RESEARCH

The relationship between family function and the incidence of overweight/obesity in children and adolescents in Chengdu city, Sichuan province of China: based on latent profile analysis

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Abstract

Background Overweight/obesity in children and adolescents has become a global health problem, and family function may be associated with its occurrence. Studies exploring the association between family function and overweight/obesity in children and adolescents were performed in Western and Taiwan, China. To date, related studies haven't been conducted in Mainland China.

Objectives To investigate the current status of overweight, obesity, and family function among children and adolescents in Chengdu, China, and to explore their associations.

Methods Children and adolescents in five primary and middle schools were chosen by cluster sampling. Body Mass Index was used to measure the status of overweight and obesity, and the Chinese family assessment instrument was adopted to assess family function. Latent profile analysis and stepwise logistic regression were applied to identify family classification and explore the relationships between family function and overweight/obesity.

Results A total of 7616 (84.92%) children and adolescents out of 8968 completed the study with qualified-filled questionnaires. Nine hundred and sixty-six (12.68%)participants were overweight and 656 (8.61%) were obese. The family function was categorized into three profiles: mild (63.93%), moderate (12.32%), and severe (23.75%) dysfunction. The prevalence of overweight was 12.16%, 14.71%, and 13.05% for mild, moderate, and severe family dysfunction, respectively. And the prevalence of obesity was 8.19%, 10.77%, and 8.62% respectively. Participants in moderate and severe dysfunction families were more likely to be overweight (moderate: OR = 1.27, 95% CI:1.01 ~ 1.59, $P = 0.04$; severe: OR = 1.38, 95% CI:1.15 ~ 1.66, $P = 0.001$) and obese (moderate: OR = 1.35, 95% CI:1.02 ~ 1.79, $P = 0.03$; severe: OR = 1.55, 95% CI:1.23 ~ 1.96, $P < 0.001$). Sociodemographic data such as gender, residence, grade, pocket

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money per week, the number of siblings, and the education level of the mother were all associated with the risk of being overweight/obese in children and adolescents.

Conclusions The problems of being overweight or obese exist among children and adolescents in Chengdu. And the risk of being overweight or obese increases along with the decrease in family function.

Keywords Family function, Overweight, Obesity, Chengdu, Latent profile analysis

Introduction

Overweight/obesity is defined as abnormal or extreme fat accumulation that may impair health. There are more than 340 million children and adolescents with overweight/obese around the world [1]. China has the most children and adolescents with obesity, and the prevalence of overweight/obesity was expected to increase to 28.0% in 2030, with the absolute number of 49.48 million [2, 3]. Former studies indicated that being overweight/obese during childhood or adolescence had a negative influence on their physical and psychological health, and the impact may continue to their adulthood, causing long-term damage [4–8].

Many factors, such as the consumption of sugar-sweetened beverages [9, 10], screen media use [11, 12], decreasing physical activity [13–15], and inadequate sleep [16] contributed to the occurrence of overweight or obesity. And literature demonstrated that family function might play a role [17–20]. For example, Halliday et al [19]. concluded that more obese individuals were from dysfunctional families, and the specific aspects of family function, like poor communication, high levels of family conflict were linked to an elevated risk of child and adolescent obesity. Other studies [18, 20] also revealed reduction in the risk of obesity in healthy function family. Moreover, investigation [17] conducted in Chinese populations residing in Taiwan and the United States found that family function, rather than dietary behaviors, or physical activities, was associated with overweight/obesity, further emphasizing its importance. Building upon these existing findings, we believed that family function was associated with the risk of being overweight/obese in Mainland China, and sought to explore the associations between them.

Family function emphasizes the interactions among all family members, and how those interactions influence the relationship and functioning of the family as a whole [21]. Some elements, such as connectedness, mutuality, involvement, role assignment, and communication, made up the core of family function, although a series of theories supported their connotations in the specific context [22, 23]. In China, scholars found that emotional expression and communication were less likely to be regarded as attributes of family function, the absence of conflict, interpersonal harmony, mutuality, connectedness, and positive parent-adolescent relationship were considered important compared with the perception of healthy family function in the western context [24]. The issue of children and adolescents overweight/obesity is closely related to family function, as optimal family function promotes individual well-being and development. However, existing studies examining the relationship between children and adolescents' overweight/obesity and family function have primarily focused on Western countries or Taiwan, China, leaving a research gap in the context of Chengdu, one of the cities in Mainland China. Thus, the objectives of our study were: (1) to investigate the current status of overweight, obesity, and family function among children and adolescents in Chengdu, and (2) to explore the associations between family function and overweight/obesity in this population.

Method

Study design

The study employed a cross-sectional design, utilizing data from the baseline investigation of the Chengdu Positive Child Development (CPCD) program. The research was carried out between 23 and 2019 and 13 January 2020 in Chengdu, the capital city of Sichuan province, Mainland China. Before data collection, students were provided with an explanation of the fundamental principles of the collection and utilization of data, including the study's purpose, voluntary participation, and strict confidentiality measures. The data was collected in the classroom setting, with the presence of two trained research assistants. Each participant independently completed the questionnaires and returned them to the researchers promptly after completing them. To ensure the completeness of the responses, the research assistants and school teachers swiftly reviewed the questionnaires and asked for a refill if necessary. Detailed study designs and methods have been published elsewhere [25].

Participants

The entire city was categorized into different regions based on economic status, and one district was randomly selected from each region. Subsequently, a school within the chosen district was also randomly selected. To get as much as possible information about the participants, we included all children and adolescents willing to participate in the research from grade 1 to grade 9 and didn't set specific inclusion and exclusion criteria. A total of 8968

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children and adolescents aged 6~16 in five primary and junior high schools were recruited by cluster sampling.

Measurement

Demographics

The self-designed questionnaire was utilized to gather participants' demographic information, encompassing factors such as gender, age, ethnicity, residence, number of siblings, grade, weekly pocket money, as well as the education level of both father and mother.

Body mass index (BMI)

Body mass index (BMI) is a simple and effective index for measuring overweight and obesity. Considering the Chinese context, our research referred to the standard of Chinese school-age children and adolescents released by the National Health and Family Planning Commission in 2018 (see Supplementary 1) [26].

The measurement of children's height and weight was performed by medical staff from community hospitals. All investigators and medical staff involved in the study underwent training before entering the schools. Height measurements were taken using a stadiometer, with accuracy to the nearest 0.1 cm. Weight measurements were obtained using a digital scale, with accuracy to the nearest 0.1 kg. Boys and girls were instructed to stand upright without shoes or hats, and measured separately.

The Chinese family assessment instrument (C-FAI)

The Chinese family assessment instrument (C-FAI) was used to assess family function. C-FAI contains 5 dimensions of family function, including mutuality, communication and cohesiveness, conflict and harmony, parental concern, and parent control. Each dimension includes 3~12 items with 5 answers (1=most similar, 5=most dissimilar), the average score in each dimension was calculated, and a higher score represents the worse performance in the family function dimension [27]. The Cronbach's alpha was 0.88 in our study, and previous research indicated that C-FAI has good psychometric properties and is an ideal tool to assess the Chinese family function [28, 29].

Quality control

Five percent of the questionnaires were randomly selected to verify the data quality: if the selected questionnaires' consistent rate of entry was equal to or higher than 95%, the data cleaning would be conducted, otherwise, the questionnaires were returned to the participants until the consistent rate reached 95%.

Data analysis

The data analysis was carried out using SPSS 26.0 and MPlus 7.4 software. We stored all data in SPSS 26.0,

removed the missing values and examined for their normal distributions. Descriptive statistics, including measures of central tendency and dispersion, were used to characterize the sample. The division of participants into overweight and obesity categories was accomplished using predefined SPSS syntax [30]. The Mann-Whitney U test and Kruskal-Wallis H were employed to examine the differences in overweight/obesity with different characteristics. Bivariate associations were assessed using Spearman's correlation analysis. Stepwise logistic regression was employed to investigate the relationship between family function and the occurrence of overweight and obesity based on the results from LPA.

Latent profile analysis (LPA)

LPA is an exploratory analysis characterized by a person-centered that classifies participants into specific profiles based on their combinations of strengths and weaknesses [31–33]. Before carrying on LPA, researchers always have no information about the profiles of latent variables and need to probe the number of profiles based on the data. All authors of the present literature didn't know the number of profiles about family function, and it was suitable to apply LPA to identify classifications of families based on individuals' responses to family function.

First, the one-profile model was adopted in LPA, then profiles were added until the fit indices demonstrated the unfit model. The fit indices of the final profiles models were as follows: Akaike information criterion (AIC) [34], Bayesian information criterion (BIC) [35], sample size-adjusted Bayesian information criterion (aBIC) [36], entropy, adjusted Lo-Mendel-Rubin likelihood ratio test (aLMRT) [37] and bootstrap likelihood ratio test (BLRT) [38]. For AIC, BIC, and aBIC, lower values indicated a better-fitting model. The aLMRT and BLRT statistical significance indicated that the model with the higher number of profiles was better than that with the lower number of profiles [39]. The entropy value evaluated the classification accuracy and ranged from 0 to 1, and a higher value represents the more accurate classification. And 0.8 entropy value is great, representing that more than 90% of families were classified into profiles accurately [40]. The smallest proportion of profile cut-off was 0.05 [41, 42].

Results

Participants

A total of 8968 children and adolescents in grades 1~9 (aged from 6 to 16 years old) participated in the research, and 8825 questionnaires were retrieved. And the qualified questionnaires were 7616 (84.92%). The detailed characteristics of participants were presented in Table 1.

Table 1 Demographic information of children (N = 7616)

	N (%) or mean ± SD
Gender (male)	
Boys	3908 (51.31)
Girls	3708 (48.69)
Age (years)	10.65 ± 2.15
Ethnicity	
The Hans	7551 (99.15)
Minorities	65 (0.85)
Residence	
Urban	4876 (64.02)
Rural	2740 (35.98)
The number of siblings	
0	6132 (80.51)
1–2	1403 (18.42)
≥ 3	81 (1.06)
Grade	
Primary school	5187 (68.11)
Junior high school	2429 (31.89)
Pocket money per week (Yuan)	
≤ 20	5599 (73.52)
21–40	982 (12.89)
41–60	651 (8.55)
≥ 61	384 (5.04)
Father education level	
Primary school or below	562 (7.38)
Junior high school	3150 (41.36)
Senior high school	1926 (25.29)
Vocational or technical school	755 (9.91)
College or higher	1223 (16.06)
Mother education level	
Primary school or below	858 (11.27)
Middle school	3037 (39.88)
High school	1788 (23.48)
Vocational or technical school	797 (10.46)
College or higher	1136 (14.92)

Table 3 The score of family function

	Mean ± SD	Skewness	Kurtosis
Mut	1.82 ± 0.89	1.28	1.37
Com	1.94 ± 0.95	1.06	0.63
CH	2.10 ± 0.87	0.62	-0.31
PCC	1.70 ± 0.95	1.19	0.50
PCT	2.22 ± 1.17	0.77	-0.37

Notes: Mut = mutuality, Com = communication and cohesiveness, CH = conflict and harmony, PCC = parental concern, PCT = parent control

(Z=-4.19, $P<0.001$) had higher risks of being overweight/obese. The detailed outcomes were presented in Table 2.

Family function

The scores of the five dimensions in family function were presented in Table 3, and these data were normally distributed with the skewness value ranged from 0.62 to 1.28 and the kurtosis ranged from −0.31 to 1.37.

Latent profile analysis

The summary of LPA was displayed in Table 4. Three profiles model were selected with indices of entropy (0.89), aLMRT ($P<0.001$), BLRT ($P<0.001$) and the smallest proportion of profile (12.32%). The three profiles were named mild, moderate, and severe family dysfunction, respectively. Examining indices of entropy values, BLRT, and aLMRT, all models appeared to be acceptable. The consideration of the smallest proportion among the profiles led us to conclude that the five-profile model wasn't the most suitable choice, while AIC, BIC, and aBIC suggested that it might be the best fit. Thus, taking all these indices into account, the three-profile model was chosen as the final model.

Figure 1 displayed the estimated means in the 5 dimensions of the three-profile model. The results showed that mild family dysfunction got the lowest mean in each dimension, moderate family dysfunction had the highest means in conflict and harmony and parent control dimensions. Severe family dysfunction possessed the highest scores in mutuality, communication and cohesivenes, and parental concern dimensions.

Family function, overweight and obesity

Table 5 demonstrated the detailed information about non-overweight, overweight, and obesity in the three types of family dysfunction. The prevalence of

Overweight and obesity

The prevalence of overweight/obesity among our participants was 12.68% and 8.61%, respectively. There were 572 (14.64%) boys and 394 (10.63%) girls who were overweight, while 384 (9.83%) boys and 272 (7.34%) girls were obese. The occurrences of overweight and obesity were 8.26% and 5.93% among participants living in urban areas, compared with that of 4.12% and 2.68% in rural areas. The Mann-Whitney U test suggested boys (Z=-6.11, $P<0.001$) and participants living in urban areas

Table 2 The prevalence of children and adolescents overweight / obesity

		Non-overweight	Overweight	Obesity	Total	Z	P
Gender	Boys	2952 (75.54)	572 (14.64)	384 (9.83)	3908 (51.31)	-6.11	< 0.001
	Girls	3042 (82.04)	394 (10.63)	272 (7.34)	3708 (48.69)		
Residence	Urban	3772 (49.53)	652 (8.26)	452 (5.93)	4876 (64.02)	-4.19	< 0.001
	Rural	2222 (29.18)	314 (4.12)	204 (2.68)	2740 (35.98)		
Total		5994 (78.70)	966 (12.68)	656 (8.61)	7616		

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Table 4 The summary of LPA

Model	k	χ2	AIC	BIC	aBIC	entropy	aLMRT	BLRT	Classification probabilities
1	10	-52,414	101,820	104,919	104,887				
2	16	-46,386	92,805	92,916	92,865	0.89	<0.001	<0.001	0.7181/0.2819
3	22	-44,302	88,650	88,029	88,732	0.89	<0.001	<0.001	0.6390/0.1232/0.2375
4	28	-42,489	85,034	85,228	85,139	0.92	<0.001	<0.001	0.5928/0.2773/0.0840/0.0458
5	34	-41,366	82,802	83,038	82,930	0.90	<0.001	<0.001	0.5194/0.2016/0.0885/0.1585/0.0320
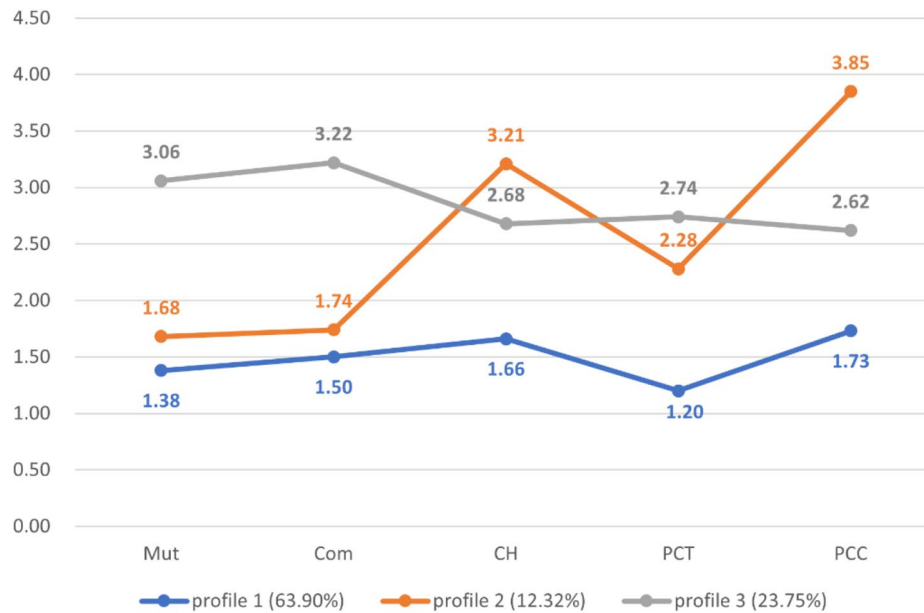
Fig. 1 The three-profile model estimated means in each dimension. Notes: Mut = mutuality, Com = communication and cohesiveness, CH = conflict and harmony, PCC = parental concern, PCT = parent control, profile 1 = mild family dysfunction, profile 2 = moderate family dysfunction, profile 3 = severe family dysfunction. Final profile proportions based on the most likely latent profile membership are specified in parenthesis

Table 5 Non-overweight, overweight and obesity in three types of family dysfunction

	Non-overweight	Overweight	Obesity	Total(%)
Mild family dysfunction	3878(79.65)	592(12.16)	399(8.19)	4869 (63.93)
Moderate family dysfunction	699(74.52)	138(14.71)	101(10.77)	938 (12.32)
Severe family dysfunction	1417(78.33)	236(13.05)	156(8.62)	1809 (23.75)
Total(%)	5994 (78.70)	966(12.68)	656(8.61)	7616

overweight/obesity was 12.16%/8.19%, 14.71%/10.77%, and 13.05%/8.62% for families with mild, moderate, and severe dysfunction, respectively. The risk of overweight/obesity was positively associated with increasing levels of family dysfunction ($P<0.001$).

Bivariate correlations

Table 6 displayed the result of bivariate correlations, which indicated that gender, ethnicity, the number of siblings, residence, grade, pocket money per week, and the education level of parents might be associated with being overweight/obese, in addition to family function.

Stepwise logistic regression

Stepwise logistic regression was applied to further explore the connections between family function and overweight/obesity, family function was regarded as an independent variable, and the other variables were entered as the covariates. Results suggested that the risk of overweight/obesity was higher in the moderate (overweight: OR=1.27, 95% CI:1.01~1.59, $P=0.04$; obesity: OR=1.35, 95% CI:1.02~1.79, $P=0.03$) and severe (overweight: OR=1.38, 95% CI:1.15~1.66, $P=0.001$; obesity: OR=1.55, 95% CI:1.23~1.96, $P<0.001$) dysfunction families when compared with the mild dysfunction family. Gender, residence, grade, pocket money per week, the number of siblings, and mother's education level might relate to being overweight/obese in children and

Table 5 Bivariate correlations

	Gender	Ethnicity	TNOS	Residence	Age	Grade	Edu[1]	Edu[2]	PM	FF	OW/OB
Gender	1.00										
Ethnicity	-0.03	1.00									
TNOS	0.07**	-0.02	1.00								
Residence	0.45**	-0.04**	0.08**	1.00							
Age	0.00	0.02	-0.015	-0.21**	1.00						
Grade	0.01	0.00	0.031**	0.06**	0.16**	1.00					
Edu[1]	0.00	0.00	0.71**	0.07**	0.01	0.54**	1.00				
Edu[2]	0.03**	0.00	0.52**	0.04**	0.02	0.30**	0.63**	1.00			
PM	-0.05**	0.04**	-0.33**	-0.07**	0.09**	0.16**	0.07**	0.04**	1.00		
FF	-0.03*	-0.01	0.00	-0.01	-0.25**	-0.05**	0.00	0.00	0.00	1.00	
OW/OB	-0.08**	0.03*	-0.10**	-0.04**	-0.02	0.53**	0.39**	0.25**	0.15**	0.02*	1.00

Notes: TNOS=the number of siblings; Edu[1]=father education level; Edu[2]=mother education level; PM=pocket money per week; FF=family function; OW=overweight; OB=obesity.

* $P<0.05$, ** $P<0.001$

Table 6 Stepwise logistic regression outcomes

		P	OR	95%CI
Overweight	Mild FD			
	Moderate FD	0.04	1.27	1.01, 1.59
	Severe FD	0.00	1.38	1.15, 1.66
	Gender	0.00	0.65	0.55, 0.77
	Residence	0.02	0.81	0.67, 0.97
	Grade	0.00	8.26	7.03, 9.71
	PM	0.01	1.13	1.04, 1.23
	TNOS	0.00	0.18	0.14, 0.23
	Edu[2]	0.00	1.76	1.62, 1.90
Obesity	Mild FD			
	Moderate FD	0.03	1.35	1.02, 1.79
	Severe FD	0.00	1.55	1.23, 1.96
	Gender	0.00	0.67	0.54, 0.83
	Residence	0.00	0.68	0.55, 0.85
	Grade	0.00	54.89	39.59,76.12
	PM	0.00	1.22	1.10, 1.35
	TNOS	0.00	0.12	0.08, 0.16
	Edu[2]	0.00	1.82	1.65, 2.01

Notes: FD=family dysfunction; PM=pocket money per week; TNOS=the number of siblings; Edu[2]=mother education level

adolescents. The detailed information was presented in Table 7.

Discussion

Overweight /obesity in children and adolescents

The current research demonstrated that the incidence of children and adolescents overweight was higher than in previous research investigating youngsters from 9 Chinese provinces but not including Chengdu city (12.58% vs. 11.70%) in 2015, while obesity was lower (8.61% vs. 12.74%) [43]. Previous research predicted [3, 44] that the overweight and obesity occurrences were likely to grow sustainably, but our results weren't following the same tendency, which might have been influenced by the regional disparities. When Comparing the developing and developed countries [45, 46], the prevalence of obesity in Chengdu (boys: 9.83%, girls: 7.34%) was close to the two developing countries like Brazil (boys: 9.2%, girls: 7.6%) and Russian (boys: 9.9%, girls: 7%), but lower than some developed countries like American (boys:16.5%, girls: 15%), Canada (boys:12%, girls: 9.1%), and Korean (boys:17.7%, girls: 12%).

The risk factors of overweight/obesity

The stepwise logistic model displayed some interesting results. The risk of being overweight in primary school was 8.26 times more than in junior high. For obesity, the OR value even reached 54.89. It's amazing and suggested that more attention deserves to be paid to junior high school students. Interestingly, only the education level of the mother had a significant association with the youth's overweight/obesity in the stepwise logistic model, although the bivariate correlation outcomes showed the relationships between both the father's and mother's education levels and overweight/obesity. This outcome suggested mothers' crucial role in being overweight/obese.

LPA categorized family function into three classifications: mild with the lowest scores in all dimensions, moderate with the highest scores in conflict and harmony, and parental control, and severe with the highest scores in mutuality, communication and cohesiveness, and parental concern. Our findings indicated a greater risk of being overweight/obese in families with poorer functioning, consistent with previous research [17, 19]. It is worth noting that Kinston et al [47]. reported an inverse conclusion, associating obesity with better family function. Chen et al [48]. didn't find significant difference in family functioning among underweight, normal-weight, and overweight children. However, it is well-documented that children from poorly functioning families experience negative health effects and consume fewer servings of fruits and vegetables compared to children from healthy family environments [49–51]. Besides, children growing

up in families with healthy functioning are encouraged to engage in physical activities and participate in obesity prevention programs [49, 52]. In a word, more evidence seems to support our conclusion about family function and overweight/obesity.

Family conflict was considered as an environmental stressor, contributing to poor social support in the family [53]. The stress-related reaction was accompanied by increases in corticosteroids and catecholamines, affecting fat storage and blood sugar levels [54]. Moreover, stress has been found to increase the desire to consume highly palatable foods [55]. Therefore, members in a situation with a high level of family conflict for a long time were more likely to develop overweight/obesity [56, 57].

Parental control is a parenting strategy aiming at expressing and maintaining behavioral standards for children. Different levels of parental control could have different effects [24]. Exerting control over food choices and behaviors might prevent overweight/obesity to some extent, particularly for younger children whose food intake (food choice, frequency) is largely dependent on parental decisions. For example, parental control in feeding patterns, such as pressure to eat (like forcing children to eat certain foods), was positively associated with overweight/obesity, but restriction (constraint of child's access to or intake of certain foods) was not [58, 59]. And early weight status tended to persist throughout a child's growth. Furthermore, excessive parental control has been demonstrated to be associated with lower fruit and vegetable intake and increased consumption of unhealthy snacks, causing higher BMI and promoting the occurrence of overweight/obesity [60].

Mutuality, Communication, and Parental Concern represent dimensions that are closely related to cohesiveness and communication within the family [28]. Family cohesion refers to the emotional bond shared among all family members [23]. Our findings, along with the research conducted by McConley et al [61]. supported that a cohesive family environment could decrease the risk of overweight/obesity. However, it is worth noting that Hooper et al. [62] suggested that cohesion wasn't significantly associated with children's BMI. Nonetheless, the conclusions drawn in their study may be limited by the small sample size.

Strengths and limitations

The obvious strength of the current research was its sampling method. To represent the situation in Chengdu, all schools were selected from the south, north, west, east, and downtown of Chengdu, and contained enough participants, supplying ample information on family function, the prevalence of overweight/obesity in children and adolescents, and both connections. Another advantage was the application of LPA. LPA divided the family function into three profiles, providing another perspective to identify and further learn the family function specialty.

However, there were certain limitations to consider in the current research. Firstly, the study focused on family function and its associations with overweight/obesity in children and adolescents, but there were multiple factors influencing overweight/obesity. The subsequent follow-up was expected to further identify their connections. The other limitation was the generalizability of our findings beyond Chengdu. The study provided valuable insights into the specific context of Chengdu, caution should be exercised when applying these findings to other regions. Additional research in different settings is necessary to validate and expand upon the conclusions drawn in this study.

Conclusion

The prevalence of overweight/obesity among children and adolescents in Chengdu was a concern. In this study, the classification of family function into three profiles - mild, moderate, and severe family dysfunction based on individual scores in each dimension, revealed a corresponding increase in the risk of overweight/obesity as the level of family dysfunction escalated. Further research was expected to gain a deeper understanding of the relationships between family dysfunction and overweight/obesity, as well as to explore the generalizability of these findings.

Authors' contributions
Li Zhao, Xiufang Zhao and Xixi Jiang contributed to the study design, data interpretation, writing of manuscript. Xixi Jiang and Xiujuan Zhang performed the data analysis. Xixi Jiang, Yan Song and Junxia Zhou prepared tables and figure.

Data Availability
The datasets generated and/or analysed during the current study are available reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate
The study was conducted according to the guidelines of the Declaration of Helsinki and approved by Medical Ethics Committee of Sichuan University

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(K2020025). Written informed consents were obtained from all participants and their legal guardians before participating.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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