Physical literacy consensus for England: evidence review

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About the Physical Literacy Consensus for England project

Liverpool John Moores University's Research Institute for Sport and Exercise Sciences is collaborating with academics from Coventry University, the University of Gloucestershire, the University of Bradford and Bradford Teaching Hospitals NHS Trust in a Sport England funded year-long project that aims to develop a physical literacy consensus statement for England.

The term 'physical literacy' will, and can, mean different things to different people and organisations. This project aims to create a universal definition of physical literacy in England to hopefully catalyse efforts to adopt, support and promote physical literacy in practice. The year-long project commenced in March 2022 and is structured into three phases of work and five work packages:

1. Review of the existing evidence surrounding physical literacy
2. First national consultation on physical literacy
3. Insight with children and young people
4. Consensus methodologies and co-development with an expert panel
5. Second national consultation on physical literacy and dissemination

This report outlines the findings from work package 1, a summary of evidence related to the physical literacy.

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Executive summary

Physical literacy has gained popularity in recent years and has been described as a gateway to lifelong participation in physical activity, with relevance to sport, recreation, physical education, play and health-related contexts. Whilst there is considerable momentum in physical literacy in recent years, it remains a contested term in research and practice. Indeed, this review identified 23 different definitions of physical literacy from academic and grey literature sources. Definitions vary in length and complexity, and in the aspects of the concept illuminated through the definitional wording, which presents challenges for understanding amongst researchers, practitioners, professionals, and target audiences.

Each of the identified physical literacy definitions integrate various areas of learning and development (domains), and/or specific elements of learning (also considered capabilities, attributes, components, skills or characteristics), typically with regards to a person's engagement in physical activity for life. Most countries' definitions include affective (e.g. motivation, confidence), physical (e.g. physical competence) and cognitive (e.g. knowledge) domains. However, social, spiritual, sensory-perceptive and behavioural domains are also mentioned in some international definitions. Indeed, the latter behavioural domain integrates the key physical literacy concept of lifelong participation in physical activity.

The elements (e.g. motivation) are predominantly presented as being necessary to be physically active (i.e. antecedents), though benefits and aspects of importance are also stated for supporting elements such as for health and holistic learning and development. However, there are many elements described in different variations of physical literacy, with a particularly large number of elements (e.g. speed, coordination) within the physical domain. This may be because researcher/practitioner knowledge of areas of learning within some domains (e.g. physical) may be more advance than others (e.g. social).

Nevertheless, there is a lack of consensus on the domains and/or elements that should be highlighted in a definition of physical literacy. Some definitions include only domains (e.g. physical, social, cognitive, affective), others reference only elements (e.g. confidence and competence), while some include a mixture of domains and elements (e.g. physical competence, motivation, confidence). Furthermore, different terminology is used to describe similar elements, adding to the confusion about what is and what is not physical literacy.

What is accepted and consistent across physical literacy related literature is that physical literacy is a holistic, inclusive, person-centred concept. Each individual is on their own unique lifelong physical literacy journey (relationship with physical activity across the lifecourse), all domains are intertwined and the whole person should be nurtured. Less consistently accepted across definitions is the concept of embodiment, interacting with the environment or environmental affordances (e.g. identifying opportunities for activity in the environment), and the philosophical underpinnings of physical literacy.

We identified thirteen different physical literacy conceptual frameworks or models that can be used to visualise the theoretical connections between the domains, outcomes and key principles of physical literacy. Different frameworks focus on different aspects of physical literacy (e.g. policy considerations, relationship with health, physical education, assessment etc.). Most frameworks display the different domains or elements of PL as interconnected or overlapping constructs, linked to it being accepted as a holistic concept.

The evidence base surrounding the outcomes/benefits of supporting physical literacy is still in its infancy. Twelve cross-sectional studies reported outcomes from the physical, affective and behavioural domains, and amongst others include associations between PL and body composition, PA and sport participation, psychological well-being and resilience. However, the evidence reviewed was insufficient to support any claims about proposed benefits of physical literacy at this stage.

The lack of high-quality evidence is likely hampered by the aforementioned definitional issues, as well as the challenges in assessing a holistic, person-centred physical literacy concept across childhood and adolescence. More quantitative and qualitative longitudinal and intervention research is needed on the benefits of physical literacy.

Introduction

Physical literacy (PL) has been stated as a gateway to lifelong participation in physical activity (PA) [1-4]. As a result, PL is being promoted in sport, recreation, physical education and health-related contexts [5-7]. Some argue PL is a term that has been around since the late 19th century [8,9]; however, current interest has led from the work of Whitehead, who re-introduced PL in 2001 [10] and has since published several evolving definitions, with the latest in 2017 [11] adopted by the International Association of Physical Literacy (IPLA), of which Whitehead is the founder.

Over the last decade, conceptual and opinion papers about PL have dominated the scientific literature [12]. Indeed, a systematic review by Edwards et al. (2017) of 50 scientific papers on PL revealed various interpretations of the concept and limited consensus regarding its definition, philosophical assumption, components and expected outcomes [13]. Across the academic literature, PL has been described as an ambiguous [9], contested, and controversial concept [4]. This lack of consensus has hampered attempts to effectively promote PL, as well as assessment of the concept [1,13-15]. Five years on from the Edwards et al. [13] systematic review, it is unclear how the concept has evolved and moved forward.

This research forms part of a Sport England funded year-long project that aims to develop a PL consensus statement for England. To reach consensus, it is important to collate and review contemporary perspectives on what PL is and what it is not. Consensus on a definition for PL in England is crucial, as only with a clear definition can the concept be effectively promoted, supported and developed in practice, and comprehensively assessed [13], which in turn would lead to evidence supporting the large number of anecdotal claims surrounding the benefits of PL (e.g. improved health, well-being and quality of life for all [3]).

This evidence review aimed to identify, compare, and analyse the existing definitions and conceptualisation of PL, by answering the following five research questions:

1. How is PL currently defined nationally and internationally?
2. What are the perceived components / elements of PL?
3. What are the key philosophies, concepts, and principles that underpin PL?
4. What frameworks exist that are relevant to PL?
5. What existing evidence is there on the benefits / outcomes of PL, and what is the quality of this evidence?

Methods

The evidence review adopted a narrative review approach. Narrative reviews aim to identify and summarise recent or current literature, and can cover a wide range of subject matter (multiple research questions) [16]. In contrast to systematic reviews, the selection criteria for the inclusion of resources within a narrative review are not always specified explicitly [17].

The evidence included in this review included empirical evidence, which had come from published, peer-reviewed research, and grey literature. Grey literature is information produced outside of traditional publishing and includes reports, newsletters, websites, blog posts and government documents found online.

A scientific search was conducted to identify empirical evidence, which involved electronically searching academic databases[1] using the keywords “physical literacy”. Studies were also identified through the reference lists of relevant systematic reviews and via the research team.

The review targeted the most recent articulations of PL, therefore only peer-reviewed research published in English since 1 January 2015 were considered for inclusion, which represents the year the concept was first stated in a UK Government policy document [18].

The grey literature search was conducted using Google Chrome. An incognito search query using the term “physical literacy” was run to collect the top 100 URLs (websites).

Eighty-three academic studies and 85 grey literature sources were included in this evidence review. Appendix A shows the process for identification and selection of evidence.

[1] MEDLINE, SPORTDiscus, Education Research Complete (all via EBSCOhost), ScienceDirect, PsycINFO and Google Scholar

National and international definitions of physical literacy

A range of definitions for PL were identified from the evidence base. Definitions developed by expert groups, organisations or government agencies are presented in Table 1 and summarised below.

Country-specific definitions

United Kingdom and Ireland

The International Physical Literacy Association (IPLA) [19] was founded in 2014 and initially connected with UK partners, promoting PL within the UK [1]. Its reach, however, has subsequently gone beyond UK borders, generating interest, collaborations and contacts across the world [20,21]. The IPLA definition of PL is the same as Whitehead's latest definition [21] and is most commonly used by identified grey literature resources (30%).

In 2013, the Youth Sport Trust (YST; a UK-based charity) and partners created a Primary School Physical Literacy Framework that defined PL slightly differently, by adding the phrase "that provide children with the movement foundation…" instead of "to value and take responsibility" [1]. While recent blogposts on the YST website uses the IPLA definition [22], the definition used in their PL framework has made its way to a number of websites including that of a primary school [23], UK coaching [24] and an international website dedicated to Early Years physical development, activity, health and wellbeing [25].

In Wales, Sport Wales uses an equation to define PL [26]. Initially, the equation contained "+ Lots of opportunities" [1]; however, Sport Wales have recently adopted the IPLA definition [21]; thus changed their equation to include "+ knowledge + understanding". Their previous equation, however, is still being used in articles hosted on the Welsh Parliament website [27] and promotional videos around the world [28,29]. Sport Wales and the Welsh Government collaborated with stakeholders to produce 'The Physical Literacy journey' [30], a website in which they use the IPLA definition in full. The Wales Academy of Health and Physical Literacy, located at the University of Wales Trinity Saint David and managing a Welsh Government

funded PL project for schools, quotes various definitions on their website, including Whitehead's, the Australian Sports Commission, and the old Sport Wales equation [29].

The recently developed PL consensus statement for the Island of Ireland [31] is yet to be published. Grey literature search results, however, included a Sport Ireland Coaching factsheet [32] that uses the IPLA definition, while a Sport Northern Ireland resource from 2008 [33] uses a definition with a strong focus on fundamental movement skills, with the terms "motivation", "knowledge and understanding" notably absent (Table 1).

United States

In the United States (U.S.), PL is mainly supported by the Society of Health and Physical Educators (SHAPE America) [34] and promoted by The Aspen Institute (an education and policy studies organisation) [7]. However, these two organisations' definitions of PL differ considerably, with the latter including "ability" and not specific physical competencies in its definition. Their report reveals that ability refers to "competency in basic movement skills and overall fitness that allows individuals to engage in a variety of games and activities" [7,8]. Both the Aspen Institute and the National Association of Physical Literacy (NAPL) include "desire" in their base definitions, with the latter adding "explorative nature to live an active, healthy life" [35].

Canada

Canada is a strong advocate of PL [1], with many sectors embracing the concept as a core priority of their business [36]. Two leading government-funded groups that promote PL in Canada are Physical and Health Education (PHE) Canada [6] and the Sport for Life society [5]. In 2015 a multi-sector collaboration, led by ParticipACTION, released Canada's *Physical Literacy Consensus Statement*, in which they adopted the IPLA definition [36]. Six Canadian organisations including PHE Canada and Sport for Life Society, were involved in the consensus project, thus now endorsing their definition. However, PHE Canada's previous definition of PL (which is the same as that of SHAPE America; see Table 1) is still displayed in multiple resources hosted on their website.

Table 1 Definitions by expert groups, organisations, or government agencies

Country of origin	Group / Author / Year*	Reference	Physical Literacy Definition
United Kingdom	International Physical Literacy Association (IPLA), 2017	[19]	the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life.
England	Youth Sport Trust and partners, 2013	[37]	the motivation, confidence, physical competence, knowledge and understanding that provides children with the movement foundation for lifelong participation in physical activities.
Wales	Sport Wales	[26]	Physical Skills + Confidence + Motivation + Knowledge + Understanding = PL
Northern Ireland	Sport Northern Ireland, 2008	[33]	the ability to use body management, locomotor, and object control skills in a competent manner, with the capacity to apply them with confidence in settings which may lead to sustained involvement in sport and physical recreation.
Ireland	Sport Ireland Coaching, 2018	[32]	the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life.
United States	Society of Health and Physical Education (SHAPE America)	[34]	the ability to move with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person.
	The Aspen Institute	[7]	the ability, confidence, and desire to be physically active for life.
	National association of Physical Literacy (NAPL)	[35]	the ability, balance, confidence, desire and explorative nature to live an active, healthy life.
Canada	Tremblay et al. 2018	[36]	the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life.

Australia	Australian Sports Commission (Keegan et al. 2019)	[38]	Four defining statements: *Core:* PL is lifelong holistic learning acquired and applied in movement and physical activity contexts. *Constitution:* PL reflects ongoing changes integrating physical, psychological, cognitive, and social capabilities. *Importance:* PL is vital in helping us lead healthy and fulfilling lives through movement and physical activities. *Aspiration:* A physically literate person is able to draw on their integrated physical, psychological, cognitive, and social capacities to support health-promoting and fulfilling movement and physical activity – relative to their situation and context – throughout their lifespan.
New Zealand	Sport New Zealand	[39]	A person's PL is a combination of their motivation, confidence and competence to be active, along with their knowledge and understanding of how being active contributes to their life.
China	Li et al. 2022	[40]	the integration of physical, perceptual, cognitive, psychological, and behavioural capabilities, echoing with the need for an active, healthy, and fulfilling lifestyle, which involves continuous positive interactions with the environment and embodied engagement in physical activities for life.
United Nations	United Nations Educational, Scientific and Cultural Organisation (UNESCO), 2015	[41]	the motivation, confidence, physical competence, knowledge and understanding to maintain physical activity throughout life, and refers to the skills needed to obtain, understand and use the information to make good decisions for health.

Note: Some references in this table are from grey literature sources (websites) that do not display dates of publication. PL = physical literacy

Australia

The team of researchers (Keegan and colleagues) who developed Australia's PL definitions and standards framework, published *four* defining statements [38]. Their aim was to produce a definition "ready-for-implementation" by Australian teachers, practitioners, policy-makers and researchers [38]. The authors argued that the "Westernised" concepts of motivation, confidence, competence, and knowledge are misleading and inappropriate for Australia's indigenous and immigrant cultures and further questioned why these specific elements were consistently featured in existing definitions when there were others of equal relevance. Contrary to the equation approach used by Sport Wales, Keegan and colleagues felt that PL needed to be defined as "more than the sum of its parts" [38]. Together with addressing the physical-, psychological- and cognitive domains of learning, notably, the Australian experts added a social domain [38].

New Zealand

In New Zealand, PL is defined in Sport New Zealand's PL Approach [39] and is similar to the IPLA definition, except for the inclusion of a spiritual aspect to their interpretation of PL. Spiritual facets of the Maori culture are specific and important to New Zealand culture and society [1]. Their approach states that "everyone has their own unique PL that contributes to their overall wellbeing", "affects how, why and if they participate in PA throughout their life", "reflects their context, environment, culture and world" and "is a holistic concept, involving physical, social, emotional, cognitive and spiritual dimensions" [39].

China

A PL consensus definition was developed for the Greater China region through a meta-narrative synthesis of literature, followed by the recommendations of an expert panel [40].

Their defining statements include a definition (Table 1) and the following further explanation:

> "As an integrated concept, PL equips and individual with purposeful knowledge, skills, understanding, and values pertaining to the physical, psychological, and cognitive aspects of life. It is comprehensively manifested through the internalisation of the variety of physical activities and a desire for lifelong participation. PL is characterised as perceptual, cognitive, behavioural, and physical attributes integrated through the

dynamic environment, and refers to the ability of communication between an individual and the environment. It helps an individual to apprehend, interpret, and create within the field of physical activity." [40]

The authors identified five domains of PL: physical, psychological, cognitive, behavioural, and sensory-perceptive. Together with their definition, the expert panel also published PL attributes, philosophical underpinnings, and practical and theoretical models of PL, all relevant to Chinese culture [40].

Additional definitions from academic authors and grey literature resources

Further to the above-mentioned definitions that were derived from expert groups, organisations or government agencies, there were five additional definitions by academic authors (Table 2).

Jubala (2015) for example [42], argues for a communication-based definition, where, similar to language literacy but in a sport setting, an individual "reads the game" and responds accordingly.

Dudley (2018) on the other hand, likens PL to the way engineers view the construction of a bridge, connecting people to the world and joining communities [43]. His definition (see Table 2) is adapted from a 2004 definition of "literacy" by UNESCO [44]. However, UNESCO [41] uses a previous version of Whitehead's definition of PL (Table 1).

Seven grey literature search results were found to use definitions not previously mentioned. These are listed in Table 3 and include the website of a city council, a rugby club as well as learning resources for teachers, coaches, and families. While these definitions typically include some elements from the IPLA definition (simplified for their target audiences), some add aspects like the love of movement [45] and creativity [46].

Table 2 Additional definitions identified from the academic literature

Author and Year	Reference	Physical Literacy Definition
Morison 1969 (cited by Liu & Chen 2020)	[47]	… be creative, imaginative, and clear in expressive movement, competent and efficient in utilitarian movement and inventive, versatile, and skilful in objective movement.
Higgs et al. 2008 (cited by Liu & Chen 2020)	[47]	…the development of fundamental movement skills and fundamental sport skills that permit a child to move confidently and with control, in a wide range of physical activity, rhythmic (dance) and sport situations.
Jurbala 2015	[42]	the dynamic communication between the embodied self and the physical environment, which continuously integrates perceptive reading of, and appropriate response to, physical challenges.
Dudley 2018	[43]	the ability to move with confidence and competence using all the physical assets one has at their disposal at any given point in time across varying contexts. PL involves a continuum of learning by enabling individuals to achieve their goals, to develop their knowledge, movement and potential, and to participate fully in their community and wider society.
Liu and Chen 2020	[47]	a state of being physically cultured for lifelong active lifestyles as characterized by development in the cognitive, affective, physical, and behavioural domains.

Table 3 Additional definitions identified from grey literature

Country of origin	Name (type of resource)	Reference	Physical Literacy Definition
Canada	Active for Life (non-profit social initiative)	[45]	when kids have developed the skills, confidence, and love of movement to by physically active for life.
England	Boing Kids (play-based curriculum)	[48]	the understanding and awareness of how we interact with the environment.
England and Wales	Try Time Kids' Rugby (children's rugby club)	[49]	the ability for individuals to move confidently and competently, doing a wide range of activities.
England	Derby City Council	[50]	the ability to have sufficient control of the body to enable age-appropriate gross and fine motor skills.
Australia	KIDDO (Physical literacy programme and resources for schools)	[51]	the skills, motivation, confidence and knowledge to be active.
England	Centre for holistic improvement and learning development	[46]	the ability to use the body as an instrument of expression and creativity.
Canada	Strong4Life (resources from Children's healthcare of Atlanta)	[52]	what kids learn from birth through adolescence about moving their bodies. By developing physical literacy, kids learn the skills they need to remain active for life

Overview of definitions of physical literacy

Figure 1 presents a word cloud as a visual representation of terms used in the definitions listed in Tables 1-3. Figure 2 presents a summary of concepts used to define PL.

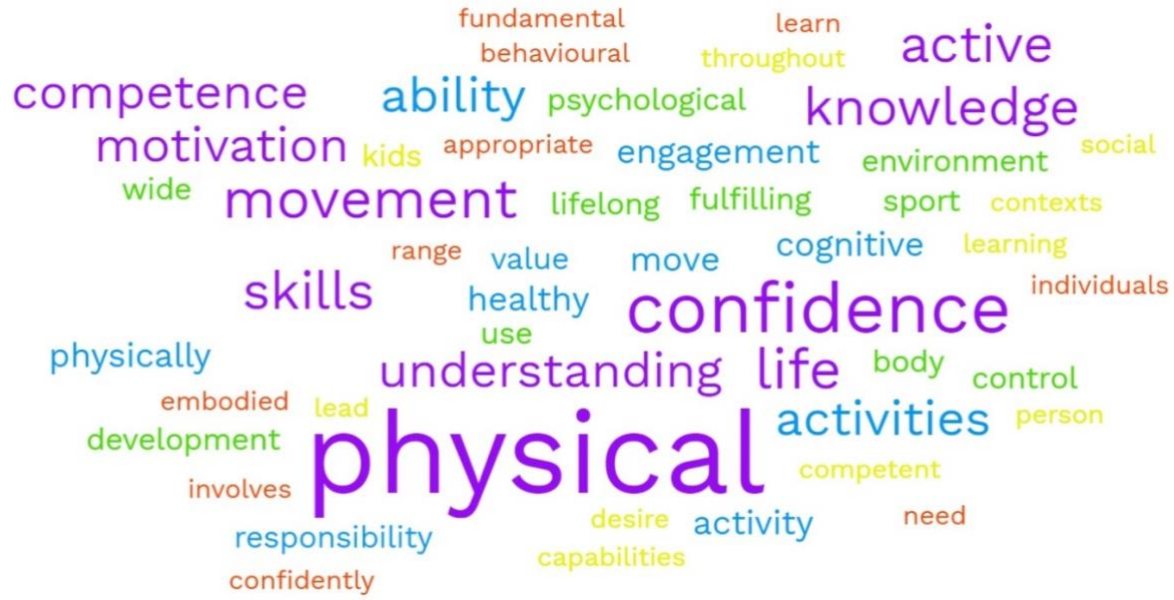


Figure 1 Word cloud as a visual representation of definitions identified in scientific and grey literature searches (larger words reflect greater frequency of terms used in definitions).

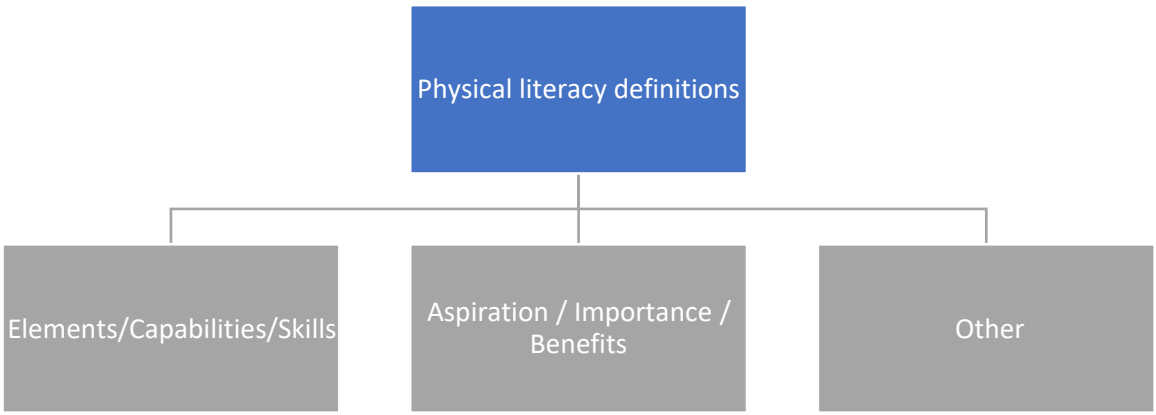


Figure 2 Concepts included in definitions of physical literacy

- 23 different definitions of PL were identified, which has implications for understanding.

- Most country-specific definitions include the concept of lifelong participation in physical activity, and elements of physical competence and confidence in their base definitions.

- Most countries' definitions include affective (e.g. motivation, confidence), physical (e.g. physical competence) and cognitive (e.g. knowledge) domains. However, Australia includes a social-, New Zealand a spiritual- and China a sensory-perceptive domain.

- Canada and China refer to a behavioural domain within which the lifelong participation in physical activity falls. While some country-specific definitions refer to the concept of motivation, two definitions originating in the United States use the term "desire", as does further explanation published alongside the Chinese definition.

- PL is frequently described as a holistic concept [e.g. 1,12,13,53], meaning that the person is placed in the centre of their PL journey and nurtured in all the domains of PL in response to their individual needs [53]. However, apart from the Australian work [38], the term "holistic" does not feature in any other definition identified through our search.

- In contrast to the country-specific definitions, additional definitions by academic authors and grey literature resources revealed no similarities other than aspects of the development of movement / physical competence.

- Figure 2 summarises the different concepts identified in PL definitions. All definitions of PL make reference to PL including specified elements/attributes/capabilities/skills. These are predominantly presented as being necessary to be physically active (i.e. antecedents), though other benefits and aspects of importance are also stated such as for health [e.g. 23,25,27] and holistic learning and development [e.g. 43].

- In a few definitions, reading/perceiving/interacting with the environment or applying movement in different contexts was noted [e.g. 22,24,27,29,42,43], as was participation in a wide variety of activities [e.g. 24,48].

- Definitions vary in length and complexity. While in Wales PL is defined by a simple equation, the Australian and Chinese versions are expanded statements accompanied by further explanation of the concept.

Components / elements of physical literacy

Each of the definitions of PL include various terms or phrases that represent the concept of PL. In the literature these terms are either called components [31,47], attributes [21], characteristics [8], constructs [54] or elements [12,36,38]. For the purposes of this review, we will consider the terms included in each definition as elements. These elements can be considered as the capabilities required to support engagement in physical activity for life.

Table 4 lists the elements extracted from definitions and definition papers. While some authors published explanations for the terms they use [8], most often this is not the case, leaving the reader with terms that can be interpreted in more than one way. Edwards and colleagues emphasised the importance of clarity of terms and phrases [13], which will ensure easy implementation into practical settings.

Approaches differ considerably across the evidence reviewed in terms of the range of elements stated for physical literacy. For example, Sport Australia identified 30 elements spanning across four domains (physical, psychological, cognitive and social) [55], and likening them to the chemical elements of the periodic table, with which profiles of movement and activities to engage in could be "built" [38]. Conversely, the Canadian consensus statement describe four "essential and interconnected" elements across four domains (physical, affective, cognitive and behavioural) [36].

Whitehead's latest work [21] includes eight "attributes" that individuals who are making progress on their PL journey will demonstrate, while SHAPE America presents five "standards" of physically literate individuals [56].

In some cases (mostly consensus papers), authors have specified which domains their elements belong to [e.g. 36,38], while others merely listed the elements [e.g. 47]. However, authors are not always in agreement as to which domain specific elements belong to. Belton and colleagues for example places "responsibility for own participation in PA and sport" in the cognitive domain [31], while others classify it as an element within the affective domain [8,40].

Table 4 Elements (also termed components, attributes, or characteristics) of physical literacy

Physical domain	Cognitive domain	Affective	Behavioural domain	Social domain
Physical competence [13,19,36,37,57] Competence [39,40,47,54] Motor competence [31] Movement competencies [42,58] Competency in a variety of motor skills and movement patterns [56] Motor skill competence [13] Diverse forms of movement [47] Diversity / variety of movement [59]† Ability [7,35] Ability to perform basic exercises [60]	Knowledge [19,26,36,37,39,40,42,47,57] Knowledge of PA [31,61] Knowledge of movement [31] Knowledge and understanding of activities [13]	Confidence [7,8,13,19,26,31,33,35-40,42,54,57] Confidence and competence [47] Confidence and physical competence [47]	Engagement [40] Engagement in PAs for life [19,36,57] Physical activity [8,13,31] Positive PA behaviours [31] PA Behaviours [54] Active lifestyle [40] PA level [60,61] PA practice [61] Time spent in PA [61] Behaviour [62] Capacity for an active lifestyle [59]†	Social skills [31]* Social participation [42] Self-expression and communication with others [47] Expression and interaction [47] Interaction with others [8] Social interactions / interpersonal relationships [59]†
Physical skills [26] Movement skills [38,40] Fundamental movement skills [13,31] Motor skills [8,62] Movement capacities [13] Fine motor skills [61] Global motor skills [61] Locomotor skills [33,61] Proficiency of movement / motor skills [59] †	Understanding [19,26,36,37,39,47,57] Understanding how to move in PA and sport [31] Understanding how to improve in PA and sport [31] Understanding, communication, application and analysis [47]	Motivation [8,13,19,26,31,36-40,42,47,57,62] Motivation and behavioural skills of movement [58]	Lifelong participation [37,40] Lifespan [31]* Lifespan healthy behaviours and PA participation [47] Responsibility for engagement for life [8] Throughout the lifespan [13] Sustained involvement in sport and physical recreation [33]	Support from significant others [13] Parental support for PA [61] Support from friends for PA [61] Teacher support for PA [61]

Physical fitness [31,40,60] Health-related fitness [47] General physical fitness [61] Cardiorespiratory fitness [61] Physical health [60]	Rules [38] Strategy and planning [38] Tactics [38] Rules, tactics and strategies of movement [58] Strategic thinking [47] Knowledge of concepts, principles, strategies and tactics related to movement and performance [56]	Interaction with the environment [40,47] Environment [47] Perception of environment [8,61] Read/interact with the environment [13] Communication self/environment [63] Environmental awareness / understanding [59]† Perceptive reading and appropriate response to physical challenges [63]	Better life choices [31]* Healthy active choice [47] Health behaviours [13] Optimise choices / maximise success [59]†	Safety and risk [38] Safety awareness [59]†
Movement with poise, economy [13] and effectiveness in a wide variety of challenging situations [21] Ability to move your body effectively in order to carry out tasks and avoid injury [31]* Body management [33]	Awareness [38,40] Knowledge of awareness of importance of PA for health [31] Knowledge and skills to achieve and maintain a health-enhancing level of PA and fitness [56] Knowledge and understanding of healthy active lifestyles [13]	Enjoyment [31,40] Enjoyment and engagement [38] Engage, enthuse and enjoy [13] Positive effect (fun, happiness, enjoyment) [42,62]	Responsible personal and social behaviour that respects self and others [56] Beneficial to and respectful of themselves, others and their environment [47]	Relationships [38] Relate well to others [31]*
Stability / balance [38] Balance [35,61] Adequate balance / strength / mobility / endurance [59]†	Content knowledge [38] Knowledge provided by PE programme [60]	Attitude [40] PA attitudes [31,61] Mental attitude and strength [31]* Positive affect / attitude [59]†	Experience [40] Mastery experience [59]†	Connectedness [38] Connection [54]
Muscular endurance [38,61] Sustained movement [59]†	Knowledge and attitudes [54]	Self-awareness [38] Self-awareness of one's own body [31]*	Performance [40]	Competent with society for life [31]*

	Physical attitude knowledge [61]	Sense of self [47] Sense of self and self-confidence [47] Mindful and aware of the body and confident [31]* Body Mind awareness [31]*		
Object manipulation [33,64]	Cognitive skills [8] Cognitive activity [59]†	Valuing PA [8,31] Value PA for health, enjoyment, challenge, self-expression and/or social interaction [56] Value and take responsibility for PA [13,19]	Diet [59]†	Participate in a meaningful way in society [31]*
Flexibility [38,61]	Creativity in a range of PA and sport [31] Creativity [47]	Self-assurance and self-esteem to take responsibility for choosing PA for life [21] Self-esteem [13,61]	Personal development and fulfilment [31]*	Become a better citizen [31]*
Agility [38,61]	Understanding of the principles of holistic embodied health, in respect of a rich and balanced lifestyle [21]	Resilience [31,59]†	Survival ability [40]	Personal and social attributes of movement [58]
Purposeful physical pursuits [13] Meaningful person centred and purposeful activities [59]†	Ability to identify and articulate the essential qualities that influence the effectiveness of movement performance [21]	Desire to be physically active for life [7] Desire [35]		Society and culture [38]
Thoughtful and sensitive perception in appreciating all aspects of the physical	Purpose and reasoning [38]	Posture self-perception [61] Body perception [61]		Collaboration [38]

environment, responding as appropriate with imagination and creativity [21]			
Ability to work independently and with others in different PAs in both cooperative and competitive situations [21]	Decision-making [40]	Self-efficacy [31,61]	Ethics [38]
Movement using equipment [38]	Moral [40]	Responsibility [8,40]	
Coordination [38]	Optimising potential [40]	Self-regulation [38,59]†	
Strength [38]	Ideology [40]	Sport value [40]	
Reaction time [38]	Responsibility for own participation in PA and sport [31]	Confidence in relation to the ability to make progress in learning new tasks and activities, and assurance that these experiences will be rewarding [21]	
Speed [38]	Philosophy of movement and activity [31]*	Integration [40]	
Power [38]	Emotional and cognitive benefits [31]*	Motivation to be proactive in taking part in PA, applying self to PA tasks with interest and enthusiasm, and persevering through challenging situations in PA environments [21]	
Exercise [40]	Knowledge of body changes related to aging [59]†	Manner and appearance [40]	
Well-being [40]		Cultural dispositions [40]	
Body scheme [61]		Autonomy [40]	

Engaging in movement [31]	Aesthetics and appreciation [40]
Language of sport [31]*	Self-competence [31]
Body's needs and limits to enjoy PA safely [31]*	Interaction with others in PA and sport [31]
Achieve optimal movement [31]*	Respond to the demands of life [31]*
Spatial organisation [61]	Character [54]
Temporal organisation [61]	Satisfaction for PA [61]
Posture [61]	Explorative nature [35]
Velocity [61]	
Physical / age adaptation [59]†	

Notes: PA = physical activity.
* These elements originate from the Irish and Northern Ireland consensus statement work involving stakeholders' views and are listed as *potential additional components* of physical literacy, under the following themes: social benefits, movement vocabulary and safety, lifelong journey and personal benefits.
† These are new components identified through an integrative review aiming to define PL for the rehabilitation needs of aging adults.

As stated earlier, the elements listed in Tables 4 might be called attributes, characteristics, components of PL, etc. Findings from a concept analysis of PL divide these elements into attributes and antecedents [11]. The authors suggest that “motivation”, “confidence”, “knowledge and understanding”, as well as “engagement in PA” are all *attributes* (characteristics) of PL, while e.g. “engaging in a variety of activities” and “support from significant others” are seen as *antecedents* (i.e. events or phenomena that precede PL).

Similarly, results from a Delphi study that aimed to operationally conceptualize PL for application in the United States [65] recommend that the traditionally referred to concepts of “physical competence”, “motivation”, “confidence” and “knowledge” should be reconceptualised as either determinants or outcomes of PL.

Summary

- Definitions and accompanying statements of PL include terms and phrases that are known as elements, components, attributes, or characteristics of PL.
- This lack of consensus regarding terminology and/or insufficient description of elements might be adding to any confusion surrounding the multiple definitions of PL.
- We identified many elements described in different variations of PL.
- Elements within the physical-, cognitive- and affective domains of PL are the most commonly cited in the available evidence.
- There are more elements within the physical domain than any other domain, although different terms are often used to describe similar physical elements (e.g. the various terms used to describe physical competence). Further, some simply refer to general “physical competence [36] or movement/motor competence” [44], however, others include a list of specific movement capacities, such as “balance” or “coordination” [38].
- Variations of knowledge and understanding are most cited within the cognitive domain.
- Motivation and confidence are most often cited within the affective domain.
- Variations of “engaging in PA for life” are often stated in the behavioural domain.
- Among the consensus definitions, only the Australian Physical Literacy Framework [38] refers to elements within the social domain, however, other resources often refer to social elements e.g. “interaction with others” [8,31].
- Taken together, despite PL’s increasing proliferation, there remains a lack of clarity in the selection, description and interpretation of elements used to portray the concept. Without clarity, PL and its subsequent implementation in practice will remain opaque.

Key philosophies, concepts, and principles that underpin physical literacy

Literacy

Over the last two decades (and concurrent to the development of PL), the notion of "literacy" has received considerable attention [21,44,66]. The term might be familiar to most people in a linguistic sense, in fact, PL has often been compared to reading and writing, but in a physical setting [13]. Whitehead defines being literate as having the ability to interact effectively with the world around us [67]. Dudley and Cairney (2021) however, states that literacy is a complex, dynamic concept which continues to be interpreted and defined in new ways [66]. They quote the UNESCO *Education for All Global Monitoring Report*, that describes literacy as:

> "simultaneously an outcome, a process (e.g., taught and learned through formal schooling, non-formal programmes or informal networks), and an input (paving the way to: further cognitive skill development; participation in lifelong learning opportunities, including technical and vocational education and training, and continuing education; better education for children; and broader societal developments)." [66, page 7]

Monism, existentialism, and phenomenology

Whitehead's work [e.g. 68] utilised three philosophical schools of thought - monism, existentialism, and phenomenology - as the foundation for the concept of PL. Monism is the belief that a person is an indivisible whole [68], with the mind and body working together in unison. For example, thinking, feeling, moving and talking are all interwoven and deemed embodied, which is in opposition to the traditional dualistic view of mind and body as separate entities [67]. Existentialism proposes that each person is an individual as a result of their interactions with the world [68], and richer, more varied interactions will lead to that person flourishing and realising their potential [67]. Similarly, phenomenologists believe that every individual perceives the world from the unique perspective of their previous experiences [68]. An individual's interactions with the environment (whether positive, negative, meaningful or meaningless) will shape their view of the world [67].

An understanding of Whitehead's philosophical roots of PL is deemed by some authors as vital for the successful application of these principles within policy and practice [9,12,13,21,69], with studies often criticised for not declaring or discussing their philosophical assumptions [1,13,70]. Several authors have argued that the philosophical underpinnings of PL are too complex for practitioners to access and interpret, thus presenting a barrier for translation into practice [12,13,42]. Pot and colleagues [67] responded to this critique by providing practical examples of how PL can be fostered within a physical education setting. They argue that activities should be inclusive, diverse, context rich, learner-centred, challenging across different domains, and adaptable to each individual's preferences [67].

Other concepts or principles of physical literacy

Figure 3 provides an overview of agreed principles of PL. Most authors agree that PL is a holistic concept [e.g. 1,12,13,53], centered around the development of the whole person [13].

Pot and colleagues demonstrates how an holistic approach can practically be applied in fostering PL, by using the example of a teacher choreographing a dance [67]:

> "…learners will be challenged physically to perform movement routines. They will also be challenged cognitively to solve the problems of the creative task set and aesthetically to make judgments about the quality of the final piece." (page 248)

Other philosophical tenets or principles identified through review papers are:

- embodied nature [12,13,47] - a term that encompasses both our body as an instrument, often called the living body, and as a perceptuomotor dimension of being, otherwise known as the lived body [71]
- individuality and uniqueness of perspectives [12,47]
- the importance of environment-related opportunities and interactions [12],
- a human disposition [13]
- a unique and lifelong journey [13,47]
- inclusive with all individuals, irrespective of culture, age or ability able to progress along their PL journey at their own pace [68].

Unfortunately, despite the conceptualisation of PL as inclusive, in practice there is evidence of "enlightened ableism", i.e. the presence of a modern, well-informed world view, yet the continuation of practices that marginalise persons with disabilities [72].

Figure 3 Overview of key principles underpinning physical literacy

Summary

- Similar to PL, the term “literacy” has received increased attention over the last two decades as a complex concept with a continuously evolving definition.
- Different authors have proposed distinctive meanings for ‘literacy’ in physical literacy.
- Three philosophical underpinnings stemming from Whitehead’s perspective are widely cited in PL literature: monism, existentialism, and phenomenology. These philosophies have been identified as potentially too complex for practitioners to understand.
- PL is seen as a holistic concept, where the individual is placed in the centre of their PL journey and development of the whole person is nurtured.
- Key principles of PL include the embodied nature, individuality and uniqueness of perspectives, the importance of environment-related opportunities and interactions, a human disposition, a unique and lifelong journey, and an inclusive concept.

Frameworks and models relevant to physical literacy

In recent years, several frameworks and visual models related to PL have been published. Each framework is unique in the way that it positions PL; such as focussing on PL's association with health outcomes [63], policy considerations [44] or its role in physical education [73]. The following pages present these frameworks and models, with a summary provided.

Dudley's conceptual model of observed physical literacy

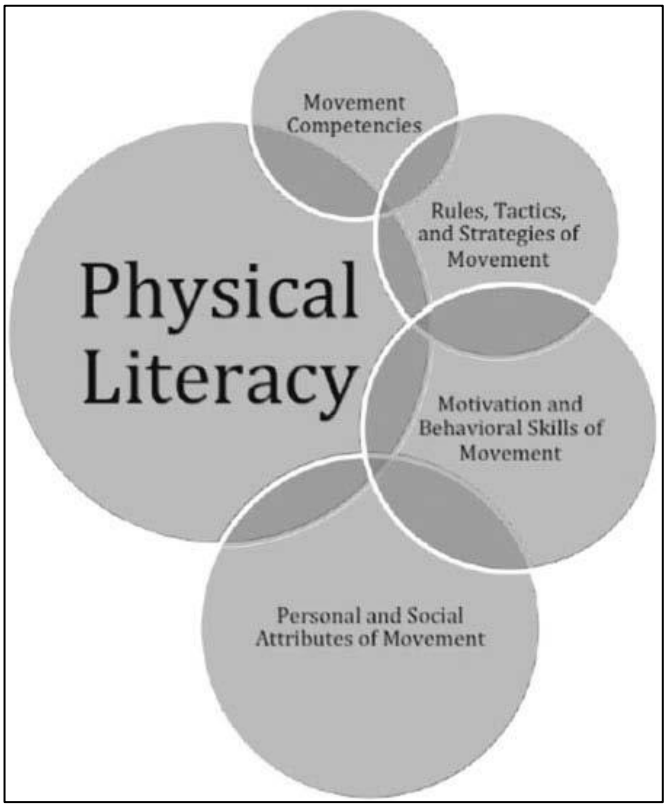


Figure 4 Dudley's conceptual model of observed physical literacy [58]

Dudley's model of observed PL (Figure 4; [58]) was developed for practitioners, and positions PL as a construct of learning that involves a combination of physical, social, affective, and cognitive elements.

Dudley and colleagues' four pillars of physical literacy policy

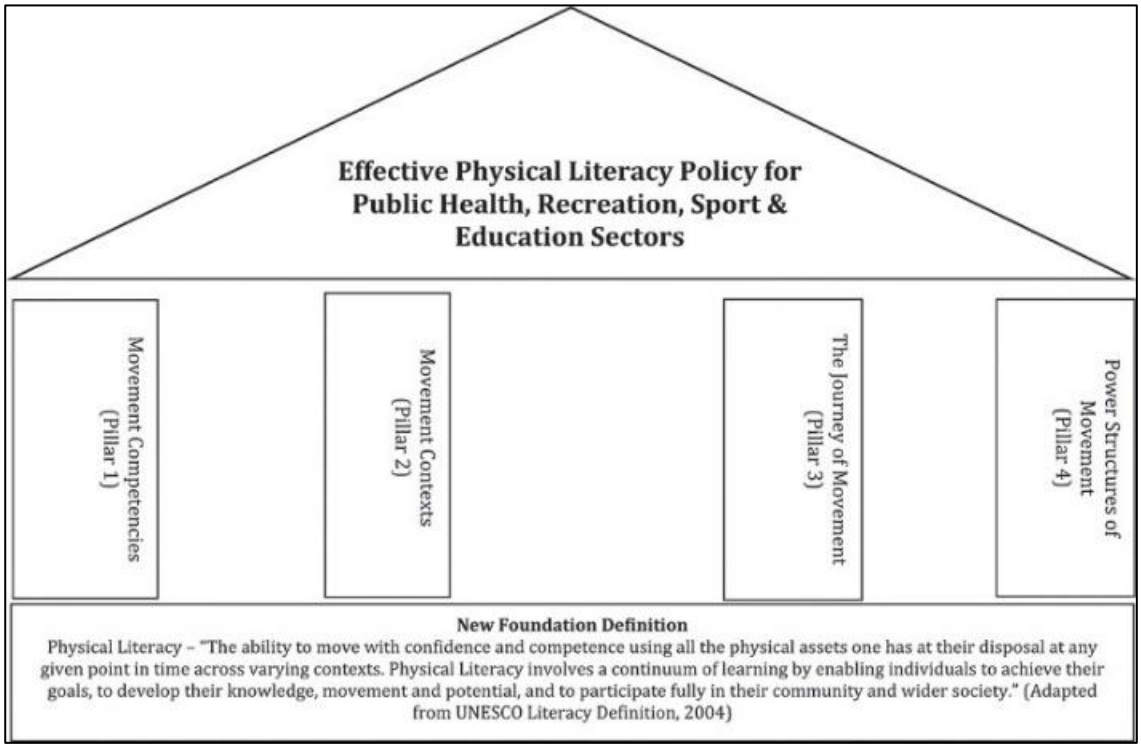


Figure 5 Dudley's four pillars of physical literacy policy [44]

In 2017, Dudley and colleagues presented a new model, with four pillars of PL for policy considerations (Figure 5; [44]). These are: Pillar 1 - Movement competencies (PL as an autonomous set of skills); Pillar 2 - Movement contexts (PL is situated, practiced, and applied in context); Pillar 3 - The journey of movement (PL progress) and Pillar 4 - Power structures of movement. The authors argue that public health, sport and education policy all share a commonality of purpose, despite their differences in ontology and epistemology [44]. The authors advise education, sport, recreation and health agencies to clearly state in policy documents how they address each of the pillars, suggesting that doing so will provide environments rich in PA participation opportunities across the lifespan [44].

Cairney et al. model

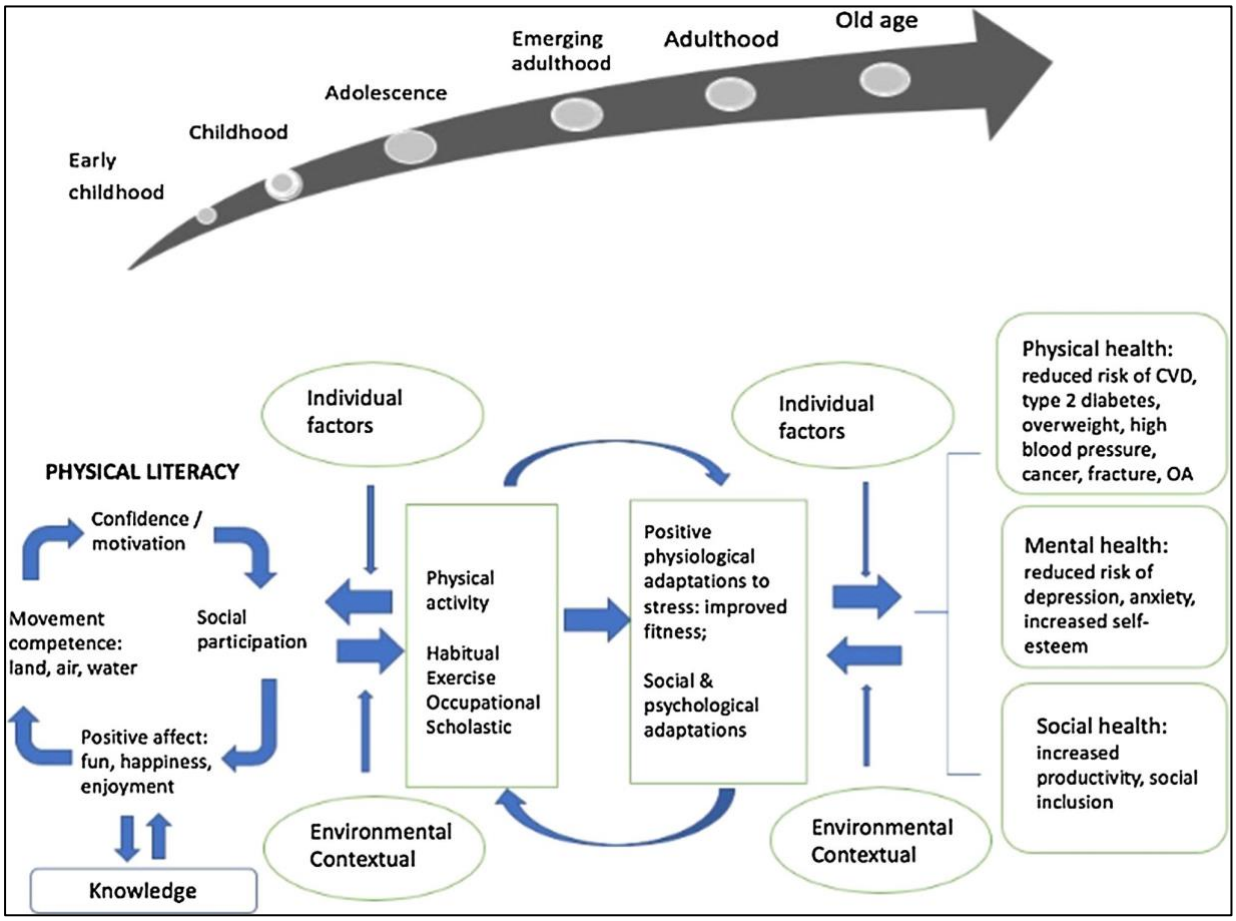
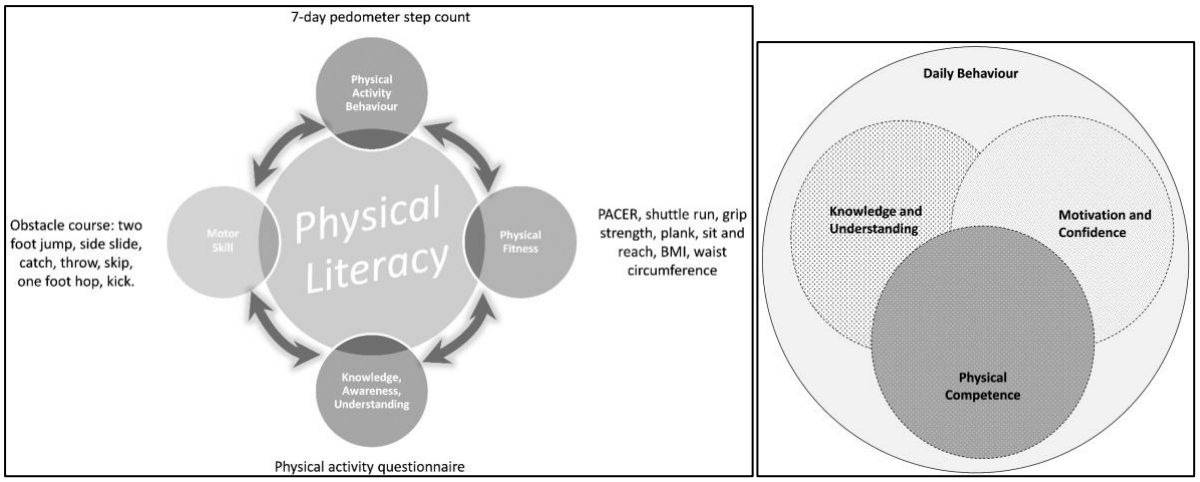


Figure 6 Cairney et al.'s conceptual model linking physical literacy, physical activity and health [63].
CVD = cardiovascular disease; *OA* = osteoarthritis

Cairney and colleagues position PL as a determinant of health and disease in their model (Figure 6; [63]), by linking PL, PA and health. Their model describes PL as an intertwining concept of motor competencies, social participation, positive affect, and confidence / motivation. Knowledge is positioned outside the cycle, but connected with opposing arrows, showing that knowledge can arise as an outcome of the process of the cycle of engagement, but can also influence engagement [63]. Similarly, opposing arrows connects PL and PA, depicting PL as a determinant of PA, whilst also emphasising that sustained participation in PA leads to further development of PL. The core of the model shows PA leading to positive physiological, psychological, and social adaptations, which in turn result in positive health benefits. Individual level (e.g. sex, ethnicity) and social / environmental conditions (e.g. neighbourhood, climate) can potentially influence this process. Lastly, an overarching arrow emphasises PL as a lifelong journey [63].

The Canadian Assessment of Physical Literacy models



7A 7B

Figure 7 A) The original Canadian Assessment of Physical Literacy model and B) the revised version by Francis et al. 2016 [2].

The Canadian Assessment of Physical Literacy (CAPL) [2] was developed as a comprehensive measure [14] of PL for children aged 8 to 12. Their original theoretical model consisted of four domains, each accompanied by specific protocols for its assessment (Figure 7A). Francis and colleagues argued that the model needed revision in order to align with newly developed definitions of PL, and after a three-round Delphi process (with 19 experts), a revised conceptual model was published in 2016 (Figure 7B; [2]). This model depicts three overlapping domains representing motivation, physical competence, and knowledge. The authors state that effective PA interventions will increase knowledge and motivation for active, healthy living, while also building the skills necessary for behaviour change [2]. A fourth domain, daily behaviour, encompasses the other domains, suggesting that a physically literate person will lead a healthy, active life if they have the required physical competence, motivation, and knowledge to support this behaviour.

A physical literacy model for older adults

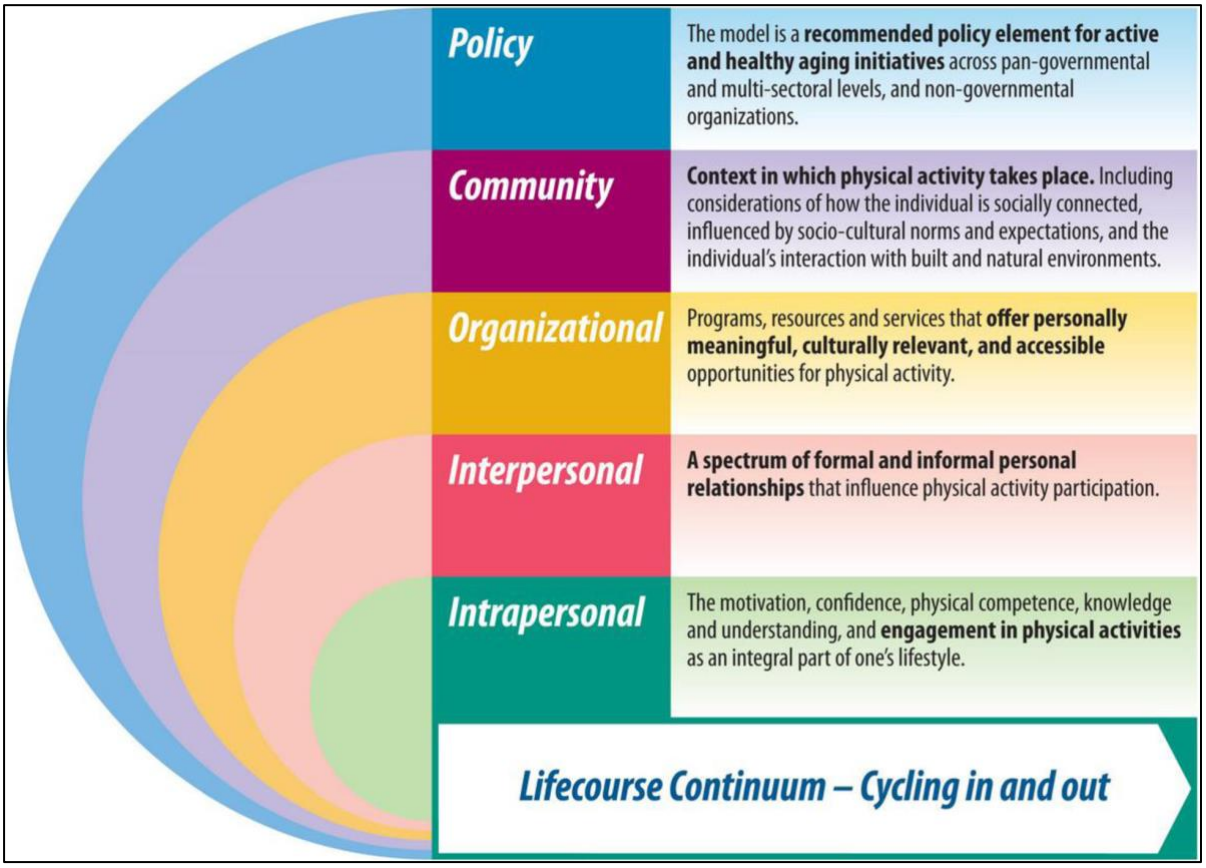


Figure 8 Physical literacy model for older adults: An ecological approach, by Jones et al. 2018 [74]

Through a consensus process, a collaborative working group of experts in Canada has developed a PL model for older adults (Figure 8; [74]). By using an ecological approach, the model integrates all components (intrapersonal, interpersonal, organisational, community and policy) as being involved in the promotion and adoption of PL into the lifestyles of older adults [74].

Long-term development model

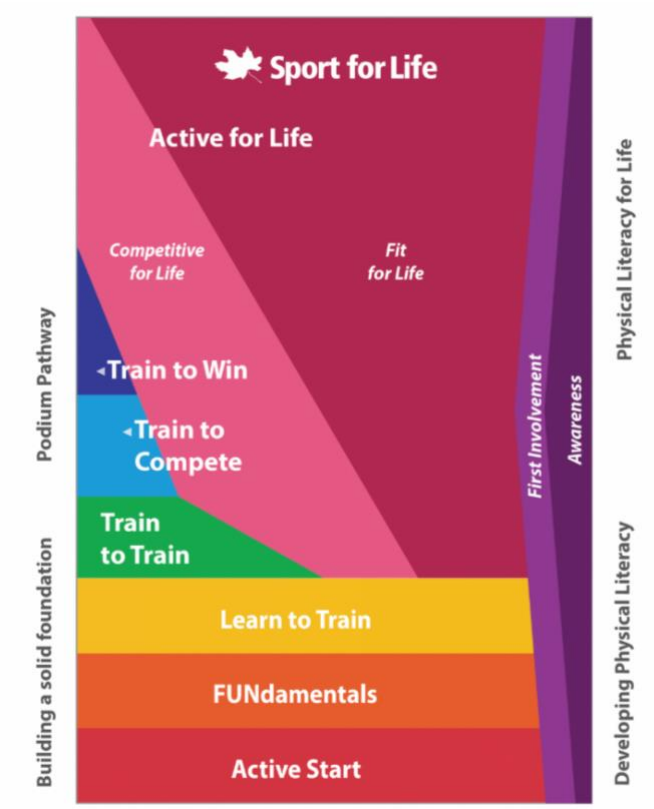


Figure 9 Long-Term Development Framework from Canada's Sport for Life [75]

PL has also been adopted into the context of sport, with Canada's Sport for Life society identifying PL as one of 10 key factors influencing their Long-term Athlete Development (LTAD) model [54]. The LTAD is an internationally recognised talent development model, but its performance-driven approach and narrow focus on fundamental movement skills have been criticised by the PL community for not acknowledging the holistic nature of PL [54,57,64]. The model continues to be revised and updated [64] to recognise the variety of factors influencing PL.

The current version on Sport for Life's website [75] is called Long-term Development Framework (LTD; Figure 9), noticeably omitting the word "athlete". The LTD (like the LTAD) framework describes specific stages (Active start, Fundamentals, Learn to Train) and what athletes should be doing each stage, which is also connected to specific age groups. It goes by the assumption that children and adults will become active, stay active and even reach the highest sporting achievements if they "do the right thing at the right time" [75].

Australia's physical literacy standards framework

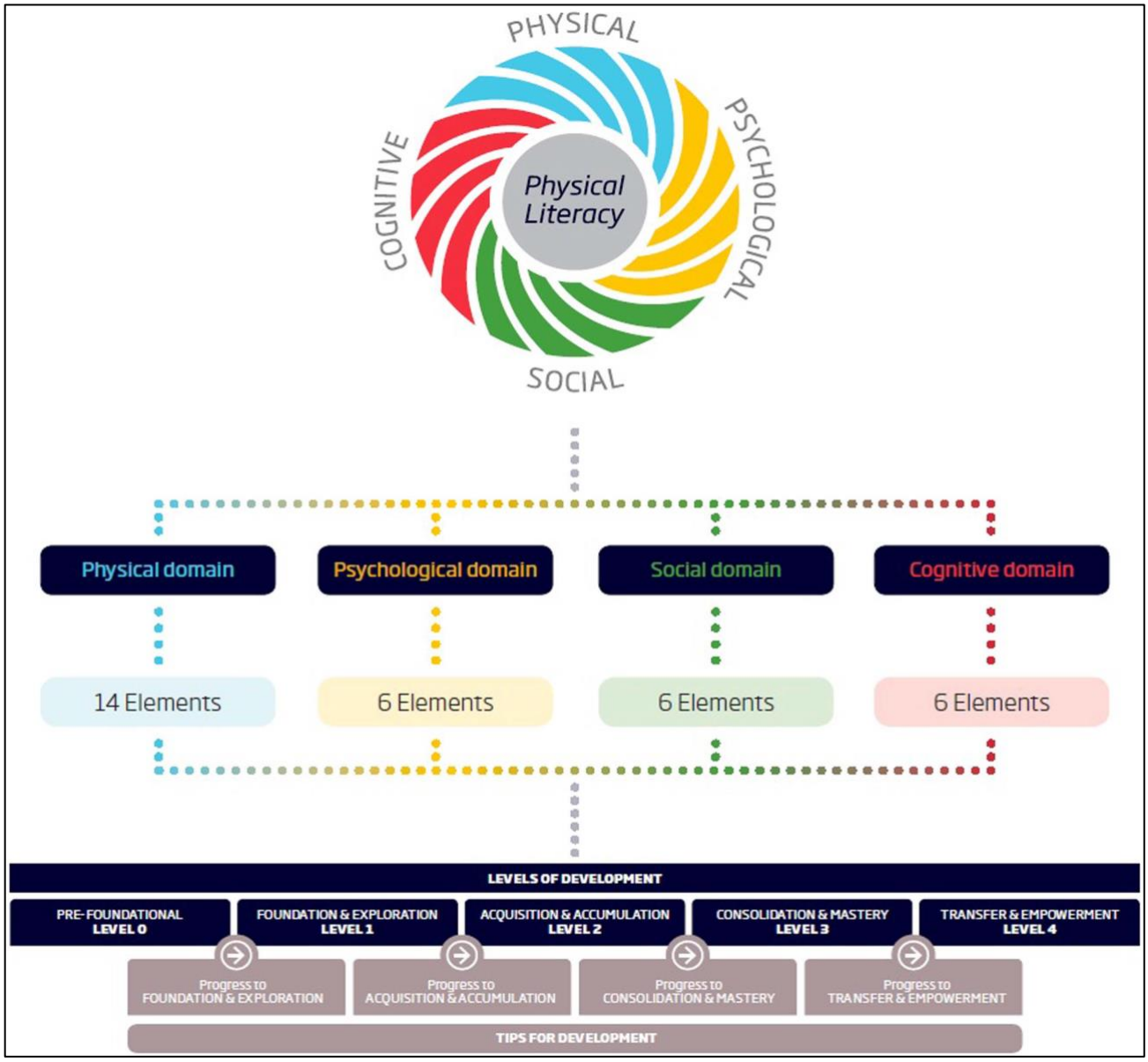


Figure 10 Australia's standards framework by Keegan et al. 2019 [38]

In contrast to Canada's LTD framework, the expert group who developed Australia's standards framework (Figure 10; [38]), argued that PL should not be considered a linear trajectory nor should age be used as a determinant of expectations (e.g. age-based descriptors). They used Biggs' System of Observed Learning Outcomes (SOLO) taxonomy to structure the learning progression or PL journey [38]. The SOLO taxonomy implies that human learning and skill development are not isolated, precise, individual skills, but rather integrated, connected and portable capabilities [21]. Their standards framework was developed to support implementation in a variety of settings, including schools, community or elite sport, policy-making, research, adult exercise and health settings as well aged care [38].

Jurbala's cycle of physical literacy development

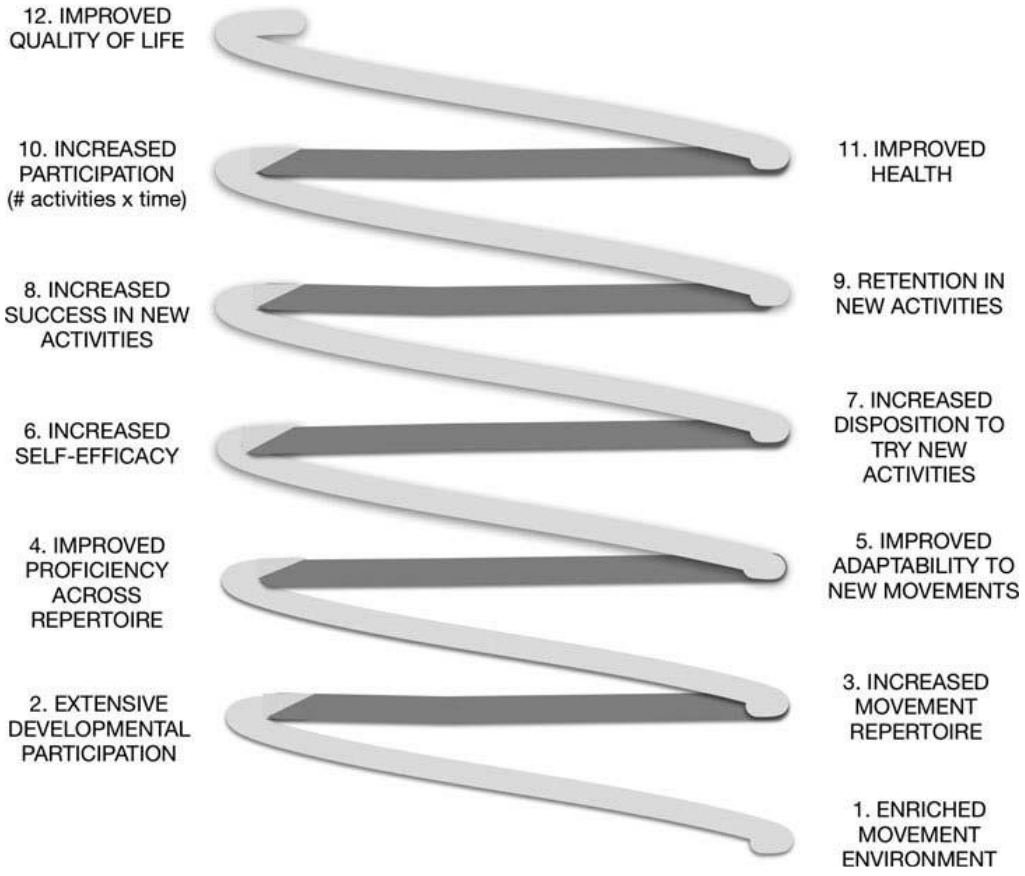


Figure 11 A virtuous cycle of physical literacy development, proposed by Jurbala 2015 [42]

Together with his communication-based definition of PL, Jurbala [42] published a model (Figure 11) likening the development of PL to a continuously moving spiral escalator. The author emphasises that "improved quality of life" at the top of the model is a product of the ongoing cycle of communication with the physical world, therefore should not be seen as a fixed accomplishment resulting from earlier acquisition of PL [42]. Ongoing engagement in movement yields intermediate outcomes as the individual ascends to enduring improvements in health and quality of life (or descends through decreased PA, thus losing self-efficacy and movement confidence) [42].

The Physical Literacy Praxis

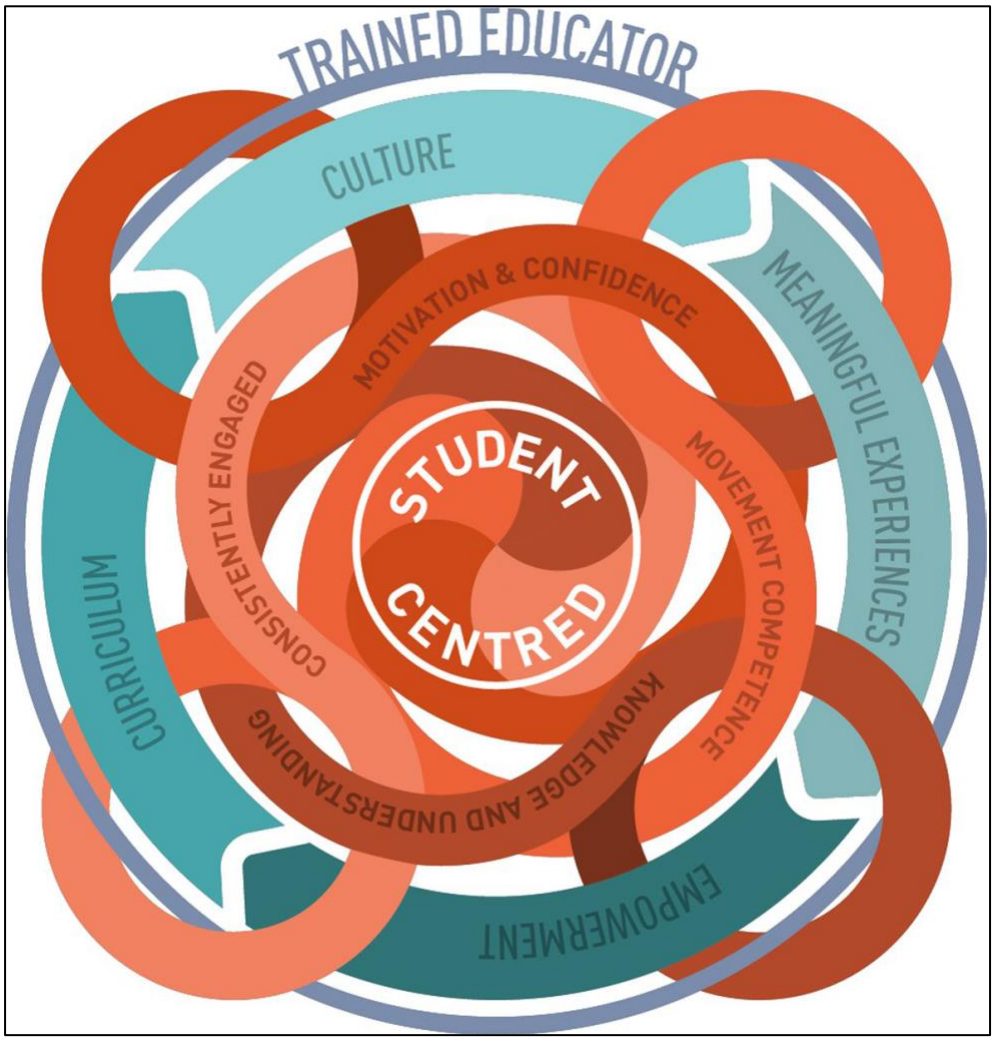


Figure 12 Physical Literacy Praxis: a framework for transformative physical education, by Gleddie and Morgan, 2021 [73]

Gleddie and Morgan (2021) developed a framework called Physical Literacy Praxis (PLP; Figure 12; [73]), with the intent to "bridge the gap" between research and practice in physical education. PLP begins with a trained physical educator, followed by four elements the authors believe are critical to delivering quality physical education. These are: 1) a culture that values the tenets of PL, 2) a curriculum that supports students' PL journey, 3) the empowerment of students by their educators, to become architects of their own learning, and 4) meaningful experiences in physical education [73]. Four knots, representing four domains of PL (physical, affective, cognitive, and behavioural), weave through the above-mentioned elements and are riveted in a student-centred approach. PE provides student activities in diverse environments, allowing for learning and growth to take place in all four above-mentioned domains of PL [73].

A continuum of paediatric physical literacy

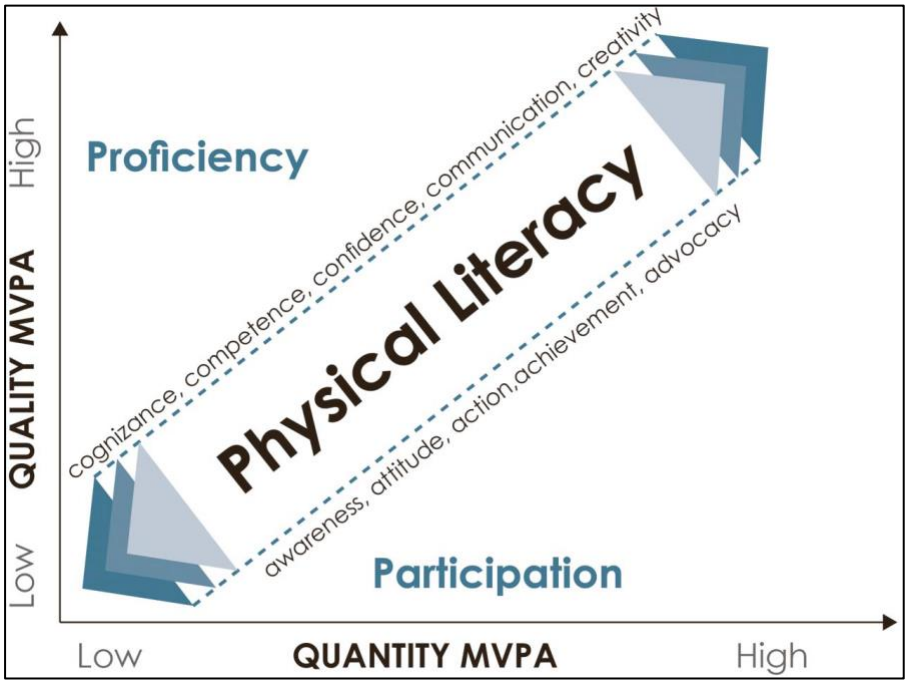


Figure 13 The bidirectional continuum of pediatric physical literacy, by Faigenbaum et al. 2018 [76]

Faigenbaum and Rebullido (2018) argues that the PL journey can be viewed along a continuum, and is influenced (positively and negatively) by life experiences and interactions with the physical world [76]. Their proposed model for PL in youth (Figure 13; [76]) features interrelated components that are dependent on the quality and quantity of each individual's moderate-to-vigorous PA experiences. The authors state that youth can progress or regress along the continuum depending on physical, psychosocial and environmental factors [76].

Practical and theoretical models of physical literacy for the Greater China region

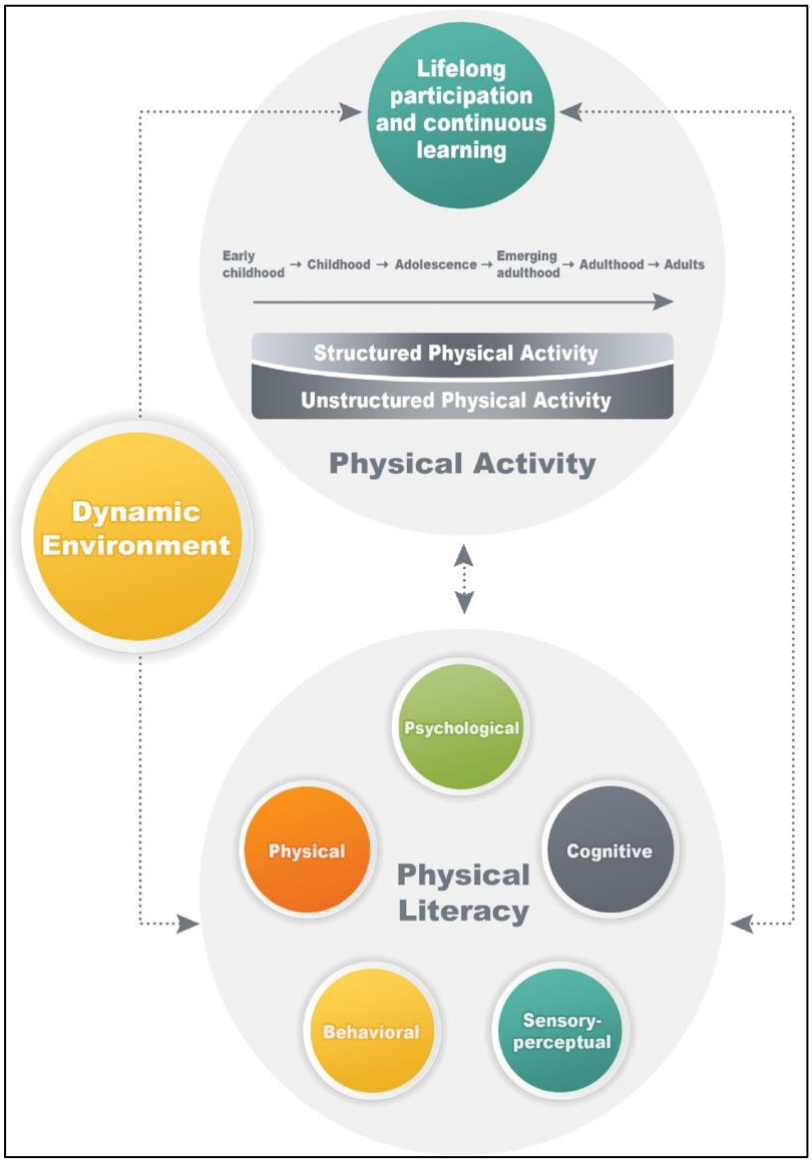


Figure 14 Practical model of physical literacy in the Greater China region, by Li et al. 2022 [40]

Li and colleagues published the defining statements of PL for the Greater China region, along with practical and theoretical models [40]. Their practical model of PL addresses five domains (physical, psychological, cognitive, behavioural and sensory-perceptual) and one important overlapping factor (dynamic environment). Lifelong participation in PA and the dynamic environment are closely inter-related (Figure 14; [40]). The theoretical model (Figure 15; [40]) includes Whitehead's three philosophical schools of thought, together with traditional Chinese terms or philosophies that they align with. For example, Confucianism, Buddhism and Taoism are consistent with the essence of monism [40].

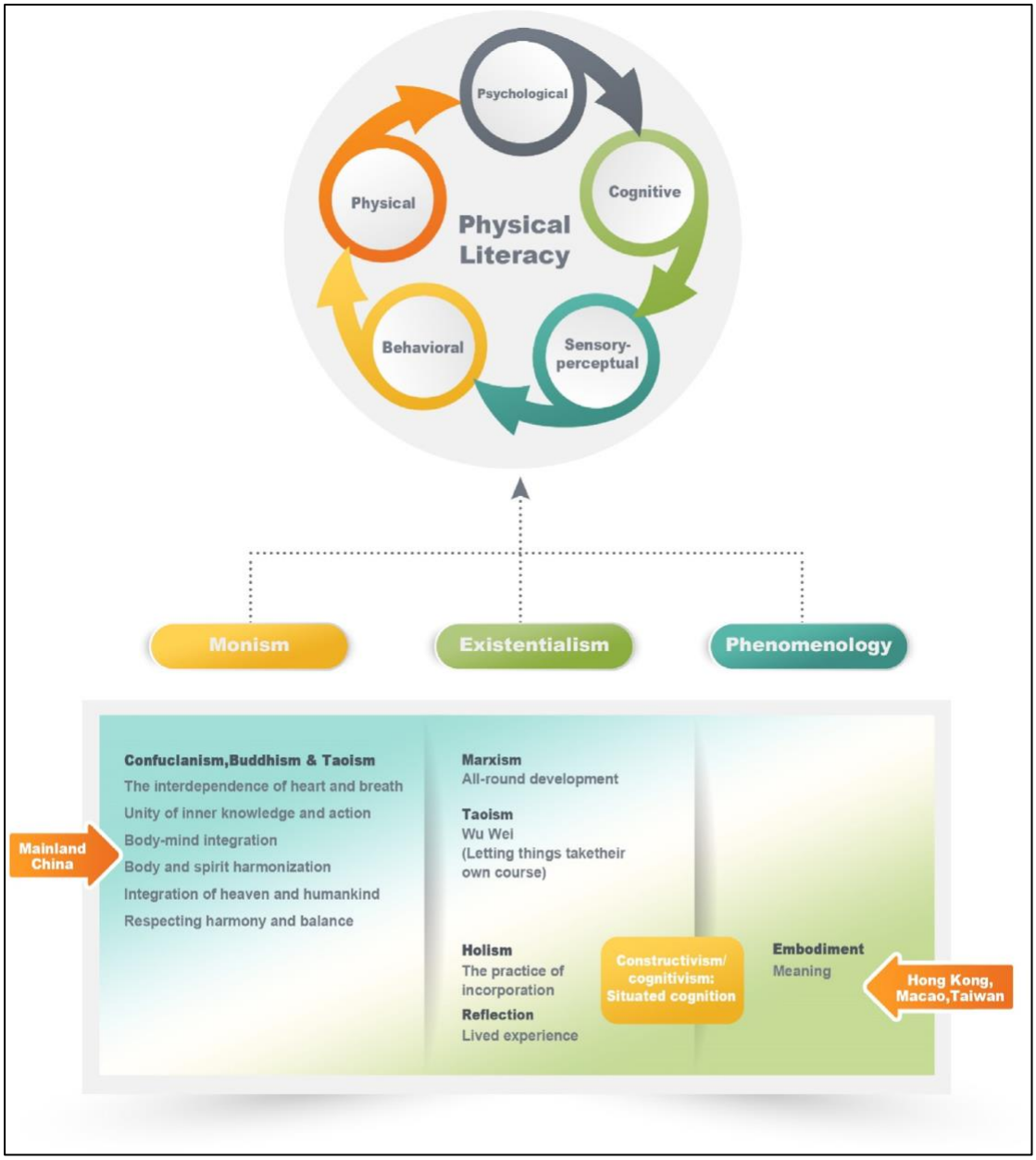


Figure 15 Theoretical model of physical literacy in the Greater China region, by Li et al. 2022 [40]

Summary

- Thirteen different PL conceptual frameworks or models were identified by our search.
- Different frameworks focus on different aspects of PL (e.g. policy considerations, PL's relationship with health, physical education, assessing PL etc.)
- Most frameworks display the different domains or elements of PL as interconnected or overlapping constructs.

Evidence for the benefits / outcomes of physical literacy

Despite the growing popularity of PL, the scientific evidence of its proposed benefits has lagged behind theoretical interest [77-79]. The numerous definitions of the concept, coupled with its complex nature have perhaps deterred researchers from attempting to assess PL and its outcomes. Edwards and colleagues state that this chaotic situation undermines any meaningful assessment of PL and interpretation of findings.

The current evidence derives from cross-sectional studies and is summarised below. The evidence includes outcomes within the physical, affective and behavioural domains. There is currently limited high-quality evaluation and / or research which has focussed on the benefits / outcomes of PL interventions. A lack of high-quality evidence is to be expected in an emerging field like PL, where consensus is needed on its definition and assessments of the concept are still evolving. Further quantitative and qualitative research is therefore needed to draw firm conclusions on its outcomes.

For more details on how the evidence was collected as well as the methods for the quality appraisal of each outcome, please refer to Appendix B.

Physical domain outcomes

Body composition

Three studies examined associations between PL and body composition [80-82]. Delisle Nyström and colleagues (2018) used body mass index (BMI) and waist circumference to determine weight status, with healthy weight children scoring significantly higher in PL compared to their overweight counterparts [81]. Mendoza-Munoz and colleagues reported higher PL scores to be associated with lower BMI [82]. Similarly, two studies found percent fat mass to be negatively associated with PL scores [80,82].

Physical fitness

Two studies found cardiorespiratory fitness to be positively associated with PL scores [80,83]. Children (8-12 years old, n = 9393) with higher levels of cardiorespiratory fitness consistently

demonstrated better PL regardless of age and sex [83]. A third study used a self-report questionnaire to compare perceived fitness levels with PL [84], and found self-perceived cardiorespiratory fitness and speed to be significantly associated with PL, but not self-perceived general fitness, muscular fitness or flexibility.

Blood pressure

Caldwell et al. (2020), focussing on various health indicators including CRF and body composition discussed above, found systolic blood pressure (a predictor of hypertension) to be positively associated with PL [80].

Health-Related Quality of Life (HRQOL)

Caldwell and colleagues also assessed HRQOL using the Pediatric Quality of Life (PedsQL) questionnaire [80]. PedsQL evaluates children's quality of life in four domains: physical, emotional, social, and school functioning. Higher aggregate scores for HRQOL was associated with higher PL scores [80].

Affective domain outcomes

Psychological well-being

Two studies examined the association between PL and psychological well-being [85,86]. Blain and colleagues (2021) reported positive associations between PL and vitality as well as positive affect (feeling happy, cheerful, proud, joyful and lively [85]). A significant negative association was found between PL and negative affect (i.e., feelings of sadness, scared, miserable, afraid and mad). Ma et al. [86] used self-report measures to assess both PL and mental health. Their mental health questionnaire captured three dimensions of well-being: emotional, psychological and social, with all three positively associated with perceived PL.

Resilience

Two studies, both using self-report measures to capture overall PL, investigated its association with resilience [86,87]. One found perceived PL to be positively correlated with resilience scores (obtained from the Chinese version of the Child and Youth Resilience measure [86]). Using the English version of the same questionnaire, the other study [87] also reported a significant association between resilience and self-report PL as well as resilience and

children's overall PL rating by their PE teacher. However, parent's view of their children's overall PL showed no significant associations between PL and resilience [87].

Intention to participate in future sport

Interscholastic sport intention (i.e. the intention to participate in physical activity and sport in future) was investigated by Farren et al. (2021) and found to be positively associated with PL [88].

Behavioural domain outcomes

Participation in PA, Sport and Exercise

Four studies focussed on PL's association with PA behaviours [80,85,88,89]. Belanger et al. (2018) investigated adherence to PA guidelines and found children with higher levels of physical competence, motivation and confidence, were more likely to reach PA guidelines of 60 minutes of moderate-to-vigorous PA per day. A two-item self-report measure by Farren et al. (2021) showed both PA- and sports team participation to be significantly associated with PL [88]. Similarly, leisure-time exercise levels captured by the Leisure-Time Exercise questionnaire was also positively associated with PL [85].

Engagement in Physical Education (PE)

One study captured engagement in PE by using a modified version of the Classroom Engagement measure [85] and found PL to be associated with heightened engagement in PE classes, with the authors claiming that as PE classes provide structured PA experiences, engagement in PE is highly relevant to physical health [85].

Moderate-to-vigorous physical activity

Coyne et al. (2019) found levels of moderate-to-vigorous physical activity to be significantly associated with PL scores [90], while Caldwell et al. (2020) reported moderate-to-vigorous physical activity to play a mediating role in the relationship between PL and cardiorespiratory fitness [80]. The authors claimed that their findings provide initial support for theories that positions PL as a health determinant across the lifespan [80].

Sedentary behaviour

Three studies investigated sedentary behaviour, all via self-report measures [88,89,91]. Using two questions from the Youth Risk Behaviour Surveillance System, Belanger et al. (2018) reported that children with higher physical competence, motivation and confidence, were more likely to adhere to sedentary behaviour guidelines of no more than two hours of screen-time per day [89]. While both Saunders et al. (2018) and Farren et al. (2021) found PL to be negatively associated with sedentary screen-time and total sedentary behaviours, the former reported the same association with non-screen sedentary behaviours [91] while the latter reported no such association [88].

Quality of the evidence

All the reported outcomes were from cross-sectional studies, therefore limiting the conclusions regarding the directionality of the associations. For example, PL has been associated with increased physical activity [88], an increased likelihood of meeting physical activity guidelines [89] and sport participation [88]. In each of these cases, PL might have influenced these positive outcomes, but equally, these behaviours might have contributed to enhanced PL [13]. A detailed explanation of how the quality of the evidence was assessed for each outcome can be found in Appendix B.

While the quality of PL-related outcomes evidence is currently low, this should not deter practitioners, researchers and others from focussing on this important public health matter. In an emerging field like PL, it is typical that evidence starts with cross-sectional studies as they cost lower to conduct and can be highly efficient in researcher and participant time [92]. Spector (2019) states that cross-sectional studies are “an important starting point for a programmatic approach to addressing a research question that begins with simple designs and builds design complexity as more information becomes available that can inform how subsequent study designs should be formulated” [92]. This is especially true in the case of PL, where consensus around its definition (and assessment) would help for the field to advance.

Summary of the evidence

- Twelve scientific papers met the inclusion criteria for the review of evidence for PL.
- All studies were cross-sectional in nature, which limits conclusions regarding the directionality / causality of associations between PL and outcomes of interest.
- Outcomes reported were from the physical, affective and behavioural domains, and amongst others include associations between PL and body composition, PA and sport participation, psychological well-being and resilience.
- Table 5 summarises the outcomes based on the quality and consistency of the evidence. See Appendix B for details of the rating system.
- While the evidence from cross-sectional studies of the outcomes of PL is currently low or very low, it signals the start of an emerging evidence base.
- More quantitative and qualitative longitudinal and intervention research is needed on the benefits of PL. Evolution of assessments capable of capturing PL in its holistic sense across (early) childhood to adolescence is also vital to collating better evidence.

Table 5: Summary of the strength of association between physical literacy and each outcome

Physical domain	Affective domain	Behaviour domain
Body composition	Psychological well-being	PA participation
Physical fitness	Resilience	Sport participation
Blood pressure	Intention to participate in future sport	Leisure-time exercise
Health-related quality of life		Engagement in PE
		MVPA
		Sedentary behaviour

Blue outcomes show consistent evidence from high quality studies

Orange outcomes show inconsistent evidence from small amount of studies

Grey outcomes are those with insufficient evidence

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Appendix A

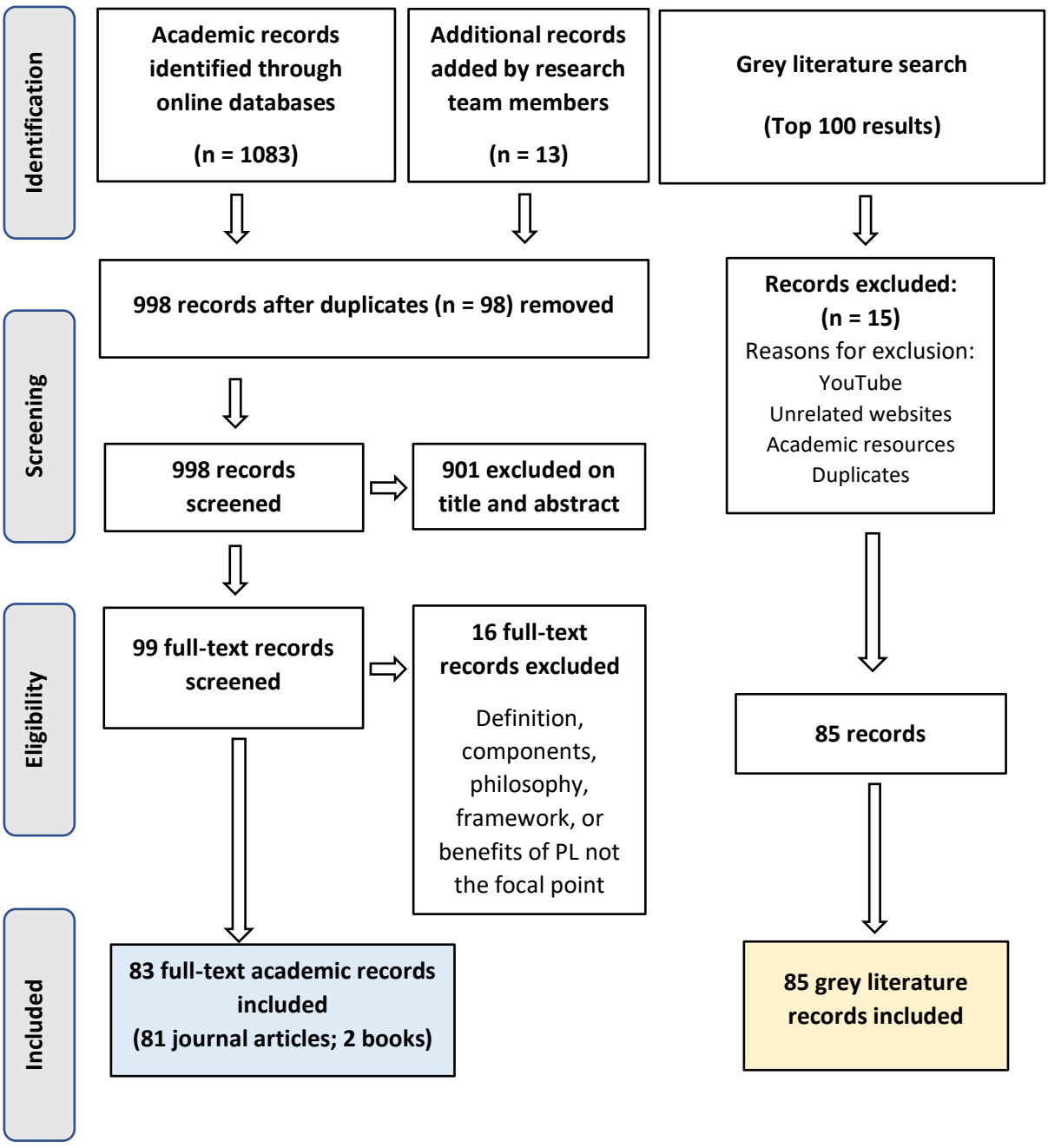

Figure 1: Flow chart of the literature selection process for the evidence review

Appendix B

Inclusion criteria for studies reporting outcomes / benefits of PL

Studies within our search reporting empirical evidence on the benefits / outcomes of PL were selected to answer research question 5. In addition, these studies had to meet the following inclusion criteria: investigations of child and youth populations (aged 5-18 years); measures of both PL and the associated outcome variables to have taken place on at least two time-points (in case of intervention studies) and the use of a composite / overall score for PL (comprising of scores from at least the physical, affective and cognitive domains, thus embracing the complexity and holistic nature of the concept). As such, studies that assessed components of PL in isolation and associated those with outcome measures, were excluded (n = 8). For example, Gu and colleagues [93] in their investigation of the relationship between PL and academic performance, as a measure of PL assessed only motor competence, health-related fitness and school-based moderate-to-vigorous PA. Because the affective and cognitive domains of PL were neglected, the paper was excluded from the analysis. Twelve studies met the inclusion criteria. Study characteristics, assessments and findings are summarised in Table 1 below.

Quality appraisal of reported outcomes

The quality of the evidence for each outcome was assessed using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework [94]. The GRADE framework categorises the overall quality of evidence into four groups: “high”, “moderate”, “low” and “very low”. For example, randomised control trials start with a “high” rating. Due to the cross-sectional nature of the observational studies (i.e. causal inferences cannot be determined), their quality of evidence rating starts at “low” [95], and can be downgraded to “very low” if there are limitations because of risk of bias, inconsistency, imprecision, indirectness, or other factors. If, however, no such limitations are identified, a cross-sectional study can be upgraded based on large effect sizes or evidence of a gradient of higher exposure with higher / lower outcome [96]. The GRADE framework does not have a tool for assessing risk of bias in observational studies, however, it does recommend certain study limitations to examine [97]. Studies were screened for any potential sources of bias, e.g. selection bias (i.e. appropriate sampling), performance bias (i.e. flawed measurement), selective reporting bias, detection bias (i.e. differences between comparison groups), attrition

bias (i.e. high loss of participants), and others (e.g. inadequate control for key confounders) [97]. The outcomes of PL as reported by the studies are outlined in Table 2, together with the quality assessment for each outcome. Unless otherwise stated, positive associations between PL and evaluated outcomes were reported.

Two independent reviewers (LH and IE) evaluated each of the included studies and outcomes. Any discrepancies between reviewers' quality of evidence ratings were resolved by discussion between reviewers or by consulting with a third reviewer (LF) until consensus was reached. The reviewers decided not to rate down the quality of evidence if using a convenient sample was the only potential source of bias. Using only self-report PA measures, however, was deemed a serious limitation (i.e. subject to recall errors and social desirability). Eight of the included studies used the CAPL as an assessment of PL, and therefore utilised pedometers to measure the PA behaviour component of PL (as described in the CAPL guidelines). Pedometers only provide step count and are unable to assess intensity, frequency or duration of activity [98]. However, the reviewers decided not to downgrade studies for using pedometers, unless serious issues like device malfunctioning or high attrition rates were reported.

The quality of the evidence for most of the outcomes was downgraded from low to very low due to serious risks of bias. These risks include recall bias and social desirability associated with self-report measure of PA, other measurement issues (e.g. using unvalidated questionnaires or high attrition rates) and failure to control for confounders like socio-economic status or maturation.

A rating system based on two criteria (quality and consistency) was applied to the evidence, in order to present it in a concise way. An overall score was calculated as an average of the scores for the two criteria (see Table 3).

Table 1 Descriptive summary of included studies and their findings

Study; location; design	Sample; age; sex	Physical literacy assessment	Outcomes of interest and assessments	Findings
Belanger et al. 2018 [89] Canada Cross-sectional	n = 2956; 8-12 years; 56.6% girls	CAPL (version 1) *Physical competence:* Plank test, PACER, handgrip strength, sit and reach, CAMSA, height, weight, waist circumference *Daily behaviour:* Pedometers, self-reported PA and self-reported screen-time *Knowledge and understanding:* Questionnaire developed for CAPL *Motivation and confidence:* Children's Self-perception of Adequacy in and Predilection for PA scale	Adherence to Canadian PAG and SBG PAG adherence assessed using pedometers; participants divided into meeting PAG (≥12 000 steps ≥6 days/week) and not meeting PAG. SBG adherence assessed using 2 questions from United States' Youth Risk Behaviour Surveillance System	Associations between guideline adherence and overall PL not analysed. PAG: Participants had greater odds of meeting PAG if they achieved minimum recommended level of physical competence (OR 2.1; 95% CI: 1.7, 2.5), motivation and confidence (OR 1.2; 95% CI: 1.0, 1.5) SBG: Participants had greater odds of meeting SBG if they achieved minimum recommended level of physical competence (OR 1.5; 95% CI: 1.2, 1.7), motivation and confidence (OR 2.1; 95% CI: 1.7, 2.5). PAG and SBG: No significant findings identified for Knowledge and Understanding (Cognitive domain).
Blain et al. 2021 [85] Wales Cross-sectional	n = 187; Mean age: 12.8 years (SD: 0.55); 52.9% girls	CAPL (version 1) See above	Engagement in PE: assessed using 19 questions adapted from Classroom Engagement measure. Leisure-time exercise: Leisure-time Exercise Questionnaire. Psychological well-being: 10-item Positive and Negative Affect Schedule for Children.	Significant positive relationship between: PL and Engagement in PE (β = 0.57, $p < 0.05$, $R^2 = 0.33$), levels of Leisure-time exercise (β = 0.38, $p < 0.001$, $R^2 = 0.14$), Vitality (β = 0.53, $p < 0.001$, $R^2 = 0.28$) and Positive affect (β = 0.39, $p < 0.001$, $R^2 = 0.15$) Significant negative relationship between PL and Negative affect: (β = -0.25, $p < 0.05$, $R^2 = 0.06$)

Caldwell et al. 2020 [80] Canada Cross-sectional	n = 222; Mean age: 10.7 years (SD: 1.0); 50.9% girls	PL composite score calculated from 3 measures from the Physical Literacy Assessment for Youth (PLAY) tools: PLAYfun (18 movement skills), PLAYparent (parent's view of child's PL) and PLAYself (PL questionnaire)	PA assessed using accelerometers over 7 days (MVPA in min/day). Body composition: % body fat Aerobic fitness: time to exhaustion using modified Bruce Protocol (a progressive treadmill test with increasing speed and grade every 3 minutes) and 60s heart rate recovery (HRR) Blood pressure: resting systolic blood pressure Health-related Quality of Life (HRQOL): Pediatric Quality of Life 4.0 Child Self-report questionnaire	PL was significantly associated with all health indicators: Percent body fat (β = -0.56; 95% CI -0.93, -1.94; p = 0.003; R^2 = 0.228), treadmill time (β = 0.52; 95% CI 0.36, 0.69; p < 0.001; R^2 = 0.212), 60 s HRR (β = 0.92; 95% CI 0.22, 1.61; p = 0.010; R^2 = 0.357), Systolic blood pressure (β = -0.54; 95% CI -0.93, -0.15; p = 0.007; R^2 = 0.109), and HRQOL (β = 1.73; 95% CI 1.05, 2.40; p < 0.001; R^2 = 0.156), MVPA partially mediated the association between PL and Aerobic fitness.
Coyne et al. 2019 [90] Canada Cross-sectional	n = 1059; 8–12 years; % girls unknown	CAPL (version 1) See above	MVPA (min/day) assessed using pedometers and calculated as average amount of time spent in >110 steps per minute	MVPA was significantly associated with overall PL, daily behaviour score, physical competence, motivation and confidence (all p < 0.001), but not with knowledge and understanding (p = 0.165). However, all effect sizes were considered negligible.
Delisle Nyström et al. 2018 [81] Canada Cross-sectional	n = 8343; 8–12 years; 50.1% girls	CAPL (version 1) See above	Weight status measured by BMI/waist circumference (participants divided into either healthy weight or overweight/obese categories)	Healthy weight children had significantly higher scores for overall PL (p < 0.001), but with small effect size (Cohen's d = 0.3)

Farren et al. 2021 [88] United States Cross-sectional	n = 419; Mean age: 11.5 years (SD: 0.5); 58.2% girls	*Affective domain* Self-efficacy: 6-item PE self-efficacy questionnaire Intrinsic motivation towards PE: 4-item intrinsic motivation subscale of the Perceived Locus of Causality scale Self-esteem: 6-item Global self-esteem scale *Physical domain* Motor skill assessment: overhand throwing Aerobic fitness: 20m PACER Muscular fitness: plank test Body composition: BMI *Cognitive domain:* Knowledge and understanding: 10-item measure of the CAPL questionnaire Confirmatory factor analyses used to construct PL models.	Sedentary behaviour: Adolescent Sedentary Activity Questionnaire (divided into screen-time and non-screen behaviours) PA and sport team participation: 2 items from Middle School Youth Risk Behaviour Surveillance Survey Interscholastic sport intention (i.e., the intention to participate in PA/sport in future): 4 questions created based on Activity Intension Scales	PL significantly associated with PA participation (r = 0.59; $p < 0.01$), Sport team participation (r = 0.42; $p < 0.01$), and negatively associated with screen-time sedentary behaviours (r = -0.22; $p < 0.01$). No significant association between PL and non-screen sedentary behaviour (r = 0.04). PL significantly related to interscholastic sport intention ($p < 0.001$).
Jefferies et al. 2019 [87] Canada Cross-sectional	n = 227; 9–12 years; 53.7% girls	PL assessed using 5 measures from the PLAY tools: PLAYfun (18 movement skills), PLAYself (PL questionnaire), PLAYinventory (count of the number of activities regularly participated in over last 12 months), PLAYparent (parent's view of child's PL), PLAYpe_teacher (PE teacher's view of child's PL, overall fitness and visual BMI, a modified version of PLAYcoach)	Resilience: Child and Youth Resilience Measure questionnaire	Positive correlation between resilience and PE teacher ratings of overall PL (r = 0.21 $p \leq 0.05$), self-report PL (r = 0.30; $p \leq 0.001$), but not between parent's overall rating of PL and resilience (r = 0.14).

Lang et al. 2018 [83] Canada Cross-sectional	n = 9393; 8–12 years; 49.9% girls	CAPL (version 1) See above	Cardiorespiratory fitness (CRF): 20m shuttle run test, with participants divided into Low, Medium and High CRF tertiles.	Participants in the high CRF tertile consistently demonstrated better PL in comparison with their peers in lower CRF tertile groups ($p < 0.001$ for main effect), regardless of age and gender.
Ma et al. 2021 [86] China Cross-sectional	n = 5265; 17–21 years; 53.4% girls	PL was assessed using the simplified Chinese version of Perceived PL instrument (questionnaire)	Mental health: simplified Chinese version of the Mental Health Continuum Short Form Resilience: simplified Chinese version of the 12-item Child and Youth Resilience measure	Positive correlation between perceived PL and mental health (β = 1.46; SE = 1.08; $p < 0.01$; $R^2 = 0.25$), and perceived PL and resilience (β = 1.01; SE = 0.40; $p < 0.01$; $R^2 = 0.53$). Resilience showed a mediating effect (accounting for 66.3% of the total effect) on the relationship between perceived PL and mental health.
Mendoza-Munoz et al. 2021 [82] Spain Cross-sectional	n = 135; 8-12 years; 53.3% girls	CAPL-2 *Physical competence* Plank test, PACER, CAMSA *Daily behaviour* Pedometer and self-reported PA *Knowledge and understanding* 5 questions, shortened from the 10-item questionnaire developed for CAPL (v1) *Motivation and competence* 12 items modified from the Children's Self-perception of Adequacy in and Predilection for PA scale	Body composition: BMI, Fat Body Mass (FM), % fat body mass (%FM)	Slight to moderate negative correlation between PL and BMI (r = -0.446; $p < 0.0012$), FM (r = -0.478; $p < 0.0012$) and %FM (r = -0.491; $p < 0.0012$).

Pastor-Cisneros et al. 2021 [84] Spain Cross-sectional	n = 90; 8–12 years; 53.3% girls	CAPL-2 Same as above	Self-perceived fitness level: Fitness Perception Scale for Adolescents, including perceived general-, cardiorespiratory-, muscular fitness, speed and flexibility	PL was significantly correlated with perceived cardiorespiratory fitness (r = 0.391; $p \leq 0.003$) and perceived speed (r = 0.384; $p \leq 0.003$).
Saunders et al. 2018 [91] Canada Cross-sectional	n = 8307; 8–12.9 years; 50% girls	CAPL (version 1) See above	Sedentary behaviour: author-designed self-report questionnaire	PL significantly correlated with Screen-time (β = -0.048, 95% CI -0.052, -0.045; $p < 0.001$), Non-screen SB (β = -0.004; 95% CI -0.007, -0.002; $p < 0.001$), and total SB (β = -0.053; 95% CI -0.058, -0.048; $p = 0.001$).

Notes: CAPL = Canadian Assessment of Physical Literacy; PACER = Progressive Aerobic Cardiovascular Endurance Run; CAMSA = Canadian Agility and Movement Skill Assessment; SD = standard deviation; SE = standard error; PE = physical education; MVPA = moderate-to-vigorous physical activity; CAPL-2 = CAPL second edition.

Table 2: Outcomes / benefits of physical literacy (as reported in empirical studies) and quality assessment for each outcome

Outcome	Studies reporting the outcome	Total number of participants	Quality assessment			Final rating	Comments
			Risk of bias	Indirectness[a]	Imprecision[b]		
Physical domain							
Body composition[c] (negative association)	Caldwell et al. [80] Mendoza-Munoz et al. [82] Delisle Nyström et al. [81]	222 [80] 135 [82] 8343 [81]	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: lack of psychometric evidence on scoring strategy [80]; failure to control for confounders [81,82] Imprecision: small sample size ([82]; n=135)
Aerobic fitness	Caldwell et al. [80] Lang et al. [83]	222 [80] 9393 [83]	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: lack of psychometric evidence on scoring strategy [80]; failure to control for confounders [83]
Systolic blood pressure	Caldwell et al. [80]	222	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: lack of psychometric evidence on scoring strategy
Self-perceived cardiorespiratory fitness	Pastor-Cisneros et al. [84]	90	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: failure to control for confounders; self-report nature of measures Imprecision: No confidence intervals to determine imprecision, but suspected due to small sample size
Self-perceived speed	Pastor-Cisneros et al. [84]	90	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: failure to control for confounders; self-report nature of measures Imprecision: No confidence intervals to determine imprecision, but suspected due to small sample size

Health-related quality of life	Caldwell et al. [80]	222	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: lack of psychometric evidence on scoring strategy
Affective domain							
Resilience	Jefferies et al. [87] Ma et al. [86]	5492	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: self-report and proxy-report measures; visual BMI [87]; self-report measures and perceived PL [86]
Psychological well-being[d]	Blain et al. [85] Ma et al. [86]	5452	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: attrition bias (36% missing pedometer data); self-reported MVPA; failure to control for confounders; sample comprised children in age range for which CAPL is not validated for [85]; self-report of perceived PL [86] Imprecision: No confidence intervals to determine imprecision, but suspected due to small sample size [85]
Negative affect[e] (negative association)	Blain et al. [85]	187	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: attrition bias (36% missing pedometer data); self-reported MVPA; failure to control for confounders; sample comprised children in age range for which CAPL is not validated for Imprecision: No confidence intervals to determine imprecision, but suspected due to small sample size
Intention to participate in future sport or PA	Farren et al. [88]	419	No serious risk of bias	No indirectness	No imprecision	Low	

Behavioural domain							
Adherence to PA and SB guidelines	Belanger et al. [89]	2956	Serious risk of bias	Serious indirectness	No imprecision	Very low	Risk of bias: failure to control for confounders Indirectness: composite score for PL calculated but not used in analysis
Participation in physical activity	Farren et al. [88]	419	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: self-report PA measurement
Sports participation	Farren et al. [88]	419	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: self-report PA measurement
Sedentary behaviours[f] (negative association)	Farren et al. [88] Saunders et al. [91]	419	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: self-report nature of SB measurement [88]; unvalidated self-report questionnaire [91]
MVPA	Coyne et al. [90]	1059	Serious risk of bias	No indirectness	No imprecision	Very low	Risk of bias: flawed measurement as pedometers malfunctioned
Engagement in physical education	Blain et al. [85]	187	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: attrition bias (36% missing pedometer data); self-reported MVPA; sample comprised children in age range for which CAPL is not validated for Imprecision: No confidence intervals to determine imprecision, but suspected due to small sample size
Leisure-time exercise	Blain et al. [85]	187	Serious risk of bias	No indirectness	Serious imprecision	Very low	Risk of bias: attrition bias (36% missing pedometer data); self-reported MVPA; sample comprised children in age range for which CAPL is not validated for

Notes: [a] Indirectness: includes differences in population of interest and those being studied, differences in interventions delivered at various sites, differences in outcome measure (measuring a different outcome from the one interested in) and no direct comparisons between interventions. [b] Imprecision refers to confidence in estimates of effect and involve the examination of the 95% confidence intervals.

[c] Negative associations between PL and BMI, fat mass and % fat mass. [d] Blain et al. reported association between PL and positive affect / vitality, while Ma et al. reported association between PL and mental health (emotional-, psychological- and social well-being). [e] refers to feelings of sadness, scared, miserable, afraid and mad.
[f] Both studies reported a negative association between PL and screen-based behaviours. Saunders et al. also reported a negative association between non-screen and overall sedentary behaviours.PA = physical activity; SB = sedentary behaviour; BMI = body mass index; MVPA = moderate-to-vigorous physical activity

Table 3: Rating of the evidence based on quality (strength) and consistency

Quality (strength) of the evidence		**Consistency of the evidence**		**Overall score of the evidence**	
Grade rating	**Coding**	**Reasoning**	**Coding**	**Average score**	**Coding**
High	4	Consistent evidence across studies	3	>2	Blue
Moderate	3	Inconsistent and equivocal evidence	2	1-2	Orange
Low	2	Insufficient evidence	1	0-1	Grey
Very low	1				