



Original Article

Water intake and oral disease symptoms in adolescents : a cross-sectional study conducted in Korea in 2021

So-Yeong Kim¹ · Sun-A Lim²

¹Department of Preventive Medicine, College of Medicine, Chosun University

²Department of Dental Hygiene, Songwon University

Corresponding Author: Sun-A Lim, Department of Dental Hygiene, Songwon University, 73, Songam-ro, Nam-gu, Gwangju-si, 61756, Korea. Tel: +82-62-360-5791, Fax: +82-62-360-5962, E-mail: givesuna@nate.com

ABSTRACT

Objectives: Water constitutes a majority of the human body and is essential for health. In addition, water intake can prevent dental caries by improving salivary lubrication and self-cleaning. This study aimed to determine the relationship between the amount of daily water intake and the symptoms of oral disease in Korean adolescents. **Methods:** We used data from the Korea Youth Risk Behavior Web-based Survey (KYRBS), conducted in Korea in 2021, and identified the relationship between daily water intake and oral disease symptoms in Korean adolescents. KYRBS is a nationwide cross-sectional survey conducted by the Korea Disease Control and Prevention Agency (KDCA), and a total of 54,848 participants were included in this study. **Results:** After adjusting for confounding factors, logistic regression analysis showed that tooth pain was more often experienced by those who drank less than two cups of water per day (odds ratio [OR]: 1.14; 95% confidence interval [CI]: 1.01–1.30) than those who drank five or more cups of water per day. **Conclusions:** A low daily water intake is associated with tooth pain, a symptom of dental caries. The results of our study suggest that increasing water intake may reduce dental caries. Therefore, adequate water intake may help prevent dental caries.

Key Words: Adolescents, Dental caries, Tooth pain, Water

Introduction

Adolescence is a period of change and development from childhood to adulthood. The lifestyle habitual of adolescents are closely related to a healthy lifestyle in adulthood [1]. The dietary habits of adolescents affect their oral health, which is closely linked to systemic health [2]. Dietary intake and oral health are closely linked to several factors. Malnutrition can affect the growth and development of the orofacial components, oral mucosa, dental disease and oral cancers. Similarly, a compromised oral cavity can affect daily food intake resulting in poor nutritional status [3].

Water constitutes the majority of the human body and is essential for health. As the body can not store water, any water lost over a period of time must be replaced [4]. In addition, drinking water can help prevent dental caries by improving salivary lubrication and self-cleaning. Increasing your daily water intake can also help reduce your intake of other drinks [5].

In addition, a lack of water in the body can lead to dry mouth and thirst, and can cause various health-related symptoms in the mouth, such as burning mouth due to oral thirst and reduced salivation. If these symptoms persist, they can create an environment conducive to oral diseases [6]. Saliva is necessary to maintain the normal function of the oral soft tissues of the mouth and to suppress oral diseases. When the salivary secretion is reduced, the buffering capacity and pH of the saliva are reduced, which can cause and increase dental caries [7].

Therefore, it is necessary to re-evaluate the relationship between dental caries and periodontal disease according to the amount

of water consumed per day. Most previous studies have examined the relationship between water intake and systemic diseases [8-10]. However, few studies have examined the relationship between oral health behaviors and oral health status in adolescents. Therefore, in this study, we compared oral health status according to demographic characteristics, oral health disease symptoms, and water intake through an online behavioral survey of adolescents representing Korean youth and attempted to predict actual oral health status.

Methods

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines [11].

1. Data Source and Study Participants

This study used data from the 17th Korea Youth Risk Behavior Web-Based Survey (KYRBS), 2021 conducted by the Ministry of Education, the Ministry of Health and Welfare, and the Korea Disease Control and Prevention Agency (KDCA). The KYRBS is an annual cross-sectional survey designed to collect health information from Korean adolescents. To select a nationally representative sample, the KYRBS used stratified cluster sampling to 800 sample schools (400 middle school and 400 high schools). Health information was collected using an anonymous, self-administered online method. In the 2021 survey, 59,006 adolescents were selected, and 54,848 participated in the survey (response rate: 92.9%). The KYRBS protocol was approved by the Institutional Review Board of the KDCA (2021-06EXP-02-P-A), and informed consent was obtained from all participants prior to their participation in the study. Additional information can be found in previous studies [12,13].

2. Frequency of water intake

The participants were asked, 'In the past seven days, how often did you drink water (including bottled water, carbonated water, barley tea, etc.)?' The answers were categorised as 'less than two cups a day', 'three to four cups a day', and 'more than five cups a day'.

3. Oral disease symptoms

Oral disease symptoms included toothache and gingival bleeding. Regarding toothache the participants were asked, 'In the past 12 months, have you had a sore, throbbing, or painful tooth?'. The participants were considered to have tooth pain if they answered yes. Regarding gingival bleeding, the participants were asked, 'Have you had any symptoms of sore or bleeding gums in the past 12 months?'. The participants were considered to have gingival bleeding if they answered yes.

4. Health status characteristics

The health status characteristics of the subjects were subjective perception of their health (very good, good, normal, poor, very poor), current smoking (no, yes), current drinking (no, yes), body mass index (BMI; $\text{underweight} \leq 18.5 \text{ kg/m}^2$, normal ($18.5\text{-}22.9 \text{ kg/m}^2$), overweight ($23.0\text{-}24.9 \text{ kg/m}^2$), obese ($\geq 25.0 \text{ kg/m}^2$), and the number of times they brushed their teeth the previous day (0, 1-2, ≥ 3).

5. Dietary habits

The dietary habits of the participants were determined on the basis of whether they had eaten food in the last seven days. Specifically, the participants were asked about eating breakfast (zero days, one to three days, four to six days, daily), eating fruit (zero

days, one to two times, three to four times, five to six times, daily), drinking carbonated soda drinks (zero days, one to two times, three to four times, five to six times, daily), drinking sweet drinks (zero times, one to two times, three to four times, five to six times, daily), and eating fast food (zero times, one to two times, three to four times, five to six times, daily).

6. General characteristics

The general characteristics of the participants included sex (boy and girl), grade (middle school 1, 2, 3, high school 1, 2, 3), academic grades (very low, low, normal, high, very high), household economic status (very low, low, normal, high, very high), father's education (middle school, high school, \geq college), and mother's education (middle school, high school, \geq college).

7. Statistical analyses

All the statistical analyses were performed using complex sampling methods and procedures. General characteristics, frequency water intake, oral disease symptoms, health status characteristics, and dietary habits were analyzed. The Rao-Scott chi-square test was used to investigate differences in the overall characteristics, health-related characteristics, dietary, toothache, and gingival bleeding. Simple analysis adjusted for significant variable, and multiple logistic regression analysis was conducted to determine the relationship between frequency of daily water intake and toothache gingival bleeding. All analyses were conducted using IBM SPSS Statistics for Mac (ver. 27.0; IBM Corp., Armonk, NY USA). The threshold for statistical significance was $p < 0.05$ for all tests.

Results

1. Oral disease symptoms according to general characteristics

Among the general characteristics of the participants, there were statistically significant differences in tooth pain and gingival bleeding according to sex, grade, academic performance, household economic status, father's education, and mother's education ($p < 0.05$) <Table 1>.

Table 1. General characteristics and oral disease symptoms

Variables	Tooth pain	p^*	Gingival bleeding	p^*
Total				
Sex		<0.001		<0.001
Male	18.0(0.3)		16.6(0.3)	
Female	24.7(0.3)		21.8(0.3)	
Grade		<0.001		<0.001
Middle 1	15.2(0.4)		16.2(0.4)	
Middle 2	18.9(0.5)		17.2(0.4)	
Middle 3	23.1(0.5)		19.7(0.5)	
High 1	22.0(0.5)		18.9(0.5)	
High 2	23.6(0.5)		21.0(0.5)	
High 3	25.0(0.6)		21.7(0.6)	
Academic performance		<0.001		0.007
Very low	21.5(0.6)		19.0(0.5)	
Low	20.8(0.4)		19.5(0.4)	
Normal	20.3(0.4)		18.2(0.3)	
High	21.8(0.4)		19.5(0.4)	
Very high	23.5(0.7)		20.2(0.6)	

Table 1. To be continued

Variables	Tooth pain	<i>p</i> *	Gingival bleeding	<i>p</i> *
Household income		<0.001		<0.001
Very high	17.8(0.6)		17.1(0.6)	
High	20.0(0.4)		18.3(0.3)	
Normal	21.4(0.3)		19.0(0.3)	
Low	27.2(0.7)		23.6(0.7)	
Very low	28.5(1.5)		24.6(1.4)	
Father's education		<0.001		<0.001
Middle	25.9(2.1)		26.6(2.2)	
High	22.5(0.5)		20.1(0.5)	
College	22.3(0.4)		20.0(0.3)	
Mother's education		<0.001		<0.001
Middle	25.8(2.1)		27.0(2.4)	
High	22.1(0.5)		20.1(0.5)	
College	22.4(0.4)		19.9(0.3)	

Values are presented as the weighted% (SE%).

*by Rao-Scott chi-square test

2. Oral disease symptoms according to health status characteristics

Looking at the health-related characteristics related to gingival pain, participants who considered themselves to be in poor health and those who brushed zero times a day had the highest rates of tooth pain at 36.4% and 27.2%, respectively. These results were considered statistically significant ($p < 0.05$). The health-related characteristics associated with gingival bleeding were subjective health, current alcohol consumption, and brushing the previous day ($p < 0.05$) <Table 2>.

Table 2. Health characteristics and oral disease symptoms

Variables	Tooth pain	<i>p</i> *	Gingival bleeding	<i>p</i> *
Subjective health		<0.001		<0.001
Very good	13.7(0.4)		13.3(0.3)	
Good	20.0(0.3)		17.7(0.3)	
Normal	25.1(0.4)		22.5(0.4)	
Bad	33.9(0.7)		29.5(0.8)	
Very bad	36.4(3.0)		38.6(3.1)	
Smoking		0.752		0.597
No	25.9(0.8)		21.7(0.8)	
Yes	25.5(0.9)		22.4(1.0)	
Drinking		0.793		0.003
No	25.2(0.5)		21.3(0.4)	
Yes	25.0(0.6)		23.4(0.6)	
BMI (kg/m ²)		0.080		0.062
Underweight	20.7(0.4)		19.5(0.4)	
Normal	21.6(0.3)		19.3(0.3)	
Overweight	21.5(0.6)		18.4(0.5)	
Obesity	20.4(0.5)		18.2(0.5)	
Brushing previous day		<0.001		<0.001
0	27.2(2.1)		28.5(2.2)	
1-2	22.2(0.3)		19.5(0.3)	
≥3	19.8(0.3)		18.3(0.3)	

BMI, Body mass index

Values are presented as the weighted% (SE%).

*by Rao-Scott chi-square test

3. Oral disease symptoms according to eating habits

The variable dietary habits was related to toothache and breakfast consumption. The consumption of fruit, carbonated drinks, sweet drinks, fast food, and water intake were all statistically significant ($p < 0.05$). It was confirmed that the higher the water intake, the lower the rate of toothache.

Dietary variables associated with gingival bleeding included the consumption of breakfast, fruit, and carbonated drinks. The consumption of sweet drinks, fast food, and water intake were all statistically significant ($p < 0.05$). The higher the water intake, the lower the rate of gingival bleeding <Table 3>.

Table 3. Nutrition status characteristics and oral disease symptoms

Variables	Tooth pain	p^*	Gingival bleeding	p^*
Breakfast		<0.001		<0.001
0	21.3(0.4)		19.4(0.4)	
1-3	22.8(0.4)		20.6(0.4)	
4-6	22.1(0.4)		19.3(0.4)	
Daily	19.0(0.4)		17.3(0.3)	
Fruit		0.002		0.017
0/week	22.7(0.6)		20.5(0.6)	
1-2/week	21.5(0.4)		19.4(0.3)	
3-4/week	21.0(0.4)		18.7(0.4)	
5-6/week	21.6(0.6)		19.2(0.6)	
Daily	19.9(0.5)		18.4(0.4)	
Drinking sparkling soda		<0.001		0.012
0/week	20.8(0.4)		19.3(0.4)	
1-2/week	20.6(0.3)		18.6(0.3)	
3-4/week	21.4(0.4)		19.0(0.4)	
5-6/week	24.1(0.8)		21.3(0.8)	
Daily	23.5(0.8)		19.8(0.7)	
Drinking sweet drinks		<0.001		<0.001
0/week	18.6(0.5)		18.0(0.4)	
1-2/week	19.3(0.3)		18.2(0.3)	
3-4/week	22.1(0.4)		19.4(0.4)	
5-6/week	24.5(0.6)		20.2(0.6)	
Daily	26.2(0.7)		22.1(0.6)	
Fast food		<0.001		<0.001
0/week	18.3(0.4)		17.5(0.4)	
1-2/week	20.5(0.3)		18.7(0.3)	
3-4/week	24.2(0.5)		20.7(0.5)	
5-6/week	26.3(1.1)		21.7(1.0)	
Daily	27.7(1.6)		24.6(1.5)	
Water intake		<0.001		<0.001
< 1 cup	28.5(1.2)		23.7(1.0)	
1-2 cups/day	25.1(0.5)		22.0(0.4)	
3 cups/day	21.6(0.4)		19.2(0.4)	
4 cups/day	19.8(0.5)		17.7(0.4)	
≥5 cups/day	19.2(0.3)		17.9(0.3)	

Values are presented as the weighted% (SE%).

*by Rao-Scott chi-square test

4. Association between frequency of daily water intake and oral disease symptoms in Korean adolescents

Compared with adolescents who consumed an average of five cups of water per day, adolescents who consumed one to two glasses or less were OR (Odds Ratio); 1.14 (95% CI; Confidence Interval: 1.01-1.30) more likely to experience toothache, which was a statistically significant difference.

In addition, the odds of experiencing gingival bleeding were OR; 1.10 (95% CI: 0.96-1.25) higher in adolescents who consumed less than one to two cups of water per day compared with adolescents who consumed an average of five cups of water per day, but this result was not significant <Table 4>.

Table 4. Association between daily water intake frequency and oral disease symptoms in Korean adolescents

Variable	Tooth pain	Gingival bleeding
Water intake		
≥5 cups/day	1.00	1.00
3-4 cups/day	1.10(0.93-1.15)	0.97(0.86-1.10)
1-2 cups/day	1.14(1.01-1.30)	1.10(0.96-1.25)

Data are expressed as the adjusted odds ratios (95% confidence intervals).

Tooth pain adjusted; sex, grade, academic performance, household income, father's education, mother's education, subjective health, brushing previous day, breakfast, fruit, drinking sparkling soda, drinking sweet, fast food

Gingival bleeding adjusted; sex, grade, academic performance, household income, father's education, mother's education, subjective health, drinking, brushing previous day, breakfast, fruit, drinking sparkling soda, drinking sweet, fast food by complex sampling binary logistic regression analysis

Discussion

A lack of moisture in the body can create an environment that is conducive to oral diseases, such as dry mouth, tooth decay, and systemic problems. Therefore, it is necessary to re-evaluate the relationship between tooth decay and periodontal disease according to daily water intake. Adolescence is a period of change and development from childhood to adulthood. Dietary and lifestyle habits in adolescence are closely related to healthy lifestyle habits in adulthood. So, this study aimed to investigate the relationship between daily water intake and oral disease symptoms in adolescents. In this study, the incidences of toothache, gingival pain, and bleeding was high in the group with low daily water intake group. In addition, multivariate logistic regression analysis showed that, compared with those who consumed five cups of water daily, those who consumed less than one cup had 1.14 times more tooth pain, which was a statistically significant difference. This result is similar to previous studies in which *Streptococcus mutans* (*S. mutans*) bacteria was found in a group with minimal water intake [14]. Dental diseases can be classified as dental caries or periodontal disease, both of which are caused by microbial infections. *S. mutans* is the major causative agent of dental caries [7]. Improving salivary lubrication and self-cleaning with drinking water [5] can reduce the incidence of dental caries caused by *S. mutans*. Accordingly, it is necessary to reduce the incidence of dental caries through proper education on water intake and the preparation oral health management plans. Water is also an important component of renal metabolism as it transports nutrients and excretes waste products, and although water has no calories, it provides a feeling of satiety [15]. Therefore, drinking large amounts of water is thought to prevent dental caries by reducing the intake of sugar-sweetened beverages and those that cause dental caries.

Even low water intake or mild dehydration may be associated with the risk of chronic disease [16]. Awareness of the importance of adequate water intake for health has increased [17]. While there have been many studies on the effect of adequate water intake on chronic diseases, however there is a lack of studies on oral diseases. Dental caries and periodontal disease are multifactorial diseases in which various factors work in combination. Therefore, water intake alone does not increase or decrease the likelihood

of oral disease. However, the current study confirmed that water intake is related to the symptoms of oral disease. Therefore, given importance of water intake, dietary guidelines should include a recommended amount of water intake so as to prevent oral disease [18].

There are several limitations to the current study. First, there are few previous studies on water intake and oral health behaviors and conditions, making it difficult to compare and interpret the results of this study. In addition, only associations and not causal relationships can be inferred from the results, owing to the cross-sectional design. Therefore, inferred research is needed. Nevertheless, this study is important because our findings may help to motivate Korean adolescents to increase their water intake. In addition, the current study provides baseline data for establishing hydration recommendations at the national level.

Conclusions

1. Dental caries is a common childhood disease, affecting 60-90% of children and adolescents worldwide. It causes pain, infection and interferes with daily activities.

2. Research in Korean adolescents found a link between daily water intake and oral health. Those who consumed more water (5 or more cups) had less toothache.

3. Adequate water intake is essential for oral health and may help prevent oral disease.

It is recommended that dietary guidelines include recommendations for water intake to promote oral health.

Conflicts of interest

The authors declared no conflicts of interest.

Authorship

Conceptualization: SY Kim, SA Lim; Data collection: SY Kim, SA Lim; Formal analysis: SY Kim; Writing-original draft: SY Kim; Writing-review&editing: SA Lim, SA Lim

References

1. Do KY, Lee KS. Relationship between problematic internet use, sleep problems, and oral health in Korean adolescents: a national survey. *Int J Environ Res Public Health* 2018;15(9):1870. <https://doi.org/10.3390/ijerph15091870>
2. Sfreddo CS, Moreira CHC, Nicolau B, Ortiz FR, Ardenghi TM. Socioeconomic inequalities in oral health-related quality of life in adolescents: a cohort study. *Qual Life Res* 2019;28(9):2491-500. <https://doi.org/10.1007/s11136-019-02229-2>
3. Gondivkar SM, Gadgil AR, Gondivkar RS, Sarode SC, Sarode GS, Patil S, et al. Nutrition and oral health. *Disease-A-Month* 2019;65(6):147-54. <https://doi.org/10.1016/j.disamonth.2018.09.009>
4. Kaushik A, Mullee MA, Bryant TN, Hill CM. A study of the association between children's access to drinking water in primary schools and their fluid intake: can water be 'cool' in school?. *Child Care Health Dev* 2007;33(4):409-15. <https://doi.org/10.1111/j.1365-2214.2006.00721.x>
5. Han YJ. Relationship between oral symptoms experience according to dietary habits of Korean adolescents. *J Korean Soc Oral Health Sci* 2021;9(4):25-32. <https://doi.org/10.33615/jkohs.2021.9.4.25>
6. Nam JY, Kim HJ, Park SM, Choi SH, Jeon HI, Kim MJ, et al. The influence of water drinking on oral management behavior and bad breath in college student. *AJMAHS* 2017;7(5):421-9. <https://doi.org/10.35873/ajmahs.2017.7.5.038>
7. Hong MH. Study on detection of oral bacteria in the saliva and risk factors of adults. *J Korea Acad-Ind Coop Soc* 2014;15(9):5675-82. <https://doi.org/10.5762/KAIS.2014.15.9.5675>

8. Lee JS. The effects of gender, obesity rate, nutrition knowledge and dietary attitude on the dietary self-efficacy of adolescents. Korean J Commun Nutr 2003;8(5):652-7.
9. Hillyer M, Menon K, Singh R. The effects of dehydration on skill-based performance. Int J Sports Sci 2015;5(3):99-107. <https://doi.org/10.5923/j.sports.20150503.02>
10. Daniels MC, Popkin BM. Impact of water intake on energy intake and weight status: a systematic review. Nutr Rev 2010;68(9):505-21. <https://doi.org/10.1111/j.1753-4887.2010.00311.x>
11. von Elm Ev, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann Intern Med 2007;147(8):573-7. <https://doi.org/10.7326/0003-4819-147-8-200710160-00010>
12. Kim YJ, Choi SH, Chun CM, Park SY, Khang YH, Oh KW. Data resource profile: the Korea Youth Risk Behavior Web-based Survey (KYRBS). Int J Epidemiol 2016;45(4):1076-e. <https://doi.org/10.1093/ije/dyw070>
13. Bae JS, Joung HJ, Kim JY, Kwon KN, Kim YT, Park SW. Test-retest reliability of a questionnaire for the Korea youth risk behavior web-based survey. J Prev Med Public Health 2010;43(5):403-10. <https://doi.org/10.3961/jpmph.2010.43.5.403>
14. Joung HY, Choi YI, Choe HJ, Jung IH. A convergence study of water intake on relationship between xerostomia, halitosis, oral microorganisms in the elderly. J Korea Conver Soc 2019;10(6):309-16. <https://doi.org/10.15207/JKCS.2019.10.6.309>
15. Jung EJ, Park IS. Beverage consumption and related factors of undergraduates in Jeonnam. J Korean Soc Dent Hyg 2016;16(6):1009-22. <https://doi.org/10.13065/jksdh.2016.16.06.1009>.
16. Gandy J. Water intake: validity of population assessment and recommendations. Eur J Nutr 2015;54(S2):11-6. <https://doi.org/10.1007/s00394-015-0944-8>
17. Popkin BM, D'Anci KE, Rosenberg IH. Water, hydration, and health. Nutr Rev 2010;68(8):439-58. <https://doi.org/10.1111/j.1753-4887.2010.0030s>
18. Kim YR. Analysis of the effect of daily water intake on oral health: result from seven waves of a population-based panel study. Water 2021;13(19):2716. <https://doi.org/10.3390/w13192716>

우리나라 청소년의 수분 섭취에 따른 구강질환 증상 : 2021년 청소년온라인행태조사 자료를 이용한 단면연구

초록

연구목적: 물은 신체의 대부분을 구성하는 건강의 필수 인자이며, 적정량의 물 섭취 시 타액 윤활 및 자정작용을 개선하여 치아우식증을 예방할 수 있다. 또한 물 섭취가 부족할 시 가당 음료 섭취 등으로 인한 구강질환을 유발하는 것으로 알려져있다. 이에 본 연구는 물 섭취와 구강질환 증상 사이의 관계를 밝히는것을 목표로 했다. **연구방법:** 2021년 한국에서 실시된 한국청소년위험행태 웹기반 조사(KYRBS)의 데이터를 이용하여 한국 청소년의 일일 수분 섭취량과 구강질환 증상의 관계를 확인했다. KYRBS는 질병관리청(KDCA)이 실시하는 전국 단면 조사로, 이번 연구에는 총 54,848명의 참가자가 포함됐다. **연구결과:** 교란요인을 보정한 후 로지스틱 회귀분석 결과, 하루에 물을 2컵 미만 마시는 사람에서 하루에 5컵 이상의 물을 마신 사람보다 치아 통증을 더 자주 경험하는 것으로 나타났다(OR: 1.14; 95% CI: 1.01-1.30). **결론:** 일일 수분 섭취량이 적은 것은 충치의 증상인 치아 통증과 관련이 있다. 우리 연구 결과는 물 섭취를 늘리면 치아 우식증을 줄일 수 있음을 시사한다. 따라서 적절한 물 섭취는 충치 예방에 도움이 될 수 있다.

색인: 청소년, 치아우식증, 치아통증, 물