

The Connection between Hand Washing and Brushing Teeth

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Background: The purpose of this study was to identify the connection between handwashing and toothbrushing, focusing on eating habits, and to verify whether eating habits can be used as an action cue for forming health habits.

Methods: This was a cross-sectional study using secondary data from the 2019 community health survey. The participants included 229,099 adults aged 19 years or older, representative of the South Korean people. We employed two dependent variables: one was washing hands, and the other was brushing teeth. Eating habits was a major independent variable. Socioeconomic variables, such as age, gender, income, occupation, economic activity, education, and residence were adjusted as confounders. Multivariate logistic regression was performed to calculate adjusted odds ratio and 95% confidence intervals.

Results: Most of the participants had good health behaviors: those who wash their hands and brush their teeth were each approximately 80%. Our finding indicated that brushing teeth and washing hands can be connected with eating habits. After adjusting for confounders, it was found that people who wash their hands before meals (compared to those who did not wash their hands before meals) had a higher toothbrushing rate after meals (i.e., socioeconomic status) (Adjusted Odds Ratio: 2.0, Confidence Intervals: 1.9 to 2.1).

Conclusion: Those who practice either washing hands before meals or brushing teeth after meals were found to have a connection between washing hands and brushing teeth based on the results of practicing other health behaviors. This implies that eating habits can be connected as a behavior cue to promote health habits, such as washing hands before meals and brushing teeth after meals.

Key Words: Behavioral cue, Brushing teeth, Eating habits, Health behavior, Washing hands

Introduction

1. Background

World Health Organization emphasizes the importance of hand washing after returning home and before and after the meal to prevent infectious diseases¹. This hand washing campaign has been more emphasized since the Coronavirus disease 2019 (COVID-19) outbreak, and currently, such hand washing practice has improved after

the COVID-19 pandemic in Korea². Hand washing is also known to contribute to prevention of foodborne diseases and food poisoning and interruption of the spread of diseases³.

A previous study that supported the importance of hand washing before the meal has suggested the necessity of connecting two behaviors. For example, a study that investigated the association between the number of hand washings before distributing foods at school cafeteria and

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the incidences of *Staphylococcus aureus*, a bacteria that causes food poisoning, pneumonia, and sepsis, has demonstrated the importance of hand washing before the meal⁴⁾. In addition, a study that analyzed detection of *Staphylococcus aureus* from cooking appliances and ingredients handled by cooks' hands has emphasized the necessity of practicing hand washing to prevent cross infection⁵⁾.

Washing the hands before the meal is important to prevent infectious materials from entering into the mouth through the hands. In the same context, toothbrushing is a healthy oral hygiene behavior to remove the risk factors for oral diseases caused by food debris in the mouth after the meal^{6,7)}. Toothbrushing removes food debris and dental plaques from the teeth surfaces and those stuck between teeth and increases resistance to infections by promoting keratinization of the gingival epithelium⁸⁾. Also, tooth loss due to oral diseases has social-psychological effects as it causes loss of chewing ability and decreases nutrient intakes, leading to the poor quality of meal, dissatisfaction with pronunciation and appearance, and poor quality of life⁹⁾. Toothbrushing is a representative behavior that prevent these oral disease^{10,11)}.

Hypothesis of our study is supported by previous studies that have reported the association between toothbrushing and hand washing. For example, the studies had emphasized the association between hand washing and toothbrushing by demonstrating that low practice of hand washing resulted in low frequency of toothbrushing, and suggested plans to increase the frequency of practicing those behaviors by connecting these behaviors¹²⁻¹⁷⁾.

Meanwhile, as food (eating) is a basic human need, we practice this behavior every day to take nutrient necessary for physical activities^{18,19)}. Regular breakfast is also advantageous for nutrient intakes and health conditions²⁰⁾, and since quality as well as quantity of nutrients are associated with the morbidity or longevity, eating plays an important role in the quality of life²¹⁾.

The three behaviors (i.e., handwashing, eating and toothbrushing) are referred to as healthy behaviors because we practice these behaviors every day and these are closely related to health. Thus, we thought that these behaviors can be connected to each other as action cues to make them habits if there is any association between the three beha-

viors. For example, hand washing before eating is a habit, and eating can be an action cue for the handwashing behavior. In the same manner, for a person who has the 'meal' and brushes his/her teeth, 'an action for eating' can already be an action cue for toothbrushing behavior. Likewise, the principle is that repeated exposure to any associated behaviors can become a habit naturally as a precedent action becomes an action cue (motivation) that leads the subsequent action²²⁾. Therefore, the investigators of this study thought that there is a chance to advocate associated actions such as 'handwashing before eating' and 'toothbrushing after eating' based on eating behavior if eating meals can become an action cue for hand washing and toothbrushing. This study was conducted to demonstrate this possibility.

2. Objectives

This study aimed to assess the association between handwashing and toothbrushing based on eating meals and to demonstrate whether eating every day can be used as a factor developing healthy habits.

Materials and Methods

1. Study participants

This is a cross-section study and used data of the 2019 Community Health Survey (CHS) from the Korea Disease Control and Prevention Agency for analysis. The CHS is the questionnaire generating community health data of community based on the Regional Public Health Act and Enforcement Decree of the Regional Public Health Act. A population of this study included 229,099 adults aged at least 19 years over the country for analysis.

2. Study design and method

This study used two dependent variables: 'hand washing before eating' and 'toothbrushing after eating.' For 'hand washing before eating,' the question was 'how many time have you washed your hands before eating?' The answers were categorized into ① do and ② don't. For 'toothbrushing after eating,' the question was 'have you brushed your teeth yesterday after having a breakfast?' The answer was categorized into ① do and ② don't.

‘How many days a week do you eat breakfast annually’ and sociodemographic variables were used as independent variables. For the question about ‘how many days a week do you eat breakfast annually,’ the answer was classified into ① do and ② don’t.

Sociodemographic variables included gender, age,

household monthly income, occupation, participation in economic activity, education level, and administrative districts (Dong, Eup/Myeon). Gender was categorized into ① man and ② woman, and age was categorized into ① 19~34 years, ② 35~44 years, ③ 45~54 years, ④ 55~64 years, and ⑤ ≥65 years. Household monthly income was

Table 1. Variables Description in the Analysis

Variable	Definition
Dependent variables	Washing hands before eating ① Washing hands all the time ② Washing hands frequently (=do) ③ Washing hands occasionally ④ Washing hands hardly (=don't) Brushing teeth after breakfast ① Do ② Don't
Independent variables	Eating breakfast ① 5~7 times a week ② 3~4 times a week (=do) ③ 1~2 times a week ④ Hardly eat breakfast (=don't) Gender ① Man ② Woman Age ① 19~34 ② 35~44 ③ 45~54 ④ 55~64 ⑤ ≥65 Household monthly income ① Less than 3 million won (=lower) ② Less than 5 million won (=lower-middle) ③ Less than 7 million won (=upper-middle) ④ More than 7 million won (=high) Occupation ① Managers and professionals ② Office workers ③ Service and sales workers ④ Agricultural and fishery workers ⑤ Machine operators ⑥ Daily labors ⑦ Other (soldiers, housewives, students, etc) Economic activity ① Active ② Inactive Education ① Middle school ② High school ③ University Residence ① Dong ② Eup/Myeon

categorized into ① low, ② lower-middle, ③ upper-middle, and ④ high. Occupation was classified into ① managers and professionals, ② office workers, ③ service providers and sales workers, ④ agricultural and fishery workers, ⑤ machine operators, ⑥ daily labors, and ⑦ other (soldiers, housewives, students, retakers, and unemployed). Participation in economic activity was categorized into ① active and ② inactive, and education level was categorized into ① middle school graduates or lower level, ② high school graduates, and ③ college graduates or higher level. Administrative districts (Dong, Eup/Myeon) were classified into ① Dong and ② Eup/Myeon (Table 1).

3. Statistical analysis

Cross analysis was performed to test the association between sociodemographic characteristics and hand washing, eating, and toothbrushing, and the distribution between variables was demonstrated. Multivariate logistic regression analysis was performed to investigate that how much and how differently independent variables affect hand washing and toothbrushing. For statistical analysis, data were analyzed using the SAS Institute (SAS Institute, Cary, NC, USA). A significance level was set to be 0.05.

Result

1. Proportion of practicing hand washing, eating, and toothbrushing by sociodemographic characteristics

Of the total subjects, 77.1% of subjects were found to have breakfast, of which 87.3% and 92.3% were found to wash their hands before eating breakfast and brush their teeth after eating breakfast, respectively. However, of those who washed their hands before eating, 93.3% were found to brush their teeth after eating breakfast (Table 2).

2. The association between eating breakfast and handwashing before eating breakfast

Subjects who ate breakfast were 1.1 times more likely to wash their hands compared to those who did not have breakfast (Adjusted Odds Ratio [aOR]: 1.1, Confidence Intervals [CI]: 1.1~1.2). Those who participated in socio-

economic activity (Adjusted Odds Ratio [aOR]: 1.7, [CI]: 1.4~2.0) and had higher education level (Adjusted Odds Ratio [aOR]: 1.8, [CI]: 1.7~1.9) were more likely to practice hand washing before eating (Table 3).

3. The association between eating breakfast and toothbrushing after eating breakfast

Subjects who ate breakfast were 1.8 times more likely to brush their teeth compared to those who did not have breakfast (OR: 1.8, CI: 1.7~1.9). Subjects who washed their hands before eating breakfast were 2 times more likely to brush their teeth after eating breakfast compared to those who did not wash their hands before eating breakfast (OR: 2.0, CI: 1.9~2.1). Those who are office workers (OR: 1.8, CI: 1.6~2.0), participated in economic activity (OR: 1.3, CI: 1.2~1.4), and had higher education level (OR: 1.4, CI: 1.3~1.6) were more likely to practice toothbrushing a lot after eating breakfast (Table 4).

Discussion

1. Interpretation

This study investigated the association between hand washing before eating breakfast and toothbrushing after eating breakfast based on eating breakfast as healthy behaviors of adults aged at least 19 years over the country, by using data of 2019 CHS. Of those who ate breakfast, 87.3% washed their hands before eating breakfast (Table 2), and those who ate breakfast were 1.1 times more likely to wash their hands compared to those who did not eat breakfast (OR: 1.1, CI: 1.1~1.2) (Table 3).

Also, subjects who had breakfast were 1.8 times (OR: 1.8, CI: 1.7~1.9) more likely to brush their teeth compared to those who did not eat breakfast. Those who washed their hands were 2.0 times (CI: 1.9~2.1) more likely to brush their teeth compared to those who did not wash their hands (Table 4).

2. Key results and comparison with the results of previous studies

Analysis performed based on occupation showed that those who are managers, professionals, and relevant workers, office workers, service providers, and sales workers (clas-

Table 2. Proportion of Practicing Hand Washing, Eating, and Toothbrushing by Sociodemographic Characteristics

Variable	Total	Washing hands before eating		Eating breakfast		Brushing teeth after breakfast	
		Do	Don't	Do	Don't	Do	Don't
Total	229,099	197,901 (86.4)	31,165 (13.6)	176,625 (77.1)	52,470 (22.9)	188,383 (92.3)	15,785 (7.7)
Gender	102,572 (44.8)	73,147 (46.2)	17,286 (68.0)	76,998(48.7)	13,435 (50.1)	81,693 (48.1)	8,849 (60.4)
	126,527 (55.2)	103,696 (53.8)	9,529 (32.0)	97,056 (51.3)	16,169 (49.9)	106,411 (51.9)	6,904 (39.6)
Age	34,474 (15.0)	20,810 (19.6)	3,438 (22.8)	14,710 (15.2)	9,538 (38.8)	21,787 (19.4)	2,500 (27.7)
	31,816 (13.9)	22,963 (17.6)	2,607 (13.5)	17,746 (14.6)	7,824 (27.0)	23,702 (17.0)	1,905 (17.6)
	40,198 (17.6)	31,148 (21.1)	4,178 (20.0)	28,623 (20.9)	6,703 (21.3)	33,220 (21.3)	2,147 (17.0)
	48,064 (21.0)	40,139 (20.1)	5,228 (18.7)	41,724 (22.5)	3,643 (9.5)	42,851 (20.4)	2,556 (14.3)
	74,547 (32.5)	61,783 (21.6)	11,364 (25.0)	71,251 (26.8)	1,896 (3.4)	66,544 (21.9)	6,645 (23.4)
Income	88,467 (38.6)	70,058 (28.7)	12,276 (33.9)	75,060 (31.5)	7,274 (20.9)	75,197 (29.1)	7,193 (32.8)
	47,649 (20.8)	36,174 (24.1)	4,853 (22.9)	332,939 (23.2)	7,734 (26.7)	38,308(24.0)	2,758 (22.8)
	38,050 (16.6)	28,361 (21.8)	3,681 (19.8)	25,179 (20.7)	6,863 (25.1)	30,084 (21.7)	1,989 (19.7)
	54,933 (24.0)	42,250 (25.4)	6,005 (23.4)	40,522 (24.6)	7,733 (27.3)	44,515 (25.2)	3,813 (24.7)
Occupation	23,194 (10.1)	17,364 (14.2)	1,961 (11.1)	14,390 (12.6)	4,935 (18.7)	18,150(13.9)	1,175 (12.0)
	19,696 (8.6)	14,142 (11.5)	1,773 (10.2)	11,465 (10.0)	4,450 (16.7)	14,960 (11.5)	955 (9.9)
	30,083 (13.1)	23,040 (13.8)	2,420 (10.9)	20,219 (12.5)	5,241 (16.9)	24,044 (13.6)	1,416 (11.3)
	25,354 (11.1)	21,238 (3.6)	3,611 (4.2)	24,011 (4.4)	838 (0.9)	22,289 (3.5)	2,560 (5.2)
	21,196 (9.3)	15,171 (10.6)	3,035 (14.9)	15,013 (11.2)	3,193 (11.0)	16,764 (11.1)	1,442 (12.3)
	21,672 (9.5)	17,228 (8.3)	2,647 (9.7)	17,543 (8.9)	2,332 (6.8)	18,487 (8.5)	1,388 (8.2)
	87,590 (38.3)	68,660 (38.0)	11,368 (39.0)	71,413 (40.4)	8,615 (29.0)	73,221 (37.9)	6,807 (41.1)
Economic activity	141,960 (62.0)	108,611 (62.3)	15,470 (61.1)	102,936 (59.8)	21,145 (71.4)	115,221 (62.4)	8,979 (59.2)
	87,056 (38.0)	68,232 (37.7)	11,345 (38.9)	71,118 (40.2)	8,459 (28.6)	72,883 (37.6)	6,774 (40.8)
Education	80,883 (35.3)	66,696 (22.1)	12,016 (26.6)	75,634 (26.8)	3,078 (6.1)	71,743 (22.5)	7,018 (24.2)
	65,466 (28.6)	50,414 (29.6)	7,348 (31.2)	48,363 (30.1)	9,399 (28.8)	53,899 (30.0)	3,916 (28.1)
	82,527 (36.1)	59,733 (48.3)	7,451 (42.2)	50,057 (43.1)	17,127 (65.1)	62,462 (47.5)	4,819 (47.7)
	128,724 (56.2)	96,306 (80.4)	13,841 (79.2)	90,071 (79.2)	20,076 (84.4)	102,433 (80.4)	7,843 (78.5)
Residence	100,375 (43.8)	80,537 (19.6)	12,974 (20.8)	83,983 (20.8)	9,528 (15.6)	85,671 (19.6)	7,910 (21.5)
	197,901 (86.4)	NA	NA	151,320 (87.3)	25,523 (86.0)	165,284 (88.0)	11,559 (75.8)
	31,165 (13.6)	NA	NA	22,734 (12.7)	4,081 (14.0)	22,631 (12.0)	4,184 (24.2)
Eating breakfast	176,625 (77.1)	151,320 (80.1)	22,734 (78.3)	NA	NA	161,706 (80.7)	12,348 (69.3)
	52,470 (22.9)	25,523 (19.9)	4,081 (21.7)	NA	NA	26,209 (19.3)	3,395 (30.7)
Tooth brushing	188,383 (92.3)	165,284 (93.3)	22,632 (85.5)	161,706 (93.3)	26,209 (88.2)	NA	NA
	15,785 (7.7)	11,559 (6.7)	4,184 (14.5)	12,348 (6.7)	3,395 (11.8)	NA	NA

NA: not applicable.

Table 3. The Association with Eating Breakfast and Washing Hands

	Variable	Washing hands	
		Crude	Adjusted
		OR (95% CI)	OR (95% CI)
Eating breakfast	Do	1.1 (1.1 ~ 1.2)	1.1 (1.1 ~ 1.2)
	Don't (ref)	NA	NA
Gender	Man (ref)	NA	NA
	Woman	2.5 (2.4 ~ 2.6)	2.7 (2.6 ~ 2.8)
Age	19 ~ 34	0.7 (0.6 ~ 0.7)	0.7 (0.7 ~ 0.8)
	35 ~ 44 (ref)	NA	NA
	45 ~ 54	0.8 (0.8 ~ 0.9)	0.9 (0.8 ~ 1.0)
	55 ~ 64	0.7 (0.6 ~ 0.7)	1.0 (0.9 ~ 1.1)
	≥ 65	0.7 (0.6 ~ 0.7)	1.0 (0.9 ~ 1.1)
Income	Lower	0.8 (0.7 ~ 0.8)	0.9 (0.8 ~ 1.0)
	Lower-middle	1.0 (0.9 ~ 1.0)	1.0 (0.9 ~ 1.0)
	Middle-high (ref)	NA	NA
	High	1.0 (0.9 ~ 1.0)	1.0 (0.9 ~ 1.0)
Occupation	Managers and professionals	1.5 (1.4 ~ 1.6)	1.1 (1.0 ~ 1.2)
	Office workers	1.3 (1.2 ~ 1.4)	1.0 (0.9 ~ 1.1)
	Service and sales workers	1.4 (1.4 ~ 1.6)	1.1 (1.0 ~ 1.2)
	Agricultural and fishery workers (ref)	NA	NA
	Machine operators	0.8 (0.8 ~ 0.9)	0.9 (0.9 ~ 1.0)
	Daily labors	1.0 (1.0 ~ 1.1)	0.9 (0.8 ~ 0.9)
	Other (soliders, housewives, students, etc)	1.1 (1.1 ~ 1.2)	1.4 (1.2 ~ 1.7)
Economic activity	Active	1.1 (1.0 ~ 1.1)	1.7 (1.4 ~ 2.0)
	None (ref)	NA	NA
Education	Middle (ref)	NA	NA
	High	1.2 (1.1 ~ 1.2)	1.4 (1.3 ~ 1.4)
	University	1.4 (1.3 ~ 1.4)	1.8 (1.7 ~ 1.9)
Residence	Dong	1.1 (1.0 ~ 1.1)	1.0 (0.9 ~ 1.0)
	Eup/Myeon (ref)	NA	NA

Values are presented as n (%).
ref: reference, NA: not applicable.

sified as indoor workers) were more likely to practice toothbrushing and hand washing compared to those who are agricultural and fishery workers, which was not statistically significant. With regard to eating breakfast, the proportion of individuals who ate breakfast was much higher in managers, professionals, relevant workers, office workers, service providers, and sales workers than those who are agricultural and fishery workers. Since office workers or managers have higher education compared to agricultural and fishery workers²³⁾, educational level can affect the practice of healthy behaviors. In previous studies, the proportions of subjects who washed their hands²⁴⁾ and brushed their teeth²⁵⁾ were much higher in the group of office workers compared to non-office workers, and the propo-

rtion of eating breakfast was higher in factory workers²⁶⁾. Similarly, this study showed that agricultural and fishery workers tend to practice healthy behaviors little.

More subjects of this study practiced hand washing and toothbrushing as they participated in economic activity and had higher education level. This is supported by a previous study that reported that the level of practicing healthy behavior is increased as the socioeconomic level is higher, which positively affects the subjective health level²⁷⁾. However, this result also implies the possibility of that environment and infrastructure of the community, surrounding the corresponding jobs, might impact on practicing healthy behavior of those who had the jobs²⁸⁾.

In addition, this study reviewed the association between

Table 4. The Association with Eating Breakfast and Brushing Teeth

	Variable	Brushing teeth	
		Crude	Adjusted
		OR (95% CI)	OR (95% CI)
Eating breakfast	Do	1.9 (1.8 ~ 1.9)	1.8 (1.7 ~ 1.9)
	Don't (ref)	NA	NA
Washing hands	Do	2.3 (2.2 ~ 2.5)	2.0 (1.9 ~ 2.1)
	Don't (ref)	NA	NA
Gender	Man (ref)	NA	NA
	Woman	1.6 (1.6 ~ 1.7)	1.6 (1.6 ~ 1.7)
Age	19 ~ 34	0.7 (0.7 ~ 0.8)	0.8 (0.8 ~ 0.9)
	35 ~ 44 (ref)	NA	NA
	45 ~ 54	1.3 (1.2 ~ 1.4)	1.3 (1.2 ~ 1.4)
	55 ~ 64	1.5 (1.4 ~ 1.6)	1.6 (1.5 ~ 1.8)
	≥ 65	1.0 (0.9 ~ 1.0)	1.3 (1.2 ~ 1.4)
Income	Lower	0.8 (0.8 ~ 0.9)	0.9 (0.8 ~ 1.0)
	Lower-middle	1.0 (0.9 ~ 1.0)	1.0 (0.9 ~ 1.1)
	Middle-high (ref)	NA	NA
	High	0.9 (0.9 ~ 1.0)	1.0 (0.9 ~ 1.0)
Occupation	Managers and professionals	1.7 (1.6 ~ 1.9)	1.7 (1.6 ~ 1.9)
	Office workers	1.7 (1.5 ~ 1.9)	1.8 (1.6 ~ 2.0)
	Service and sales workers	1.8 (1.6 ~ 1.9)	1.7 (1.6 ~ 1.9)
	Agricultural and fishery workers (ref)	NA	NA
	Machine operators	1.3 (1.2 ~ 1.4)	1.6 (1.4 ~ 1.7)
	Daily labors	1.5 (1.4 ~ 1.7)	1.5 (1.4 ~ 1.7)
	Other (soliders, housewives, students)	1.3 (1.2 ~ 1.4)	1.7 (1.3 ~ 2.1)
Economic activity	Active	1.1 (1.1 ~ 1.2)	1.3 (1.0 ~ 1.7)
	None (ref)	NA	NA
Education	Middle (ref)	NA	NA
	High	1.1 (1.1 ~ 1.2)	1.3 (1.2 ~ 1.4)
	University	1. (1.0 ~ 1.1)	1.4 (1.3 ~ 1.6)
Residence	Dong	1.1 (1.1 ~ 1.2)	1.0 (1.0 ~ 1.1)
	Eup/Myeon (ref)	NA	NA

Values are presented as n (%).
ref: reference, NA: not applicable.

eating breakfast and hand washing, eating breakfast and toothbrushing, and hand washing and toothbrushing to determine the interconnectivity between healthy behaviors. Consequently, like the result that practice of healthy behaviors is increased as the health belief is higher²⁹⁾, we found that an individual who performs one healthy behavior also tends to practice other healthy behaviors naturally owing to a belief in health and hygiene. Therefore, a factor affecting health promoting behaviors that enable people to recognize the importance of health and enhance the healthy lifestyles and the ability to manage health is health recognition that is aware of health-related behaviors³⁰⁾. This means that health promoting behaviors at individual

levels originating from such health recognition and health belief is important.

3. Suggestions

Practicing three or more healthy behaviors has more positive effects than practicing a part of relevant behaviors³¹⁾. Likewise, since practicing hand washing before the meal, having a meal, and practicing toothbrushing together can have complementary influences on nutrient intakes, prevention of infectious diseases, and prevention of oral diseases, it is necessary to build habits to establish positive influences that can build such healthy behaviors.

In addition, as hand washing and toothbrushing can be

practiced using public restrooms and sinks, environment and opportunity to practice the three behaviors continuously by establishing relevant facilities near the dining area. An effort is required to create environment that can facilitate better health promoting behaviors.

4. Limitations

This study has some limitation. Since CHS used as study data did not include variables that show presence of lunch and dinner, we were not able to investigate the association between hand washing and toothbrushing by meal time. Thus, this study analyzed eating breakfast and practice of toothbrushing after eating breakfast only. Second limitation was that this study could not consider the unmeasured confounding the practice of hand washing or toothbrushing. It should be considered to subgroup analysis with eating breakfast. It may have endogenous issues for those who eat breakfast every day.

Despite of these limitations, this study has demonstrated the intercorrelation between hand washing, having meals, and toothbrushing that had never been studied. This study demonstrated that more subjects who ate breakfast washed their hands and brushed their teeth compared to those who did not eat breakfast, and more subjects who washed their hands brushed their teeth compared to those who did not wash their hands. Therefore, eating behavior is considered a cue that promotes hand washing and toothbrushing and can be used to induce consistent health promoting behaviors by applying it.

The subjects who practiced one of behaviors (hand washing before eating and toothbrushing after eating) also practiced another behavior, showing that there is association between the two behaviors. To encourage an individual to practice hand washing and toothbrushing sequentially (e.g., hand washing before eating and toothbrushing after eating), eating meals can be used as a cue and applied for habit formation of health promoting behaviors.

Notes

Conflict of interest

No potential conflict of interest relevant to this article

was reported.

Ethical approval

This study was approved by the Institutional Review Board of Yonsei University Mirae Campus (IRB No. 1041849-202211-SB-216-02).

Author contributions

Conceptualization: Ra-Ae Bak and Nam-Hee Kim. Data acquisition: Ra-Ae Bak. Formal analysis: Ra-Ae Bak. Funding: Ra-Ae Bak. Supervision: Sun-Jung Shin, Hee-Jung Park, Jin-Young Jung, Hwa-Young Lee, and Nam-Hee Kim. Writing-original draft: Ra-Ae Bak. Writing-review & editing: Ra-Ae Bak and Nam-Hee Kim.

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Data availability

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References

1. World Health Organization: Water, sanitation, hygiene and waste management for COVID-19. Retrieved 2023 May 1, from: <https://apps.who.int/iris/handle/10665/331305> (2020, March 3).
2. Park SJ, Kim JS, Kim GH, et al.: Changes in the hygienic behavior of Korean youth after COVID-19: Korea Youth Risk Behavior Survey from 2016 to 2021, focusing on hand washing behavior. *Korean J Health Educ Promot* 39: 33-41, 2022. <https://doi.org/10.14367/kjhep.2022.39.3.33>

3. Kim YB: Infectious disease prevention and personal hygiene education: focusing on the handwashing education. *Korean J Health Educ Promot* 37: 59-69, 2020.
<https://doi.org/10.14367/kjhep.2020.37.4.59>
4. Park HJ, Bae HJ: Evaluation of microbiological hazards of hygiene by the customers' hands in university foodservice operation. *J Korean Soc Food Sci Nutr* 35: 940-944, 2006.
<https://doi.org/10.3746/jkfn.2006.35.7.940>
5. Bae HJ: Analysis of contamination of bacteria from raw materials, utensils and workers' hands to prepared foods in foodservice operations. *J Korean Soc Food Sci Nutr* 35: 655-660, 2006.
<https://doi.org/10.3746/jkfn.2006.35.5.655>
6. Lim JY, Nam HS: Comparison of oral health conditions according to the practice of brushing before sleeping in adults using the 7th Korean National Health and Nutrition Survey (KNHANES VII-2) data. *J Korea Acad-Ind cooper Soc* 22: 379-386, 2021.
<https://doi.org/10.5762/KAIS.2021.22.10.3>
7. Cha ES, Son KY, Yun JM, Chung WJ, Cho BL, Jin BH: Associations between atherosclerosis and periodontitis, physical health and dental care: a pilot study. *J Korean Acad Oral Health* 41: 274-281, 2017.
<https://doi.org/10.11149/jkaoh.2017.41.4.274>
8. Lee KH, Kim BY, Kim CJ, et al.: Factors affecting oral health care and toothbrush use in adults. *J Korean Soc Dent Hyg* 17: 1081-1094, 2017.
<https://doi.org/10.13065/jksdh.2017.17.06.1081>
9. Kim SK, Park MY, Byeon EH, Yang SH, Choi SJ, Jung ES: A study on treatment satisfaction and oral health-related quality of life (OHIP-14) among implant patients. *J Korean Soc Dent Hyg* 18: 741-759, 2018.
<https://doi.org/10.13065/jksdh.20180047>
10. An HH, Lee MH, Seo HJ: Oral hygiene performance ability according to toothbrushing instruction. *J Korea Soc Health Inform Stat* 37: 43-52, 2012.
11. Kim SH: The effect of plaque control (tooth brushing instruction) for oral health improvement on periodontitis patients. *J Korean Soc Dent Hyg* 11: 293-301, 2011.
12. Dorri M, Sheiham A, Watt RG: Relationship between general hygiene behaviours and oral hygiene behaviours in Iranian adolescents. *Eur J Oral Sci* 117: 407-412, 2009.
<https://doi.org/10.1111/j.1600-0722.2009.00657.x>
13. Tran D, Phongsavan P, Bauman AE, Havea D, Galea G: Hygiene behaviour of adolescents in the Pacific: associations with socio-demographic, health behaviour and school environment. *Asia Pac J Public Health* 18: 3-11, 2006.
<https://doi.org/10.1177/10105395060180020201>
14. Kim EJ, Lee HJ: Relationship between the toothbrushing behavior and hand hygiene practices of Korean adolescents: a study focused on the 15th Korea Youth Risk Behavior Survey conducted in 2019. *Int J Environ Res Public Health* 18: 5913, 2021.
<https://doi.org/10.3390/ijerph18115913>
15. Jin HJ, Lee YE, Ahn SH, et al.: The relationship between frequency of tooth brushing and hand washing in Korea adolescent. *J Korean Soc Dent Hyg* 13: 82-88, 2013.
<https://doi.org/10.13065/jksdh.2013.13.1.082>
16. Jung YS, Kim KR: Relationship between tooth brushing and hand washing among university students in Daegu · Gyeongbuk province. *Korean J Clin Dent Hyg* 10: 37-43, 2022.
<https://doi.org/10.12972/kjcdh.20220005>
17. Kim JH, Kim MY: The relationship between tooth brushing and hand washing in hypertensive patients amidst COVID-19 pandemic. *J Korea Converg Soc* 13: 501-508, 2022.
<https://doi.org/10.15207/JKCS.2022.13.05.501>
18. Shin KH, Chae KY, Yoo YJ: A study on the breakfast habits of salaried people in Seoul. *Korean J Food Cook Sci* 18: 119-128, 2002.
19. Drewnowski A, Rehm CD, Vieux F: Breakfast in the United States: food and nutrient intakes in relation to diet quality in National Health and Examination Survey 2011-2014. a study from the international breakfast research initiative. *Nutrients* 10: 1200, 2018.
<https://doi.org/10.3390/nu10091200>
20. Lee JS, Song JE: Nutritional status of Korean middle-age adults according to breakfast frequency- based on the 2015 Korean National Health and Nutrition Examination Survey -. *Korean J Food Nutr* 30: 644-652, 2017.
<https://doi.org/10.9799/ksfan.2017.30.4.644>
21. Lee SB, Choi HJ, Kim MJ: The relationships among quality of life and stress, health-related habits and food intake in Korean healthy adults based on 2013 Korea National Health and Nutrition Examination Survey. *Korean J Community Nutr* 20: 411-422, 2015.
<https://doi.org/10.5720/kjcn.2015.20.6.411>

22. Roberto CA, Kawachi I: Behavioral economics and public health. Oxford University Press, New York, pp.69-76, 2015.
23. Park HR: A study on the status of oral health & oral health attitude of workers in industries. *J Dent Hyg Sci* 6: 177-186, 2006.
24. Kim YR: Integrated study on factors related to hand washing practice after COVID-19. *J Korea Converg Soc* 13: 85-91, 2022. <https://doi.org/10.15207/JKCS.2022.13.02.085>
25. Shin BM, Bae SM, Yoo SH, Shin SJ: Oral health and occupational status among Korean adults. *J Dent Hyg Sci* 16: 225-234, 2016. <https://doi.org/10.17135/jdhs.2016.16.3.225>
26. Cho SH, Jang JH, Ha TY, Lee KS, Kim MK, Seo JS: A survey on breakfast of workers in Daegu area. *Korean J Community Nutr* 9: 673-682, 2004.
27. Lee JM, Kim WJ, Sohn HS, Chun JH, Lee MJ, Park HS: Influences on health behaviors execution and self rated health as socioeconomic class by the age bracket. *J Korea Contents Assoc* 12: 317-327, 2012. <https://doi.org/10.5392/JKCA.2012.12.06.317>
28. Hanson MD, Chen E: Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* 30: 263-285, 2007. <https://doi.org/10.1007/s10865-007-9098-3>
29. Kim GH, Kwon YS: The relationship between hand washing practice and health belief model of hand washing among dental practitioners. *J Korean Appl Sci Technol* 35: 587-594, 2018. <https://doi.org/10.12925/jkocs.2018.35.3.587>
30. Kim SJ, Jung EY: A relevance on health perception, health knowledge and health promotion behavior of the university students. *J Korea Acad-Ind cooper Soc* 16: 5394-5403, 2015. <https://doi.org/10.5762/KAIS.2015.16.8.5394>
31. Kim JH, Jung IK: Relationship between practice of physical activities guideline and health-related factors in adolescents: based on 11th (2015) Korea Youth Risk Behavior Web-based Survey (KYRBS). *J Korean Assoc Phys Educ Sport Girls Women* 30: 335-355, 2016. <https://doi.org/10.16915/jkapesgw.2016.12.30.4.335>