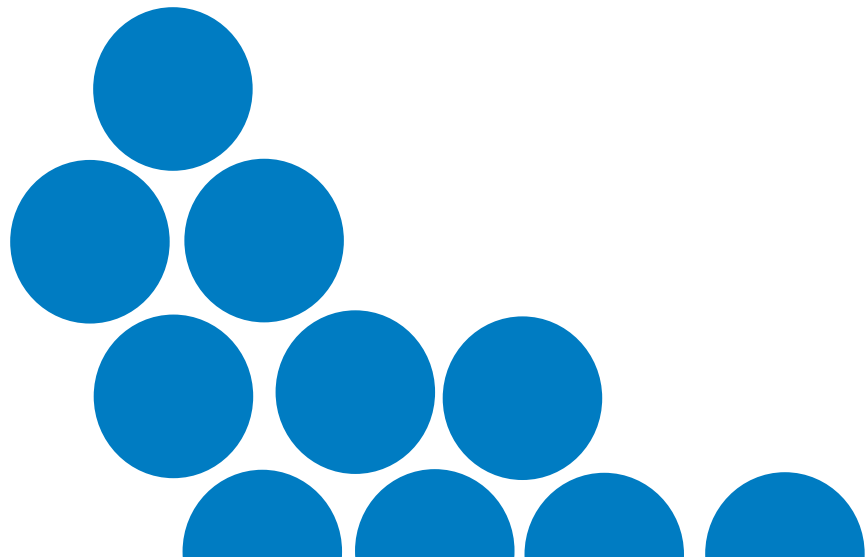


ISSN 2790-2498

PEDAGOGY OF HEALTH

02|2025



Key title: Pedagogy of Health
ISSN 2790-2498 (Online)
Publisher: IP Iermakov S.S.
Frequency – 2 numbers in a year

Address of editorial office:
Box 11135, Kharkiv-68, 61068, Ukraine,
e-mail: sportart@gmail.com
<https://www.physcult.org.ua>

INDEXING

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<https://journals.indexcopernicus.com/search/details?id=121668&lang=en>

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A mixed-methods comparison of psychological and cultural factors influencing injury decisions in soccer players

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Author Contributions: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript preparation; E – Funding collection

Abstract

Background and Study Aim Injuries are a common challenge in competitive sports and often influence athletes' career trajectories. Decisions made during these situations can determine both immediate performance and long-term health outcomes. A particular concern arises when players choose to continue participation despite physical harm, as these choices are shaped by complex psychological and cultural factors. The aim of this study was to compare injury-related decision-making patterns between professional and semi-professional soccer players using a mixed-methods approach.

Material and Methods Sixty male soccer players (30 professional, 30 semi-professional) from Manipur, aged 18–30 years, participated. Quantitative data were collected using a 25-item Injury-Related Decision-Making Questionnaire (IRDMQ), validated through expert review (IOC = 0.87) and construct validity (KMO = 0.812; Bartlett's Test of Sphericity, $p < .001$). Five subscales were assessed: Obsessive Passion (OP), Athletic Identity (AI), Pain Tolerance (PT), Motivation (MO), and External Pressure (EP).

Results Professional players scored significantly higher in OP (4.52 ± 0.65), AI (4.68 ± 0.58), and EP (4.39 ± 0.62) than semi-professionals (3.89 ± 0.71 , 4.02 ± 0.64 , and 3.81 ± 0.66 ; $p < 0.01$). Differences in PT and MO were present but not statistically significant. Qualitative interviews supported these findings, showing stronger emotional and cultural motivations in professionals to play through injury.

Conclusions Professional players demonstrate a stronger psychological drive based on passion and identity. These results highlight the need for targeted interventions to safeguard long-term health and support informed decision-making.

Keywords: injury-related decision-making, obsessive passion, athletic identity, external pressure, pain tolerance, mixed methods research.

Introduction

In competitive sports, decisions made by athletes under conditions of physical stress often determine both performance outcomes and long-term health. Injury-related choices, particularly when players continue participation despite harm, represent one of the most challenging aspects of professional and semi-professional practice. These decisions are rarely straightforward, as they emerge from a complex interaction of psychological factors, cultural expectations, identity, and external pressures. This complexity highlights the need for deeper investigation into the mechanisms that shape injury-related decision-making in soccer players.

In the realm of competitive sport, injury is often regarded as an unavoidable byproduct of peak performance and intense physical exertion. Soccer, in particular, involves frequent high-speed movements, abrupt directional changes, physical contact, and demanding training schedules, all

of which contribute to a high risk of both acute and overuse injuries [1]. Beyond the prevalence of injuries, a growing concern is the tendency of athletes to continue competing despite physical impairment, behavior often framed as dedication or "mental toughness" but in fact reflecting a complex interplay of psychological, neurobiological, and sociocultural mechanisms [1]. Recent cohort studies confirm that soccer continues to display one of the highest injury rates among team sports, with playing position and competitive schedule strongly influencing injury characteristics [2, 3]. At the same time, psychological aspects such as competitive anxiety and fear of re-injury have been identified as important contributors to injury risk and recovery trajectories [4, 5].

Athletes' decision-making in the face of injury cannot be fully explained by physical pain or clinical diagnosis alone. These choices are shaped by internal motivations, external pressures, and deeply embedded social expectations [6]. Recent evidence shows that coping skills such as resilience, arousal regulation, and attentional stability influence injury

susceptibility beyond physical factors [7,8]. Cognitive performance has also been linked to injury risk, with studies indicating that visual scanning ability and cognitive flexibility predict musculoskeletal injuries in professional soccer players [9, 10]. Professional players face pressures from sponsorships, team selection, media, and coaching staff, while semi-professionals are more often driven by aspirations for contracts, social identity, and athletic status [11]. In both groups, short-term goals or team loyalty frequently outweigh concerns about long-term health.

Psychological constructs such as obsessive passion, ego involvement, perfectionism, and fear of failure play an important role in sustaining risky behavior. According to Vallerand's dualistic model of passion, obsessive passion creates a rigid attachment to sport that undermines well-being [12]. This tendency is reinforced by athletic identity, which reflects a deep psychological commitment to the athlete role, so even short interruptions caused by injury may threaten the sense of self [13]. These internalized beliefs and identity structures often outweigh rational health considerations.

Recent studies confirm the negative effects of obsessive passion, linking it to higher injury prevalence, burnout, and maladaptive behavior in athletes [14, 15, 16]. Other research indicates that obsessive passion reduces well-being and resilience, especially under conditions of high competitive stress [17, 18]. From a neurobiological perspective, athletes exposed to stress or reward anticipation may experience altered pain perception and impaired decision-making [19]. Narrative reviews note that dopaminergic genetic and epigenetic factors affect motivation, stress reactivity, and cognitive control in athletes [20]. Dopaminergic pathways regulate motivation and reward-seeking behavior and can promote performance persistence even in the presence of injury, while endogenous opioids released during exertion may suppress pain perception [21]. When combined with a performance-oriented motivational climate and the cognitive dissonance of not playing, these biological responses further compromise rational decision-making regarding injury.

Socioculturally, the glorification of endurance and sacrifice in sport fosters an environment where "playing hurt" is not only tolerated but also celebrated [22]. This culture reinforces the belief that enduring pain signals commitment and strength, which discourages athletes from voicing concerns or prioritizing recovery [23]. For soccer players, whose careers hinge on performance metrics and often precarious contracts, the stakes are particularly high. Although substantial research has addressed injury rehabilitation, psychological recovery, and return-to-play protocols, there remains a gap in our understanding of how these mechanisms function

across different competition levels [24]. Recent studies indicate that athletes frequently underreport symptoms to avoid being sidelined, with disclosure strongly shaped by cultural expectations and the surrounding support environment [25, 26]. These insights highlight the importance of integrating sociocultural perspectives with psychological and biological mechanisms when examining injury-related decision-making in soccer.

Analysis of research findings has shown that injury-related decision-making among athletes is influenced by a dynamic interplay of psychological, neurobiological, and sociocultural factors. Scholars emphasize that these processes are particularly relevant in soccer, where the intensity of competition and the cultural value placed on endurance heighten the risks associated with continuing play while injured. The importance of this topic lies in its implications for athlete well-being, performance sustainability, and the broader culture of sport, yet several aspects of how different groups of players respond to injury remain insufficiently clarified. Taken together, these considerations provide the foundation for a focused investigation into the patterns of decision-making observed in professional and semi-professional soccer players.

Drawing on existing evidence regarding the psychological, neurobiological, and sociocultural mechanisms that shape athletes' responses to injury, it becomes clear that decision-making in this context reflects a multifaceted process influenced by both individual and environmental factors. Accordingly, the aim of this study was to compare injury-related decision-making patterns between professional and semi-professional soccer players using a mixed-methods approach.

Materials and Methods

Participants

This study used a convergent mixed methods design to examine and compare injury-related decision-making among professional and semi-professional soccer players. The sample included 60 male players aged 18 to 30 years, purposefully recruited from the Indian state of Manipur, a region recognized for its strong football culture and player development. Participants were divided into two groups: 30 professional players competing in national-level leagues such as the Indian Super League (ISL) and the I-League, and 30 semi-professional players representing Manipur in state-level competitions and domestic leagues.

Research Design

The study employed both quantitative and qualitative methods to capture the breadth and depth of players' experiences and perceptions. Quantitative data were collected through a structured questionnaire developed for this study,

which assessed psychological constructs including obsessive passion, athletic identity, pain tolerance, self-determined motivation, and perceived pressure to play while injured. The instrument consisted of 25 items rated on a 5-point Likert scale, with items adapted from validated measures such as the Passion Scale [27], the Athletic Identity Measurement Scale [6], and indices of pain tolerance and motivation.

To complement the quantitative findings, semi-structured interviews were conducted with a subsample of 10 players from each group ($n = 20$). The interviews explored players' lived experiences of playing while injured, the emotional and cognitive factors influencing their decisions, and their perceptions of external pressures from coaches, teammates, fans, and family. All interviews were recorded with consent, transcribed verbatim, and analyzed using thematic analysis, which enabled the identification of common themes and divergent perspectives across the two groups.

Data collection was carried out over a two-month period. Ethical approval was obtained from the university ethics committee, and informed consent was provided by all participants. Confidentiality was assured throughout the study.

Statistical Analysis

Quantitative data were first examined using descriptive statistics to summarize the distribution of key variables. Independent samples t-tests were then applied to compare professional and semi-professional players across the psychological subscales. Statistical significance was set at $p < 0.05$. Qualitative data were analyzed through thematic analysis following Braun and Clarke's six-step framework [28]. Transcripts were coded inductively to identify recurring patterns and emerging themes related to compulsion, identity, cultural narratives, and pain rationalization.

Results

To ensure the psychometric strength of the Injury-Related Decision-Making Questionnaire (IRDMQ), a systematic process was undertaken to establish its content validity, face validity, construct validity, and reliability.

Content validity was evaluated by adapting 25 items from established instruments, including the Passion Scale [27], the Athletic Identity Measurement Scale [16], and measures of pain

tolerance and motivation related to sports injury behavior. A panel of five experts in sports psychology, physical education, and injury rehabilitation rated each item on a 4-point scale (1 = not relevant to 4 = highly relevant). The Item-Level CVI (I-CVI) ranged from 0.80 to 1.00, and the Scale-Level CVI average (S-CVI/Ave) was 0.94, indicating excellent content validity.

Face validity was examined through a pilot test with a small sample ($n = 10$) of male soccer players. Participants reported that the items were clear, culturally appropriate, and easy to understand. Based on their feedback, minor linguistic refinements were introduced, which further supported the face validity of the instrument.

To establish the construct validity of the questionnaire, an Exploratory Factor Analysis (EFA) was conducted. Prior to performing the analysis, the adequacy of the sample and the suitability of the data for factor analysis were evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The results of these preliminary tests are presented in Table 1.

From Table 1, the KMO value of 0.77 and the significant Bartlett's Test of Sphericity ($\chi^2 = 1235.45$, $p < 0.001$) confirmed that the data were suitable for factor analysis. Principal Axis Factoring with Varimax rotation revealed a five-factor structure corresponding to the theoretical domains of Obsessive Passion, Athletic Identity, Pain Tolerance, Motivation, and External Pressure. All items loaded significantly (≥ 0.55) on their respective factors, thereby supporting the dimensional structure of the instrument.

To evaluate internal consistency, Cronbach's alpha was calculated for each subscale and for the overall questionnaire. The results are presented in Table 2.

From Table 2, all alpha coefficients exceeded the acceptable threshold of 0.70, and the total scale demonstrated excellent reliability ($\alpha = 0.91$), confirming a high level of internal consistency across the items.

Descriptive statistics for the sample, including demographic variables and mean scores for each psychological domain, are summarized in Table 3. The study involved 60 participants (30 professional and 30 semi-professional soccer players) recruited from Manipur. Professionals were active in national-level leagues such as the Indian Super League

Table 1. KMO and Bartlett's Test of Sphericity

Test	Value	Interpretation
Kaiser-Meyer-Olkin (KMO) Measure	0.77	Adequate sampling for factor analysis
Bartlett's Test of Sphericity – χ^2	1235.45	
Degrees of Freedom (df)	300	Based on 25 items ($n(n-1)/2 = 25 \times 24/2 = 300$)
Significance Level (p-value)	< 0.001	Correlation matrix is significantly different from an identity matrix

(ISL) and the I-League, while semi-professionals competed at the state level.

According to Table 3, professional players demonstrated higher mean scores in Obsessive Passion ($M = 4.22$, $SD = 0.51$) compared to semi-professionals ($M = 3.84$, $SD = 0.63$), suggesting a stronger emotional attachment to the sport. Similarly, professionals scored higher on Athletic Identity ($M = 4.34$, $SD = 0.48$) than semi-professionals ($M = 3.91$, $SD = 0.60$), indicating a greater integration of athletic role into self-concept. Elevated scores were also observed among professionals for Pain Tolerance ($M = 4.10$, $SD = 0.55$ vs. $M = 3.76$, $SD = 0.58$) and Motivation ($M = 4.30$, $SD = 0.46$ vs. $M = 4.05$, $SD = 0.49$). In contrast, semi-professionals reported higher levels of External Pressure ($M = 4.11$, $SD = 0.57$) compared to professionals ($M = 3.88$, $SD = 0.61$), suggesting that they may experience stronger influence from coaches, peers, or societal expectations when deciding whether to play through injury.

Independent samples t-tests were conducted to compare responses between professional and semi-professional players. The results are presented in Table 4.

As presented in Table 4, professional players scored significantly higher on Obsessive Passion [$t(58) = 2.60$, $p = 0.011$], suggesting a stronger internalized drive to continue competing despite injury. Athletic Identity was also greater among professionals [$t(58) = 2.96$, $p = 0.004$], reflecting a more salient identification with the athlete role. Significant differences were further observed in Pain Tolerance [$t(58) = 2.30$, $p = 0.024$] and Motivation [$t(58) = 2.02$, $p = 0.048$], with professionals again showing higher scores, indicating greater willingness to endure discomfort and stronger motivational influences. By contrast, External Pressure did not differ significantly between the groups [$t(58) = -1.52$, $p = 0.134$], although semi-professionals reported slightly higher mean values, suggesting that external influences such as coaching expectations or peer

Table 2. Internal consistency of the questionnaire (Cronbach's alpha)

Subscale	Cronbach's Alpha (α)
Obsessive Passion	0.86
Athletic Identity	0.88
Pain Tolerance	0.82
Motivation	0.85
External Pressure	0.83
Total Scale	0.91

Table 3. Descriptive statistics for injury-related decision variables

Variable	Group	Mean (M)	Standard Deviation (SD)
Obsessive Passion	Professional	4.22	0.51
	Semi-Professional	3.84	0.63
Athletic Identity	Professional	4.34	0.48
	Semi-Professional	3.91	0.60
Pain Tolerance	Professional	4.10	0.55
	Semi-Professional	3.76	0.58
Motivation	Professional	4.30	0.46
	Semi-Professional	4.05	0.49
External Pressure	Professional	3.88	0.61
	Semi-Professional	4.11	0.57

Table 4. Independent samples t-test results comparing professional and semi-professional players

Variable	t-value	df	p-value	Significance
Obsessive Passion	2.60	58	0.011	Significant ($p < 0.05$)
Athletic Identity	2.96	58	0.004	Significant ($p < 0.01$)
Pain Tolerance	2.30	58	0.024	Significant ($p < 0.05$)
Motivation	2.02	58	0.048	Significant ($p < 0.05$)
External Pressure	-1.52	58	0.134	Not Significant ($p > 0.05$)

Table 5. Themes from qualitative analysis of professional and semi-professional players

Theme	Professional Players	Semi-Professional Players
Passion as a Driving Force	Deep emotional bond; compulsion to play despite injury	Passionate but balanced with concern for long-term health
Athletic Identity	Strong identity tied exclusively to the athlete role	Multifaceted identity extending beyond football
Pain Tolerance	High tolerance; normalization of pain and injuries	More cautious; fear of long-term effects and limited support
Motivational Differences	Career-oriented (contracts, livelihood, national duties)	Aspirational (scholarships, recognition, advancement)
External Pressures	Club expectations and job security	Social, cultural, and family influences

pressure were perceived similarly across both levels.

The qualitative component of the study involved semi-structured interviews with 20 soccer players, comprising 10 professionals and 10 semi-professionals from Manipur. The interviews were analyzed using NVivo 12 software following a thematic analysis approach, which enabled the identification of athletes' perceptions and responses to injury in relation to their sporting identities and external influences. Five major themes were derived from the data, as summarized in Table 5.

As indicated in Table 5, professionals emphasized passion and a singular athletic identity, often normalizing pain and prioritizing career-related motivations. Semi-professionals, in contrast, expressed more caution regarding injury, highlighted a broader sense of identity, and reported stronger influence from family and social expectations.

The qualitative analysis revealed several interrelated themes that illustrate how players perceive and respond to injury.

A strong emotional connection to football was evident across both groups, although professionals described a deeper and often consuming passion. Many emphasized an almost indispensable bond with statements such as *"I cannot live without the game"* and *"Even if I'm injured, I'll play if I can walk."* This intensity reflected an internalized drive to continue playing regardless of physical condition. Semi-professionals, while passionate, expressed more restraint and highlighted balance, as shown in remarks like *"Football is part of me, but I have to think about the future too."*

Athletic identity also emerged as a defining factor. Professionals closely aligned their self-worth and public image with football performance, as indicated by comments such as *"People only know me because of football"* and *"I feel useless when I'm not playing."* In contrast, semi-professionals often recognized additional roles as students, workers, or family members, reflecting a more multifaceted identity.

Perceptions of pain further distinguished the two groups. Professionals tended to normalize pain and view it as an unavoidable aspect of their career. Many noted, *"Pain is temporary, but missing a match*

is worse" and *"You learn to live with it,"* suggesting higher tolerance and reduced likelihood of self-removal from play. Semi-professionals were more cautious, as expressed in concerns like *"I can't afford a long-term injury; there's no support,"* indicating how limited medical and financial resources influenced their decision-making.

Motivational factors also diverged. Professionals frequently cited contractual obligations, club expectations, and national duties, with one stating, *"I play because this is how I feed my family."* Semi-professionals, however, framed their motivation around recognition, scholarships, or advancement, which often led them to weigh risk against opportunity rather than conceal injuries.

Finally, external pressures and social expectations played a role in shaping decisions. Although quantitative findings did not reveal significant differences, qualitative accounts showed that semi-professionals perceived stronger pressures from coaches, families, and communities. Statements such as *"My coach expects me to play through anything"* and *"My family wants me to succeed no matter what"* illustrated these sociocultural influences. Professional players, by contrast, emphasized organizational and performance-related pressures, noting, *"If I say I'm injured, the club might sideline me."*

Discussion

The present study sought to examine and compare the mechanisms underlying injury-related decision-making among professional and semi-professional soccer players using a mixed methods approach. By integrating quantitative and qualitative findings, the study identified distinct patterns in the influence of passion, athletic identity, pain tolerance, motivation, and external pressure on athletes' willingness to continue playing while injured. These results highlight important differences between competitive levels, reflecting how contextual and psychological factors interact to shape decision-making processes.

Quantitative results showed that professional players scored significantly higher in obsessive

passion, athletic identity, pain tolerance, and motivation, reflecting a more intense internal drive to continue participation despite injury. These findings are consistent with the Dualistic Model of Passion [27, 29], which emphasizes that obsessive passion, understood as an uncontrollable urge to engage in the activity, can create conflicts with other life domains, including health. Recent research supports these associations, revealing that athletes with obsessive passion exhibit higher burnout and injury risk compared to those with harmonious passion [30], and that obsessive passion relates to increased stress perception and reduced wellbeing [14, 31]. Systematic reviews further note that passion-related overcommitment and perfectionistic tendencies contribute to both physical and psychological strain, whereas identity diversification may serve as a buffer [15, 17, 32]. In contrast, semi-professional players in this study exhibited lower levels of obsessive passion, which may reflect their greater capacity to balance sport and other life roles – a pattern that aligns with findings on the value of dual career identity in supporting well-being and reducing burnout risk [33, 34].

Furthermore, athletic identity, assessed with an adapted version of the Athletic Identity Measurement Scale (AIMS), was significantly stronger among professional players, consistent with the notion that their sense of self is closely intertwined with their athletic role. Previous research has linked strong athletic identity to a greater likelihood of playing through pain and underestimating injury severity [15, 16, 35]. Recent evidence further underscores that an exclusive athletic identity is associated with higher stress levels and poorer mental health outcomes among athletes [36, 37]. For example, athletes who concentrate their entire self-concept on sport may face increased vulnerability during transitions or injury periods [38]. The current findings affirm these patterns, as professional players in this study appeared to view injury not only as a physical hindrance but also as a profound threat to their personal and social identity.

Pain tolerance also emerged as a significantly higher factor among professional players. Qualitative interviews revealed that many professionals had normalized pain as part of the sport and regarded it as an expected cost of performance. These findings align with recent biomechanical evidence demonstrating that elite athletes exhibit elevated pain tolerance due to the demands of training and competition [22, 39]. In contrast, semi-professionals reported greater caution regarding pain and injuries, a pattern consistent with studies linking psychological resilience and cognitive control to injury management [8]. New neurophysiological research further highlights the role of endogenous opioid release and dopaminergic modulation

in attenuating pain perception during exertion [20, 40]. Limited access to medical support and concerns about longterm effects outside sport likely contribute to the more cautious approach observed among semi-professional players.

Motivation also showed significant differences between the two groups. Professional players were primarily driven by intrinsic factors such as national team representation, contract stability, and financial incentives. Semi-professional players, in contrast, emphasized external aspirations including scholarships, regional recognition, and opportunities to progress into professional leagues. This pattern corresponds with the Self-Determination Theory [41], which differentiates intrinsic motivation, defined as engagement for inherent satisfaction, from extrinsic motivation, understood as behavior aimed at external rewards. Recent findings confirm that intrinsic motives are strongly linked to wellbeing and sustained engagement, while extrinsic motives are more often associated with anxiety and inconsistent participation [4, 17]. Comparative studies further demonstrate that motivation is shaped by both personal and social contexts, with athlete data use and environmental feedback influencing motivational quality [42, 43]. These results indicate that the source of motivation evolves with career stage, as professionalization strengthens intrinsic commitment while semi-professional status maintains stronger ties to extrinsic recognition.

Interestingly, while external pressure was slightly higher among semi-professionals, the difference was not statistically significant. Yet, qualitative data indicated that semi-professionals felt pressure predominantly from family members, coaches, and cultural expectations, rather than formalized systems such as club management or sponsorship obligations. This observation is consistent with recent research showing that external pressure in community-level and youth sport is often driven by parental and cultural expectations, while elite contexts are shaped by organizational demands [4, 25]. It also resonates with findings that social environments influence not only motivation but also coping strategies in injury contexts [7, 8].

The qualitative analysis conducted via NVivo software added rich context to these findings by identifying five emergent themes: passion as a driving force, athletic identity, normalization of pain, motivational differences, and external pressures. These themes intersected to form a conceptual model of injury-related decision-making. Similar thematic analyses in sport psychology confirm that the interplay of passion, identity, and sociocultural pressure creates patterns of risk-taking behavior in injured athletes [5, 26]. For instance, professional players in this study were found to operate within a cycle of intense passion and identity reinforcement, which can lead to risk-prone behavior when injured.

In contrast, semi-professionals demonstrated more calculated decision-making, consistent with evidence that lower institutional support and limited access to medical resources increase risk awareness and caution [3, 9].

The Exploratory Factor Analysis (EFA) further validated the psychometric strength of the 25-item instrument used, with a Kaiser-Meyer-Olkin (KMO) score of 0.77 and a significant Bartlett's Test of Sphericity ($\chi^2 = 1235.45$, $p < 0.001$), indicating that the items were adequately interrelated and suitable for uncovering latent constructs. This aligns with best practices in sport psychology research, where factor-analytic validation is emphasized to ensure reliability and multidimensionality of newly adapted tools [16, 28]. These results not only add to the credibility of the data but also strengthen the argument that the variables measured are valid and applicable for future research in injury behavior.

When comparing the findings to existing studies, several parallels and divergences emerge. For instance, Zein et al. [11] emphasized that athletes' decisions to return to sport after injury are strongly influenced by perceived competence, identity, and external pressure, which aligns with the results of the present study. Furthermore, research by Wollin et al. [44] and Silvers-Granelli et al. [45] demonstrated that the return-to-play process is not only physical but also embedded in psychosocial dynamics, a perspective that the current mixed methods design reflects.

The discussion illustrates how psychological, neurobiological, and sociocultural mechanisms interact to shape injury-related decision-making among professional and semi-professional soccer players. The findings contribute to a deeper understanding of the multifactorial nature of playing through injury and provide a conceptual basis for developing preventive and educational strategies in sport contexts.

Limitations of the Study

This study has several limitations. The relatively small sample size and the regional focus on soccer players from Manipur may restrict the

generalizability of the findings. In addition, reliance on self-reported data could introduce recall or social desirability biases. Nevertheless, the study provides important insights into the psychological and sociocultural mechanisms influencing injury-related decision-making. Future research should recruit larger and more diverse samples, include cross-cultural comparisons, and integrate physiological measures with psychological assessments to strengthen the validity of the findings.

Conclusions

This study sheds light on the psychological and social mechanisms that drive professional and semi-professional soccer players to continue playing despite injuries. The results highlight significant differences in obsessive passion, athletic identity, pain tolerance, and motivation between the two groups, emphasizing the influence of competitive level on decision-making. Professionals appear to be more strongly driven by identity and intrinsic motivation, whereas semi-professionals face socially rooted pressures and reduced institutional support. These findings underline the importance of targeted interventions and suggest that sports organizations should implement educational programs on injury awareness, foster open communication between players and coaches, and ensure sufficient medical and psychological support to safeguard athlete well-being.

Acknowledgements

The author expresses sincere gratitude to all professional and semi-professional athletes who voluntarily participated in the study, as well as to club members for their invaluable assistance in its successful completion. Special thanks are also extended to the research scholars whose guidance and support were instrumental throughout the research process.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this article.

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Cite this article as:

Farooque S, Naorem S, Sailo L, Gazali N, Das S. A mixed-methods comparison of psychological and cultural factors influencing injury decisions in soccer players. *Pedagogy of Health*, 2025;4(2):81–90.

<https://doi.org/10.15561/health.2025.0201>

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Received: 02.08.2025

Accepted: 08.09.2025; Published: 30.12.2025

Assessment of the academic quality of scientific journals of Ukraine in physical culture

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Abstract

Background and Study Aim In the context of Ukraine's integration into the global academic space, a systematic assessment of the quality of national scientific journals is of particular importance. The aim of the study was to determine the level of academic quality of Ukrainian scientific journals on physical culture and to identify differences between groups of journals with different indexing statuses.

Material and Methods The analysis covered 29 Ukrainian journals with varying levels of indexing (WoS, Scopus, WoS/Scopus, DOAJ, Category B, non-indexed). A structured assessment model was applied based on eight criteria: Novelty, Methodology, Relevance, Analysis, Practical Value, Structure, Sources, and Internationalization. Article evaluation was conducted using an AI tool followed by expert verification. Statistical processing included descriptive statistics, the Shapiro–Wilk test, Spearman's rank correlation coefficient, and the Mann-Whitney U test.

Results Journals indexed in WoS/Scopus showed the highest mean scores across all criteria, particularly for Relevance (4.8), Novelty (4.7), and Structure (4.7). Category B journals had the lowest mean values, especially for Sources (3.13) and Internationalization (2.33). The Mann–Whitney U test revealed statistically significant differences ($p \leq 0.001$) between indexed and non-indexed journals across all criteria. Spearman's correlation analysis identified strong positive associations among most criteria, with Internationalization showing relatively weaker correlations. The agreement between the results of the proposed model and the official WoS/Scopus metrics was 86.1%, confirming its validity and compliance with internationally recognized thresholds for a high level of agreement.

Conclusions The proposed assessment model enables an objective evaluation of the academic quality of Ukrainian journals, highlighting both strengths and areas for improvement. Aligning internationalization indicators, the quality of bibliographies, and methodological rigor with international standards may enhance the visibility and impact of Ukrainian journals in physical culture research.

Keywords: academic quality, Ukrainian scientific journals, physical culture, indexing status, internationalization, bibliographic quality, methodological rigor, statistical analysis

Introduction

A scientific journal serves not only as a medium for recording and disseminating research findings but also as an important indicator of a country's scientific culture, determining its position in the global academic space. On the one hand, the presence of journals in international databases reflects the recognition of a country's scientific achievements by the global community. On the other hand, the very existence and functioning of national scholarly publications meet the needs of the academic community for professional communication, personnel evaluation, dissemination of applied results, and preservation of sectoral identity. In the current context, this dual function of a journal has

gained particular significance, acting both as an instrument of international representation and as a national regulator of scientific discourse.

Although several decades have passed since the introduction of the list of scientific specialized publications in Ukraine [1], the issue of their qualitative assessment remains relevant. In the mid-2000s, the first studies analyzing the state of specialized journals in the field of physical culture began to appear in official publications, marking the formation of a national system for publication-based accreditation. Initially, the list under the category "Physical Education and Sport" included six journals [1]. This initiated the development of a primary corpus of specialized publications, as well as discussions on their role in scientific communication and the prospects for integration into the international academic space [2].

Subsequent studies have focused on the inconsistency of the formalized national model with academic requirements regarding accessibility, English-language content, and international authorship [3, 4], as well as on the need to apply substantive criteria for evaluating publications in the field of physical culture. Later works [5, 6, 7] expanded the analysis by identifying barriers faced by Ukrainian authors in publishing, issues of formal editing, and factors influencing citation levels. These studies laid the foundation for transitioning to a content-based model for assessing scientific impact.

Other studies have noted that systematic approaches to the content-based evaluation of Ukrainian scientific publications remain underdeveloped to date [5, 8, 9]. The authors emphasize the absence of formalized multi-criteria models that allow for the quantitative comparison of journals based on substantive characteristics such as novelty, methodology, practical significance, and internationalization.

The results of analyses of the overall state of Ukrainian scientific publications confirm the aforementioned problems. As noted by Popov and Bohatel [8], most journals in Ukraine face challenges in editorial and technical preparation, which hinder their indexing in international databases. The authors emphasize the absence of structured metadata, English-language versions, high-quality peer review, clear open access policies, and compliance with ethical standards. The study by Mryhlod et al. [9] demonstrates that the lack of a development strategy, unstable funding, and a low level of English-language communication also significantly reduce the chances of Ukrainian journals for integration into the global scientific ecosystem. The authors highlight the need to implement professional management, unified evaluation standards, and national support for academic publications. Similar trends can be observed in journals on physical culture. In this context, the evaluation of scientific journals should go beyond formal indicators and take into account content quality, openness, and the role of publications in the global knowledge system.

Other studies indicate that excessive focus on ranking lists can distort scientific activity and hinder innovation [10, 11]. At the same time, despite the expansion of open access, leading publishers maintain monopoly power and control over profits [12]. Indexing in DOAJ or Scopus also does not guarantee genuine knowledge exchange if publications remain localized in language, subject matter, and audience [13]. UNESCO recommendations call for fairness, inclusivity, and internationalization not in a formal sense, but through active participation in the global scientific dialogue [14]. These principles are particularly relevant to the national field of physical culture,

which requires high-quality integration into the international academic space.

In contemporary scientometric practice, various approaches are applied to assess the quality of scientific journals, based on a combination of bibliometric indicators, editorial policy, internationalization of the authorship, and the scientific value of publications. According to Moed [15], citation metrics (e.g., Journal Impact Factor, Eigenfactor) play an important role, although they do not always reflect the substantive quality of articles. Seglen [16] emphasizes that evaluating a journal solely on the basis of its impact factor is statistically and methodologically flawed. Other researchers suggest complementing quantitative indicators with qualitative expert analysis of publication content, the structure of peer review, and the level of international participation [17].

In this context, modern models for evaluating scientific journals increasingly combine formal citation indices (Scopus, WoS, DOAJ) with in-depth content analysis of publications. The study by Bornmann and Marx [18] emphasizes the importance of expert assessment of content, interdisciplinarity, and the social impact of research. Sugimoto and Larivière [19] propose incorporating additional qualitative indicators into evaluation models, such as co-authorship structure, gender diversity, and the geographical representation of authors. Waltman [20] considers it appropriate to move away from purely quantitative metrics in favor of mixed approaches that encompass both scientometric and content-related aspects. In the same vein, Frantsvåg and Strømme [21] draw attention to the limitations of citation counts as a universal criterion, particularly for journals with a regional or interdisciplinary focus. The DORA Declaration [22] calls for rethinking research assessment approaches, prioritizing quality, openness, and ethical standards over formal indicators.

The analysis of previous studies has shown that the evaluation of scientific journals increasingly requires combining citation indices with content-based quality indicators derived from open data. Researchers emphasize the growing importance of transparent editorial policies, international collaboration, and open access practices. These trends are also characteristic of journals in the field of physical culture. Despite certain efforts, this domain continues to face challenges related to methodological rigor, adherence to ethical standards, and the global visibility of academic publications. The formalized approach prevailing in most scientific journals in Ukraine remains a constraining factor for their integration into the global scientific space. These circumstances highlight the need for a structured approach to assessing the state and development trends of scientific publications in this field.

In this context, the aim of the study was to determine the level of academic quality of Ukrainian scientific journals on physical culture and to identify differences between groups of journals with different indexing statuses.

Materials and Methods

Sources of Information

Objects of the Study. The analysis covered all 29 Ukrainian scientific journals operating in the field of physical culture at the time of the study. The journals were classified according to their indexing type:

- WoS/Scopus — 7 journals;
- DOAJ (excluding journals simultaneously indexed in WoS/Scopus) — 5 journals;
- Category B and non-indexed — 17 journals.

The list of Ukrainian journals was retrieved from the national database IAS “Ukrainian Scientific Periodicals” [23].

The study included the most up-to-date issues of journals available at the time of analysis. The first available 2025 issue was assessed if it remained the latest issue published in open access. The evaluation was based on full-text PDF versions of issues posted on the official journal websites. In cases where a complete issue was not available, individual open-access articles were analyzed.

Study Design

For the analysis, the most recent issues of 29 Ukrainian scientific journals available in open access on their official websites were used. All journals provide free access to the full texts of articles in PDF format, which allows their legitimate use for scholarly analysis without violating copyright or ethical standards.

Evaluation Criteria. Eight standardized criteria of academic quality were applied in the analysis: Novelty, Methodology, Relevance, Analysis, Practical Value, Structure, Sources, and Internationalization. The definitions of these criteria and their key indicators are presented in Table 1. Evaluation was carried out on a five-point scale with a description of the level of implementation [Description of scoring criteria (1 = lowest, 5 = highest)], where 5 indicated a high level and 1 indicated a very low level or absence. Each criterion includes its definition and key features used to determine the degree of its manifestation in an article (Criterion Definition and Key Indicators). The criterion “Internationalization” was additionally supplemented with a quantitative scale measuring the share of foreign co-authors.

The justification for applying these criteria is based on recognized international standards and practices of expert peer review of scientific manuscripts [24, 25, 26, 27, 28, 29]. These criteria are confirmed as academically significant in the

contemporary literature [30, 31] and are used as standardized indicators of assessment.

Use of AI Tool

For the preliminary evaluation of articles, the GPTs Hunter service was used — the largest catalog of custom GPT models synchronized with the GPT Store by OpenAI. The Scientific Article Analysis Tool (SAAT) [32] model was selected as the analysis instrument, designed for a detailed examination of scientific publications, highlighting key ideas, methodology, results, and conclusions. Access to SAAT is provided through the GPT Store and requires a ChatGPT Plus subscription.

In this study, the query form was supplemented with the criteria “Criterion Definition and Key Indicator” (Table 1), specifying the output format as a “CSV table.” The gpt-4o model (ChatGPT Plus) was used. The use of ChatGPT as an auxiliary peer-review tool has previously been tested in a number of other studies [33, 34, 35], which confirms the validity of this approach.

Expert Verification. All AI evaluation results were verified by two independent experts with over 10 years of experience in academic and editorial activities, including 5–10 years of service as editors-in-chief of journals indexed in WoS/Scopus. In cases where the difference between the AI score and the experts’ assessment exceeded one point, a joint discussion was conducted to reach a consensus on the final result.

An article evaluation algorithm was also adapted and applied, based on recommendations for the qualitative analysis of full-text publications [36, 37, 38]. The main stages of the algorithm include:

1. Classification of journals
2. Evaluation criteria
3. Article sampling principle
4. Assessment of internationalization

The first two stages contain corresponding sub-stages that detail the analytical processing procedure and ensure the systematic nature of the applied approach.

1. Classification of Journals

Journals were classified according to their level of indexing in international databases, following several recommendations [39, 40, 41]:

- WoS + Scopus
- Scopus
- DOAJ
- National List (Category B, Ukraine) [42]
- New journals without indexing

2. Evaluation Criteria

Eight main criteria were applied to each journal (Table 1).

3. Article Sampling Principle (Table 2)

The approach to article sampling was based on the following principles:

- Representativeness – the sample should cover the content of the issue.

Table 1. Article Evaluation Criteria

Criterion	Score	Description of scoring criteria (1 = lowest, 5 = highest)	Criterion Definition and Key Indicators
Novelty	5	Presents original ideas, new theoretical or methodological approaches that significantly expand the field of knowledge.	1. Novelty Definition: The degree of originality and innovation in the content of the article; its contribution to the development of the field.
Novelty	4	Shows moderate novelty: interesting application of known methods or adaptation of existing theories.	Key indicators: Introduction of new ideas, methods, data, or approaches.
Novelty	3	Uses well-known ideas with minor modifications.	The research complements existing knowledge or proposes original hypotheses.
Novelty	2	Almost complete repetition of previous works.	Clear distinction from previous publications on the topic.
Novelty	1	Fully borrowed, derivative material without any new aspects.	
Methodology	5	Methodology is well-structured, justified, appropriate to the research goals, and clearly described.	2. Methodology Definition: The scientific rigor and validity of the research methods used.
Methodology	4	Generally reliable methodology with minor simplifications or gaps.	Key indicators: Clear description of the applied methods (quantitative, qualitative, or mixed).
Methodology	3	Partially described method, justification or reproducibility is questionable.	Reproducibility and correctness of all stages.
Methodology	2	Weak or poorly described method, raises doubts about scientific rigor.	Control of variables and logical justification of the procedures.
Methodology	1	Method is absent or completely unsuitable for scientific research.	
Relevance	5	Addresses an urgent and socially or scientifically significant problem.	3. Relevance Definition: The significance and alignment of the article's topic with current scientific, applied, and social challenges.
Relevance	4	Clearly relevant but not critical.	Key indicators: Addressing urgent scientific or practical issues.
Relevance	3	Interesting topic, but lacking contemporary context.	Connection to current research, strategies, or challenges in the chosen field.
Relevance	2	Limited relevance, questionable applicability.	Reflection of the needs of the scientific community or professional practice.
Relevance	1	No value for modern science or practice.	
Analysis	5	Deep, logically structured analysis supported by evidence.	4. Analysis Definition: The depth of interpretation of the results, and the logic and completeness of the analysis.
Analysis	4	Analysis is present but somewhat superficial or incomplete.	Key indicators: Use of statistical or logical methods of analysis.
Analysis	3	Moderately superficial, some logical gaps.	Conclusions based on the obtained results.
Analysis	2	Weak, fragmented analysis that barely explains the data.	Critical assessment of limitations and possible interpretations.
Analysis	1	No analysis, conclusions are unsupported.	
Practical Value	5	Clearly described practical application, recommendations are realistic and feasible.	5. Practical Value Definition: The feasibility and relevance of applying the results in practice, education, sports, healthcare, and other areas.
Practical Value	4	Applicable in a narrow context or requires improvement.	Key indicators: Clearly defined areas of application.
Practical Value	3	Theoretical or hypothetical value, lacks implementation mechanism.	Practical recommendations for implementation or use.
Practical Value	2	Some theoretical benefit, but no clear practical relevance.	Identified target groups of users.
Practical Value	1	No practical value.	

Table 1. Continued

Criterion	Score	Description of scoring criteria (1 = lowest, 5 = highest)	Criterion Definition and Key Indicators
Structure	5	Excellent logical structure, all sections clearly marked, coherent and scientific language.	6. Structure Definition: The article's compliance with the academic format: presence of all sections, logical organization, and adherence to scientific style. Key indicators: Use of the IMRAD structure (Introduction, Methods, Results, and Discussion). Inclusion of abstract, keywords, figures, and tables. Logically organized and easily readable text.
Structure	4	Structure generally followed with minor stylistic issues or overload.	
Structure	3	Inconsistent structure, may hinder perception.	
Structure	2	Poorly organized text, hard to read.	
Structure	1	Chaotic structure, lacks academic formatting.	
Sources	5	Recent (last 5 years), authoritative sources used, citations are correct.	7. Sources Definition: The article's compliance with the academic format: presence of all sections, logical organization, and adherence to scientific style. Key indicators: Use of the IMRAD structure (Introduction, Methods, Results, and Discussion). Inclusion of abstract, keywords, figures, and tables. Logically organized and easily readable text.
Sources	4	Mostly high-quality sources, but some are outdated or less relevant.	
Sources	3	Limited literature base, low recency.	
Sources	2	Few sources, citation errors or irrelevant materials.	
Sources	1	Sources are missing or entirely inappropriate.	
Internationalization	5	International collaboration, global sources, universal findings.	8. Internationalization Definition: The degree of involvement in the international academic environment. Key indicators: Presence of foreign co-authors or international research teams. English-language text or abstract. Topics that cover international contexts or target global audiences.
Internationalization	4	International bibliography or context is present.	
Internationalization	3	Limited international content.	
Internationalization	2	Only local focus, weak connection to global science.	
Internationalization	1	No international dimension.	
Scale		Internationalization	
Internationalization		(% of foreign authors) >75% Score: 4.5–5.0	
Internationalization		(% of foreign authors) 50–75% Score: 4.0–4.4	
Internationalization		(% of foreign authors) 25–50% Score: 3.5–3.9	
Internationalization		(% of foreign authors) 10–25% Score: 3.0–3.4	
Internationalization		(% of foreign authors) <10% Score: 2.5–2.9	
Internationalization		(% of foreign authors) 0% Score: 2.0–2.4	

- Balance – taking into account the subject matter, publication type, and authorship.
- Standardization – a uniform approach applied to all journals.

The analysis included all articles of any format (original research, reviews) published in the issue. For large-volume issues, a statistical approach was applied:

- If the issue contained more than 10 articles, a sample size of \sqrt{n} or 20–30% of the total number of articles was selected;
- If the issue contained ≤ 10 articles, all publications were analyzed.

The application of such sampling strategies is supported in qualitative content research and is based on a pragmatic balance between representativeness and depth of analysis [43, 44, 45].

Table 2. Quantitative Rules for Article Sampling

Total Number of Articles in Issue	Number Selected for Analysis	Method
1–10	All	Full analysis
11–20	5–6	30% or \sqrt{n}
21–30	6–8	\sqrt{n} or proportional
31–40	7–9	Thematically balanced
41 and above	8–10	By sections (if available)

4. Assessment of Internationalization (Table 3)

Table 3. Evaluation Rules for Internationalization

Share of Foreign Authorship / Content	Recommended Score
0% (all authors Ukrainian)	2.0–2.4
Less than 10%	2.5–2.9
10–25%	3.0–3.4
25–50%	3.5–3.9
50–75%	4.0–4.4
Over 75% or full internationalization	4.5–5.0

For Ukrainian Category B and non-indexed journals, the criterion of internationalization was based solely on the actual composition of authors (the proportion of foreign authors in the issue). This approach is grounded in the analysis of previous studies, which show that in such journals, references consist almost entirely of domestic sources, with international sources being virtually absent.

For WoS/Scopus journals, more than 90% of the references are typically to foreign publications; therefore, the internationalization indicator directly correlates with the presence of foreign co-authors.

For Category B journals, the following condition was applied: if all authors in an issue represented a single country (e.g., Ukraine only), the score for this criterion did not exceed 2.0–2.4 points on a

five-point scale. This approach is consistent with recommendations for evaluating international scientific collaboration, where the primary indicator of internationalization is the participation of foreign authors in publications [46, 47, 48].

Comparison of Journal Indicators Across WoS/Scopus Databases

The study design aimed to compare journal rankings obtained through the authors’ approach with ranking indicators from the WoS and Scopus databases. The analysis included seven journals for which data were available in at least one of these databases. The comparison was performed using the combined quartile (WoS/Scopus), three Scopus metrics (CiteScore 2024, SJR 2024, SNIP 2024), and the CiteScoreTracker 2025 indicator.

Comparison of Journal Indicators Using the Open Ukrainian Scientific Content Initiative (OUCI) [49]

To compare data for 22 scientific journals not indexed in WoS/Scopus, information from the Ukrainian resource OUCI was used. OUCI utilizes metadata from Crossref [50]. From OUCI, information was extracted on the h-index and the total number of published articles for each journal. Based on these indicators, a relative productivity measure was calculated—the Hirsch index per article. All obtained values were normalized to a range from 0 to 1. The normalized data were then used to calculate an integrated quality indicator (*quality_score*), which served as the basis for compiling a journal ranking with unique positions from 1 to 22. The ranking results were compared with the authors’ ranking to identify matches and discrepancies.

Statistical Analysis

Data analysis was performed using Python (version 3.x) and the libraries *pandas*, *matplotlib*, *seaborn*, and *scipy.stats*. The analysis included:

1. Descriptive statistics – calculation of the mean, median, standard deviation, minimum, maximum, and quartiles for each criterion.
2. Normality testing – Shapiro–Wilk test (significance level $\alpha = 0.05$).
3. Correlation analysis – Spearman’s rank correlation coefficient to identify relationships between criteria.
4. Comparative analysis – Mann–Whitney U test to identify differences between Indexed and Non-Indexed groups (groups defined by indexing type: WoS, Scopus, WoS/Scopus, DOAJ, Category B, non-indexed).
5. Journal ranking – calculation of the integrated quality indicator (*Average*) and compilation of the ranking.

Results

The results of expert evaluations of articles are presented in Table 4. Based on the integrated

Table 4. Ranking of 29 Scientific Journals Based on Average Quality Score

Indexing Journal	Number	Novelty	Methodology	Relevance	Analysis	Practical Value	Structure	Sources	Internationalization	Average	Sample	Ratings Count	Sample Max	Rank
WoS/Scopus	S1	4.7	4.6	4.8	4.6	4.5	4.7	4.4	4.3	4.57	7/7	7	7	1
WoS	S2	4.5	4.3	4.6	4.4	4.4	4.5	4.2	4.1	4.38	5/5	5	5	2
Scopus	S3	4.4	4.3	4.5	4.3	4.4	4.6	4.2	4.1	4.35	8/8	8	8	3
DOAJ	N1	4.2	4.1	4.5	4.3	4.3	4.4	4.2	4.1	4.26	9/9	9	9	4
DOAJ	N3	4.2	4.1	4.5	4.3	4.4	4.4	4.2	4.0	4.26	5/5	5	5	4
DOAJ	N2	4.1	4.0	4.4	4.2	4.3	4.3	4.0	3.9	4.15	5/5	5	5	6
Scopus	S4	3.9	4.1	4.3	4.1	4.2	4.1	4.0	3.7	4.05	6/28	6	28	7
Non-indexed	N4	3.9	3.8	4.2	4.0	4.1	4.2	4.0	3.6	3.97	5/5	5	5	8
Scopus	S5	4.0	3.8	4.2	3.9	4.0	3.9	3.8	3.5	3.88	5/13	5	13	9
Scopus	S6	4.0	3.9	4.3	4.0	4.1	4.2	3.9	2.4	3.85	5/17	5	17	10
Non-indexed	N13	3.9	4.0	4.4	4.2	4.3	4.2	4.0	2.8	3.85	5/5	5	5	10
Scopus	S7	3.9	4.0	4.4	4.1	4.3	4.2	4.1	2.4	3.8	8/45	8	45	12
Category B	N10	3.6	3.7	4.1	3.8	4.0	3.6	3.2	2.7	3.71	7/7	7	7	13
DOAJ	N14	3.8	3.7	4.2	3.9	4.1	3.8	3.4	2.4	3.66	4/10	4	10	14
Category B	N15	3.6	3.6	4.1	3.7	4.0	3.6	3.3	2.3	3.65	6/26	6	26	15
Category B	N8	3.7	3.8	4.2	3.9	4.0	3.6	3.2	2.4	3.6	8/8	8	8	16
Category B	N17	3.7	3.6	4.1	3.8	4.0	3.8	3.2	2.3	3.56	5/41	5	41	17
Category B	N21	3.6	3.7	4.1	3.8	4.0	3.7	3.2	2.4	3.56	5/10	5	10	17
Category B	N20	3.5	3.6	4.0	3.6	3.8	3.7	3.5	2.6	3.54	3/3	3	3	19
Category B	N11	3.6	3.5	4.0	3.6	3.8	3.6	3.2	2.4	3.46	5/15	5	15	20
Category B	N16	3.4	3.4	4.0	3.5	3.7	3.4	3.1	2.2	3.46	5/24	5	24	20
Category B	N9	3.6	3.5	4.0	3.6	3.8	3.6	3.3	2.3	3.46	10/10	10	10	20
Category B	N22	3.5	3.5	4.0	3.6	3.8	3.4	3.2	2.2	3.4	4/11	4	11	23
Category B	N12	3.4	3.3	4.1	3.5	3.8	3.6	3.1	2.1	3.36	4/13	4	13	24
Category B	N18	3.6	3.3	4.1	3.4	3.7	2.8	3.1	2.4	3.3	6/26	6	26	25
Category B	N7	3.4	3.3	4.0	3.4	3.5	3.4	3.1	2.3	3.3	4/12	4	12	25
DOAJ	N5	2.8	2.9	4.0	3.0	3.1	3.2	3.1	2.6	3.1	5/15	5	15	27
Category B	N6	3.2	3.0	3.7	3.2	3.5	2.9	2.7	2.0	3.03	5/20	5	20	28
Category B	N19	2.5	2.6	3.2	2.6	2.9	2.7	2.6	2.3	2.68	8/40	8	40	29

The list of journals with abbreviations is as follows: S1 = Pedagogy of Physical Culture and Sports; S2 = Physical Education of Students; S3 = Health, Sport, Rehabilitation; S4 = Physical Education Theory and Methodology; S5 = Slobozhanskyi Herald of Science and Sport; S6 = Rehabilitation & Recreation; S7 = Physical Rehabilitation and Recreational Health Technologies; N1 = Journal of Learning Theory and Methodology; N2 = Pedagogy of Health; N3 = Physical Culture, Recreation and Rehabilitation; N4 = Health Technologies; N5 = Education: Modern Discourses; N6 = Scientific Bulletin of the Izmil State Humanitarian University; N7 = Sports Games; N8 = Martial Arts; N9 = Physical Activity, Health and Sports; N10 = Visnyk of Kamianets-Podilsky Ivan Ohienko National University; N11 = Sport Science and Human Health; N12 = Newsletter of Precarpathian University; N13 = Health-saving technologies, rehabilitation and physical therapy; N14 = Physical Education, Sport and Health Culture in Modern Society; N15 = Physical Culture Sports and Health of the Nation; N16 = Sportyvnyi Visnyk Prydniprovia; N17 = Sports Medicine, Physical Therapy And Occupational Therapy; N18 = Physical Education and Sports; N19 = Scientific Journal of Drahomanov Ukrainian State University; N20 = Ukrainian Journal of Medicine, Biology and Sports; N21 = Scientific Discourse in Physical Education and Sports; N22 = Sport Science Spectrum

quality indicator (*Average*), a ranking of 29 scientific journals (*Rank*) was compiled.

The analysis of the data in Table 4 shows that the highest positions in the ranking are occupied by journals indexed in WoS and/or Scopus, while Category B journals occupy the lowest positions. The main differences between the groups are determined by the values for the criteria “Internationalization,” “Structure,” and “Sources.”

A descriptive statistical analysis was conducted for the evaluations of 29 scientific journals according to the following criteria: “Novelty,” “Methodology,” “Relevance,” “Analysis,” “Practical Value,” “Structure,” “Sources,” “Internationalization,” and “Average.” The results of the basic statistics are presented in Table 5.

As shown in Table 5, the highest mean value was obtained for the criterion “Relevance.” Relatively high scores were also recorded for the criteria “Practical Value” and “Analysis.” The lowest mean values were observed for the criteria “Internationalization” and “Sources.” The overall mean value across all criteria (*Average*) was 3.70 ± 0.44 .

The Shapiro–Wilk test was applied to assess the normality of the distribution for each quality assessment criterion (Table 6). The results showed that several variables, including “Relevance,” “Practical Value,” “Sources,” and “Internationalization,” exhibited statistically significant deviations from a normal distribution ($p \leq 0.05$). Given these deviations and the discrete nature of the 0–5 scoring scale, Spearman’s rank

correlation coefficient was chosen as the most appropriate method to identify associations between the eight independent criteria. The analysis revealed consistently strong positive associations among most criteria, with the highest coefficients observed between “Methodology” and “Analysis” ($\rho = 0.99$), “Novelty” and “Analysis” ($\rho = 0.97$), and “Methodology” and “Novelty” ($\rho = 0.97$). In contrast, “Internationalization” demonstrated comparatively weaker correlations, particularly with “Practical Value” ($\rho = 0.66$) and “Relevance” ($\rho = 0.72$), indicating its relative independence from other components of academic quality. A visual representation of the identified relationships between the criteria is provided in the correlation heatmap (Figure 1).

To confirm the statistical significance of the differences between indexed and non-indexed journals, the non-parametric Mann–Whitney U test was applied to each of the eight quality criteria (Table 7). The grouping was as follows: journals indexed in WoS, Scopus, WoS/Scopus, and DOAJ were combined into the *Indexed* group, while journals from category B and non-indexed journals were combined into the *Non-Indexed* group. The results indicated statistically significant differences ($p \leq 0.001$) for all criteria, with indexed journals generally achieving higher scores across all quality indicators compared to non-indexed journals. The largest differences were observed for the criteria “Novelty” and “Relevance,” reflecting the higher level of originality and topicality of research content

Table 5. Descriptive statistics of the evaluations of 29 scientific journals based on the main quality criteria

Quality Assessment Criterion	count	mean	std	min	25 %	50 %	75 %	max
Novelty	29.0	3.73	0.46	2.5	3.5	3.7	4.0	4.7
Methodology	29.0	3.69	0.44	2.6	3.5	3.7	4.0	4.6
Relevance	29.0	4.17	0.3	3.2	4.0	4.1	4.4	4.8
Analysis	29.0	3.8	0.44	2.6	3.6	3.8	4.1	4.6
Practical Value	29.0	3.96	0.38	2.9	3.8	4.0	4.3	4.5
Structure	29.0	3.8	0.53	2.7	3.6	3.7	4.2	4.7
Sources	29.0	3.53	0.51	2.6	3.2	3.3	4.0	4.4
Internationalization	29.0	2.86	0.76	2.0	2.3	2.4	3.6	4.3
Average	29.0	3.7	0.44	2.68	3.46	3.65	3.97	4.57

Table 6. Results of the Normality Test for Criterion Scores (Shapiro–Wilk Test)

Criterion	Shapiro-Wilk stat	p-value	Conclusion
Novelty	0.9627	0.3829	Normal
Methodology	0.9816	0.8773	Normal
Relevance	0.9087	0.0159	Not normal
Analysis	0.9698	0.5555	Normal
Practical Value	0.9181	0.0272	Not normal
Structure	0.9617	0.3623	Normal
Sources	0.9014	0.0106	Not normal
Internationalization	0.797	0.0001	Not normal
Average	0.9837	0.9207	Normal

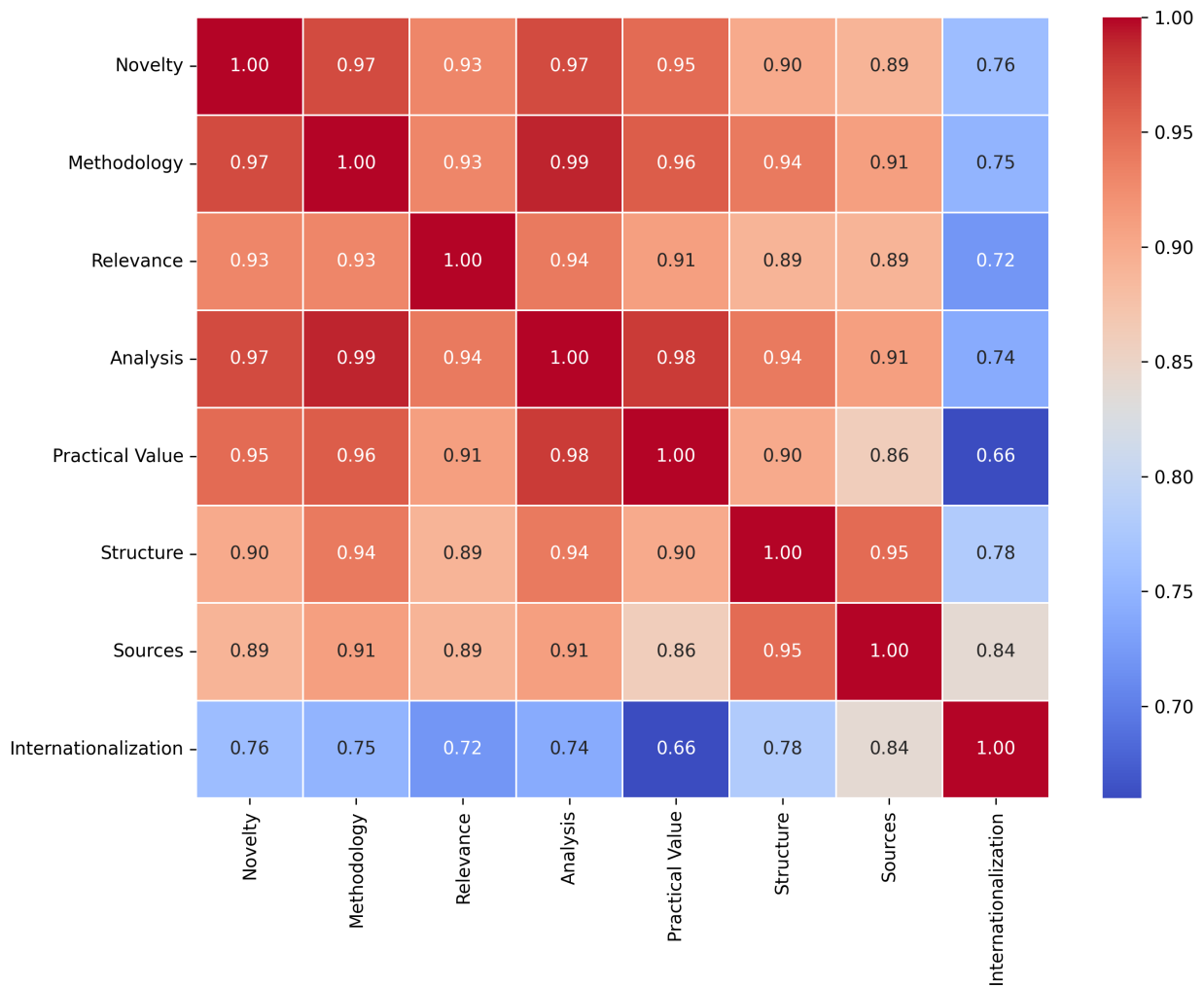


Figure 1. Spearman correlation heatmap of quality assessment criteria (0–5 scale)

in indexed publications.

Table 7. Results of Mann–Whitney U-Test Comparing Indexed vs. Non-Indexed Journals Across Quality Criteria

Criterion	U-statistic	p-value
Novelty	184.0	0.0
Methodology	180.0	0.001
Relevance	185.0	0.0
Analysis	179.0	0.001
Practical Value	178.0	0.001
Structure	181.5	0.0
Sources	182.0	0.0
Internationalization	181.5	0.0

Table 8 presents the mean values for nine quality criteria for each group of journals classified by indexing type (Category B, DOAJ, Non-indexed, Scopus, WoS, WoS/Scopus). The data are based on aggregated evaluation results of publications from 29 journals.

The data in Table 8 indicate that:

- Journals indexed in WoS/Scopus demonstrate the highest mean scores across all criteria,

particularly for *Relevance*(4.8), *Novelty* (4.7), and *Structure* (4.7).

- WoS and Scopus journals are also characterized by high scores, averaging from 4.0 to 4.4 for most parameters.
- Publications listed in DOAJ and non-indexed journals show moderate values, with DOAJ journals having a comparatively high *Relevance* score (4.32) and *Structure* score (4.02).
- Category B journals demonstrate the lowest values for the criteria *Sources* (3.13) and *Internationalization* (2.33), which significantly impacts their average score (3.4).
- The most substantial differences between groups are observed for the criteria *Internationalization*, *Sources*, and *Structure*.

A comparison of the data obtained using the authors' approach with the indicators presented in the WoS/Scopus databases revealed a high level of agreement (Table 9). The proportion of matches between the authors' approach and the official rankings was 86.1%, confirming its applicability for journal evaluation.

The analysis of the data in Table 9 shows that

the smallest discrepancies (MAE = 0.83; 13.9%) are observed when using the three integrated Scopus metrics CiteScore 2024, SJR 2024 and SNIP 2024 as well as when comparing with the CiteScoreTracker

2025 indicator. When combining the Q positions from WoS and Scopus, the mean deviation was 1.86 (31.0%) which indicates greater variability when evaluating solely by quartiles.

The ranking of 22 journals not indexed in WoS/

Table 9. Comparative analysis of journal indicators according to WoS, Scopus, and the developed approach

Indexing Journal	Title	Rank	Q(WoS)	IF(WoS)	Q(Scopus)	CiteScoreTracker 2025 (05 August, 2025)	CiteScore 2024	SJR 2024	SNIP 2024	Q_unified_num	Q_pos_start	Q_pos_end	Q_pos_center	AbsDiff_Q	Metric_Mean_3	Rank_Metric_3	AbsDiff_3	Rank_CT	AbsDiff_CT
WoS/Scopus	S1	1	Q2	1.5	Q2	3.0	2.8	0.334	0.654	2.0	1.0	2.0	1.5	0.5	1.26	1.0	0.0	1.0	0.0
WoS	S2	2	Q3	0.7						3.0	3.0	6.0	4.5	2.5					
Scopus	S3	3			Q3	1.7	2.1	0.331	0.608	3.0	3.0	6.0	4.5	1.5	1.01	3.0	0.0	3.0	0.0
Scopus	S4	4			Q2	2.5	2.7	0.318	0.57	2.0	1.0	2.0	1.5	2.5	1.2	2.0	2.0	2.0	2.0
Scopus	S5	5			Q4	1.3	0.7	0.182	0.202	4.0	7.0	7.0	7.0	2.0	0.36	5.0	0.0	4.0	1.0
Scopus	S6	6			Q3	0.6	0.5	0.159	0.137	3.0	3.0	6.0	4.5	1.5	0.27	6.0	0.0	6.0	0.0
Scopus	S7	7			Q3	0.9	1.1	0.196	0.269	3.0	3.0	6.0	4.5	2.5	0.52	4.0	3.0	5.0	2.0

Note. Indexing Journal – database in which the journal is indexed. Q(WoS), IF(WoS) – quartile and impact factor in WoS. Q(Scopus), CiteScore, SJR, SNIP – official Scopus metrics. Q_unified_num – unified quartile (WoS/Scopus). AbsDiff_Q, AbsDiff_3, AbsDiff_CT – absolute deviations between the rankings according to the authors’ method and the official indicators. Metric_Mean_3 – mean value of the three Scopus metrics.

Table 10. Calculation of journal ranking based on OUCI data

Journal	total_articles	h_index	h_per_article	h_per_article_norm	quality_score	rank_quality
N1	81	9	0.111	1.0	1.0	1
N2	36	4	0.111	1.0	1.0	2
N3	36	3	0.083	0.75	0.75	3
N4	50	3	0.06	0.54	0.54	4
N5	119	6	0.05	0.454	0.454	5
N6	30	1	0.033	0.3	0.3	6
N7	100	3	0.03	0.27	0.27	7
N8	224	5	0.022	0.201	0.201	8
N9	45	1	0.022	0.2	0.2	9
N10	229	4	0.017	0.157	0.157	10
N11	176	3	0.017	0.153	0.153	11
N12	147	2	0.014	0.122	0.122	12
N13	150	2	0.013	0.12	0.12	13
N14	487	5	0.01	0.092	0.092	14
N15	398	4	0.01	0.09	0.09	15
N16	420	4	0.01	0.086	0.086	16
N17	388	3	0.008	0.07	0.07	17
N18	369	2	0.005	0.049	0.049	18
N19	2717	10	0.004	0.033	0.033	19
N20	1932	4	0.002	0.019	0.019	20
N21	25	0	0.0	0.0	0.0	21
N22	83	0	0.0	0.0	0.0	22

Note: total_articles = total number of articles; h_index = Hirsch index; h_per_article = Hirsch index calculated per article; h_per_article_norm = normalized value of h_per_article; quality_score = integrated quality score; rank_quality= position in the ranking.

Scopus, calculated based on OUCI data, is presented in Table 10.

The analysis of the data in Table 10 showed that the highest positions in the ranking are occupied by journals with a relatively small number of publications but a high h-index per article (N1, N2, N3, N4). Journals with a large number of articles and a low h-index are found in the lower part of the list. The absence of citations (h-index = 0) results in the minimum integrated quality score and places the journals in the last positions of the ranking (N21, N22).

A comparison of journal rankings calculated using OUCI data with the authors' ranking is presented in Table 11.

Table 11. Comparison of journal positions in the authors' ranking and according to OUCI data

Number	rank_my	rank_quality	rank_diff
N1	1	1	0
N3	2	3	1
N2	3	2	1
N4	4	4	0
N13	5	13	8
N10	6	10	4
N14	7	14	7
N15	8	15	7
N8	9	8	1
N17	10	17	7
N21	11	21	10
N20	12	20	8
N11	13	11	2
N16	14	16	2
N9	15	9	6
N22	16	22	6
N12	17	12	5
N18	18	18	0
N7	19	7	12
N5	20	5	15
N6	21	6	15
N19	22	19	3

Note: *number* = journal code; *rank_my* = position in the ranking according to the authors' calculation; *rank_quality* = position in the ranking according to OUCI; *rank_diff* = difference between the rankings.

A comparative analysis of the data in Table 11 showed that for four journals (N1, N2, N3, N4) the rankings in both systems fully coincide, indicating the stability of their positions regardless of the calculation method. The largest discrepancies (ranking differences of more than 10 positions) were recorded for journals N5, N6 and N7, which occupy higher positions in the authors' ranking compared to OUCI. The overall trend indicates that the OUCI methodology is more sensitive to quantitative citation metrics, whereas the authors' ranking takes

into account additional aspects of quality.

Discussion

The aim of this study was to assess the level of academic quality of Ukrainian scientific journals in the field of physical culture and to identify differences between groups of journals with different indexing statuses. The results showed that journals indexed in the WoS/Scopus databases demonstrate the highest average scores for key criteria, whereas publications classified as Category B are considerably below the overall level of academic quality.

Assessment of the Reliability of AI Tools in the Peer Review Process

To confirm the validity of using AI tools in the peer review of scientific articles, publications comparing ChatGPT evaluations with those of human reviewers were considered. According to the study by Carabantes and Redondo-Sama [33], the average level of agreement was 60–70%, and in one out of three articles, a 100% distortion of the content structure was identified. In the work by Tai et al. [34], which covered 30 medical articles, it was found that in 13% of cases there were significant discrepancies between the article content and the ChatGPT review, in 30% of cases there were hallucinated sources, and the overall agreement with editors' opinions was 70–75%. The analysis by Saad et al. [35] showed that in 100% of cases ChatGPT did not note the absence of ethical approvals and also failed to detect methodological gaps, which reduces the reliability of its reviews.

Our findings are consistent with these results. However, the errors reported in similar studies can be avoided by ensuring the accuracy of the queries submitted and refining them when necessary. In our study, a modified approach was applied: eight specialized queries were used, each containing a detailed algorithm for evaluating a scientific article according to each of the eight criteria (Table 1). This made it possible to increase the accuracy of ChatGPT responses and minimize the number of significant discrepancies. Thus, the preliminary structuring of queries can be considered a factor that enhances the accuracy of AI-generated reviews. At the same time, the comparison and correction of the final result by experts remains an essential procedure.

The obtained data indicate that the proposed ranking method demonstrates high agreement with Scopus evaluations and moderate concordance with the combined WoS/Scopus quartile. Exceeding the agreement level of 85% (86.1% for individual metrics) confirms the applicability of the approach for journals present in international databases. However, extending these conclusions to the entire set of 29 journals is limited by the absence of standardized indicators for a significant portion of them. In this regard, the method can be used as

an auxiliary tool for evaluating journals without full indexing in WoS or Scopus.

Conceptual and Methodological Approaches to Assessing the Quality of Scientific Journals

In our study, the criteria for assessing the quality of Ukrainian journals were identified based on existing recommendations and scholarly evaluation practices [5, 8, 36]. Certain aspects revealed during the analysis are consistent with the results of previous studies, which emphasize the importance of characteristics such as originality, methodological rigor, logical structure, clarity of argumentation, and academic formatting of articles [37, 43, 44]. The quality of peer review as a tool for maintaining scientific standards is also considered an important component of the publication process [30, 38, 51]. In addition, text structure, the relevance of keywords, and international co-authorship may be associated with the perception of a publication as high quality and with its scientometric indicators [7, 48, 52].

In contemporary academic practice, the quality of a scientific article is viewed as a multifaceted concept that encompasses the originality of content, methodological rigor, logical structure, thematic relevance, formatting, and other elements of scholarly culture [36, 43, 44]. Our analysis confirms that these parameters play an important role in the perception of a publication as high quality and may also correlate with citation indices and the status of the journal [7, 48, 52]. The trends we identified are consistent with approaches in studies focused on evaluating peer review and the intrinsic quality of publications [38, 51, 53]. Thus, the inclusion of such criteria in the algorithm for assessing scientific journals makes it possible to objectify the analysis procedure and enhance its validity.

The results of our study complement existing approaches to assessing the quality of scientific publications and highlight the importance of components such as internationalization, article structure, and methodological rigor. These findings are consistent with the recommendations presented in the study by Agustian [54], which emphasizes the importance of clearly describing the research design, ensuring reproducibility, and controlling variables as hallmarks of sound research. In turn, Kosmützky [55] stresses the need for a flexible yet well-justified choice of methodology depending on the objectives and context of the study. Furthermore, as noted by Synowiec et al. [56], transparency and adaptability in method selection enhance the scientific credibility and practical relevance of publications. Thus, the criteria and differences between journal groups identified in our analysis confirm the relevance and applicability of these theoretical and methodological guidelines in the context of evaluating Ukrainian scientific journals.

Empirical Basis and Quantitative Analysis of

Differences in Academic Quality

Statistical analysis (Mann–Whitney U test) revealed significant differences between indexed and non-indexed journals across all nine criteria of academic quality. The most pronounced discrepancies were recorded for the indicators of scientific novelty, relevance, article structure, and internationalization (all: $p = 0.000$), which underscores the advantage of journals included in international databases. These results are consistent with previously identified trends indicating the association between indexation and compliance with the standards of scholarly communication and international authorship [17, 19]. Formal elements such as DOI assignment and adherence to the IMRAD structure, along with the participation of foreign authors, serve as indicators of the academic level of a journal. Thus, the identified quantitative differences justify the need for Ukrainian journals to adapt to the requirements of international platforms.

This study obtained a high degree of agreement (86.1%) between the authors' evaluation method and the official indicators of the WoS/Scopus databases, which indicates the robustness of the proposed approach. According to Traag et al. [57], at the institutional level, the degree of agreement between metrics and peer review can be comparable to the internal agreement among reviewers. Tunger and Schaer [58] demonstrated that post-publication expert evaluations can show high consistency with bibliometric and altmetric indicators when AI analysis of expert statements is applied. According to generally accepted methodological guidelines, an agreement level of $\geq 80\%$ is considered acceptable and reflects a high degree of concordance [59, 60]. The classic classification by Landis and Koch [61] categorizes such values as "almost perfect" agreement. Similar levels of concordance between bibliometric metrics and expert evaluations have been demonstrated in other studies [62, 63], which confirms the validity of combined approaches.

In this context, the novelty of this study lies in the adaptation of a multi-criteria evaluation model, typically applied at the level of individual publications, to the comprehensive ranking of scientific journals based on eight content-related criteria. Unlike traditional studies focused on the correlation of individual metrics with expert evaluations, the proposed approach integrates content analysis, AI tools, and expert verification. This approach makes it possible to obtain robust results even in the absence of a complete set of scientometric indicators.

The comparative analysis (Table 8) showed that journals indexed in WoS and Scopus demonstrate significantly higher average scores for key criteria. Category B journals and non-indexed publications

lag behind, particularly in terms of international participation, which indicates their limited integration into the international academic space. The Mann–Whitney U test (Table 7) confirmed statistically significant differences in the indicators. An example is a journal that occupies the last and first positions in Table 4 (Rank) for the “Average” criterion. These differences are consistent with previous studies [17, 19], which emphasize the role of internationalization, methodological rigor, and transparency in academic quality.

The results of this study confirm that the bibliographic component is an important indicator of the quality of scientific publications. For the “Sources” criterion, Category B journals lag significantly behind journals indexed in WoS and Scopus. These findings are consistent with the conclusions of Santini [64], Kumar [65], and Mammola et al. [66], who emphasize the importance of the relevance, accuracy, and completeness of the “References” section. As shown by Tykhonkova [67], Ukrainian journals also suffer from the absence of DOIs and the use of outdated sources, which reduces their international visibility.

Specific Features of the Functioning of Ukrainian Scientific Publications in the National Context

A number of domestic studies confirm the need to move from formal indicators (presence of ISSN, indexation, publication frequency) to a multi-criteria content-based assessment of the quality of scientific journals. For example, in the works of Vlokh [68] and Demin [69], models based on bibliometric and statistical data are proposed: the first focuses on the distribution of publication activity in the field of physics, and the second applies an integrated QI vector at the level of national analytics. These approaches align with our position regarding the consideration of comprehensive metrics and scientific significance.

The study by Tykhonkova [67] emphasizes that the integration of Ukrainian journals into the international scientific space requires not only formal compliance (indexation, ISSN) but also substantive improvement, including the quality of metadata, transparency of editorial policy, language adaptation, and adherence to open access standards. These conclusions confirm the relevance of the multi-criteria approach applied in our study.

The works of Nazarovets [70] and Nazarovets and Mryglod [71] show that a high level of publication citations is not always determined by indexation in international databases but is driven by such content-related parameters as the language of the article, international co-authorship, and open access. This confirms the need to account for the content characteristics incorporated into the model we propose.

The study by Mryglod et al. [72] is of particular

significance, as it was the first to implement an analysis of Ukrainian economic science based on open metadata (Crossref, OUCI). This approach serves as an alternative to formal expert review and supports the logic of multi-criteria content evaluation adopted in our study.

These results are complemented by earlier research [2, 3, 4, 5], which emphasized the importance of both formal and content-related characteristics in the evaluation of Ukrainian scientific journals. Later publications [6, 7] examined factors of citation and scientific novelty that directly influence publication quality. These findings formed the basis of the proposed structured model for journal evaluation.

Thus, our study is supported by the results of previous works in terms of its focus on content-based evaluation, the use of open data, and comprehensive indicators. At the same time, its distinctive feature is the universality and extensiveness of the approach: the model covers not only quantitative but also structural, linguistic, collaborative, and thematic parameters applicable to a wide range of Ukrainian scientific journals.

Adaptation to International Criteria and Improvement of Editorial Practice

Our results correlate with the quality criteria established by Scopus and Web of Science, such as international authorship, transparent editorial policy, peer review, and the availability of metadata [39, 41]. However, Category B and non-indexed journals often lag behind in internationalization, transparency, and bibliography. This is also confirmed by the findings of Mongeon and Paul-Hus [40], who note the uneven coverage of journals. Ukrainian publications need to align with international standards to enhance their academic legitimacy and visibility.

The results of the study show that Category B journals are primarily focused on meeting the formal criteria set by the national system of scientific accreditation. This orientation is driven by the current monitoring procedures of the Ministry of Education and Science of Ukraine and the editorial boards’ aim to maintain their status in the approved list. As a result, priority is often given to quantitative indicators (publication frequency, volume of publications), while methodological rigor, content quality, and international visibility are relegated to the background. This is reflected in low average scores for a number of key criteria that characterize articles with foreign participation, transparency of editorial procedures, peer review policy, and bibliography quality. These indicators point to the limited integration of such publications into the international scientific community and the insufficient maturity of their editorial policies.

Comparison of Journal Rankings Based on OUCI Data

A comparison of the indicators for 22 Ukrainian journals not indexed in WoS/Scopus showed that when using Crossref data, only citations of publications with a DOI registered in this system are taken into account. This limits the completeness of the evaluation, since some publications may be registered in other systems. At the same time, most Ukrainian journals cite publications with a DOI to a limited extent and tend to cite national sources more frequently. The analysis of Tables 1 and 2 revealed that complete coincidence of rankings in both systems was observed for only 4 out of 22 journals (18.2%), the difference did not exceed 8 positions for 14 journals (63.6%), and for 8 journals (36.4%) the discrepancies were more substantial, reaching up to 15 positions.

Taken together, the obtained data confirm the effectiveness of the proposed algorithm for assessing the quality of Ukrainian scientific journals in the field of physical culture. The use of comprehensive criteria, including article structure, methodological rigor, internationalization, and the accuracy of bibliographies, made it possible to identify both the strengths and the problem areas in the development of academic publications. Comparison with international practices such as Scopus, WoS, and DOAJ shows that Ukrainian journals indexed in authoritative databases are aligned with global standards. At the same time, Category B publications often retain a formal approach and insufficient transparency. These results highlight the need for systemic changes in the activities of Ukrainian Category B journals aimed at improving research integrity, increasing the openness of editorial processes, and strengthening integration into the international scientific space.

Limitations of the Study

The results of this study should be interpreted in light of several limitations. The first limitation is the reliance on information available in open access on the official websites of the journals. In cases where such information was absent or presented only partially, the evaluation may have been incomplete. The second limitation concerns quantitative indicators (for example, citation index), which were not always available for journals published in the Ukrainian language, thereby limiting the possibility

of objective comparison with international practices. The third limitation is the number of issues analyzed for each journal (only one current issue) and the number of experts involved in the article evaluation process.

Conclusions

The conducted study made it possible to comprehensively assess the quality of Ukrainian scientific journals in the field of physical culture based on objective criteria and to compare them with international practices. The results revealed a significant differentiation of indicators depending on the category of the journal and its indexing status. Journals represented in the WoS and Scopus databases demonstrate higher values for such criteria as methodological rigor, internationalization, article structure, and bibliography quality. In contrast, Category B publications are characterized predominantly by formal compliance with standards, which limits their integration into the international academic space.

Thus, the proposed evaluation algorithm can be used not only for monitoring the academic quality of journals but also as a tool for enhancing the international visibility of Ukrainian scientific publications. Improvements in such indicators as internationalization, bibliography quality, and article structure contribute to increased citation rates, compliance with the requirements of international indexing databases (Scopus, WoS), and, consequently, the strengthening of Ukrainian journals' positions in the global scientific space.

Conflict of Interest

One of the authors (Sergii Iermakov) serves as the Editor-in-Chief and Publisher of this journal. To ensure an objective review process, the manuscript was handled by an independent editorial board member, and the peer review was conducted by external reviewers who had no affiliations with the authors. The Editor-in-Chief did not participate in the review or editorial decision-making process regarding this manuscript. The other co-authors (Georgiy Korobeynikov and David Curby) declare that they have no conflict of interest related to this publication.

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Cite this article as:

Iermakov S, Korobeynikov G, Curby D. Assessment of the academic quality of scientific journals of Ukraine in physical culture. *Pedagogy of Health*, 2025;4(2):91–107. <https://doi.org/10.15561/health.2025.0202>

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Received: 12.07.2025

Accepted: 14.09.2025; Published: 30.12.2025

Assessment of the physical education learning environment among Ukrainian university students during wartime: validation of the SAPPE questionnaire and gender-regional analysis

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Abstract

Background and Study Aim The ongoing military conflict in Ukraine has profoundly disrupted university life, limiting students' access to physical activity, altering the educational environment, and increasing psychological stress. These conditions make it essential to understand how students perceive physical education and what factors influence their engagement in physical activity. This study aimed to assess the structure and development of key components of the physical education learning environment among Ukrainian university students during wartime, using an adapted version of the SAPPE questionnaire.

Material and Methods The study included 89 university students from Eastern and Western Ukraine and 8 physical education instructors. Data were collected online using the adapted Ukrainian version of the Scale to Assess Perception of Physical Education (SAPPE), which consists of six subscales covering key dimensions of the physical education environment. Reliability and construct validity of the instrument were confirmed through internal consistency analysis and exploratory factor analysis.

Results The SAPPE questionnaire demonstrated high reliability (Cronbach's alpha = 0.894) and adequate construct validity, confirmed by interscale correlations and exploratory factor analysis. The identified two-factor structure reflected infrastructural aspects and motivational-personal components of the physical education environment. Regional differences were observed: 78 students scored high on the Classroom Climate subscale, while 40 scored low on Self-Efficacy in PE, indicating uneven perceptions across regions. Gender-based cluster analysis showed no statistically significant differences ($\chi^2 = 2.905$, $p = 0.234$), suggesting similar patterns in male and female responses.

Conclusions The adapted SAPPE questionnaire is a reliable and valid tool for assessing university students' perceptions of the physical education environment under wartime conditions. Regional and gender-related patterns, although limited, highlight the need to tailor pedagogical strategies to contextual differences. The instrument may be effectively used for ongoing monitoring and to support targeted interventions aimed at improving student well-being.

Keywords: physical education, educational environment, student well-being, self-efficacy, gender and regional differences, wartime Ukraine

Introduction

The contemporary social and political circumstances resulting from the full-scale war in Ukraine have profoundly affected all aspects of daily life, including the educational sector. Within this context, the system of physical education has proven to be particularly vulnerable, requiring adaptation in both organizational structures and instructional content. In these new conditions, it has become especially important to foster stable

behavioral patterns, promote a positive attitude toward physical activity, and ensure that students perceive the learning environment as safe and supportive. This highlights the urgent need for scholarly assessment of the physical education environment and for the development of reliable instruments to monitor students' perceptions across different regions of Ukraine.

In light of the challenges faced by educational institutions during wartime, researchers have placed particular emphasis on the need to adapt and assess the learning environment, especially in the field of physical education as a critical component

of students' overall well-being. A substantial body of international research underscores the importance of students' perceptions of the educational environment in physical education, particularly in relation to the development of motivation, self-efficacy, and a sustainable attitude toward physical activity [1, 2, 3, 4]. Notably, in China, the Scale to Assess Perception of Physical Education (SAPPE) was developed and validated to evaluate students' perceptions of physical education [5]. Moreover, successful applications of questionnaires adapted to post-conflict and high-stress contexts have also been documented [6, 7, 8].

Motivation and self-efficacy, as conceptualized within self-determination theory, are recognized as key factors influencing students' sustained engagement in physical activity. Under conditions of social stress and instability, these characteristics serve as protective resources that facilitate adaptation and support active behavior. However, empirical studies addressing these constructs in the Ukrainian context remain limited. Recent works by Ukrainian scholars have documented significant challenges in organizing the educational process under martial law, especially during the transition to remote learning in universities located in Eastern Ukraine [9, 10; 11, 12].

An effective approach to studying students' motivation, engagement, and perceptions of the educational environment involves the use of standardized questionnaires and psychometric scales. The application of such instruments provides structured data on students' psycho-emotional states and educational needs. This is particularly relevant during wartime conditions, when the educational system functions under high stress, relies on distance learning, and suffers from limited interaction between students and instructors.

In both international and Ukrainian practice, standardized questionnaires are widely used to assess students' quality of life, stress levels, and psychological well-being, particularly under conditions of armed conflict. These instruments include symptom checklists and coping strategy scales [13], the Perceived Stress Scale (PSS-10) validated for Ukrainian samples [14], and the General Well-Being Index [15]. Similar tools have been successfully applied in other post-conflict regions, such as Uganda and South Africa, to evaluate the impact of physical activity on students' mental health [6, 7, 16].

Within the Ukrainian context, several empirical studies have reported declines in students' motivation, increased stress, and reduced engagement in physical activity during wartime [17, 18]. Monitoring efforts further emphasize the need for adaptive physical education programs that account for the realities of war [19, 20]. Additionally, instruments such as the SF-36 and PSS-10 have

been adapted and used to assess students' quality of life and health status during the conflict [11, 12, 20], reinforcing the relevance of standardized approaches in unstable social conditions.

One validated tool used to assess students' perceptions of physical education is the Scale to Assess Perception of Physical Education (SAPPE) [5]. Initially developed in China, the instrument has demonstrated strong reliability and construct validity. It consists of six subscales that capture key aspects of the educational environment: behavioral dispositions toward physical activity, self-efficacy, attitudes and experiences, knowledge and skills, classroom climate, and infrastructural and normative conditions.

Due to its multidimensional structure, the SAPPE enables identification of specific features in students' perceptions across various educational and cultural settings, including systems undergoing crisis-related transformation, such as Ukraine's higher education sector [11, 12]. Internationally, interest in evaluating physical education outcomes has been reflected in efforts by organizations like SHAPE America, which provides standardized guidelines for assessment [21]. Research from Qatar and Saudi Arabia has highlighted gender- and motivation-related differences in PE perceptions, further supporting the scale's broad applicability [22, 23]. Comparative analyses across countries, including the United States and Finland, also reinforce the cross-cultural relevance of constructs such as motivation and self-efficacy in the field of physical education [1, 2, 24].

Despite the widespread use of standardized scales in international research, Ukrainian studies in this field remain limited. Most validation and applied studies have been conducted in countries with stable educational systems and secure environments, such as China [5], the United States, and Finland [1, 2]. Studies from Qatar and Saudi Arabia have also provided important insights, particularly regarding gender- and motivation-related differences in students' attitudes toward physical education [22, 23].

In Ukraine, the full-scale war has brought about systemic challenges, including decentralized learning, a rapid shift to remote instruction, and elevated psychological stress among students and faculty [9, 10]. Although some instruments assessing stress and well-being have been validated locally [11, 12, 15, 20], and several studies have addressed the impact of physical education on students' psycho-emotional states under crisis conditions [6, 25], a comprehensive tool specifically adapted to evaluate students' perceptions of physical education in the Ukrainian context is still lacking.

This gap underscores the need for empirical research using validated instruments that are responsive to regional, social, and wartime

conditions. The influence of the learning environment on students' motivation and behavior during armed conflict remains poorly understood. Factors such as socioeconomic hardship, displacement, disrupted educational pathways, and reduced institutional support may further shape student outcomes. The absence of systematic inquiry into these aspects hinders the development of evidence-based pedagogical models adapted to crisis conditions.

Given these challenges, there is a pressing need to locally adapt and apply a validated scale to assess Ukrainian students' perceptions of the physical education environment.

It was hypothesized that students' perceptions of the physical education learning environment would vary based on regional and gender-related factors due to differences in educational formats, infrastructure availability, and exposure to wartime stressors. Specifically, it was expected that students from Western Ukraine – where offline learning conditions are more stable – would report more favorable perceptions across SAPPE subscales, particularly in classroom climate and self-efficacy. Additionally, motivational and personal aspects were expected to load onto a separate factor, thereby supporting the multidimensional design of the SAPPE scale and confirming its theoretical validity in a conflict-affected context.

The aim of this study was to analyze the structure and level of development of components of the physical education learning environment among Ukrainian university students under wartime conditions using the adapted SAPPE questionnaire.

Materials and Methods

Participants

The study initially involved 110 students and 10 instructors from Ukrainian universities. Following a preliminary screening and the removal of incomplete or incorrectly completed questionnaires, data from 89 students and 8 instructors representing higher education institutions in Eastern and Western Ukraine were retained for analysis. Participation in the study was voluntary: the survey link was distributed through official university channels and online student groups specifically targeting learners in wartime conditions.

Ethical Standards. The study was conducted in accordance with the principles of the World Medical Association's Declaration of Helsinki [26]. The ethical aspects of the research were reviewed and approved by the academic council of [Ivano-Frankivsk National Technical University of Oil and Gas], which determined that formal approval from an institutional ethics committee was not required due to the non-invasive, anonymous nature of the study. Participants were informed in advance about

the purpose and content of the study, provided voluntary informed consent, and were notified of their right to withdraw at any stage without consequences. All data were collected anonymously and processed in compliance with principles of confidentiality.

Inclusion and Exclusion Criteria. The inclusion criteria for students were: enrollment at a Ukrainian university, participation in physical education classes, voluntary informed consent, and full and accurate completion of the questionnaire. Instructors were included if they had experience teaching courses related to physical education and had provided explicit consent to participate in the study.

Questionnaires containing missing values in key sections of the SAPPE scale were excluded from the analysis to ensure the reliability of statistical processing. As a result of the preliminary screening, questionnaires from 21 students and 2 instructors were removed from the initial sample.

All six SAPPE subscales were included in the factor analysis to assess the construct validity of the instrument. However, Factor 6 (*Facilities, equipment, and norms [Environmental factor]*) was excluded from the comparative analysis between students and instructors, as well as from the descriptive distribution tables, since it primarily reflects external conditions that vary substantially across different regions of Ukraine. Under the conditions of full-scale war, many sports facilities in Eastern Ukraine were severely damaged or completely destroyed, making an objective comparison of this factor between respondents from different regions impossible. Including this factor could distort the interpretation of the results, as infrastructure assessments in this context depend not on individual perception or behavior but on the physical state of the educational environment, which is beyond the control of the survey participants.

The distribution of students by gender and region, along with mean anthropometric characteristics, is presented in Table 1.

As shown in Table 1, the sample is relatively balanced by gender and region. The mean anthropometric values reflect the expected differences between men and women, which is important to consider in subsequent analyses. The representation of students from different regions also allows for the examination of territorial variations in perceptions of physical education.

The instructor group included an equal number of men and women. Their responses were incorporated into the comparative analysis with student results at the final stage of the study. The group consisted of eight instructors (four men and four women), and their assessments were considered in relation to the student data.

Table 1. Socio-demographic characteristics of students by region (n = 89)

Indicator	Eastern Ukraine	Western Ukraine	Total
Number of participants	53	36	89
Men	28 (53%)	21 (58%)	49 (55%)
Women	25 (47%)	15 (42%)	40 (45%)
Mean height of men (cm)	177.2 ± 7.4	179.4 ± 7.7	178.1 ± 7.5
Mean weight of men (kg)	71.3 ± 11.7	75.5 ± 10.4	73.1 ± 11.2
Mean height of women (cm)	168.2 ± 7.0	166.3 ± 5.5	167.5 ± 6.5
Mean weight of women (kg)	61.4 ± 11.4	58.0 ± 7.9	60.1 ± 10.2

Study Design

The study employed a cross-sectional quantitative design. Its primary objective was to examine the characteristics of students' perceptions of physical education in Ukrainian universities, as well as to identify latent structures and differences among participants. Data collection was conducted using a standardized questionnaire, and subsequent analyses included assessments of reliability and validity, as well as comparative and cluster analyses. Both descriptive and inferential statistical methods were applied to ensure well-grounded conclusions.

Instrument. Data were collected using the *Scale to Assess Perception of Physical Education (SAPPE)*. The application of the SAPPE scale is based on the methodology validated in the study by Qin et al. [5] and is consistent with international practice [8]. This approach supports the appropriateness of its use in academic contexts.

Prior to the study, the SAPPE scale was adapted to the Ukrainian context in accordance with international standards: a professional translation from English was carried out, followed by a back-translation conducted by independent experts. The procedures of translation, adaptation, and psychometric testing were selected based on successful experiences of questionnaire adaptation for Ukrainian samples [27, 28], which supports the validity of localizing the SAPPE scale. The consensus version underwent both linguistic and content expert review involving specialists in the fields of physical education and pedagogy.

The SAPPE scale consists of six subscales and includes 20 items rated on a 7-point Likert scale, where 1 indicates "strongly disagree" and 7 indicates "strongly agree." The factors (n = 6) and items (n = 20) of the SAPPE scale (PA – physical activity; PE – physical education) are as follows [5]:

Habituated behavior in PA (Behavioral factor)

1. Based on the knowledge and skills I have gained in PE, I can be physically active in my community.

2. On campus, I can frequently organise sports competitions or physical activities on my own

initiative with other students, using the knowledge and skills I have gained in PE.

3. Based on the knowledge and skills I acquired in PE, I can perform moderate exercise at home.

Self-efficacy in PE (Personal factor)

4. At least one sport is one in which I am more proficient than the majority of my classmates.

5. It is easy for me to master the motor skills and the content taught in PE.

6. I am the best performer in PE.

Attitude and experience in PE (Personal factor)

7. I'm excited in PE.

8. I am able to gain "fun" experiences in PE.

9. I am always focused during PE.

10. I look forward to every PE class.

Skills and knowledge (Environmental factor)

11. I have learned sports knowledge in PE.

12. I have learned basic exercise and physical training methods in PE.

13. I have learned how to avoid injuries during physical activity through PE.

Classroom climate (Environmental factor)

14. In PE, I have the same opportunities to practice as other students.

15. The teacher treats every student equally in PE.

16. The PE class environment is relaxed and enjoyable.

Facilities, equipment, and norms (Environmental factor)

17. The university provides adequate facilities and equipment for PE.

18. The sports venues are safe and suitable for PE.

19. The PE course has clear requirements and rules.

20. PE equipment is regularly maintained and updated.

Procedure

The survey was administered online using the Google Forms platform. Participants received the questionnaire link through university mailing lists and student group messengers. Completion of the survey required approximately 10-12 minutes.

Data collection took place between November and December 2024. Respondents were also asked to provide demographic information, including gender, age, height, weight, year of study, and region. The survey results were stored in the form of six factors, which were conditionally designated as columns 9-14 in the response dataset.

9 - Habituated behavior in PA (Behavioral factor)

10 - Self-efficacy in PE (Personal factor)

11 - Attitude and experience in PE (Personal factor)

12 - Skills and knowledge (Environmental factor)

13 - Classroom climate (Environmental factor)

14 - Facilities, equipment, and norms (Environmental factor).

The SAPPE questionnaire was tested for reliability and construct validity. Data collection was conducted in universities located in both Eastern and Western Ukraine. The questionnaire was distributed through online learning platforms and university email channels. Participation was voluntary, and all respondents were informed in advance about the purpose of the study. After data cleaning and the exclusion of incomplete responses, a total of 89 students and 8 instructors were included in the analysis.

Statistical Analysis

Data processing and analysis were performed using the Python programming language (version 3.11) with the libraries *pandas*, *scipy*, *matplotlib*, *seaborn*, and *sklearn*. All data were preliminarily checked for missing values and anomalies. The Shapiro-Wilk test was used to assess the normality of variable distributions. Since most variables did not follow a normal distribution, nonparametric methods were applied for group comparisons, specifically the Mann-Whitney U test. This approach is consistent with recommendations for analyzing nonparametric data [29, 30]. Internal consistency of the scales was assessed using Cronbach's alpha. Construct validity was examined through Spearman's correlation analysis between the scales, as well as exploratory factor analysis (EFA) with varimax rotation, following established practices [31, 32]. Cluster analysis was conducted using the K-means method, with prior standardization of scale data. The optimal number of clusters was determined using the Silhouette score, which was also applied to evaluate clustering quality [33, 34]. Associations between clusters and socio-demographic characteristics (e.g., gender) were analyzed using Pearson's χ^2 test. Statistical significance was set at $p < 0.05$.

Results

To evaluate the normality of data distributions across the six SAPPE subscales, the Shapiro-Wilk test was applied. The results demonstrated that,

for both Eastern and Western Ukrainian student samples, the distributions of all subscales deviated from normality (p-values ranged from 0.0000 to 0.0469). This justified the use of nonparametric statistical methods for further data analysis.

The reliability of the SAPPE questionnaire was assessed through Cronbach's alpha, calculated across all subscales (items 9-14). The obtained value of 0.894, with a 95% confidence interval [0.856; 0.925], indicates a high level of internal consistency and thus supports the reliability of the instrument.

Construct validity was examined through correlation analysis between the subscales (items 9-14) using Spearman's rho (ρ) (Figure 1). Correlation coefficients ranged from 0.32 to 0.77, reflecting moderate to strong positive associations among the subscales. All p-values were statistically significant ($p < 0.05$), confirming internal consistency among indicators that capture various aspects of physical activity, attitudes toward physical education, and the learning environment. These findings support the structural validity of the instrument at the level of interscale relationships.

To further assess the factor structure of the questionnaire, an exploratory factor analysis was conducted using the principal components method with varimax rotation. The analysis included subscales 9-14, which reflect different components of students' attitudes toward physical education and their perceptions of the learning environment. The results indicated that, according to Kaiser's criterion (eigenvalue > 1), it would be appropriate to retain only one factor. However, the scree plot (Figure 2) displayed a clear inflection between the first and second components, suggesting the possible presence of two latent factors.

In Figure 2, the first factor (eigenvalue = 4.19) accounts for the largest portion of variance, while the second factor (eigenvalue = 0.88) represents a less substantial component. The scree plot supports the conclusion that two components may adequately explain the structure of the questionnaire.

Regarding factor loadings, most subscales demonstrated values above 0.40, confirming their contribution to the explanation of the latent structure. The first factor group (items 12-14) primarily described infrastructural and organizational conditions, whereas the second group (items 9-11) was focused on motivational and personal components.

Thus, the construct validity of the questionnaire is supported by two complementary methods. First, Spearman's correlation analysis revealed significant associations among all subscales (ρ ranging from 0.32 to 0.77, $p < 0.05$), indicating high consistency and homogeneity of the measured constructs. Second, exploratory factor analysis confirmed a two-factor structure, reflecting both personal and infrastructural aspects of attitudes toward physical

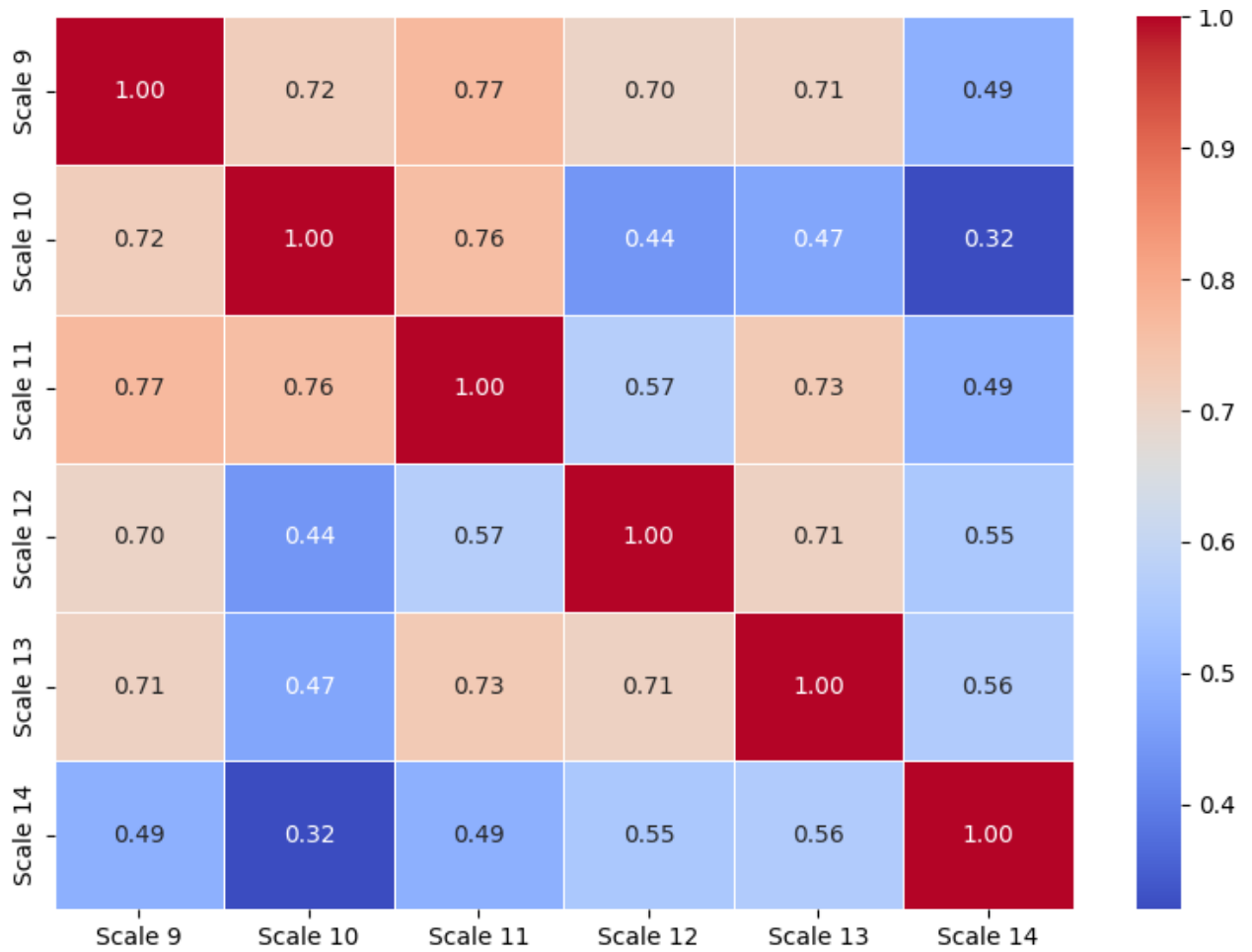


Figure 1. Spearman Correlation Matrix for SAPPE Scales with Student Data from Eastern and Western Ukraine. Note. $p < 0.05$

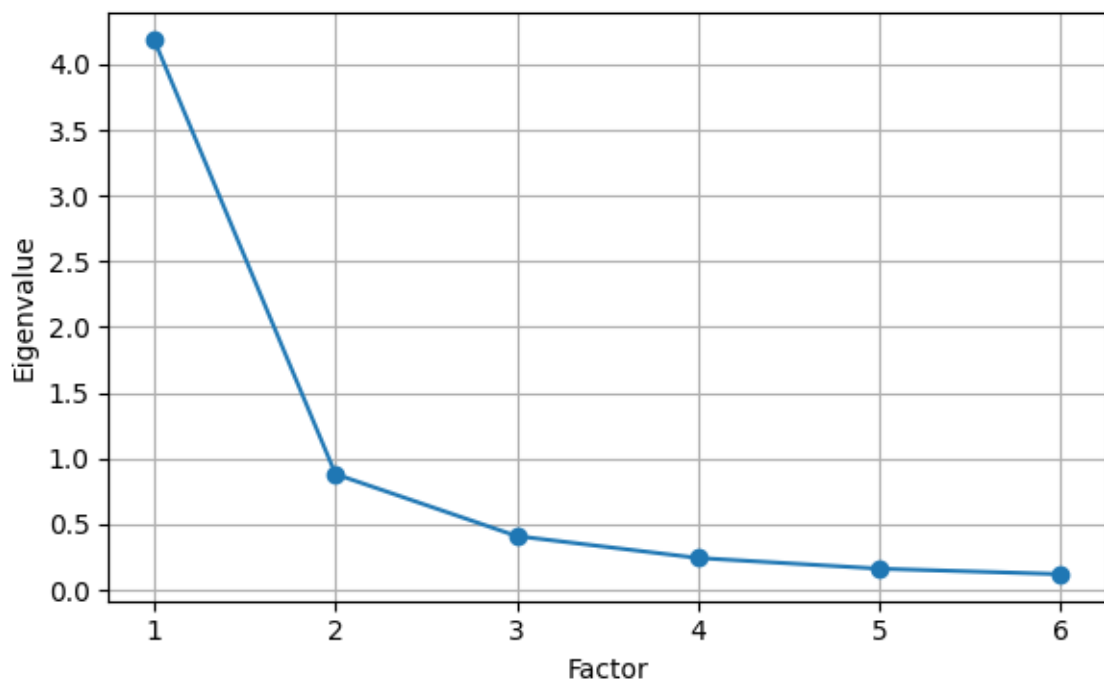


Figure 2. Eigenvalue plot for determining the optimal number of factors

education. Together, these findings demonstrate the theoretical soundness and internal coherence of the applied instrument.

Thus, the SAPPE questionnaire, adapted for the Ukrainian sample, demonstrated high internal consistency, with an overall Cronbach's alpha of 0.894 (95% CI: 0.856-0.925), indicating strong reliability of the instrument. Construct validity was confirmed through correlation analysis among the subscales ($\rho = 0.32-0.77$, $p < 0.05$) and exploratory factor analysis, the results of which revealed a two-factor structure with eigenvalues of 4.19 and 0.88.

To assess differences in the perception of physical education between students and instructors, scores on five SAPPE subscales were analyzed. The Mann-Whitney U test was applied, as the distributions of the indicators did not meet the criteria for normality (Table 2).

The results (Table 2) indicated no statistically significant differences between student and instructor scores across all SAPPE subscales ($p > 0.05$). The largest divergence was observed for Subscale 1, where instructors demonstrated a tendency toward higher ratings of students' habituated behavioral patterns (median = 19.5 vs. 17.0; $p = 0.1068$; $r = 0.163$); however, this difference did not reach statistical significance. For the remaining subscales (2, 3, 4, and 5), median values were similar across the groups, and the effect sizes suggested weak or very weak differences ($r < 0.13$). These findings suggest a general alignment in perceptions of the key components of physical education between students and their instructors.

To examine the structure of interrelationships among the five SAPPE subscales in the student

sample, Spearman's rank-order correlation coefficient was applied to assess the direction and strength of associations between the scales. All obtained coefficients were statistically significant ($p < 0.001$), indicating stable positive correlations across the subscales. The values of Spearman's correlation coefficients (ρ) are presented in Figure 3.

The strongest association (Figure 3) was observed between Subscales 1 and 3 ($\rho = 0.77$), indicating a close link between habituated behavioral patterns and a positive attitude toward physical education classes. Substantial correlations were also found between Subscales 3 and 5 ($\rho = 0.73$), 1 and 2 ($\rho = 0.72$), and 4 and 5 ($\rho = 0.71$). These results confirm the interdependence of components that shape positive perceptions of physical education and provide further support for the construct validity of the SAPPE questionnaire.

To identify latent profiles of students based on their perceptions of physical education, a cluster analysis was conducted using the five SAPPE subscales. The k-means procedure was applied after prior z-transformation of the data. Evaluation of clustering quality using the silhouette metric indicated that the optimal solution was achieved at $k = 3$ (Figure 4). Table 3 presents the median values for each SAPPE subscale across the three identified clusters.

Analysis of median values across the SAPPE subscales allowed for the identification of three typological student profiles (Table 3). The clustering revealed differences in attitudes, self-efficacy, knowledge, skills, and perceptions of the learning environment, reflecting the heterogeneity of the student population in the context of physical

Table 2. Comparison of student and instructor scores across SAPPE subscales

Scale no.	Factor	Median (students)	IQR (students)	Median (instructors)	IQR (instructors)	p-value	Effect size (r)
1	Habituated behavior in PA	17.0	6.0	19.5	1.5	0.1068	0.163
2	Self-efficacy in PE	14.0	8.0	17.5	3.0	0.2185	0.125
3	Attitude and experience in PE	23.0	9.0	24.0	2.0	0.3605	0.093
4	Skills and knowledge	18.0	4.0	17.5	1.75	0.7960	0.027
5	Classroom climate	19.0	6.0	19.5	3.25	0.5156	0.065

Note: IQR – interquartile range; r – effect size.

Table 3. Median values for SAPPE subscales across identified student clusters

Cluster / Subscale no.	1	2	3	4	5
0	13.0	9.5	16.0	15.0	15.5
1	19.5	18.0	25.0	18.0	20.5
2	9.0	7.0	7.0	8.0	8.0

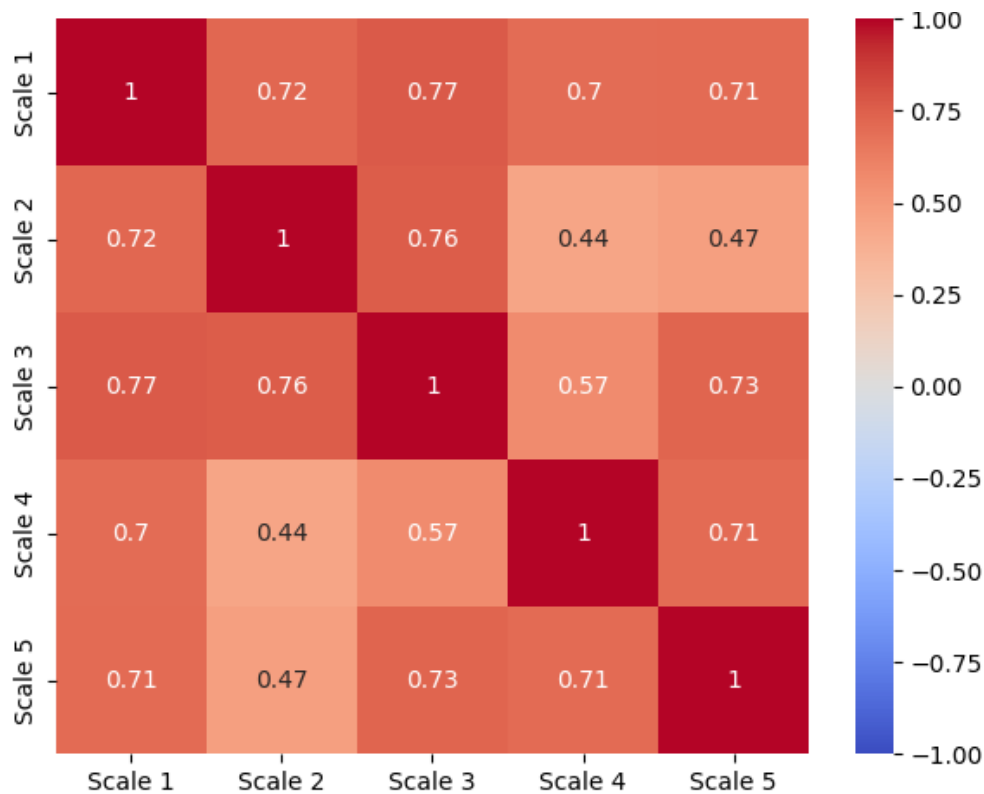


Figure 3. Matrix of pairwise Spearman rank correlation coefficients among SAPPE subscales in the student sample. Note: ρ – Spearman’s coefficient; all correlations statistically significant at $p < 0.001$.

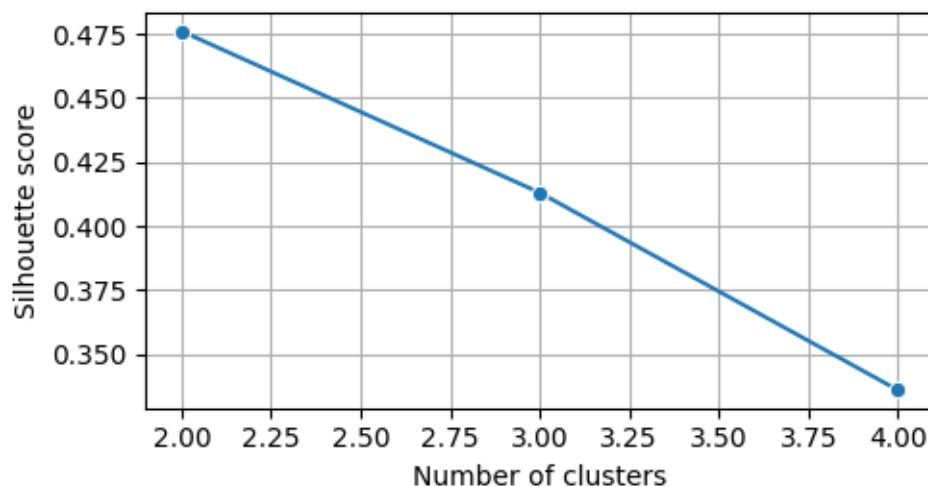


Figure 4. Evaluation of clustering quality using the silhouette metric

education.

- *Cluster 1* ($n = 54$): Students with high scores across all SAPPE components. These participants demonstrated a positive and stable attitude toward physical education, strong self-efficacy, well-developed knowledge and skills, and a favorable perception of the classroom climate. This profile indicates high intrinsic motivation and active engagement in the educational process.
- *Cluster 0* ($n = 30$): Students with moderate scores.

- Their attitudes toward physical education can be described as neutral or moderately positive. Levels of self-efficacy and habituated behaviors were less developed compared to Cluster 1. This profile suggests potential for pedagogical support and motivation enhancement.
- *Cluster 2* ($n = 5$): The smallest group, characterized by low scores across all scales. This may indicate weak motivation, limited engagement, or negative experiences with the physical education system. Such students may

require special attention from instructors and potentially individualized support strategies.

The identified profiles should be considered in the development of differentiated teaching approaches, adaptation of programs, and the creation of a supportive learning environment, particularly under wartime conditions and associated constraints.

To assess potential differences between clusters by student gender, Pearson’s χ^2 test was applied. The distribution of students by gender across the identified clusters is presented in Table 4.

Table 4. Distribution of students by gender across identified clusters

Cluster	Men (1)	Women (2)
0	16	14
1	32	22
2	1	4

Note: expected values according to Pearson’s χ^2 test: Cluster 0: 16.5 men and 13.5 women; Cluster 1: 29.7 men and 24.3 women; Cluster 2: 2.8 men and 2.2 women

The results of Pearson’s χ^2 test indicated no statistically significant differences between clusters by student gender: $\chi^2 = 2.905$, $p = 0.2340$, $df = 2$. This finding suggests that the distribution of students across clusters was not dependent on gender.

To further analyze the characteristics of SAPPE

components, students were categorized into levels of expression for each of the six subscales. The analysis was conducted for the entire sample as well as separately by gender. A three-level classification was applied: low, medium, and high, based on the total scores for each subscale (Table 5).

As shown in Table 5, high-level scores predominated across all subscales, particularly for Subscales 5 (*Classroom climate*) and 4 (*Skills and knowledge*). Male students demonstrated slightly higher levels across most subscales; however, the differences between genders were not pronounced. The lowest number of low scores was recorded for Subscale 4, suggesting good mastery of the educational material in the field of physical education.

To assess general trends in students’ perceptions of physical education and related infrastructure, descriptive statistics ($M \pm SD$) were calculated for the SAPPE subscales (Table 6). To evaluate the statistical significance of differences between groups, the Mann-Whitney U test was applied, with medians and effect sizes additionally reported.

The data presented in Table 6 indicate that male students consistently scored slightly higher across all subscales compared to female students. The largest difference was observed for Subscale 3 (21.6 in men vs. 19.9 in women), suggesting a more positive experience of participation in physical

Table 5. Distribution of students by levels of SAPPE subscales (total and by gender)

Scale no.	Subscale name	Low (all)	Medium (all)	High (all)	Low (men)	Medium (men)	High (men)	Low (women)	Medium (women)	High (women)
1	Habituated behavior in PA	3	24	62	2	11	36	1	13	26
2	Self-efficacy in PE	14	35	40	8	18	23	6	17	17
3	Attitude and experience in PE	5	24	60	3	11	35	2	13	25
4	Skills and knowledge	1	17	71	0	7	42	1	10	29
5	Classroom climate	2	9	78	1	4	44	1	5	34

Note: (All) = men + women; levels determined by total scores: low = lower quartile, medium = interquartile range, high = upper quartile.

Table 6. Mean values and standard deviations for SAPPE subscales among students (n = 89)

Scale no.	All (M ± SD)	Men (M ± SD)	Women (M ± SD)
1	16.4 ± 4.1	17.0 ± 3.9	15.7 ± 4.2
2	13.9 ± 5.0	14.2 ± 4.9	13.6 ± 5.1
3	20.8 ± 5.9	21.6 ± 5.8	19.9 ± 5.9
4	16.7 ± 3.6	17.1 ± 3.2	16.1 ± 4.1
5	17.8 ± 3.8	18.2 ± 3.5	17.2 ± 4.1

Note: All = men + women.

education classes among men. Similar trends were also evident in the other subscales, with men reporting stronger habituated behaviors, higher self-efficacy, and a more favorable perception of the classroom climate.

To assess gender-based differences across the five SAPPE subscales, the Mann-Whitney U test was applied, as the distributions did not meet the assumptions of normality. The results are presented in Table 7.

Analysis of Table 7 showed that men had slightly higher median values across all subscales compared to women; however, none of the differences reached statistical significance ($p > 0.05$ in all cases). The largest discrepancy was observed for Subscale 3, where the effect size was $r = 0.178$, suggesting a weak tendency toward a more positive experience of physical education among men. In contrast, for Subscale 2, the medians were identical, and the effect size was minimal. These findings indicate a range of shared characteristics in perceptions of physical education between men and women, with only minor differences observed in certain aspects.

For a more detailed interpretation of the results, students were further categorized by levels of expression (low, medium, high) for each of the six subscales. The highest proportion of students scoring at the high level was observed for Subscale

5 (78 students), while the lowest proportion was recorded for Subscale 2 (40 students). These differences suggest varying degrees of perception of the learning environment and motivation among the participants.

For a more detailed analysis, the distribution of levels of SAPPE component development was compared between students from Eastern and Western Ukraine (Table 8).

The data presented in Table 8 show that in both Eastern and Western Ukraine the majority of students achieved high levels across the key components, particularly on Subscales 5 and 4. At the same time, certain differences were observed: for example, students from Eastern Ukraine demonstrated a higher proportion of respondents scoring at the high level on Subscale 5, whereas in Western Ukraine more students reached high levels on Subscales 4 and 2. These differences may be explained both by objective characteristics of the educational environment and by students' subjective orientations, which vary depending on the region of residence and study.

For a more in-depth analysis, mean values and standard deviations for each of the six SAPPE subscales were calculated separately for students from Eastern and Western Ukraine, taking gender into account (Table 9). These data make it possible

Table 7. Gender differences across SAPPE subscales (Mann–Whitney U test)

Scale no.	Median (men)	Median (women)	p-value	Effect size (r)
1	18.0	16.0	0.1336	0.158
2	14.0	14.0	0.5708	0.060
3	23.0	22.0	0.0923	0.178
4	18.0	16.5	0.3273	0.103
5	20.0	19.0	0.2642	0.116

Table 8. Distribution of students from Eastern and Western Ukraine by levels of SAPPE component development

Scale no.	Low (all)	Medium (all)	High (all)	Low (men)	Medium (men)	High (men)	Low (women)	Medium (women)	High (women)
Eastern Ukraine									
1	0	15	38	0	7	21	0	8	17
2	6	24	23	2	13	13	4	11	10
3	2	14	37	1	6	21	1	8	16
4	0	11	42	0	5	23	0	6	19
5	0	7	46	0	3	25	0	4	21
Western Ukraine									
1	3	9	24	2	4	15	1	5	9
2	8	11	17	6	5	10	2	6	7
3	3	10	23	2	5	14	1	5	9
4	1	6	29	0	2	19	1	4	10
5	2	2	32	1	1	19	1	1	13

Note: The table presents the absolute number of students at low, medium, and high levels across the five SAPPE subscales, including breakdown by gender.

to identify specific differences in the perception and experience of physical education among groups exposed to varying social and educational conditions.

Analysis of the mean values presented in Table 9 shows that overall, the indicators of both groups are at a comparable level; however, certain trends can be observed:

- Students from Eastern Ukraine reported slightly higher mean values on Subscales 3 and 5, which may reflect a more favorable perception of the learning environment despite challenging external circumstances.
- Students from Western Ukraine showed marginally higher mean values on Subscale 4, particularly among men.
- Gender-based differences persisted in both groups, with men generally scoring somewhat higher across most subscales.

These findings emphasize the importance of considering both regional and gender contexts when developing educational strategies in the field of physical education.

To assess differences in the perception of physical education components between students from Eastern ($n = 53$) and Western ($n = 36$) Ukraine,

the Mann-Whitney U test was applied, as the distributions of SAPPE subscales did not meet the assumptions of normality. Table 10 presents the median values for each subscale, along with p-values and effect sizes (r).

Analysis of Table 10 revealed no statistically significant differences between the groups on any of the subscales ($p > 0.05$ in all cases). However, several tendencies can be noted:

- Students from Eastern Ukraine demonstrated slightly higher median values on Subscales 3 and 5, which may indicate a more positive perception of the educational environment despite the challenging conditions of the region.
- In the Western student group, the median value for Subscale 2 was marginally higher, although the difference was not statistically significant.
- Effect sizes across all comparisons were low ($r < 0.2$), indicating weak differences between the regions.

Thus, the regional differences in the perception of physical education among Ukrainian university students recorded in this study were not pronounced. Nevertheless, certain aspects warrant further investigation in light of the wartime context.

Table 9. Mean values of SAPPE subscales among students from Eastern Ukraine ($n = 53$) and Western Ukraine ($n = 36$)

Scale no.	All (M ± SD)	Men (M ± SD)	Women (M ± SD)
Eastern Ukraine (n = 53)			
1	16.7 ± 3.4	17.2 ± 3.2	16.2 ± 3.5
2	14.0 ± 4.9	14.3 ± 4.4	13.6 ± 5.4
3	21.2 ± 5.5	22.1 ± 5.0	20.0 ± 5.8
4	16.9 ± 3.4	16.9 ± 3.1	16.8 ± 3.8
5	17.9 ± 3.5	18.5 ± 3.2	17.2 ± 3.7
Western Ukraine (n = 36)			
1	16.0 ± 5.0	16.8 ± 4.7	15.0 ± 5.3
2	13.8 ± 5.3	14.0 ± 5.7	13.7 ± 4.9
3	20.4 ± 6.5	21.0 ± 6.7	19.6 ± 6.3
4	16.4 ± 3.9	17.4 ± 3.2	15.0 ± 4.3
5	17.5 ± 4.3	17.8 ± 4.0	17.1 ± 4.9

Table 10. Comparison of SAPPE subscale medians among students from Eastern and Western Ukraine (Mann–Whitney U test)

Scale no.	Median (East)	Median (West)	p-value	Effect size (r)
1	17.0	17.5	0.8201	0.024
2	14.0	14.0	1.0000	0.000
3	22.0	23.0	0.8669	0.018
4	18.0	18.0	0.6331	0.051
5	19.0	19.0	0.7617	0.032

Note: The table presents medians, p-values, and effect sizes (r) for each of the five SAPPE subscales. The analysis was conducted using the Mann-Whitney U test due to the non-normal distribution of the data.

Discussion

The aim of this study was to analyze the structure and level of development of components of the physical education learning environment among Ukrainian university students under wartime conditions using the adapted SAPPE questionnaire. The findings revealed a high level of formation of such components as *Classroom Climate* and *Skills and Knowledge*, as well as statistically significant interscale correlations. It was also established that students from Western Ukraine, who study predominantly in offline settings, demonstrate higher scores on most subscales compared to their peers from Eastern Ukraine, who are exposed to the challenges of distance learning and elevated stress levels.

Perceptions of the Educational Environment: Cross-National Tools and Regional Implications

The development and implementation of questionnaires for assessing components of physical education remain an important focus in international research. For instance, in China, the SAPPE scale was validated to measure students' perceptions of the learning environment across six subscales, including behavioral attitudes, self-efficacy, classroom climate, and infrastructure [5]. In other regions, instruments have been designed and adapted to evaluate the quality of physical education, sustainable development, and attitudes toward the use of digital technologies in PE. For example, a scale with eight dimensions for assessing the quality of physical education was developed and validated in Asia [5], while in Spain a tool for evaluating sustainable physical education was introduced [35]. In Germany, a questionnaire on the perception of video-based instruments in PE was validated [36], and in China additional instruments were created to analyze the implementation of school PE programs [37] and to assess the quality of physical education [38]. In Serbia, social, lifestyle, and health-related factors among students were identified [39]. These developments highlight the relevance and diversity of approaches to investigating the educational environment in PE. The results of the present study align with these directions and support the use of the comprehensive SAPPE scale for evaluating factors that influence student engagement.

The combined results confirm that the perception of a positive educational environment, including classroom climate, self-efficacy, and motivation, plays a decisive role in shaping students' sustainable attitudes toward physical activity, as supported by both the present findings and international literature [1, 2, 4]. High scores on the "Classroom Climate" scale, particularly among students from Western Ukraine, may reflect the presence of a favorable learning atmosphere characterized by support from teachers and students. Such conditions foster not

only academic engagement but also strengthen self-efficacy. At the same time, the observed regional differences may be attributed to the specific organization of the educational process: universities in Eastern Ukraine predominantly rely on distance learning due to the ongoing war, whereas in Western Ukraine classes are more frequently held offline. This factor, together with broader social instability, is likely to influence students' perceptions of the learning environment and their level of motivation [9, 10]. These regional differences should be taken into account when interpreting the educational environment and students' engagement in physical activity.

Interpretation of Cluster Profiles

The two-cluster solution derived from the analysis provides insight into distinct patterns of student engagement with physical education during wartime. Students in the first cluster reported high scores in Classroom Climate, Self-Efficacy, and Attitudes toward Physical Education. This profile suggests a group of learners with strong intrinsic motivation and a perception of physical education as a socially supportive and meaningful activity. In contrast, the second cluster was marked by lower levels of self-efficacy and less favorable perceptions of the classroom environment, although slightly higher scores were observed in items related to formal structures and infrastructure. This may reflect a group whose participation is driven more by external expectations or institutional norms than by internalized value. These differentiated patterns align with findings from studies in Saudi Arabia and Qatar, which have reported similar splits in motivational profiles related to gender and perceived competence [22, 23]. For Ukrainian universities, these profiles highlight the need for flexible instructional strategies: one-size-fits-all approaches are unlikely to address the needs of both highly engaged and less motivated students, particularly under conflict-driven educational constraints. These distinct profiles underscore the heterogeneity of student experiences and the need for differentiated pedagogical responses.

International and National Evidence on Physical Education and Student Well-Being

International evidence. Cross-national and local studies consistently emphasize the importance of evaluating the educational and physical education environment in relation to student well-being, particularly under conditions of conflict and social instability. In post-conflict Uganda, participation in sports programs was associated with improvements in both physical fitness and psychological well-being among adolescents [6, 25]. A systematic review conducted by Hamilton et al. confirmed the effectiveness of physical activity interventions in restoring mental health in crisis-affected regions [16].

In South Africa, during the FeesMustFall movement characterized by episodes of unrest and institutional disruption, the educational environment emerged as a key factor influencing students' subjective well-being. This was demonstrated through qualitative methods including photo-elicitation and self-report questionnaires [7, 40]. Other studies in conflict-affected contexts have also highlighted the supportive role of physical education in promoting mental health and encouraging a constructive attitude toward learning [3, 8].

Ukrainian context and alignment with present findings.

Comparable patterns have been observed in recent Ukrainian studies. Skrypchenko et al. [17] found that students were able to maintain moderate levels of physical activity during wartime, particularly when supported by flexible learning formats and a positive educational atmosphere. Byshevets et al. [18] demonstrated a statistically significant association between physical activity and reduced symptoms of stress and anxiety, which confirms the value of physical education as a means of psychological support. Rohal et al. [19] identified a decline in motivation to engage in physical activity under martial law, most notably among female students. This trend is reflected in the present study's gender analysis. Kurapov et al. [20] reported a general deterioration in the psycho-emotional state of both students and faculty, which further illustrates the need for adaptive pedagogical approaches during wartime.

Findings from the present study contribute to this body of evidence. Consistent with earlier findings, students in Western Ukraine maintained more positive perceptions of classroom climate and infrastructure. These results affirm the applicability of standardized instruments such as the SAPPE questionnaire in conflict settings. These results reaffirm previously identified links between educational climate and student motivation, even under wartime conditions. The observed regional differences reinforce the necessity of tailoring educational programs to the specific conditions of each region, with careful attention to the effects of armed conflict on both infrastructure and psychological well-being.

Gender-Specific Patterns in Student Perception

The observed gender-related differences in the perception of the educational environment among Ukrainian students are consistent with a range of international findings. A study conducted in Qatar demonstrated that boys and girls differed significantly in both physical activity levels and academic performance associated with physical education classes [22]. Lauderdale et al. reported that men exhibited stronger motivation for physical activity, largely driven by internal self-determination factors [24]. Similar results were found among

Chinese students, where gender and self-efficacy significantly influenced both motivation and actual engagement in physical activity [4]. Furthermore, evidence from Saudi Arabia indicated that under online learning conditions, female students reported higher satisfaction of psychological needs, whereas male students more often experienced a lack of motivation [23]. These findings align with the results of the present study, where female students more frequently showed positive evaluations on the "Classroom Climate" and "Self-efficacy" scales, while male students tended to demonstrate moderate or lower scores. This pattern may reflect gender-specific adaptation to the educational environment under wartime conditions. At the same time, other factors not captured in this study, such as students' socioeconomic status, access to sports infrastructure, or the professional training of instructors, could also have contributed to differences in perception.

Validation Implications and Synthesis of Findings

The findings support the contextual validity and adaptability of the SAPPE scale as an instrument for assessing students' perceptions of the physical education environment in conflict-affected settings. The scale demonstrated consistent performance in measuring key components such as classroom climate, self-efficacy, and attitudes toward physical activity, even under conditions of educational disruption and psychological stress. This confirms that standardized assessment tools, when appropriately adapted, can yield meaningful data in unstable environments. Furthermore, the results highlight the necessity of flexible and individualized pedagogical strategies to sustain students' engagement and well-being during wartime, reinforcing the value of evidence-based educational monitoring in times of crisis. The SAPPE scale may be integrated into institutional monitoring tools to track student adaptation, inform PE curriculum revisions, and guide targeted interventions across regions.

Pedagogical Implications in Contexts of Regional Disparities

The exclusion of Factor 6 (Facilities, Equipment, and Norms) from interregional comparisons highlights a critical pedagogical challenge. The physical conditions under which physical education is delivered differ significantly across Ukraine. In the eastern regions, proximity to the war zone has resulted in the destruction or inaccessibility of sports infrastructure. This situation limits the feasibility of traditional forms of physical activity. To address these disparities, institutions should consider implementing flexible and context-sensitive formats of physical education. These may include home-based training programs, physical activity sessions that require minimal equipment, and digital tools

for monitoring and encouraging participation. At the same time, educators are encouraged to focus on motivational and psychosocial components of physical education. Elements such as self-efficacy and perceived support remain relevant and impactful, even in infrastructure-poor settings. Such tailored strategies are essential to ensure educational equity and to maintain students' well-being in both stable and conflict-affected regions.

Limitations and Directions for Future Research

Despite the significant results obtained, this study has several limitations. First, the data were collected during an ongoing war, which may have influenced the emotional state of respondents and their perception of the survey questions. Second, the sample included only a limited number of universities, primarily from the eastern and western regions of Ukraine, which restricts the generalizability of the findings to the entire country. Third, although the SAPPE scale has demonstrated validity, it requires further testing across broader social and cultural contexts. These limitations notwithstanding, the findings provide a valuable snapshot of student perceptions during a critical phase of Ukraine's educational restructuring. Future research could focus on longitudinal analyses of changes in perceptions of physical education over time as well as cross-country comparisons with student samples from other crisis-affected settings.

Conclusions

This study confirmed the contextual validity and internal reliability of the SAPPE scale for assessing perceptions of the physical education environment among Ukrainian university students during wartime. The results demonstrated consistently

high scores on the "Classroom Climate" and "Self-efficacy" subscales. These findings indicate that students were able to maintain positive attitudes toward physical education despite elevated stress and limited access to traditional learning formats. Significant regional variation in responses was also observed. Higher scores reported by students in Western Ukraine suggest that social and organizational factors influence perceptions of the learning environment. These outcomes support the need to adapt educational strategies to local conditions and to apply validated tools for ongoing assessment of the educational context during prolonged emergencies.

Practical Implications

The SAPPE scale serves as a practical and reliable tool for monitoring students' perceptions of physical education within higher education institutions. It can assist educators, university staff, and policy makers in evaluating student motivation, self-efficacy, and perceived support under various instructional settings. The scale is particularly useful when teaching takes place remotely or when physical infrastructure is limited. Regular use of this instrument may help identify challenges, inform instructional improvements, and support the development of inclusive and resilient physical education programs. The integration of SAPPE-based assessments into institutional practices may contribute to safeguarding student well-being and sustaining engagement during periods of instability.

Conflict of interests

The authors declare that there is no conflict of interests.

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Cite this article as:

Vypasniak I, Boichuk R, Ivanyshyn I, Lutskiy V, Temchenko V, Jagiello M. Assessment of the physical education learning environment among Ukrainian university students during wartime: validation of the SAPPE questionnaire and gender-regional analysis. *Pedagogy of Health*, 2025;4(2):108–123. <https://doi.org/10.15561/health.2025.0203>

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Received: 25.07.2025

Accepted: 15.09.2025; Published: 30.12.2025

The effect of diabetes exercise, brisk walking, and dietary management on blood glucose levels in patients with type 2 diabetes mellitus

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Abstract

Background and Study Aim Effective lifestyle interventions are essential for identifying strategies to reduce blood glucose levels in patients with type 2 diabetes mellitus. Diabetes exercise, brisk walking, and dietary management are commonly applied approaches that support glycemic control and overall well-being. Although these interventions are widely practiced, their relative effectiveness in improving blood glucose regulation remains a matter of practical interest. From a pedagogical perspective, such interventions are also important in the context of health education by promoting safe exercise practices and culturally relevant approaches to sustaining healthy lifestyles. The aim of this study was to analyze and compare the effectiveness of these three interventions in lowering blood glucose levels and supporting health education.

Material and Methods This study employed a randomized pretest-posttest experimental design with three intervention groups: diabetes exercise (Group 1), brisk walking (Group 2), and dietary management (Group 3). A total of 30 patients (23 women and seven men), aged 41–80 years (mean = 58.4 ± 10.76), were recruited according to inclusion and exclusion criteria. Groups 1 and 2 underwent 12 sessions of supervised exercise (Wednesday, Friday, and Sunday, 06:00–07:00). Each session consisted of 30 minutes of core training and 30 minutes of warm-up and cool-down activities. Diabetes exercise (Group 1) was performed with slow-to-moderate music rhythms. Brisk walking (Group 2) was conducted at 4–6 km/h. Group 3 received dietary guidance through a structured food manual outlining portion sizes, food types, and nutritional content. Blood glucose levels were measured using an Autocheck GCU 3-in-1 device.

Results In Group 1, mean blood glucose levels decreased from 243 (pretest) to 193 (posttest), a reduction of 50. Group 2 decreased from 205 to 160, a reduction of 45. Group 3 decreased from 196 to 161, a reduction of 34. The Wilcoxon test indicated significant reductions within each group (Group 1: $p = 0.001 < 0.05$; Group 2: $p = 0.000 < 0.05$; Group 3: $p = 0.019 < 0.05$). However, the Kruskal-Wallis test showed no significant difference among the three groups ($p = 0.078$).

Conclusions Diabetes exercise, brisk walking, and dietary management significantly reduced blood glucose levels after 12 sessions. However, no significant differences were observed among the three interventions. These findings highlight the importance of lifestyle-based strategies focused on physical activity and dietary regulation to improve short-term glycemic control. Future studies should consider larger sample sizes, the inclusion of control groups, and the evaluation of long-term outcomes and adherence. In addition, the results underline the pedagogical value of integrating safe exercise and dietary practices into health education programs.

Keywords: healthy lifestyle, physical activity, dietary management, diabetes mellitus, health education, pedagogy

Introduction

Type 2 diabetes mellitus is a chronic metabolic disorder characterized by impaired insulin regulation and elevated blood glucose levels. It is closely associated with obesity, sedentary behavior, and unhealthy dietary patterns, making its management a complex and multifactorial challenge. Persistent hyperglycemia contributes to the development of

serious complications, including cardiovascular disease, neuropathy, nephropathy, and retinopathy, which significantly reduce patients' quality of life and increase healthcare burdens.

Blood glucose levels reflect the concentration of circulating glucose, which is the primary energy source for cells. In type 2 diabetes mellitus (T2DM), a combination of insulin resistance and pancreatic β -cell dysfunction impairs glucose uptake by peripheral tissues and increases hepatic glucose production [1, 2]. This condition leads to persistent

fasting and postprandial hyperglycemia, typically assessed through fasting blood glucose, 2-hour postprandial glucose, and glycated hemoglobin (HbA1c). Chronic hyperglycemia is closely associated with microvascular and macrovascular complications, making glycemic control a central objective in T2DM management [3, 4].

Various interventions have been shown to lower blood glucose levels in patients with T2DM. Lifestyle modifications, including light-to-moderate or moderate-to-vigorous aerobic exercise, resistance training, or a combination of both, improve insulin sensitivity and enhance muscle glucose utilization [5]. Nutritional interventions, such as structured dietary programs involving portion and calorie control, are also important, particularly when supported by continuous education to improve adherence [6]. Additional strategies, including self-monitoring of blood glucose, weight management, adequate sleep, and stress reduction, further contribute to better glycemic outcomes [7]. This study focuses on diabetes exercise, brisk walking, and education-based dietary interventions as practical, accessible, and non-pharmacological approaches.

Diabetes exercise refers to structured physical activity tailored for patients with diabetes, typically combining low-to-moderate intensity aerobic movements with simple strengthening exercises [8]. Physiologically, repeated muscle contractions enhance glucose transporter type 4 (GLUT4) translocation to muscle cell membranes through both insulin-dependent and insulin-independent pathways [9]. Regular participation improves insulin sensitivity and lowers both fasting and postprandial glucose levels. Group-based sessions additionally promote motivation, safety, and adherence. Previous studies have confirmed that diabetes exercise effectively reduces blood glucose in patients with T2DM [10].

Brisk walking, a moderate-intensity aerobic activity, is widely recognized as a safe, simple, and standardized form of exercise. It enhances glucose uptake by active muscles through increased blood flow and contraction-mediated pathways, which facilitate glucose entry into cells independently of insulin [11, 12]. Regular brisk walking also improves cardiorespiratory fitness and body composition, thereby contributing to better insulin sensitivity. The frequency, intensity, and duration of walking are key determinants of its effectiveness in lowering blood glucose and HbA1c levels [5]. Therefore, brisk walking can lower blood glucose levels in patients with type 2 diabetes mellitus.

Dietary management through structured food guides emphasizes practical education and the application of nutritional principles tailored to individual needs. Well-designed food guides promote the selection of low-glycemic index carbohydrate sources, portion control,

and appropriate distribution of carbohydrates throughout the day [13, 14]. These guides often incorporate culturally relevant portion sizes and utensils, aligning energy intake with metabolic requirements to minimize postprandial glucose surges and overall daily glycemic load. Furthermore, structured dietary tools can enhance self-efficacy, long-term adherence, and informed food choices, thereby supporting sustained glycemic control [15]. Taken together, these findings highlight the broader spectrum of lifestyle-based strategies, including structured exercise, brisk walking, and culturally adapted nutrition education, which underpin the pedagogical directions of health promotion and form the basis for subsequent research analysis.

In this context, recent studies have proposed various non-pharmacological strategies to improve glycemic control in patients with type 2 diabetes mellitus. Pharmacological reviews underline the importance of lifestyle interventions alongside medication [1, 2], while relaxation techniques and self-care behaviors have also been shown to contribute to lower blood glucose levels [3, 4]. Safe physical activity technologies are emphasized in international consensus statements, confirming the role of structured exercise in diabetes management [5, 6, 7]. Specific exercise formats, including diabetic gymnastics and motor-based programs, demonstrate measurable benefits [8, 10], consistent with the idea of art therapy through human motor actions. Likewise, brisk walking has repeatedly been recommended as a simple and safe form of aerobic exercise [11, 12]. Culturally adapted nutritional education, often delivered through counseling and illustrated dietary guides, reflects folk traditions of health promotion and supports sustained adherence [13, 14, 15]. Collectively, these findings provide the scientific and pedagogical basis for evaluating diabetes exercise, brisk walking, and dietary management as integrated health education strategies.

Analysis of research findings has shown that both structured exercise and dietary management play a significant role in improving glycemic control in patients with type 2 diabetes mellitus. Researchers emphasize that lifestyle-based strategies, including diabetes exercise, brisk walking, and nutrition education, provide practical, safe, and sustainable benefits that complement pharmacological treatment. At the same time, the complexity of patient adherence, variations in physiological response, and the integration of these approaches into daily routines remain important challenges. From a pedagogical perspective, these strategies are also important as elements of health education that promote safe physical activity and culturally adapted nutritional practices. In addition, they illustrate how non-pharmacological interventions can be incorporated into pedagogical models of health promotion, linking clinical outcomes with

educational value. This context creates the basis for evaluating and comparing specific lifestyle interventions in order to clarify their relative effectiveness in managing blood glucose levels.

The research problem arises from the urgent need for effective, safe, affordable, and sustainable lifestyle interventions for patients with T2DM, as well as the limited direct comparative evidence to guide the selection of the most effective strategies. To date, no study has directly compared the effects of diabetes exercise, brisk walking, and education-based dietary interventions on blood glucose reduction in patients with T2DM. Therefore, this study aimed to analyze and compare the effects of these three interventions in lowering blood glucose levels and their relevance for health education.

Materials and Methods

Participants

The study population consisted of patients with diabetes mellitus attending the Pakem District Community Health Center, Sleman Regency, Indonesia. The study sample included elderly patients with type 2 diabetes mellitus who met the following inclusion criteria:

- age >40 years,
- registered at the Pakem Community Health Center,
- willingness to participate by signing informed consent.

Exclusion criteria were:

- incomplete medical records,
- refusal or failure to provide written informed consent.

A total of 30 patients were recruited, comprising 23 women and 7 men, aged 41–80 years (mean = 58.4 ± 10.76 years). The demographic characteristics of the participants are presented in Table 1. The choice of elderly patients was justified by the fact that this group represents one of the most vulnerable populations, which requires focused

health education and lifestyle interventions.

Research Design

This study employed a randomized pretest–posttest experimental design with three intervention groups and no control group. Thirty patients with type 2 diabetes mellitus underwent baseline (pretest) assessments and were then randomly allocated to one of three groups:

1. diabetes exercise,
2. brisk walking,
3. dietary management using a structured food guide.

The design also included an educational element, as participants were introduced to safe exercise practices and nutritional guidance.

Randomization was performed using a simple lottery method with a 1:1:1 allocation ratio. Allocation concealment was maintained through sequentially numbered opaque envelopes. Each group underwent a four-week intervention consisting of 12 sessions (three sessions per week). Post-intervention assessments (posttest) were conducted on the same glycemic outcome variables. Blood glucose levels were measured using the Autocheck GCU 3-in-1 Monitoring System [16, 17, 18].

This study was also approved by the university ethics committee (B/1778/UN34.16/PT.01.04/2025).

Intervention Program

The intervention program was conducted over four weeks with three sessions per week (Wednesday, Friday, and Sunday, 06:00–07:00 a.m.). Each session consisted of a 15-minute warm-up, a 30-minute main activity, and a 15-minute cool-down.

In the diabetes exercise group (Group 1) and the brisk walking group (Group 2), participants first engaged in joint physical activity consisting of static–dynamic warm-ups for approximately 30 minutes during the first week. The aim was to allow the body to adapt before beginning the main intervention program.

Table 1. Demographic characteristics of respondents

Patient Data	Category	Frequency
Age	41 - 45	4
	46 - 50	3
	51 - 55	5
	56 - 60	7
	61 - 65	3
	66 - 70	2
	71 - 75	5
	76 - 80	1
Diagnosis	Type 2 Diabetes Mellitus	22
	Type 2 Diabetes Mellitus with multiple complications (non-insulin dependent)	8

The intervention programs in Groups 1 and 2 were conducted according to the recommendations of the American College of Sports Medicine (ACSM) and modified according to specific needs [19]. Group 1 performed structured exercise movements using music with a slow-to-moderate tempo, following a rhythm of 4 counts of 8, as recommended in previous studies [10, 20]. Group 2 performed brisk walking at a speed of 4–6 km/h, in line with published guidelines [11]. To monitor adherence and intensity in Groups 1 and 2, smartwatches were used to record heart rate, step count, and duration of activity. The structured use of rhythm and movement may also be viewed as a form of motor-based art therapy, supporting motivation and adherence through pedagogical methods.

For Group 3, the intervention used food booklets officially published by the Indonesian Ministry of Health as a reference for dietary management [15]. These booklets contained photographs of food in appropriate portions, names of food types, nutritional content, and explanations of the effects of macro- and micronutrient deficiencies on the body.

Statistical Analysis

Data analysis was performed in three stages. First, descriptive statistics were used to summarize pretest and posttest values. Second, within-group comparisons of pretest and posttest values were conducted using the Wilcoxon signed-rank test, with statistical significance set at $p < 0.05$, according to standard recommendations [21]. Third, between-group comparisons of posttest values were performed using the Kruskal–Wallis test, followed by post hoc analyses if required [21]. Data analysis was carried out using SPSS version 27, in line with established guidelines [21].

Results

Data were collected twice, at baseline (pretest) and after the intervention (posttest). Descriptive statistics of blood glucose levels in each intervention group are presented in Table 2.

As shown in Table 2, all three groups demonstrated a decrease in mean blood glucose levels after the intervention. The reduction was most pronounced in the diabetes exercise and brisk walking groups, while the dietary management group also showed a favorable decrease. Overall, the results indicate that lifestyle-based interventions were effective in lowering blood glucose levels across all groups.

A Wilcoxon signed-rank test was performed to evaluate within-group differences between pretest and posttest values. The results are presented in Table 3.

As shown in Table 3, all three intervention groups demonstrated statistically significant reductions in blood glucose levels ($p < 0.05$). The negative Z values indicate a consistent decline across groups.

The second analysis used the Kruskal–Wallis test to examine the differences between the three groups. This non-parametric test was applied to analyze differences among more than two groups. The results of the Kruskal–Wallis test are presented in Table 4.

As shown in Table 4, the Kruskal–Wallis test indicated no statistically significant difference among the three intervention groups ($p = 0.078$). Therefore, no post hoc analysis was performed.

The consistent reductions in blood glucose levels across all groups also confirm the value of safe and structured exercise as an effective pedagogical tool in health promotion. In particular, the rhythmic character of diabetes exercise may be viewed as

Table 2. Descriptive statistics of intervention groups (mg/dL)

Blood glucose status	Group 1	Group 2	Group 3
Pretest	243.80 ± 78.40	205.60 ± 94.28	196.40 ± 92.29
Posttest	193.80 ± 63.32	160.60 ± 70.91	161.50 ± 78.65
Difference	50.00	45.00	34.90

Table 3. Wilcoxon signed-rank test results

Test statistic	Group 1	Group 2	Group 3
Z	-3.108	-3.503	-2.271
Asymp. Sig. (2-tailed)	0.001	0.000	0.019

Table 4. Kruskal–Wallis test results

Test statistic	Blood glucose levels
Kruskal–Wallis H	0.169
df	2
Asymp. Sig.	0.078

having an art therapy component, which is in line with previous recommendations and findings on diabetes-specific exercise programs [10, 17, 20]. Similarly, the effectiveness of brisk walking corresponds with published recommendations emphasizing its role in glycemic control [11, 12]. For the dietary management group, the use of illustrated food booklets functioned not only as nutritional guidance but also as a simple educational tool, consistent with recommendations for culturally adapted dietary education [14, 15]. Taken together, these findings demonstrate that lifestyle-based interventions can serve not only as clinical strategies but also as practical elements for health-oriented teaching and learning.

Discussion

The aim of this study was to analyze and compare the effects of diabetes exercise, brisk walking, and education-based dietary management on blood glucose reduction in patients with type 2 diabetes mellitus (T2DM). The findings showed that all three intervention groups achieved significant reductions in blood glucose levels after 12 sessions. However, no significant differences were observed between groups in the posttest analysis. The consistent within-group improvements confirm that non-pharmacological lifestyle interventions, particularly physical activity and dietary management, can effectively improve glycemic control in patients with T2DM within a relatively short intervention period. These results also show that such approaches can be viewed not only as clinical measures but also as educational practices that help patients acquire knowledge and skills for healthier living.

These findings are consistent with previous studies that reported reductions in blood glucose levels following diabetes exercise and brisk walking interventions. Several one-group pre-post and quasi-experimental studies have demonstrated glucose-lowering effects after structured exercise programs [8, 21, 22, 23, 24]. Similarly, the effectiveness of dietary interventions in this study aligns with existing evidence that dietary adherence is strongly associated with improved blood glucose levels [6]. Collectively, these results reaffirm the two fundamental pillars of T2DM management: physical activity and diet.

The use of a food guide as an educational tool proved to be effective and represents a practical, low-cost strategy that can be implemented in diverse healthcare settings. Illustrated food guides, which provide examples of portion sizes, low-glycemic carbohydrate options, and visual cues, help patients better understand and apply dietary changes in daily life, thereby potentially improving adherence [7]. From a pedagogical point of view, the use of illustrated food guides demonstrates how simple educational tools can translate scientific

recommendations into practical daily habits, thereby enhancing patient self-efficacy. Improved dietary habits, such as portion control and healthier food selection, reduce overall glycemic load and postprandial glucose response [12], contributing to lower blood glucose levels.

The absence of significant differences between groups may be explained by several factors. These include the relatively small sample size, which limits statistical power; the possibility that all three interventions were similarly effective, resulting in minor between-group differences; and inter-individual variability in response and adherence [9, 25]. Furthermore, analyses based solely on posttest data without baseline adjustment may have reduced sensitivity in detecting group differences when pretest scores were not fully equivalent. These methodological limitations also underline the importance of developing educational strategies that strengthen adherence, motivate participation, and reduce variability in patient response.

Physical activity interventions, specifically diabetes exercise and brisk walking, appeared particularly effective. Previous studies have shown that 15 minutes of walking after each meal (a total of 45 minutes per day) can lower HbA1c by 0.4–0.94% [26, 27]. The physiological mechanisms underlying this effect include increased glucose transporter type 4 (GLUT4) translocation in skeletal muscle during contraction, which enhances glucose uptake independent of insulin. Additionally, muscle contractions increase blood flow and capillary recruitment, thereby improving insulin receptor activity and facilitating glucose clearance [5, 28]. In addition to clinical outcomes, the study highlights the pedagogical dimension of lifestyle interventions, showing that structured exercise and dietary education can serve as practical models for health promotion and patient training.

Taken together, the findings of this study emphasize the consistent benefits of lifestyle-based, non-pharmacological approaches in managing blood glucose levels among patients with type 2 diabetes mellitus. The comparable effects of diabetes exercise, brisk walking, and structured dietary guidance highlight their practical value as complementary strategies in routine diabetes care. These results contribute to the broader discussion on how accessible, low-cost interventions can be effectively applied in real-world healthcare settings to support glycemic control.

Limitations

The study's limitations include its relatively small sample size, the absence of a non-intervention control group, and reliance on posttest-only comparisons. Another limitation is the absence of a structured educational follow-up, which could have provided insights into how patients retain and apply

knowledge gained through exercise and dietary guidance. Future research should involve larger sample sizes, the inclusion of a non-intervention control group, and long-term outcome measures such as HbA1c. It would also be valuable to assess adherence levels more rigorously to strengthen the validity of findings. Future research should also evaluate the pedagogical effectiveness of lifestyle interventions, for example, how illustrated dietary guides or group-based exercise sessions contribute to long-term learning and health behavior change. From a practical perspective, the results of this study support the integration of diabetes exercise and brisk walking programs into routine diabetes care and demonstrate the potential of food guide-based dietary education as a feasible option in resource-limited settings. From a practical perspective, replication of this study with a more rigorous design is recommended to provide stronger clinical evidence for intervention guidelines.

Conclusions

This study demonstrated that diabetes exercise, brisk walking, and dietary management using a food guide significantly reduced blood glucose levels after 12 sessions, although no significant differences were found between the three interventions. Consistent within-group results confirm that lifestyle-based, non-pharmacological interventions focusing on physical activity and dietary modification can

effectively improve glycemic control in a relatively short period. The physiological effectiveness of diabetes exercise and brisk walking is linked to enhanced GLUT4 translocation to muscle cell membranes and increased capillary perfusion, mechanisms that improve glucose uptake by muscles and enhance insulin sensitivity. Similarly, the use of a food guide that provides portion recommendations and low-glycemic food choices proved effective in improving dietary understanding and adherence. Beyond clinical outcomes, the study also emphasizes the pedagogical value of integrating structured exercise and dietary education into health promotion, showing their potential as practical tools for teaching patients safe and sustainable lifestyle practices.

Acknowledgment

The researcher expresses sincere gratitude to Yogyakarta State University for the material and financial support that contributed significantly to the successful completion of this research. This study was conducted as part of the requirements for the first author's master's program in Sports and Health Sciences at Yogyakarta State University.

Conflict of Interest

The author declares no conflict of interest regarding this research or its findings.

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Cite this article as:

Suci ME, Budayati ES, Salsabila NA, Prabowo TA. The effect of diabetes exercise, brisk walking, and dietary management on blood glucose levels in patients with type 2 diabetes mellitus. *Pedagogy of Health*, 2025;4(2):124–131.

<https://doi.org/10.15561/health.2025.0204>

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Received: 20.08.2025

Accepted: 28.09.2025; Published: 30.12.2025

The effectiveness of the TGFU approach in increasing student engagement in physical education lessons

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Abstract

Background and Study Aim Physical education contributes to students' physical, social, and emotional development. Traditional teaching approaches, however, often emphasize repetitive drills that fail to sustain students' interest and participation. Although innovative models such as the Teaching Games for Understanding (TGFU) approach are increasingly applied in schools, their relative effectiveness in enhancing motivation and engagement remains of practical interest. The present study aimed to evaluate the effectiveness of the TGFU approach in increasing student participation, motivation, and engagement in physical education.

Material and Methods The study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. The process consisted of four stages: database search, screening, eligibility assessment, and inclusion. Relevant publications were identified through searches in Taylor & Francis, Scopus, and the Multidisciplinary Digital Publishing Institute using predefined keywords related to the Teaching Games for Understanding (TGFU) approach. The initial search yielded 187 papers. After screening 162 titles and abstracts, 98 papers were excluded for not meeting the inclusion criteria. Fifty-seven full texts were reviewed, and 15 studies were finally included in the analysis. Data from these studies were summarized to identify trends and evaluate the effectiveness of TGFU-based learning strategies.

Results The analysis showed that both the TGFU approach and hybrid models such as TGFU/SE and TGFU/TPSR contributed to improvements in students' physical fitness, sport-specific skills, and participation levels. The reviewed studies also indicated positive effects on motivation, decision-making, and enjoyment in physical education settings.

Conclusions The findings suggest that the TGFU approach supports students' physical, cognitive, and affective development. Nevertheless, its successful implementation depends on careful planning, adequate teacher preparation, and ongoing support. Broader and longer-term studies are recommended to confirm the consistency and generalizability of these results.

Keywords: teaching games for understanding, physical education, student participation, motivation

Introduction

Physical education contributes to the development of students' physical competence, social interaction, and lifelong attitudes toward physical activity. In school settings, the effectiveness of learning largely depends on students' engagement and the quality of instructional methods used by teachers. However, maintaining high levels of participation in physical education lessons is often challenging, as students' motivation can fluctuate due to repetitive activities, limited contextual understanding, and varying individual interests. These factors make the development of dynamic and inclusive teaching approaches a necessary part of improving learning outcomes and overall student experience.

In this regard, understanding the role of student participation in the broader educational process provides a foundation for examining teaching effectiveness. In education, particularly

in elementary schools, student participation in learning is an important part of educational success [1]. When students are engaged, they improve their understanding and retention of the material and show greater motivation to continue learning and developing [2]. Teachers recognize the challenge of creating an engaging and effective learning environment, especially in physical education. However, their focus on self-development sometimes becomes a barrier, leading them to apply teaching strategies limited to what they learned during training.

In this context, physical education contributes to students' physical, social, and emotional development [3]. Traditional teaching methods, however, often fail to address the diverse needs of students and demand active participation without providing sufficient understanding of the learning purpose. Students are frequently asked to repeat exercises without recognizing their meaning or relevance, which can reduce their interest and make the process monotonous. Excessive repetition and

an emphasis on discipline may cause fatigue and discourage students who do not perceive direct benefits from such activities [4]. As a result, some students may become passive or lose motivation toward physical education, indicating the need for a more contextual and engaging approach.

The Teaching Games for Understanding (TGFU) model offers a possible way to address this issue. It focuses on helping students understand games through tactical and strategic principles rather than through isolated technical drills [5]. This approach encourages students to think, collaborate, and make decisions in real game situations, thereby supporting the development of both cognitive and social skills [6].

The TGFU approach aligns with the natural curiosity and activity of elementary school students [7]. By offering a structured yet interactive learning environment, it encourages learners to participate more actively in lessons and sustain their interest. Strategically designed games support motivation and engagement, making physical education a more coherent and purposeful experience for students [8]. In this context, the literature review provides an overview of key aspects of the TGFU model [9], including implementation strategies, effects on student motivation, and comparisons with traditional instructional methods. Moreover, the analysis of available studies helps identify common challenges in applying TGFU and outlines practical solutions that teachers may consider [10].

Analysis of research findings has shown that innovative pedagogical models, particularly those emphasizing understanding and decision-making, can enhance students' motivation and learning effectiveness in physical education. Researchers emphasize that game-based instructional methods contribute to a more meaningful learning experience by connecting physical activity with cognitive and social development. Despite these positive outcomes, practical implementation in school settings still involves various contextual and methodological challenges that require careful consideration. Therefore, examining how the Teaching Games for Understanding (TGFU) approach influences student participation and engagement provides a logical basis for further exploration within this study.

Based on this rationale, the present study aimed to evaluate the effectiveness of the TGFU approach in increasing student participation, motivation, and engagement in physical education.

Materials and Methods

Sources of Information

The initial database search yielded 187 papers from three databases: Taylor & Francis, Scopus, and the Multidisciplinary Digital Publishing Institute (MDPI). After screening 162 titles and abstracts, 98

papers were excluded for not meeting the inclusion criteria. Fifty-seven studies underwent full-text evaluation, and 15 publications were ultimately included in the final analysis. The overall process of selection and inclusion is illustrated in *Figure 1. PRISMA Research Method Flowchart*.

The study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to ensure transparency and systematic organization of the literature review process. These three electronic databases were chosen as the primary sources of information. Relevant publications were identified using predetermined keywords related to learning strategies and the Teaching Games for Understanding (TGFU) approach. The search was conducted in May 2024 and covered the period from 2017 to 2024.

Study Design

The PRISMA procedure consisted of four main stages:

1. Identification – Searching databases using selected keywords and topics related to the TGFU approach.
2. Screening – Reviewing titles and abstracts to exclude irrelevant studies.
3. Eligibility – Evaluating full-text articles based on inclusion and exclusion criteria.
4. Inclusion – Selecting studies that met all criteria for final analysis.

The inclusion criteria comprised: (a) research focused on the Teaching Games for Understanding (TGFU) method; (b) open-access articles; and (c) publications written in English. Studies were excluded if they focused on fields outside of sports or were reviews, book chapters, or conference materials. Bibliographic references of selected publications were manually checked to identify additional relevant studies that might have been missed during database searches.

Statistical Analysis

Data extracted from the eligible studies were organized and analyzed descriptively. Quantitative indicators such as the number of studies, publication years, and thematic trends were compiled in an electronic spreadsheet. The analysis focused on identifying patterns in how the TGFU method affects student participation, motivation, and learning outcomes.

Results

The analysis of the selected studies revealed a variety of approaches used to implement the Teaching Games for Understanding (TGFU) method in physical education. The reviewed works demonstrated its adaptability across different educational contexts and sports disciplines. The main characteristics and outcomes of the included studies are summarized in *Table 1. Differentiated Learning in Physical Education*.

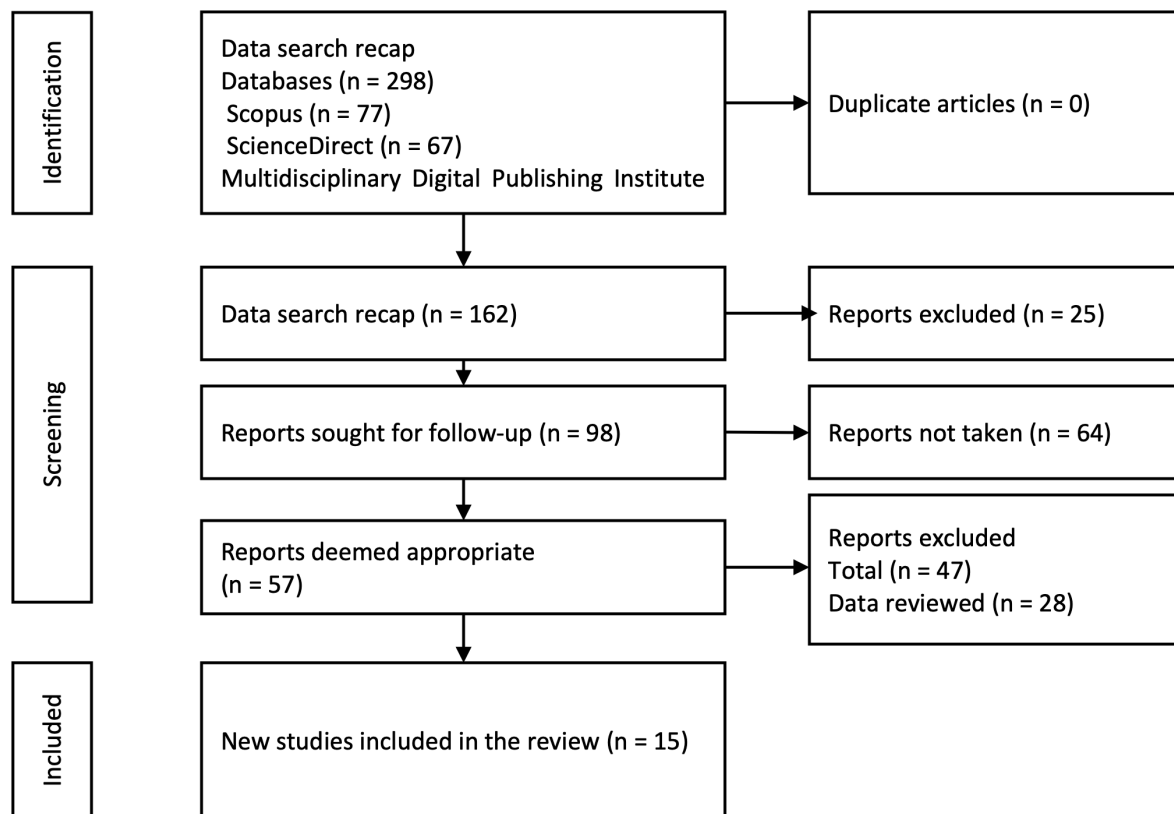


Figure 1. PRISMA Research Method Flowchart

Table 1. Differentiated Learning in Physical Education

No	Author	Title	Research result
1	Stojanović et al., 2023 [22]	School-Based TGFU Volleyball Intervention Improves Physical Fitness and Body Composition in Primary School Students: A Cluster-Randomized Trial	Incorporating a TGFU volleyball intervention into the physical education curriculum improved elementary school students' physical fitness and body composition. The intervention demonstrated potential to reduce obesity and enhance fitness through a contextual and engaging game-based learning approach. Identifying and addressing potential barriers is important to ensure the program's effectiveness.
2	Gil-Arias et al., 2017 [11]	Impact of a Hybrid TGFU–Sport Education Unit on Student Motivation in Physical Education	The study showed that a hybrid TGFU/SE model in physical education classes increased students' self-motivation, perceived competence, and enjoyment. This pedagogical approach combining elements of TGFU and Sport Education supports the development of cognitive, emotional, and psychomotor skills. Addressing implementation barriers is essential for sustaining student motivation and participation.
3	López-Lemus et al., 2023 [15]	Could the Hybridization of the SE/TGFU Pedagogical Models Be an Alternative for Learning Sports and Promoting Health? A School Context Study	Implementing a hybrid SE/TGFU model in physical education classes enhanced student motivation, perceived competence, enjoyment, and participation. The model provides a more comprehensive and meaningful learning experience. Overcoming implementation barriers remains important for improving learning outcomes in physical education.
4	Ortiz et al., 2023 [17]	Teaching Games for Understanding in Game Performance and Psychosocial Variables: Systematic Review and Meta-Analysis of Randomized Controlled Trials	The study found that the TGFU approach positively influenced students' decision-making and tactical performance in game contexts. It also improved the motivational environment and task orientation, though its effects on perceived ability, enjoyment, and intention to engage in physical activity remain inconclusive. Further well-controlled research is recommended to clarify the effectiveness of the TGFU approach in physical education.

Table 1. Continued

No	Author	Title	Research result
5	Batez et al., 2021 [4]	Effects of a Teaching Program Based on the Teaching Games for Understanding Model on Volleyball Skills and Enjoyment in Secondary School Students	The study indicated that the TGFU model effectively improved volleyball-specific skills (overhead and underhand passes, serve accuracy) and increased students' enjoyment of physical education. While some limitations in skill development were noted, the model appears to provide a balanced and engaging instructional framework for physical education.
6	García-Castejón et al., 2021 [7]	Implementation of a Hybrid Educational Program between the Model of Personal and Social Responsibility (TPSR) and the Teaching Games for Understanding (TGFU) in Physical Education and Its Effects on Health: A Mixed-Methods Approach	The study demonstrated that combining the TPSR and TGFU models offered an effective alternative for promoting students' motivation, responsibility, and enjoyment in physical education. Teachers reported favorable experiences with the program and emphasized the importance of adequate training to support successful implementation.
7	García-González et al., 2020 [8]	Can a Hybrid Sport Education/Teaching Games for Understanding Volleyball Unit Be More Effective for Less Motivated Students? An Examination of Motivation-Related Variables	The study found that a hybrid SE/TGFU model in volleyball instruction improved self-determination theory (SDT)-related variables, particularly for students with moderate or low initial motivation. The approach also increased satisfaction with instructional novelty and variety, as well as motivation to engage in physical activity. Effective implementation of this hybrid model requires careful planning to ensure benefits for all students.
8	Sierra-Ríos et al., 2020 [21]	Effects of Six Weeks of Direct Instruction and Teaching Games for Understanding Programs on Physical Activity and Tactical Behavior in U-12 Soccer Players	The TGFU program was more effective than direct instruction in improving decision-making and ball-play execution among U-12 soccer players. It also increased participation in light physical activity and had a positive influence on motivation and satisfaction during training. However, no significant differences were observed for moderate and vigorous activity levels. The findings suggest that TGFU may provide a more suitable approach to enhancing student engagement and performance in sports.
9	Arias-Estero et al., 2020 [1]	Effects of Two TGFU Lesson Periods on Game Performance, Knowledge, and Psychosocial Variables in Elementary Physical Education	The implementation of TGFU among fourth-grade students over two instructional periods improved game performance, knowledge, enjoyment, perceived competence, and intention to be physically active. Although no significant differences were found between the two period durations, both showed improvement compared to baseline. This suggests that exercise volume alone is not decisive, and that pedagogical design plays an important role in the effectiveness of TGFU interventions.
10	Robles et al., 2020 [20]	Effects of Teaching Games on Decision Making and Skill Execution: A Systematic Review and Meta-Analysis	The review examined the effectiveness of technical and tactical instructional approaches in games and physical education. Findings indicated that tactical approaches improved decision-making but did not lead to significant gains in skill execution compared with technical approaches. Considerable heterogeneity and limited evidence quality were noted across studies. Tactical approaches are recommended to enhance understanding, strategic thinking, and decision-making in educational and sports settings.

The data presented in Table 1 indicate that the TGFU and hybrid models (TGFU/SE and TGFU/TPSR) contribute to improved student motivation, engagement, and learning outcomes in physical education. Across studies, consistent positive effects

were observed on physical fitness, sport-specific skills, and participation levels. Additionally, several studies emphasized cognitive and affective benefits, including enhanced decision-making, collaboration, and enjoyment. These findings suggest that the

integration of tactical and reflective elements in TGFU-based instruction can make learning more meaningful and contextually relevant for students.

Discussion

The purpose of this study was to evaluate the effectiveness of the Teaching Games for Understanding (TGFU) approach in enhancing student participation, motivation, and engagement in physical education. The analysis of 15 selected studies demonstrated that the TGFU model, as well as its hybrid applications with Sport Education (SE) and the Teaching Personal and Social Responsibility (TPSR) frameworks, positively influences students' learning experiences. The reviewed evidence indicates consistent improvements in physical fitness, sport-specific skills, and active involvement during lessons. In addition, several studies reported cognitive and affective benefits, including better decision-making, higher intrinsic motivation, and increased enjoyment of physical activity. Overall, the findings confirm that the TGFU approach provides a structured yet flexible framework that supports both physical and psychological dimensions of student development in educational settings.

Building on the reviewed findings that highlight the effectiveness of game-based instructional strategies, the following section elaborates on the pedagogical foundations of the Teaching Games for Understanding (TGFU) approach. The Teaching Games for Understanding (TGFU) approach is a pedagogical method that promotes conceptual understanding and supports the development of "game intelligence" as a learning outcome [11]. Its main contribution to learning lies in contextualizing technical skills within meaningful game situations, which helps students overcome task-related limitations, develop tactical awareness, and enhance problem-solving through active decision-making [12].

Learning effectiveness within this framework can be assessed through cognitive, affective, and psychomotor indicators. Teachers play a central role in guiding this process, as they are responsible for selecting learning content, managing activities, and monitoring the development of students' abilities across all domains [13]. Therefore, the inclusion of game-based models such as mini-volleyball and the TGFU approach in school curricula may improve students' understanding of both technical and tactical aspects of games [14].

The findings of the present review, supported by previously published studies, confirm that the TGFU model positively influences learning outcomes in physical education. Comparative analysis shows that its effectiveness is reflected not only in improved performance but also in enhanced motivation, social interaction, and emotional development. Collectively, the evidence demonstrates that the

TGFU approach contributes to a more integrated learning experience by combining physical practice with reflective understanding. Based on this, an analysis of specific areas of influence of the TGFU model on learning outcomes allows for a more detailed examination of how this approach supports student development across cognitive, affective, and psychomotor domains, beginning with cognitive enhancement.

Based on the collected literature, the Teaching Games for Understanding (TGFU) approach improves several cognitive aspects of learning. Although few studies provide direct measures of cognitive change, the results show that participation in TGFU increases students' understanding of game concepts and strategies [15]. Students who took part in TGFU-based lessons demonstrated better decision-making and game performance than those taught through direct instruction.

The TGFU approach develops cognitive skills by placing learning within real game situations, which enhances analysis and tactical reasoning. It also helps students learn and apply techniques such as overpassing and underpassing, showing progress in understanding. After TGFU interventions, students in sports such as volleyball and floorball showed greater tactical awareness and the ability to make situational decisions.

The use of questioning within the TGFU method increases students' participation and supports active engagement in learning. Discussion of tactical options and problem-solving tasks helps students think more deeply about game situations and strategies. The hybrid TGFU/SE model further contributes to students' autonomy and sense of competence, reflecting higher cognitive involvement in physical education. Overall, the TGFU approach enhances students' ability to analyze, make decisions, and apply knowledge during games, supporting both technical and cognitive development.

According to the reviewed literature, the Teaching Games for Understanding (TGFU) approach has a positive effect on students' emotional well-being. Although not all studies directly measured emotional outcomes, many reported that the use of TGFU increases students' motivation and engagement in physical activity [16]. For instance, the hybrid TGFU/SE model led to higher levels of intrinsic motivation, satisfaction, and positive attitudes toward exercise, contributing to a more engaging learning process.

Greater enjoyment and motivation toward physical activity were linked to better emotional well-being. Students who participated in hybrid SE/TGFU programs reported higher enjoyment, perceived competence, and satisfaction with participation in physical activity [17]. The TGFU approach also improved the motivational environment and task

orientation, supporting intrinsic motivation and a sense of accomplishment in physical education.

Students taught with the TGFU method reported enjoying lessons more than those in control groups, reflecting improved emotional engagement and motivation to participate. Increases in self-directed motivation and enjoyment suggest that students became more interested in physical education activities. The TGFU model also helps students develop a sense of personal and social responsibility, which is an important component of educational development [18].

Students with initially low or moderate motivation experienced higher levels of motivation and psychological satisfaction after participating in SE/TGFU lessons. Greater satisfaction with the variety and novelty of volleyball instruction indicates that this hybrid model makes physical education more engaging for students [19]. The TGFU program also promoted participation in light physical activity, reflecting increased motivation and satisfaction during lessons.

After TGFU interventions, students expressed higher enjoyment of physical activity and a stronger willingness to continue it. Implementation of the model through questioning reduced teacher corrections, encouraged peer interaction, and provided more positive feedback, which improved students' confidence and intrinsic motivation [20]. Teacher support that encouraged teamwork and participation strengthened students' sense of belonging and satisfaction with the learning process.

Participation in TGFU-based lessons has also been linked to more positive attitudes toward physical activity and greater motivation to remain active. Although some studies did not report strong emotional effects or increased enjoyment, they found higher intentions to engage in physical activity. Overall, the TGFU approach improves the emotional aspects of physical education by increasing students' motivation, enjoyment, and participation in learning.

According to the reviewed literature, the Teaching Games for Understanding (TGFU) approach has a positive effect on students' psychomotor development. Several studies reported that participation in TGFU lessons improved physical abilities such as vertical jump, 30-meter sprint, agility, and cardiorespiratory endurance [21]. These findings indicate that the TGFU approach contributes to the development of students' physical fitness and movement efficiency. The hybrid TGFU/SE model that includes practical learning tasks has also been found to enhance motor coordination and the application of movement skills during gameplay [22]. Greater engagement and active participation during play are associated with improvements in motor and practical skills necessary for effective performance [23].

Although some studies did not observe significant differences between TGFU and technical instruction in specific skill execution, improvements were noted in tactical abilities and game performance [24]. Enhanced accuracy in overpassing, underpassing, and serving suggests that the TGFU method supports motor skill development in volleyball. Some abilities may require longer intervention periods or different methods, yet the use of TGFU has been linked to overall gains in speed, flexibility, strength, and coordination. Students in TGFU-based lessons also showed better perceptual abilities compared with control groups, possibly due to learning activities adapted to their developmental level.

Participation in physical education lessons using the TGFU framework led to improved athletic performance, especially in volleyball. Students demonstrated progress in both fine and gross motor skills relevant to sports performance. Although not all studies explicitly examined psychomotor outcomes, the available evidence indicates that the TGFU approach supports the development of motor abilities and enhances performance quality in physical education.

Study Limitations and Implementation Challenges

Based on the reviewed studies, several limitations and challenges related to the implementation of the Teaching Games for Understanding (TGFU) approach have been identified. Although not all papers directly addressed these aspects, a number of recurring issues can be observed. Time constraints are frequently mentioned as a major barrier to integrating the TGFU model into regular school curricula. Differences in student engagement and the level of institutional and teacher support also influence the effectiveness of interventions [25]. Successful implementation of hybrid models such as TGFU/SE requires adequate teacher training, which can be difficult due to additional time and workload demands. Variation in students' motivation and initial reactions to new instructional methods further complicates the process.

Several methodological limitations were also observed. Differences in research design, short intervention periods, and small sample sizes reduce the generalizability of findings. The absence of control groups and the use of quasi-experimental designs may introduce bias related to participant selection and maturation. Moreover, high variability in measuring decision-making outcomes limits the comparability of results. Some studies also reported a decline in long-term exercise motivation, particularly among male students, which suggests difficulties in maintaining engagement over extended periods.

While the TGFU model demonstrates promising outcomes, these limitations highlight the need for more comprehensive and longitudinal studies to

strengthen the evidence base and refine practical implementation strategies in physical education.

Conclusions

Based on the reviewed research, the study summarized evidence on the effectiveness of the Teaching Games for Understanding (TGFU) approach and its hybrid forms, including Sport Education (SE) and Teaching Personal and Social Responsibility (TPSR). The findings indicate that TGFU-based interventions in physical education can improve students' physical fitness, body composition, sport-specific skills in activities such as volleyball and soccer, and overall participation in physical activity. In addition, hybrid TGFU/SE and TGFU/TPSR

models support students' initiative, competence, enjoyment, and engagement in lessons.

The TGFU approach contributes to the development of physical, cognitive, emotional, and psychomotor skills, including decision-making and tactical abilities. However, effective implementation requires systematic planning and appropriate teacher preparation to address practical and methodological challenges. Further studies with larger and more diverse samples, as well as controlled designs, are recommended to validate and expand current evidence on the role of TGFU and its hybrid models in physical education.

Conflict of Interest

The authors declare no conflict of interest.

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Cite this article as:

Wicaksono GB, Listari, Islam S. The effectiveness of the TGFU approach in increasing student engagement in physical education lessons. *Pedagogy of Health*, 2025;4(2):132–140.

<https://doi.org/10.15561/health.2025.0205>

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Received: 11.10.2025

Accepted: 14.11.2025; Published: 30.12.2025

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SCIENTIFIC EDITION (journal)
Pedagogy of Health, 2025;4(2):

Editorial to the publisher department:
certificate DK No 7472; 07.10.2021

designer - Sergii Iermakov
editing - Tetiana Yermakova T.
administrator of sites - Sergii Iermakov
