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RESEARCH ARTICLE

Influence of Family Environmental Factors on Physical Health of Adolescents

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ABSTRACT

Purpose: With the rapid development of China's social economy and the diversification of family environments, the physical health of adolescents has not reached the ideal level. Research on adolescent physical health often uses simple regression analysis and correlation analysis, but the existence of latent variables, interactions between variables, and causal pathways have not been fully considered, which limits a comprehensive understanding of the relationship between family environmental factors and physical health. This article combines structural equation modeling and nested measurement weighted models to explore how family environmental factors affect the physical health of adolescents. Method: In the experiment, stratified random sampling is used to select adolescents in junior high school and senior high school in Nanchang city from March to July 2024 as the objects. A survey is conducted based on the general information survey form, parents' physical health knowledge level scale, family relationships and atmosphere scale, family support for sports activities scale, parents' mental health status scale, and living environment (distance from parks and sports fields) evaluation scale. Physical fitness index (PFI) is used to statistically analyze the physical health level of adolescents, and structural equation modeling and nested measurement weighted models are used to analyze influencing factors. Result: The direct effect of family eating habits reaches the highest, at 0.4. Parents' knowledge level of physical health reaches 0.36.

1 INTRODUCTION

The physical health of adolescents is an important indicator for measuring their overall health status, which has a profound influence on their growth, development, and future quality of life (Suwarsi et al., 2023; Cabral et al., 2023). In recent years, with the rapid development of the social economy, the role of family environmental factors in the physical health of adolescents has received increasing attention. At present, research mainly focuses on analyzing the influence of a single factor, such as household income, parents' education level, etc., lacking a comprehensive analysis of the family environment, and often uses simple statistical analysis methods, which fail to fully consider the role of latent variables and complex causal paths, resulting in certain limitations in understanding the relationship between family environmental factors and the physical health of adolescent populations. Exploration of the comprehensive influence of family environmental factors on the physical health of adolescents has important theoretical and practical significance.

Family environmental factors have a profound influence on the physical health of adolescents. Family is the core environment for the growth and development of adolescents. Family eating habits, parents' health knowledge, family structure, parents' mental health, family support for sports activities, and living environment all directly or indirectly affect the physical health of adolescents. The significance of studying these influencing factors can provide scientific basis for formulating targeted intervention strategies, helping parents and educators to more effectively promote the physical health and comprehensive development of adolescents. Through in-depth analysis of the specific mechanisms by which family environmental factors affect the physical health of adolescents, this article provides practical guidance for policy makers, educators, and families, promoting the optimization of family environments and improving the health level of adolescents, so that the overall health level of society can be ultimately promoted.

To systematically explore the influence of family environmental factors on the physical health of adolescents, this article conducts an in-depth analysis of the potential mechanisms underlying these effects using structural equation modeling (SEM). A stratified random sampling method is used in this article to select samples from adolescents in a junior high school and senior high school in Nanchang city. By combining tools such as general information survey, parents' physical health knowledge level scale, family relationships and atmosphere scale, family support for sports activities scale, parents' mental health status scale, and living environment evaluation scale, the physical health level of adolescents is comprehensively evaluated. In the experiment, physical health level statistics are conducted using physical fitness index (PFI), and influencing factors are analyzed using structural equation modeling and measurement weighted models. This article reveals the significant influence of factors such as family eating habits, parents' health knowledge, family structure, parents' mental health, family support for sports activities, and living environment on the physical health of adolescents. The roles of gender differences in these influencing factors are found, providing data support and theoretical basis for the development of targeted intervention measures..

2 RELATED WORK

With the increasing importance of national awareness of adolescent physical health, many scholars have begun to explore the influence of family environmental factors on adolescent physical health. Boraita R J and other scholars studied the factors associated with low levels of physical activity in adolescents and found that socioeconomic status and living in a family environment that was not conducive to physical exercise resulted in lower levels of physical activity. (Boraita et al., 2023). Claussen A H and other scholars conducted research on the impact of family environment on attention deficit and hyperactivity disorder in adolescents. The results showed significant heterogeneity in the analysis of adolescent hyperactivity symptoms (Claussen et al., 2023). Multivariate logistic regression models and meta-analysis have been used to evaluate the impact of family environment on adolescent health, showing that poverty and family adversity, as well as parents' mental health, can easily lead to unhealthy physical conditions and obesity in adolescents. (Adjei et al., 2022; Knapp et al., 2023)[5-6]. Cluster and correlation analysis have been widely used in evaluating the relationship between adolescent quality of life, physical activity level, and family happiness. The application has shown that there is a direct statistically significant relationship between family happiness scores and the components of respondents' quality of life. Andrieieva et al., (2022). Wang B and other scholars conducted research on the relationship between rural family environment and early childhood development in China and found that a good family environment was significantly correlated with children's development. Wang et al., (2022). The above-mentioned scholars have extensively explored the relationship between family environmental factors and adolescent physical health, revealing the significant impact of factors such as socioeconomic level, family environment, and family happiness on adolescent physical activity level, attention deficit and hyperactivity disorder, obesity, and overall quality of life. Most studies used multivariate logistic regression models and meta-analysis to clarify the negative effects of poverty, family adversity, and parents' mental health on the physical health of adolescents. However, these studies mainly focused on specific

health issues or the influence of a single variable and were mostly cross-sectional studies, which did not fully consider the interaction between different family environmental factors and the complex relationship between latent variables. Therefore, the comprehensive analysis of the impact on adolescent physical health is still insufficient.

To fully consider the interrelationships between variables, structural equations have gradually become popular among the public. Structural equation modeling is a statistical technique used to analyze complex variable relationships, which combines causal modeling, path analysis, and latent variable analysis to simultaneously handle relationships between multiple dependent and independent variables. There were studies that explored the relationship between parental burnout and adolescent growth using SEM model and investigated the impact of parental absence on physical activity and subjective well-being of adolescents in Southwest China, fully revealing the multifactorial effects of parental burnout and parental absence on adolescent physical health. (Wang et al., 2023; Zhang et al., 2023). Xie H and other scholars used structural equation modeling to explore the influence of parents on the sports experience of urban adolescents. The results indicated that parents' support had a positive impact on the reorganization ability and motivation of adolescent sports activities, demonstrating the correlation between parents' support and adolescent physical health. Xie et al., (2024). Barnhart S and other scholars combined SEM models to study the relationship between family resiliency and adolescent growth, and the results showed an indirect positive correlation between the two. Barnhart et al., (2022). These scholars used structural equation modeling to explore in depth the complex impact of family environmental factors on the physical health of adolescents, especially the roles of parental burnout, parental absence, parents' support, and family resiliency. However, these studies still mainly focused on a single influence pathway of specific factors, and did not fully integrate the comprehensive effects of multiple family environmental factors on the physical health of adolescents. This article further expands and integrates these research results, comprehensively exploring the overall influence of multiple family environmental factors on the physical health of adolescents.

3 RESEARCH OBJECTS AND METHODS

3.1 Research Objects

The research objects of this article are the adolescent population from a junior high school and a senior high school in Nanchang city, Jiangxi Province, with an age range of 12 to 18 years old. Using the method of stratified random sampling, (Zaman et al., 2023; Welis et al., 2023) based on factors such as the economic development level and distribution of educational resources in different districts and counties of Nanchang city, the city's middle schools are divided into several levels, and some schools are randomly selected from each level to determine the specific sample for the survey. In each school, the students participating in the survey are determined through random sampling to ensure the representativeness and diversity of the sample. With the assistance of school staff, students' school and family situations are checked. Preliminary screening is conducted based on inclusion and exclusion criteria, and basic information of students who meet the research criteria is registered. The researchers have explained in detail the purpose, content, significance, benefits, and risks of the study to the students who pass the initial screening.

Inclusion criteria: (1) students with nuclear families or immediate families that live together for at least one year and have blood relationship or legal adoption relationship; (2) students' age being between 12 and 18 years old, including junior high school and senior high school students; (3) students and their guardians signing an informed consent form; (4) students with normal physical health, not suffering from serious or chronic diseases, so as to exclude the impact of other diseases on their physical health.

Exclusion criteria: (1) students with intellectual disabilities or learning disabilities who are unable to fill out the questionnaire; (2) students who do not obtain informed consent from their guardians; (3) adolescents with serious physical illnesses or psychological disorders.

To ensure the effectiveness of reliability and validity testing, the sample size is 10-20 times the number of questionnaire items. Mokkink et al., (2023). A total of 1528 survey questionnaires are distributed in this study, and 1500 valid questionnaires are collected, with an effective response rate of 98.17%. Among them, there are 750 questionnaires from students and 750 questionnaires from parents.

3.2 Research Methods

3.2.1 Literature Review Method

Keywords such as "adolescent physical health" and "family environment" are used to conduct literature search and classification. Simultaneously articles related to adolescent health and family environment in the Jiangxi Provincial Library are reviewed. A deeper understanding of the research content is then gained, and a preliminary understanding and logical system is formed, providing theoretical support for subsequent research.

3.2.2 Questionnaire Survey Method

(1) General information survey form

To comprehensively collect factor information on adolescent students and parents, a general information survey form is designed for the experiment, including family eating habits, family economic status, parents' education level, parents' health status, and family structure.

(2) Parents' physical health knowledge level scale

In terms of parents' physical health knowledge level, the dimensions are divided into basic health knowledge, nutrition knowledge, exercise and physical fitness knowledge, and disease prevention and health care knowledge, with a total of 24 items and a total score of 24 points. The higher the total score, the more understanding parents have of physical health knowledge.

(3) Family relationships and atmosphere scale

Family relationships and atmosphere can be divided into two dimensions: parent relationships and parent-child relationships. Parent relationships are specifically divided into two aspects: frequent arguments between parents and whether parents have a good relationship. Kan. (2023), each of which is evaluated using the Likert 5-point scoring method. The total score is 20 points, and the higher the score, the more harmonious the relationship between parents. To ensure consistency in the trends of the two aspects, reverse scoring is implemented for the first aspect to ensure consistency in the trends of the two aspects.

Parent-child relationships are divided into two aspects, namely the relationship between the child and the mother, and the relationship between the child and the father. Each aspect is evaluated using the Likert 5-point scoring method. Among them, 1 point indicates that the relationship is quite not close; 2 points indicate that the relationship is not close; 3 points indicate that the relationship is average; 4 points indicate that the relationship is close; 5 points indicate that the relationship is very close. The total score is 10 points, and the higher the score, the better the relationship with their parents.

(4) Family support for sports activities scale

In terms of family support for sports activities, the experimental questionnaire is evaluated using the Likert 5-point scoring method. Li. (2024). The dimensions are divided into emotional support, material support, social support, and time support. Among them, 1 point indicates being strongly unsupported; 2 points indicate being unsupported; 3 points indicate being neutral; 4 points indicate being supported; 5 points indicate being strongly supported. The total score is 20 points, and the higher the score, the higher the family support for sports activities.

(5) Parents' mental health status scale

The mental health status of parents can be divided into six dimensions: emotional health, psychological resilience, interpersonal relationships, self-esteem and self-identity, behavioral

health, and cognitive function. The survey adopts the Likert 5-point scoring method, with 1 point indicating never and 5 points indicating always. The total score is 30 points, and the higher the total score, the worse the parents' mental health condition.

(6) Living environment (distance from parks and sports fields) evaluation scale

Living environment refers to the distance from parks or sports fields, which can be divided into four dimensions: distance, accessibility, community culture, and safety. Each dimension is evaluated using the Likert 5-point scoring method. The total score is 20 points, with higher scores indicating a safer living environment and more suitable for exercise.

3.2.3 Measurement of Adolescent Physical Health

The physical fitness index (PFI) is used to evaluate the physical health of adolescents, which covers three dimensions: body shape, body function, and physical quality. Lun et al., (2023). Body shape is evaluated using the body mass index (BMI), and body function is evaluated using vital capacity. Physical fitness includes speed, agility, flexibility, strength, and endurance. The speed and agility are measured using a 50m run. The strength of the upper and lower limbs is measured by standing long jump and sit-ups or pull-ups. Flexibility is measured by sit-and-reach. Endurance quality is measured using a 1000m run. The total score of the physical fitness index is 100 points, ranging from 0 to 100. The higher the score, the better the physical health status of adolescents. The calculation formula for PFI is shown in Formula (1).

$$PFI = 0.15z_1 + 0.15z_2 + 0.20z_3 + 0.10z_4 + 0.10z_5 + 0.20z_6 + 0.10z_7 (1)$$

Among them, z_1 represents BMI. z_2 to z_7 represent the scores for vital capacity, 50m run, standing long jump, sit-and-reach, 1000m run, and sit-up or pull-up in sequence.

3.2.4 Data Collection Method

With the consent and assistance of a school in Nanchang, data is collected through face-to-face questionnaire surveys from March to July 2024. Before the survey, the researchers provide unified training to the investigators to ensure that they guide students and parents who meet the inclusion criteria to fill out the questionnaire and answer questions according to unified guidelines. After obtaining the informed consent of the students and their parents, the investigators instruct them to fill in the questionnaires one-on-one and check and recover them on site. After recycling, questionnaires that are missing or clearly invalid are eliminated.

3.2.5 Statistical Processing Method

In the experiment, SPSS 26.0 software is used to process the data, and AMOS 26.0 is used to test and calibrate the structural equation modeling. On the basis of matching the model with the collected data, the Bootstrap method with bias correction is used to test the mediating effect. If the 95% CI (confidence intervals) of the effect does not include 0, it indicates that the effect is significant. For metric data that follows a normal distribution, $\bar{x} \pm s$ is used to represent it, while for others, frequency and composition ratio are used to represent it. To further analyze the causal relationship between variables of adolescents and family environment in structural equation modeling, this article adds one-way analysis of variance and Pearson correlation analysis to the model to assist in the interpretation of the structural equation modeling. Dufera et al., (2023). Simultaneously gender tests are added to explore identity testing when gender data matches the model. The model used for identity testing is a nested model, and in this experiment, the nested model adopts a measurement weighted model with equal measurement coefficients. (Dai et al., 2024; Ayan et al., 2023).

4 RESULTS

4.1 Reliability Test of Survey Questionnaire Form

Reliability refers to the stability, consistency, and reliability exhibited by a measuring tool during repeated measurements. Robbins. (2024). Reliability measures whether a measuring tool can produce consistent results when used multiple times under the same conditions. High reliability

indicates that the measurement results have high repeatability and consistency, and low reliability indicates that there may be significant random errors or inconsistencies in the results. This experiment uses internal consistency and uses Cronbach's coefficient to evaluate reliability. (Izah et al., 2023; Dabbagh et al., 2023). The closer the value is to 1, the higher the internal consistency. The reliability of the survey questionnaire is shown in Table 1.

Table 1. Reliability test

Parent scale	Cronbach' s α	Standardized Cronbach's α	Adolescent scale	Cronbach's α	Standardized Cronbach's α
Parents' physical health knowledge level scale	0.872	0.901	Family relationships and atmosphere scale	0.835	0.862
Family relationships and atmosphere scale	0.856	0.875			
Family support for sports activities scale	0.822	0.849			
Parents' mental health status scale	0.793	0.815			
Living environment (distance from parks and sports fields) evaluation scale	0.816	0.839			

In Table 1, the parent scales include the parents' physical health knowledge level scale, family relationships and atmosphere scale, family support for sports activities scale, parents' mental health status scale, and living environment (distance from parks and sports fields) evaluation scale. The adolescent scale includes family relationships and atmosphere scale.

In general, a Cronbach's α coefficient above 0.9 indicates excellent test reliability; 0.8-0.9 indicates good reliability; 0.7-0.8 indicates average reliability. In Table 1, overall, most survey questionnaires are good in terms of reliability. The Cronbach's α coefficients of all scales range from 0.793 to 0.872, and the standardized Cronbach's α coefficients further increase to a range of 0.815 to 0.901, indicating high internal consistency and reliability among the scales.

The Cronbach's α coefficient of the parents' physical health knowledge level scale is the highest, reaching 0.872, and after standardization, it increases to 0.901, showing extremely high reliability. The Cronbach's α coefficient of the parents' mental health status scale is relatively low, at 0.793, and the standardized coefficient reaches 0.815, maintaining a high level of reliability. The Cronbach's α coefficients of the family relationships and atmosphere scale, family support for sports activities scale, and living environment evaluation scale all exceed 0.8, and the standardized coefficients are further improved to verify the internal consistency of each scale. Overall, all scales have high reliability in this experiment.

4.2 Correlation Analysis

To explore the mediating effect of experimental scales, a correlation analysis is conducted based on structural equation modeling on parents' knowledge level of physical health, family relationships and atmosphere, family support for sports activities, parents' mental health status, living environment (distance from parks and sports fields), and adolescent physical fitness index. The correlation analysis results are shown in Figure 1. The significance level is less than 0.01.

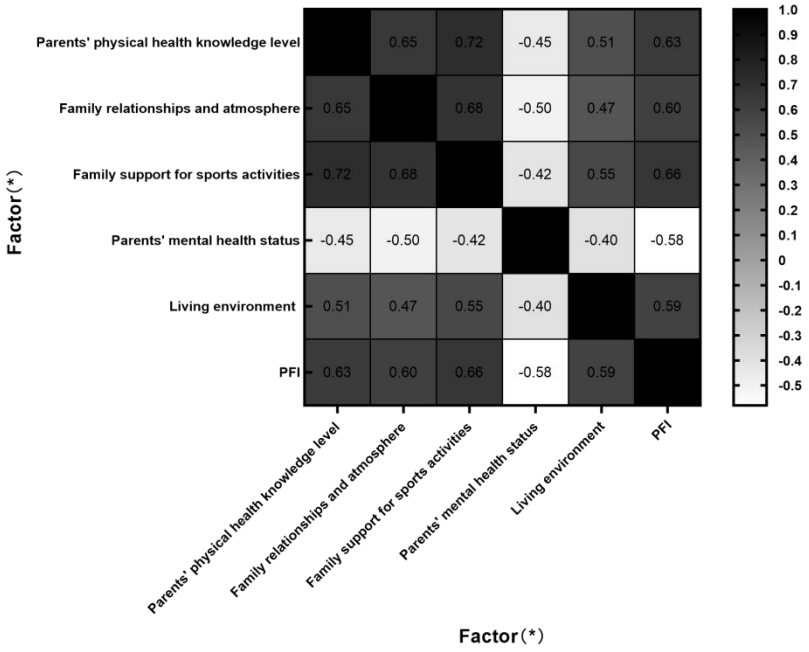

Figure 1. Correlation analysis results

In Figure 1, * represents P<0.01. There is a significant positive correlation between parents' physical health knowledge level, family relationships and atmosphere, family support for sports activities, living environment (distance from parks and sports fields), and adolescents' physical fitness index, with correlation coefficients of 0.63, 0.60, 0.66, and 0.59, respectively. It can be seen that the higher the parents' awareness of health knowledge, the harmony of family and parent-child relationships, the family support for sports activities, and the suitability of the living environment, the better the physical health status of adolescents.

There is a significant negative correlation between the mental health status of parents and the physical fitness index of adolescents, with a correlation coefficient of -0.58, indicating that the worse the mental health status of parents, the worse the physical health status of adolescents. The mental health status of parents is also negatively correlated with other factors, indicating that poor mental health status of parents can have a negative impact on the overall health support and environment of the family, thereby affecting the physical health of adolescents.

4.3 Single Factor Analysis

The results of the single influencing factor of family environment on the physical health of adolescents are shown in Table 2.

Table 2. Single influencing factor results of family environment on adolescent physical health

Items	Quantity [n(%)]	PFI (points)	t/F	P	Items	Quantity[n(%)]	PFI (points)	t/F	P
Family eating habits			4.15	<0.001	Family economic status			3.25	0.07
Preference for light diet	320 (42.7%)	80.1±5.4			<2000 yuan	75 (10%)	62.5±7.3		
Preference for high-fat and high-salt diet	140 (18.7%)	65.2±6.9			2000-6000 yuan	280 (37.3%)	74.3±6.8		

Preference for high-sugar diet	180 (24%)	67.3±6.5			6000-10000 yuan	240 (32%)	78.4±6.1		
Preference for high-protein diet	90 (12%)	75.7±5.8			>10000 yuan	155 (20.7%)	82.1±5.2		
Preference for vegetarian diet	45 (6%)	73.5±6.1			Parents' health status			4.57	0.005
Irregular diet	75 (10%)	60.4±7.1			Healthy	510 (68%)	80.4±5.3		
Family structure			3.95	<0.001	Mild health problems	130 (17.3%)	68.2±6.9		
Nuclear family	380 (50.7%)	77.3±5.7			Moderate health problems	80 (10.7%)	65.7±6.8		
Extended family	200 (26.7%)	72.4±6.2			Severe health problems	20 (2.7%)	61.9±7.4		
Single-parent family	100 (13.3%)	65.5±6.8			Weak and sick	10 (1.3%)	58.2±7.8		
Reconstituted family	45 (6%)	63.3±7.0			Parents' education level			3.89	<0.001
Grandparent-raising family	25 (3.3%)	60.2±7.3			Primary school	50 (6.7%)	61.8±7.2		
-					Junior high school	130 (17.3%)	68.7±6.5		
					Senior high school	240 (32%)	74.5±6.2		
					College	210 (28%)	77.3±5.6		
					Undergraduate	120 (16%)	81.2±5.4		

In Table 2, family eating habits, family structure, parents' health status, and parents' education level all have a significant impact on the physical health of adolescents with a P value less than 0.05. The statistical value of parents' health status is 4.57, with a P value of 0.005. The statistical values of family eating habits, family structure, and parents' education level are 4.15, 3.95, and 3.89, respectively, with P values less than 0.001.

4.4 Construction and Results Analysis of Structural Equation Modeling

4.4.1 Construction of Structural Equation Modeling

Structural equation modeling (SEM) is a multivariate statistical analysis method that can simultaneously handle complex relationships between multiple dependent and independent variables. Zeng et al., (2023). To explore the impact of family environmental factors on the physical health of adolescents, this article constructs a model using SEM to analyze the direct and indirect effects of factors such as parents' knowledge level of physical health, family relationships and atmosphere, family support for sports activities, parents' mental health status, and living environment (distance from parks and sports fields) on PFI.

SEM includes observed variables and latent variables. Observed variables are indicators directly measured through questionnaires, and latent variables represent indicators that cannot be directly observed. SEM includes measurement models and structural models. In the measurement model, to construct the SEM model, the experiment first determines the relationship between each latent variable and the observed variable and uses confirmatory factor analysis (CFA) (Baharum et al., 2023; Sureshchandar, 2023; Goretzko et al., 2024) to test it. The specific calculation formulas are shown in Formulas (2) and (3).

$$E = \Lambda_e \rho + \varepsilon (2)$$

$$F = \Lambda_f \lambda + \zeta (3)$$

Among them, E and F represent the observed variable vectors. ρ and λ represent latent variable vectors. Λ_e and Λ_f represent the factor loading matrix. ε and ζ represent error terms.

The structural model mainly displays the causal relationship between latent variables. Based on the hypothesis, a path diagram between latent variables is constructed, and the direct and indirect effects are determined. The specific expression is shown in Formula (4).

$$\lambda = B\lambda + \varphi\rho + \omega (4)$$

Among them, B represents the relationship matrix between latent dependent variables. φ represents the relationship matrix between latent independent variables and PFI. ω represents the structural error term.

To verify the goodness of fit of the model, the experiment uses chi-square test, fitting index, adjusted fitting index, comparative fitting index, root mean squared error and other indicators to validate the structural equation modeling. (Al-Ghamdi et al., 2023; Beribisky and Hancock, 2024). The chi-square test is mainly used to test the differences between the model and the observed data. The smaller the chi-square value, the better the model fit. The fitting index and adjusted fitting index represent the overall level of model goodness of fit, and the closer the value is to 1, the better the fit. The closer the value of comparative fitting index is to 1, the better the goodness of fit of the model. The smaller the root mean squared error value, the smaller the model error. In general, root mean square error of approximation (RMSEA) less than 0.08 indicates good model fit.

The research results are shown in Table 3.

Table 3. Model fitting validation results

Indicators	Value	Indicators	Value
Chi-square degrees of freedom ratio	3.89	Comparative fitting index	0.96
Overall goodness of fitting index	0.95	Root mean square error of approximation	0.05

Adjusted goodness of fitting index	0.92	Normalized fitting index	0.93
Value-added fitting index	0.95	-	

In Table 3, the chi-square degrees of freedom ratio is 3.89. The overall goodness of fit is 0.95. The adjusted goodness of fitting index is 0.92. The value-added fitting index is 0.95. The comparative fitting index is 0.96. The normalized fitting index is 0.93. The root mean square error of the approximation is 0.05. It can be seen that the structural equation modeling constructed in this article has a good fit with the observed data.

4.4.2 Factor Paths and Effects in SEM

1) Estimation of path coefficient for SEM

The estimated path coefficient values of SEM are shown in Table 4. In Table 4, Sβ represents the standard error of the standardized path coefficient, and Z represents a statistical measure used to test the significance of the path coefficient.

Table 4. Estimated path coefficient values for SEM

Path	Unstandardized β value	Standardized β value	Sβ	Z	P
Parents' physical health knowledge level → adolescent physical health	0.42	0.36	0.08	5.25	<0.01
Family relationships and atmosphere → adolescent physical health	0.3	0.28	0.07	4	<0.01
Parents' mental health status → adolescent physical health	-0.26	-0.24	0.06	-4.33	<0.01
Family support for sports activities → adolescent physical health	0.35	0.32	0.07	5	<0.01
Living environment (distance from parks and sports fields) → adolescent physical health	0.28	0.25	0.06	4.67	<0.01
Family eating habits → adolescent physical health	0.47	0.4	0.08	5.88	<0.01
Parents' health status → adolescent physical health	0.39	0.34	0.07	5.57	<0.01
Family structure → family relationships and atmosphere → adolescent physical health	0.22	0.21	0.05	4.4	<0.01
Parents' education level → family support for sports activities → adolescent physical health	0.31	0.28	0.06	5.17	<0.01
Parents' education level → living environment (distance from parks	0.27	0.23	0.06	4.5	<0.01

and sports fields) → adolescent physical health					
Parents' education level → parents' physical health knowledge level → adolescent physical health	0.33	0.3	0.07	4.71	<0.01

In Table 4, it can be seen that the P values of the path coefficients of the structural equation modeling are all less than 0.01, indicating that each measurement path and structural path have a significant impact on the physical health of adolescents. Family eating habits and parents' knowledge of physical health have a significant impact on the physical health of adolescents, with standardized β values reaching 0.40 and 0.36, respectively.

2) SEM paths and effect results

SEM paths and effect results are shown in Table 5.

Table 5. SEM paths and effect results

Path	Standardized β	Standard error	Boot 95% CI		Effect ratio (%)
			Lower limit	Upper limit	
Parents' physical health knowledge level → adolescent physical health	0.36	0.05	0.26	0.46	11.90%
Family relationships and atmosphere → adolescent physical health	0.28	0.04	0.2	0.36	9.70%
Parents' mental health → adolescent physical health	0.24	0.07	0.15	0.33	8.30%
Family support for sports activities → adolescent physical health	0.32	0.05	0.22	0.42	10.10%
Living environment (distance from parks and sports fields) → adolescent physical health	0.25	0.04	0.17	0.33	7.70%
Family eating habits → adolescent physical health	0.4	0.06	0.3	0.5	13.90%
Parents' health status → adolescent physical health	0.34	0.05	0.24	0.44	11.80%
Family structure → family relationships and atmosphere → adolescent physical health	0.21	0.03	0.13	0.29	4.30%
Parents' education level → family support for sports activities → adolescent physical health	0.28	0.05	0.19	0.37	7.70%
Parents' education level → living environment (distance	0.23	0.04	0.15	0.31	6.00%

from parks and sports fields) → adolescent physical health					
Parents' education level → parents' physical health knowledge level → adolescent physical health	0.3	0.03	0.2	0.4	8.60%

In Table 5, family eating habits have the greatest impact on the physical health of adolescents, with a standardized β value of 0.4 and an effect ratio of 13.90%. It can be seen that healthy eating habits are crucial for improving the physical fitness of adolescents. The standardized β corresponding to parents' physical health knowledge level is 0.36, and the effect ratio reaches 11.90%, indicating that parents' level of health knowledge has a significant impact on the physical fitness of adolescents. Family support for sports activities also plays an important role, while factors such as family relationships and atmosphere, parents' mental health status, and living environment have a relatively small but still significant impact on the physical health of adolescents. Family structure indirectly affects the physical health of adolescents by influencing family relationships. The standardized β reaches 0.21, with an effect ratio of 4.30%, suggesting that family relationships play a certain mediating role in physical health. The parents' education level affects the physical health of adolescents through family support for sports activities, living environment (distance from parks and sports fields), and parents' knowledge of physical health as mediators, with effect ratios reaching 7.70%, 6.00%, and 8.60%, respectively.

Overall, among the influencing factors of family environment on the physical health of adolescents, the indirect effect accounts for a total of 26.6%, and the total direct effect accounts for 73.4%.

The structural equation modeling of the influencing factors of family environment on adolescent physical health is shown in Figure 2.

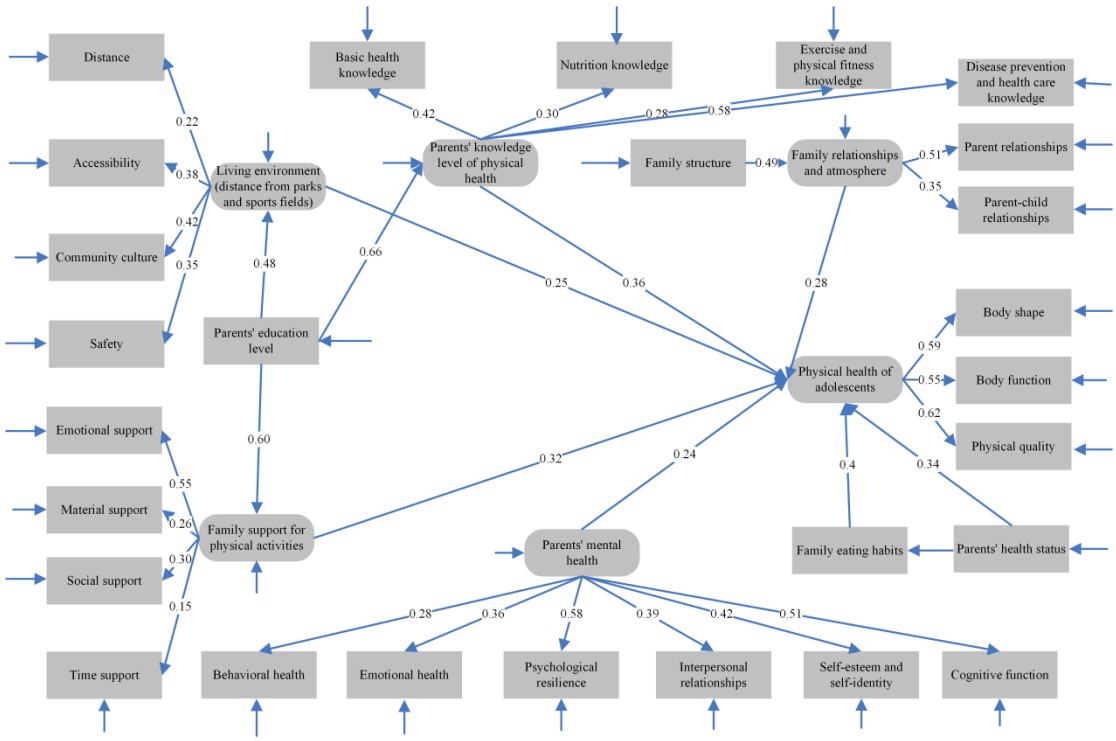

Figure 2. Structural equation modeling of the influencing factors of family environment on adolescent physical health

In Figure 2, it can be seen that the effect coefficients of each observed variable and latent variable have statistical significance at P<0.05. The direct effects of family eating habits and parents'

health status reach 0.4 and 0.34, respectively. The direct effect of parents' mental health status reaches 0.24. The family support for sports activities reaches 0.32. The living environment reaches 0.25. The parents' knowledge level of physical health reaches 0.36. The family relationships and atmosphere reach 0.28. Family structure uses family relationships and atmosphere as intermediaries to influence the physical health of adolescents, with a mediating effect of 0.21. The level of parents' education affects the physical health of adolescents through the mediation of living environment, parents' knowledge of physical health, and family support for sports activities, with mediating effects reaching 0.23, 0.30, and 0.28, respectively.

3) Comparison of path coefficients between measurement weighted models for males and females

The comparison of path coefficients between the measurement weighted models for males and females is shown in Table 6.

Table 6. Path coefficients of measurement weighted models for males and females

Path	Male	Female	Critical ratio
Parents' physical health knowledge level → adolescent physical health	0.42	0.38	1.27
Family relationships and atmosphere → adolescent physical health	0.28	0.31	1.98
Parents' mental health → adolescent physical health	-0.22	-0.26	-2.18
Family support for sports activities → adolescent physical health	0.35	0.29	2.45
Living environment (distance from parks and sports fields) → adolescent physical health	0.24	0.27	0.89

In Table 6, from an overall perspective, the absolute values of the critical ratios of the coefficient differences between the three paths of family relationships and atmosphere → adolescent physical health, parents' mental health → adolescent physical health, family support for sports activities → adolescent physical health for adolescents of different genders are all greater than 1.96, indicating that gender differences in these three paths are statistically significant, while other path differences are not statistically significant.

In terms of the path parents' mental health → adolescent physical health, the absolute value of the path coefficient for females is greater than that for males, |-0.26|>|-0.22|. It can be seen that compared to males, the physical health of female adolescents is more susceptible to the negative impact of their parents' mental health status. In terms of the path family relationships and atmosphere → adolescent physical health, the absolute value of the path coefficient for females is greater than that for males, 0.31>0.28, indicating that family relationships and atmosphere have a greater positive impact on the physical health of adolescents on females than on males. In terms of the path family support for sports activities → adolescent physical health, the absolute value of the path coefficient for males is greater than that for females, 0.35>0.29, indicating that for males, the positive impact of family support for sports activities on adolescent physical health is greater than that for females.

5. DISCUSSION

5.1 Significant Influence of Family Eating Habits on Physical Health of Adolescents

From the single factor analysis perspective, family eating habits have the most significant influence on the physical health of adolescents. Among adolescents who prefer a light diet, their physical fitness index is the highest, reaching 80.1±5.4. Adolescents who prefer high-fat and high-salt diets and irregular diets have lower physical fitness indexes, with scores of 65.2±6.9 and 60.4±7.1, respectively (P<0.001). The results of the structural equation modeling further indicate

that the standardized path coefficient of family eating habits reaches 0.40, with an effect ratio of 13.9%. Among all family factors, it has the greatest impact on the physical health of adolescents, indicating that healthy eating habits play a crucial role in the physical health of adolescents.

Excessive intake of high-fat, high-sugar, and high-salt foods in the diet can have long-term negative effects on the physical fitness of adolescents, leading to problems such as obesity and metabolic disorders. Parents are advised to pay more attention to balanced nutrition in their daily diet and encourage adolescents to develop light and healthy eating habits.

5.2 Role of Parents' Health Status and Physical Health Knowledge Level

The health status and knowledge level of physical health of parents are key factors affecting the physical health of adolescents. The single factor analysis shows that adolescents with good parents' health have a higher physical fitness index, reaching 80.4±5.3, while adolescents with severe parents' health problems have a significantly lower physical health score, only 61.9±7.4.

The results of the structural equation modeling indicate that the standardized path coefficients for parents' health status and physical health knowledge level are 0.34 and 0.36, respectively, with effect ratios of 11.8% and 11.9%, respectively. This indicates that the health status of parents not only directly affects the physical health of adolescents, but also promotes the improvement of their physical health by providing correct health guidance to them. It is recommended to enhance parents' health literacy, which not only benefits their own health, but also provides a healthier growth environment for adolescents.

5.3 Indirect Effects of Family Structure and Parents' Education Level

Research finds that family structure indirectly affects the physical health of adolescents by influencing family relationships. The single factor analysis shows that adolescents from nuclear families have higher physical fitness indexes, reaching 77.3±5.7, while those from reconstituted families and grandparent-raising families have lower physical fitness indexes, at 63.3±7.0 and 60.2±7.3, respectively ($P<0.001$). The structural equation modeling shows that family structure affects the physical health of adolescents through family relationships and atmosphere, with a standardized path coefficient of 0.21 and an effect ratio of 4.3%. This means that a harmonious atmosphere within the family and good parent-child relationships can to some extent alleviate the negative impact of family structure on the physical health of adolescents. It is suggested that family members should pay attention to establishing a good family atmosphere, especially in single-parent and reconstituted families, and pay more attention to the harmony of family relationships to support the healthy development of adolescents.

The impact of parents' education level on the physical health of adolescents is mediated by multiple factors. The results of the structural equation modeling indicate that parents' education level indirectly affects adolescent physical health by influencing family support for sports activities, living environment, and parents' knowledge of physical health. The standardized path coefficients are 0.28, 0.23, and 0.30, respectively. The total effect ratio is 22.3%, indicating that the indirect role of parents' education level in improving the physical health of adolescents cannot be ignored. It is recommended to improve the education level of parents, especially in terms of health knowledge and sports activity support, which can have a significant promoting effect on the physical health of adolescents.

5.4 Influence of Parents' Mental Health Status, Family Support for Activities, and Living Environment

The mental health status of parents has a significant negative impact on the physical health of adolescents, especially for female adolescents. The SEM path coefficient analysis shows that the standardized path coefficient of parents' mental health status on adolescent physical health is -0.24, and the P value is less than 0.01, indicating a significant negative impact of parents' mental status. The psychological pressure or anxiety of parents can affect their children's physical and mental health through the family atmosphere. The comparison of gender weighted models shows that female adolescents are more significantly negatively affected by their parents' mental health

status, which is positively related to their stronger emotional sensitivity during adolescence. They are more sensitive to the emotional fluctuations of their parents. It is suggested that the mental health status of parents can be improved to have a positive impact on the physical health of adolescents, especially in preventing negative effects of emotional stress on their physical health. Parents should be provided with more psychological support and counseling.

Family support for sports activities is one of the important factors affecting the physical health of adolescents. The SEM analysis results show that the standardized path coefficient of family support for sports activities on the physical health of adolescents is 0.32, and the P value is less than 0.01, indicating that family support in encouraging sports activities has a significant positive impact on the physical health of adolescents. The analysis results of the gender weighted model also indicate that this support has a more significant impact on male adolescents. The male path coefficient is 0.35, and the female path coefficient is 0.29. This is related to the fact that male adolescents are more inclined to participate in highly competitive sports activities, and family support can directly enhance their sports participation and physical fitness. To improve the physical health of adolescents, families should actively create an environment that supports physical exercise, such as encouraging children to participate in extracurricular sports activities or increasing opportunities for families to exercise together.

The influence of living environment on the physical health of adolescents is relatively small, but still statistically significant. SEM path coefficient analysis shows that the standardized path coefficient of residential environment on adolescent physical health is 0.25, and the P value is less than 0.01, indicating that the closer the distance to sports facilities, the better the physical health of adolescents. A living environment close to facilities such as parks or sports fields can provide more outdoor exercise opportunities for adolescents, thereby promoting physical health. In the gender weighted model, the difference in living environment factors between genders is not significant, indicating that the improvement of living environment has a positive impact on the physical health of both male and female adolescents. It is suggested that policy makers and urban planners should focus on providing more convenient sports and exercise facilities for adolescents and promote their healthy growth by improving the urban living environment.

5.5 Moderating Effect of Gender Differences on Impact of Family Environmental Factors

In this article, from the results of the weighted model, there are significant differences in the impact of family relationships and atmosphere, parents' mental health status, and family support for sports activities between males and females. In the path parents' mental health → adolescent physical health, females are more negatively affected by parents' mental health status than males, reaching $|Z|=2.18$. In the path family relationships and atmosphere → adolescent physical health, females are more positively influenced by family relationships than males, with $Z=1.98$. In the path of family support for sports activities → adolescent physical health, the positive impact of family support on males is greater than that on females, with $Z=2.45$. The results show that gender to some extent moderates the impact of family environmental factors on the physical health of adolescents. When formulating intervention strategies, targeted family environment optimization measures should be taken for adolescents of different genders. For female adolescents, the focus should be on improving their parents' mental health and family atmosphere, while for male adolescents, family support for their physical activities should be strengthened.

6. CONCLUSION, COUNTERMEASURES AND SUGGESTIONS

6.1 Conclusion

This article uses SEM and nested measurement weighted models to systematically explore the influence of family environmental factors on the physical health of adolescents. In the experiment, a stratified random sampling of adolescents from a junior high school and senior high school in Nanchang city is conducted, and they are evaluated using multiple scales. It is found that factors such as family eating habits, parents' knowledge of physical health, family structure, parents' mental health, family support for sports activities, and living environment have a significant

impact on the physical health of adolescents. The direct effect of family eating habits and parents' health knowledge level on physical health is the greatest. The influence of gender differences on family relationships, parents' mental health, and physical activity support is revealed through the study. This article provides data support for developing effective intervention measures, but there are still shortcomings such as sample limitations and variable complexity. In future research, the sample size can be expanded and the interactive effects of different environmental factors can be explored in depth. More potential impact mechanisms can also be explored to further optimize intervention strategies.

6.2 Countermeasures and Suggestions

Based on the above research results, the suggested countermeasures are as follows.

(1) Parents should actively encourage their children to participate in sports activities organized by schools and communities and increase their frequency of exercise. Families can organize regular parent-child sports activities, such as walking, running, or cycling, to create a positive family sports atmosphere. At the same time, parents should pay attention to balanced nutrition and encourage adolescents to develop light and healthy eating habits.

(2) Mental health lectures or counseling classes can be regularly organized to help parents cope with psychological stress in their daily lives. Parents need to be assisted in managing their relationship with their children through family psychological counseling programs, especially providing emotional support during their children's adolescence.

(3) Sports facilities in the city should be increased, such as community gyms, basketball courts, and parks, to ensure that every community resident can conveniently use these facilities. The concept of "healthy cities" can be promoted, and the popularization of healthy lifestyles such as walking and cycling in the community can be encouraged. At the same time, through policy guidance, it is more convenient for adolescents to access and use sports venues.

(4) The parent committee and school sports department can jointly organize off-campus sports competitions or activities to increase the participation of students' physical exercise. Schools can also provide training on home physical education to help parents understand how to scientifically and effectively improve their children's physical health.

(5) Healthy family lifestyles can be promoted in the media to encourage adolescents' families to exercise more, sit less, and develop positive healthy habits. It is also necessary to popularize parents' knowledge of physical health management. In addition, relevant policies or incentive mechanisms can be issued to encourage family members to actively participate in community sports activities, such as reducing or exempting fees for the use of public sports facilities.

(6) Targeted intervention measures can be developed according to the differences in factors influencing physical health among adolescents of different genders. Gender differences should be considered in health education and family support activities to ensure the effectiveness of intervention measures.

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