on the physiological mechanisms underlying the observed effects.

Another limitation is that VO_{2avg} , VO_{2max} , and $EPOC_{peak}$ were estimated by the Suunto application rather than measured directly. Although this may reduce the precision of the physiological assessment, directly measuring these variables during an NF session would be technically challenging and could interfere with the intervention's natural performance. Finally, because NF combines breathing techniques, coordinated movement, music, relaxation, and group interaction, the present study could not determine the individual contribution of these components to the observed outcomes. Likewise, the study design does not allow conclusions regarding whether NF is more effective than other low-intensity mind-body activities, such as yoga, Pilates, stretching, breathing exercises, walking, or quiet relaxation. Future randomized controlled trials with appropriate comparison groups, objective physiological measurements, and longer

follow-up periods are needed to address these questions.

5. Conclusion

This study showed that a single 60-minute NF session was followed by changes in mood states in young women. Participants had a moderate level of physical activity and normal BMI values; however, relatively high body fat and a low proportion of muscle mass were also observed, highlighting the limited utility of BMI as a standalone indicator of nutritional and health status. Analysis of physiological parameters classified NF as low- to moderate-intensity physical activity, resulting in moderate energy expenditure and relatively low cardiorespiratory strain. Despite the low exercise intensity, significant pre-post changes in mood states were observed, including reductions in emotional tension, depression, anger, confusion, and fatigue, as well as increased vigor and a reduction in the TMD score. These findings should be considered preliminary, as the single-arm pre-post design does not allow attribution of these changes specifically to NF. Although the observed changes may indicate potential short-term psychological benefits, they may also reflect non-specific factors associated with the session. Controlled studies are therefore needed to determine NF's specific contribution to changes in psychological well-being and stress-related outcomes. To achieve greater improvements in body composition, NF could be complemented with resistance training or higher-intensity physical activity.

Acknowledgments

The authors thank the students who participated in the study.

Funding

None.

Conflict of interest

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions

Conceptualization: Robert Podstawski, Bożenia Hince

Data curation: Robert Podstawski

Formal analysis: Krzysztof Boryślowski

Funding acquisition: Robert Podstawski, Paweł Jastrzębski

Investigation: Robert Podstawski, Emilia Bałdyga, Bożenia Hince, Anna Podstawska, Paweł Jastrzębski

Methodology: Robert Podstawski, Attila Szabo

Project administration: Robert Podstawski

Resources: Robert Podstawski

Software: Krzysztof Boryśławski

Supervision: Robert Podstawski

Visualization: Robert Podstawski

Validation: Krzysztof Boryśławski, Robert Podstawski

Writing–original draft: Robert Podstawski, Krzysztof Boryśławski, Attila Szabo, Paweł Jastrzębski, Aneta Omelan

Writing–review & editing: Robert Podstawski, Anna Podstawska, Emilia Bałdyga, Paweł Jastrzębski

Ethics approval and consent to participate

The research was conducted in accordance with the guidelines and policies of the Health Science Council and the Declaration of Helsinki, and it was approved by the Ethics Committee of the University of Warmia and Mazury in Olsztyn (Approval number: 39/2011). All participants gave their voluntary and informed consent to participate in the study by signing an informed consent form.

Consent for publication

Consent was obtained from each participant for the publication of survey data.

Availability of data

The Ethics Committee of the University of Warmia and Mazury in Olsztyn has restricted access to the Excel dataset generated during this study to protect participants' privacy. Researchers who meet the criteria for access to the confidential data may submit a data request by email to the corresponding author.

References

1. Jankauskiene R, Balciuniene V, Rutkauskaite R, Pajaujiene S, Baceviciene M. The effects of Nirvana fitness and functional training on the body appreciation of young women: a non-randomized controlled trial. *Front Psychol.* 2024;15:1412259. doi: 10.3389/fpsyg.2024.1412259
2. Brown RP, Gerbarg PL. Sudarshan Kriya yogic breathing in the treatment of stress, anxiety, and depression. Part I: neurophysiologic model. *J Altern Complement Med.* 2005;11(1):189-201. doi: 10.1089/acm.2005.11.189
3. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing and autonomic nervous system shift. *Med Hypotheses.* 2006;67(3):566-571. doi: 10.1016/j.mehy.2006.02.042
4. Zaccaro A, Piarulli A, Laurino M, Garbella E, Menicucci D, Neri B, et al. How breath-control can change your life: a systematic review on psycho-physiological correlates of slow breathing. *Front Hum Neurosci.* 2018;12:353. doi: 10.3389/fnhum.2018.00353
5. Jayawardena R, Ranasinghe P, Ranawaka H, Gamage N, Dissanayake D, Misra A. Therapeutic benefits of pranayama: systematic review. *Int J Yoga.* 2020;13(2):99-110. doi: 10.4103/ijoy.IJOY_37_19
6. Kavitha N, Pal P, Pal GK, Bharadwaj B, Nanda N. Effects of slow breathing exercises on cardiac autonomic functions in anxiety disorder: a randomised control trial. *Ann Neurosci.* 2024;33(3):283-292. doi: 10.1177/09727531241266094
7. Lehrer PM, Gevirtz R. Heart rate variability biofeedback: how and why does it work? *Front Psychol.* 2014;5:756. doi: 10.3389/fpsyg.2014.00756
8. Kesar, Nathani N. Scientific effect of pranayama (hatha yogic breath regulation techniques) on physiological and psychological variables: a systematic review. *Yoga Mimamsa.* 2025;57(1):48-56. doi: 10.4103/ym.ym_11_25
9. Jankauskiene R, Balciuniene V, Rutkauskaite R, Pajaujiene S, Baceviciene M. Evaluating the impact of the Nirvana fitness and functional training programs on young women's state body appreciation and its correlates. *Healthcare (Basel).* 2024;12(16):1632. doi: 10.3390/healthcare12161632
10. Courtney R. The functions of breathing and its dysfunctions and their relationship to breathing therapy. *Int J Osteopath Med.* 2009;12(3):78-85. doi: 10.1016/j.ijosm.2009.04.002
11. Kolar P, Sulc J, Kyncl M, Sanda J, Cakrt O, Andel R, et al. Postural function of the diaphragm in persons with and without chronic low back pain. *J Orthop Sports Phys Ther.* 2012;42(4):352-362. doi: 10.2519/jospt.2012.3830
12. Balban MY, Neri E, Kogon MM, et al. Brief structured respiration practices enhance mood and reduce physiological arousal. *Cell Rep Med.* 2023;4(1):100895. doi: 10.1016/j.xcrm.2022.100895
13. Siebieszuk A, Płoński AF, Baranowski M. Breathwork for chronic stress and mental health: does choosing a specific technique matter? *Med Sci (Basel).* 2025;13(3):127. doi: 10.3390/medsci13030127
14. Solianik R, Ivanova J. Effects of the Nirvana fitness exercise programme on perceived stress and cognition. *Reabilit Moksl.* 2022;2(27):1-7. doi: 10.33607/rmske.v2i27.1257
15. Russo M, De Luca R, Naro A, et al. Does body shadow improve the efficacy of virtual reality-based training with BTS NIRVANA?: a pilot study. *Medicine (Baltimore).*

- 2017;96(38):e8096.
doi: 10.1097/MD.0000000000008096
16. De Luca R, Russo M, Naro A, Tomasello P, Leonardi S, Santamaria F, *et al.* Effects of virtual reality-based training with BTS-Nirvana on functional recovery in stroke patients: preliminary considerations. *Int J Neurosci.* 2018;128(9):791-796.
doi: 10.1080/00207454.2017.1403915
 17. Balciuniene V, Jankauskiene R, Baceviciene M. Effect of an education and mindfulness-based physical activity intervention for the promotion of positive body image in Lithuanian female students. *Eat Weight Disord.* 2022;27(2):563-577.
doi: 10.1007/s40519-021-01195-4
 18. Jankauskiene R, Balciuniene V, Rutkauskaitė R, Baceviciene M. Sustainability of positive body image changes one year after exercise interventions in young women. *Behav Sci (Basel).* 2026;16(1):83.
doi: 10.3390/bs16010083
 19. Yeung RR. The acute effects of exercise on mood state. *J Psychosom Res.* 1996;40(2):123-141.
doi: 10.1016/0022-3999(95)00554-4
 20. Weinstein AA, van Aert RCM, Donovan K, Muskens L, Kop WJ. Affective responses to acute exercise: a meta-analysis of the potential beneficial effects of a single bout of exercise on general mood, anxiety, and depressive symptoms. *Psychosom Med.* 2024;86(6):486-497.
doi: 10.1097/PSY.0000000000001321
 21. Fleming KM, Campbell M, Herring MP. Acute effects of Pilates on mood states among young adult males. *Complement Ther Med.* 2020;49:102313.
doi: 10.1016/j.ctim.2020.102313
 22. Mandlik GV, Siopis G, Nguyen B, Ding D, Edwards KM. Effect of a single session of yoga and meditation on stress reactivity: a systematic review. *Stress Health.* 2024;40(3):e3324.
doi: 10.1002/smi.3324
 23. Fincham GW, Strauss C, Montero-Marin J, Cavanagh K. Effect of breathwork on stress and mental health: a meta-analysis of randomised-controlled trials. *Sci Rep.* 2023;13(1):432.
doi: 10.1038/s41598-022-27247-y
 24. Shao R, Man ISC, Lee TMC. The effect of slow-paced breathing on cardiovascular and emotion functions: a meta-analysis and systematic review. *Mindfulness.* 2024;15(1):1-18.
doi: 10.1007/s12671-023-02294-2
 25. McNulty KL, Elliott-Sale KJ, Dolan E, *et al.* Effects of menstrual cycle phase on exercise performance: systematic review and meta-analysis. *Sports Med.* 2020;50(10):1813-1827.
doi: 10.1007/s40279-020-01319-3
 26. Elorduy-Terrado A, Torres-Luque G, Radesca K, Muñoz-Andradas G, Saenz-Bravo M, Domínguez-Balmaseda D. Impact of hormonal fluctuations during the menstrual cycle on performance of female athletes: systematic review. *Muscles.* 2025;4(2):15.
doi: 10.3390/muscles4020015
 27. Biernat E, Stupnicki R, Gajewski AK. International Physical Activity Questionnaire (IPAQ) - Polish version. *Phys Educ Sport.* 2007;51(1):47-54.
 28. Podstawski R, Żurawik MA, Clark CCT, Ihasz F, Żurek P. The intensities of various forms of physical activity in physical education programs offered by universities for female students. *Motriz Rev Educ Fis.* 2020;26(4).
doi: 10.1590/s1980-65742020000400089
 29. Dudek B, Koniarek J. Adaptacja testu McNair DM, Lorr M, Droppleman LF "Profile of Mood States" (POMS) [Adaptation of the test "Profile of Mood States" (POMS) by McNair DM, Lorr M, Droppleman LF]. *Przegląd Psychologiczny.* 1987;3:753-762. [In Polish]
 30. Lee J, Park BJ, Tsunetsugu Y, Ohira T, Kagawa T, Miyazaki Y. Effect of forest bathing on physiological and psychological responses in young Japanese male subjects. *Public Health.* 2011;125(2):93-100.
doi: 10.1016/j.puhe.2010.09.005
 31. Bielinis E, Łukowski A, Omelan A, Boiko S, Takayama N, Grebner DL. The effect of recreation in a snow-covered forest environment on the psychological wellbeing of young adults: randomized controlled study. *Forests.* 2019;10(10):827.
doi: 10.3390/f10100827
 32. McNair DM, Lorr M, Droppleman LF. *Manual for the Profile of Mood States.* San Diego, CA: Educational and Industrial Testing Service; 1971.
 33. Terry PC, Lane AM, Fogarty GJ. Construct validity of the Profile of Mood States-Adolescents for use with adults. *Psychol Sport Exerc.* 2003;4(2):125-139.
doi: 10.1016/S1469-0292(01)00035-8
 34. Gibson SJ. Measurement of mood states in older adults. *J Gerontol B Psychol Sci Soc Sci.* 1997;52B(4):P167-P174.
doi: 10.1093/geronb/52B.4.P167
 35. Czartoryski P, Garcia J, Manimaleth R, *et al.* Body composition assessment: a comparison of DXA, InBody 270, and Omron. *J Exerc Nutr.* 2020;3(1):1-6. Accessed March 3, 2020. <https://journalofexerciseandnutrition.com/index.php/JEN/article/view/57>
 36. Podstawski R, Boryśławski K, Clark CCT, Choszcz D,

- Finn KJ, Gronek P. Correlations between repeated use of dry sauna for 4 x 10 minutes, physiological parameters, anthropometric features, and body composition in young sedentary and overweight men: health implications. *Biomed Res Int*. 2019;2019:1-13.
doi: 10.1155/2019/7535140
37. Grosicki GJ, Durk RP, Bagley JR. Rapid gut microbiome changes in a world-class ultramarathon runner. *Physiol Rep*. 2019;7(24):e14313.
doi: 10.14814/phy2.14313
38. Montgomery PG, Green DJ, Etzebarria N, Pyne DB, Saunders PU, Minahan CL. Validation of heart rate monitor-based predictions of oxygen uptake and energy expenditure. *J Strength Cond Res*. 2009;23(5):1489-1495.
doi: 10.1519/JSC.0b013e3181a39277
39. Podstawski R, Boryślawski K, Józefacka NM, Snarska J, Hincă B, Biernat E, *et al*. Influence of extreme thermal stress on physiological and psychological characteristics of young women. *Front Public Health*. 2024;11:1303804.
doi: 10.3389/fpubh.2023.1303804
40. Podstawski R, Boryślawski K, Pomianowski A, Soós I, Boraczyński M, Gronek P. Physiological response to thermal stress in obese vs non-obese inactive men. *Biology (Basel)*. 2022;11(3):471.
doi: 10.3390/biology11030471
41. Omelan A, Wisniewska J, Podstawski R. Body composition and psychophysical well-being of women practicing yoga. *Balt J Health Phys Act*. 2022;14(3):e04.
doi: 10.29359/BJHPA.14.3.04
42. World Health Organization. *Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation, Geneva, 8-11 December 2008*. Geneva, Switzerland: World Health Organization; 2011.
43. Jayedi A, Soltani S, Zargar MS, Khan TA, Shab-Bidar S. Central fatness and risk of all cause mortality: systematic review and dose-response meta-analysis of 72 prospective cohort studies. *BMJ*. 2020;370:m3324.
doi: 10.1136/bmj.m3324
44. Singh P, Sharma H. Mental and physical health of yoga practitioners and non-practitioners. *Int J Multidiscip Approach Stud*. 2017;4(4):14-24.
45. Vogler S, Salyer RE, Giacobbi PR. Yoga and mental well-being: a qualitative exploration of lived experiences. *Int J Yoga*. 2023;16(3):192-201.
doi: 10.4103/ijoy.ijoy_191_23
46. Fleming KM, Herring MP. Effects of Pilates on mental health outcomes: meta-analysis of controlled trials. *Complement Ther Med*. 2018;37:80-95.
doi: 10.1016/j.ctim.2018.02.003