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Perceived and actual physical literacy and physical activity: A test of reverse pathway among Hong Kong children

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ABSTRACT

Background/objective: The directional relationship between physical literacy (PL) and physical activity (PA) in children remains unclear. This study explored the directionality of the relationship between children's actual PL and PA, and whether their PL perceptions mediate this relationship.
Methods: This was a cross-sectional study. In total, 371 children (153 boys; M_{age} = 10.0 ± 1.0) from Chinese primary schools were recruited to complete all the assessments. Structural equation modeling (SEM) was conducted to determine a reciprocal relationship between Motivation and Confidence, Daily Behavior and moderate-to vigorous-intensity physical activity (MVPA).
Results: When perceived PL was examined as a mediator, the model with direction from MVPA to actual PL was observed with significance in Motivation and Confidence ($\beta = 0.48$) and Daily Behavior ($\beta = 0.20$). Perceived PL displayed no mediation effect for the direction from actual PL to MVPA.
Conclusions: This study provides evidence that engagement in PA might be useful to support the continuous development of PL. As perceived PL is an integral part of this relationship, future research is needed to understand its role for providing potential intervention targets to improve these outcomes among Chinese children.

Introduction

Physical literacy (PL)—which encompasses the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life—is regarded as an important prerequisite to physical activity and sport.[1,2] The multidimensional underpinnings of PL has covered a broad terms in related to children and adolescents' PA participation. For example, it would include their motivation to participate in PA, the evidence of confidence to engage in PA, some foundational movement patterns to the basis of PA regarding the attributes of physical competence, and mastering knowledge and understanding with respect to movement performance. In this case, other than a direct performance could be identified when monitoring actual level of PL,[3] researchers also proposed perceived PL as an important tradition when understanding the concept of PL.[4,5] Although scholars advocate for its tracking and development throughout the lifespan,[1,6] there is no clear evidence presenting that childhood PL may be associated with subsequent PA and health, or engagement in PA would foster PL development, especially when considering PL perceptions and its actual level as two independent traditions. Therefore, considering that the importance of identifying the correlates and consequences of PA and their interactions are important for developing strategies to improve children's health,[7] it is essential to enhance the understanding of the role of both PL perceptions and PL actual level in promoting PA and the relationship between PL and PA.

Previous research has indicated that PL perception is essential for predicting actual levels of PL among primary school-aged children,[8] which has included three attributes: (i) Knowledge & Understanding; (ii) Self-expression & Communication with others; and (iii) Sense of self & Self-confidence.[4,5] The Knowledge & Understanding attribute is assumed to be possessed by individuals who can describe and evaluate their physically active lifestyle, including how to improve upon their movement and general

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Table 1
Correlation matrix of model variables.

Variable	1	2	3	4	5	6	7	8	9
(1) Perceived PL	–								
(2) K&U	.85**	–							
(3) S&C	.89**	.61**	–						
(4) S&S	.91**	.68**	.73**	–					
(5) CAPL	.44**	.41**	.33**	.43**	–				
(6) KU	.17**	.14*	.15**	.14*	.40**	–			
(7) MC	.44**	.43**	.34**	.41**	.70**	.11*	–		
(8) DB	.24**	.25**	.17**	.24**	.62**	.01	.26**	–	
(9) PC	.24**	.19**	.18**	.26**	.73**	.24**	.29**	.18**	–
(10) MVPA per day (mins)	.10	.16**	.01	.11	.37**	-.07	.22**	.63**	.06

Note. *$p < 0.05$, **$p < 0.01$.
K&U, S&C, and S&S were three attributes of Perceived Physical Literacy; PC - physical competence; DB - daily behavior; MC - motivation and confidence; KU - knowledge and understanding; Perceived PL = total score of Perceived Physical Literacy; CAPL-2 = total score of actual Physical Literacy measured by CAPL-2; MVPA – Moderate to Vigorous Physical Activity.

health; the attribute Self-expression & Communication with others encourages individuals to respond to interpersonal interactions with feeling, while participating in PA; finally, the Sense of self & Self-confidence attribute enables adolescents to gain rewarding PA experiences through which they may develop their PL journey. This is, in part, supported by a previous study in which a significant positive association was identified between PA and perceived PL in adolescents, with these attributes generating 5.2% of the variance in PA levels.[9] An intervention study has also examined that childhood perceived PL, may predict increases in PA,[10] while the direct PL actual level has not been further explored in these studies. Accordingly, identifying the possible mediating role of perceived PL in the relationship between actual PL level and PA would be of great value.[11]

Theoretically, an evidence-based model by Cairney, Dudley[12] has provided a holistic conceptualization linking PL, PA, and health, in which PL is positioned as a determinant of health, while considering the possible mediating role of PA. This model also describes a developmentally dynamic and reciprocal relationship between PA and PL, although it fails to acknowledge the role of perceived PL. In regards to the multidimensional nature of PL, which encompasses motivation, confidence, physical competence, knowledge and understanding as the core elements, the perceived PL could demonstrate its mediating role towards PA. Previous studies have presented that some aspects of PL, such as perceived motor competence, mediated the relationship between actual motor competence and PA, and actual motor competence and cardiorespiratory endurance,[13,14] and this relationship has been empirically proved to be reciprocal.[15] However, few studies have examined whether the potential relationships between PA behaviors and PL actual level or PL perceptions are bidirectional since the concept of PL is an emergent fields of study,[9,16] together with the possible mediating role of perceived PL in this association. Besides, significant associations have been previously found between PL perceptions and its actual level,[8] which would provide support to examine the mediation effect of perceived PL. Therefore, it is promising to take into consideration actual PL, perceived PL and PA in the same study.

As the measure of actual PL adopted the Chinese version of Canadian Assessment of Physical Literacy, 2nd version (CAPL-2, Chinese), which monitored children's PL actual level from 8 to 12 years old, the current study aimed to examined the following research aims in this population: (i) explore the directional relationships between actual PL and participation in PA, and (ii) assess whether perceived PL acts as a mediator in these pathways. Given that actual PL contains four inter-related domains—Daily Behavior, Physical Competence, Knowledge and Understanding, and Motivation and Confidence—and that a previous study identified the Motivation and Confidence domain as a more significant predictor of perceived PL,[8] another purpose of this study is to (iii) assess the relative contribution of the relationship to each actual PL level domain.

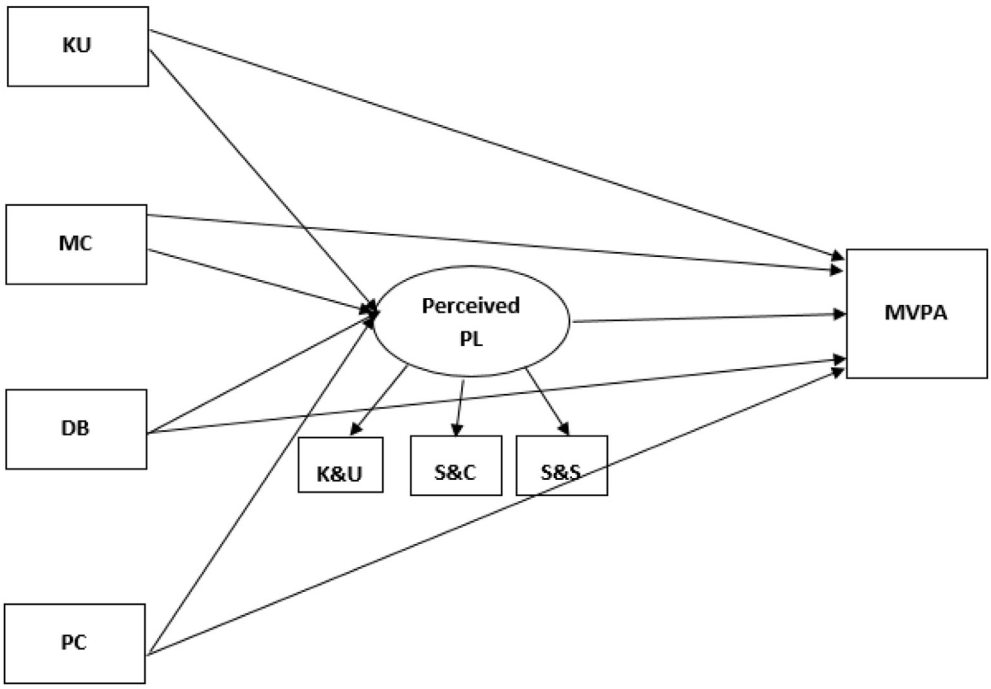
Methods

Participants

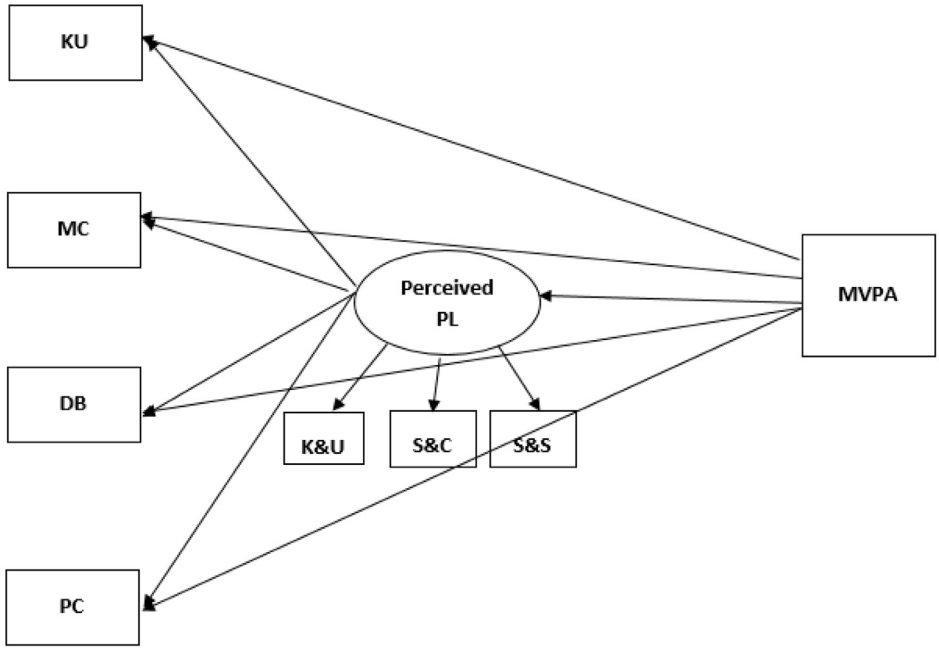
In total, 371 primary schoolchildren aged 4–6 years were recruited from two public schools in Shenzhen and Hong Kong SAR, China. These two cities are both located in the Southern part of China and has been sharing the similar social, economic, and cultural background in China. Although the PE curriculums may vary due to their specific school settings, choosing public schools would provide representative information of students' socio-economic status, school size, class schedules, and frequency of physical education. This study acquired written consent forms from parents or legal guardians prior to participation. After deleting missing values and incomplete data (the actual PL assessment includes four domains), 324 participants remained (153 boys, 174 girls; $M_{age} = 10.0$) as the research dataset.

Measures

Children's perceived PL was assessed using the adolescent version of the Perceived Physical Literacy Instrument (PPLI), a nine-item questionnaire consisting of three domains: Knowledge & Understanding (e.g., "I have a positive attitude and interest toward sports"), Self-expression & Communication with others (e.g., "I am capable of handling problems and difficulties"), and Sense of self & Self-confidence (e.g. "I possess self-management skills for fitness"). Specifically, "Knowledge & Understanding" examined whether an individual's acquisition of knowledge contributed toward being physically literate; "Self-expression & Communication with others" monitored PL levels when an individual expresses oneself, or communicates with the environment, through PA; "Sense of self & Self-confidence" examined a participant's sense of self and his/her self-confidence when participating in physical activities.[4] Each response was rated on a 5-point Likert scale ranging from strongly disagree to strongly agree. Adapted from a previous version constructed by physical education teachers, the validity of the current questionnaire was confirmed through confirmatory factor analysis (CFA): chi-square ($\chi^2 = 321.54$, $df = 24$, $p < 0.05$), comparative fit index (CFI) = 0.95, root mean square error of approximation (RMSEA) = 0.08, and standardized root mean square residual



(a)



(b)

Fig. 1. Hypothetical models tested in this study, showing all indicators, covariates, and proposed paths. Note. Covariate paths are indicated by a dotted line. K&U, S&C, and S&S were three attributes of Perceived Physical Literacy; PC - physical competence; DB - daily behavior; MC - motivation and confidence; KU - knowledge and understanding; Perceived PL = total score of Perceived Physical Literacy; MVPA – Moderate to Vigorous Physical Activity.

(SRMR) = 0.04.[5] Furthermore, the questionnaire showed acceptable reliability, with α values ranging from 0.68 to 0.76.

Children's actual PL levels were assessed using the Chinese version of the Canadian Assessment of Physical Literacy, second edition (CAPL-2, Chinese).[3] The CAPL-2 is an all-inclusive accurate and reliable protocol that assesses a broad spectrum of skills and abilities contributing to and characterizing a participating child's PL level.[17] It has been translated and culturally adapted from English to Chinese.[3] This assessment tool consists of four domains—Daily Behavior, Physical Competence, Knowledge and Understanding, and Motivation and Confidence—with a total possible score of 100 for a child's level of PL. Construct validity for subscales and total model reported a good fit in the Chinese population after adjusting for covariation paths: chi-square ($\chi^2 = 70.16$, $df = 43$, $p < 0.05$),

Table 2
Participants characteristics.

Variables (range)	n	Mean	*SD*	Min	Max
Age	324	10.0	1.0	8.0	12.0
Perceived PL (9–45)	324	36.9	6.1	18.0	45.0
K&U (3–15)	324	12.8	2.1	5.0	15.0
S&C (3–15)	324	11.9	2.4	3.0	15.0
S&S (3–15)	324	12.1	2.4	5.0	15.0
CAPL-2 (0–100)	324	56.8	10.5	28.4	90.3
KU (0–10)	324	12.8	2.1	0.0	10.0
MC (0–30)	324	22.2	4.5	6.6	30.0
DB (0–30)	324	11.6	4.5	3.0	26.0
PC (0–30)	324	17.3	5.0	4.9	28.3
MVPA per day (min)	324	31.0	12.1	7.6	74.8

Note. K&U, S&C, and S&S were three attributes of perceived physical literacy; PC - physical competence; DB - daily behavior; MC - motivation and confidence; KU - knowledge and understanding; Perceived PL = total score of perceived physical literacy; CAPL-2 = total score of actual physical literacy measured by CAPL-2 (Chinese); MVPA – Moderate to Vigorous Physical Activity.

RMSEA = 0.04, 90% CI (0.024–0.062), CFI = 0.94, TLI = 0.90.[3]

Specifically, the "Daily Behavior" domain contained two parts: objectively measured step counts and self-reported moderate-to-vigorous physical activity (MVPA), defined as the number of days a week a child engaged in activities that made them breathe harder or increased their heart rate. The total possible score for Daily Behavior was 30 points. The "Physical Competence" domain consisted of three parts: i) a FitnessGram 15 m/20 m PACER (Progressive Aerobic Cardiovascular Endurance Run),[18] to evaluate aerobic fitness; ii) a Plank Assessment of Torso Strength,[19] to assess musculoskeletal endurance relating to back health, the ability to stabilize the body, and both upper and lower limb functionality; and iii) the Canadian Agility and Movement Skill Assessment (CAMSA), to assess motor competence.[20] The total possible score for Physical Competence was 30 points. Through five questions equaling a total of 10 points, the "Knowledge and Understanding" domain assessed a child's PA-related knowledge. The "Motivation and Confidence" domain evaluated a child's confidence in his/her ability to be physically active and his/her motivation to participate in PA. This domain was assessed using a revised version of the "What's most like me" (CSAPPA) questionnaire,[21] with a total of 30 possible points. The CAPL is reportedly a valid and reliable instrument for use in children aged 8–12 years, with a chi-square ($\chi^2 = 98.63$, $df = 38$, $p < 0.05$) showing acceptable fit, CFI = 0.96, RMSEA = 0.06. Furthermore, the CAPL-2 was also evaluated for model fit following the PL concept revision.[22]

Children's MVPA was assessed using ActiGraph GT3X + accelerometers[23] worn on the waist for 7 consecutive days. To account for children's natural activity levels, which occur in short bouts, data were collected in 15 s epochs;[24] this approach has

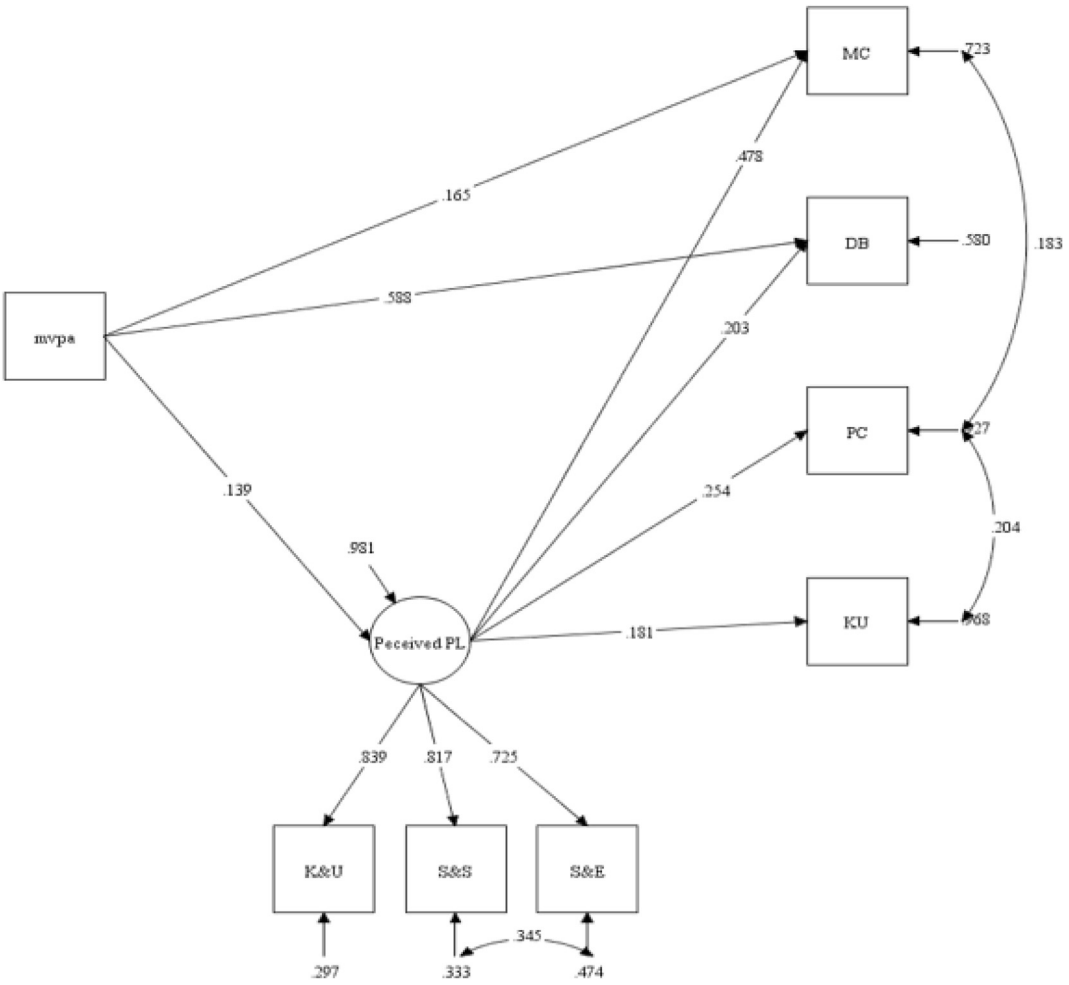


Fig. 2. Structural model (a) with hypothesized paths and standardized beta coefficients. Note. Only significant paths are presented. K&U, S&C, and S&S were three attributes of Perceived Physical Literacy; PC - physical competence; DB - daily behavior; MC - motivation and confidence; KU - knowledge and understanding; Perceived PL = total score of Perceived Physical Literacy; MVPA – Moderate to Vigorous Physical Activity.

been shown to reflect the most acceptable classification accuracy for accelerometer use in children. Furthermore, Evenson cut points (MVPA $\geq$ 2296 counts min^{-1}) were applied to intensity levels. Monitor wear time was at least 8 h/day, for a minimum of 4 days, inclusive of at least one valid weekend.[25] Accelerometers could be removed only for water activities, such as showering or swimming, with all participants required to provide details on log sheets.

Procedures

Upon receiving ethical approval from the University Survey and Behavioral Research Ethics Committee at the Chinese University of Hong Kong, invitation letters were sent to school principals. Informed consent forms were collected from parents or guardians. As the manual recommended, two appraisers, one male and one female, were required to evaluate the aerobic test, motor skill test, and muscular endurance test. Hence, an appraiser training workshop was conducted to establish a consistent scoring system prior to data collection. Appraisers were required to have valid first aid and cardiopulmonary resuscitation (CPR) training, as well as a valid criminal record check.

Data collection included the following phases: On the first day of testing, participants were required to complete CAMSA, Plank, Knowledge and Understanding questionnaires, and PPLI. Upon completing these instruments, participants were divided into two groups, with one appraiser per group, and rotated around stations (one test per station) until completion of all assessments. Prior to CAMSA, children watched test presentations performed twice by a single appraiser. During the first presentation, the presenter moved slowly through the entire course while offering a detailed verbal description of each skill. The second presentation involved a full speed demonstration during which the appraiser performed skills accurately. Participants were required to perform two full speed practices while maintaining skill accuracy. The final score was considered as the highest combined result for time and skill. For the Plank test, participants watched demonstrations that they were then required to accurately mimic, at which point, stopwatches were used to record the time for which they held the posture. A warning was announced if a participant's position was too low/high, or if they were unable to maintain it. The second time a participant's posture moved, time recording was ceased.

At the second school visit, after completing the Motivation and Confidence questionnaire, children participated in the PACER 15 m/20 m shuttle run to enable monitoring of their aerobic fitness. Due to limited space, all participants ran between two markers set 15 m apart, while keeping pace with a prerecorded Cantonese cadence. Each participant's total number of achieved laps was recorded and converted to a standardized 20 m PACER score using a FitnessGram PACER Conversion Chart.[18] Lastly, children were issued an ActiGraph GT3X + accelerometer to measure their step counts and MVPA for 7 consecutive days. All measurements were performed during scheduled school PE lessons.

Data analysis

Statistical analyses were conducted using MPLUS version 7.0 through structural equation modeling (SEM), which is an appropriate technique for testing the fit of a hypothesized model to observed data using goodness-of-fit statistics.[26] Before performing SEM, a correlation matrix was presented for all variables in the model (Table 1). The RMSEA, with an associated 90% confidence interval, CFI, and SRMR were largely considered as reliable indices[27] as chi-square statistics (χ^2) for model fit may be overly sensitive when used for large samples.[28] CFI and Tucker-Lewis index (TLI) values were considered as an acceptable fit for values > 0.90.[29] RMSEA values, considered among the most robust fit indices, was a good fit when values were <0.05, and acceptable between 0.05 and 0.08.[29]

The proposed model (Fig. 1) has outlined two hypothesized models showing all indicators and proposed paths. These two models consisted of observed variables—actual PL, including Motivation and Confidence, Physical Competence, Knowledge and Understanding, and Daily Behavior, and MVPA—as well as latent variables—perceived PL, including Knowledge & Understanding, Self-expression & Communication with others, and Sense of self & Self-confidence. Model (a) indicates paths emanating from MVPA to actual PL, as mediated by latent variables such as perceived PL, while model (b) has hypothesized the path from each actual PL domain to MVPA, as mediated by perceived PL. To account for their influence on all latent constructs and indicators, both models considered age, gender, and BMI as covariates. It is hypothesized that individuals participating in more physical activities are more likely to demonstrate a higher level of actual and perceived PL, with these experiences continuously providing further opportunities through which to develop motivation, confidence, physical competence, knowledge, and understanding, thereby encouraging engagement in, and maintenance of, physical activities.

Results

Descriptive statistics of the studied sample are presented in Table 2. Results of model (a) were significant (Fig. 2) for the hypothesized paths and standardized beta coefficients. This model indicated adequate fit to the observed data—chi-square $\chi^2 = 18.79$, $df = 9$, $p < 0.05$, RMSEA = 0.06, 90% CI [0.019, 0.095], CFI = 0.99, SRMR = 0.02—after adjusting for children's age and gender.

In model (a), significant associations were found between (i) MVPA and two actual PL domains—Motivation and Confidence ($\beta = 0.17$) and Daily Behavior ($\beta = 0.59$); (ii) perceived PL and four actual PL domains— Motivation and Confidence ($\beta = 0.48$), Daily Behavior ($\beta = 0.20$), Physical Competence ($\beta = 0.25$), and Knowledge and Understanding ($\beta = 0.18$); and (iii) MVPA and perceived PL ($\beta = 0.14$). MVPA had significant indirect effects on both Motivation and Confidence and Daily Behavior within actual PL levels through PL perceptions.

In model (b), significant associations were found between (i) MVPA and two actual PL domains—Motivation and Confidence ($\beta = 0.13$) and Daily Behavior ($\beta = 0.62$) and (ii) perceived PL and two actual PL domains—Motivation and Confidence ($\beta = 0.38$) and Daily Behavior ($\beta = 0.15$). However, no significant association was found between MVPA and perceived PL. Model (b) could not be identified and PL perceptions did not show significant indirect effects on predictions.

Discussion

This study is the first to identify a directional relationship between PA and PL in children. Overall, PA explained 17% and 59% of actual PL variance in the Motivation and Confidence and Daily Behavior domains, respectively, with these domains in turn and respectively accounting for 13% and 62% of PA variance. However, when considering the mediating role of perceived PL, the pathway between actual PL and physical activity was weak and not significant when PA was the outcome, but significant when actual PL was the outcome. The results indicate that, when both types of PL are examined together as determinants of PA, any effect of perceived PL appears negated. Therefore, a reciprocal relationship between actual PL and PA, when using perceived PL as the mediator, was not observed in the studied population. This may be due to the absence of a physical competence attribute within the PPLI instrument;

although it is considered a reliable tool for assessing perceived PL, it does not include a dimension for perceived competency.[8] Considering that few empirical studies are currently available in this novel field, self-perceived PL, as a construct, requires thorough development and exploration. For instance, children's perceived motor competence has been thoroughly assessed using a pictorial self-perception assessment involving tasks identical to actual, objectively measured, movement skills.[30,31] Instruments used for such a purpose should be concrete, concise, and identical. However, unlike movement skills, PL is an abstract construct encompassing a wide variety of dimensions. As such, future research should explore more comprehensive and streamlined instruments through which to assess perceived PL, ideally also including a measure of physical competence.[8] In addition, bidirectional relationships have not previously been considered in studies of PL and PA, with reciprocal relationships often not addressed within the PA field. For example, when referring to the relationship between obesity and PA, it is common for studies to examine the effect of PA on weight loss/gain but not vice versa.[32] Although our results do not support a bidirectional relationship when considering the mediation effect of perceived PL, they may contribute to a greater understanding of the potential association between PL and PA—a relationship which is not fixed, but fluid.[33]

The significant relationship identified between actual PL and MVPA was, in part, consistent with a previous study,[34] in which all four domains were reported as significantly correlated with MVPA, in contrast to the two identified in the current study. This previous study accumulated MVPA data using pedometers and defined MVPA as >110 and > 130 steps/minute, respectively. As this method showed distinct differences with increasing pedometer-determined activity quartiles, it was not deemed the most appropriate approach for measuring MVPA.[35]

Furthermore, our findings indicated that, regardless of the direction, the relationship between PA and Daily Behavior was stronger than the relationship between PA and Motivation and Confidence. This is understandable as a large portion of the Daily Behavior domain score was influenced by children's MVPA.[11] No significant association was found between PA and either the Physical Competence or the Knowledge and Understanding domains, when considering perceived PL as a mediator. For Physical Competence, this may be explained by the lack of a physical competency measure within the PPLI.[8] The three PPLI attributes, Sense of self & Self-confidence, Self-expression & Communication with others, and Knowledge & Understanding, underpin key factors of environmental interaction, each of which may be enriched through all aspects of participation, rather than children's actual movement skills.[1] Furthermore, the Knowledge & Understanding attribute of perceived PL supported both physical literacy development and perceptions of different environments, while the Knowledge & Understanding domain of actual PL only assessed a child's PL knowledge. The lower reliability of some items in the Knowledge and Understanding domain offer another possible explanation for the nonsignificant results.[36]

In addition, the relevance of the Motivation and Confidence domain was reinforced following the addition of perceived PL to the models. This partially mediated the PA predictions of two actual PL domains, illustrating that PL perception may also work as an important contributor to the relationship between PA and actual PL. In model (a), the direct path between Motivation and Confidence and perceived PL was stronger than that between Daily Behavior and perceived PL ($\beta = 0.48$ vs $\beta = 0.20$). As proposed by the self-determination theory, motivation for PA can be regulated along a continuum based on the degree to which the behavior is autonomous,[37] and it was also reviewed as relevant within the context of physical literacy.[38] For the current study, Motivation and Confidence are more noticeable to the self through continuous participation in PA, therefore, an individual's perception of their ability to participate in PA may be less influential on their actual behavior than an individual's perception of their motivation and confidence to engage in PA.

A significant relationship existed in directional model (a) (i.e., being physically active and having higher perceived PL was associated with better performances in two actual PL domains), further reinforcing the idea that participation in sports and games helps to develop PL.[12] However, evidence of a reciprocal relationship was not found, as the direct pathway between PA and Daily Behavior in model (a) was stronger than that of Motivation and Confidence ($\beta = 0.59$ vs $\beta = 0.17$). This indicates that participating in more activities may provide greater opportunities through which to foster daily behaviors in children that underpin PL.

Using SEM to explore directional pathways and mediating effects is a novel approach in this field. Other study strengths include an adequate sample size and the use of a comprehensive battery of PL measures, including the four domains of Knowledge and Understanding, Physical Competence, Motivation and Confidence, and Daily Behavior. A limitation of this study pertains to the lack of a physical competency attribute within the PPLI, which may be responsible for the nonsignificant actual PL prediction relating to PA, as mentioned above. As research in this field is emergent, further studies are needed to explore a comprehensive instrument for perceived PL. Another limitation is the relatively low reliability of one question of the Knowledge and Understanding questionnaire, specifically how to "get in better shape," which may have influenced the results, although alternative wording was adopted to avoid this bias.[36] Additionally, as the current study examined possible bidirectional associations using cross-sectional data obtained from Chinese children aged 8–12 years, the results may only be applied to the specific age group, under a single time point measure. Future research should consider charting physical literacy levels longitudinally, given the nature of children's PL development.[39]

Conclusions

The implication of actual and perceived PL being inextricably linked to PA in this sample underlines the importance of PL development, not only for contributions to PA, but also for the outcomes of PA participation. Although a reciprocal relationship, when using perceived PL as the mediator, is not evident in the current sample, our data provide some evidence that encouraging PA throughout the lifespan may be useful in supporting subsequent PL development. If this relationship was to be further explored, it would seem appropriate to target PL development and activity simultaneously. Furthermore, as perceived PL is an integral part of the relationship between PA and actual PL, interventions to encourage Chinese children to be physically active should also focus on increasing perceived PL.

Author statement

MHL, YL conceived of the study design, analyzed the data and contributed to the writing of the manuscript; RKWS, CHPS provided support for data collection and revised the manuscript, YL and RL provided help for data analysis. All authors reviewed and contributed to the manuscript.

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