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ORIGINAL ARTICLE

Design and psychometrics evaluation of Adolescent Physical Literacy Questionnaire (APLQ)

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Abstract

Purpose Despite the global introduction of physical literacy in recent years, a lack of a comprehensive physical literacy tool is still evident in adolescents. This study was conducted to design and perform psychometric evaluation of self-assessment adolescent physical literacy questionnaire in the Iranian sample.

Methods A mixed research method, including 3 phases, was used on 836 adolescents in the age range of 12–18 years old. A questionnaire with 59 items was designed based on the qualitative stage, refined during the validity and reliability stages, and finally, formed a questionnaire with 25 items.

Results The exploratory factor analysis showed 3 factors with an explanation of 59.5% of the total variance, and the results of confirmatory factor analysis confirmed the 3-factor model. Results also showed good internal consistency ($\alpha = 0.951$), retest reliability (0.981–0.837), and concurrent validity of the questionnaire with the PPLI instrument (0.680–0.790).

Conclusion The results showed good validity and reliability of the Adolescent Physical Literacy Questionnaire (APLQ) with 3 dimensions. Therefore, it can be a suitable tool to assess adolescent physical literacy.

Keywords Physical literacy · Physical activity · Active lifestyle · Physical competence · Daily behavior · Motivation

Introduction

With the development of the sedentary and inactive lifestyle, physical literacy has become one of the most important topics in the field of physical activity [1]. Research in several countries has reflected different areas of physical literacy, all of which have one thing in common: the concern about the increase of sedentary behaviors, giving rise to physical literacy due to such inactive behaviors and lifestyles [2]. The obese and overweight children and adolescents have increased from 4 to 18% from 1975 to 2016, close to 340 million people [3]. Having physical activity in childhood and adolescence can guarantee participation in physical activity in the future [4] in addition to having positive health effects for individuals [5].

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Whitehead [2] defines Physical Literacy as the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engaging in physical activities for life. International Association of Physical Literacy [6], like Whitehead's definition of physical literacy, emphasizes motivation, self-confidence, and physical competence, noting that physical literacy is designed to help individuals take responsibility for being active. Researchers have identified physical literacy with greater involvement in lifelong physical activity [7] as a new way to expand physical activity [8]. It is believed that physical literacy is designed to provide a framework for individuals to engage in physical activity and exercise, sports success, and healthy lifelong [9, 10]. In this field, motivation to be active, physical activity and sports participation, healthy behaviors, and active lifestyles have been reported to be good physical literacy outcomes [11, 12].

Giblin [13] states that there is no strong tool for assessing skill learning and physical literacy. This severe limitation requires the design of appropriate tools that can be developed and used for physical literacy interventions. Standard tools in the field of physical literacy assessment are limited

to 2 tools: The Perceived Physical Literacy Instrument (PPLI) designed by Sum [14] to measure the perceived physical literacy of physical education teachers, and the Canadian Assessment of Physical Literacy (CAPL) designed for Canadian children at the age range of 8–12. The CAPL assesses 4 dimensions to measure the children's physical literacy at the age range of 8–12 years [15, 16], including daily behavior (pedometer and self-report), motivation and confidence (questionnaire), physical competence (Planck, PACER, and CAMSA), and knowledge and understanding (questionnaire) [17]. As the CAPL is designed to assess children's physical literacy in the Canadian education system, it does not seem appropriate for the assessment of adolescent physical literacy. Because its questions and tests are designed for children 8–12 years old and no standard has been reported for 12–18 years old. Also, use of tests requires a specialist examiner and long-term application (1 week) of a pedometer, making it difficult to use. The PPLI instrument was also identified and approved in Hong Kong to assess teachers' perceived physical literacy with 9 questions and 3 factors [14]. Sum [18] examined the PPLI questionnaire in 1945 adolescents, and confirmed that in a 3-factor model. This questionnaire was also approved in Chinese undergraduates in 3 dimensions [19]. In the Sum [14] model, the knowledge and understanding dimension came by questions about attitude and interest in sports, appreciation for sports, and awareness of sports health benefits; The sense of self and self-confidence dimension came by questions about physical fit, self-management skills, and self-evaluation for health. The dimension of self-expression and communication with others came by questions on social skills, confidence, and capability to handle problems. However, the questionnaire designed by Sum [14] seems flawed in several ways to assess adolescents' physical literacy. First, the primary objective to design this questionnaire was to assess the teachers' perceived physical literacy, and did not consider adolescents' characteristics (such as psychological characteristics, knowledge, and awareness). Second, this questionnaire had difficulty considering the various dimensions of the common concepts presented about physical literacy, especially since the limited questions in this questionnaire did not fully cover the physical dimension, activity, motivation, and other concepts in physical literacy definitions. Furthermore, it seems that this questionnaire does not have the content validity in terms of general content to measure adolescents' physical literacy.

Since, there is no specific tool for measuring the physical literacy of adolescents and also due to the inadequacy of the above tools for measuring the physical literacy of adolescents, it seems necessary to design a new tool for measuring physical literacy of adolescents 12–18 years old. There is no specific tool designed to measure adolescent physical literacy, In contrast, an adolescent at this stage of development is strongly influenced by physical literacy dimensions (such as daily physical activity, knowledge and awareness, self-confidence and motivation to activity, and physical competence), and low physical literacy leads to low self-confidence because of which the individual will have no motivation to participate in structured physical activity [20]. Lack of tools to measure physical literacy in adolescence and the importance of studying various aspects of physical literacy in their developmental stage motivated researchers to create and design a specific tool to measure physical literacy at this age.

Methods

The present study was a mixed study consisting of 3 phases. In phase 1, questionnaire items were initially designed using the qualitative method with codes extracted from the literature and interviews with experts. In phase 2, after the questionnaire compilation, the content of the questionnaire items was evaluated to check the face and content validities. Finally, in phase 3, the construct validity, concurrent validity, and reliability of the questionnaire were examined.

Participants

The sample of the present study included 836 adolescent students (aged 12 to 18 years, with a mean age of 14.96 ± 1.68 years) who were selected by multi-stage cluster sampling in different Tehran areas. Researchers have reported various proportions for the sample size required for factor analysis research, but the sample size above 500 is described as very good [21, 22]. All participants were informed of the study's aim, expressed their and parents' consent in a form and volunteered to participate in the study.

Procedure

In the first phase, the initial items were obtained from a comprehensive literature review (including databases of Science Direct, PubMed, Ebsco, and google scholar) followed by interviews with 14 specialists. A total of 151 articles were found considering inclusion criteria: English written language, quantitative/qualitative research, publication between 2000 and 2020, and the use of the term *physical literacy* in the title of the research. Interviews were performed with 14 experts (with Ph.D. degree in sports psychology, sports management, motor development, motor learning and control, and physical education and pedagogy, a teacher, and a Ph.D. student), who had sufficient knowledge and experience in the field of physical literacy and physical education. They also had research work in physical literacy and physical education. Interviews continued according to theoretical

sampling until theoretical data saturation according to Glaser & Strauss [23]. Semi-structured interviews and open-ended questions were conducted face to face. Individuals participated in the interviews voluntarily, and the interviews were recorded on an audio file (between 12 and 50 min) by a mobile phone in the interviewee's office. The literature and interview data were coded and analyzed using MAXQda software (MAXQDA 2018, VERBI Software GmbH, Berlin, Germany). After reviewing the literature and interviews' coding, 510 codes were identified, and a questionnaire with 59 items was designed by removing duplicate codes and merging some codes.

In the second phase, the evaluation of face and content validities was carried out initially using opinions of ten experts and ten adolescents. Thus, based on the experts' opinions and the adolescents' answers, some items were corrected and merged, and some phrases were removed, leading to 39 items. The questions' scoring was based on a 5-point Likert scale graded in different writing (for example, very low-very high). The range of scores for each question varied from 1 point (the lowest score) to 5 points (the highest score). The range of responses (such as daily activity time) was determined based on a pilot study on 10 adolescents. Then, the quantitative face validity, content validity ratio (CVR), and content validity index (CVI) were used to ensure the correct content of the items. The impact score results indicated that all items had a score ≥ 1.5, which meant that all items had good face validity. The CVR (evaluated by eleven experts different from the previous stage) showed that ten items did not have lower criteria of Lawshe's [24] table. The CVI (evaluated by twelve experts different from the previous stage) showed that 3 items did not have good criteria based on Waltz and Bausell's index [25]. Also, the s-CVI index was equal to 0.90. At the end of the face and content evaluation, a 26-item questionnaire was formed. Figure 1 shows the development process of APLQ.

In the third phase, the construct validity, test–retest reliability, internal consistency, and concurrent validity (with PPLI) were evaluated, and the final version of the questionnaire was shaped with 25 items and an internal consistency of $\alpha = 0.951$. A five-point Likert scale was used to score items; for example, the respond to item 2 (I like to acquire more skills in sports) was *Strongly Disagree* (1 point), *Disagree* (2 points), *Neither Agree nor Disagree* (3 points), *Agree* (4 points), and *Strongly Agree* (5 points). Total possible scores of APLQ (25 items) ranged between 25 and 125, and the questionnaire could be completed in 10–15 min.

The consent form for participation in the study consisted of questions about personal information including age, height, weight, educational level, health or medical defects, and parental consent to participate in the study.

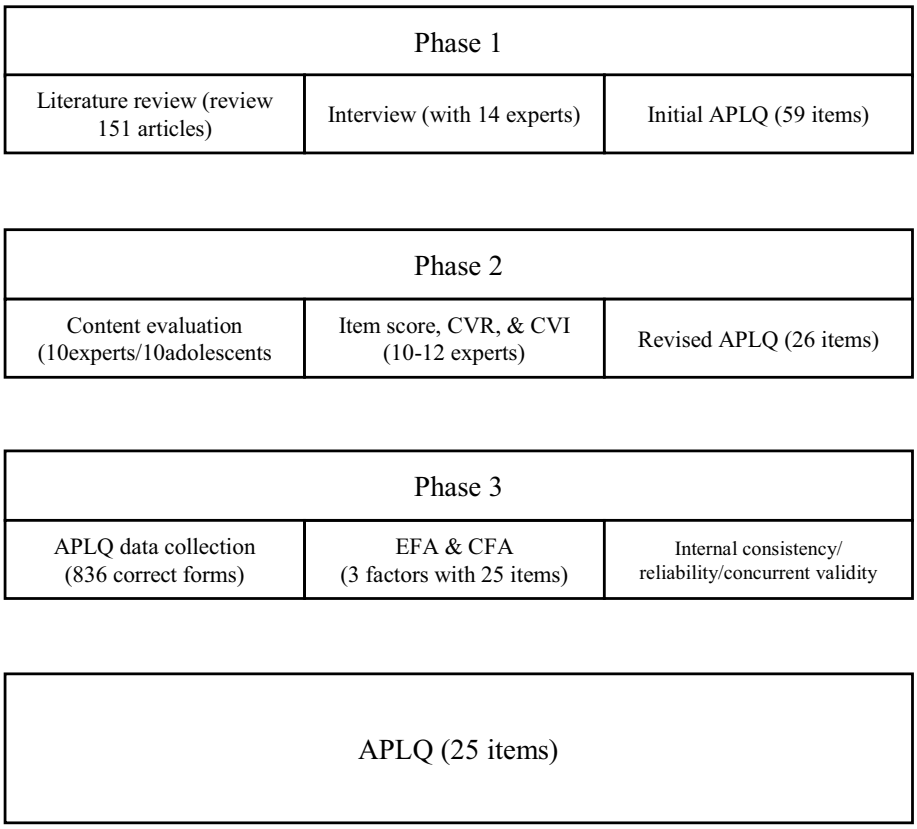

Fig. 1 Overview of research process to develop APLQ

Perceived Physical Literacy Instrument was used to measure perceived physical literacy as a concurrent tool [14]. This 9-item scale with 3 factors was approved by sum et al., (2016) for teachers, and factor loads were reported from 0.69 to 0.87 with Cronbach's alpha of tools from 0.73 to 0.76. This self-report tool provides scores based on a 5-point Likert scale (from strongly agree to strongly disagree). Sum also reviewed the 9-item tool in 1945 adolescents aged 12–18 years in Hong Kong and validated the questionnaire using CFA [18].

Data collection

Data collection was conducted, and 894 forms were collected, out of which 58 questionnaires were removed because of failure to comply with the inclusion criteria or incomplete and distorted data, resulting in 836 questionnaires for the analysis. Inclusion criteria were physical health, no specific disease (e.g., heart, respiratory, neurological disease), no musculoskeletal disabilities, and age between 12–18 years.

An Exploratory Factor Analysis (EFA) was performed to check the construct validity and determine the factor structure of the questionnaire while a Confirmatory Factor Analysis (CFA) with maximum likelihood was performed to evaluate the fit of the model. The Interclass correlation coefficient (ICC) was used to determine the reliability coefficient of the test–retest. The concurrent validity of APLQ with PPLI was tested by bivariate correlation. The internal consistency coefficient was calculated by Cronbach's alpha correlation. The Excel 2013 (Microsoft Corporation), SPSS version 24 (IBM products), and AMOS version 24 (IBM products) were used to perform the statistical calculations. All statistical analyses were done with a CI of 95%.

Ethical considerations

The Ethics Committee approved this study. Before the interviews, interviewees were allowed to record the audio of the interviews. According to the frame work of the research ethics, all interviewees were assured that their interview information would be confidential and remain with the researcher. They were also free to leave the research at any stage and could be informed of the study results upon request. The researcher did not induce any mentality in the participants during the data collection.

Results

EFA for APLQ

EFA (with principal component analysis) was used to determine the structure of the questionnaire and identify the number of factors and items related to each factor in the APLQ. In examining the correlation matrix between items, item 26 was omitted due to the lack of appropriate correlation, and analysis was performed on 25 items. According to the results of Table 1, the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO) value was close to 1 (0.958). Bartlett's test of Sphericity was also significant ($\chi^2_{(300)} = 12{,}992.408$, $P < 0.001$), which indicates the sampling adequacy for each variable in the model and complete model, along with the proportion of variance in variables.

By performing EFA through the method of principal components with varimax rotation, 3 factors were identified with an Eigen-value of > 1 (Fig. 2). These 3 factors together explained 59.50% of the total observed variance. The first factor showed an Eigen-value of 11.77 and variance of 47.10%, while second factor had an Eigen-value of 1.70 and variance of 6.81%, and the third factor had an Eigen-value of 1.39 and variance of 5.58%. The first factor included items 1, 2, 3, 4, 5, 6, 7, 8, 15, 16, and 17, with a factor load of 0.706–0.566. According to the content of the questions, this factor measured the psychological and behavioral dimension. The second factor included items 9, 10, 11, 12, 13, 14, and 18 with a factor load of 0.701–0.481., According to the content of the questions, this factor measured knowledge and awareness. The third factor included items 19, 20, 21, 22, 23, 24, and 25 with a factor load of 0.796–0.478. According to the content of the question, this factor measured physical competence and physical activity.

CFA for APLQ

CFA was used to investigate the fitness of the 3-factor structure. The fitness of this model was calculated and evaluated using AMOS statistical software with the "maximum likelihood" estimation method. The results of Table 2 show that the chi-square index (χ^2) was significant ($P < 0.001$, DF = 253, $\chi^2 = 645.\ 761$), and the assumed model did not fit exactly; yet, χ^2 was strongly affected by the sample size. In large samples, the probability of its significance is high. However, χ^2/df, GFI, RMSEA, CFI, NFI, IFI, TLI, PCFI, PNFI, and AGFI indices showed a good model fit (Table 3). The results of CFA confirmed the identified model of APLQ (Fig. 3) with 3 factors of *psychological and behavioral*, *Knowledge and awareness*, and *physical competence and physical activity* for the sample of this study.

Table 1 Bartlett sphericity and KMO test results

Sampling adequacy	KMO	0.959
Bartlett sphericity test	χ^2	12,992.408
	df	300
	P	0.0001

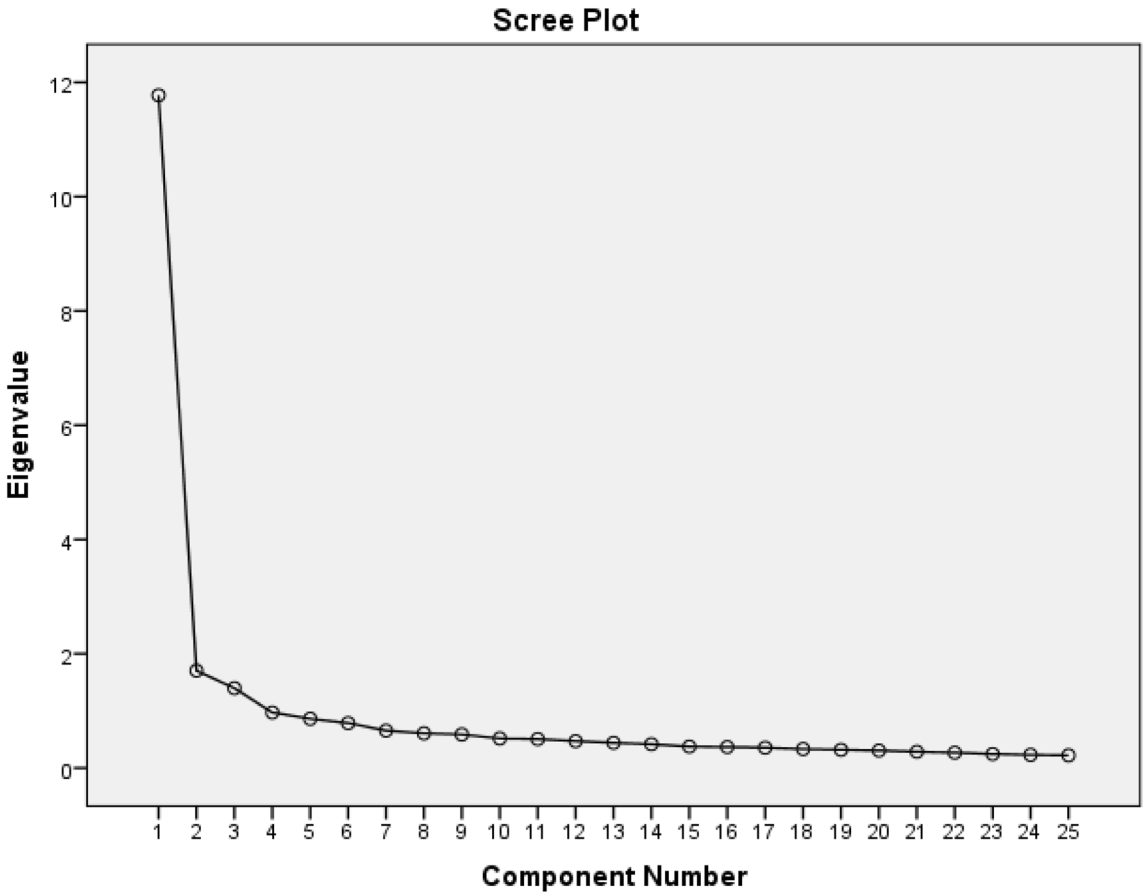

Fig. 2 Scree plot of Eigen-values in EFA

Table 2 Indices of fitness of 3-factor APLQ model

Index	χ^2/df^*	RMSEA	GFI	CFI	IFI	NFI	TLI	PCFI	PNFI	AGFI
3-Factor model	2.85	0.047	0.932	0.962	0.963	0.943	0.957	0.834	0.818	0.915

$^*P < 0.001$, $df = 260$

Table 3 The internal consistency and ICC in two times test of APLQ

Factor	N of Items	Mean (SD)	Cronbach's alpha (n = 836)	ICC (95%CI)	Bivariate correlation with PPLI
Psychological and behavioral	11	42.39 (7.64)	0.918	0.978 (0.954–0.990)*	0.726*
Knowledge and awareness	7	25.41 (5.57)	0.882	0.910 (0.812–0.957)*	0.736*
Physical competence and activity	7	22.23 (5.80)	0.882	0.968 (0.932–0.985)*	0.676*
APLQ	25	90.04 (17.12)	0.951	0.988 (0.976–0.995)*	0.792*

ICC interclass correlation coefficient, *CI* Confidence Interval

$^*P < 0.05$

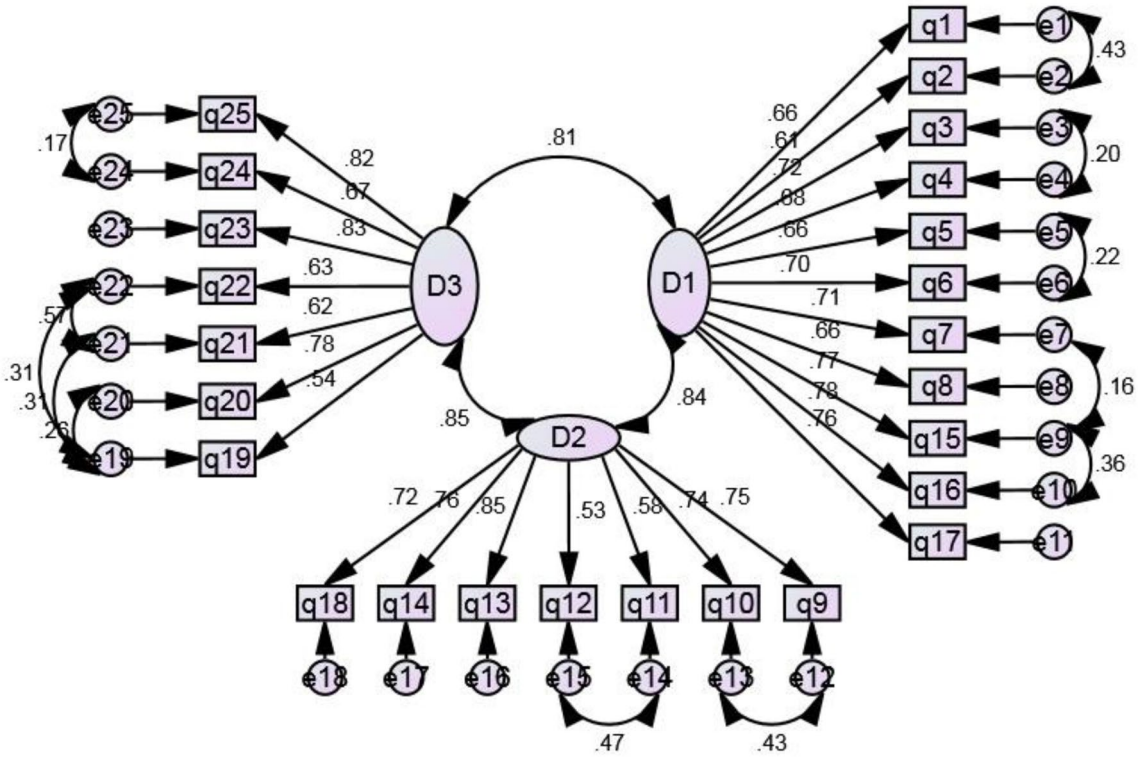

Fig. 3 Final model of the 3-factor structure of APLQ with standardized estimates

Internal consistency

Cronbach's alpha correlation coefficient was used to examine the internal consistency. The analysis was performed on 25 items of the questionnaire for the whole sample (836 subjects). Cronbach's alpha coefficient for the whole questionnaire was reported well ($\alpha = 0.951$). The internal consistency of the factors was > 0.7 (Table 3), indicating good internal consistency in all 3 dimensions and the whole questionnaire.

Test–retest reliability

Thirty subjects completed the questionnaire again following eleven days to evaluate the retest reliability, after which the correlation between the 2 test scores was analyzed. Calculation of ICC was for the 3 factors and the whole questionnaire, indicating an appropriate correlation between the 2 test times (Table 3). These results indicated the appropriate reliability of the questionnaire for application at different times of the test.

Concurrent validity

Bivariate correlation was calculated between APLQ scores and the scores obtained from the PPLI to evaluate the concurrent validity. Table 3 shows a high and significant correlation ($P < 0.001$) between the three dimensions and the total scores of the APLQ with the PPLI, confirming the concurrent validity of the APLQ with the PPLI instrument.

Discussion

The face and content validities of the questionnaire were assessed through some corrections, such as merging similar items, deleting, and modifying items, which reduced the initial questions from 59 to 39 items. The CVR evaluation was according to the Lawshe table and the CVI content validity index was based on the Waltz and Basel index. Thirteen items with lower than standard criteria were removed, and a 26-item questionnaire was formed. The results of the quantitative content analysis showed that the remaining 26 items in the questionnaire could be measured in terms of face and content.

The EFA results with the principal component analysis approach showed that the factor structure of the APLQ

measured the 3 main factors or structures. The factor load of all items in the model was higher than the acceptance criterion of 0.3 [26]. By examining the factors, it was found that the first factor measured the psychological and behavioral structure because the questions were about the individuals' psychological characteristics and behaviors. The second factor was knowledge and awareness because the questions were around knowledge, awareness, and cognition. The third factor was physical fitness and activity because all the questions were about physical fitness and physical activity. Almost all of the items identified in the final 3-factor model were consistent with the research literature. For example, questions that measured motivation, self-confidence, attitude, pleasure, and communication (items 1–8) were identified in the psychological and behavioral dimensions.

Items related to cognitive concepts, knowledge, and awareness (14–9) were in the dimension of knowledge and awareness. Also, items related to physical fitness and physical activity (19–25) were identified in physical fitness and activity. Items 15–17 related to having a habit of activity, doing outdoor activities, and learning a new skill were identified in the psychological and behavioral dimension. Item 18, related to making the change in life, was identified in the knowledge and awareness dimension. These results are consistent with the theoretical models presented in Australia [27, 28], the USA [12, 29], Canada [17], and Whitehead definitions [2, 8]. The 3-factor model fit of APLQ was assessed through CFA for adolescents at the age range of 12–18 years old. According to the CFA results, the model identified in the EFA showed good fit of the input model for this research sample, and the model was approved.

Evaluation of the internal consistency of APLQ showed that the 25-item version of the questionnaire had a high internal consistency. The range of internal consistency coefficient is between 0–1, and a coefficient > 0.7 is considered desirable [30]. The internal consistency coefficient means the extent to which all test components measure the same concept. The results indicate the high internal relevance of the components of the test [31]. The degree of internal correlation of the whole scale was higher than the correlation of individual dimensions, indicating that the sum of the items of the questionnaire had a correlated and related structure similar to physical literacy. In the study of the reliability of adolescent physical literacy questionnaire, the results showed a significant and high correlation between the scores of the 3 dimensions and the total APLQ with the questionnaire retest scores. In this study, test–retest was performed after 11 days, which is in the desired 1–2 weeks interval [32]. The ICC results for 2 tests showed a perfect agreement between the results of the 2 tests. According to the results obtained on the reliability of retesting, it can be stated that the APLQ is a stable tool, and the results are highly reproducible.

In examining the concurrent validity of APLQ with PPLI, the study results showed high correlation of APLQ with PPLI. In previous studies, Sum [18] confirmed the validity of the PPLI questionnaire on adolescents but did not report on the concurrent validity of the PPLI [14, 18]. According to the results obtained from concurrent validity, it can be stated that the APLQ is a valid tool to measure the physical literacy of adolescents aged 18–12 years and the results are consistent with one of the existing standard tools, measuring same structure as physical literacy.

The standard tools available in the physical literacy field are limited to 2 tools, the first of which is the PPLI designed by Sum [14] for teachers. The questionnaire designed by Sum [14] had several shortcomings. First, the initial purpose of designing PPLI is to assess the teachers' perceived physical literacy, and it does not consider the characteristics of adolescents (such as psychological characteristics, knowledge, and awareness). Second, this questionnaire has difficulty considering the various dimensions of physical literacy concept, such as physical dimension, activity, motivation.

Accordingly, it seems that the PPLI questionnaire does not have a suitable narrative for measuring adolescents' physical literacy in terms of general content because of these two shortcomings. Compared with the Sum model (2016), the present questionnaire (the 3-dimensional questions identified in appendix) is more comprehensive and integrated. The questionnaire designed in the present study had a comprehensive approach to the concept and various dimensions of physical literacy, looking at the target community of adolescents in all stages of design (literature studies + interviews with experts) and psychometric evaluation. This tool was thoroughly screened for qualitative and quantitative analysis during different stages of qualitative face validity, quantitative face validity, qualitative content validity, quantitative content validity, structural validity, internal consistency, and retest reliability. Moreover, a review of the various questions included in the questionnaire in different physical literacy dimensions shows that this tool does not have the shortcomings of the Sum [14] questionnaire and is a suitable and approved tool to assess adolescent physical literacy.

Another standard tool is the Canadian Physical Literacy Assessment (CAPL-2), designed for Canadian children at the age range of 8–12 Years [17]. This instrument assesses 4 domains (daily behavior, motivation and confidence, physical competence, and knowledge and understanding) of physical literacy [15, 16]. Most of the features evaluated in the CAPL tool through cognitive and psychological dimensions have also been examined in the present questionnaire. However, application of the questionnaire in children aged 8–12 years seems a little complicated. According to

the aimed population, adolescents aged 12–18 years seem to respond more accurately to the individual's age. Also, the physical instruments of the CAPL may provide more accurate results on daily activities and physical fitness, but requires a specialist examiner and long-term application (1 week) making it difficult to use. However, given the proper understanding of adolescents about the levels of daily physical activity and physical competencies, the use of the designed tools seems logical and valid in the present study. On the other hand, it is easy to use and does not require a long time and a particular examiner; thus, APLQ seems to be a more efficient and facile self-assessment tool in adolescents.

Conclusion

The present study is unique because it seeks to assess the adolescents' physical literacy. Furthermore, its items are designed based on literature review and interviews with experts looking at the target population of adolescence, which distinguishes it from other similar studies. In summary, the research findings identified a 25-item questionnaire during factor analysis with 3 dimensions of physical competence and activity, knowledge and awareness, and psychological and behavioral, confirmed by the CFA of this 3-factor model. Results also showed that Adolescent Physical Literacy Questionnaire (APLQ) has good validity and reliability and can be used as a self-assessment and facile tool to assess adolescents' physical literacy.

This study suffered limitations as it was impossible to check the questionnaire's concurrent validity with CAPL and other standard physical fitness and physical activity tools due to the COVID-19 pandemic and its related restrictions. It is suggested that researchers should examine the alignment of this questionnaire with standard physical competence tools and examine the physical literacy of individuals in normal living conditions of citizens after overcoming the limitations of the COVID-19 pandemic in future. Given that the tools designed in this study are explicitly approved for adolescents, teachers, educators, and parents can use them to assess adolescents' physical literacy in various dimensions and take the necessary measures to improve their physical literacy.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11332-021-00818-8.

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Declarations

Conflict of interest No potential conflict of interest was reported by the authors. This study did not have any financial support or funding.

Ethical approval This research was conducted for a Ph.D. thesis and approved by the Ethics Committee (IR.UT.SPORT.REC.1398.060). The study was performed under the ethical standards as laid down in the 1964 Declaration of Helsinki and its later ethical standards. Written informed consent was obtained from the parents.

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