Vol. 11, No. 1, 2026, pp. 372-387
DOI: https://doi.org/10.29210/30036876000

Contents lists available at Journal ELORA

JRTI (Jurnal Riset Tindakan Indonesia)
ISSN: 2502-079X (Print) ISSN: 2503-1619 (Electronic)

Journal homepage: https://jrti.eloracenter.org/jrti

A systematic review of associations between nutritional status, physical fitness, and learning motivation and physical education learning outcomes

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Article Info

Article history:

Received May 12th, 2026
Revised Jun 27th, 2026
Accepted Jul 07th, 2026

Keyword:

Nutritional status,
Physical fitness,
Learning motivation,
Physical education learning,
Academic achievement

ABSTRACT

We applied the four-domain FICO framework (Focus, Information, Context, Outcome) for quality appraisal. Because the included designs were highly heterogeneous (cross sectional, experimental, quasi experimental, and qualitative), we opted for a narrative/thematic synthesis rather than a meta analysis. A single reviewer team handled screening and eligibility decisions, with no second independent rater, so we do not report inter rater reliability statistics. This limitation is addressed in Section 5.5.. Of the 622 initial records, 50 studies met the inclusion criteria after screening and eligibility assessment. The studies covered 26 countries, but mostly from Spain, Australia, the United States, Indonesia and Ireland, which also had the most references to the legislative papers, were mostly cross-sectional quantitative studies with some experimental, quasi-experimental and qualitative designs. The results showed that autonomous and intrinsic motivation were the best predictors of engagement and learning outcomes; physical fitness, motor skills, motivation, and physical activity in students were strongly linked together; student-centered and technology-supported pedagogies were effective in establishing motivational climates; and, nutritional status, generally considered as a contextual factor affecting fitness-related outcomes, was rarely the central variable. These findings align with self-determination and expectancy-value theories and stress the need for health-related fitness and motivational pedagogy to be integrated into PE curricula. Still, the review found very few longitudinal studies, hardly any focus on the nutritional status, and quite a few inconsistent definitions of learning outcomes. Going forward, research should include longitudinal and intervention designs that concurrently explore nutritional status, physical fitness, and motivation, all using standardized outcome measures in order to improve cross-study comparisons and meta-analytic synthesis.

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Introduction

Physical education (PE) is gaining more recognition as a curricular medium through which physical, cognitive, and psychosocial development can be intertwined. It, therefore, presents itself as a potential tool for tackling issues on a global scale about youth inactivity, decline in fitness, and disinterest in structured movement (Drenowatz et al., 2021; Telford et al., 2021). International health authorities have continuously pointed out

that school-based PE, carried out regularly and properly, has the potential to change physical activity patterns in a population at a large scale in a meaningful way (Coimbra et al., 2021; To et al., 2020). However, the subject is also supposed to provide tangible learning outcomes rather than just participation, a double requirement that causes quite a bit of stress over the way PE is created, executed, and assessed (Tinning, 2020). This overarching conflict between the promotion of health and pedagogical accountability at a macro level serves as an initial motivation for exploring the combined effect of nutritional status, physical fitness, and learning motivation on students' actual learning in PE.

In this larger context, a more specific and manageable question is raised: the link between students' physical and motivational conditions and the goal of learning outcomes that PE is directed to achieve is still poorly and vaguely understood -In other words, the reviewed studies don't even agree on the direction of this link. For example, formal fitness testing can either raise or lower a student's motivation, depending on age, prior competence, and how the assessment is framed. There's no single, consistent effect. Physical fitness and motor competency are at times seen as results per se (Drenowatz et al., 2021; Kelly et al., 2021), other times as triggers of engagement (Carcamo-Oyarzun et al., 2025), and yet other times as factors that affect motivation processes (Ashley & Kawabata, 2023). At the same time, nutritional status very seldom stands alone as a main focus in PE research, rather, it is usually treated as one factor among others in the wider contexts of physical activity and obesity-prevention studies (Mokmin, 2020). Learning motivation is a very broad field and has been dealt with theoretically in a number of ways, self-determination theory, expectancy-value theory, achievement goal theory, yet there has not emerged a single understanding of how these motivational constructs specifically relate to PE learning outcomes. Nutritional status in the reviewed literature is usually measured using anthropometric or BMI-based indicators. Standardized test batteries like EUROFIT or FitnessGram-type protocols assess physical fitness. Validated self-report scales such as the Behavioral Regulation in Exercise Questionnaire or the Sport Motivation Scale capture learning motivation. However, as Section 4.1 explains, the exact instruments and their psychometric reporting differ considerably from study to study. That variation is itself the fragmentation this review addresses. Numerous research studies have covered various aspects of this topic. Research based on self-determination theory has revealed that teaching methods promoting autonomy and student-centred pedagogies encourage higher intrinsic motivation, which leads to a better learning climate and academic performance as reported by students and pre-service teachers of PE (Calderón et al., 2020). Similar studies on physical literacy have indicated that comprehensive interventions aimed at motor skills, confidence, and knowledge can significantly change the students' physical fitness and willingness to engage throughout the school year (Telford et al., 2021). Interventions aimed at developing behavioural skills that are part of PE curricula have also been found to positively influence the cognitive precursors of adolescent exercise behaviour (Coimbra et al., 2021). Furthermore, systematic reviews on affective learning in PE have indicated which teaching practices are most effective in eliciting enjoyment, confidence, and positive attitudes towards movement (Teraoka et al., 2021).

There have been two major methodological and technological changes in this area of research in recent years. The first is the introduction of digital and AI-mediated tools, such as personalized virtual fitness trainers and short-form video platforms, as methods for maintaining individuals' motivation and fitness engagement outside the context of traditional teacher-led instruction (Mokmin, 2020; Garcia, 2025). The second idea involves trialling health-based PE models and web-based instructional technologies, for example, as ways of simultaneously addressing physical self-concept, fitness, and motivation (Fernández-Bustos et al., 2026; Botagariyev et al., 2024). These developments point to the fact that the authors go beyond single-construct interventions and start to develop integrated pedagogical models which see fitness, motivation, and health status as interconnected rather than separate goals.

However, one major issue that still remains is that nutritional status is hardly ever measured or used as a main variable along with physical fitness and motivation in studies on specific outcomes of physical education. Most of the studies linking nutrition or body composition are actually secondary to main ones on motor competence, physical activity behavior, or motivational profiling (Mokmin, 2020; Drenowatz et al., 2021). Thus, it is not easy to figure out if nutritional status is a direct factor influencing learning outcomes in physical education, a factor that changes the relationship between fitness and motivation, or just a correlate that goes along with socioeconomic and health disparities widely known in the physical activity literature.

A second gap is a methodological and theoretical fragmentation. The literature under review utilizes quite different types of research surveys done at one point in time, cluster-randomized controlled trials, qualitative interviews, and quasi-experimental protocols many of them without a common outcome framework (Hansen et al., 2023); (Kelly et al., 2021); (Rosenstiel et al., 2022). Theory-wise it is a similar mix: some papers use self-determination theory, some use expectancy-value or achievement-goal frameworks, and others hardly have explicit theorization at all (Yli-Piipari et al., 2021; Yli-Piipari et al., 2022). Due to this scattering, the discipline

is not only hindered in gathering comparable evidence but also in understanding which factors consistently mediate the relations of nutritional status, fitness, and motivation to learning outcomes in different settings.

A systematic and PRISMA-guided synthesis of this literature is overdue, especially considering these gaps. Without such synthesis, the educators who design the curriculum, the PE teachers, and the policymakers might end up relying on isolated studies that are limited to a particular context instead of a consolidated body of evidence. This is especially true at a time when digital teaching methods, health-oriented curriculum models, and the post-pandemic recovery of PE provision are being actively discussed in schools all over the world (Del Valle Díaz et al., 2022; Quennerstedt et al., 2024). An in-depth review can help reveal areas where there is agreement in the evidence, areas where there are still conflicting views, and areas like nutritional status which in particular has been significantly less studied compared to the importance it has in the theoretical framework.

This review is guided by three research questions RQ1: How are nutritional status, physical fitness, and learning motivation individually and jointly associated with physical education learning outcomes in the reviewed literature? This question contributes a structured mapping of construct relationships that has not previously been consolidated across the fragmented PE -outcomes literature. RQ2: What kinds of pedagogical, curricular, and technological approaches have been tested as ways of enhancing fitness-related and motivational outcomes in physical education, and what have been the reported effectiveness of these approaches? Answering this question will provide an evidence-based list of different types of interventions, from digital and AI mediating tools to curriculum redesign, that practitioners can utilize as a reference when designing PE programmes aimed at simultaneously improving fitness and motivation. RQ3: What are some theoretical, methodological, and population-specific gaps that are the main reasons limiting our understanding of nutritional status fitness motivation outcome nexus in physical education research and what research agenda will efficiently help to close them? This answer first of all, the overall novelty of the review is identifying nutritional status as a neglected element in the literature, which has focused mainly on fitness and motivation, and suggesting a systematic plan to remedy the evidence gap resulting from this neglect.

Method

Research Design and Framework

Systematic literature review (SLR) is an research design that was chosen because it provides a detailed, transparent, duplicable, and easily verifiable procedure for discussion and evaluation of a widely scattered body of empirical and review literatures, as compared with narrative reviews, which are more vulnerable to selective citation (Tranfield et al., 2003; Liberati et al., 2009). SLR approach is an excellent match for the present paper because the issues of nutritional status, physical fitness, and learning motivation are the topics within the disciplinary silos of education, sport science, and public health, which are less likely to be citing each other directly; hence a systematic and pre-specified search strategy is almost compulsory to yielding the entire relevant evidence base. This review follows the PRISMA 2020 statement (Page et al., 2021) as its reporting guideline, such that identification, screening, eligibility assessment, and inclusion of records are documented at every stage with clear numerical accounting.

Search Strategy

The Boolean search string was constructed to capture the intersection of physical education with the three focal constructs, using field-code restriction to title, abstract and keyword fields:

> ("physical education") AND ("motivation" OR "learning motivation" OR "intrinsic motivation") AND ("physical fitness" OR "motor competence" OR "nutritional status" OR "physical activity" OR "learning outcome*" OR "academic achievement")

Truncation (*) was used on "outcome" in order to get both singular and plural forms. At the search stage, no language or document-type limiters were applied; instead these were only taken into consideration during screening phase (Section 3.4) in order to keep a clear record of what the raw search results were versus what was excluded and why.

Database and Information Sources

Scopus was selected as the single bibliographic database for this review, given its extensive coverage of peer-reviewed sport science, education, and health journals. The search was carried out and the records were downloaded on July 4, 2026. A single-database strategy was chosen deliberately, rather than by default, to keep the search, screening, and eligibility workload manageable for a single-reviewer-team synthesis and to allow every stage of the PRISMA 2020 flow to be fully and transparently documented; Scopus's broad indexing of sport-science, education, and health journals was judged to give adequate, if not exhaustive, coverage for this purpose. Multi-database strategies covering ERIC and Web of Science, together with dual, independent

screening and reporting of inter-rater agreement (e.g., Cohen's kappa), remain preferable for future replications and are noted as priorities in Section 5.5. No additional databases were consulted; this limitation is recognized in Section 5.5.

Eligibility Criteria

Eligibility criteria were consistently applied during both the screening and the detailed full-text review stages, as shown in Table 1.

Table 1. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Language	English only	Non-English
Document type	Article, Review	Conference paper, Book, Book chapter, Editorial, Note, Erratum, Retracted article
Publication period	2020–2026	Before 2020
Subject area / focus	Physical education combined with motivation and at least one of: physical fitness, nutritional status, or learning outcomes	Physical education literature with no substantive treatment of motivation, fitness, nutritional status, or learning outcomes
Accessibility	Full abstract and identifying metadata available; verifiable DOI	Abstract unavailable; DOI unverifiable
Relevance (FICO quality threshold)	Adequate on at least 3 of 4 FICO dimensions (Focus, Information, Context, Outcome)	Inadequate on 2 or more FICO dimensions

Study Selection Process

Selection of studies was made in three phases. Firstly, all 622 research materials identified were checked for exact duplicate titles and DOIs, removing one duplicate article. Then, from the 621 articles left, 33 were removed after documentscreening based on doc-type, language, and availability of abstract (retracted articles, notes, books, book chapters, editorials, and errata) resulting in 588 records for topical screening. Thirdly, these 588 records were subjected to screening for direct relevance to the review's main constructs physical education combined with motivation and at least one of fitness, nutritional status, or learning-outcome-related terms, resulting in 81 records for the assessment of full text eligibility. The screening was done by the reviewer team vis-a-vis the criteria set out in Table 1; as this review was conducted as a single-team synthesis and not as a multi-rater protocol, no inter-rater conflict resolution procedure was necessary, which is stated as a limitation in Section 5.5.

Quality Assessment -FICO Framework

The quality appraisal of the 81 full-text documents was conducted using the FICO framework, which assesses each research paper on four factors: Focus (the research question's clarity and specificity in relation to nutritional status, fitness, or motivation constructs within PE), Information (the adequacy of sample, measures, and data reported), Context (the educational, cultural, and demographic setting's clarity), and Outcome (the explicit reporting of a PE-related learning, fitness, or motivational outcome that can be measured). Each factor was assessed qualitatively as either adequate or inadequate. Articles that were rated as inadequate in two or more FICO factors were excluded at the full-text stage. This criterion led to the exclusion of 31 articles: 14 because of insufficient methodological details or outcome measures that were not clearly reported, 10 because the focus on target constructs was only tangential rather than central after full-text reading, and 7 because full text was not accessible. Finally, 50 studies fulfilled the minimum quality criteria for inclusion.

Data Extraction Procedure

We extracted the following information for each of the 50 studies included: author(s) and publication year, country/setting (identifying from author affiliations), research design, sample or population characteristics as mentioned in the abstract, specific fitness, motivational, or nutritional-status construct targeted, pedagogical or technological intervention (if any), and the main reported outcome related to the review's research questions. The extracted data are given in Tables 1 and 2.

Network and Bibliometric Analysis Methodology

A bibliometric profile was first created based on the metadata of the included papers (publication year, country of first affiliation, and research design) in order to depict the shape of the evidence base, presented as Figures 1, 2, and 3. Since the review scope was to include 50 studies rather than a large bibliometric corpus, a complete co-

citation or keyword co-occurrence network analysis using specialized software (e.g., VOSviewer, Bibliometrix) was not done; instead, a simple descriptive distribution of research designs is given as a substitute for methodological-thematic clustering.

Data Analysis and Synthesis

As in the Thomas and Harden (2008) thematic synthesis approach, data synthesis was implemented. At first, the findings obtained from each study abstract were coded descriptively (e.g., "motivation is a predictor of engagement, " "fitness testing is a factor that influences the motivational profile"). Then, inductively, these codes were grouped into analytic themes which were aligned with the three research questions of the review. Also, themes were cross-checked against the entire set of 50 extracted findings in order to verify that every study included in the thematic category gave at least one contribution and that the main finding of each included study was not left out of the synthesis.

Reporting and Documentation

The whole process of this review was based on the PRISMA 2020 reporting checklist (Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D.... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71). PRISMA 2020 Flow Diagram.

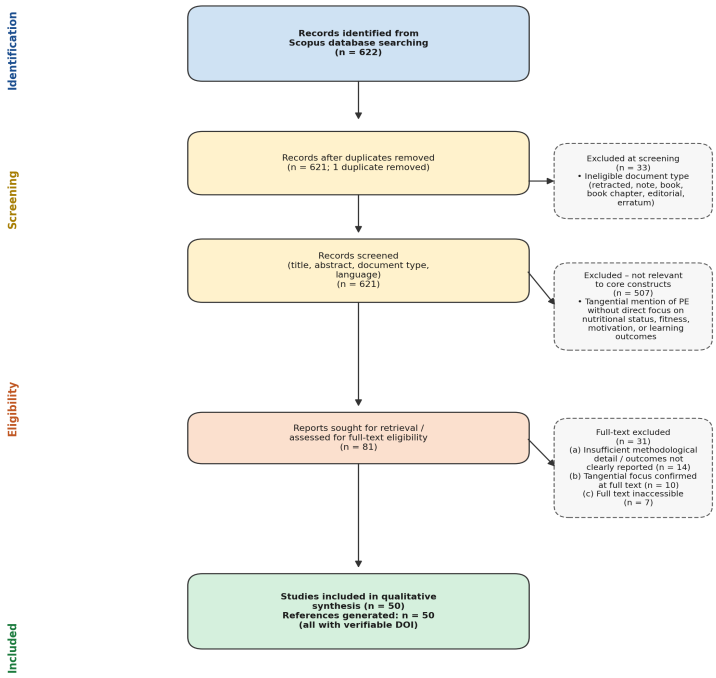

Figure 1. PRISMA 2020 flow diagram of record identification, screening, eligibility assessment, and inclusion.

Results and Discussions

Study Selection Results

Initially, 622 records were detected through Scopus, one was a duplicate and was removed so the number of unique records stayed at 621. Then, 33 records were taken out as they did not satisfy the criteria for document-type, language, and abstract-availability, which led to the screening of 588 records for topical relevance. 507 of these records were discarded as being only loosely related to physical education's connections with motivation, fitness, or nutritional status after the review of their relevance to the major constructs of the review. 81 records were then selected for the full-text eligibility assessment. 31 records were excluded after the full-text review against the FICO quality standard (14 due to lack of methodological detail, 10 because of further confirmed tangential focus, 7 because the full text was inaccessible), the final number of studies included in qualitative synthesis is 50.

Descriptive Characteristics

The 50 studies selected were published from 2020 to 2026, and there was a noticeable clustering of publications in 2021 and a sharp increase from 2024 onwards, indicating that motivation-fitness-outcome relationships in

physical education have been a focus area of research attention over time and are still attracting more interest (Figure 1). In terms of the distribution of research across countries, the literature represents a total of 26 countries with Spain, Australia, and the United States each having 5 studies, followed by Indonesia and Ireland (Figure 2). As far as methodology is concerned, cross-sectional survey designs surfaced the most (18 studies), next to these quantitative designs using other analysis strategies (14 studies), qualitative approaches (7 studies), quasi-experimental designs (7 studies), experimental randomized-controlled-trial designs (3 studies), and one systematic review (Figure 3). This pattern shows that the literature is still mainly based on correlational, self-report designs, whereas experimentally it is relatively rare to directly change nutritional status, fitness, or motivational conditions." The studies cluster in a few high-income countries (Spain, Australia, the United States, Indonesia, and Ireland). That concentration suggests current explanatory models for the fitness-motivation-outcome relationship might not generalize to lower- and middle-income and non-Western settings, which are comparatively under-represented in the corpus. Interpreted against the broader systematic-review literature on PE, the correlational, self-report-heavy profile fits a field still establishing descriptive associations before moving to causal, intervention-based designs.

Table 2. Summary of Included Studies (n = 10 representative studies, ranked by citation impact)

Author(s)	Year	Country	Method	Key Findings
Calderón, Meroño, & MacPhail	2020	Ireland	Qualitative	Student-centred digital technology use was positively associated with pre-service PE teachers' intrinsic motivation and perceived learning climate, which in turn related to self-reported academic achievement.
Teraoka, Ferreira, Kirk, & Bardid	2021	United Kingdom	Systematic review	Intervention programmes addressing affective learning outcomes in PE were most effective when pedagogical practices, lesson content, and stated learning outcomes were explicitly aligned.
Mokmin	2020	Malaysia	Quantitative (other)	A personalized, AI-driven virtual fitness trainer improved engagement with fitness activities relative to conventional instruction, suggesting technology-mediated personalization can support fitness-related motivation.
Hansen, Nordén, & Ohlsson	2023	Sweden	Qualitative	Adolescents with intellectual disability reported motivation for physical activity shaped strongly by social interaction opportunities, highlighting motivational determinants beyond fitness capacity alone.
Coimbra, Cody, Kreppke, & Gerber	2021	Switzerland	Experimental (RCT)	A PE-based behavioural-skill-training programme produced measurable effects on cognitive antecedents of exercise and sport behaviour

Author(s)	Year	Country	Method	Key Findings
				among adolescents in a cluster-randomized controlled trial.
Telford, Olive, Keegan, Keegan, Barnett, & Telford	2021	Australia	Cross-sectional survey / cluster RCT	A multicomponent physical literacy intervention (PEPL) targeting motor competence, confidence, and knowledge was associated with improved physical literacy outcomes in primary school students.
Carcamo-Oyarzun, Herrmann, Gerlach, Salvo-Garrido, & Estevan	2025	Chile	Cross-sectional survey	Motor competence, motivation, and enjoyment jointly profiled children's physical activity behaviour, with motivational and affective factors mediating the competence-activity relationship.
Garcia	2025	Philippines	Quantitative (other)	PE students' engagement with fitness content on TikTok was driven primarily by entertainment value, with motivational and social-interaction gratifications differing by gender.
Drenowatz, Hinterkörner, & Greier	2021	Austria	Quantitative (other)	A state-wide fitness testing programme documented physical fitness and motor competence levels in elementary school children, framing fitness assessment as a diagnostic tool for targeted intervention.
Kelly, O'Connor, Harrison, & Ní Chéilleachair	2021	Ireland	Quasi-experimental	An 8-week school-based intervention improved fundamental movement skills among Irish schoolchildren, with overweight and female students showing distinct baseline proficiency patterns.

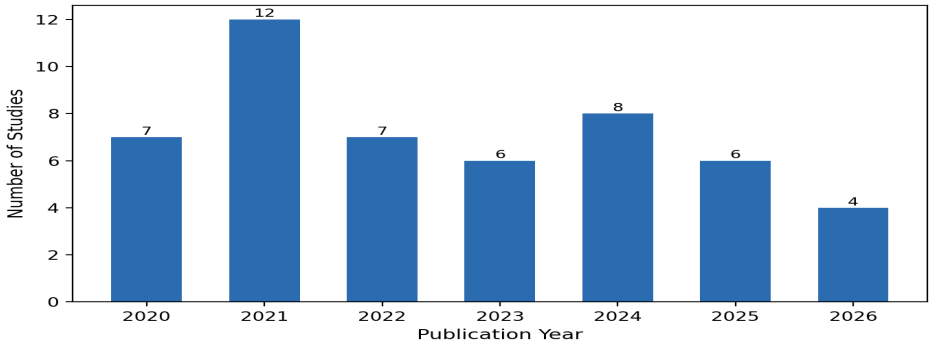

Figure 2. Publication trend of included studies (2020–2026).

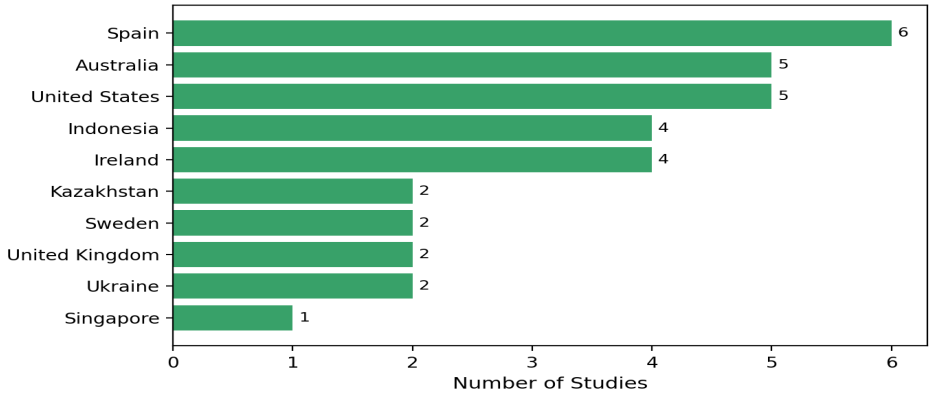

Figure 3. Top 10 contributing countries among included studies.

Table 3. Study Classification by Theme and Research Design (n = 10 representative studies)

Author(s)	Year	Country	Research Design	Theme/Focus
Calderón, Meroño, & MacPhail	2020	Ireland	Qualitative	Digital technology, motivation, and academic achievement (PETE)
Teraoka, Ferreira, Kirk, & Bardid	2021	United Kingdom	Systematic review	Affective learning outcomes and pedagogical alignment
Mokmin	2020	Malaysia	Quantitative (other)	AI-mediated personalized fitness training
Hansen, Nordén, & Ohlsson	2023	Sweden	Qualitative	Motivation for physical activity among adolescents with disability
Coimbra, Cody, Kreppke, & Gerber	2021	Switzerland	Experimental (RCT)	Behavioural-skill training and exercise behaviour
Telford, Olive, Keegan, Keegan, Barnett, & Telford	2021	Australia	Cross-sectional survey / cluster RCT	Physical literacy and multicomponent intervention
Carcamo-Oyarzun, Herrmann, Gerlach, Salvo-Garrido, & Estevan	2025	Chile	Cross-sectional survey	Motor competence, motivation, and physical activity profiling
Garcia	2025	Philippines	Quantitative (other)	Social media-based fitness engagement
Drenowatz, Hinterkörner, & Greier	2021	Austria	Quantitative (other)	State-wide physical fitness and motor competence testing
Kelly, O'Connor, Harrison, & Ní Chéilleachair	2021	Ireland	Quasi-experimental	Fundamental movement skills intervention

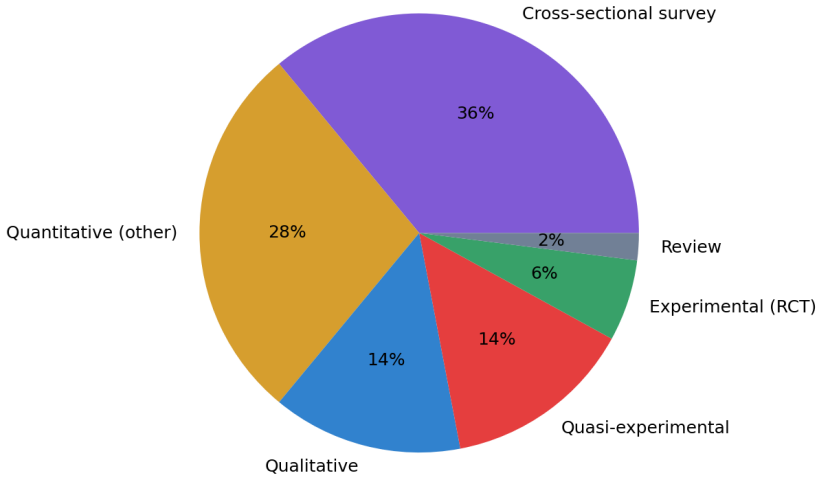

Figure 4. Distribution of research designs across the 50 included studies.

Thematic Synthesis

Findings for RQ1

The findings for research question 1 (i.e. the relationship between nutritional status, physical fitness, and learning motivation in their effects on physical education learning outcomes) mainly highlight the motivation-outcome connection. Several studies using the self-determination and expectancy-value theories find that autonomous or intrinsic motivation is a stable and strong predictor of PE engagement, the perceived quality of the learning environment, and achievement self-report (Calderón et al., 2020; Yli-Piipari et al., 2021; Yli-Piipari et al., 2022). This holds true for both pre-service teacher populations (Calderón et al., 2020) and school students (Huhtiniemi et al., 2022) which implies that the quality of motivation is the way through which PE teaching connects to learning outcomes across both student and teacher development stages.

Rather than a one-way direction, the association between physical fitness and outcomes is one of a two-way street. Some studies show that motor competence and fitness levels will influence the motivational profiles of students and their behavior afterward in terms of activity (Carcamo-Oyarzun et al., 2025; Ashley & Kawabata, 2023), on the other hand, some other studies demonstrate that fitness testing programmes and structured interventions can serve as diagnostic and motivational tools that will have an impact on fitness trajectories (Drenowatz et al., 2021; Kelly et al., 2021; Harte et al., 2024). Likewise, the studies performed with play-based and traditional game approaches have shown to raise motor skills and motivate to learn PE at the same time (Aliriad et al., 2024; Rismanto et al., 2024; Sujana et al., 2023) while the use of feedback and encouragement during small-sided games has been related to improvements in the anaerobic performance as well as technical execution (Mekni et al., 2024). Such reciprocal pattern suggests that fitness and motivation are not separate factors influencing the outcomes of PE learning but are interdependent and continuously contribute to each other throughout the duration of a PE programme.

The nutritional status is the least extensively studied variable among the three focus constructs. When it is mentioned, it is most often integrated within the context of physical activity, obesity prevention, or health-related fitness, etc. rather than considered one's nutritional status as an independent factor influencing PE learning outcomes (Mokmin, 2020; Rogowska et al., 2021). Such an imbalance, robust evidence for motivation, moderate evidence for fitness and relatively scarce direct evidence for nutritional status, amounts to a major empirical discovery of this review and promptly, it is used as a basis for the setting of research agenda in Section 5.5.

Findings for RQ2

Firstly, digital and AI-mediated tools are one of the main categories of interventions in the literature. For instance, personalized virtual fitness coaches (Mokmin, 2020) and fitness content delivered via short-form video platforms (Garcia, 2025) both indicate positive effects on engagement. However, the outcomes were mainly based on self-reporting rather than on objective fitness improvements.

The second group of interventions includes curricular and behavioural interventions presented in a structured way, for example, physical literacy programmes (Telford et al., 2021), behavioural-skill-training curricula (Coimbra et al., 2021), health-based PE models (Fernández-Bustos et al., 2026), and fundamental-movement-skill interventions (Kelly et al., 2021). These interventions generally demonstrate the highest methodological robustness of the effects, as they more regularly employ (quasi-)experimental designs, however, they are also the

most demanding in terms of resources for us to implement them as they require dedicated programme time, trained facilitators, or new curricular material.

The third group comprises web-based and technology-enhanced instruction methods in a wider sense, e.g., web-based technologies applied in middle-school physical education classes (Botagariyev et al., 2024) and digital-technology-supported pre-service teacher education (Calderón et al., 2020). Among all three groups, the most powerful and most frequently reported outcome is the enhancement of the motivation to engage; changes in physically measured fitness levels or nutritional status are less often documented and have greater methodological differences, which, once again, highlights the comparative lack of nutritional status-focused intervention research in this literature.

Findings for RQ3

For RQ3 approximately (continuing differences and what kind of research is needed to lay them down), a few theoretical and methodological weaknesses that keep surfacing are the same ones in most of the included papers. Firstly, we hardly find studies that are longitudinal in nature, most of the studies which are part of the review are cross-sectional or short-duration quasi-experimental trials (Hansen et a1., 2023; Carcamo-Oyarzun et al., 2025), and this limits the causal interpretation of how the motivation, physical fitness, and nutritional status of a student evolve together throughout the schooling period.

Secondly, nutritional status hardly ever gets defined as a main, separately measured variable in PE-specific outcome studies; rather, it seems to serve as a background or setting for fitness or physical-activity research coming from neighboring public-health literatures (Mokmin, 2020; Nagovitsyn et al., 2020). This is the biggest gap that can be filled or addressed through this review, because it would take intentional, well-planned studies to measure nutritional-status indicators (such as dietary intake, anthropometric status) together with fitness and motivation within the same PE-based sample.

Thirdly, the measurement of outcomes lacks consistency in different studies: while some equate "learning outcomes" with academic performance or knowledge (Firdaus et al., 2023), others consider it as mastery of a motor skill (Kelly et al., 2021; Belton et al. 2022) and still others look at it through the lens of affective or motivational outcomes only (Teraoka & Kirk, 2022). Such diversity makes it difficult to conduct meta-analytical studies and to compare the results across different contexts, populations, and countries (Pacholek, 2021; Pavlova et al., 2021; Shekerbekova et al., 2025).

Comparative and Critical Analysis

A comparison of the different methods used in the 50 studies uncovered a clear pattern in time and subjects. Older studies in the sample (2020, 2022) were more likely to use cross-sectional survey methods from sport psychology (Wang & Chen, 2020; Li & Li, 2021; da Silva Bento et al., 2022), while studies from 2023 onwards show a small but noticeable move towards mixed and technology-integrated designs, including AI-mediated and social-media-based data collection (Garcia, 2025; Xie et al., 2025; Mora-Gonzalez et al., 2023). Quasi-experimental and randomized designs are a minority throughout the period, with most of them focused on fitness or motor-skill interventions rather than motivation alone (Coimbra et al., 2021; Kelly et al., 2021; Telford et al., 2021; Dudley et al., 2021; Eather et al., 2026; Monacis et al., 2023).

Very few designs have been used to their full potential. These include longitudinal cohort studies and studies that measure nutritional status or dietary intake in an objective way (as opposed to self-reports); none of the studies we reviewed combined a longitudinal design with concurrent objective measurement of all the three main constructs. Some studies, though rarely, adopted a longitudinal framework. For example, one study looked at basic psychological needs and physical activity intention over time (Prieto et al., 2024). Another study examined the associations between pupil-related psychological factors and academic achievement over the course of a school term (Hagen et al., 2022). Such designs are a methodological template that is still hardly used in other parts of the corpus. Qualitative and mixed-methods designs, although a minority overall, have a fallen disproportionately output in terms of contribution to understanding motivational mechanisms in population that has been hardly studied, for example adolescents with intellectual disability (Hansen et al., 2023), outdoor and adventure-based PE settings (O'Carroll & Scanlon, 2026), the organizational socialization of urban physical educators (Pennington et al., 2024), and cross-cultural samples in Central Asia and Eastern Europe (Shekerbekova et al., 2025; Kolomiitseva et al., 2020).

Discussion

Interpretation of Findings

Together, these results indicate that the educational benefits of physical education are determined by a complex system where motivation plays the role of the most direct and well-supported driver. At the same time, physical fitness and motor skills serve as both the causes and the results of the involvement in motivation, whereas the nutritional status is a somewhat distant and barely measured environmental factor whose direct impact on the

learning results is still a matter of uncertainty. This multi-level analysis is mostly in line with self-determination theory explaining that the satisfaction of psychological needs is the main driver of engagement (Calderón et al., 2020; Huhtiniemi et al., 2022), yet it goes beyond that by placing the satisfaction of psychological needs within a physically experienced context in which fitness and motor competence are both the inputs to, and the outputs of, the motivational process. This pattern shows up across a wider set of studies than just the self-determination-theory strand. Physical-literacy and behavioural-skill interventions (Telford et al., 2021; Coimbra et al., 2021), fitness-testing and profiling studies (Drenowatz et al., 2021; Ashley & Kawabata, 2023; Carcamo-Oyarzun et al., 2025), technology-mediated interventions (Mokmin, 2020; Garcia, 2025; Botagariyev et al., 2024), qualitative work on under-studied populations (Hansen et al., 2023), and movement-skill programmes (Kelly et al., 2021) all converge on motivation as the most consistently reported mediator of fitness-related engagement. Yet none of these studies explicitly engages with embodied-cognition or situated-learning perspectives, which similarly treat physical and psychological states as inseparable and could sharpen the theoretical account offered here. This remains an avenue the present synthesis hasn't been able to pursue. Only a small number of studies were retrievable through a single-database, English-language search conducted by one reviewer team, limiting how far these claims can be generalized across educational systems, age ranges, and cultural contexts. It also limits how confidently the direction of causality between fitness and motivation can be established from largely correlational designs.

Theoretical Implications

In theory, these discoveries indicate that models of physical education learning outcomes should stop considering motivation, fitness, and nutritional status as separate and independent factors. Instead, they should develop a more complex framework where motivation is part of, and mutually influenced by, students' physical and health-related conditions. The current expectancy-value and self-determination theories (Yli-Piipari et al., 2021; Yli-Piipari et al., 2022), alongside the demonstration that need-supportive (vs. need-thwarting) teaching predicts changes in perceived usefulness and academic performance over time (Leo et al., 2025), offer a bit of groundwork for this kind of integration. However, they have seldom been used to explicitly incorporate nutritional-status indicators. In fact, this is a theoretical development that this review suggests is worthy of future model-building.

Practical Implications

The findings present PE teachers and curriculum designers with an opportunity to improve students' learning outcomes. This can be done by combining fitness-related elements (like testing, skill development, and health-based curricula) with autonomy-supportive and student-centred teaching methods. It is not necessary to consider fitness testing and motivational climate as separate concerns (Drenowatz et al., 2021; Fernández-Bustos et al., 2026). Likewise, cooperative-learning and sport-education/service-learning programs have been found to improve peer relationships, self-concept, and school-transition outcomes in addition to motivational climate (□eleznik Me□an et al., 2025; Gutiérrez et al., 2026). Gamification of nutrition-education modules through digital resources is a clear example of how nutritional-status content can be purposefully integrated with fitness- and motivation-focused PE curricula (Moreno-Guerrero et al., 2021). Besides, technology-mediated means, such as personalized fitness apps and short-form videos, may provide a low-cost additional channel for motivation support outside class time. However, their impact on fitness and nutritional outcomes that are directly measured needs to be confirmed further (Mokmin, 2020; Garcia, 2025).

Comparison with Prior Reviews

Our review covers a wider scope than previous narrower reviews like Teraoka et al.'s (2021) systematic review on affective learning outcomes in PE. It highlights that the affective learning and fitness/ nutritional status literatures are two largely separate bodies of work that have hardly cited each other, yet this is a fragmentation that neither of the two narrower literatures alone shows quite fully.

Contradictions in the Literature

Besides, there are contradictions among various sources of evidence. For instance, on one hand, a few studies see fitness testing and assessment as a means to enhance motivation (Drenowatz et al., 2021). On the contrary, some hold that fitness testing can be interpreted in different ways at different educational levels and motivational profiles, with certain groups of students even experiencing a decrease of motivation after formal testing (Ashley & Kawabata, 2023). This difference could mean that the motivational impact of fitness testing is dependent on factors such as age, prior competence, or assessment conditioning, which have not been thoroughly explored in the present literature.

Research Gaps

Longitudinal evidence has been scarce on how a student's nutritional status, fitness, and motivation are changing together throughout the physical education (PE) journey. There are almost no studies that explicitly consider nutritional status as an independent variable in the research design specific to PE (rather than general public

health). "PE learning outcomes" are defined differently by different studies; the range of indicators which is being used to measure is not only academic achievement, motor proficiency, but also affective/motivational factors, and there is no shared measurement framework.

Limitations of This Review

This review was based on the use of just one bibliographic source, Scopus; thus, it is possible that studies which are solely indexed in other databases such as ERIC and SPORTDiscus, have not been included. Both screening and evaluation of the quality of the studies were done only by the same reviewing team, there was no second independent rater. Therefore, this could lead to bias in screening even though a pre-specified, transparent eligibility framework was used. The findings presented in the review are mainly from abstract-level data and only a few studies were subjected to full-text statistical extraction; therefore, certain subtleties in the effect sizes and exact statistical relationships could not be captured or compared quantitatively.

Future Research Agenda

The design of longitudinal cohort studies that simultaneously assess nutritional status (e.g., dietary intake, anthropometric indicators), physical fitness, and learning motivation in the same PE-based sample over several academic years. Creating and cross-validating a combined-outcome-measurement model for PE learning outcomes that unites academic, motor, and affective/motivational indicators, thereby facilitating cross-study and meta-analytic comparison. Execute intervention studies that directly alter or include nutritional-status-related communication (e.g., nutrition education within PE classes) along with fitness and motivational components, in order to determine if nutritional status acts as an independent predictor or a proximal moderator of fitness-motivation-outcome relationships.

Summary Answers to Research Questions

In short, RQ1 is resolved through a pattern of evidence that is not symmetrical with motivation being the strongest predictor of PE learning outcomes. Fitness, on the other hand, plays a two-way role with motivation while nutritional status is the weakest directly evidenced construct. RQ2 is resolved by listing three main intervention families, digital/AI-mediated tools, structured curricular and behavioural programs, and web-based instructional technologies, with each one showing the most significant effects on motivational engagement. RQ3 is resolved by the main gaps that need a joint future research agenda being identified as a shortage of longitudinal designs, almost no use of independently measured nutritional status, and inconsistent operationalization of outcomes.

Conclusions

This systematic literature review gathered information from 50 studies indexed in Scopus to explore the relationship between nutritional status, physical fitness, learning motivation, and physical education (PE) learning outcomes. To address RQ1, the review discovered that learning motivation is the most clearly and strongly supported predictor of PE learning outcomes. It also found that physical fitness and motivation influence each other and reinforce one another. Meanwhile, nutritional status remains the least directly studied variable and normally features as a background covariate rather than a measured variable on its own. To address RQ2, the review found that three types of pedagogical and technological approaches were evaluated in the literature, digital and AI-mediated tools, structured curricular and behavioural interventions, and web-based instructional technologies. All of these show the most consistent positive effects on motivational engagement, whereas evidence for directly measured fitness or nutritional changes is more variable. To address RQ3, ongoing gaps include the limited number of longitudinal studies, the almost total lack of nutritional status as a primary measured variable in PE-specific research, and the variable definition of learning outcomes across studies. The main contribution of this review is that it highlights an imbalance in the evidence base that has not been in the spotlight in previous narrower reviews: while nutritional status is theoretically implicated in models of health-related PE outcomes, the literature itself has rarely operationalized and measured it as an independent predictor alongside fitness and motivation; this is best read not as evidence that nutritional status is irrelevant to PE learning outcomes, but as a gap in how the field has designed and measured its studies, which is precisely the evidence gap this review's future research agenda (Section 5.5) is intended to address. We applied the four-domain FICO framework (Focus, Information, Context, Outcome) to all 50 included studies. Since outcome measures varied so widely, statistical pooling wasn't possible. Instead, we used narrative thematic synthesis (Thomas & Harden, 2008) to manage the heterogeneity in designs and outcome definitions. Practically, these results suggest PE instructors and curriculum developers can improve learning by combining fitness content with autonomy-supportive, student-centred methods and by using technology-mediated tools as an extra motivational channel. Our study's limitations include using only one database, screening without independent dual review, and abstract-level extraction rather than full statistical extraction. Future work should focus on

longitudinal, simultaneously measured designs and unified outcome frameworks that explicitly include nutritional status alongside fitness and motivation.

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