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An empirical investigation of physical literacy-based adolescent health promotion

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Abstract

A reexamination of the health problems of Chinese adolescents based on the concept of physical literacy (PL) was necessary. Through the use of follow-up data collected from the China Education Panel Survey 2014–2015, the main factors affecting the health of adolescents were identified, and possible explanations were investigated after cluster and inductive analyses were conducted. The results showed that (1) the 10 main factors identified as affecting adolescent health promotion are in line with the four main elements of PL (emotional, cognitive, social and physical elements) and (2) the three major categories of influencing factors identified through a cluster analysis were aligned with the three main factors of PL (endogeneity, fundamentality and permeability). These findings suggest that the factors influencing adolescent health promotion are closely associated with PL. The study results can provide empirical evidence for adolescent health promotion research and a reference for the development of evidence-based PL training models.

Keywords: adolescents, health promotion, physical literacy, logistic regression, cluster analysis

1 Introduction

To help countries worldwide deal with health crises (World Health Organization (WHO), 2002), British educator Margaret Whitehead proposed the concept of physical literacy (PL), which is based on the philosophical theory of body-mind monism (Whitehead, 2010). The International Physical Literacy Association (IPLA) defines PL as ‘the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activity for life’. Different from physical education and physical ability development (even simple participation in physical activity), the concept of PL, in terms of the pursuit of a healthy lifestyle, has broader and more complete meanings (International Physical Literacy Association (IPLA), 2016). As a concept, PL has been disseminated and accepted worldwide, and it has been introduced in empirical research (Delaney et al., 2008; Schools and Physical Activity Task and Finish Group, 2013; Tremblay, 2012; Almond, 2013; Wang et al., 2005; Moreno, 2013; Alagul et al., 2012; Macdonald et al., 2014; Corbin, 2016).

Many countries, such as the United Kingdom, the United States, Canada, New Zealand, and Australia, have applied the concept of PL at the national level, even using it as a basis for sports policies (Warburton et al., 2006). Helping adolescents develop a healthy lifestyle is an important component of physical education, and the physical fitness of students should be incorporated into the assessment system of government bodies, education administration departments and schools so that an adolescent sports promotion plan can be fully implemented. PL is a crucial guiding ideology for the reform and development of China's physical education policy. The aim of implementing PL policies is to replace the instrumental view of physical activity with a subjective one and change the approach of passive participation for survival into one of active participation in pursuit of improved quality of life; the goal is to reverse the declining tendency to engage in physical activity worldwide and improve human health (Ren, 2018). A review of the literature revealed that adolescent PL is strongly associated with physical activity, an important factor affecting the health of adolescents. Its importance has led to sports-related research devoting increased attention to PL in recent years.

The research of Chinese scholars in this area has mainly focused on PL interpretation (Ren, 2018; Gao and Lu, 2019), reviews of the developmental status, evolution, and trends of international PL studies (Wang, 2019; Zheng et al., 2020; Yan et al., 2020), and the presentation of results and related findings (Chen et al., 2019; Yang, 2019). However, few empirical studies on PL have been conducted. In the Outline for Building a Leading Sports Nation, goals related to students' physical health and PL were established to promote adolescents' physical activity; in the document, PL is considered to be 'a concept guide' and 'a way of promoting national fitness programmes and adolescent sports development'. From a review of research on adolescent health promotion in China, it is evident much practical work has been conducted. However, the factors influencing adolescent health promotion and the design of interventions have been insufficiently studied; this is, to some extent, related to an absence of theories (Hu and Yu, 2019; Wangfu, 2019). For this reason, the health problems of Chinese adolescents should be reexamined based on the concept of PL. Whether the factors influencing adolescent health promotion are closely associated with PL and whether PL plays a positive role in improving the physical activity of adolescents, thereby improving their health, are topics worth exploring. First, in this study, factors influencing adolescent health promotion were identified using CEPS data (CEPS, 2014–2015), and the potential relationship between health promotion and PL was investigated. The aim was to add empirical evidence to the body of health promotion research and provide a reference for those developing evidence-based PL training models.

2 Methodology

2.1 Data source

The CEPS is a nationally representative large-scale follow-up survey designed and implemented by the National Survey Research Center of Renmin University of China. The project aims to reveal the effect of families, schools, communities and macrolevel social structures on the educational output of individuals and explore the process of educational output in an individual's life course. With the 2013–2014 school year as the baseline and first- (grade 7) and third-grade (grade 9) junior high school students as the two study cohorts, data were collected from 28 county-level units (counties, districts, and cities) randomly selected as survey points. From the county-level units, 488 classes in 112 schools were randomly selected as the basis for survey implementation, and all students in these classes were sampled. For the survey, a multistage probability proportional to scale sampling method was employed: In Stage I, (primary sampling units), 28 counties (districts) were sampled from the county (district)-level administrative units across China; in Stage II (secondary sampling units), the seventh-grade and/or ninth-grade students of four schools were sampled from the geographic area under the jurisdiction of each sample county (district); in Stage III (tertiary sampling units), four classes (two seventh-grade classes and two ninth-grade classes) were sampled from each sample school; in Stage IV, all students in the sample classes made up the final survey sample. The questionnaires were self-administered, and the response rate was 91.9%.

2.2 Data processing methods

CEPS follow-up data for 2014–2015 were downloaded and imported into Excel for sorting, and the sorted data were imported into SPSS version 23.0 for statistical analysis. The concept of wellness, whether it relates to PL or health promotion, is related to overall health. The health triangle is formed by physical, psychological, and social adaptation factors. Factors influencing mental health include stress, relationships with others, hobbies, psychological quality, and health education knowledge. Factors influencing physical health include physical exercise, family financial situation, sleep quality, physical condition, and health knowledge. Societal adaptation is influenced by factors such as self-confidence, interpersonal relationships, and emotional regulation ability. Based on these influencing factors, 19 of the most representative questions were extracted from the questionnaire: A29 (What do you think about this expectation?), A5 (Are you the only child in your family?), A8 (What is the marital status of your biological parents?), A17 (How would you describe the relationship between your parents?), C19 (Do you have the following sleep problems under normal circumstances?), B12 (Do you have any hobbies?), C26 (Do you agree that you can quickly adjust to the above emotions?), C21 (Have you ever attended health education classes in junior high school?), B8 (Do you usually complete homework assigned by teachers on weekends?), C20 (Did you attend health education classes in elementary school?), B16 (What is your means of transportation between home and school?), C13 (How often and for how long do you engage in physical activity: [] days a week, [] minutes a day?), A9 (What do you think of your family's current financial situation?), C5 (Have you often fallen ill in the past year?), C1C2 (What are your height and weight measurements? [] cm, [] kg), B21 (Are you confident about your future?), A9 (What do you think of your family's financial situation?), B6 (Do you agree that the people in this school are kind to you?), and C4 (How is your overall health?).

A total of 17 independent variables (or predictive factors) were included in the research model: whether a child is an only child, parental marital status, family financial situation, parents' expectations regarding their children's education, the degree of closeness to teachers or students, time spent doing schoolwork, whether a child has hobbies, means of transportation to school, degree of confidence about the future, whether a child has been sick in the past year, whether a child has sleep problems, whether a child attended health education classes in elementary school, whether a child has attended health education classes in junior high school, emotional adjustment speed, weekly physical activity frequency and time, and BMI.

A single-factor analysis was adopted to analyse the 17 factors that may affect adolescent health. Then, logistic regression was applied to identify the factors substantially affecting adolescent health. The factors identified were classified and summarised. A comparison of the two groups of measurement data was performed using a one-way t-test, and a comparison of the two groups of count data was performed using a one-way chi-squared test. Binary logistic regression was used to investigate the main factors affecting adolescent health, and a systematic cluster analysis was used to perform index classification.

3 Analysis of results

3.1 Preliminary exploration of factors affecting adolescent health

As stated, 17 independent variables (or predictive factors) were included in the research model. A one-way chi-squared test or t-test was conducted to analyse these factors, and the results are shown in Table 1.

Table 1 Screening of possible factors affecting adolescent health.

Possible factors	Grouping	Physical conditions		Chi-square/t	P
		Grouping (n)	Good (n)		
The only child in the family or not	Yes	1127	2407	24.282	0.000
	No	1612	2720		
The marital relationship of parents-married or not	No	279	329	35.562	0.000
	Yes	2460	4798		
Family financial conditions	Very deprived	88	106	194.411	0.000
	Deprived	466	468		
	Medium	1998	3805		
	Rich	178	699		
	Very rich	9	49		
Relationship between parents	Good	2356	4751	90.543	0.000
	Not good	383	376		
	No pressure	170	340		
Parental expectations in education	Little pressure	818	1772	36.853	0.000
	Medium pressure	825	1550		
	Much pressure	642	1093		
	Tremendous pressure	284	372		
Do you agree that the people in this school are kind to you	Not at all	266	278	243.753	0.000
	Not agree	699	799		
	Agree	1164	2221		
	Totally agree	610	1829		
	No	91	110		
The time to do schoolwork on weekends	Less 2 h	826	1464	29.149	0.000
	2–4 h	1093	2273		
	4–6 h	472	905		
	6–8 h	164	237		
	8 h or more	93	138		
Whether to have hobbies,	No	2329	4598	36.737	0.000
	Yes	410	529		
Means of transportation from home to school	By walk	983	1776	4.753	0.093
	By bike	406	855		
	Others	1350	2496		
Degree of confidence in the future	Not at all	61	25	393.612	0.000
	Less confident	620	541		
	Confident	1506	2659		
	Very confident	552	1902		
Whether to have sickness in the past year	No	119	762	632.255	0.000
	Seldom	2117	4184		
	Often	503	181		
Whether to have sleep problems	No	1554	1897	282.378	0.000
	Yes	1185	3230		
Whether to have attended health education classes in elementary school	Yes	1641	3534	64.490	0.000
	No	1098	1593		
Whether to have attended health education classes in junior high school	Yes	1630	3336	23.682	0.000
	No	1109	1791		
	Not at all	151	183		
Do you agree that you can quickly adjust your emotions?	Not agree	786	759	378.675	0.000
	Agree	1262	2247		
	Totally agree	540	1938		
	0–180	2193	3642		
Weekly physical activity time	181–360	421	1077	81.152	0.000
	361–540	67	246		
	541–	58	162		
BMI		2739	5127	0.059	0.953
		19.12±3.45	19.12±3.21		

Note: It is statistically significant when $P \leq 0.05$.

As illustrated in Table 1, preliminary statistics showed that of the 17 factors, 15 were statistically significant ($P \leq 0.05$). These factors were whether a child was an only child, parental marital status, family financial situation, relationship between parents, parents' expectations regarding their children's education, closeness to teachers or students, time spent doing schoolwork on weekends, whether a child has hobbies, degree of confidence about the future, physical condition in the past year, whether a child has had sleep problems, whether a child attended health education classes in elementary school, whether a child has attended health education classes in junior high school, emotional adjustment speed, and weekly physical activity time; as factors, means of transportation to school and BMI were not statistically significant ($P > 0.05$).

3.2 Main factors affecting adolescent health and their importance

Because the 15 influencing factors may interact with each other and become confounding factors, binary logistic regression was conducted to identify the true influencing factors. The results are shown in Tables 2-6.

Table 2 Omnibus test of binary logistic regression model coefficients.

	Step	Chi-square	DOF	Significance
10	Step	12.489	3	0.006
	Block	1464.421	22	0.000
	Model	1464.421	22	0.000

Note: Statistical significance is denoted by $P \leq 0.05$.

Table 3 Explained variance of the binary logistic regression model.

Step	-2 Log-likelihood	Cox and Snell R-square	Nagelkerke R-square
10	8703.641a	0.170	0.234

Table 4 Accuracy of the binary logistic regression model.

Step	Actual measurement	Prediction			
		Binary overall health condition			Percentage of correction
		Poor	Good		
10	Binary overall health condition	Poor	1081	1658	39.5
		Good	560	4567	89.1
	Overall percentage				71.8

Note: Statistical significance is denoted by $P \leq 0.05$.

The binary logistic regression results were statistically significant ($\chi^2 = 1464.421$, $P < 0.0005$), meaning the model was appropriately constructed.

As illustrated in Table 3, the model explained 23.4% of the variance in participants' answers in terms of whether they were healthy.

As illustrated in Table 4, the sensitivity, specificity, positive predictive value, and negative predictive value of the model were 89.1%, 39.5%, 73.36% and 65.87%, respectively.

Table 5 Identification of the main factors affecting adolescent health and their importance.

Variables	B	Standard error	Wald	DOF	Significance	Exp(B)	95% confidence interval of EXP(B)	
							Lower limit	Upper limit
Marital status of your parents (married)	0.361	0.094	14.612	1	0.000	1.434	1.192	1.725
What do you think of your family's current financial situation			64.750	4	0.000			
What do you think of your family's current financial situation (1)	-1.033	0.436	5.619	1	0.018	0.356	0.152	0.836
What do you think of your family's current financial situation (2)	-1.143	0.411	7.713	1	0.005	0.319	0.142	0.714
What do you think of your family's current financial situation (3)	-0.746	0.406	3.377	1	0.066	0.474	0.214	1.051
What do you think of your family's current financial situation (4)	-0.250	0.414	.365	1	0.546	0.779	.346	1.754
I feel close to the people in this school			38.635	3	0.000			
I feel close to the people in this school (1)	-0.400	0.112	12.738	1	0.000	0.671	0.538	0.835
I feel close to the people in this school (2)	-0.468	0.079	35.311	1	0.000	0.626	0.537	0.731
I feel close to the people in this school (3)	-0.190	0.066	8.259	1	0.004	0.827	0.726	0.941
Do you have any hobbies?	-0.318	0.079	16.357	1	0.000	0.728	0.624	0.849
Are you confident about your future?			117.255	3	0.000			
Are you confident about your future? (1)	-1.703	0.266	40.889	1	0.000	0.182	0.108	0.307
Are you confident about your future? (2)	-0.816	0.085	91.299	1	0.000	0.442	0.374	0.523
Are you confident about your future? (3)	-0.393	0.064	37.439	1	0.000	0.675	0.595	0.766
Have you often been ill in the past year?			394.639	2	0.000			
Have you often been ill in the past year? (1)	2.644	0.138	365.791	1	0.000	14.069	10.730	18.448
Have you often been ill in the past year? (2)	1.552	0.096	263.364	1	0.000	4.720	3.913	5.692
Do you have the following sleep problems? (No sleep problems)	0.503	0.053	89.835	1	0.000	1.653	1.490	1.834
Did you attend health education classes in elementary school?	-0.177	0.055	10.315	1	0.001	0.838	0.752	0.933
Usually, I can adjust my emotions quickly			90.117	3	0.000			
Usually, I can adjust my emotions quickly (1)	-0.481	.137	12.228	1	0.000	0.618	0.472	0.810
Usually, I can adjust my emotions quickly (2)	-0.749	0.079	89.444	1	0.000	0.473	0.405	0.552
Usually, I can adjust my emotions quickly (3)	-0.396	0.067	35.290	1	0.000	0.673	0.591	0.767
Weekly physical activity time	-0.273	0.116	5.597	1	0.018	0.761	1.048	1.648
Constant	0.635	0.455	1.945	1	0.163	1.887		

Note: Statistical significance is denoted by $P \leq 0.05$.

As illustrated in Table 5, 10 variables were statistically significant ($P \leq 0.05$) in the model, and they were the main factors affecting adolescent health. These variables were parental marital status, family financial situation, closeness to teachers or students, whether a child has hobbies, degree of confidence about the future, physical condition in the past year, whether a child had sleep problems, whether a child attended health education classes in elementary school, emotional adjustment speed, and weekly physical activity time. In order of importance, the influencing factors are as follows: physical condition in the past year, whether a child has hobbies, degree of confidence about the future, family financial situation, and emotional adjustment speed.

As illustrated in Table 6, five variables were not included in the binary logistic regression equation: whether

Table 6 Variables omitted from the binary logistic regression equation

Variables	Score	FOD	Significance
Are you the only child in your family?	0.046	1	0.830
How is the relationship between your parents?	3.205	1	0.073
What do you think of the expectation?	9.036	4	0.060
What do you think of the expectation? (1)	2.082	1	0.149
What do you think of the expectation? (2)	2.413	1	0.120
What do you think of the expectation? (3)	5.513	1	0.019
What do you think of the expectation? (4)	1.015	1	0.314
Time spent doing schoolwork per day on weekends	6.906	5	0.228
Time spent doing schoolwork per day on weekends (1)	0.170	1	0.680
Time spent doing schoolwork per day on weekends (2)	0.004	1	0.947
Time spent doing schoolwork per day on weekends (3)	2.520	1	0.112
Time spent doing schoolwork per day on weekends (4)	0.014	1	0.906
Time spent doing schoolwork per day on weekends (5)	3.637	1	0.057
Have you ever attended a health education class in junior high school?	0.056	1	0.813
Total	19.125	12	0.086

a child is an only child, relationship between parents, parents' expectations regarding their children's education, time spent doing schoolwork on weekends, and whether a child attended health education classes in junior high school.

3.3 Cluster analysis of the main factors affecting adolescent health

Ten main variables were selected for the model, these are parental marital status, family financial situation, whether a child attended health education classes in elementary school, closeness to teachers or students, whether a child has sleep problems, whether a child has hobbies, weekly physical activity time, physical condition in the past year, degree of confidence about the future, and emotional adjustment speed. In the model, these factors appeared to be scattered with little connection and could not be explained on a practical level. For this reason, further index clustering of these 10 factors was performed through a cluster analysis, and an attempt was made to explain the results.

As illustrated in Figure 1, the factors affecting adolescent health can be divided into three categories: category I (parental marital status, whether a child has had sleep problems, whether a child has hobbies), category II (whether a child attended health education classes in elementary school, weekly physical activity time, physical condition in the past year), and category III (family financial situation, degree of confidence about the future, emotional adjustment speed, and closeness to teachers or students). Parental marital status affected the sleep quality and hobbies of adolescents; whether adolescents attended health education classes in elementary school affected their weekly physical activity time and physical conditions in the past year; and family economic conditions affected their confidence about the future and emotional adjustment speed, which in turn affected their adjustment in society (closeness to teachers or students). These three-factor categories can be summarised as endogenous (motivation), fundamental (physical ability), and permeable (confidence); these factors independently affect the health of adolescents. This categorisation is consistent with the main dimensions of PL proposed by Whitehead (Whitehead, 2010): motivation, confidence, physical ability, knowledge, and understanding.

Fig. 1 Cluster analysis of factors affecting adolescent health.

4 Discussion

4.1 Research ideas

Based on an extensive review of the literature and expert argumentation, 17 factors were initially identified that may affect the health of adolescents. Empirical research revealed that of these factors, 15 were statistically significant in a single-factor statistical analysis and two were nonsignificant. Then, using a binary logistic regression equation, multifactor analyses were conducted to remove confounding factors; 10 factors remained that directly affected the health of adolescents. Next, a cluster analysis was performed for these 10 influencing factors, and they were categorised into three groups.

4.2 Core components and characteristics of PL and empirical findings

International scholars have attempted to identify the factors influencing PL from various perspectives. PL can be influenced by the self, parents and other family members, teachers or coaches, peers, and others. A child's PL can be affected by their household, community, school, and other environments. PL is affected by diet, sleep, psychological status, lifestyle, physical activity, interpersonal relationships, physical fitness, motor skills, and other factors (Corbin, 2016; Robinson and Randall, 2017). Whitehead (2010) stated that motivation, confidence, physical ability, knowledge, understanding and effective interaction with one's environment are the core elements that constitute PL, and they complement each other. Motivation promotes participation, which enhances a person's confidence and physical ability. This in turn maintains or enhances a person's motivation. Enhancements in confidence and physical ability can promote smooth interactions in various environments. Positive environmental interactions and taking on new challenges can in turn enhance a person's confidence and physical ability. In this study, we classified the factors influencing PL through a cluster analysis, and the factors were consistent in terms of endogeneity, fundamentality, and permeability, as proposed by Ren (2018). Variables in categories I, II, and III were respectively the endogenous, fundamental, and permeable factors related to PL.

Canada is the first country in which PL was examined and where related research was applied in practice. According to the IPLA's definition (International Physical Literacy Association (IPLA), 2016), PL has emotional (motivation and confidence), physical (physical ability), cognitive (knowledge and understanding) and behavioural (in terms of participation in physical activity for life) elements, and they are all interrelated (Can-

dian Sport for Life (CS4L), 2016; Ren, 2018). Through a binary logistic regression, 10 main factors affecting adolescent health were identified, and they can be classified based on their relation to these elements. Specifically, parental marital status, closeness to teachers or students, whether a child has hobbies, and the degree of confidence about future are emotional elements; family financial situation, physical condition in the past year, and whether a child has had sleep problems are physical elements; whether a child attended health education classes in elementary school and emotional adjustment speed are cognitive elements; and weekly physical activity time is a behavioural element. In the next section, we discuss these four elements separately.

4.2.1 Emotional elements

Emotional elements provide the motivation and sense of value (confidence) that drive individuals to participate in physical activity (De Rossi et al., 2012). Motivation is an internal force that drives individuals to participate in physical activity. Diversified physical activity experiences contribute to positive self-value, including self-esteem and self-confidence (Belanger et al., 2016; Silverman et al., 2015; Whitehead, 2001). Sufficient participation in physical activity promotes individual mental health and plays a positive role in emotion management (Peluso, 2011), thereby improving self-value. Individuals with high self-value are more inclined to engage in adequate physical activity (Whitehead, 2013).

Studies have revealed that the physical activity of people in different age groups is positively correlated with their level of motivation (Brunet et al., 2011). Children and adolescents mainly engage in physical activity at their homes (Edwardson et al., 2010). The motivation to engage in physical activity mainly comes from the individuals themselves and their families. Parental child-rearing styles have a direct effect on adolescents' development of interests and hobbies; these in turn produce motivation (Zuo Azhu et al., 2016). This study revealed that parental marital status, the relationship between parents, parents' expectations regarding their children's education, and whether a child is an only child significantly promoted the PL of adolescents, and these factors had interaction effects. However, adolescents whose parents were unmarried (divorced or widowed) had slightly better physical health than those whose parents were married. This may be associated with the widowed parenting phenomenon discussed in family education (Chen Yu, 2019); a nominal father or mother may cause disharmony in the conjugal relationship, which is harmful to the growth of children. Being an only child and parental marital status also affected the physical health of adolescents; these findings echo those of Guo Zhiyong et al. (Guo Zhiyong et al., 2017). It has been said that interest is the best teacher. Adolescents with diverse interests and hobbies have better physical health than those who do not. Hobbies affect the motivation to relieve stress through exercise (Li Ying, 2019). Many parents tend to arrange various tutorials for cultural courses for teenagers in the hope of improving their grades and relieving the pressure on them to do well. The interests and hobbies of adolescents are sometimes considered by their parents to be irrelevant distractions, resulting in many adolescents not pursuing hobbies. Home is the source of adolescents' safety, and it is where they develop their behaviours and concepts. Thus, parents should adjust their mentality, place reasonable expectations upon their children, and help them reduce pressure on themselves and pursue hobbies. Apart from vocalised care and encouragement, parents should set an example for their children by taking part in related activities (Chen Peijie, 2018).

Confidence is a crucial factor affecting the health of adolescents. Confident people tend to have good relations with others and satisfactory social adaptation ability. This study revealed that the physical health of adolescents with a high confidence level about their future was 5.494 times better than that of children with a complete lack of confidence. Adolescents' self-confidence is positively related to their overall physical activity level (Bandura, 1998) and physical health. Therefore, parents with low socioeconomic status can redouble their efforts to promote their children's self-confidence from an early age and give them affirmation and encouragement.

4.2.2 Physical elements

Physical elements contribute to the development of individual sports skills. Adolescents who did not report falling ill in the past year had 14.069 times better health than those who frequently fell ill. Adolescents' physical

health is affected by their physical condition; this is consistent with the findings of international scholars that a person with health problems in childhood is more likely to have ill-health in adulthood (Quartly-Scott et al., 2019). Adolescents who did not report being ill in the past year may have been in good health either due to genetic influences or favourable exercise habits. Insomnia is a serious problem for many adolescents, and it is often associated with poor physical and mental health (Quartly-Scott et al., 2019).

This study revealed that adolescents with sleep problems had worse physical health than those without such problems. Rapid economic and social changes have placed tremendous pressure on adolescents, and the high expectations of their parents regarding education have increased this pressure. Pressure from both society and parents may lead to adolescents developing insomnia, which harms their health. For adolescents, high expectations regarding educational achievement do not contribute positively to their health. Excessive or insufficient parental expectations regarding education can adversely affect adolescents' academic achievements (Li, 2019). Family financial situations affect the physical level of adolescents, but this result is not consistent for both children and adolescents. Our results suggested that a family's financial situation plays a positive and significant role in promoting adolescents' physical health; adolescents whose family's financial situation could be described as adequate had the best physical health, and those whose family financial status could be described as relatively low (but not the lowest) had the poorest physical health. This finding conflicts with previous research. Hu and Yu (2019) concluded that a family's socioeconomic status had a positive and significant effect on middle school children's time spend engaging in physical exercise. Adolescents from families of an extremely low socioeconomic status tend to become independent relatively early and engage in more physical labour such as housework, warding off obesity. Adolescents from families with a relatively low socioeconomic status may have adverse health status due to a lack of health awareness.

Adolescents' physical activity pursuits tend to be informal in nature, with costs rarely incurred; thus, adolescents from a family with an extremely low socioeconomic status are not hindered from participating in sports activities. However, most physical activities performed by adolescents in China are related to formal skill-learning courses, which may mean that such activities have a higher financial cost (Ferreira et al., 2016). This may explain why adolescents from families with the highest socioeconomic status had the best health conditions.

4.2.3 Cognitive elements

Cognitive elements concern individuals' perception of physical activity, healthy living, the environment, as well as their understanding of health-related knowledge. Cognition is important because it relates to a person's recognition and understanding of cultural values (Corlett and Mandigo, 2013). Through engagement in physical activity, adolescents seek harmony with their environment and begin to comprehend the meaning of life (Brunet et al., 2011). Cognition affects individuals' perception of their environment; this perception is a precondition for individuals to predict their physical activity needs and respond to such needs in a creative manner (Whitehead, 2010).

This study revealed that attending health education classes in elementary and junior high school is positively correlated with the physical health of adolescents. However, attending health education classes in junior high school was not included in the logistic regression equation; this may have been due to its interaction with other factors or its role being offset by other factors. According to Hu and Yu (2019), health education courses have a positive and significant effect on middle school students' time spent engaging in physical activity. However, no study has indicated that health education in elementary school is important for adolescents to develop health and fitness knowledge (Li, 2019). It is necessary to implement intervention measures as early as possible, starting from elementary school or even before school, to promote the physical health of adolescents.

In China, current physical education curricula for elementary school students attach little importance to the dissemination of health knowledge; this runs contrary to the development of students' health concepts, and it may lead to adolescents failing to develop correct health concepts and awareness of fitness, which could, in turn, result in adolescents having significantly worse physical health than primary school students. International scholars have indicated that children's and adolescents' physical activity levels decrease with age (Telama, 2009). Emotion, a collective term for a series of subjective cognitive experiences, relates to individuals' attitudes

and corresponding behavioural responses to objective phenomena. Furthermore, emotions are psychological processes mediated by individual desires and needs. The cognitive theory of emotion is rooted in psychology; proponents claim that emotions arise from the evaluation of stimuli or phenomena. Sun (2005) considered emotional regulation to be the foundation of positive mental health, and Xing and Hu (2008) asserted that most physical diseases are caused by negative emotions. The period of adolescence is characterised by mood swings, impulsive behaviour, and sensitivity. During adolescence, self-awareness develops rapidly, but behavioural control has a slower development process. Adolescents' emotional adjustment speed has a crucial effect on their health promotion.

4.2.4 Behavioural elements

Behavioural elements relate to individuals taking responsibility for their physical activity. During an individual's life course, they can voluntarily participate in physical activity regularly and make it an important part of their lifestyle (Ren, 2018; Tremblay et al., 2018). Exercise is medicine. Sports play an irreplaceable role in promoting the growth and development of adolescents. Research has repeatedly shown that physical exercise improves strength, balance, flexibility, and the durability of nerve cells. Physical exercise can also enhance an individual's ability to fight certain diseases. For adolescents, physical activity also has mental health benefits. According to Fang and Guo (2019), physical exercise plays a critical role in helping Chinese urban and rural residents resist depression. Furthermore, it is thought to improve adolescents' ability to resist stress in life as well as promote their mental health and interpersonal relationships. Time spent engaging in physical exercise is positively correlated with people's endurance in terms of psychological stress and mental health setbacks.

The results of this study suggest that weekly physical activity time has a significant and positive effect on the physical health of adolescents; the longer adolescents spend engaging in physical activity each week, the healthier they are. For today's adolescents, who generally have a sedentary lifestyle, engagement in any type of physical activity is crucial for health promotion. Adolescents need not focus solely on total exercise time. As long as adolescents engage in physical activity of some sort, it is still beneficial to physical health. This finding conflicts with the results of many studies, but it is consistent with the research result obtained by Chen (2019). A regular exercise habit is more important than total exercise time for adolescents' physical health. Therefore, adolescents must develop good exercise habits. Studies have shown that continual action for at least 2 months is required for people to form a particular habit. However, because adolescents tend to lose their interest in an activity after a period of exposure, it is challenging for them to perform sufficient and regular physical activity such that they form a habit of it; thus, long-term interventions may be required. For this reason, our future research will focus on the cultivation of adolescents' exercise habits.

5 Summary and suggestions

Hierarchical analyses of the main components of PL (motivation, confidence, emotion, physical ability, knowledge, understanding, cognition, and physical activity for physical and mental health) were conducted, and the results revealed the top 10 factors affecting adolescents' physical health, which can be categorised based on four distinct elements. Emotional elements are parental marital status, closeness to teachers or students, whether a child has hobbies, and the degree of confidence about the future; physical elements are family financial situation, physical condition in the past year, and whether a child has had sleep problems; cognitive elements are attending health education classes in elementary school and emotional adjustment speed; and weekly physical activity time is a behavioural element.

In addition, the three factors (endogeneity, fundamentality, and permeability) affecting adolescent health summarised in this study through a cluster analysis are in line with the three main characteristics of PL proposed by Ren (2018). Parental marital status, whether a child has had sleep problems, and whether a child has hobbies are endogenous factors of PL; attending health education classes in elementary school, weekly physical activity time, and physical conditions in the past year are fundamental factors; and family financial situation, degree of

confidence about the future, emotional adjustment speed, and closeness to teachers or students are permeable factors.

Through data analysis and data mining, we verified the research hypothesis that the factors affecting the health promotion of adolescents are closely associated with the concept of PL. This finding serves as a reminder that adolescent health promotion research, if based on PL, should have clear theoretical underpinnings, rendering the design of relevant interventions more precisely targeted and more effective. Regarding the effectiveness of PL in improving the physical activity levels of adolescents, further empirical research must be conducted to provide references for the development of evidence-based PL training models.

References

- [1] Alagul, O., Gursel, F. and Keske, G. (2012) Dance unit with physical literacy. *The Procedia - Social and Behavioral Sciences*, 47, 1135-1140.
- [2] Almond, L. (2013) What is the relevance of physical literacy for adults? *ICSSPE: Bullentin Journal of Sport Science and Physical Education*, 65, 14-22.
- [3] Bandura, A. (1998) Health promotion from the perspective of social cognitive theory. *Psychology Health*, 13, 623-649.
- [4] Chen, P. (2018) Report on Physical Activity and Fitness in China: The Youth Study 2016. Science Press, Beijing.
- [5] Chen, S., Yang, L., Yan, T., Yujun, C. and Chen, P. (2019) Current situation, challenges and future of physical literacy measurement and evaluation. *Journal of Physical Education*, 26, 110-117.
- [6] Chen, Y. (2019) Analysis of the transformation of psychological problems of college students grown up in a "widowed" child-rearing education environment. *Education Modernization*, 6, 291-292.
- [7] Corbin, C.B. (2016) Implications of physical literacy for research and practice: A commentary (review). *Research Quarterly for Exercise and Sport*, 87, 14-27.
- [8] Corlett, J. and Mandigo, J. (2013) A day in the life: Teaching physical literacy. *Physical Health in Education*, 78, 18.
- [9] Delaney, B., Donnelly, P., News, J. and Haughey, T. J. (2008) Improving Physical Literacy. Sport Northern Ireland, Belfast.
- [10] Fang, L. and Guo, J. (2019) Does physical activity promote health equity? –Effect of physical activity on the residents' depression in China. *China Sport Science*, 39, 65-74.
- [11] Ferreira, I., Van Der Horst, K., Wendel-Vos, W., Kremers, S., van Lenthe, F. J. and Brug, J. (2006) Environmental correlates of physical activity in youth: A review and update. *Obesity Reviews*, 8, 129-154.
- [12] Gao, H. and Lu, C. (2019) Constitutive elements of physical literacy and its theoretical value. *China Sport Science*, 39, 92-97.
- [13] Guo, Z. and Sun, D. (2017) Investigation on the physical condition of adolescent students in different urban areas of Xi'an and its influencing factors. *Journal of Xi'an Institute of Physical Education*, 34, 221-225.
- [14] Hu, P. and Yu, F. (2019) A study about the restrictive factors on physical exercise of the middle school students –An HLM model based on CEPS (2014-2015) data. *China Sport Science*, 39, 76-84.
- [15] Li Ying. The Influence of Sports in Senior High School Entrance Examination on Junior Middle School Physical Education [D]. Xi'an Institute of Physical Education, 2019.
- [16] Macdonald, D., Abbott, R., Hunter, L., Hay, P. and McCuaig, L. (2014) Physical activity academic achievement: Student and teacher perspectives on the new nexus. *Physical Education and Sport Pedagogy*, 19, 436-449.
- [17] Moreno, T. (2013) American physical education: A discursive essay on the potential unifying role of physical literacy in the United States. *ICSSPE: Bullentin Journal of Sport Science and Physical Education*, 65, 371-377.
- [18] Quartly-Scott, G. I., Miller, C. B., Hawes, D. J. (2019) A brief behavioral treatment for unresolved insomnia in adolescents: A single-case multiple baseline pilot study, evaluating self-reported outcomes of efficacy, safety, and acceptability. *Journal of Clinical Sleep Medicine*, 16, 97-105.
- [19] Ren, H. (2018) Physical literacy: A concept to integrate sport reforms and developments in contemporary era. *China Sport Science*, 38, 3-11.
- [20] Robinson, D. B. and Randall, L. (2017) Marking physical literacy or missing the mark on physical literacy? A conceptual critique of Canada's physical literacy assessment instruments. *Measurement in Physical Education and Exercise Science*, 21, 40-55.
- [21] Schools and Physical Activity Task and Finish Group. (2013) Physical Literacy an All-wales Approach to Increasing Levels of Physical Activity for Children and Young People. Crown, Cardiff.
- [22] Sun, X. (2005) Mood Fluctuations and Health. People's Military Medical Publishing House, Beijing.
- [23] Telama, R. (2009) Tracking of physical activity from childhood to adulthood: A review. *Obesity Facts*, 2, 187-195.
- [24] Tremblay, M. (2012) Major initiatives related to childhood obesity and physical inactivity in Canada: The year in review. *Canadian Journal of Public Health*, 103, 164-169.

- [25] Tremblay, M., Costas-Bradstreet, C., Barnes, J., Bartlett, B., Dampier, D., Lalonde, C. et al. (2018) Canada's physical literacy consensus statement: Process and outcome. *BMC Public Health*, 18, 1034.
- [26] Wang, F., McDonald, T., Reffitt, B. and Edington, D. W. (2005) BMI, physical activity, and health care utilization/costs among medicare retirees. *Obesity Research*, 13, 1450-1457.
- [27] Wangfu, B. (2019) Family capital and parenting style: Family class differences in adolescent physical activity. *China Sport Science*, 39, 48-57.
- [28] Wang, X. (2019) Frontier hotspots, theme clustering and development space of international sports literacy research. *Journal of Beijing Sport University*, 42, 102-116.
- [29] Warburton, D., Nicol, C. and Bredin, S. (2006) Health benefits of physical activity: The evidence. *CMAJ*, 174, 801-809.
- [30] Whitehead, M. (2010) *Physical Literacy Throughout the Lifecourse*. Routledge, London.
- [31] Xing, H. and Hu, J. (2008) *Emotions and Health*. China Society Press, Beijing.
- [32] Yang, H. (2019) Taking the anniversary of "Yangzhou conference" as an opportunity to promote the new development and leap-forward of school physical education: Keynote speech at the National University Summit Forum of Physical Education and the 40th anniversary exchange activities of the "Yangzhou conference". *Journal of Sports and Science*, 40, 1-2.
- [33] Yan, L., Sun, H. and Zhang, Q. (2020) Status quo, evolution and trends of international physical literacy – A visual analysis based on WOS database. *Journal of Xi'an Institute of Physical Education*, 37, 257-266.
- [34] Zheng, X., Xiao, Z., Zhao, G. and Nie, Y. (2020) Hotspot, evolution trend and prospects of physical literacy in foreign countries. *Journal of Wuhan Institute of Physical Education*, 54, 25-31.
- [35] Zuo Azhu, Tao Xingyong, Tao Fangbiao. The Influence of Parental Child-rearing Styles on Children's Psychological Behavior [J]. *Chinese Journal of School Health*. 2016,37(10):1598-1600.

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