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DETERMINATION OF ORIGINAL-EMPIRICAL STUDIES IN PHYSICAL LITERACY

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Abstract *-- This study aimed at identifying actual numbers of original empirical studies on physical literacy currently existed, and quantifying its findings. Records identified through Web of Science (WoS) Core Collections, IngentaConnect, PubMed Central and Medline databases, with some additional records from Google Scholar database for studies published outside commercial or academic publishing channels (grey literature) such as postgraduate thesis output etc. Only original research article (primary source) accepted, involving specific test to measure physical literacy related items as per definition given in this review. Participants of the selected studies were of all ages, with both quantitative and qualitative methods of study either acute of longitudinal in nature are accepted. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol was used. Database searched after first initial screening produced 135 records. Records after duplicates removed were 111. Second level screening resulted in 86 articles eliminated and 25 selected for further assessment based on eligibility criteria. Articles assessed for eligibility resulted in 13 articles, which 4 full-text articles were later excluded, with reasons. At the end, only 9 studies included in synthesis of results. More studies are needed in the area of physical literacy. Main priority would be to improve number of studies concerning reliability and validity of instruments, production of more quality studies with low risk of bias, studies concerning profiling of physical literacy among populations, and impact of physical literacy on other part of daily life.*

Keywords: *Reliability and validity, risk of bias, qualitative, quantitative*

1. INTRODUCTION

A fit society depicts a fit nation. A physically fit individual will tend to be more productive and reduced healthcare costs typically need to be taken care of by their organizations [1], [2], [3], [4]. For the developing countries, the move towards developed country's status cannot avoid the need of a more active and physically fit citizens [5], especially even developed countries seems struggling in ensuring physically active community, although programs starting from childhood to adulthood is available [6], [7], [8], [9]. Physical literacy has been introduced as the pillar and soul to physical education and lifelong physical activity participations. A physically literate individual is expected to keep active physically

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throughout lifespan, benefitting not just themselves but also the country as a whole. However, the concept of physical literacy itself while gaining popularity seems to be dictated more by non-empirical, subjective opinion and idea throwing, with lack of original empirical studies performed [10] in contrary to its 'factual-educational' based. This hindered many especially organizations within developing countries to establish their own personalized mould of physical literacy program. Factual empirical baseline data assist the process of creating or choosing precise assessment and monitoring tools. To progress forwards, actual empirical based data sources need to be identified and explored, so that facts about what are lacking can be produced and further original studies can be planned and perform.

While the popularity of physical literacy seems to be started around the year of 2000, it has been shown that other similar concepts has actually started as early as 1900s, with each terminology coined produced models and framework which seems appropriate for that period of time [11]. It is widely accepted that physical literacy means the motivation, confidence, physical competence, knowledge, and understanding to maintain physical activity throughout the life course [12], [13]. The definition that has been given clearly stated that physical literacy should be monitored throughout the lifespan. However, what is currently happening is the concept of physical literacy seems to only be focused on children, with the misconception or over focus on children has triggered a 'clarification' article from its founder [14]. Due to this, this review considers physical literacy is relevant to all ages, in line with its definition.

Based on definition that has been given, physical literacy encompasses a wide area of expertise. In general it covers the area of psychology (motivation and confidence) [15], paediatric exercise, physical conditioning and motor learning (physical competence, knowledge, and understanding), which can derives from physical education, medical and early childhood school of study. Thus who should be focusing on this area? As it involved various branches of knowledge, and encompassed stages as early as 6 months up to youth and late adulthood, the best answers is, it involved anyone with knowledge, expertise and practice of the discussed area. It can be a physical education experts, strength and conditioning trainers, medical professionals or early childhood education teachers.

A recent systematic review by Edwards, Bryant, Keegan, Morgan, & Jones [16] provides the best insight so far on each individual items existed in the general definition of physical literacy as coined by Margerate Whitehead and accepted by many [13], [17]. In fact, too many research questions still need to be answered before physical literacy concept can be

appropriately implement in both developed and developing countries, mainly on monitoring methods, enhancement suggestions and benefits of physical literacy [18].

Most of the approach now been done in a framework that utilize heavy involvement of resource distribution via a website, which triggered a proposition of a more functional based framework for physical literacy promotion and implementation [19]. In term of structured and unstructured nature of its activities, some just suggested deliberate play as the way it should be (20), indicating that it may not take into considerations various age group and lifelong process.

Therefore, this study aimed at identifying actual numbers of original research on physical literacy currently existed. Second to this it is the purpose of this systematic review and meta-analysis to clarify issues pertaining to physical literacy. Issues such as lifelong assessment and monitoring methods for all healthy individuals, by comparing assessment methods used, age groups involved, gender differences in comparison with maturation status, and discuss possible types of assessment throughout lifetime.

2. RESEARCH METHODS

2.1 Participants

Studies with healthy subjects of any age, gender or activity level were included. Studies were limited to the English language with no restrictions were imposed on publication date or publication status. Only original research article accepted, involving physical literacy related items as per definition of physical literacy given in this review, for either in childhood or adulthood or both.

2.2 Protocol

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol was used to conduct the systematic review [21], [22], [23]. The protocol is available online at http://www.prisma-statement.org/Protocols/ProtocolGuidance.aspx.

2.3 Information sources & Literature Search & Study selection

Search were done on 1st and 2nd November 2017. Records identified through Web of Science (WoS) Core Collections, IngentaConnect, PubMed Central and Medline database using search phrase ‘physical literacy’ and/or Boolean phrases: (physical literacy[Title]) OR

ISSN 2515-8260 Volume 07, Issue 02, 2020

physical literacy[Abstract]) OR physical literacy [Body - All Words]. No restrictions imposed on categories (Sports Sciences, Education Educational Research etc).

2.4 Data collection process

(Figure 1.) shows the systematic data collection process used. Once the screening process completed, data items of interest were extracted from each articles into table form. Risk of bias were analyzed using Cochrane Risk of Bias Tool (for randomized studies) Synthesis of results were then presented in numbers of contribution of each items out of all studies analyzed.

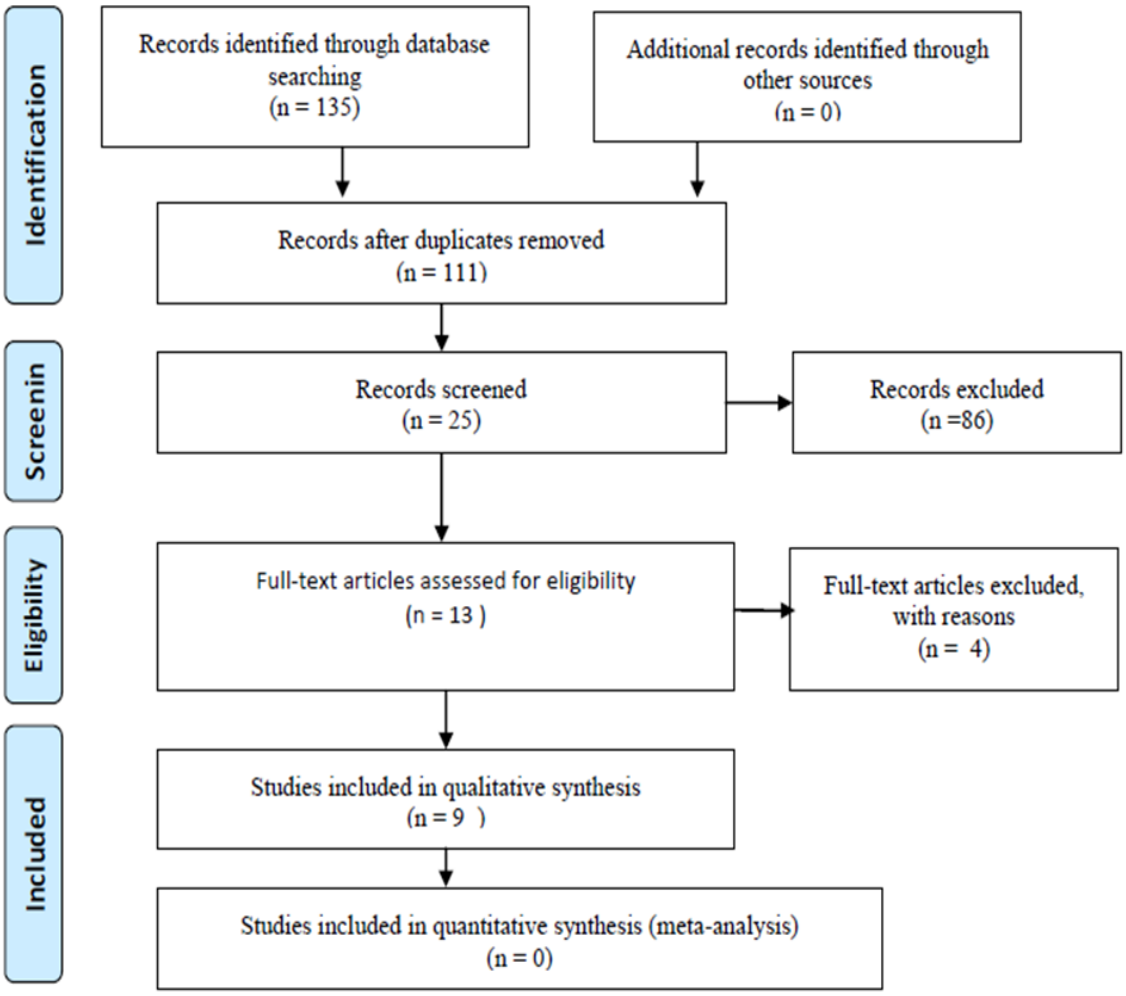

Figure 1. Flow diagram of information through the different phases of the systematic review. Diagram adopted based on (liberati et al., 2009).

ISSN 2515-8260 Volume 07, Issue 02, 2020

2.5 Statistical analysis

WoS search produced results of 1449 articles. Out of the 1449 articles, only 101 WoS's articles identified for further screening. The high number of articles selected at first sight (101) for WoS was due to several reasons such as some studies did touch a phrase or two on physical literacy in it articles, but physical literacy was not studied or focus of the article. These were later eliminated at later stages of screenings. IngentaConnect database searched produced 264 articles, with only 11 selected for further screening. PubMed Central database produced 42 articles with 7 articles selected fur further screenings. Medline database searched produced 1108 articles, in which 16 articles selected for further screenings. Duplicates from this search of all of the databases were then removed producing 111 articles, which then eliminated systematically based on eligibility criteria stated. Four full texts articles eliminated at final stages of screening due to involving unhealthy research participants [24], publication's published is a study protocol / proposal [25] and does not met 'physical literacy' definition of term accepted [26], [27]. Figure 1 summarizes the result of the systematic review process with finally only 9 full-text articles were accepted for further analyses [24], [28], [29], [30], [31],[32], [33], [34], [35].

Analysis on risk of bias were done for each individual study and rated based on seven items and with each items for each studies were rated as having high risk of bias, low risk of bias or unclear risk of bias. Evaluating the risk of bias is important so as at least provided some insight on the quality of each of the studies selected. Selected articles as summarize in (Table 1.), followed by other tables providing qualitative and quantitative analyses.

ISSN 2515-8260 Volume 07, Issue 02, 2020

Table 1. Physical literacy's original research studies.

No.	Study	Subjects (sex and mean ± SD age, height and mass)	Methodology (measurements)	Results	Conclusion/Suggestion
1	Longmuir, Boyer, Lloyd, Borghese, Knight, Saunders, … Tremblay [33]	n=1165 (598 (51%) females), Children, 8–12 years of age,	3 phases, from 2007 to 2012 a) Expert consultations were combined with an environmental scan of physical education curricula and published research to develop the activities included in the initial assessment (2007–2009). b) Feasibility of the assessment was established through an iterative design process with students in Grades 4–6 (2009–2011). c) cross-sectional assessments were used to generate evidence of the validity and objectivity of the Canadian Agility and Movement Skill Assessment (CAMSA) (2011–2012). Children performed the	Median total score was 21 of 28 points (range 5–28). Median completion time was 17 s. Total scores were feasible for all 995 children who self-reported age and gender. Total score did not differ between inside and outside environments (95% confidence interval (CI) of difference: −0.7 to 0.6; $p = 0.91$) or with/without footwear (95%CI of difference: −2.5 to 1.9; $p = 0.77$). Older age ($p < 0.001$, $\eta 2 = 0.15$) and male gender ($p < 0.001$, $\eta 2 = 0.02$) were associated with a higher total score. Inter-rater objectivity evidence was excellent (intraclass correlation coefficient (ICC) = 0.99) for completion time and substantial for skill score (ICC = 0.69) for 104 attempts by 53 children (34%	The Canadian Agility and Movement Skill Assessment is a feasible measure of selected fundamental, complex and combined movement skills, which are an important building block for childhood physical literacy. Moderate-to-excellent objectivity was demonstrated for children 8–12 years of age. Test–retest reliability has been established over an interval of at least 1 week. The time and skill scores can be accurately estimated by 1 trained examiner.

			CAMSA during 1 study visit, while each performance was video recorded. Video recordings were used to establish the intra-rater and inter-rater objectivity of the assessment. Repeated performance of the assessment across intervals of 3–14 days evaluated test–retest reliability.	female). Intra-rater objectivity was moderate (ICC = 0.52) for skill score and excellent for completion time (ICC = 0.99). Reliability was excellent for completion time over a short (2–4 days; ICC = 0.84) or long (8–14 days; ICC = 0.82) interval. Skill score reliability was moderate (ICC = 0.46) over a short interval, and substantial (ICC = 0.74) over a long interval.	
2	Sum et al [35]	(n=336) physical education teachers in Hong Kong	Reliability and validity of "Perceived Physical Literacy Instrument" (PPLI) were tested. Based on literature review and focus group interviews, an 18-item instrument was developed for the initial tests. This self-report measure, using a 5-point Likert scale, formed the PPLI and was administered to 336 physical education teachers in Hong Kong.	The sample was randomly split, and exploratory and confirmatory factor analyses resulted in a 9-item, 3-factor scale. Exploratory factor analysis (EFA) item loadings ranged from 0.69 to 0.87, and Cronbach's alpha ranged from 0.73 to 0.76. Confirmatory factor analysis (CFA) showed that the construct demonstrated good fit to the model.	The PPLI thus appeared to be reliable and valid to measure the perceived physical literacy of physical education teachers. It is argued that the instrument can be used for both research and applied purposes and potential uses for the instrument in physical education, medical and health settings are discussed.
3	Lloyd	(n=153) students	Motion-sensitive phenomenological approach	Exemplars of two in depth student experiences are featured	Exploring the lived experiences of students'

	[32]	from seven different schools in Ottawa	conceptually framed by the Function2Flow (F2F) model, was conducted with samples who booked the JungleSport climbing program of their own accord. Sources of information included phenomenological observations, small group interviews, and journal entries.	in this article. The phenomenological analyses of the climbing experiences were presented using the two exemplars. No quantitative data set reported.	movements within the physical education context through various interdisciplinary lenses inspired by the F2F model attunes both teachers and students alike to the movement *function, form, feelings* and sense of *flow* possible within the process of becoming physically literate. Provide practical and philosophical pathways for understanding how we may broaden assessments of learning in physical education.
4	George, Rohr, & Byrne, [31]	(n= 15) children age 6–12,	For six weeks children played one of four pre-selected AVGs (minimum 20 min, twice per week). Pre and post measures of motivation, enjoyment, and physical literacy were completed.	a near significant improvement in aiming and catching ($p = 0.06$). Manual dexterity significantly improved in males ($p = 0.001$), and females felt significantly less pressured to engage in PA ($p = 0.008$).	Overall, there appears to be some positive impact of an AVG intervention on components of physical literacy
5	Francis et al.	(n=19) childhood	Participants completed a 3-	Delphi participant consensus	The revised CAPL model

	[30]	physical activity/fitness experts	round Delphi process. Round 1 was open-ended questions. Subsequent rounds rated statements using a 5-point Likert scale. Recommendations were sought regarding protocol inclusion, relative importance within composite scores and score interpretation.	was achieved for 64% (47/73) of statement topics, including a revised conceptual model, specific assessment protocols, the importance of longitudinal tracking, and the relative importance of individual protocols and composite scores. Divergent opinions remained regarding the inclusion of sleep time, assessment/ scoring of the obstacle course assessment of motor skill, and the need for an overall physical literacy classification.	(overlapping domains of physical competence, motivation, and knowledge, encompassed by daily behavior) is appropriate for monitoring the physical literacy of children aged 8 to 12 years. Objectively measured domains (daily behavior, physical competence) have higher relative importance. The interpretation of CAPL results should be reevaluated as more data become available.
6	Lynch & Soukup [34]	SHAPE America members. (n=5) elementary/primary teachers. (n=1) middle school teacher. (n=1) secondary teachers.	Participants were asked an open-ended question relating to PE nomenclatures. A question relating to this nomenclature concern was posted on SHAPE America's Exchange online network as a discussion topic. Data collections and analyses involved 4 stages. (1) interview / questionnaires distributed; (2) Data coding and	Findings confirmed that practitioner confusion does exist. No quantitative results presented.	It is suggested that children are first and foremost "physically educated"; therefore a strong, clear and comprehensive grounding in quality PE is essential for teachers and students.

		(n=2) educationalist	distillations based on themes from data gathered; (3) Generation of key themes from stage 2; (4) story report and conclusion		
7	Longmuir, et al. [36]	963 children (55 % female) in grades 4, 5 and 6. Children were 8 to 12 years of age (mean 10.1 years)	CAPL validity was evaluated through three analyses that utilized cross-sectional data obtained through local schools in Eastern Ontario, Canada. A confirmatory factor analysis compared the data to the theoretical model. Patterns of association between self-reported age and gender and the CAPL total and domain scores were examined using regression models. Teacher ratings of participants' knowledge, attitude and physical activity competence were compared to assessment results.	Confirmatory factor analysis using data from 489 children with complete raw scores supported a model with four domains: engagement in physical activity (active and sedentary), physical competence (fitness and motor skill), motivation and confidence, and knowledge and understanding. Raw domain scores followed expected patterns for age and gender, providing evidence for their validity. Interpretive categories, developed from age and gender adjusted normative data, were not associated with age indicating that the CAPL is suitable for use across this age range. Children's gender was associated with the physical competence, motivation and	CAPL offers a comprehensive assessment of engagement in physical activity, physical competence, motivation and confidence, and knowledge and understanding as components of childhood (grades 4 to 6, 8 to 12 years) physical literacy. Monitoring of these measures enhances our understanding of children's physical literacy, and assists with the identification of areas where additional supports are required.

				engagement in physical activity domain scores, indicating that further research is required regarding the gender adjustment of the raw CAPL scores. CAPL domain and total scores were statistically significantly associated with teacher ratings of the child's motivation, attitudes, fitness, skill and overall physical activity.	
8	Dominick, Friedman, Saunders, Hussey, & Watkins, [29]	(n=91) foster parents	Surveys assessing PA literacy (overall and specific), perceptions of child PA, coordination, PA enjoyment, psychosocial variables: positive/negative beliefs, normative beliefs, perceived behavioural control (PBC), and self-efficacy.	Race, negative beliefs, PBC, and foster parent sport involvement were associated with specific PA literacy. Race and education were associated with overall PA literacy. Modified Cloze assessment indicate 87.7% of participants achieved adequate overall PA literacy whereas 12.2% were determined to have marginal or inadequate overall PA literacy. 19% of African American participants scored less than adequate overall PA literacy whereas no other racial group	Lower PA literacy is associated with greater negative beliefs and lower perceived control suggesting greater perceived barriers and lower perceived support for/among African Americans and those with less education.

				achieved less than adequate overall PA literacy. Foster parents with a college education or higher were more likely to have achieved adequate overall PA literacy (93.0%) compared to those with less than a college education (80.0%).	
9	Adele Kentel & Dobson, [28]	Movement videotaped: (n=14) children from National Kenyan School Formal interview: head teachers (n=8); teachers (n=5); students (n=9); dance director (n=1), professional dancer (n=1), cultural expert (n=1).	Qualitative study. Engage educators in conversations how we might practically and theoretically dissolve boundaries between body and mind with a view to exploring curricular structures and pedagogical methodologies that promote holistic approaches to learning. Inquiry is part of a larger study took place in Kenya, East Africa Data collection primarily in national Kenyan schools (N ¼ 14), which included public (N ¼ 8) and private (N ¼ 6) institutions located in urban (N ¼ 6), suburban (N ¼ 3), and rural (N ¼ 5) settings. Four	Data suggested that the most original, inventive learning took place in the playing fields during unstructured time. The absences of formal structures and manufactured toys afforded children the opportunity to create and explore. They invented their own technologies (e.g. footballs made from rubbish bound with a fibrous plant), explored and negotiated gender boundaries, and were constantly on the move. Their activities presented a marked contrast to the behaviours we were familiar with in observing children in industrialized nations in the	Observing the contrast between the schoolroom and the playing fields led us to contemplate the fundamental icon of schooling across many cultures: the desk. The desk as a technology for learning is a contrivance aimed at controlling movement and attention in whichever setting it inhabits. As such, it points to the premise underlying education in many cultures: to learn we must be still. Watching the Kenyan children combine learning with

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representative cases were identified within larger dataset, each of which demonstrates significance of movement literacy in games and dance among Kenyan children. These referred to as 'movement texts'. A hermeneutical approach, involving interpretation and reinterpretation of data from multiple sources, was employed in data analysis. Children's dance, games, and other forms of movement were videotaped. The movement experiences of children and adults were also explored through observations, interviews, and the personal reflections of the participants. Formal interviews occurred with head teachers (N ¼ 8), teachers (N ¼ 5), students (N ¼ 9), a dance director (N ¼ 1), a professional dancer (N ¼ 1), and a cultural expert (N ¼ 1). These were tape-recorded and transcribed for analysis. Dialogue in the context of the

context of their schools, homes, and community play areas.

movement in a variety of settings sends a message to educators in industrialized nations where a variety of factors are conspiring to limit opportunities for children to move and play freely. The message is this: we must redouble our efforts to engage in holistic methods of education; we must make space within our curricula for movement; we must oppose efforts to remove free play periods such as recess; we must focus on educating caregivers and teachers across disciplines respecting the importance of active play and learning; we must engage children in conversations about their play choices with a view to improving our understanding of the complex interdependencies

video material was transcribed as well. Less formal conversations also transpired with many teachers and students. These were recorded in field notes and a research journal. Data compiled and interpreted. Analysis entailed close readings of interview transcripts in relation to video materials, field notes, and so on. Every attempt was made to relate the apparent meaning of an action or statement to the world-view from which it originated.

of movement and learning. Finally, and most importantly, we must stress the inherent value of movement and free play, not only as a means to an educational end, but as an end in itself.

ISSN 2515-8260 Volume 07, Issue 02, 2020

3. RESULTS AND DISCUSSION

3.1 Results

Table 2. Risk of bias within randomized studies based on cochrane risk of bias tool [37], [38]. *(a) random sequence generation (selection bias); (b) allocation concealment (selection bias); (c) blinding of participants and researchers (performance bias); (d) blinding of outcome assessment (detection bias); (e) incomplete outcome data (attrition bias); (f) selective reporting (reporting bias); and (g) other bias. ** ↑high risk of bias, ↓low risk of bias and ? Unclear risk of bias.

No.	Authors	a	b	c	d	e	f	g
1	Longmuir et al. (2017) [33]	↓	↓	↓	↓	↓	↓	↓
2	Sum et al. (2016) [35]	↓	↓	↓	↓	↓	↓	↓
3	Lloyd (2016) [32]	↑	↑	↑	↑	↑	↑	**?**
4	George, Rohr & Byrne (2016) [31]	↓	↓	↓	↓	↓	↓	↓
5	Lynch & Soukup (2016) [34]	↓	↓	↓	↓	↓	↓	↓
6	Longmuir et al. (2015) [36]	↑	↑	↑	↓	↓	↓	↓
7	Dominick, Friedman, Saunders, Hussey & Watkins (2012) [29]	↑	↑	↑	↑	↓	↓	↓
8	Adele Kentel & Dobson (2007) [28]	**?**	↑	↑	↓	**?**	↑	**?**
9	Francis et al. 2016 [30]	↑	↓	↑	↑	↑	↓	↓

Further review and analysis on all of the selected articles yields findings as shown in (Table 3.).

Table 3. Study characteristics and synthesis of results of all selected studies

Key points	Results
Number of eligible studies	**9** [28], [29], [30], [31], [32], [33], [34], [35], [36]
Total numbers of research participants/respondents	**2777**
Children aged 6 to 13 years old tested as research participants/respondents	**2296** (aged 6-15 years old) [31], [32], [33], [36]
Total number of quantitative based research	**6** [29], [30], [31], [33], [35], [36]
Total number of qualitative based research	**3** [28], [32], [34]

Types of assessment used	· Canadian Assessment of Physical Literacy (CAPL) [30], [36] · Canadian Agility & Movement Skill Assessment (CAMSA) [33] · Perceived Physical Literacy Instrument (PPLI) [35]
Total original study on reliability and validity of test instruments	**4** [30], [33], [35], [36]
Studies on population understandings on the term 'physical literacy' (i.e. need more works / interventions to improve people's understandings on physical literacy)	**3** [29], [34], [35]
Studies on effect of physical literacy on certain factors	**0**
Studies on effect of certain factors on physical literacy	**2** [29], [31]

3.2 Discussion

3.2.1 Summary of evidence

Interestingly while the concept of physical literacy has been widely discussed and promoted, the number of original empirical studies which properly published and replicable at this time of write-up were less than ten. Out of the nine studies reviewed, only four studies look into the issues of reliability and validity of instruments used in physical literacy. This lack of studies pertaining to reliability and validity of instruments can be considered as critical, as it will determine the quality of upcoming future empirical studies. As indicated in the risk of bias analysis, some of the studies actually can be rated overall as having high risk of bias. This again undermined the factual support that can be used to promote and plan physical literacy implementations. Most important, three studies that explore community understandings on the concept of physical literacy found that people actually quite confused with what physical literacy is actually. For these reasons (instrument and understanding) it may explain why lack of original empirical research performed on physical literacy so far.

3.2.2 Limitations

While in the end the nine studies were selected, it is worth to be noted that there are a few more (less than 5 studies) which may have some empirical quantitative data. But the unavailability of it full text due to publications only as conference abstract hinder further analysis on them. With wide gap in term of types of studies performed and data output produced, it become almost impossible to compare numerical data or perform further meta-analysis on all of studies selected.

Physical literacy concept can only be meaningful with the existence of valid, reliable and easy to administer testing method and equipment. One of the plausible reasons cited for lack of original research studies in physical literacy is due to limitations in movement assessment batteries [39]. The testing method and equipment need to also able to be used from childhood to adulthood, so as the progress can be track and compare.

As for Malaysia, adopting the existing sets of tests can be one of the choices, as it helps to compare the outcome with other nations. However, implementation can only be done precisely by most practitioners if only the language of the materials, resources and courses conducted be translated into the national language of Malaysia; and availability of well-trained experts to guide on the selected instruments.

Physical literacy movement or activities itself should also not only focus on children. There should be a movement which advocate physical literacy for adult and older generation, as also proposed by [40], [41], [42]. Apart from that, resistance training in addition to free play and other structured physical activity training can serve as a protective means against injury and a positive catalyst for the development of physical literacy to offset the impact of diminishing physical activity and early sport specialization in today's youth [43].

4. CONCLUSION

As a conclusion, more studies are needed in the area of physical literacy. Main priority would be to improve number of studies concerning reliability and validity of instruments, production of more quality studies with low risk of bias, studies concerning profiling of physical literacy among populations, and impact of physical literacy on other part of daily life.

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