JPEHS
Journal of Physical Education and Health Science

E-ISSN. 3124-5420
https://journal.sainspenapublisher.com/jpehs

LITERATURE REVIEW

Fitness Centers and Gyms from a Physical Education Perspective: A Literature Review on Their Concepts, Functions, and Contributions to Improving Public Health and Fitness

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Received : 17 March 2026
Revised : 24 March 2026
Accepted : 30 March 2026

Abstract:
This study addresses the growing paradox between the well-established benefits of physical activity and the persistent global prevalence of physical inactivity by examining the role of fitness centers and gyms from a physical education perspective. While these facilities are commonly viewed as spaces for exercise, their broader educational, behavioral, and public health contributions remain underexplored. Therefore, this study aims to analyze the concepts, functions, and contributions of fitness centers and gyms in promoting physical literacy and sustainable active lifestyles. A systematic literature review (SLR) was conducted following PRISMA 2020 guidelines, using data from Scopus, Web of Science, PubMed, and Google Scholar. A total of 245 records were identified, of which 20 studies met the inclusion criteria after screening and eligibility assessment. The findings indicate that fitness centers and gyms contribute significantly to improving physical fitness, metabolic health, and psychological well-being. Beyond physiological outcomes, these facilities also play an important role in shaping motivation, self-efficacy, and long-term engagement in physical activity. Additionally, factors such as accessibility, inclusivity, and socioecological influences were found to affect participation. The review further reveals that fitness environments can function as informal learning spaces that support the development of physical literacy, although this role remains underemphasized in existing research. In conclusion, fitness centers and gyms have substantial potential as strategic platforms for promoting public health and active lifestyles. A more integrative approach that combines physical, educational, and behavioral dimensions is needed to optimize their contribution within the broader context of physical education and public health.
Keywords: active lifestyle; fitness center; gyms; physical activity; physical education; physical health; physical literacy; public fitness.

1. Introduction

Physical activity is widely recognized as a fundamental determinant of health, contributing to improved cardiorespiratory fitness, muscular strength, metabolic regulation, and reduced risk of non-communicable diseases (NCDs), including cardiovascular disease, diabetes mellitus, and obesity (Oppert et al., 2023; Wargama et al., 2022). Beyond its physiological benefits, regular participation in physical activity also supports psychological well-being and social interaction, which are essential components of overall quality of life (Marquez et al., 2020). Although this evidence is well-established, global trends indicate that the prevalence of physical inactivity continues and is even increasing, largely driven by sedentary lifestyles associated with technological advancements and urbanization (Lyons et

al., 2018). This paradox between the well-documented benefits of physical activity and low participation rates represents a critical public health challenge that has not yet been adequately addressed.

One of the most visible responses to this issue has been the rapid proliferation of fitness centers and gyms as structured environments that facilitate physical activity. Although public discourse often uses both interchangeably, they differ conceptually and functionally. Fitness centers typically provide a holistic range of services, including cardiovascular training, strength conditioning, flexibility exercises, and instructor-led group programs, whereas gyms tend to emphasize resistance training and muscle development (Wargama, 2026; Wanasari et al., 2024). This distinction is not merely semantic but reflects different pedagogical potentials and user experiences in promoting sustained engagement in physical activity.

One of the most noticeable responses to this issue has been the rapid growth of fitness centers and gyms as structured facilities that facilitate physical activity. Although these two terms are often used interchangeably in public discourse, they differ conceptually and functionally. Most studies focus on measurable health outcomes-such as aerobic capacity, muscle strength, and body composition (Ramos et al., 2021; Leslie et al ., 2023), or on psychological benefits such as stress reduction and improved mood (Vella et al., 2023). While these findings are important, they overlook a critical dimension: the role of fitness centers and gyms as educational ecosystems that shape knowledge, behavior, and long-term physical activity habits. In other words, current literature tends to treat these facilities as sites of exercise, rather than as spaces of learning and behavior formation.

In addition, there is a notable lack of an integrative framework that connects the concepts, functions, and broader social contributions of fitness centers and gyms within the field of physical education. Previous studies have often overlooked how these facilities contribute to the development of physical literacy, self-regulation in exercise, and lifelong engagement in physical activity. This gap is particularly significant in the context of rising noncommunicable diseases, where sustained behavioral change is not merely a short-term fitness outcome but also a primary goal of public health interventions (Duarte et al., 2025).

Given these limitations, this study positions itself to address two key gaps. First, it critically synthesizes existing literature to move beyond a purely physiological perspective, incorporating educational, behavioral, and social dimensions of fitness center and gym participation. Second, it proposes a conceptual repositioning of fitness centers and gyms as informal yet structured learning environments within the broader framework of physical education. This dual positioning constitutes the novelty of the study, as it integrates fragmented evidence into a coherent perspective that bridges public health and physical education.

Therefore, this study aims to conduct a systematic literature review to analyze the concepts, functions, and contributions of fitness centers and gyms, with a specific emphasis on their role in fostering physical literacy and sustainable active lifestyles. By doing so, the study seeks not only to consolidate existing knowledge but also to offer a more nuanced and human-centered understanding of how individuals interact with fitness environments in their daily lives.

Practically, the findings of this study are expected to provide a theoretical and empirical foundation for educators, practitioners, and policymakers in designing more effective and sustainable physical activity programs. More importantly, this study underscores the need to reframe fitness centers and gyms not merely as places for physical training, but as strategic platforms for health education and lifelong behavior change, thereby contributing to the development of a healthier, more active, and socially connected society.

2. Materials and Methods

Study Design

This study employed a systematic literature review (SLR) using the PRISMA 2020 guidelines to ensure transparency, reproducibility, and methodological rigor. Unlike a traditional narrative review, this approach allows for a structured identification, screening, and synthesis of relevant studies, thereby minimizing bias and enhancing the reliability of findings.

The review focuses on analyzing the concepts, functions, and contributions of fitness centers and gyms, with a specific emphasis on their role as educational and behavioral environments within the context of physical education and public health.

Data Sources and Search Strategy

A systematic search of the literature was carried out using several major scientific databases to ensure comprehensive coverage of relevant studies. The databases included Scopus, Web of Science (WoS), and PubMed as primary sources, while Google Scholar was utilized as a supplementary database to identify additional potentially relevant articles. The search strategy was designed using Boolean operators to combine key terms related to the focus of the study. Specifically, the keywords included "fitness center" OR "gym" combined with "physical activity" OR "exercise," and further linked with "health," "physical fitness," "public health," or "physical education." To maintain the relevance and timeliness of the review, the search was to publications released between January 2019 and December 2026. This time frame was selected to capture recent developments and contemporary evidence regarding the role of fitness centers and gyms in promoting physical activity, health outcomes, and educational perspectives within the field of physical education.

Inclusion Criteria

The selection of studies in this review was guided by clearly defined inclusion criteria to ensure the relevance and quality of the analyzed literature. Only peer-reviewed journal articles indexed in reputable databases, such as Scopus, Scimago Journal Rank (SJR), or Web of Science, were considered to maintain a high standard of scientific credibility. All included studies were required to be published in English to ensure consistency in analysis and interpretation. In addition, the publication period was limited to articles published between 2019 and 2026, allowing the review to reflect recent developments and current trends in the field. Substantively, the selected studies needed to focus on topics related to fitness centers or gyms, as well as issues concerning physical activity or exercise. Furthermore, the articles had to address aspects of public health or physical fitness, ensuring alignment with the broader objective of examining the role of fitness environments in promoting health and active lifestyles.

Procedure

The literature search initially identified 245 records from selected databases. After removing 65 duplicate records, 180 articles remained and were screened based on titles and abstracts, leading to the exclusion of 110 records due to irrelevance.

A total of 70 articles were then sought for full-text retrieval; however, 10 articles could not be accessed. The remaining 65 articles were assessed for eligibility through full-text review. Of these, 45 articles were excluded due to reasons such as lack of relevance, absence of a specific focus on fitness centers or gyms, incomplete data, non-indexed sources, and methodological limitations. Finally, 20 studies met all inclusion criteria and were included in

the review. The overall selection process followed PRISMA 2020 guidelines and is illustrated in Figure 1.

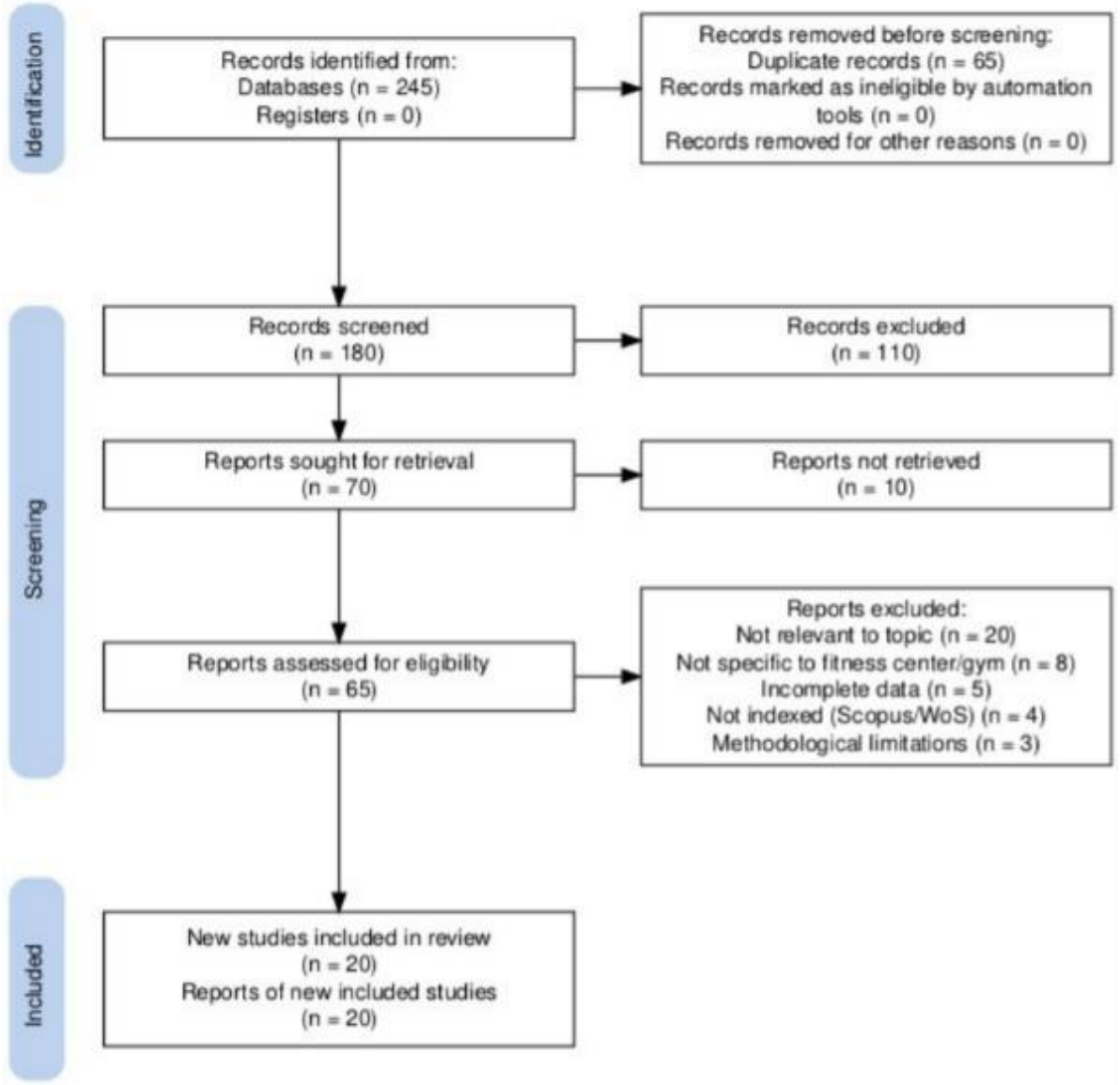

Figure 1. PRISMA Research Flow Diagram

3. Results

The results are presented in a literature review table summarizing 20 selected studies, including authors, research focus, key findings, and publication index. Overall, the findings show that fitness centers and gyms contribute positively to improving physical fitness, health, and physical activity participation. In addition, these facilities play a role in supporting behavioral change and promoting active lifestyles from a physical education perspective.

No	Author and Year	Research Title	Results	Publication Index
1	(Zhou et al., 2026)	Rom the school gym to adulthood: gendered pathways of physical education and post-divorce physical activity in China	The findings indicate that gender and the HPE curriculum contribute to unequal engagement in physical activity, influencing type, intensity, and duration, and	Sport, Education and Society (Q1)

No	Author and Year	Research Title	Results	Publication Index
			reinforcing the marginalization of girls. This inequality is associated with lower health awareness and reduced physical activity in adulthood, particularly among divorced single mothers. These results underscore the need for structural and cultural changes to promote gender-equitable curricula and improve access to physical activity and health resources.	
2	(Biddle et al., 2019)	Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality	Higher or increased fitness and physical activity are associated with better health and cognitive performance. There is partial support for a causal association with depression, limited support for self-esteem, but strong support for cognitive function.	Psychology of sport and exercise (Q1)
3	(Soekmawati et al., 2022)	Gym-Goers' Self-Identification with Physically Attractive Fitness Trainers and Intention to Exercise	The findings indicate that appearance and weight management motives are associated with a stronger identification with physically attractive fitness trainers, which in turn influences exercise intention. Gender moderates this relationship, with these motives having a greater impact on exercise intention among female gym-goers. The study highlights the role of trainer attractiveness in shaping exercise intention through self and social identification processes.	Behavioral Sciences (Q1)
4	(Ekelund et al., 2020)	Joint associations of accelerometer-measured physical activity and sedentary time with all-cause mortality: a harmonised meta-analysis in more than 44 000 middle-aged and older individuals	Average sitting time is 8.5-10.5 hours per day, and moderate-to-vigorous physical activity (MVPA) is 8-35 minutes per day. The risk of mortality increases in individuals with low MVPA and high sitting time, whereas high MVPA can reduce or offset the increased risk of mortality associated with prolonged sitting.	British Journal of Sports Medicine (Q1)
5	(Van Pelt et al., 2021)	Data-Driven Risk Classification of Concussion Rates: A Systematic Review and Meta-Analysis	Of the 83 studies analyzed, rugby had the highest rate of concussions (28.25 per 10,000 athlete exposures). Women had higher rates of concussions than men, except in lacrosse. College athletes had a higher risk than high school athletes, and games resulted in more concussions than practices.	Sports Medicine (Q1)

No	Author and Year	Research Title	Results	Publication Index
6	(Kandola etal., 2020)	Depressive symptoms and objectively measured physical activity and sedentary behaviour throughout adolescence: a prospective cohort study	Longitudinal studies show that increased sedentary behavior in adolescents (ages 12–16) is associated with higher depression scores at age 18, whereas physical activity-particularly light and moderate-to-vigorous activity-is associated with a reduction in depressive symptoms.	The Lancet Psychiatry (Q1)
7	(Celli et al., 2022)	Lifestyle intervention strategy to treat diabetes in older adults: a randomized controlled trial	The results show that the intensive lifestyle intervention (ILI) group experienced greater improvements in HbA1c, insulin sensitivity, body weight, visceral fat, physical performance, and VO_2peak compared to the healthy lifestyle (HL) group ($p < 0.05$). Additionally, strength, gait, quality of life, and insulin requirements improved significantly in the ILI group, although mild hypoglycemia occurred more frequently. Overall, lifestyle intervention was effective in enhancing metabolic and functional health among older adults with diabetes.	Diabetes Care (Q1)
8	(Mitchell et al., 2026)	Comparing performance and experience in a conventional and accessible gym: a mixed methods study	The study involving 39 participants with and without disabilities found that adapted gyms present fewer barriers and more supportive factors compared to conventional gyms. Key influences on accessibility include physical, social, cognitive, sensory, and environmental aspects. The findings suggest that applying Universal Design (UD) can enhance gym accessibility and inclusivity, thereby supporting diverse users and potentially reducing health disparities.	Disability and Rehabilitation (Q1)
9	(Cunningham et al., 2023)	Gym staff perspectives on disability inclusion: a qualitative study	The findings, based on a socioecological perspective, indicate that gym participation benefits individuals with disabilities at the personal level. Positive social interactions, supportive staff, accessible facilities, and organizational practices. At the community and policy levels, factors such as awareness, collaboration with healthcare professionals,	Disability and Rehabilitation (Q1)

No	Author and Year	Research Title	Results	Publication Index
			transportation access, and local policies play important roles in facilitating participation.	
10	(I. M. D. S. Wargama et al., 2024)	¿Cuál es la relación entre socioeconomía y actividad física? Revisión bibliográfica (What is the relationship between socioeconomics and physical activity? Literature review)	Socioeconomic status (SES) influences participation in physical activity; higher-SES groups are more active, while lower-SES groups face barriers related to access, cost, and time, which have been further exacerbated by the COVID-19 pandemic. Policy interventions and improved access are needed to reduce these disparities.	Retos (Q1)
11	(Avci et al., 2024)	Exercise and resting periods: Thermal comfort dynamics in gym environments	The results of this study contribute to the operation of indoor gym environments to refine their indoor environmental parameters to optimize users' thermal comfort and well-being.	Building Simulation (Q1)
12	(Lee & Jin, 2024)	Combined Virtual-Reality- and Gym-Based Physical Activity Intervention for Children With a Developmental Disability: Effects on Physical Activity Levels, Motor Skills, and Social Skills	The findings indicate that a combined virtual reality- and fitness center-based physical activity program resulted in significant improvements in physical activity levels, motor skills, and social skills among children with developmental disabilities in the experimental group. Importantly, these improvements persisted for 12 weeks following the intervention.	Adapted Physical Activity Quarterly (Q2)
13	(Terauchi et al., 2022)	A randomized controlled trial of a structured program combining aerobic and resistance exercise for adults with type 2 diabetes in Japan	Among 228 participants, 85.8% in the supervised exercise group and 93.9% in the standard therapy group completed the study. Supervised exercise significantly improved glycemic outcomes, including HbA1c, fasting blood glucose, and glycoalbumin ($p < 0.001$). Reductions in fasting insulin and HOMA-IR were observed but were not statistically significant. Although adverse events were more frequent in the exercise group, no serious safety concerns were identified. A structured, supervised aerobic and resistance exercise program improved HbA1c and was well accepted among patients with T2DM.	Diabetology International (Q3)
14	(Plotnikoff et al., 2023)	mHealth to Support Outdoor Gym Resistance Training: The ecofit Effectiveness RCT	Significant improvements in upper and lower body muscular fitness were observed at 9 months, but not at 3 months.	American Journal of Preventive Medicine (Q1)

No	Author and Year	Research Title	Results	Publication Index
			However, self-reported resistance training, self-efficacy, and intention to engage in resistance training increased significantly at both time points. The findings indicate that an mHealth-based intervention can effectively enhance muscular fitness, physical activity behavior, and related psychological factors in adults.	
15	(Jansson et al., 2022)	Descriptive epidemiology of outdoor gym use in an Australian regional setting	A total of 2,950 individuals were observed over 56 hours, with only 3.8% using outdoor gym equipment. Usage was higher among males and predominantly among young to middle-aged adults, while participation from women, older adults, and younger groups was relatively low. Outdoor gyms show potential to support community physical activity; however, increased utilization requires targeted promotion and education strategies, particularly to engage women and older populations.	Journal of Public Health (Q1)
16	(Nathan et al., 2022)	Fitness trainers' physical attractiveness and gym goers' exercise intention	The findings indicate that perceived expertise and likeability of fitness trainers play a significant mediating role in the relationship between trainers' physical attractiveness and gym members' intention to exercise. Physical attractiveness influences exercise intention indirectly through these perceived qualities. The study also outlines theoretical and practical implications and offers directions for future research.	International Journal of Business and Society (Q3)
17	(Riseth et al., 2022)	Fitness center use and subsequent achievement of exercise goals. A prospective study on long-term fitness center members	Frequent and consistent attendance at the gym, as well as participation in group activities, is associated with higher levels of self-reported goal achievement. Individuals with low attendance rates are significantly more likely to report less satisfactory results compared to those with high attendance rates. In contrast, sessions with a fitness trainer do not show a clear association with goal achievement.	BMC Sports Science, Medicine and Rehabilitation (Q1)
18	(Tross et al., 2024)	Maintaining exercise in fitness centre settings:	Autonomous motivation and self-efficacy play a key role in	International Journal of

No	Author and Year	Research Title	Results	Publication Index
		insights from the physical activity maintenance theory	sustaining fitness center attendance. Environmental factors, such as facility quality and social support, also influence exercise adherence. However, barriers including time limitations and personal constraints may reduce participation. Personalized training programs are identified as important in enhancing long-term commitment to exercise.	Qualitative Studies on Health and Well-being (Q1)
19	(Arena et al., 2021)	Current Activities Centered on Healthy Living and Recommendations for the Future: A Position Statement from the HL-PIVOT Network	Adopting a healthy lifestyle has been recognized as a protective factor, particularly during the COVID-19 pandemic, highlighting the importance of promoting healthy lifestyle behaviors (HL) and management (HLM). In response, the HL-PIVOT network was established to enhance resilience and quality of life through four key areas: knowledge development, education, policy, and implementation. This initiative outlines current evidence, best practices, and future directions for strengthening healthy lifestyle promotion globally.	Current problems in cardiology
20	(Tokarski et al., 2023)	The Need for Health and Prevention through Fitness Sports	Adopting a healthy lifestyle has been recognized as a protective factor, particularly during the COVID-19 pandemic, which has highlighted the importance of promoting healthy lifestyle behaviors (HLB) and healthy lifestyle management (HLM). In response, the HL-PIVOT network was established to enhance resilience and quality of life through four key areas: knowledge development, education, policy, and implementation. This initiative outlines the latest evidence, best practices, and future directions to strengthen the promotion of healthy lifestyles globally.	European Open Science

4. Discussion

This section critically examines the findings of the systematic literature review by integrating evidence on the concepts, functions, and contributions of fitness centers and gyms from a physical education perspective. Unlike previous studies that predominantly emphasize

physiological outcomes, this discussion extends the analysis to behavioral, educational, and socioecological dimensions, thereby offering a more comprehensive interpretation of the role of fitness environments in contemporary society.

In line with the objectives of this study, the discussion highlights that fitness centers and gyms should be understood not solely as spaces for physical training but as environments that facilitate learning processes, shape behavioral patterns, and support long-term engagement in physical activity. This perspective is particularly relevant in addressing the persistent gap between the known benefits of physical activity and low participation rates globally.

1). Concepts of Fitness Centers and Gyms in Physical Education

The findings suggest that fitness centers and gyms are conceptually evolving beyond their traditional roles as exercise facilities into environments with educational significance. While fitness centers provide a more comprehensive approach to overall fitness (Paschalidou et al., 2023; Kelly, 2024), gyms tend to emphasize strength training modalities. Although strength training has well-documented benefits, its integration into youth and school-based settings remains limited due to persistent concerns among practitioners (Santos et al., 2022).

This indicates a disconnect between scientific evidence and practical implementation, highlighting a critical gap in physical education. From this perspective, both fitness centers and gyms can be repositioned as part of a broader learning ecosystem that supports not only physical development but also knowledge acquisition and behavioral competence.

2). Functions of Fitness Centers and Gyms

The multifunctional nature of fitness centers and gyms is consistently supported across the reviewed studies. Physiologically, they contribute to improved fitness and health outcomes (Wang et al., 2021). Psychologically and socially, they foster well-being, motivation, and social interaction (Wargama, 2025).

However, most existing studies tend to treat these functions as isolated outcomes rather than interconnected processes. This review highlights that these dimensions are inherently interdependent, suggesting that the effectiveness of fitness environments lies in their ability to simultaneously address physical, psychological, and social needs. From a physical education perspective, the findings reinforce their role as informal yet structured learning environments.

3). Contributions to Public Health and Physical Fitness

The contribution of fitness centers and gyms to public health is well-established, particularly in improving physical fitness and reducing the risk of noncommunicable diseases(Wargama, 2025). This is evident from improvements in health indicators such as cardiorespiratory fitness and muscle strength, as well as a reduced risk of noncommunicable diseases. Furthermore, the availability of these facilities also supports public health promotion and prevention efforts, particularly in addressing the growing problem of physical inactivity (Monadi et al., 2025).

Nevertheless, a critical issue emerges: increased availability of fitness facilities does not necessarily translate into increased participation. This suggests that structural provision alone is insufficient without addressing behavioral and motivational determinants (Fahdan & Pratama, 2025; Irawan, 2025). Therefore, the contribution of fitness centers should not be evaluated solely based on health outcomes, but also on their capacity to influence sustained engagement in physical activity.

4). **Behavioral and Educational Dimensions**

This study identifies behavioral and educational factors as central to understanding participation in fitness environments. Motivation, self-efficacy, and social interaction significantly influence adherence (Yu & Song, 2022; Farmer et al., 2022). In the realm of physical education, fitness centers and gyms contribute to the development of physical literacy, defined as an individual's capacity to comprehend, appreciate, and consistently participate in physical activity throughout their lifetime. This study suggests that the educational function of fitness facilities has not yet been fully utilized in previous research.

Importantly, these findings reveal that fitness centers and gyms function as sites for the development of physical literacy. However, this educational role remains underexplored in the literature, which largely prioritizes short-term physical outcomes. This imbalance suggests a need to shift the research focus toward long-term behavioral change and learning processes, aligning more closely with the goals of physical education.

5). **Accessibility, Inclusivity, and Socioecological Factors**

The findings also highlight disparities in access and participation, influenced by gender, socioeconomic status, and disability (Chen et al., 2024; Lange et al., 2025). While some studies emphasize environmental and policy factors (Sharma, 2023). There remains limited integration of these factors within a comprehensive socioecological framework.

This indicates that barriers to participation are not merely individual but are embedded within broader structural and cultural contexts. Addressing these challenges requires a systemic approach that integrates facility design, policy support, and community engagement.

The primary contribution of this study lies in its integrative perspective. While previous research has largely focused on physiological outcomes, this study bridges public health and physical education by positioning fitness centers and gyms as learning environments that facilitate long-term behavioral change. This conceptual repositioning provides a novel framework that connects concepts, functions, and contributions, offering a more holistic understanding of how fitness environments can support sustainable health behaviors.

The findings suggest that optimizing the role of fitness centers and gyms requires more than improving physical infrastructure. Programs should incorporate motivational and educational components, while facilities should be designed with inclusivity in mind. Collaboration among stakeholders is essential to enhance effectiveness.

Overall, fitness centers and gyms hold significant potential as platforms for promoting public health. However, maximizing this potential requires a paradigm shift—from viewing them as exercise spaces to recognizing them as integral components of the physical education system that support lifelong, active, and sustainable lifestyles.

Research Limitations

This study has several limitations. First, it includes only English-language articles indexed in major databases, which may exclude relevant studies from other sources. Second, the review is limited to publications from 2019 to 2026, potentially overlooking earlier foundational research. Third, the analysis is primarily qualitative, relying on narrative synthesis rather than quantitative meta-analysis, which may limit generalizability. Additionally, variations in study designs and populations may affect the comparability of findings. Finally, most included studies focus on physiological outcomes, with limited

emphasis on the physical education perspective, which may constrain the depth of analysis in educational dimensions.

Directions for Future Research

Future research should examine fitness centers and gyms from a physical education perspective, particularly their role in developing physical literacy and sustaining long-term physical activity. More longitudinal and experimental studies are needed to strengthen causal evidence. In addition, further research should address issues of inclusivity and accessibility, as well as explore the use of digital and technology-based interventions to enhance participation. Developing integrated frameworks that connect fitness environments with educational and public health outcomes is also recommended.

5. Conclusions

This study highlights that fitness centers and gyms should not be viewed solely as exercise facilities, but as multidimensional environments that contribute to physical, psychological, social, and educational outcomes. The findings demonstrate their significant role in improving physical fitness, supporting behavioral change, and promoting public health, particularly in addressing physical inactivity and non-communicable diseases.

The main contribution of this review lies in integrating public health and physical education perspectives by positioning fitness environments as informal learning spaces that foster physical literacy and long-term engagement in physical activity. Normatively, this study emphasizes the need for a more holistic approach in designing fitness programs by incorporating educational, motivational, and inclusive elements. Collaboration among stakeholders is essential to optimize their role.

In conclusion, fitness centers and gyms have strong potential as strategic platforms for promoting sustainable active lifestyles and improving population health.

Acknowledgement

The author would like to express appreciation and gratitude to all parties who have provided support during the preparation of this study. In particular, thanks are extended to the academic institutions that provided access to various sources of scientific literature, enabling this study to be successfully carried out. The author also acknowledges the researchers and academics whose works served as references in this study. Their contributions have been instrumental in enriching our understanding of the role of physical activity, fitness centers, and gyms in improving public health and fitness.

The author would also like to express gratitude to colleagues and all those who provided input, support, and encouragement throughout the writing of this article. Finally, the author hopes that this study will contribute to the advancement of sports education and serve as a reference for future research.

Conflict of Interest

The author declares that there are no conflicts of interest in this study-whether financial or non-financial-that could influence the results or interpretation of the research. The entire process of writing this article was conducted independently based on objective scientific analysis. The author also confirms that there are no relationships or affiliations with any specific parties that could potentially introduce bias in the presentation of data and

discussion. All sources used have been cited transparently in accordance with academic ethical principles.

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