Perceived physical literacy instrument for adolescents: A further validation of PPLI

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ABSTRACT

Background/Objective: The purpose of this study is to examine the reliability and validity of "Perceived Physical Literacy Instrument" (PPLI) questionnaire in adolescents.
Methods: Based on physical literacy literature, a 9-item instrument was developed for initial tests. The self-report measure was administered to 1945 adolescents in Hong Kong. Confirmatory factor analysis (CFA) was used to examine a three-factor structure of physical literacy. A chi-square difference test analysed several competing models and compared the results between the proposed models (i.e., a three-factor solution) and other alternative models (i.e., a one-factor or two-factor solution). Furthermore, the measurement invariance across gender groups was examined by using multiple-group confirmatory factor analysis. Mean scores for physical literacy factors were also examined by demographic characteristics.
Results: Confirmatory factor analysis (CFA) showed that the construct demonstrated a good fit to the model. For convergent validity, our results, evaluating the factor loading of each items, the values of composite reliability (CR) and the average variance extracted (AVE) of the three factors, revealed that the three-factor validity of physical literacy was satisfactory. The chi-square difference test between models was significant indicating that all the latent variables had satisfactory discriminant validity. Moreover, the findings of measurement invariance showed that the PPLI is invariant across gender.
Conclusions: The PPLI thus appeared to be reliable and valid as a measure of the perceived physical literacy of adolescents. Thus, along with other validated instruments, protocols and research designs, the PPLI could be widely used to test adolescents' self-perception of physical literacy and their own physical and mental health conditions and thereby health. Physical education professionals may thus recommend appropriate intervention programmes for younger generations.

Introduction

The development of individual physical literacy has been recognised as critically important to long-term individual health. Several international agencies have suggested that it is a necessary disposition for children and adolescents of all abilities to establish lifelong adherence to physical activity.[1,2] Physical literacy is not equivalent to physical activity, but rather an intelligence related to physicality, which is an important antecedent to physical activity.[3] In this sense, individuals might not participate in physical activity without the understanding of physical literacy, yet through participating in physical activity, they can develop as physically literate individuals. Physically literate adolescents can gain self-confidence in fundamental movement, coordination and control in their changing environments through physical activity. Therefore, physical literacy is also developed through participation in physical activity. The components of physical literacy and physical

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activity are interlinked and concomitant. Physical literacy is considered to be an integral component of whole-person development which is made up of a wide range of intelligences.[4] Physical literacy is a specific intelligence that includes the motivation, confidence, physical competence, and knowledge and understanding to value and take responsibility for maintaining purposeful physical pursuits and activities throughout the course of one's life.[5]

Understanding adolescent physical literacy development remains a priority as levels of physical activity participation within this population have continued to decline due to an increase in sedentary lifestyles.[6] These reduced patterns of physical activity seem to also continue into adulthood which may have implications for their future lifestyle and subsequent health and well-being.[7] The benefits of higher levels of physical literacy remain unanswered in literature,[8] therefore understanding the development of adolescents' physical literacy not only prepares the adolescents of today to live a healthier lifestyle, but also may have implications for future generations to establish lifelong physical activity behaviours.

Physical literacy is developed through participation in physical activity.[3] From this connection, United Nations Educational, Scientific and Cultural Organization (UNESCO)[9] has asserted that quality physical education (QPE) should be a core component of school curricula as it is a foundation for a lifelong engagement in physical activity and sport for adolescents. QPE is designed to help students develop an interest in sports, engage regularly in physical activity, and lead an active and healthy lifestyle.[9] Adolescents are entitled to a learning experience in QPE which develops their physical literacy and fosters the following key attributes: 1) their physical self and self-confidence; 2) motivation to engage; 3) how they interact with the environment, self-express and communicate with others, and 4) knowledge and understanding of how to maintain physical activity.[4] Therefore, when adolescents acquire physical literacy, they have self-confidence in fundamental movement, coordination and control with respect to the changing environment. They can also demonstrate verbal and non-verbal communication to interact with other people in a physical environment, and enjoy discovering new physical activities.

Over the past two decades, the assessment of physical literacy has mainly focused on the demonstration of fundamental movement skills or sports talent identification.[10,11] This assessment remains a somewhat narrow interpretation of physical literacy, which is biased towards skill-oriented assessment.[3] Lundvall[12] has argued that this narrow assessment of physical literacy is insufficient in terms of understanding the complexity of the concept and has suggested that other aspects of physical literacy should be assessed. These physical literacy attributes should include "states of being"[13] such as physical movement competency, and knowledge and understanding of how to be physically active, but also "health behaviour determinants"[13] such as having the necessary motivation and confidence to want to be active. Despite this warrant there remains a dearth of instruments that have been validated to capture the broader attributes of physical literacy. Sum et al.[14] provided an initial self-report instrument namely Perceived Physical Literacy Instrument (PPLI) that was designed to measure physical education teachers' perception of their own physical literacy in terms of their sense of self and self-confidence, self-expression and communication with others, and knowledge and understanding. The original PPLI has gone through a comprehensive literature review of physical literacy by focus group interviews utilising experienced physical education subject specialists followed by a panel of four experts from sports science, physical education, health education and instrument development in order to comment upon and revise the initial instrument. The PPLI appeared to be reliable and valid in order to measure the perceived physical literacy of physical education teachers.

Given the importance of physical literacy in the above key attributes particularly for adolescents and given that there was no self-report instrument to measure the self-perception of physical literacy of adolescents, the purpose of this study is therefore to examine the reliability and validity of "Perceived Physical Literacy Instrument" (PPLI) questionnaire in adolescents.

Methods

Designing the PPLI instrument

The version of the PPLI was constructed based upon the "Perceived Physical Literacy Instrument" (PPLI) for physical education teachers.[14] The PPLI consists of 9 items scored on a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) (see Table 1). The 9 items of the PPLI are equally divided into three subscales including: "knowledge and understanding" (3 items), "self-expression and communication with others" (3 items), and "sense of self and self-confidence" (3 items). Confirmatory factor analysis (CFA) showed that the construct demonstrated a good fit to the model. Since the questioning tone is quite generic and not designed for a designated population or profession, there were no changes made to the vocabulary for the adolescent population.

Data collection and sampling

The participants of this survey were Chinese adolescents from secondary schools in Hong Kong. A total of 1945 Hong Kong adolescents from 11 randomly selected secondary schools (ages 11–19) agreed to participate in this study after letters of invitation were sent to their school principals and PE teachers. All participants were asked to provide informed consent with emphasis on the voluntary nature of the survey before participating in the study. Approval for the use of human subjects was obtained from the first author's University Survey and Behavioural Research Ethics Committee.

Two classes were randomly selected in each grade (secondary one to secondary six) and parental consent was obtained before the questionnaire was distributed. The questionnaires were distributed to the participants by a research assistant in quiet conditions before the physical education classes. The research assistant was available to clarify questions raised by the participants and the questionnaires were returned within the lesson. The average range of questionnaire completion time was 8–10 min.

Data analysis and results

The research team used SPSS version 22 for Windows for the data analysis. The expectation-maximization (EM) algorithm was employed to estimate missing values in returned questionnaires.

Table 1
Original 9-items of perceived physical literacy instrument for PE teachers.

Item	Items
PL1	I am physically fit, in accordance with my age.
PL2	I have a positive attitude and interest in sports
PL3	I appreciate myself or others doing sports
PL4	I possess self-management skills for fitness
PL5	I possess self-evaluation skills for health
PL6	I have strong social skills
PL7	I am confident in wild/natural survival
PL8	I am capable in handling problems and difficulties
PL9	I am aware of the benefits of sports related to health

All items are measured on a 5-point Likert scale (1: strongly disagree to 5: strongly agree).

The research team implemented an *ad hoc* deletion of missing data before proceeding to the next step. In advance of validation of the PPLI, adolescents' demographic characteristics (gender, age and sports experience) were analysed in Table 2. After checking and confirming the validity of the raw data, the research team then conducted a confirmatory factor analysis (CFA). CFA was used as a critical step in refining the instrument and identifying the factorial structure of physical literacy in the PPLI.

In the CFA, we confirmed the three-factor structure of physical literacy, through evaluating the factor loading of each of the items, the values of composite reliability (CR) and the average variance extracted (AVE) of the three factors. Also, we used a chi-square difference test to analyse several competing models and compare the results between proposed models (i.e., a three-factor solution) and other alternative models (i.e., a one-factor or two-factor solution). We further examined the measurement invariance by using multiple-group confirmatory factor analysis. For testing invariance across gender groups, we divided our sample into male and female.

Confirmatory factor analysis (CFA)

CFA was performed to cross-validate and confirm the three-factor structure derived in the analysis (see Table 3). The goodness-of-fit test on the model was assessed using chi-square, root mean square error of approximation (RMSEA; < 0.08), comparative fit index (CFI; > 0.90), and standardised root mean square residual SRMR; < .08.[15] Final fit statistics were all adequate as follows: chi-square ($\chi^2 = 321.54$, $df = 24$, $p < .05$), CFI = 0.95, RMSEA = 0.08, SRMR = 0.04. The factor loading of all items above the standard of 0.45, ranged from 0.51 to 0.82, suggesting that observed variables sufficiently represented the latent variables.

For convergent validity, the AVE values ranged from 0.43 to 0.54, and the CR values were higher than .60.[16] We further examined the factor structure by conducting an alternative one-factor model and three two-factor models to compare with the three-factor model (see Table 4). In accordance with our hypothesis, the results showed that the three-factor model had a significantly better fit than the one-factor model and the other three two-factor models. The chi-square difference test between models was significant ($\Delta\chi^2 = 43.24–1013.48$, $df = 24–27$, $p < .05$), which indicated that all the latent variables had satisfactory discriminant validity.[17] Overall, our results revealed that the three-factor validity of physical literacy was satisfactory.

Table 2
Adolescents' demographic characteristics.

Total N	N = 1945	%
Gender		
Female	917	47.1
Male	1028	52.9
Age		
11 years old	2	.1
12 years old	146	7.5
13 years old	274	14.1
14 years old	369	19.0
15 years old	436	22.4
16 years old	416	21.4
17 years old	215	11.5
18 years old	66	3.4
19 years old	20	1.0
Experience in sports		
1years or under	423	21.7
1 to 3 years	622	32.0
4 to 6 years	414	21.3
7 to 9 years	260	13.4
10 to 13 years	149	7.7
14 years or more	77	4.0

Table 3
Model comparison for confirmatory factor analysis (N = 1945).

Model	df	χ^2	$\triangle\chi^2$	RMSEA	SRMR	CFI
Three-factor model	24	321.57	–	.08	.04	.94
Two-factor model[a]	25	1335.02	1013.48*	.16	.23	.76
Two-factor model[b]	25	1561.37	269.59*	.18	.27	.72
Two-factor model[c]	25	1153.62	43.24*	.15	.21	.79
One-factor model	27	1604.61	450.99*	.17	.29	.71

Note. *$p < .05$; **$p < .01$; ***$p < .001$. [a]"Knowledge and understanding" items and "Sense of self and self-confidence" items loading onto the first factor; "Self-expression and communication with others" loading on to second factor. [b]"Knowledge and understanding" items and "Self-expression and communication with others" items loading on to first factor; "Sense of self and self-confidence" items loading onto the second factor. [c]"Sense of self and self-confidence" items and "Self-expression and communication with others" items loading on to first factor; "Knowledge and understanding" items loading on to second factor.

Items 1, 4 and 5 stated: "I am physically fit, in accordance with my age," "I possess self-management skills for fitness," and "I possess self-evaluation skills for health." These items illustrated that a physically literate individual should have a better *sense of self and self-confidence.* Adolescents were aware of the importance of a *sense of self and self-confidence* while performing physical activities. Previous literature had reported gender differences in sense of self during physical activity where males were stronger in building self-confidence through physical activity,[18,19] and where significant positive effects were found between physical activity and self-esteem and self-concept.[20] The results of this study would suggest that all adolescents might utilise their self-confidence in physical activity to apply to other situations that would benefit their social development as a whole.

Items 6, 7 and 8 stated: "I have strong social skills," "I am confident in wild/natural survival," and "I am capable in handling problems and difficulties," which demonstrates that a physically literate adolescent should possess better *self-expression and communication with others.* Adolescents who learn to express themselves well and who acquire communication skills from doing physical activities have greater freedom in expressing their feelings, are more balanced emotionally, and become emancipated.[21]

Items 2, 3 and 9 stated: "I have a positive attitude and interest in sports," "I appreciate myself or others doing sports," and "I am aware of the benefits of sports related to health." These items reveal that a physically literate adolescent should have a better *knowledge and understanding* of the benefits of being physically active. Adolescents who acquire knowledge and understanding of being physically active as it relates to their health and who possess a positive attitude and interest in doing physical activity would become more appreciative of themselves and others doing physical activity. Physical activity exhibits important benefits for cognitive performance in either younger or older adults.[22]

We further conducted a multiple-group analysis to examine the measurement invariance across gender (male: N = 1028; female: N = 917). Table 5 presents the results of model fits and comparisons. First, all models have satisfactory values on fit indices. Moreover, we followed the suggestion of Byrne[23] to test the measurement invariance comparisons between models. The results reveal that all the χ^2 difference tests ($\triangle\chi^2$) are significant, indicating that the invariance is not supported. However, research suggested that the invariance test can be evaluated by using other indices, that is, when the value of ΔCFI is equal or lower than .01[24] and the value of ΔTLI is lower than .05.[25] In the current findings, all the ΔCFI (0.001 ~ .003) and ΔTLI (0.008 ~ .023) are acceptable, indicating satisfactory psychometric properties for measurement invariance.

Additionally, we examined the mean scores for physical literacy factors by demographic characteristics (Table 6) which showed that

Table 4
Factor structures by confirmatory factor analysis (N = 1945).

Sign	Items	λ	SE	t	CR	AVE
PL1	I am physically fit, in accordance with my age.	.64	.04	25.60***	.78	.54
PL4	I possess self-management skills for fitness	.81	.04	30.44***		
PL5	I possess self-evaluation skills for health	.74	–	–		
PL6	I have strong social skills	.62	.05	20.26***	.70	.43
PL7	I am confident in wild/natural survival	.68	.06	21.09***		
PL8	I am capable in handling problems and difficulties	.67	–	–		
PL2	I have a positive attitude and interest in sports	.82	.10	20.00***	.72	.47
PL3	I appreciate myself or others doing sports	.69	.08	19.18***		
PL9	I am aware of the benefits of sports related to health	.51	–	–		

Note. $^*p < .05$; $^{**}p < .01$; $^{***}p < .001$. λ = factor loading standard errors; t = t-values; AVE = average variance extracted; Pc = composite reliability.

Table 5
Model fit of various invariance models.

	Model	χ^2	DF	$\Delta\chi^2$	ΔDF	SRMR	RMSEA	CFI	ΔCFI	TLI	ΔTLI
1	Configural	360.46[a]	48	–	–	.035	.058	.941	–	.912	–
2	Measurement weights	375.03[a]	54	14.57[a]	6	.038	.055	.940	.001	.920	.008
3	Structural covariances	392.60[a]	60	17.56[a]	6	.043	.053	.938	.003	.925	.013
4	Measurement residuals	400.07[a]	69	7.47	9	.043	.050	.938	.003	.935	.023

[a] $p < .05$.

Table 6
Mean scores for physical literacy factors by demographic characteristics.

Demographic variable	N	Mean	95% CI
Factor 1: Sense of self and self confidence			
Sex			
Male	1028	11.65	(11.16–12.50)
Female	917	10.98	(10.45–11.83)
Age			
11–15	1227	11.34	(11.18–11.55)
16–19	717	11.32	(11.15–11.54)
Experience in sports			
3 years or below	783	11.2912	(10.11–12.10)
4 years or above	686	12.2886	(11.11–13.10)
Factor 2: Self-expression and communication with others			
Sex			
Male	1028	11.00	(10.60–12.17)
Female	917	10.41	(10.02–11.18)
Age			
11–15	1227	10.75	(10.63–11.00)
16–19	717	10.69	(10.57–1094)
Experience in sports			
3 years or below	783	10.6935	(9.81–11.18)
4 years or above	686	11.3761	(10.50–11.86)
Factor 3: Knowledge and understanding			
Sex			
Male	1028	11.62	(11.40–12.17)
Female	917	11.24	(11.01–11.78)
Age			
11–15	1227	11.46	(11.32–11.65)
16–19	717	11.43	(11.29–11.62)
Experience in sports			
3 years or below	783	11.3550	(10.40–11.97)
4 years or above	686	12.1356	(11.17–12.75)

factor scores differed by demographic groups. Males reported higher scores than females among all three factors which means that males perceived themselves to possess a better *sense of self and self-confidence, self-expression and communication with others* and *knowledge and understanding*. Adolescents who have had more than four years of sports experience achieved a higher self-perceived physical literacy among all factors than those with less than three years of sport experiences. However, age seemed to have no influence on adolescents' perceptions of their physical literacy.

Discussion

The purpose of this study was to further validate the PPLI for adolescents based on the previous development of a PPLI.[14] Results showed that the instrument had good validity and reliability in adolescents' perceptions of their own physical literacy in terms of the three dimensions of *sense of physical self and self-confidence, self-expression and communication with others*, and *knowledge and understanding of PA*.

To further examine the findings, we compared the data from the developed PPLI[14] and found that the correlation between the items in each factor were similar, ranging from 0.48 to 0.66. It appears that the correlations found for these items in this study are consistent with the previous findings. It means that PPLI can be used for examining the self-perception of physical literacy of both PE teachers and adolescents.

The other three physical literacy attributes: 1) motivation, 2) confidence and physical competence, and 3) interaction with the environment, as advocated by Whitehead[5] are inter-related and mutually influenced by the *sense of the self*, the *self-expression and communication with others*, as well as the *knowledge and understanding* that make an impact on adolescents' perceptions of physical literacy. The assessed three attributes in this study gave valid results and formed the reciprocal relationships of physical literacy. This shows how the interaction of these two sets of attributes are reciprocally reinforced back and forth. The exploration of each attribute in terms of its causal relationship and hierarchical order would further consolidate the prevalent concept of physical literacy and its impact on adolescents' health and physical activity.

As highlighted by Canada's Long-Term Athletic Development Model,[26] adolescents between 11 and 19 years of age require scaffolding of their physical literacy with specific attention paid to their physical skill development and understanding of the role and benefits of PA in their lifestyle. During adolescence, individuals are often learning to compete in socially active environments. Teachers and coaches working with this age group need to be cognizant of the broader dimensions of physical literacy and include specific education related to those attributes on those dimensions within their training. In addition, to ensure that adolescents can practice a wide range of skills throughout their teenage years, there is a need to develop physical literacy in the early years.[27,28] In addition, adolescents' perception of their own physical literacy is also important in order for them to become physically active from their pubescent stage to their adulthood.

Since physical literacy "is the antecedent of physical activity, while also being developed through physical activity" (p. 2),[29] physically literate individuals are expected to participate in physical activity throughout the course of their lives which positively contributes to their health.[5] Physically literate adolescents need to be aware of the benefits towards quality of life through participating in physical activities; including the benefits of more awareness in expressing themselves, more empathetic interactions with others, and more positive and effective experiences relating to physical activities.[30] Furthermore, the association between perceived physical literacy and physical activity levels among adolescents provides an impetus for future study. The PPLI self-report measurement, in addition to skill-oriented assessment, provides a broader assessment instrument to measure physical literacy in this important population. The validation of the three-factor PPLI in this study provides a resource for future research related to the association between physical literacy and physical activity in this population. Combined with other validated instruments to assess the attributes of physical literacy, the field has the potential to move closer to a more holistic understanding of how adolescents' physical literacy impacts their choice to be active.

By viewing the questioning tone of the 9-item questions in the PPLI, we realised that they were not designed for a designated population or profession. Example: I am physically fit, in accordance to my age; I have a positive attitude and interest in sports; and I have strong social skills. In other words, the 9-item PPLI can be applied across different age groups and different populations. Specifically, future studies could use the PPLI to further validate the physical literacy of different populations at various life stages. For example, university students are an example of a population who are required to transition away from compulsory physical education towards more self-initiated physical activity behaviour. The PPLI may also be applicable to physical activity policy makers. For example, the investigation of the perceived physical literacy of school principals who turn policy into practice is also essential for developing an environment that is supportive of physical activity participation.

Several limitations were noted in this current study. First, this study was a rigorous design with a large and randomly selected sample from a cross-sectional study of perceived physical literacy of adolescents. Thus, it cannot demonstrate causality between factors associated with perceived physical literacy. Second, this study only examined the factorial validity, convergence validity and internal consistency reliability but not criterion validity. Third, only three factors from the PPLI were examined. Continued research is needed to identify the other factors related to perceived physical literacy such as *motivation, confidence and physical competence,* and *interaction with the environment*. Fourth, this self-reported perceived physical literacy instrument was another limitation of this study. Together with objective measure such as accelerometer, further studies could use this PPLI instrument to investigate the association between physical literacy and physical activity levels which would be more meaningful in understanding the importance of physical literacy of adolescents.

Conclusion

This study further demonstrates that the PPLI[14] appears to be a valid and reliable measure of adolescents using the PPLI with a stable factorial structure. The PPLI could be widely used to test adolescents' self-perception of physical literacy. Based on their PPLI results, health and physical education professionals may recommend appropriate intervention programmes for the younger generation. In the future it is hoped that testing of three additional attributes, i.e., *motivation, confidence and physical competence,* and *interaction with the environment* will enhance the measurement of a holistic spectrum of self-perception of physical literacy in different populations.

Declarations

Competing interests

The authors have declared that no competing interests exist.

Ethical approval and consent to participate

The protocol of the survey was reviewed and approved by the University Survey and Behavioural Research Ethics Committee at the Faculty of Education at the Chinese University of Hong Kong. All the participants were asked to provide informed consent with emphasis on the voluntary nature of the survey before participating in the study.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jesf.2018.03.002.

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