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Evaluation of the Effects of Sugary Beverages on the Health of Adolescent Students in Guangxi Based on Health System Function Scores

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Abstract: *Objective:* To evaluate the health effects of sugary beverage consumption among adolescent students in Guangxi. *Methods:* In three cities of Guangxi (Nanning, Liuzhou, and Guilin), we investigated the consumption of sugary beverages by distributing a self-administered Functional Assessment Questionnaire of Life Health System and a Dietary Behavior Questionnaire (this paper analyzes only the part of sugary beverage consumption) to adolescent students in four schools, aiming to find out the general health status of the students and also to assess the effects of sugary beverages on the functional system health of adolescent students. *Results:* A total of 953 adolescent students between the ages of 14 and 24 were surveyed. Among them, 46.17% consumed sugary beverages once a week; 37.46% consumed them 2–3 times; 11.52% consumed them more than 3 times; and 4.83% consumed them every day. The mean score of Functional Assessment Questionnaire of Life Health System was 32. There was a positive correlation between the frequency of consumption of sugary beverages and the overall systemic function assessment score ($P < 0.05$), and the rank of the total score elevated by 0.314 times for each increase in the level of consumption. Compared to those who drink sugary beverages at least once a day, drinking them once a week showed a statistically significant difference ($P < 0.05$). However, there was no statistically significant difference between drinking 2–3 times a week and more than 3 times a week ($P > 0.05$). The correlation between consuming sugary beverages once a week and 2–3 times a week and endocrine system scores was also statistically significant ($P < 0.05$). *Conclusion:* More than half of the students in the surveyed areas consumed sugary beverages two or more times a week, and the higher the frequency of consumption, the higher the scores of systemic function assessment. Health education on sugar reduction among adolescents should be strengthened.

Keywords: Adolescents; Sugary beverages; Dietary behavior; Questionnaire; Health

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1. Introduction

Sugary beverages are drinks where sugar is artificially added during the manufacturing process, and they contain more than 5% sugar [1]. The addition of sugar refers to sugars and syrups added to food during its production

and preparation process, excluding sugars naturally present in foods [2]. The 2016 Dietary Guidelines for Chinese Residents states that the recommended daily intake of added sugars for adults should not exceed 50 g, and should preferably be kept below 25 g [3]. As the human body possesses metabolic regulatory function, the intake of excessive sugar does not lead to diabetes in the short term, but the body's sugar metabolism will enter the compensatory stage (i.e., abnormal glucose tolerance) when the pancreatic islet function has been impaired [4]. The body's long-term abnormal glucose tolerance stage will eventually greatly increase the risk of developing chronic diseases such as obesity, diabetes, and cardiovascular disease [5]. Therefore, in order to truly achieve primary prevention of chronic diseases and reduce the future healthcare burden on the country, lifestyle changes such as promoting self-health concerns and actively reducing the intake of sugary beverages among children and adolescents need to be promoted.

2. Information and methods

2.1. Study subjects

953 adolescent students aged 14 to 24 years old in four colleges and vocational secondary colleges in the cities of Nanning, Liuzhou, and Guilin in 2021 in the Guangxi Zhuang Autonomous Region were surveyed.

2.2. Methods

Data were collected by completing both the Dietary Behavior Questionnaire (self-designed) and the Functional Assessment Questionnaire of Life Health System Questionnaire (cited from the Chinese Academy of Functional Medicine).

The frequency of drinking sugary beverages was defined as 1 for "no," 2 for once a week, 3 for 2–3 times a week, 4 for more than 3 times a week, and 5 for drinking them every day.

The Functional Assessment Questionnaire of Life Health System was scored as follows: 0 points for almost no symptoms; 1 point for symptoms that are mild or almost non-existent (less than 2 times per month); 2 points for moderate symptoms or occasional symptoms (e.g., 1–2 times per week); 3 points for symptoms that are more severe or frequent (every 1 or 2 days); and 4 points for severe symptoms that occur daily, the higher the total score, the more severe the symptom manifestation.

2.3. Statistical analysis

Microsoft Excel 2010 software was used for data entry and collation; one-way correlations were analyzed univariately using SPSS25.0 general linear model. The independent variables were: male = 1, female = 2; Nanning = 1, Liuzhou = 2, Guilin = 3, other = 4; Han ethnicity = 1, Zhuang ethnicity = 2, other = 3; frequency of drinking sugary beverages ≤ 1 time a week = 1, 2–3 times a week = 2, more than 3 times a week = 3, and every day = 4; and the dependent variable was individual's total score of Functional Assessment Questionnaire of Life Health System. Using the P_{25}, P_{50}, and P_{75} of individual's total score of Functional Assessment Questionnaire of Life Health System as the cut-off point, the total score was divided into 4 groups: group 1 = 0–14, group 2 = 15–32, group 3 = 33–60, and group 4 = 61 and above.

The different influencing factors and total scores, the frequency of sugary beverage consumption, and the function scores of each system were analyzed by ordinal regression, and the difference was considered statistically significant at $P < 0.05$.

3. Results

3.1. Basic characteristics of the population

A total of 953 school students aged 14 to 24 were surveyed. Among them, 629 were from Nanning, 173 from

Liuzhou, and 151 from other areas; 544 were Han ethnicity, 356 were Zhuang ethnicity, and 53 were from other ethnic minorities; male to female ratio was 1.06; mean age was 18.67 ± 3.56.

3.2. Consumption of sugary beverages

Among the 953 students, 440 students (46.17%) drank sugary beverages once a week; 357 students (37.46%) drank sugary beverages 2–3 times; 110 students (11.52%) drank sugary beverages more than 3 times; and 46 students (4.83%) drank sugary beverages every day.

3.3. Functional assessment score of life health system

The total score was 32 for P_{50}, 14 for P_{25}, and 60 for P_{75}; P_{min} 0 and P_{max} 349.

3.4. Correlation analysis between variables and overall health score

Age, gender, and frequency of consumption of sugary beverages all had statistically significant correlations with the overall score ($P < 0.05$); the difference in correlation between region and ethnicity and the overall score was not statistically significant (**Table 1**).

Table 1. Correlation table between groups and total score of systemic function assessment

Influencing factors	Group	*r* value	*P* value	*F* value	*P* value
Age	14–24 years	0.12	< 0.05	3.52	< 0.05
Gender	Male, female	0.23	< 0.05	54.53	< 0.05
Region	Nanning, Guilin, Liuzhou, others	0.05	> 0.05	1.14	> 0.05
Ethnicity	Han, Zhuang, others	0.03	> 0.05	0.49	> 0.05
Frequency of sugary beverage consumption	≤ 1 time a week = 1, 2–3 times a week = 2, more than 3 times a week = 3, every day = 4	0.11	< 0.05	4.715	< 0.05

3.5. Logistic regression of different influencing factors with the total score of systemic function assessment

Gender, frequency of sugary beverage consumption and total health score were associated. The older the age, the higher the total score; women had a higher total score on the systemic function assessment than men; and the risk of an increase in the total score increased by 0.314 times for each increasing level of sugary beverage consumption. The total score of drinking sugary beverages once a week was lower than drinking them every day ($P < 0.05$); the differences between drinking them 2–3 times a week, more than 3 times a week, and drinking them every day were not statistically significant ($P > 0.05$), as shown in **Tables 2** and **3**.

Table 2. Logistic regression analysis of different influencing factors and total scores of systemic function assessment [95% CI of ORs]

Variable	*β* value	Standard error	Wald	Significance	95% confidence interval
Age	0.018	0.330	0.29	> 0.05	-0.047–-0.083
Sex	-0.839	0.132	40.273	< 0.05	-1.098–-0.580
Region	0.047	0.037	1.636	> 0.05	-0.025–0.120
Ethnicity	0.012	0.060	0.043	> 0.05	-0.104–0.129
Frequency of drinking sugary drinks	0.314	0.072	198.065	< 0.05	0.173–0.455

Table 3. Relationship between frequency of consumption of sugary beverages and total scores of systemic function assessment

Variable	β value	Standard error	Wald	Significance	95% confidence interval
1 time a week	-0.792	0.28	7.990	< 0.05	-1.342–-0.243
2–3 times a week	-0.413	0.283	2.132	> 0.05	-0.967–0.141
More than 3 times a week	-0.504	0.316	2.546	> 0.05	-1.124–0.115
Every day	-	-	-	-	-

3.6. Sugary beverages and health scores of each system

There was a statistically significant difference between the endocrine system function abnormality score and drinking sugary beverages once a week, 2–3 times a week, and every day ($P < 0.05$), and there was no statistically significant difference between drinking more than 3 times a week and drinking every day ($P > 0.05$).

There was no statistically significant difference ($P > 0.05$) between the frequency of consumption of sugary beverages and the scores on the individual functional assessments of liver detoxification, glucose metabolism abnormalities, and circulatory system, as shown in **Table 4**.

Table 4. Logistic regression analysis of the association between frequency of sugary beverage consumption and health scores of each system

System	Variable	Estimates	Standard error	Wald	Significance	95% confidence interval
Abnormal liver detoxification function	1 time a week	-0.465	0.278	2.807	0.094	-1.010–0.079
	2–3 times a week	-0.188	0.28	0.451	0.502	-0.738–0.361
	More than 3 times a week	-0.467	0.315	2.201	0.138	-1.084–0.150
	Every day	-	-	-	-	-
Abnormal glucose metabolism	1 time a week	-0.283	0.278	1.036	0.309	-0.829–0.262
	2–3 times a week	-0.076	0.281	0.074	0.786	-0.628–0.475
	More than 3 times a week	0.021	0.315	0.005	0.946	-0.596–0.638
	Every day	-	-	-	-	-
Abnormal endocrine system function	1 time a week	-0.928	0.282	10.855	0.001	-1.480–-0.376
	2–3 times a week	-0.589	0.284	4.302	0.038	-1.146–-0.032
	More than 3 times a week	-0.555	0.317	3.07	0.08	-1.177–0.066
	Every day	-	-	-	-	-
Abnormal circulatory system function	1 time a week	-0.338	0.283	1.434	0.231	-0.892–0.215
	2–3 times a week	-0.141	0.285	0.244	0.621	-0.700–0.418
	More than 3 times a week	-0.278	0.321	0.749	0.387	-0.906–0.351
	Every day	-	-	-	-	-

4. Discussion and conclusion

Excessive sugar intake can lead to excess energy and thus trigger the occurrence of a series of metabolic diseases. In this study, the same respondents in some colleges and vocational schools in Guangxi were surveyed in

two dimensions, and the functional assessment scale was applied to assess their health while investigating their consumption of sugary beverages, so as to analyze the correlation between the two.

The results of the study showed that nearly half of the students aged 14–24 in the survey area consumed sugary beverages once a week, 37.46% consumed them two to three times a week, and 16.35% consumed them three times or more.

Functional Assessment Questionnaire of Life Health System has a total P_{50} score of 32, and a total score of over 16 is generally considered to indicate a potential health risk. As the frequency of consumption of sugary beverages increases, so does the degree of adverse health effects, and women are more likely to be affected than men.

The subjects observed in this study were in adolescence, which is both a special physiological stage crucial for growth and development, and an important period for gradual strengthening of physical fitness [6,7]. However, it has been reported that in recent years, the overall physical fitness indicators of students show a tendency to decline with age. The main reasons are the improvement of modern living conditions, the development of transport, the excessive intake of high-fat, high-protein, and high-calorie foods, the increase in the burden of learning, the reduction of physical exercise, and the intensification of the dependence on computers and the Internet, etc., which also includes the excessive consumption of sugary beverages. China is in a period of nutritional change, from the traditional model based on cereals, vegetables, and potatoes gradually to the Western model based on desserts, beverages, fast food, animal food, etc. [8], the adolescent dietary pattern is also changing. Sugary beverages do not promote satiety, but instead can lead to excessive energy intake compared to the equivalent amount of sugar in solid form. Therefore, the Healthy China Initiative (2019–2030) proposes "three reductions, three health," controlling the intake of added sugars; the 2016 Dietary Guidelines for Chinese Residents [9] suggests no or fewer sugary beverages as much as possible and many other initiatives. The aim is to provide targeted nutritional publicity, education, and guidance to adolescents to promote the development of appropriate dietary habits [10].

In this paper, when analyzing the effects of different consumption frequencies of sugary beverages on the functions of several major body systems, only the correlation with the scores of the effects on the endocrine system function was statistically significant ($P < 0.05$). This suggests that the questionnaire respondents were more sensitive in assessing the health effects of sugary beverages by using the symptom scores of observing changes in the endocrine system, while the scores of abnormalities in liver detoxification, glucose metabolism, and circulatory system function were relatively insensitive.

Functional Assessment Questionnaire of Life Health System [11] is an assessment questionnaire commonly used in the field of health management in the branch of functional medicine. As one of the screening and assessment tools for the public, it is currently used in the field of health management and nutritional personal assessment. The original intention of this survey is to combine campus propaganda work, under the conditions of incomplete health detection instruments, rapidly assess the health status of the investigators, and thereby conduct on-site targeted individual nutrition and health assessments and education for the subjects [12]. However, as functional medicine is not mainstream in modern medicine, and the questionnaire is not a research tool recognized by national research institutes, it is also the first time it is used as a metric tool to conduct surveys in groups, and therefore has some limitations in the application and dissemination of the results.

Disclosure statement

The authors declare no conflict of interest.

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