Research paper

Teenager dietary behavior and health literacy in China: influencing factors and coping strategies

Keywords
survey, diet, behavior, care, health, Teenager

Abstract
Introduction
Understanding health literacy is important for formulating health policies and conducting public health interventions. We aimed to evaluate the status quo and influencing factors of teenager dietary behavior and health literacy in China, to provide insights to the coping strategies of teenager health.

Material and methods
From March 1 2021 to May 15, 2021, teenagers in four high schools in Bengbu, China were selected. The "Interactive Health Literacy Questionnaire for Chinese Teenagers "(IHLQCT) was used for assessing health literacy. Mixed linear models were used to analyze the relationship between dietary behavior patterns, IHLQCT and individual characteristics.

Results
A total of 1920 teenagers were included. The average score of IHLQCT was (72.45±8.99). Mixed linear analyses showed that parents' educational level (β=-0.11, 95%CI: -0.19, 0.05), monthly family income (β=0.08, 95%CI:0.02, 0.16), IHLQCT scores (β=0.15, 95%CI: 0.10, 0.23) were associated with the risky dietary behavior patterns in teenagers (all P<0.05). Only child (β=-0.12, 95%CI: -0.35, -0.09), parents' educational level (β=0.49, 95%CI:0.13, 0.95) monthly family income (β=0.14, 95%CI: 0.08, 0.38), IHLQCT scores (β=0.45, 95%CI: 0.24, 0.69) were associated with the protecting dietary behavior patterns (all P<0.05). Only child (β=-0.16, 95%CI: -0.41, -0.07), parents' educational level (β=0.49, 95%CI: 0.11, 0.82) monthly family income (β=0.17, 95%CI: 0.10, 0.41), risky dietary behavior patterns (β=0.34, 95%CI: 0.14, 0.83), protecting dietary behavior patterns (β=0.22, 95%CI: 0.07, 0.51) were associated with the IHLQCT (all P<0.05).

Conclusions
Teenager dietary behavior is closely associated with health literacy. There are differences in the dietary behaviors of teenagers under different family characteristics in China.

Explanation letter
Dear editor:
Manuscript AMS-14252-2022-01R1 entitled “Teenager dietary behavior and health literacy in China: influencing factors and coping strategies", which we submitted to Archives of Medical Science, has now been revised and resubmitted, the responses to the comments of the reviewers are organized one by one at the bottom of this letter.
We sincerely thank you for your tireless patience and reviewer’s wise comments on our manuscript, we marked our responses in red color to distinct from the reviewers’ suggestion, and marked the revised parts in the manuscript with red color, sincerely hope this will simplify your work.
If you have any questions, please do not hesitate to contact us.
Best regards,
Ye
Review 1:
I suggest the following changes to the manuscript
- precise the abstract and the title. I believe that your manuscript will benefit in terms of visibility and

citations if in the abstract the setting is mentioned (i.e. China)
Thank you, we have revised and indicated the setting as you kindly suggested, please see the revised title and abstract section.

- precise the aim between the abstract and the manuscript body. As of now, for me, it is unclear and slightly different.
Thank you for your kind suggestions, we have revised and explained the aim to make it more clear, please see the revised abstract and background section.

- the Methods section is very detailed but please on line 86 you mention "our city" - which one is this?
Thank you, we have indicated the city as you kindly suggested.

- is your questionnaire validated?
Thank you, the questionnaires were validated with good reliability, we have explained it in the revised method section, please see the revised manuscript.

- please provide the questionnaires you designed
Thank you, we have provided the questionnaires as you kindly requested.

Review 2:
It is an interesting manuscript. Authors succeed to present their data in a clear way adding information to the existing literature. Therefore, I have no corrections to do and the manuscript can be published unaltered.
Thank you, we really appreciate your kind help in improving our manuscript.

Review 3:
I've read with attention the paper of Wang et al. that is potentially of interest. The background and aim of the study have been clearly defined. The methodology applied is overall correct, the results are reliable and adequately discussed. I've only some minor comments:
- The references are not always as reported in the journal style. They have to be rechecked
Thank you, we have checked and updated the references format as you kindly suggested, please see the revised manuscript.

- The authors should consider to include some recent papers recently published on the same argument on the Arch Med Sci
Thank you, we have checked and cited associated recently published reports in Arch Med Sci(Ref 11, 30,38, 39) as you kindly suggested, please see the revised manuscript.

Review 4:
GENERAL COMMENTS
The issue of Health Literacy empowerment in the all-ages population, with emphasis being given to youth, is of critical importance for addressing public health issues related to dietary habits and subsequent health problems. However, the overall impression concerning this study, is that the issues examined "Teenager dietary behavior and health literacy: influencing factors and coping strategies", are not appropriately exposed, analyzed, and discussed.
As a result, there is no evidence provided about the novelty of the study, the importance of obtained results, their presentation, and discussion. Several information is not mentioned and discussed: The relation between teenagers' dietary behavior & Health Literacy, which is the study's subject, is totally absent from the discussion. What is the effect of Health Literacy on teenagers' dietary behavior? What is its correlation with the variables being examined? Furthermore, the country's teenagers' Health Literacy profile -according to the mentioned studies- should be further mentioned either in the Introduction or in the Discussion section. Furthermore, English language editing should be advisable.
Thank you for your kind suggestions, we have added more explanations on the relation between teenagers' dietary behavior & Health Literacy, please see the revised discussion section. Besides, we have explained the China's teenagers' Health Literacy profile in the revised Introduction or in the Discussion section as you kindly suggested. Furthermore, we have carefully checked and corrected the grammar as possible as we can, see the revised manuscript. Besides, since we are not native

English speaker, we have sent our manuscript to for native language editing, see the revised manuscript and enclosed language editing certificate.

Specific comments:
1)□Line 114: Which were the possible corrected problems?
Thank you, we have explained the possible corrected problems as you kindly suggested, please see the revised method section.

2)□Lines 170-71: How this result (the percentage of 36.98% of teenagers having good Health Literacy was extracted? What was the effect of subjects' age (10-18 years of age), and sex?
Thank you for your kind consideration, 36.98% teenagers' IHLQCT was ≥70 points with good health literacy. We have checked effect of subjects' age and sex on the health Literacy, we have not found the group differences, which may be associated with the small sample size. We have explained this as you kindly suggested, please see the revised discussion section.

3)□Lines 178-79: Definition of relative evidence is needed: what is an adverse eating behavior, how is it expressed & justified? Which are the related adverse eating behaviors mentioned here?
Thank you for your kind suggestions, we have checked and explained the adverse eating behavior as you kindly suggested, please see the revised discussion section.

4)□Lines 180-81: In what specific ways level of students' Health Literacy is achieved, specifically teenagers' HL??
Thank you, we have explained the expected teenagers' HL as you kindly suggested, please see the revised discussion section.

5)□Line 186: «Factor analysis is one of the methods to study dietary patterns»: Methodological justification for this is needed.
Thank you, we have removed this sentence as you kindly considered, please see the revised discussion section.

6)□Lines 187-88: Definition of chronic non-communicable diseases is needed.
Thank you for your suggestion, we have provided the definition of chronic non-communicable diseases as you kindly suggested, please see the revised discussion section.

7)□Lines 189-91: references are not provided.
Thank you, we have added the related references (Ref38, 39) as you kindly suggested, please see the revised discussion section.

8)□Lines 191-92: references are also needed.
Thank you, we have added the related references(Ref40, 41) as you kindly suggested, please see the revised discussion section.

9)□Lines 192-95: Lack of clarification, major issues are not discussed: how this heterogeneity (those differences) are expressed in the referred studies, and which are the similarities in the factors of determining dietary patterns? A brief mention of those factors should be advisable.
Thank you for your kind suggestion, we have explained the potential factors as you kindly advised, please see the revised discussion section.

10)□Lines 197-99: How is this consumption reached? Is it a general statement, or a result of the present study? It remains to be cleared.
Thank you, we have explained it as you kindly suggested, please see the revised discussion section.

11)□Lines 208-09: “promoting some children's health problems”: Which dietary health problems are usually frequent in teenagers?
Thank you, we have explained the common dietary health problems as you kindly suggested, please see the revised the discussion section.

12)□Lines 218, 220, 225: There are no References provided for the studies mentioned.
Thank you, we have checked and added the references as you kindly suggested, please see the revised discussion section.

13)□The relation between teenager dietary behavior & health Literacy, which is the study's subject, is totally absent from the discussion. What is the effect of Health Literacy on teenagers' dietary behavior? What is its correlation with the variables being examined?
Thank you for your kind suggestions, we have added more explanations and discussions on the teenagers' dietary behavior and health literacy as you kindly suggested, please see the revised manuscript.

Section Editor recommendation
The paper needs serious improvements in the Discussion part.
Thank you, we have revised the discussions section based on our findings to make it more logic and clear, please see the revised manuscript.

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Title page

Title: Teenager dietary behavior and health literacy in China: influencing factors and coping strategies

Running title: dietary behavior & health literacy

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Abstract

Introduction: Understanding health literacy is important for formulating health policies and conducting public health interventions. We aimed to evaluate the status quo and influencing factors of teenager dietary behavior and health literacy in China, to provide insights to the coping strategies of teenager health.

Methods: From March 1 2021 to May 15, 2021, teenagers in four high schools in Bengbu, China were selected. The "Interactive Health Literacy Questionnaire for Chinese Teenagers "(IHLQCT) was used for assessing health literacy. Mixed linear models were used to analyze the relationship between dietary behavior patterns, IHLQCT and individual characteristics.

Results: A total of 1920 teenagers were included. The average score of IHLQCT was (72.45±8.99). Mixed linear analyses showed that parents' educational level (β=-0.11, 95%CI: -0.19, 0.05), monthly family income (β=0.08, 95%CI:0.02, 0.16), IHLQCT scores (β=0.15, 95%CI: 0.10, 0.23) were associated with the risky dietary behavior patterns in teenagers (all P<0.05). Only child (β=-0.12, 95%CI: -0.35, -0.09), parents' educational level (β=0.49, 95%CI:0.13, 0.95) monthly family income (β=0.14, 95%CI: 0.08, 0.38), IHLQCT scores (β=0.45, 95%CI: 0.24, 0.69) were associated with the protecting dietary behavior patterns (all P<0.05). Only child (β=-0.16, 95%CI: -0.41, -0.07), parents' educational level (β=0.49, 95%CI: 0.11, 0.82) monthly family income (β=0.17, 95%CI: 0.10, 0.41), risky dietary behavior patterns (β=0.34, 95%CI: 0.14, 0.83), protecting dietary behavior patterns (β=0.22, 95%CI: 0.07, 0.51) were associated with the IHLQCT (all P<0.05).

Conclusions: Teenager dietary behavior is closely associated with health literacy. There are differences in the dietary behaviors of teenagers under different family characteristics in China.

Keywords: Teenager; diet; behavior; health; care; survey

Background

Health literacy refers to the ability of individuals to obtain, understand, adopt and process health information and services, and make correct judgments and decisions through the health information and services, and maintain and promote their own health[1, 2]. Health literacy is a key factor to measure the overall health level of residents. Low health literacy can increase the prevalence of many types of diseases and affect the quality of public health[3]. Improving the health literacy of the whole people will help to improve the public's self-care awareness and health care ability, and it plays a positive role in improving the health status of the population[4-6]. Eating habits are important behaviors that determine the dietary structure and nutritional status of residents, which are closely related to the occurrence, development and prognosis of diseases[7, 8]. Understanding the residents' health literacy and eating habits will help the government to understand people's conditions, formulate targeted health policies, and help improve the level of public health[9].

Middle school students are in a critical period of growth and development, and their behavioral habits and health at this stage can have an important impact on adulthood[10, 11]. The results of the several national student physique and health surveys[12-14] in China conducted from 1985 to 2018 show that the detection rate of overweight and obesity among students aged 7-22 has increased year by year, which is mainly related to the daily eating behavior of students. Previous studies[15-18] have shown that low health literacy increases the risk of bad health behaviors such as smoking and

drinking among adolescents. To this end, this study aimed to understand the dietary behavior patterns of Chinese teenagers aged 10-18 years, to evaluate the related factors affecting dietary behavior patterns and health literacy, thereby providing scientific basis for formulating dietary behavior interventions to improve teenager health.

Methods

Ethics

In this study, all methods were performed in accordance with the relevant guidelines and regulations. This study protocol had been verified and approved by the ethical committee of The First Affiliated Hospital of Bengbu Medical College (Approval number:2018045). And written informed consents had been obtained from the included teenagers and their parents.

Sample size calculation

The stratified cluster sampling was adopted, and the minimum sample size of each stratum was calculated by referring to the sample size calculation method of "Chinese Citizens' Health Literacy Survey"[19]: $N=\frac{\mu_{\alpha}^{2}\times\pi(1-\pi)}{\delta^{2}}\times deff$, N was the sample size; π was the awareness rate of a certain health knowledge or the formation rate of behavior in the monitoring indicators, π=50% in this survey; ε was the allowable error, which could be determined according to the value of the selected rate and other specific circumstances, it was usually controlled within 10%-15%, in order to ensure the accuracy, this survey took ε=10%; *Deff* was the random effect of complex sampling, we took *deff* =1.8. Considering the loss of respondents, the loss to follow-up rate was calculated as 10%, that was, an additional N*10% needed to be added. In addition, considering the stratification factors, there were 2 layers for gender and 3 layers for school level with a total of 6 layers, and the final sample size should at least be: N=311 persons/layer × 6 layer = 1866.

Participants

According to the principles of geographical distribution and convenience sampling, from March 1 2021 to May 15, 2021, teenagers in four junior and senior high schools of Bengbu city, China were selected. The inclusion criteria for participants were that the age of teenagers was between 10 and 18 years old, and the children and their parents signed an informed consent form.

Survey content

Following contents and information were collected and analyzed:

(1) General information: On the basis of extensive reading of the literature, we collected the personal information including gender, school type, whether the student is the only child in the family, self-assessment of the family's economic status and parents' educational level;

(2) Health literacy evaluation: The "Interactive Health Literacy Questionnaire for Chinese Teenagers "(IHLQCT)[20] was used for the evaluation of health literacy. The Cronbach's alpha coefficient of the questionnaire was 0.84, the split-half reliability was 0.84, and the standard correlation validity was 0.31, indicating good reliability and validity. The survey content of IHLQCT included five parts: basic situation, health knowledge, health concept, health skills and health behavior. Referring to the scoring method of the Chinese Citizens Health Literacy Questionnaire, when the actual score of the overall questionnaire was greater than or equal to 70 points, indicating that the respondents have high health literacy, otherwise it was rated as low health literacy.

(3) Dietary behavior evaluation: We referred to the "2014 National Student Physical Fitness and Health Survey Questionnaire" to evaluate the frequency of dietary behaviors in the past 7 days, including eating breakfast, tofu or soy products, eggs such as eggs and duck eggs, meat, aquatic

products, milk and dairy products, fresh vegetables and fruits, fried foods, sweets, snacks and frequency of eating out. The frequency of the above eating behaviors was divided into 5 grades (never = 0, less than 1 time = 1, 1-2 = 2, 3-5 times = 3, 6-7 times = 4) accordingly. The Cronbach's alpha coefficient of the questionnaire on the dietary behaviors was 0.82 with good reliability and validity[21].

Survey implementation and quality control

In order to reduce the bias of the survey, the investigators received special training before survey. We explained the purpose of the survey, the requirements and precautions for completing the questionnaire, emphasizing that the questionnaire was anonymous to reduce students' concerns and ensure the authenticity of the results. The two researchers supervised the whole process of the investigation, collected the questionnaires on the spot, and corrected the problems in time.

Statistical analysis

We used EpiData 3.0 software to input and develop the database. Stata 13.1 software was used for data analysis. The dietary pattern was based on the average daily intake of vegetables and fruits, and the number of days in a week for breakfast, milk, sugar-sweetened beverages, fried foods, high-energy snacks, and eating out. The principal components in factor analysis with $P<0.05$ were used after correcting the resting factors. All the ten dietary items were included in the analysis using the method of the maximization of variance orthogonal rotation, and the dietary behavior pattern was determined with an eigenvalue ≥ 1. When the absolute value of the factor loading was ≥ 0.35, it was considered to be a good representative of the principal component, and then to determine the eating behavior patterns of teenagers. We used the rank sum test to compare the differences in factor scores of dietary behavior patterns of teenagers. Mixed linear models were used to analyze the relationship

between dietary behavior patterns, IHLQCT and individual characteristics of the respondents. The test level was α=0.05 in this study.

Results

1960 questionnaires were distributed in this study, and a total of 1920 valid questionnaires were obtained. The effective rate of questionnaire recovery was 97.96%. The average score of IHLQCT was (72.45±8.99). The characteristics of included teenagers were presented in Table 1.

Table 1 The characteristics of included teenagers

Two dietary behavior patterns in teenagers were obtained, its cumulative variance contribution rate was 45.16%. The contribution rate of pattern 1 was 23.21%, which was mainly related to sugar-sweetened beverages, fried foods, high-energy snacks, and eating out, it was named as risky dietary behavior pattern. The contribution rate of pattern 2 was 21.95%, which was mainly related to vegetables, fruits, breakfast, milk, it was named as protective dietary behavior pattern (Table 2).

Table 2 Factor loading matrix of dietary behavior patterns in teenagers

As presented in Table 3, univariate analyses showed that body mass index (BMI) and IHLQCT scores was associated with the risky dietary behavior pattern (all $P<0.05$). Gender, age, BMI, only child, parents' educational level, monthly family income (RMB) and IHLQCT scores were associated with the protecting dietary behavior pattern (all $P<0.05$).

Table 3 Univariate analyses on the characteristics and dietary behavior patterns

As presented in Table 4, Mixed linear analyses showed that parents' educational level (β=-0.11,

95%CI: -0.19, 0.05), monthly family income (β=0.08, 95%CI:0.02, 0.16), IHLQCT scores(β=0.15, 95%CI: 0.10, 0.23) were associated with the risky dietary behavior patterns in teenagers(all P<0.05).

Table 4 Mixed linear analyses on the between characteristics and risky dietary behavior patterns in teenagers

As presented in Table 5, mixed linear analyses showed that only child (β=-0.12, 95%CI: -0.35, -0.09), parents' educational level(β=0.49, 95%CI:0.13, 0.95) monthly family income(β=0.14, 95%CI: 0.08, 0.38), IHLQCT scores(β=0.45, 95%CI: 0.24, 0.69) were associated with the protecting dietary behavior patterns in teenagers(all P<0.05).

Table 5 Mixed linear analyses on the relationship between characteristics and protecting dietary behavior patterns in teenagers

As presented in Table 6, mixed linear analyses showed that only child (β=-0.16, 95%CI: -0.41, -0.07), parents' educational level(β=0.49, 95%CI: 0.11, 0.82) monthly family income(β=0.17, 95%CI: 0.10, 0.41), risky dietary behavior patterns(β=0.34, 95%CI: 0.14, 0.83), protecting dietary behavior patterns (β=0.22, 95%CI: 0.07, 0.51) were associated with the IHLQCT in teenagers(all P<0.05).

Table 6 Mixed linear analyses on the relationship between characteristics and IHLQCT in teenagers

Discussions

Health literacy is a comprehensive reflection of health-related abilities. It starts with acquiring health knowledge and takes understanding as a link, and then transforms the acquired health

knowledge into health concepts and health skills, and finally achieves the purpose of promoting one's own health through healthy behaviors[22-24]. In this survey, 36.98% of teenagers (IHLQCT ≥70 points) have good health literacy. We have checked effect of subjects' age and sex on the health literacy, we have not found the group differences, which may be associated with the small sample size in this present study. Previous surveys[25-27] in other areas of China showed that the proportion of middle school students with basic health literacy was between 11.25% and 41.07%. The difference may be associated with different survey areas and different difficulty coefficients and evaluation criteria of survey tools.

The relation between teenager dietary behavior & health literacy must be considered. Adolescence is a critical period of growth and development, and health during this period can have a profound impact on disease in adulthood[28, 29]. In recent years, the detection rate of obesity among teenagers around the world has been increasing[30]. Studies[31, 32] have shown that poor eating behaviors such as picky eaters/partial eclipse behaviors and eating fried foods are risk factors for obesity. Previous studies[33-35] have shown that adolescents with one risky eating behavior may also have many other risky eating behaviors. It is necessary to reduce the occurrence of risky eating behaviors such as favoring sugar-sweetened beverages, fried foods, high-energy snacks, and eating out et al. by comprehensively improving the level of students' health literacy. Some scholars[36, 37] have pointed out that improving students' health literacy should be the core goal of school health promotion. Therefore, in the future school health education work, while imparting health knowledge and health concepts to students, we should pay attention to the cultivation of health skills, so as to comprehensively reduce students' unhealthy eating behaviors and improve students' nutritional status and achieve good health literacy with IHLQCT ≥70 points.

In this study, factor analysis was used to conduct dimensionality reduction analysis on dietary behaviors related to chronic non-communicable diseases which is a class of diseases closely related to bad behavior and lifestyle, such as cardiovascular disease, diabetes, chronic obstructive pulmonary disease, etc. Two main dietary behavior patterns including risky dietary behavior pattern and protecting dietary behavior patterns were reported currently. Risky dietary behavior patterns are characterized by frequent consumption of sugar-sweetened beverages, fried foods, high-energy snacks, and eating out[38, 39]. Protecting dietary behavior pattern are characterized by high intake of vegetables, fruits, milk, and good breakfast habits[40, 41]. Due to the differences in dietary assessment methods, the number of food categories, food types and statistical analysis methods, the dietary behavior patterns of children and adolescents obtained by each study are not the same, but the factors of determined dietary behavior patterns have certain similarities[42-45]. For example, risky eating behaviors generally include high-salt or high-fat, grilled foods, healthy diets generally include green vegetables, and moderate and regular eating habits.

Identifying family characteristics of different dietary behavior patterns is helpful for targeted early intervention[46]. It should be noted that the risky eating behavior pattern and the protective eating behavior pattern are not totally opponent, and teenagers are likely to follow both the protective eating behavior pattern and the risky eating behavior pattern. For example, teens may eat a high-salt or high-fat diet, which is later adjusted to a lighter diet under the personal health concept or parents' suggestions. This study has found that parental education level is positively correlated with protective dietary behavior patterns, and negatively correlated with risky dietary behavior patterns. Higher parental education level is one of the key factors for good nutritional health knowledge and diet quality in children[47-49]. Besides, we have found that monthly family income is positively

212 correlated with the two dietary behavior patterns, that is, children with high monthly family income
213 may follow both protective dietary behavior patterns and risk dietary behavior patterns. The higher
214 the family income, the better the purchasing power of the family, which shows that it not only
215 increases the possibility of food type and quantity choice, thereby reducing children's picky eaters
216 and improving their dietary quality[50, 51]. However, it also provides the possibility to buy more
217 snacks, thereby promoting some children's health problems such as excessive consumption of fried
218 foods, excessive calorie intake, and insufficient vitamin intake. Eating habits such as eating sweets,
219 beverages, and fried foods occur as usual. Previous studies[52-54] have shown that groups with
220 lower socioeconomic status are more likely to have insufficient fruit and vegetable intake, and
221 groups with higher socioeconomic status tend to consume more fat, salt, and processed foods. The
222 results of this study show that the dual risk of dietary behavior patterns of children from families
223 with low parental education and the duality of dietary behavior patterns of children from high
224 monthly income families should be highly valued in dietary behavior interventions.
225 This study has found that children from only-child families were more likely to follow protective
226 eating behavior patterns, but we have not found any relationship with high-risk eating behavior
227 patterns. Previous studies[55, 56] have pointed out that there is consistency between the only child
228 and children eating breakfast, and the parents of the only child pay more attention to children's
229 breakfast. Studies[57, 58] have found that the number of siblings is positively correlated with the
230 adherence to the dietary patterns of "protein and fast food", "fruits and vegetables", and "sweet, soft
231 drinks and dairy products". Regarding the relationship between the only child and risky eating
232 behavior patterns, previous study[59] has shown that the presence of "junk" eating patterns (ie, high
233 fat and sugar, processed foods, and convenience foods) is positively related to the total number of

siblings. Previous Chinese studies[60, 61] have found that growing up in one-child households significantly increases the probability of children being overweight or obese, and children in one-child households eat more high-sugar, high-fat, and high-protein foods. Therefore, for only children, we should focus on tracking and correcting poor eating behaviors to promote adolescent health literacy

This study has certain limitations must be considered. Firstly, this study has used risk and protective eating behavior patterns as dependent variables to explore related influencing factors. However, the two dietary behavior patterns related to chronic non-communicable diseases are not either one or the other, and the influencing factors are not simply inversely related. Secondly, this study is only a cross-sectional survey and we only analyze the possible related factors, we cannot obtain a causal relationship. Future intervention studies on the identified influencing factors are still needed to further verify the relationship. Finally, this study is only a single regional survey, and there can be certain dietary habits and regional deviations, the results should be treated with cautions and verified in many areas.

Conclusions

In conclusion, this study has found that teenagers have low levels of health literacy, which are closely related to their eating behaviors. More attentions should be paid to the differences in the dietary behaviors of teenagers under different family characteristics, and more interventions are needed on the promotion of healthy eating habits of young residents, and reduction of their risky dietary habits, thereby improving the health literacy and physical fitness of teenagers.

List of abbreviations

BMI, body mass index

IHLQCT, Interactive Health Literacy Questionnaire for Chinese Teenagers

Declarations

Ethics approval and consent to participate

In this study, all methods were performed in accordance with the relevant guidelines and regulations. This study protocol had been verified and approved by the ethical committee of The First Affiliated Hospital of Bengbu Medical College (Approval number:2018045). And written informed consents had been obtained from the included teenagers and their parents.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

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Author contributions

H Y, Q W designed research; Q W, L Z, N L, D X, H Y conducted research; Q W, L Z, H Y analyzed data; Q W, L Z wrote the first draft of manuscript; H Y had primary responsibility for final content. All authors read and approved the final manuscript.

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Table 1 The characteristics of included teenagers

Characteristics		Cases	Percentage (%)
Gender			
	Male	1036	53.96%
	Female	884	46.04%
Age(y)			
	10~12	518	26.98%
	13~15	728	37.92%
	16~18	674	35.10%
BMI(kg/㎡)			
	<18.5	76	3.95%
	18.5~24	1112	57.92%
	24~26.9	460	23.96%
	＞26.9	272	14.17%
Only child			
	yes	1363	70.92%
	no	557	29.01%
Parents' educational level			
	Primary school	340	17.71%
	Junior high school	881	45.89%
	Senior high school	538	28.02%
	University	161	8.38%
Monthly family income (RMB)			
	≤3000	265	13.80%
	3000~6000	1016	52.92%
	6000~9000	460	23.96%

	≥9000	179	9.32%
IHLQCT scores			
	<70	710	36.98%
	≥70	1210	63.02%

BMI, body mass index; IHLQCT, Interactive Health Literacy Questionnaire for Chinese Teenagers

Table 2 Factor loading matrix of dietary behavior patterns in teenagers

Factors	Risky dietary behavior pattern	Protecting dietary behavior pattern
Vegetable	-0.068	0.694
Fruit	0.062	0.771
Breakfast	-0.944	0.498
Milk	0.125	0.556
Sugar-sweetened beverages	0.611	0.017
Fried food	0.803	0.024
High energy snack	0.619	0.016
Eating out	0.574	-0.020

Table 3 Univariate analyses on the characteristics and dietary behavior patterns

Characteristics		Risky dietary behavior pattern		Protecting dietary behavior pattern	
		$M(P_{25}\sim P_{75})$	P	$M(P_{25}\sim P_{75})$	P
Gender			0.109		0.012
	Male	-0.22(-0.75, 0.36)		-0.07(-0.19, 0.25)	
	Female	-0.21(-0.81, 0.47)		0.13(-0.10, 0.58)	
Age(y)			0.088		0.043
	10~12	-0.11(-0.64, 0.55)		0.27(-0.04, 0.77)	
	13~15	-0.15(-0.91, 0.67)		-0.14(-0.24, 0.31)	
	16~18	-0.31(-0.73, 0.09)		0.19(-0.15, 0.85)	
BMI(kg/m^2)			0.042		0.041
	<18.5	-0.07(-0.11, 0.34)		-0.24(-0.62, 0.16)	
	18.5~24	0.17(-0.42, 0.29)		-0.12(-0.28, 0.05)	
	24~26.9	0.45(0.01, 0.79)		-0.17(-0.86, 0.34)	
	＞26.9	0.53(-0.11, 0.89)		0.33(0.08, 0.95)	
Only child			0.113		0.006
	Yes	-0.22(-0.59, 0.14)		0.09(-0.15, 0.28)	
	no	-0.14(-0.45, 0.52)		-0.25(-0.58, 0.07)	
Parents' educational level			0.083		0.012
	Primary school	-0.07(-0.13, -0.10)		-0.17(-0.33, 0.14)	
	Junior high school	-0.26(-0.85, 0.12)		-0.13(-0.53, 0.04)	
	Senior high school	-0.18(-0.36, 0.19)		0.06(-0.14, 0.39)	
	University	-0.04(-0.15, 0.33)		-0.12(-0.47, 0.24)	
Monthly family income (RMB)			0.058		0.035
	≤3000	-0.28(-0.42, 0.21)		-0.04(-0.20, 0.15)	
	3000~6000	-0.16(-0.55, 0.17)		-0.17(-0.44, 0.19)	

	6000~9000	-0.23(-0.96, 0.78)		0.12(-0.41, 0.37)	
	≥9000	-0.02(-0.18, 0.72)		0.25(0.14, 0.81)	
IHLQCT scores			0.011		0.021
	<70	0.35(0.88, 0.29)		-0.03(-0.19, 0.24)	
	≥70	0.18(0.05, 0.74)		0.17(-0.05, 0.30)	

BMI, body mass index; IHLQCT, Interactive Health Literacy Questionnaire for Chinese Teenagers

Table 4 Relationship between characteristics and risky dietary behavior patterns in teenagers

Characteristics	β (95%CI)	t	P
Gender	0.25(-0.18~0.42)	0.177	0.109
Age(y)	-0.12(-0.46, 0.14)	1.183	0.114
BMI(kg/m^2)	0.18(-0.10, 0.44)	4.209	0.071
Only child	-0.13(-0.38, -0.12)	0.413	0.103
Parents' educational level	-0.11(-0.19, 0.05)	-2.405	0.018
Monthly family income	0.08(0.02, 0.16)	2.006	0.009
IHLQCT scores	0.15(0.10, 0.23)	3.184	0.015

BMI, body mass index; IHLQCT, Interactive Health Literacy Questionnaire for Chinese Teenagers

Table 5 Relationship between characteristics and protecting dietary behavior patterns in teenagers

Characteristics	β(95%CI)	t	P
Gender	0.15(-0.04~0.38)	1.207	0.103
Age(y)	-0.11(-0.63, 0.23)	1.135	0.126
BMI(kg/m^2)	0.23(-0.10, 0.61)	3.116	0.101
Only child	-0.12(-0.35, -0.09)	2.013	0.012
Parents' educational level	0.49(0.13, 0.95)	5.226	0.004
Monthly family income	0.14(0.08, 0.38)	2.163	0.022
IHLQCT scores	0.45(0.24, 0.69)	2.005	0.036

BMI, body mass index; IHLQCT, Interactive Health Literacy Questionnaire for Chinese Teenagers

Table 6 The Relationship between characteristics and IHLQCT in teenagers

Characteristics	β(95%CI)	t	P
Gender	0.22(-0.19~0.52)	2.005	0.116
Age(y)	0.14(-0.07, 0.29)	1.021	0.103
BMI(kg/m^2)	0.21(-0.19, 0.74)	2.955	0.085
Only child	-0.16(-0.41, -0.07)	3.153	0.006
Parents' educational level	0.49(0.11, 0.82)	2.011	0.012
Monthly family income	0.17(0.10, 0.41)	1.694	0.009
Risky dietary behavior patterns	0.34(0.14, 0.83)	1.992	0.036
Protecting dietary behavior patterns	0.22(0.07, 0.51)	2.976	0.018

BMI, body mass index