Received: 3 March 2025 | Accepted: 21 July 2025

DOI: 10.1111/aphw.70062

REVIEW ARTICLE

APPLIED PSYCHOLOGY: Health and Well-Being IAAP

The relationship between physical literacy and physical activity: A systematic review and meta-analysis

Yu Ying[1] | **Lin Jiabin**[1] | **Zhu Shanshan**[2] | **Yang Kaixin**[1] | **Lai Xiaomei**[1] | **Wu Shengyu**[1] | **Liu Xian**[1]

[1]School of Physical Education, Changchun Normal University, Changchun, China

[2]School of Physical Education, Northeast Normal University, Changchun, China

Correspondence
Lin Jiabin, School of Physical Education, Changchun Normal University, Changchun130032, China.
Email: 397810086@qq.com

Zhu Shanshan, School of Physical Education, Northeast Normal University, Changchun, China.
Email: zhuss548@nenu.edu.cn

Funding information
This work was supported by the Humanities and Social Science Fund Project of the Ministry of Education of China under Grant 22YJC89057; Humanities and Social Sciences Project Fund of the Jilin Province under Grant 2021C100; Humanities and Social Sciences Project Fund of the Jilin Provincial Department of Education under Grant JJKH20240985SK; Social Science Foundation of Changchun Normal University under Grant CSJJ2024003GSK; Project Fund of Jilin Association for Higher Education under Grant JGJX24D0363.

Abstract

With physical inactivity becoming a worldwide crisis, physical literacy is recognized as a potential gateway for the promotion of physical activity. This study intended to examine the relationship between physical literacy and physical activity and examine whether there exist potential moderators of this relationship. Six databases including PubMed, ScienceDirect, ProQuest, Web of Science, ERIC, and PsycINFO were searched on April 11th, 2024 for the last time. Random-effects meta-analyses were conducted to examine the strength between physical literacy and physical activity, with subgroup analyses and meta-regression analyses applied to examine the potential moderators. A total of 3,932 articles were identified, of which only 26 studies were included after undergoing title, abstract, and full-text screening. There was a positive and moderate correlation ($r = 0.369$) between physical literacy and physical activity, with physical activity intensity ($Q = 11.608$, $p < 0.05$) and the selection of physical activity assessments ($Q = 9.523$, $p < 0.05$) serving as moderators in this relationship. As for gender, the selection of physical literacy assessments, mean age,

and sample size, their moderating role wasn't significant. Future research regarding physical literacy and physical activity should pay more attention to relevant moderators and conduct more longitudinal studies to explore the dynamic change in their relationship over time.

KEYWORDS
meta-analysis, moderator, physical activity, physical literacy

INTRODUCTION

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization, 2020). Physical inactivity has become a "global public crisis" (Guthold et al., 2020). One-third of adults and 81% of students aged 11–17 worldwide are not physically active enough, and the prevalence of physical inactivity is rising in more than 100 countries (Guthold et al., 2020; Strain et al., 2024). Lack of physical activity is a predominant risk element for deaths due to non-communicable diseases, and individuals with inadequate physical activity face a 20% to 30% higher risk of mortality than those who maintain sufficient levels of exercise (World Health Organization, 2022).

Physical literacy is drawing more focus as a possible pathway to engaging in physical activities (Dudley et al., 2017; Edwards et al., 2017; Longmuir & Tremblay, 2016). At present, physical literacy is generally recognized as a multi-dimensional construct, despite the diversity in its definition (Edwards et al., 2017; Tremblay et al., 2018; Whitehead, 2013). According to the International Physical Literacy Association (IPLA), physical literacy can be described as the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life (International Physical Literacy Association, 2017). In Canada, the definition of physical literacy was derived from the IPLA and was supported by a joint consensus statement from leading non-governmental stakeholders in physical activity promotion (International Physical Literacy Association, 2015; Keegan et al., 2019; Longmuir et al., 2015). Moreover, to better reflect its specific cultural and political context, Australia developed a tailored definition. Physical literacy refers to the integration of physical, psychological, social, and cognitive capabilities that help us live active, healthy, and fulfilling lifestyles (Sport Australia, 2020). The Australian Physical Literacy Framework, which incorporates four domains (physical, psychological, social, and cognitive) and 30 corresponding elements, further elaborates on the IPLA definition. Diverse measurement tools, grounded in different definitional dimensions, currently exist. According to Barnett et al. (2023), the instruments primarily comprise self-report measures, including the Physical Literacy in Children Questionnaire (for children) (Barnett, Mazzoli, Bowe, et al., 2022; Barnett, Mazzoli, Hawkins, et al., 2022), the Adolescent Physical Literacy Questionnaire (Mohammadzadeh et al., 2022), Chinese Assessment and Evaluation of Physical Literacy (Chen et al., 2020), Portuguese Physical Literacy Assessment Questionnaire (Mota et al., 2021), Perceived Physical Literacy Inventory (Sum et al., 2018), and Perceptions of Physical Literacy for Middle-School Students (for adolescents) (Dong, 2021), and the Physical Literacy Charting Tool (no age specification)

(International Physical Literacy Association, 2018). The PLAYcoach is a proxy-report instrument designed for coaches (Caldwell et al., 2021). Mixed assessment approaches, combining self-report and observation, include the Canadian Assessment of Physical Literacy Second Edition (Longmuir et al., 2018), Passport for Life (Lodewyk & Mandigo, 2017), PLAYfun and PLAYself (Cairney, Veldhuizen, et al., 2018; Jefferies et al., 2021).

The majority of studies have identified a positive relationship regarding physical literacy with physical activity (Bremer et al., 2019; Choi et al., 2018; McKay et al., 2023; Nezondet, Gandrieau, Nguyen, & Zunquin, 2023; She et al., 2023). For example, children identified with a high physical literacy profile exhibited enhanced involvement in physical activity (Brown et al., 2020). However, the strength of the correlation coefficient relating physical literacy to physical activity was disputed. Some studies indicated that correlation coefficients (*r* values) were less than 0.3 (Melby et al., 2022; Tang et al., 2023; Yan et al., 2023), whereas others reported r values of 0.5 or higher (Farren et al., 2021; Kesic et al., 2022; Nezondet, Gandrieau, Bourrelier, et al., 2023). Besides, there were also studies that presented a negative (Choi et al., 2023) or an inapparent relationship between the two (Brandelli et al., 2022; Li, Sum, et al., 2021). Therefore, due to the lack of an overview about the relationship and the existence of different research results on the relationship, it is difficult to draw a conclusion.

Moreover, other potential elements might influence the connection regarding physical literacy with physical activity. A study reported that boys gained significantly higher overall physical literacy scores than girls (Belanger et al., 2018). This result is consistent with other research demonstrating that girls are linked to lower physical literacy scores than boys (Melby et al., 2023). Moreover, as for meeting physical activity guidelines, girls had decreased odds of meeting physical activity guidelines compared to boys, but whether there are significant differences is controversial (Belanger et al., 2018; Mazzoli et al., 2024). Similar findings were observed in other global research, which revealed that the prevalence rate of physical inactivity is higher among girls than boys (Strain et al., 2024). Recent studies found that correlation coefficients (*r* values) between physical literacy and physical activity varied with gender (Kesic et al., 2022; Melby et al., 2023), indicating that gender may be a potential moderator for these two variables.

Besides gender, age may also be a potential factor affecting an individual's physical literacy and physical activity. According to Cairney, Veldhuizen, et al. (2018), PLAYfun scores tended to increase with age, which aligns with expected developmental progression. Furthermore, physical activity decreased significantly with age, and the downward trend was more pronounced on weekends (Jago et al., 2020; Nader et al., 2008). In one study, differences in correlation coefficients between perceived physical literacy and physical activity were observed, both before and after controlling for gender and age (Ortega-Benavent et al., 2024). As such, this study centers on the potential moderating effect of age on the link involving physical literacy along with physical activity.

Moreover, the connection regarding physical literacy with physical activity may depend on physical activity intensity. A study reported a significant association relating physical literacy to three different physical activity intensities: light physical activity (LPA), moderate physical activity (MPA), and vigorous physical activity (VPA), with physical literacy being most strongly associated with vigorous physical activity (Gandrieau et al., 2023). This is similar to another study, which showed that the correlation *r* values between physical literacy and moderate-to-vigorous physical activity (MVPA) were higher than those between physical literacy and light physical activity (Yan et al., 2022). Hence, our research regards physical activity intensity as a potential moderator.

Finally, to identify more potential moderators and gain a deeper comprehension about the connection regarding physical literacy with physical activity, we examined studies presenting differing results on this relationship. Currently, three types of associations connecting physical literacy to physical activity have been reported: a significant positive correlation, no correlation, and a negative correlation (Brandelli et al., 2022; Choi et al., 2023; Li, Sum, et al., 2021). Further analysis revealed substantial variations among these studies in terms of physical literacy assessments, physical activity measurements, and sample sizes. For instance, in the same study, the *r* value was significant when the Perceived Physical Literacy Instrument was employed for assessing physical literacy, but became non-significant with the use of the Canadian Assessment of Physical Literacy Second Edition (CAPL-2) (Li, Sum, et al., 2021). Therefore, we hypothesized that these three factors might serve as potential moderators and incorporated them into our study for further examination.

In summary, numerous factors, including gender, age, physical activity intensity, physical literacy assessments, physical activity assessments as well as sample size, may account for the differences in the link uniting physical literacy with physical activity. When interpreting research findings and drawing conclusions about this relationship, it is reasonable to consider these variables, along with their respective influences and implications.

Due to the above all, there are still some questions that are not clear and need to be explored. (1) What is the relationship between physical literacy and physical activity? If they are related, what is the strength of the correlation? (2) Are there some potential moderators for this relationship?

Therefore, this study aims to (1) explore the relationship between physical literacy and physical activity, as well as evaluate the strength of their association; (2) explore whether there exist potential moderators (i.e., gender, age, physical activity intensity, physical literacy assessments, physical activity assessments, and sample size) for the connection relating physical literacy to physical activity.

METHODS

Registration and search strategy

This systematic review and meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) and was pre-registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD42024530594.

In order to find relevant articles, six major databases including PubMed, ScienceDirect, ProQuest, Web of Science, ERIC, and PsycINFO were searched on April 11th, 2024 for the last time. The following was our search strategy: ("physical literacy" AND "physical activity OR exercise OR body activity OR body movement"). In some databases, it was more convenient to search after dividing the search items such as "physical literacy" AND "physical activity", "physical literacy" AND exercise, "physical literacy" AND "body activity" and "physical literacy" AND "body movement". Moreover, reference lists of all included articles were examined for additional papers.

The screening process was conducted using EndNote X9. After removing duplication automatically and manually, two authors (YY and YKX) selected the articles independently according to the title, abstract, and full text. When there was divergence, the article was sent to a third author (LJB), and the final consensus was reached after discussion.

Inclusion/exclusion criteria

This research only comprised studies that (1) reported physical literacy along with physical activity for the same individuals, as measured by objective instruments or self-reported questionnaires, and employed physical literacy assessment tools evaluating at least three dimensions of physical literacy; (2) mentioned the connection relating physical literacy to physical activity; (3) emphasized physical literacy's influence on physical activity and the direction cannot be reverse; and (4) were cross-sectional, cohort studies and longitudinal studies, and were published in peer-reviewed journals and written in English until the date last searched April 11, 2024.

Studies were excluded if they were books, review articles, meta-analyses, editorials, protocol papers, workshops, reports, unpublished dissertations, conference abstracts, or systematic reviews.

Data extraction

In terms of data extraction, two authors (YY and LJB) collaborated to complete this process employing Microsoft Excel. A data extraction template was designed, which included authors, year of publication, sample characteristics (number, age, sex ratio), study design, physical literacy assessments, physical activities assessments, mediator, moderator, covariate, and association between physical literacy and physical activity. When multiple effect sizes were reported within a single study, each was extracted and analyzed independently.

Risk of bias assessment

Similar to Cattuzzo et al. (2016), De Meester et al. (2020), and Burton et al. (2023), the criteria for assessing the risk of bias about the included articles were adapted from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Von Elm et al., 2007) and the Consolidated Standards of Reporting Trials (CONSORT) statement (Schulz et al., 2010). Six criteria (Table 1), which were most significant in our opinion, were used to evaluate the risk of bias. We scored the situation of meeting the criteria with a different symbol. A tick ("✓") meant low risk of bias. A cross ("X") signified a high risk of bias, and a question mark ("?") presented an unclear expression. To enhance objectivity in risk bias evaluation, two authors, YY and LXM, looked through 6 articles independently and then discussed together the details of the criteria. Afterwards, they completed the process of screening. When there was a different opinion, they turned to a third author LJB, and reached a consensus after discussion.

Meta - analysis

On the basis of the correlations reported in the included studies, the primary outcome was the pooled correlation coefficient (effect size) between physical literacy and physical activity. All correlation coefficients (r) reported were used, such as Pearson's and Spearman's correlation coefficients. If there was a regression β coefficient, it was transformed into Pearson's correlation coefficients according to the following formula: $r = \beta + 0.05\lambda$ ($\lambda = 1$, when β is

TABLE 1 Overview of criteria for bias risk evaluation.

Statement	Responses
1. Was the study effectively detailed regarding the methods for selecting participants and the criteria for their inclusion?	✓ The study employed a random sampling approach for the target group. The criteria for participant inclusion were explicitly detailed, and/or the authors provided a clear summary of the participants' demographic details (at least including age and gender). × The study used convenience sampling. Neither the criteria for participant inclusion nor their demographic information were provided. ? The criteria for participant inclusion, sampling method, or demographic information were not adequately and clearly explained.
2. Did the study explicitly outlined the physical literacy Measurement tools employed?	✓ The physical literacy assessment(s) were thoroughly described, the source was cited, and the measurement tools' validity about the specific group was explicitly mentioned, or prior studies confirming their reliability were cited. For individual measures employed, they were fully detailed and validated. × The physical literacy measurement tools were not described or cited, or the measurement tools' validity for the specific group was not evidently described, and no prior validation study was cited. For individual measures employed, they were not fully detailed and validated. ? Due to insufficient description, it was unclear about the validity of the employed measurement tool.
3. Did the study offered adequate reliability data for the physical literacy measurement tools utilized?	✓ At least one acceptable reliability statistic was prominently noted (e.g., Cronbach's alpha ≥ 0.70 or test–retest reliability ICC ≥ 0.60, as per Brown et al. [2009]) or the previous reliability of the instrument was clearly stated and referenced. × Reliability data were not reported, or at least one reliability statistic was unacceptable (e.g., Cronbach's alpha < 0.70 or test–retest reliability ICC < 0.60), or a single item of a physical literacy assessment was used to assess reliability, and the previous reliability of the instrument was not clearly stated or referenced. ? The description was insufficient, making it unclear whether a reliable measure was used.
4. Did the study provide a clear description of the physical activity measurement tools utilized?	✓ The physical activity assessment(s) were clearly delineated, sources were cited, and the measurement tools' validity for the specific group was explicitly described, or prior studies confirming their reliability were cited. For individual measures employed, they were fully detailed and validated. × The physical activity assessment(s) were not delineated or cited, or the measurement tools' validity about a specific group was not clearly described, and

TABLE 1 (Continued)

Statement	Responses
	no prior studies confirming their reliability were cited. Individual measures were not delineated, and validation data were absent. ? It was unclear whether a valid measure was used due to an insufficient statement.
5. Did the study supply adequate reliability data for physical activity measurement tools utilized?	✓ One or more acceptable reliability statistics were clearly indicated (e.g., Cronbach's alpha ≥ 0.70 or test–retest reliability ICC ≥ 0.60, Brown et al. [2009]) or the previous reliability of the instrument was clearly stated and referenced. × Reliability data were not disclosed, or at least one reliability statistic was not acceptable (e.g., Cronbach's alpha < 0.70 or test–retest reliability ICC < 0.60), or a single-item physical activity assessment was used to gauge reliability, and the previous reliability of the instrument was not clearly stated or referenced. ? The description was insufficient, making it unclear whether a reliable measure was used.
6. Among study volunteers, was a sufficient percentage able to provide full data about physical literacy and physical activity measurement tools?	✓ The data presented in the article indicated that a minimum of 80% of participants in cross-sectional studies and 70% in longitudinal studies finished all assessments. × The data presented in the article indicated that less than 80% of participants in cross-sectional studies, and less than 70% in longitudinal studies, finished all assessments. ? Insufficient detail makes it ambiguous to determine the completion rate among all participants

Note: ICC intraclass correlation coefficient, ✓ indicates a low risk of bias, × indicates a high risk of bias, ? indicates unclear expression.

positive, and 0, when β is negative) (Peterson & Brown, 2005). Afterward, the entire set of values underwent conversion via Fisher's z-transformation to achieve a near-normal distribution. Following this, they were inversely transformed from Fisher's z-scores back into Pearson's r values, thereby enhancing the interpretability of the effect size (r). We performed all the relevant computations and analyses of meta-analysis utilizing Comprehensive Meta-Analysis (CMA, Version 3.0).

The strength regarding physical literacy with physical activity was examined by random-effects meta-analyses. Moreover, the heterogeneity test was used to examine whether the average effect size was heterogeneous and significant. P-values less than 0.05 were deemed statistically significant. Heterogeneity was assessed using Cochrane's Q and I^2 statistics, with I^2 values exceeding 50% and 75% signifying moderate and high heterogeneity, separately (Higgins et al., 2003; Higgins & Thompson, 2002).

Sensitivity analysis was conducted to examine the stability of the combined effect size. Specifically, each study was excluded one by one, and the combined effect size of the remaining studies was compared with the overall effect size to determine the effect size of each included

study on the overall result. The funnel plot, Egger's regression, and Rosenthal's Fail-safe *N* were used to evaluate the publication bias of the included studies.

For the purpose of finding the source of high heterogeneity, we conducted subgroup analysis and meta-regression analysis for the potential moderators between physical literacy and physical activity.

RESULTS

Description of studies and overall association

The search of six databases (PubMed, ScienceDirect, ProQuest, Web of Science, ERIC, PsycINFO) and citation searching contributed to 2,161 potentially relevant articles in total (after the removal of duplicates). Following the screening of abstracts and titles, 73 full-text articles were obtained and examined. Finally, 26 articles satisfied the inclusion criteria and were incorporated into this review. Figure 1 depicts the flow diagram of articles during the screening procedure along with the exclusion rationale. The data extraction of the included studies was detailed in the "Overview of Included Studies" table in the supplementary material.

There were 44 effect sizes, which were generated by 26 eligible studies. Because 12 studies were composed of multiple datasets. We examined the correlation regarding physical literacy with physical activity. Figure 2 shows that under the random effects model, the correlation coefficient r ($x = 44$) of the relationship between them was 0.369 (95% CI: 0.203, 0.514; $Z = 4.183$, $p < 0.001$). According to Cohen (1988), $0.30 \leq r < 0.50$ indicated a moderate positive correlation.

Overview of study risk of bias

Table 2 displays an overview of the study risk of bias. Three studies satisfied six criteria (Choi et al., 2018; Gandrieau et al., 2023; Ma et al., 2020). Eight studies met five criteria (Bremer et al., 2019; Li, Sum, et al., 2021; McKay et al., 2023; Melby et al., 2022; Ortega-Benavent et al., 2024; She et al., 2023; Yan et al., 2023; Zhang et al., 2022). Six studies conformed to four criteria (Blain et al., 2021; Yan et al., 2022; Choi et al., 2023; Nezondet, Gandrieau, Bourrelier, et al., 2023; Öztürk et al., 2023; Wang et al., 2023). Seven studies (Brandelli et al., 2022; Coyne et al., 2019; Dong et al., 2023; Kesic et al., 2022; Li, Wang, et al., 2021; Melby et al., 2023; Tang et al., 2023) conformed with three criteria, and only one study (Farren et al., 2021) corresponded with two criteria. No study met only one criterion. Among these criteria, all included studies met the second criterion (100%). As for the least satisfied criterion, the first criterion accounted for 46%. The majority of the articles (65%) met four or more of the established criteria.

Heterogeneity test

The heterogeneity test ($x = 44$) indicated $Q = 11968.270$ ($p < 0.001$), $I^2 = 99.641$. According to Higgins et al. (2003), there existed high heterogeneity. This high heterogeneity could stem from several factors, including differences in sample demographics, such as age (range: 7.8–68.2 years)

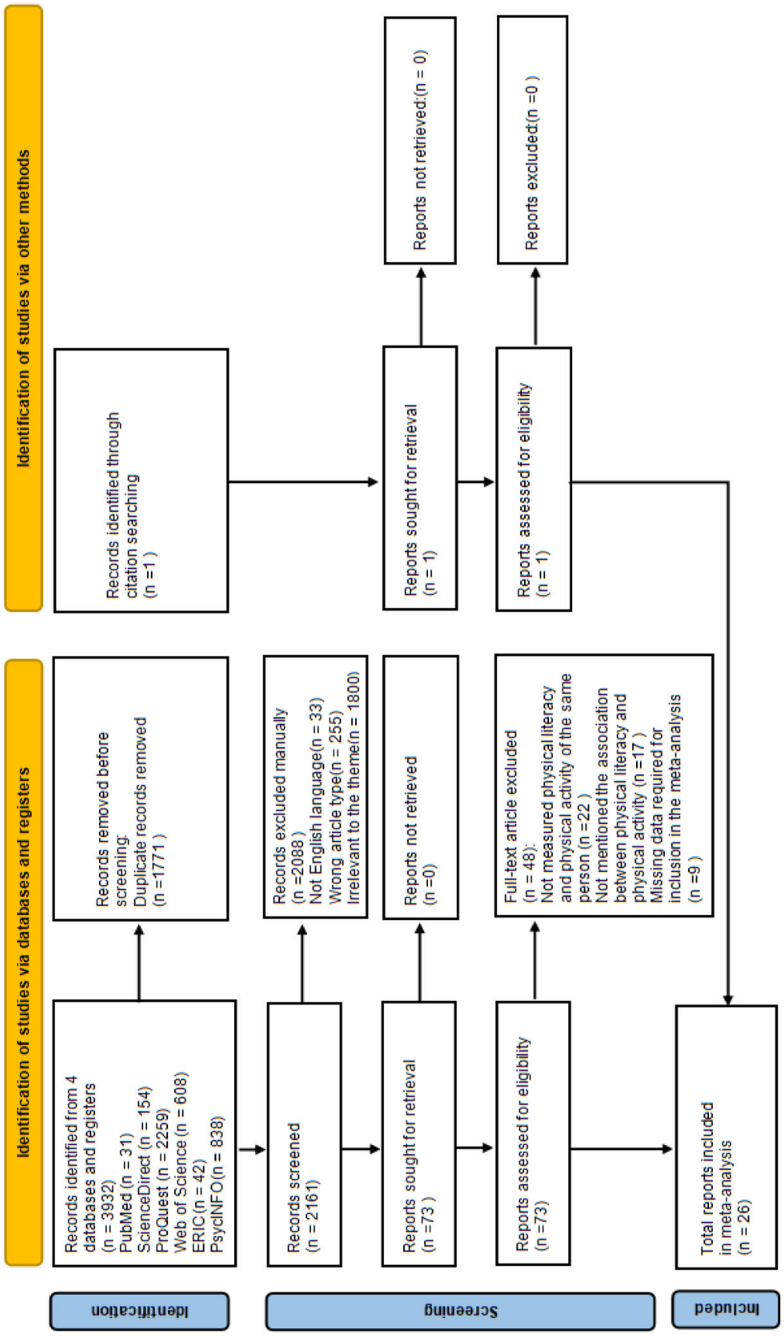

FIGURE 1 Flow diagram of the articles screening procedure.

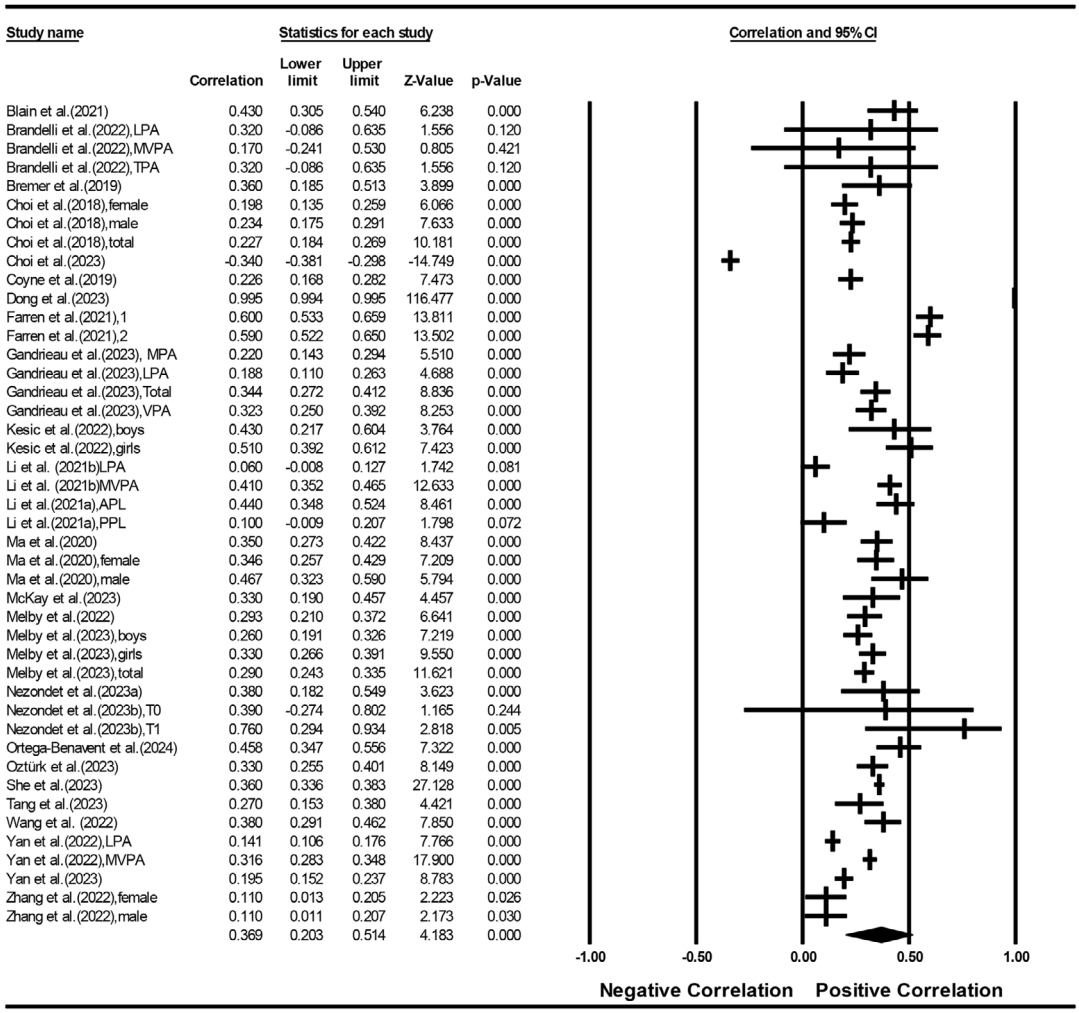

FIGURE 2 Forest plots showing the pooled correlation coefficients between physical literacy and physical activity ($r \pm 95\%$ confidence interval [CI]); note: LPA: light physical activity; MVPA: moderate-to- vigorous physical activity; TPA: total physical activity; VPA: vigorous physical activity; APL: actual physical literacy; PPL: perceived physical literacy.

and sample size (range: 11–5,184), and, in certain cases, the stratification of participants by sex. Furthermore, the variations in the measurement tools used for physical literacy and physical activity, the different focus on physical activity intensity (LPA, MVPA), and cultural background differences among the studies may have also played a role. If there was a non-ignorable heterogeneity or a big difference across the studies, it is more reasonable to apply a random effect model (Borenstein et al., 2021; Huedo-Medina et al., 2006). To explore the potential reasons of high heterogeneity, we conducted subgroup analysis and meta-regression analysis.

Sensitivity analysis and publication bias

We conducted a sensitivity analysis to inspect the stability of the combined effect size. After removing studies one by one, the connection relating physical literacy to physical activity

TABLE 2 Risk of bias assessment overview.

Reference	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
Blain et al. (2021)	?	✓	✓	✓	✓	×
Brandelli et al. (2022)	×	✓	✓	?	?	×
Bremer et al. (2019)	✓	✓	✓	✓	✓	?
Choi et al. (2018)	✓	✓	✓	✓	✓	✓
Choi et al. (2023)	?	✓	✓	✓	✓	?
Coyne et al. (2019)	×	✓	?	✓	?	✓
Dong et al. (2023)	×	✓	✓	✓	?	?
Farren et al. (2021)	?	✓	?	?	?	✓
Gandrieau et al. (2023)	✓	✓	✓	✓	✓	✓
Kesic et al. (2022)	?	✓	✓	✓	?	×
Li, Sum, et al. (2021a)	?	✓	✓	✓	✓	✓
Li, Wang, et al. (2021b)	✓	✓	✓	?	?	×
Ma et al. (2020)	✓	✓	✓	✓	✓	✓
McKay et al. (2023)	✓	✓	✓	✓	✓	×
Melby et al. (2023)	✓	✓	✓	?	×	×
Melby et al. (2022)	?	✓	✓	✓	✓	✓
Nezondet, Gandrieau, Bourrelier, et al. (2023)	?	✓	✓	✓	✓	×
Nezondet, Gandrieau, Nguyen, and Zunquin (2023)	?	✓	✓	✓	?	✓
Ortega-Benavent et al. (2024)	?	✓	✓	✓	✓	✓
Öztürk et al. (2023)	✓	✓	?	✓	?	✓
She et al. (2023)	×	✓	✓	✓	✓	✓
Tang et al. (2023)	?	✓	✓	✓	?	×
Wang et al. (2023)	✓	✓	✓	✓	?	?
Yan et al. (2023)	✓	✓	?	✓	✓	✓
Yan et al. (2022)	✓	✓	?	✓	?	✓
Zhang et al. (2022)	✓	✓	✓	✓	?	✓

Note: ✓ indicates a low risk of bias, × indicates a high risk of bias, ? indicates unclear expression.

remained positive and moderate, indicating that there were no abnormal studies to eliminate. Funnel plots, Egger's test, and Rosenthal's Fail-safe *N* were employed to identify potential publication bias. High funnel symmetry indicated low publication bias, while low funnel symmetry suggested possible publication bias. As shown in Figure 3, there was a slight asymmetry at the top of the funnel plot. Since the interpretation of the funnel plot was of high subjectivity, the publication bias was also checked using Egger's test (Egger et al., 1997). The outcome of Egger's test was that $t\,(44) = 0.056$, $p = 0.956$. No statistically significant showed that there was less likelihood of publication bias. According to Rosenthal (1986), Rosenthal Fail-safe *N* is greater than $5\,k + 10$ (k is the number of included studies) indicating that the possibility of publication bias is small. The result was $N_{fs} = 1{,}566 > 5\ k + 10$ ($k = 44$). In conclusion, there existed tiny possibility of publication bias risk in our study.

Subgroup analysis

For the purpose of finding the origins of high heterogeneity, subgroup analyses were conducted including gender, physical activity intensity, physical literacy assessments as well as physical activity assessments. As shown in Table 3, the results revealed that physical activity intensity significantly moderated the connection regarding physical literacy with physical activity ($Q = 11.608$, $p < 0.05$). Meanwhile, the subgroup analysis results of physical activity assessments showed that the Q test reached a significant level ($Q = 9.523$, $p < 0.05$), indicating the existence of moderating effects for the selection of physical activity assessments. However, as for gender and the selection of physical literacy assessments, the results were $Q = 0.990$, $p > 0.05$; and $Q = 0.159$, $p > 0.05$, respectively, suggesting that the two variables did not play a moderating role in the connection relating physical literacy to physical activity. Since some included articles treated gender as a covariate, this potentially influenced the results for gender. After excluding the articles that used gender as a covariate, we conducted a new subgroup analysis, and the moderating role of gender remained non-significant ($Q = 0.840$, $p > 0.05$).

To further investigate the impact of physical literacy assessments and physical activity assessments, we categorized the measurement tools according to their types. As shown in Table 4, neither the types of physical literacy assessments ($Q = 0.777$, $p > 0.05$) nor the types of physical activity assessments ($Q = 0.715$, $p > 0.05$) significantly moderated the relationship between physical literacy and physical activity.

Meta-regression analysis

Meta-regression analysis was used to test whether the mean age and sample size had a significant impact on the connection regarding physical literacy with physical activity. In Table 5, the moderating effects of mean age ($Beta = 0.0028$, $p > 0.05$) and sample size ($Beta = 0$, $p > 0.05$) were not significant, indicating that they did not play a moderating role in the connection regarding physical literacy with physical activity. Given that some included articles utilized age as a covariate, which might have influenced the age-related results, articles using age as a

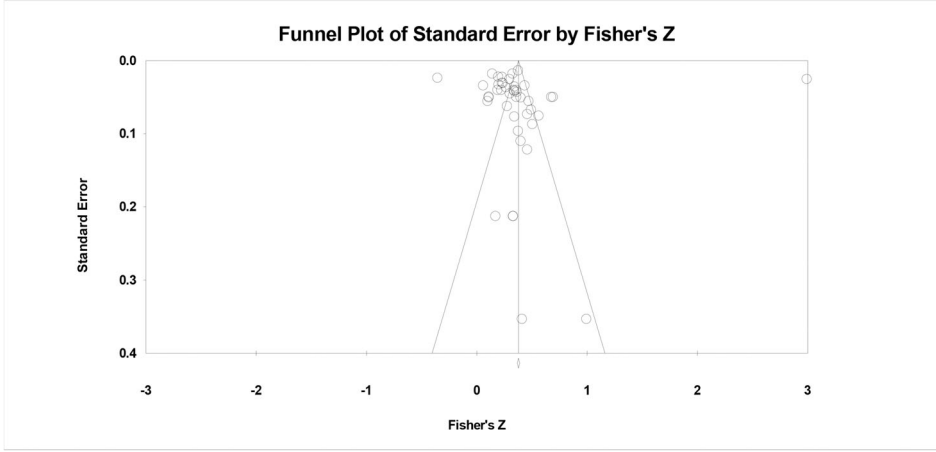

FIGURE 3 Funnel plot of all the effect size ($x = 44$).

TABLE 3 The results of the subgroup analysis.

Moderator	Subgroup	*X*	Effect size and 95% interval			Heterogeneity		
			r	Lower	Upper	*Q*	Df (*Q*)	*P*
Gender								
	Blank	34	0.388	0.183	0.560			
	Female	5	0.297	0.184	0.403			
	Male	5	0.276	0.179	0.368			
	Total between					0.990	2.000	0.609
Physical activity intensity								
	Blank	26	0.428	0.157	0.639			
	LPA	4	0.133	0.072	0.193			
	MVPA	14	0.264	0.201	0.325			
	Total between					11.608	2.000	0.003
Physical literacy assessments								
	Blank	14	0.385	0.311	0.455			
	PLAYself	6	0.398	0.302	0.486			
	PPLI	24	0.348	0.089	0.564			
	Total between					0.159	2.000	0.924
Physical activity assessments								
	Accelerometer	9	0.299	0.186	0.405			
	Blank	14	0.347	0.281	0.410			
	IPAQ-LV	3	0.366	0.307	0.422			
	IPAQ-SF	15	0.372	−0.004	0.655			
	PAQ-A	3	0.474	0.400	0.542			
	Total between					9.523	4.000	0.049

Note. *X*: number of effect sizes; Blank: lack of relevant data; LPA: light physical activity; MVPA: moderate-to vigorous physical activity; PLAYself: physical literacy assessment for youth; PPLI: perceived physical literacy instrument; IPAQ-LV: international physical activity long version; IPAQ-SF: international physical activity questionnaire short form; PAQ-A: physical activity questionnaire for adolescents.

covariate were excluded. A new meta-regression analysis was then performed, showing that the moderating role of age was still non-significant ($Beta = 0.0025$, $p > 0.05$).

DISCUSSION

Overview of findings

The first purpose of our research was to outline the strength of correlation involving physical literacy along physical activity. Generally, in our study, the *r* value of the two variables was 0.369, which indicated that there was a positive and moderate correlation between physical

TABLE 4 The results of the further subgroup analysis of assessment tools.

Moderator	Subgroup	*X*	Effect size and 95% interval			Heterogeneity		
			r	Lower	Upper	*Q*	Df (*Q*)	*P*
Physical literacy assessments								
	Blank	1	0.360	0.185	0.513			
	Combined	9	0.432	0.303	0.544			
	Self-reported	34	0.346	0.144	0.520			
	Total between					0.777	2.000	0.678
Physical activity assessments								
	Objective	11	0.289	0.208	0.367			
	Self-reported	33	0.379	0.180	0.547			
	Total between					0.715	1.000	0.398

Note: X: number of effect sizes; Blank: lack of relevant data. Combined: a mix of self-reported and objective measures.

TABLE 5 The results of the meta-regression analysis.

Moderator	*X*	*Beta*	Standard error	95%CI	*Z*	*P*
Mean age	27	0.0028	0.0128	(−0.0223,0.0279)	0.2200	0.8263
Sample size	44	0.0000	0.0001	(−0.0002,0.0002)	−0.0800	0.9394

Note. *X*, number of effect size**s.**

literacy and physical activity. Drawing from comprehensive effect size data of existing studies, this finding provided theoretical support for physical literacy as a possible contributor to physical activity, offering a novel strategy to address the global crisis of physical inactivity (Edwards et al., 2017; Yan et al., 2023). Furthermore, physical literacy, a multi-dimensional concept, encompasses both physical abilities and the motivation, confidence, and other internal factors essential for physical activity participation (International Physical Literacy Association, 2017). Education departments worldwide should reform traditional physical education teaching methods, which are confined to the cultivation of physical abilities alone, to prioritize fostering physical literacy among children and adolescents, thereby fostering their habits and comprehensive abilities for lifelong physical activity engagement. Regular physical activity participation is conducive to physical and mental health, and reduces the risks of illness and mortality (Biddle et al., 2019; Warburton & Bredin, 2017).

Our study also aimed to examine whether there exist potential moderators (i.e., gender, age, physical activity intensity, physical literacy assessments, physical activity assessments, and sample size) for the connection relating physical literacy to physical activity. First, inconsistent with the previous study (Cairney, Clark, et al., 2018), in our systematic review and meta-analysis, gender wasn't a significant moderator for the correlation relating physical literacy to physical activity. Although the effect size for females was a little higher than that for males, the difference wasn't significant. It was worth pointing out that of the 26 studies included, six regarded gender as a covariate, which might weaken the effect of gender in the analyzed data (Bremer et al., 2019; Li, Sum, et al., 2021; Melby et al., 2022; Yan et al., 2022; She et al., 2023; Tang

et al., 2023). Therefore, we conducted a new subgroup analysis excluding studies that used gender as a covariate. However, irrespective of whether articles using gender as a covariate were excluded, both subgroup analyses revealed no significant moderating effect of gender. Moreover, for some physical literacy assessments, gender differences were already taken into account in the questionnaire design. For instance, the Physical Literacy in Children Questionnaire (PL-C Quest) was carefully designed to include a diverse range of activities that boys and girls play, such as skateboarding and skipping rope, to minimize potential gender-related biases. Additionally, the central figure in each image was crafted to be gender-neutral, ensuring the scale's applicability to children of any gender identity (Barnett, Mazzoli, Hawkins, et al., 2022). Meanwhile, in the physical domain, the CAPL-2 employed different scoring criteria for the two genders taking the same test. If a girl and a boy aged 10 held the plank for the same duration of 25 seconds, the girl's physical literacy was categorized as being in the beginning stage, while the boy's was in the progressing stage (Longmuir et al., 2018). Moreover, the limited availability of correlation coefficients (*r* values) for both sexes in the included studies might also have had an impact. In our 26 included studies, only 5 provided detailed *r* values for both genders. The lack of abundant data on different genders might also be a possible reason for this insignificant result.

Second, it was reported in our study that age did not play a moderating role in the relationship regarding physical literacy with physical activity. It should be noted that with a wide range of ages in each included article, age was just calculated as the mean age in the meta-regression analysis. As such, potential age-related influences were carefully balanced and standardized across the respective studies. Similarly, in our systematic review and meta-analysis, more than a quarter of the included articles considered age as a control variable, further reducing the impact of age. Hence, we conducted a new meta-regression analysis after excluding studies that controlled for age. Two meta-regression analyses consistently showed that the moderating role of age between physical literacy and physical activity was non-significant, regardless of whether articles using age as a covariate were included or excluded. Besides, to truly clear whether age was the moderator between physical literacy and physical activity, it was necessary to focus on the longitudinal cohort studies. However, there were three longitudinal and cohort studies in our included studies, only one study showed a connection involving physical literacy with physical activity at two different time points (Nezondet, Gandrieau, Bourrelier, et al., 2023). The other articles just reported baseline data about the link regarding physical literacy with physical activity.

Third, regarding physical activity intensity, it significantly moderated the link connecting physical literacy to physical activity in our study. Physical literacy was more closely related to moderate-vigorous physical activity (MVPA) compared to light physical activity (LPA). According to Huang et al. (2022), changes in MVPA of primary school students were positively correlated with cardiopulmonary function. Moreover, replacing LPA and sedentary behavior with MVPA aided in cardiopulmonary enhancement and endurance. Cardiopulmonary enhancement and endurance were important reflections of personal physical ability. The Canadian Physical Activity Guidelines also recommended replacing sedentary behavior and LPA with additional MVPA, as this is the best intensity to promote good health (García-Hermoso et al., 2017; Tremblay et al., 2011). Similarly, according to other researches, individuals who possessed motivation for engaging in physical activity and confidence in their physical abilities tended to be more active and sustain higher levels of MVPA throughout their lives (Belanger et al., 2018; Tremblay, 2010). Physical ability, motivation, and confidence were three important

components of physical literacy. As such, it was not surprising that moderate-vigorous physical activity was more strongly associated with physical literacy.

Fourth, our study showed that the selection of physical literacy assessments did not play a significantly moderating role in the connection regarding physical literacy with physical activity. To ensure sufficient power and validity, subgroup analysis generally necessitates that each categorical subcategory include a minimum of three studies (van Eldik et al., 2020). Unfortunately, the number of certain assessment tool articles included in this study, such as the PL-C Quest and the CAPL-2, was insufficient to support further analysis. The data from the measurement tools used in the subgroup analysis, namely the Perceived Physical Literacy Instrument (PPLI) and PLAYself—both self-evaluation tools—lacked comparison with mixed measurement tools. Consistent with the International Physical Literacy Association's (IPLA) definition of physical literacy, both assessment tools (PPLI and PLAYself) emphasize the ability to communicate with the environment via physical activity (PA), as well as self-confidence and knowledge regarding PA. With good internal consistency and convergent validity (Jefferies et al., 2021; Ma et al., 2020), they have been proven to be reliable and valid assessments. As for Li, Sum, et al. (2021), they reported that the correlation relating physical literacy to physical activity was different when they employed different physical literacy assessments (PPLI and CAPL-2). The PPLI comprises three sub-scales: Sense of Self and Self-Confidence, Self-Expression and Communication with Others, and Knowledge and Understanding (Sum et al., 2016). The CAPL-2, measures physical literacy across four domains (Daily Behavior, Physical Competence, Knowledge and Understanding, and Motivation and Confidence), with objective measures in the Physical Competence domain including the Progressive Aerobic Cardiovascular Endurance Run (PACER), Plank Assessment, and the Canadian Agility and Movement Skill Assessment (CAMSA) (Longmuir et al., 2018). Similarly, the Daily Behavior dimension of the CAPL-2 also includes objectively measured step counts. However, such objective measurements are absent from the PPLI measurement tools. We speculated that the type of measurement—self-reported versus a mix of self-reported and objective measures—might contribute to the observed inconsistencies in the significance of the *r* value in the connection regarding physical literacy with physical activity. Therefore, we classified physical literacy assessments of our included studies into two major categories: self-reported and combined types, and performed subsequent subgroup analyses. However, the result was non-significant. This may be because the self-reported questionnaires had undergone rigorous reliability and validity testing, or it could be attributed to the substantial difference in the number of assessments between the combined and self-reported categories. Future research is encouraged to utilize multiple types of physical literacy assessments. This approach will allow for a more comprehensive exploration of how different measurement types impact the observed connection regarding physical literacy with physical activity.

Fifth, contrary to the selection of physical literacy assessments, the selection of physical activity assessments indeed moderated the association relating physical literacy to physical activity in our study. The physical activity assessments calculated in the subgroup analyses were as follows: IPAQ-LV (International Physical Activity Questionnaire Long Version), IPAQ-SF (International Physical Activity Questionnaire Short Form), PAQ-A (Physical Activity Questionnaire for Adolescents), and accelerometer. As we can see, there were both self-reported assessments and objective measurements. Among them, when the accelerometer was used as a physical activity measurement tool, the *r* value of the link regarding physical literacy with physical activity was the lowest. Triaxial accelerometers have been widely employed for monitoring physical activity of diverse populations and have shown high reliability and validity, although the sampling interval, wearing

position, and calculation method of the accelerometers might cause errors, which might affect the accuracy of the measurement results of physical activity (Xie et al., 2018). In our included articles, there were differences in sampling interval (e.g., 15 seconds, 30 Hz or 50 Hz), wearing position (e.g., waist, hip, wrist), and calculation method (MVPA: 2296 cpm; MPA: 4822 cpm, VPA: 9143 cpm) of the accelerometers. Compared to fixed questions and score criteria of the self-reported assessments, we suggested that the differences in the sampling interval, wearing position, and calculation method of the accelerometers across the included studies would be a possible reason for the lowest *r* value. Among self-reported assessments, employing the long or short forms of the IPAQ to measure physical activity, the correlation coefficients (*r* values) between physical literacy and activity showed tiny variation, with a slight increase observed when the shorter version was utilized. The long version of the IPAQ questionnaire covered five environmental areas: work, transportation, housework, leisure time, and sedentary behavior, while the short questionnaire included the frequency and duration of sitting and three types of physical activity (walking, MPA, and VPA) (Booth, 2000; Craig et al., 2003). This might be due to the fact that the samples in the included articles were college students, and some housework and work-related items in the long version were not suitable for college students' life, while the short version deleted these items and summarized them with moderate and vigorous physical activity. The connection uniting physical literacy with physical activity was strongest when the PAQ-A questionnaire was used. The reason might be that in the included articles, the PAQ questionnaire used a sample of middle and high school students to measure their physical activity levels during PE class, lunch, recess, after school, evenings, and weekends (Kesic et al., 2022; Kowalski et al., 2004; Ortega-Benavent et al., 2024). Multiple specific scenarios aligned better with students' real-life experiences, while the short version IPAQ was more general and lacked specific context settings, making it prone to recall bias. Additionally, we classified the physical activity assessments into two categories: self-reported and objective measurement types, and conducted further subgroup analyses. However, the moderating effect of the type of physical activity assessment was non-significant. This lack of significance might stem from the fact that the self-report instruments have undergone extensive reliability and validity testing and have been widely administered over extended periods, potentially resulting in minimal differences between the self-reported and objective measurement tools.

Finally, the moderating effect of sample size was not significant in our study, indicating that the link regarding physical literacy with physical activity was stable across different sample sizes. It is often thought that a sample size ≥ 30 is conducive to the realization of the Central Limit Theorem (Ross, 2017), meaning the distribution of the sample means approximates normality. The majority of samples in our included articles exceeded 30, which might be a possible reason for the insignificant moderating effect result.

Summary of risk of bias in included studies

There were possibly some risks of bias in our included studies, since only three studies met all six criteria. The highest adherence (100%) was the second criterion, which concerned specific measures or validity of physical literacy assessments. This demonstrated the current existence of some valid physical literacy assessments and showed a good example for future research. As for the lowest adherence (criterion 1), more than half of the included articles did not specify the sampling approach, participant eligibility criteria, or provided comprehensive demographic data of the participants such as age, gender and so on. To better improve articles' quality and reduce the possible

risk of bias for future meta-analysis, this result reminds authors of the necessity of providing detailed information about the methods for selecting participants and the participant's demographic description. With regard to the three articles that all satisfied the criteria, they set a good example for later research (Choi et al., 2018; Gandrieau et al., 2023; Ma et al., 2020).

Directions for future research

This systematic review and meta-analysis provide useful insights and guidance for future studies, as outlined below. First, to better understand whether age plays a moderating role in the connection relating physical literacy to physical activity, future research should conduct more longitudinal studies. Second, although the average age across the included studies ranged from 7.8 to 22.1 years, only one study included older adults (mean age = 68.2 years), highlighting a notable lack of middle-aged and older adult participants. Future research are supposed to focus on the connection regarding physical literacy with physical activity among adults of middle and older ages. Third, to fully understand how different physical literacy assessments and physical activity assessments affect the relationship, it is advisable to use different assessment tools on the same sample. Especially for physical literacy measurement, consider self-reported questionnaires and assessments that combine subjective and objective measurement. For physical activity tools, pedometers, accelerometers, and physical activity questionnaires should be selected to explore differences in measuring effects between subjective and objective methods. Fourth, future research is prompted to take gender differences into account when investigating the link involving physical literacy along with physical activity. Investigating this association within gender-specific groups will contribute to a more nuanced understanding of this relationship and potentially inform more targeted interventions. Fifth, given the limited number of included studies focusing on the relationship between physical literacy sub-dimensions and physical activity, this study examined the overall connection. Future research could be more detailed, exploring the association between each physical literacy dimension and physical activity. This will facilitate the precise measurement of each dimension's impact and provide a basis for formulating more tailored physical activity interventions. Sixth, future research is invited in investigating the connection relating physical literacy to different intensities of physical activity, specifically examining how an individual's physical literacy level affects their time allocation and participation patterns across activities of varying intensities. Additionally, longitudinal designs are recommended to track the dynamic interplay of mutual promotion or inhibition between physical literacy and participation in specific intensity activities over time.

Strengths and limitations

This study was relatively original and comprehensive, since we not only explored the correlation and the degree of correlation between physical literacy and physical activity, but also examined six potential moderators between the two variables. Besides, there was no publication year limit; we searched as many possible studies as we could until the latest search on April 11, 2024. In addition, we followed PRISMA guidelines (Page et al., 2021), searched multiple databases, developed strict inclusion criteria, and used multiple screeners to improve the objectivity of included articles.

When it came to limitations, our study only involved English articles. There was a lack of non-English studies. Moreover, the majority of studies paid attention to the samples of children, adolescents, and college students, so that there was a dearth of other age groups. Furthermore, as for moderators such as gender, physical activity intensity, physical literacy assessments, and physical activity assessments, only a few included articles provided complete information. Therefore, our data in the subgroup analyses were quite limited. Besides, the most included studies used a cross-sectional approach, with a relative paucity of longitudinal studies, making it hard to determine causal relationships or dynamic changes.

CONCLUSION

There was a positive and moderate correlation between physical literacy and physical activity, with physical activity intensity and the selection of physical activity assessments serving as moderators in this relationship. As for gender, the selection of physical literacy assessments, mean age, and sample size, their moderating role wasn't significant. Future research should consider these potential moderators when evaluating the connection regarding physical literacy with physical activity. When developing strategies for physical literacy to promote physical activity, the role of moderators should not be overlooked. More longitudinal studies are encouraged to better clarify the dynamic change of the connection relating physical literacy to physical activity over time.

ACKNOWLEDGMENTS
We appreciate and thank all the collaborators for their effort.

DATA AVAILABILITY STATEMENT
The datasets generated and/or analysed during this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST STATEMENT
The authors report there are no competing interests to declare.

ETHICS APPROVAL STATEMENT
Not Apply.

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES
Not Apply.

CLINICAL TRIAL REGISTRATION
This study was pre-registered in the International Prospective Register of Systematic Reviews (PROSPERO). The registration number is CRD42024530594.

ORCID
Lin Jiabin https://orcid.org/0000-0002-9593-3844

REFERENCES

Barnett, L. M., Jerebine, A., Keegan, R., Watson-Mackie, K., Arundell, L., Ridgers, N. D., Salmon, J., & Dudley, D. (2023). Validity, reliability, and feasibility of physical literacy assessments designed for school children: A systematic review. *Sports Medicine*, *53*(10), 1905–1929. https://doi.org/10.1007/s40279-023-01867-4

Barnett, L. M., Mazzoli, E., Bowe, S. J., Lander, N., & Salmon, J. (2022). Reliability and validity of the PL-C quest, a scale designed to assess children's self-reported physical literacy. *Psychology of Sport and Exercise*, *60*, 102164. https://doi.org/10.1016/j.psychsport.2022.102164

Barnett, L. M., Mazzoli, E., Hawkins, M., Lander, N., Lubans, D. R., Caldwell, S., ... Salmon, J. (2022). Development of a self-report scale to assess children's perceived physical literacy. *Physical Education and Sport Pedagogy*, *27*(1), 91–116.

Belanger, K., Barnes, J. D., Longmuir, P. E., Anderson, K. D., Bruner, B., Copeland, J. L., & Tremblay, M. S. (2018). The relationship between physical literacy scores and adherence to Canadian physical activity and sedentary behavior guidelines. *BMC Public Health*, *18*(Suppl 2), 1042. https://doi.org/10.1186/s12889-018-5897-4

Biddle, S. J., Ciaccioni, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise*, *42*, 146–155.

Blain, D. O., Curran, T., & Standage, M. (2021). Psychological and behavioral correlates of early adolescents' physical literacy. *Journal of Teaching in Physical Education*, *40*(1), 157–165.

Booth, M. (2000). Assessment of physical activity: An international perspective. *Research Quarterly for Exercise and Sport*, *71*(2 Suppl), S114–S120.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). *Introduction to meta-analysis*. John Wiley & Sons. https://doi.org/10.1002/9780470743386

Brandelli, Y. N., Stone, M., Westheuser, V., Huber, A. M., Joshi, N., Reid, A., Stringer, E., & Stevens, D. (2022). Parent risk perceptions, physical literacy, and fundamental movement skills in children with juvenile idiopathic arthritis. *Pediatric Physical Therapy*, *34*(4), 536–544. https://doi.org/10.1097/PEP.0000000000000948

Bremer, E., Graham, J. D., Bedard, C., Rodriguez, C., Kriellaars, D., & Cairney, J. (2019). The association between PLAYfun and physical activity: A convergent validation study [article]. *Research Quarterly for Exercise and Sport*, *91*(2), 179–187. https://doi.org/10.1080/02701367.2019.1652723

Brown, D. M. Y., Dudley, D. A., & Cairney, J. (2020). Physical literacy profiles are associated with differences in children's physical activity participation: A latent profile analysis approach. *Journal of Science and Medicine in Sport*, *23*(11), 1062–1067. https://doi.org/10.1016/j.jsams.2020.05.007

Burton, A. M., Cowburn, I., Thompson, F., Eisenmann, J. C., Nicholson, B., & Till, K. (2023). Associations between motor competence and physical activity, physical fitness and psychosocial characteristics in adolescents: A systematic review and meta-analysis. *Sports Medicine*, *53*(11), 2191–2256.

Cairney, J., Clark, H. J., James, M. E., Mitchell, D., Dudley, D. A., & Kriellaars, D. (2018). The preschool physical literacy assessment tool: Testing a new physical literacy tool for the early years. *Frontiers in Pediatrics*, *6*, 138. https://doi.org/10.3389/fped.2018.00138

Cairney, J., Veldhuizen, S., Graham, J. D., Rodriguez, C., Bedard, C., Bremer, E., & Kriellaars, D. (2018). A construct validation study of PLAYfun. *Medicine & Science in Sports & Exercise*, *50*(4), 855–862. https://doi.org/10.1249/MSS.0000000000001494

Caldwell, H. A., Di Cristofaro, N. A., Cairney, J., Bray, S. R., & Timmons, B. W. (2021). Measurement properties of the physical literacy assessment for youth (PLAY) tools. *Applied Physiology, Nutrition, and Metabolism*, *46*(6), 571–578. https://doi.org/10.1139/apnm-2020-0648

Cattuzzo, M. T., dos Santos Henrique, R., Ré, A. H. N., de Oliveira, I. S., Melo, B. M., de Sousa Moura, M., ... Stodden, D. (2016). Motor competence and health related physical fitness in youth: A systematic review. *Journal of Science and Medicine in Sport*, *19*(2), 123–129.

Chen, S. T., Tang, Y., Chen, P. J., & Liu, Y. (2020). The development of Chinese assessment and evaluation of physical literacy (CAEPL): A study using delphi method. *International Journal of Environmental Research and Public Health*, *17*(8), 2720. https://doi.org/10.3390/ijerph17082720

Choi, S. M., Sum, R. K. W., Leung, E. F. L., & Ng, R. S. K. (2018). Relationship between perceived physical literacy and physical activity levels among Hong Kong adolescents. *PLoS ONE*, *13*(8), e0203105. https://doi.org/10.1371/journal.pone.0203105

Choi, S. M., Sum, R. K. W., Leung, E. F. L., & Sit, C. (2023). The relationship and effect among physical literacy attributes in university physical education during the pandemic quarantine period. *Journal of Teaching in Physical Education*, *43*(1), 39–49.

Coyne, P., Dubé, P., Santarossa, S., & Woodruff, S. J. (2019). The relationship between physical literacy and moderate to vigorous physical activity among children 8-12 years. *Physical and Health Education Journal*, *84*(4), 1–13.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

De Meester, A., Barnett, L.M., Brian, A., Bowe, S.J., Jiménez-Díaz, J., Van Duyse, F., Irwin, J.M., Stodden, D.F., D'Hondt, E., Lenoir, M., & Haerens, L. (2020). The relationship between actual and perceived motor competence in children, adolescents and young adults: A systematic review and meta-analysis. *Sports Medicine*, *50*(11), 2001–2049.

Dong X. 2021 Measuring middle-school students' physical literacy: instrument development (Doctoral dissertation, Barry University)

Dong, X., Huang, F., Shi, X., Xu, M., Yan, Z., & Türegün, M. J. S. O. (2023). Mediation impact of physical literacy and activity between psychological distress and life satisfaction among college students during covid-19 pandemic. *SAGE Open*, *13*(1), 21582440231162503. https://doi.org/10.1177/21582440231162503

Dudley, D., Cairney, J., Wainwright, N., Kriellaars, D., & Mitchell, D. (2017). Critical considerations for physical literacy policy in public health, recreation, sport, and education agencies. *Quest*, *69*(4), 436–452. https://doi.org/10.1080/00336297.2016.1268967

Edwards, L. C., Bryant, A. S., Keegan, R. J., Morgan, K., & Jones, A. M. (2017). Definitions, foundations and associations of physical literacy: A systematic review. *Sports Medicine*, *47*(1), 113–126. https://doi.org/10.1007/s40279-016-0560-7

Egger, M., Smith, G. D., Schneider, M., & Minder, C. J. b. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical Research Ed.)*, *315*(7109), 629–634.

Farren, G. L., E., Y. P., & Price, B. (2021). Measuring physical literacy and its association with interscholastic sports intention in sixth-grade physical education students. *Journal of Physical Education and Sport*, *21*(6).

Gandrieau, J., Dieu, O., Potdevin, F., Derigny, T., & Schnitzler, C. (2023). Measuring physical literacy for an evidence-based approach: Validation of the French perceived physical literacy instrument for emerging adults. *Journal of Exercise Science and Fitness*, *21*(3), 295–303. https://doi.org/10.1016/j.jesf.2023.06.001

García-Hermoso, A., Saavedra, J. M., Ramírez-Vélez, R., Ekelund, U., & Del Pozo-Cruz, B. (2017). Reallocating sedentary time to moderate-to-vigorous physical activity but not to light-intensity physical activity is effective to reduce adiposity among youths: A systematic review and meta-analysis. *Obesity Reviews*, *18*(9), 1088–1095. https://doi.org/10.1111/obr.12552

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: A pooled analysis of 298 population-based surveys with 1·6 million participants. *The Lancet Child & Adolescent Health*, *4*(1), 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, *21*(11), 1539–1558. https://doi.org/10.1002/sim.1186

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ (Clinical Research Ed.)*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Huang, Wei, Z. J., Zhang, Yu, Lin, Yanyu, Wu, Jun. (2022). Effects of physical activity and sedentary behavior on physical fitness of children aged 6-9 years: A longitudinal isochronous substitution model. Chinese Society of Sports Science. Abstract compilation of the 12th National Sports Science Conference ShangDong,China.

Huedo-Medina, T. B., Sánchez-Meca, J., Marín-Martínez, F., & Botella, J. (2006). Assessing heterogeneity in meta-analysis: Q statistic or I^2 index? *Psychological Methods*, *11*(2), 193–206.

International Physical Literacy Association (IPLA). (2015). Canada's physical literacy consensus statement. Vancouver BC: International Physical Literacy Association. Retrieved August 12. https://physical.literacy.ca/physical-literacy/consensus-statement

International Physical Literacy Association (IPLA). (2017). Retrieved August 13. https://www.physical-literacy.org.uk/

International Physical Literacy Association (IPLA). (2018). Retrieved August 15. https://www.physical-literacy.org.uk/library/charting-physical-literacy-journey-tool/

Jago, R., Salway, R., Emm-Collison, L., Sebire, S. J., Thompson, J. L., & Lawlor, D. A. (2020). Association of BMI category with change in children's physical activity between ages 6 and 11 years: A longitudinal study. *International Journal of Obesity*, *44*(1), 104–113. https://doi.org/10.1038/s41366-019-0459-0

Jefferies, P., Bremer, E., Kozera, T., Cairney, J., & Kriellaars, D. (2021). Psychometric properties and construct validity of PLAYself: A self-reported measure of physical literacy for children and youth. *Applied Physiology, Nutrition, and Metabolism*, *46*(6), 579–588. https://doi.org/10.1139/apnm-2020-0410

Keegan, R., Dudley, D., & Barnett, L. (2019). A brief history of physical literacy in Australia. Physical literacy across the world, 105–124.

Kesic, M. G., Savicevic, A. J., Peric, M., Gilic, B., & Zenic, N. (2022). Specificity of the associations between indices of cardiovascular health with health literacy and physical literacy; a cross-sectional study in older adolescents. *Medicina*, *58*(10), 1316. https://doi.org/10.3390/medicina58101316

Kowalski, K. C., E, C. P. R., & Donen, R. M. (2004). The physical activity questionnaire for older children (PAQ-C) and adolescents (PAQ-A) manual. *College of Kinesiology, University of Saskatchewan*, *87*(1), 1–38.

Li, C., Wang, C. K. J., Koh, K. T., Tan, K. S. S., Tan, S. M., Ang, W. B., Wong, L. H., & Yeo, H. N. C. (2021). Basic psychological need profiles and correlates in physical activity participation: A person-centered approach. *Frontiers in Psychology*, *12*, 675639.

Li, M. H., Sum, R. K. W., Sit, C. H. P., Liu, Y., & Li, R. (2021). Perceived and actual physical literacy and physical activity: A test of reverse pathway among Hong Kong children. *Journal of Exercise Science and Fitness*, *19*(3), 171–177. https://doi.org/10.1016/j.jesf.2021.03.001

Lodewyk, K. R., & Mandigo, J. L. (2017). Early validation evidence of a Canadian practitioner-based assessment of physical literacy in physical education: Passport for life. *The Physical Educator*, *74*(3), 441–475. https://doi.org/10.18666/TPE-2017-V74-I3-7459

Longmuir, P. E., Boyer, C., Lloyd, M., Yang, Y., Boiarskaia, E., Zhu, W., & Tremblay, M. S. (2015). The Canadian assessment of physical literacy: Methods for children in grades 4 to 6 (8 to 12 years). *BMC Public Health*, *15*, 1–11.

Longmuir, P. E., Gunnell, K. E., Barnes, J. D., Belanger, K., Leduc, G., Woodruff, S. J., & Tremblay, M. S. (2018). Canadian assessment of physical literacy second edition: A streamlined assessment of the capacity for physical activity among children 8 to 12 years of age. *BMC Public Health*, *18*(Suppl 2), 1047. https://doi.org/10.1186/s12889-018-5902-y

Longmuir, P. E., & Tremblay, M. S. (2016). Top 10 research questions related to physical literacy. *Research Quarterly for Exercise and Sport*, *87*(1), 28–35. https://doi.org/10.1080/02701367.2016.1124671

Ma, R. S., Sum, R. K. W., Hu, Y. N., & Gao, T. Y. (2020). Assessing factor structure of the simplified Chinese version of perceived physical literacy instrument for undergraduates in mainland China. *Journal of Exercise Science and Fitness*, *18*(2), 68–73. https://doi.org/10.1016/j.jesf.2020.01.001

Mazzoli, E., Xu, J., & Barnett, L. M. (2024). Physical literacy is associated with children's adherence to physical activity guidelines during COVID-19. *Physical Education and Sport Pedagogy*, 1–15.

McKay, C., Hoch, J. M., Hoch, M. C., & Dlugonski, D. (2023). Sports specialization, physical literacy, and physical activity levels in young adults. *Journal of Sport Rehabilitation*, *32*(2), 190–195. https://doi.org/10.1123/jsr.2022-0057

Melby, P. S., Elsborg, P., Bentsen, P., & Nielsen, G. (2023). Cross-sectional associations between adolescents' physical literacy, sport and exercise participation, and wellbeing. *Frontiers in Public Health*, *10*, 1054482. https://doi.org/10.3389/fpubh.2022.1054482

Melby, P. S., Nielsen, G., Brønd, J. C., Tremblay, M. S., Bentsen, P., & Elsborg, P. (2022). Associations between children's physical literacy and well-being: Is physical activity a mediator? *BMC Public Health*, *22*(1), 1267. https://doi.org/10.1186/s12889-022-13517-x

Mohammadzadeh, M., Sheikh, M., Houminiyan Sharif Abadi, D., Bagherzadeh, F., & Kazemnejad, A. (2022). Design and psychometrics evaluation of adolescent physical literacy questionnaire (APLQ). *Sport Sciences for Health*, *18*(2), 397–405. https://doi.org/10.1007/s11332-021-00818-8

Mota, J., Martins, J., & Onofre, M. (2021). Portuguese physical literacy assessment questionnaire (PPLA-Q) for adolescents (15–18 years) from grades 10–12: Development, content validation and pilot testing. *BMC Public Health*, *21*, 1–22.

Nader, P. R., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *Jama*, *300*(3), 295–305. https://doi.org/10.1001/jama.300.3.295

Nezondet, C., Gandrieau, J., Bourrelier, J., Nguyen, P., & Zunquin, G. (2023). The effectiveness of a physical literacy-based intervention for increasing physical activity levels and improving health indicators in overweight and obese adolescents (CAPACITES 64). *Children*, *10*(6), 956. https://doi.org/10.3390/children10060956

Nezondet, C., Gandrieau, J., Nguyen, P., & Zunquin, G. (2023). Perceived physical literacy is associated with cardiorespiratory fitness, body composition and physical activity levels in secondary school students. *Children*, *10*(4).

Ortega-Benavent, N., Menescardi, C., Cárcamo-Oyarzún, J., & Estevan, I. (2024). Do perceived motor competence and physical literacy mediate the association between actual motor competence and physical activity engagement? *Revista de Psicodidáctica (English Ed.)*, *29*(2), 158–165. https://doi.org/10.1016/j.psicoe.2024.03.001

Öztürk, Ö., Aydoğdu, O., Kutlutürk Yıkılmaz, S., Feyzioğlu, Ö., & Pişirici, P. (2023). Physical literacy as a determinant of physical activity level among late adolescents. *PLoS ONE*, *18*(4), e0285032. https://doi.org/10.1371/journal.pone.0285032

Page, M. J., JE, M. K., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical Research Ed.)*, *372*, n71. https://doi.org/10.1136/bmj.n71

Peterson, R. A., & Brown, S. P. (2005). On the use of beta coefficients in meta-analysis. *Journal of Applied Psychology*, *90*(1), 175–181.

Rosenthal, R. (1986). Meta-analytic procedures for social science research Sage publications: Beverly Hills, 1984, 148 pp. *Educational Researcher*, *15*(8), 18–20.

Ross, S. M. (2017). *Introductory statistics*. Academic Press.

Schulz, K. F., Altman, D. G., Moher, D., & Consort Group (2010). CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *Journal of Clinical Epidemiology*, *63*(8), 834–840.

She, X., Gao, T.-Y., Ma, R.-S., Tang, D., Zhong, H., & Dong, H.-L. (2023). Relationship among positive self-esteem, physical literacy, and physical activity in college students: A study of a mediation model. *Frontiers in Psychology*, *14*.

Sport Australia. (2020). Australian physical literacy framework. https://www.sportaus.gov.au/__data/assets/pdf_file/0019/710173/35455_Physical-Literacy-Framework_access.pdf

Strain, T., Flaxman, S., Guthold, R., Semenova, E., Cowan, M., Riley, L. M., Bull, F. C., & Stevens, G. A. (2024). National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: A pooled analysis of 507 population-based surveys with 5.7 million participants. *The Lancet Global Health*, *12*(8), e1232–e1243. https://doi.org/10.1016/S2214-109X(24)00150-5

Sum, R. K., Cheng, C. F., Wallhead, T., Kuo, C. C., Wang, F. J., & Choi, S. M. (2018). Perceived physical literacy instrument for adolescents: A further validation of PPLI. *Journal of Exercise Science and Fitness*, *16*(1), 26–31. https://doi.org/10.1016/j.jesf.2018.03.002

Sum, R. K. W., Ha, A. S. C., Cheng, C. F., Chung, P. K., Yiu, K. T. C., Kuo, C. C., Yu, C. K., & Wang, F. J. (2016). Construction and validation of a perceived physical literacy instrument for physical education teachers. *PLoS ONE*, *11*(5), e0155610. https://doi.org/10.1371/journal.pone.0155610

Tang, Y., Algurén, B., Pelletier, C., Naylor, P. J., & Faulkner, G. (2023). Physical literacy for communities (PL4C): Physical literacy, physical activity and associations with wellbeing. *BMC Public Health*, *23*(1), 1266. https://doi.org/10.1186/s12889-023-16050-7

Tremblay, M. L. M. (2010). Physical literacy measurement the missing piece. *Physical and Health Education Journal*, *76*(1), 26–30.

Tremblay, M. S., Costas-Bradstreet, C., Barnes, J. D., Bartlett, B., Dampier, D., Lalonde, C., ... Yessis, J. (2018). Canada's physical literacy consensus statement: Process and outcome. *BMC Public Health*, *18*, 1–18.

Tremblay, M. S., Warburton, D. E., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., Kho, M. E., Hicks, A., Leblanc, A. G., Zehr, L., Murumets, K., & Duggan, M. (2011). New Canadian physical activity

guidelines. *Applied Physiology, Nutrition, and Metabolism*, *36*(1) 36-46; 47-58. https://doi.org/10.1139/h11-009

van Eldik, W. M., de Haan, A. D., Parry, L. Q., Davies, P. T., Luijk, M. P., Arends, L. R., & Prinzie, P. (2020). The interparental relationship: Meta-analytic associations with children's maladjustment and responses to interparental conflict. *Psychological Bulletin*, *146*(7), 553.

Von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *The Lancet*, *370*(9596), 1453–1457.

Wang, H., King, B., & Yang, R. (2023). The development and psychometric evaluation of the Perceived Physical Literacy for Chinese Elderly Questionnaire. *The Gerontologist*, *63*(9), 1478–1487.

Warburton, D. E., & Bredin, S. S. (2017). Health benefits of physical activity: A systematic review of current systematic reviews. *Current Opinion in Cardiology*, *32*(5), 541–556. https://doi.org/10.1097/HCO.0000000000000437

Whitehead, M. (2013). Definition of physical literacy and clarification of related issues. *ICSSPE Bulletin Journal of Sport Science and Physical Education*, *65*, 29–34.

World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. Retrieved August 1. https://www.who.int/publications/i/item/9789240015128

World Health Organization. (2022). Physical activity. Retrieved August 9. https://www.who.int/news-room/fact-sheets/detail/physical-activity

Xie, H., Dong, L. J., & Zhang, T. R. (2018). Evaluation of physical activity with triaxial accelerometer: Current situation and future. *Chinese Journal of Tissue Engineering Research*, *22*(35), 5706–5714. https://link.cnki.net/urlid/21.1581.R.20180719.1340.006

Yan, W., Chen, L., Wang, L., Meng, Y., Zhang, T., & Li, H. (2023). Association between enjoyment, physical activity, and physical literacy among college students: A mediation analysis. *Frontiers in Public Health*, *11*, 1156160. https://doi.org/10.3389/fpubh.2023.1156160

Yan, W., Meng, Y., Wang, L., Zhang, T., Chen, L., & Li, H. (2022). Research on the relationship between physical literacy, physical activity and sedentary behavior. *International Journal of Environmental Research and Public Health*, *19*(24). https://doi.org/10.3390/ijerph192416455

Zhang, C., Liu, Y., Xu, S., Sum, R. K., Ma, R., Zhong, P., Liu, S., & Li, M. (2022). Exploring the level of physical fitness on physical activity and physical literacy among Chinese university students: A cross-sectional study. *Frontiers in Psychology*, *13*, 833461. https://doi.org/10.3389/fpsyg.2022.833461

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Ying, Y., Jiabin, L., Shanshan, Z., Kaixin, Y., Xiaomei, L., Shengyu, W., & Xian, L. (2025). The relationship between physical literacy and physical activity: A systematic review and meta-analysis. *Applied Psychology: Health and Well-Being*, *17*(4), e70062. https://doi.org/10.1111/aphw.70062