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Research Article

Outcome expectations, self-efficacy, eating environment, and eating behaviors by the stages of change in adequate sodium intake among university students: a cross-sectional study

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Objectives: This study investigated whether outcome expectations, self-efficacy, eating environment, and eating behaviors differed according to the stages of change in adequate sodium intake among university students.
Methods: The participants were students recruited from nine universities in Seoul, Korea. An online survey was conducted, and data from 351 participants were analyzed. Participants were classified into pre-action and action stages based on adequate sodium intake. Data were analyzed using *t*-test, χ^2-test, analysis of covariance, and correlation analysis.
Results: Participants in the action stage (22.8%) felt fewer disadvantages of eating sodium adequately compared to those in the pre-action stage (77.2%, $P < 0.001$) and perceived more self-efficacy for healthy eating behaviors ($P < 0.001$) and controlling sodium intake ($P < 0.01$). The participants in the action stage also showed more desirable eating behaviors than those in the pre-action stage, including general eating behaviors, behaviors related to sodium intake, and sodium checks ($P < 0.001$). The physical environment in the action stage was more supportive of adequate sodium intake ($P < 0.05$). Eating behaviors, self-efficacy, and outcome expectations were significantly correlated with the stages of change; however, some differences were noticed in the correlation of the subscales of variables with the stages of change when examined by sex.
Conclusion: We observed differences in factors according to the stages of change in adequate sodium intake. For the pre-action stage, nutrition education can be planned to modify negative expectations of eating adequate sodium, foster self-efficacy, and practice general eating behaviors and behaviors to gradually reduce sodium intake. It is also necessary to alter the physical environment to reduce sodium intake. In the action stage, support and reinforcement are needed to continually practice and maintain desirable eating behaviors. Nutrition education for women may be planned using multiple paths, whereas a simple strategy may be useful for men.

Keywords: young adult; sodium; cognition; environment; behavior

INTRODUCTION

Young adults are at the stage of taking responsibility for their own food choices,

nutrition management, and health. Eating behaviors and habits likely persist not only during this period but also into middle and later adulthood, potentially influencing health outcomes in later life. Therefore, it is important to impart desirable eating behaviors to young adults.

Excessive sodium intake is a behavioral risk factor for noncommunicable diseases such as hypertension, heart disease, stroke, cancer, and diabetes [1]. Sodium intake among individuals aged 19 years and over in South Korea has decreased over the past ten years, however, sodium intake was 142% of the chronic disease risk reduction intake in 2022 [2, 3].

To identify factors explaining nutritional behaviors, theories such as the social cognitive theory (SCT) and the transtheoretical model (TTM) have been used. SCT suggests that personal cognitive factors, behavioral factors, and the environment interact and needs to be reflected in examining health behaviors. Personal cognitive factors include outcome expectations, self-efficacy, and knowledge. Outcome expectations are a person's expectation regarding the consequences, either advantages or disadvantages, of doing the behavior, whereas self-efficacy refers to confidence in one's ability to perform the behavior. Behavioral factors include behavioral capabilities, intentions, and reinforcement. Constructs such as social support, normative beliefs, barriers, and opportunities of behaviors represent environmental factors [4]. TTM describes the stages of change that people experience, and the mechanisms they use when adopting or modifying health-related behaviors. TTM suggests that behavioral change progresses in five stages: precontemplation, contemplation, preparation, action, and maintenance stages. It emphasizes the use of behavioral modification strategies appropriate to one's stage of change, thus making it possible to plan education that customizes one's stage of behavioral change [5]. SCT and the stages of change have been applied to research such as identifying factors related to healthy eating behaviors, planning, and evaluating the effectiveness of nutrition education programs [6-9].

Research on sodium has focused on its intake [10, 11], and the association between sodium intake and chronic diseases [12, 13]. Several studies have examined psychosocial factors related to sodium intake, and these studies were conducted in different populations such as consumers, housewives, and foodservice workers [6, 14-17]. Applying the concepts of SCT, this study aimed to investigate whether there were differences in factors such as outcome expectations, self-efficacy, eating environment, and eating behaviors according to the stages of change in adequate sodium intake among university students in Seoul, Korea. Furthermore, this study examined the association between these factors and the stages of change in adequate sodium intake according to sex. The hypothesis for this study was those in the action stage might have higher outcome expectations and self-efficacy, a more supportive eating environment, and more desirable eating behaviors than those in the pre-action stage of change in adequate sodium intake. Furthermore, the relationship between these factors and the stages of change in adequate sodium intake may differ between men and women. This study provides data for planning nutrition education tailored to the stages of change in eating adequate levels of sodium in young adults.

METHODS

Ethics statement

The study protocol was approved by the Institutional Review Board of Seoul Women's University (approval number: SWU IRB-2021A-26). Online informed consent describing the purpose and content of the study was obtained from each participant before they completed the online survey.

1. Study design

An online survey conducted between August 2021 and March 2022 was designed as a cross-sectional study. The study was performed in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement, available at https://www.strobe-statement.org/.

2. Study participants

The participants were undergraduate and graduate students from nine universities in Seoul, Korea. The investigator posted a notice describing the purpose and content of this study through channels such as websites for student communities at nine universities and bulle-

tin boards. Participants were recruited voluntarily, and those who agreed to participate completed an online informed consent form. The sample size was 341, based on the results of a previous study on population proportion [16], with a 95% confidence level, 5% margin of error, and a 10% dropout rate. We received 353 responses to the online survey, and data from 351 students (99.4%) were used for statistical analysis, excluding incomplete responses.

3. Measurement

1) Survey questionnaire

The questionnaire was made by reviewing literature on factors of sodium intake [6, 7, 9, 14, 15, 17, 18]. The questionnaire draft was revised several times considering content validity, and a pilot test was conducted with seven university students to validate it. The final questionnaire assessed general characteristics, stages of change in adequate sodium intake, outcome expectations regarding adequate sodium intake, self-efficacy, eating environment, and eating behaviors. General characteristics include age, sex, height, weight, grade, and residence type [7].

To examine the stages of change in adequate sodium intake, the item was developed based on the definition of the stages of change in the TTM [5]. Participants were asked to respond if they practiced adequate sodium intake and intended to do so if they did not. To help the participants understand adequate sodium intake, the amount of salt (limited to one teaspoon of salt per day when converting the sodium in food into salt) was suggested in the stages of change question, based on the World Health Organization's (WHO) recommendation of a daily sodium intake goal of 2,000 mg per day [19]. Participants were categorized into the precontemplation stage if they did not practice adequate sodium intake (not limited to one teaspoon of salt per day) and did not intend to do so in the future. The contemplation and preparation stages were defined as not practicing adequate sodium intake but having the intention to do so within the next six months or the next month, respectively. The action stage was defined as practicing adequate sodium intake and have been doing so for less than six months, and the maintenance stage was defined as practicing adequate sodium intake for more than six months.

Outcome expectations regarding adequate sodium intake were constructed based on the literature [6, 7, 15]. Two subscales, the advantages (six items) and disadvantages of eating adequate sodium (eight items), were obtained through factor analysis. Cronbach's α was 0.80 (total score of outcome expectations), 0.83 (advantages of eating adequate sodium), and 0.79 (disadvantages of eating adequate sodium). Self-efficacy consists of 13 items based on the literature [7, 14, 20]. Factor analysis revealed two subscales: self-efficacy for healthy eating behaviors (seven items) and sodium intake control (six items). Cronbach's α was 0.85 (total score of self-efficacy), 0.88 (self-efficacy for healthy eating behaviors), and 0.75 (self-efficacy for sodium intake control).

The eating environment comprised eight items [20], and factor analysis revealed two factors: social environment (four items) and physical environment (four items). Cronbach's α was 0.66 (total eating environment), 0.79 (social environment), and 0.45 (physical environment). Eating behaviors included twenty-five items [15, 17, 18, 20, 21] and were composed of three subscales: general eating behaviors (nine items), behaviors related to sodium intake (13 items), and behaviors related to sodium check (three items). Cronbach's α was 0.70 (total score of eating behaviors), 0.79 (general eating behaviors), 0.76 (behaviors related to sodium intake), and 0.72 (behaviors related to sodium check).

2) Measurement and scoring of items

Each item was measured using 5-point scales ranging from 'strongly disagree' to 'strongly agree' (outcome expectations, eating environment) or 'very difficult' to 'very easy' (self-efficacy). To measure the eating environment, a response category was provided if each item did not apply to the participants. Item of eating behaviors was measured using 4-point scales from '0–1 days/week' to '6–7 days/week' (general eating behaviors) or 'strongly disagree' to 'strongly agree' (behaviors related to sodium intake, and sodium check).

The total score or subscale score of the variables was the summed score of each item, while reverse scoring the negative items. A higher total or subscale score indicates that participants have more positive outcome

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expectations, higher self-efficacy, greater influence from the eating environment, and better eating behaviors. In contrast, a higher score on the disadvantages of eating adequate sodium indicated that the participants agreed more on the disadvantages. A higher score for behaviors related to sodium intake also suggests that participants practice behaviors that increase sodium intake.

4. Statistical analysis

Statistical analyses were performed using the IBM SPSS Statistics (version 24.0; IBM Co.). According to the responses on the stages of change in adequate sodium intake, the participants were classified into the pre-action stage (precontemplation, contemplation, and preparation stage) and the action stage (action and maintenance stage).

To investigate the differences in variables by the stages of change group, *t*-test, χ^2-test, and analysis of covariance (ANCOVA) were conducted. According to the analysis of general characteristics by the stages of change group, weight was used as a covariate in the ANCOVA to examine the relationship of variables with the stages of the change group. Factor analysis was conducted to obtain the subscales of the variables. To investigate the association of variables with the stages of change in adequate sodium intake according to sex, Spearman's correlation analysis between variables and the five stages of change was performed. The statistical significance level was set at $P < 0.05$.

RESULTS

1. General characteristics of participants

With respect to the stages of change in adequate sodium intake, 77.2% of the participants were in the pre-action stage and 22.8% were in the action stage. The mean age of participants was 23.6 years and 58.1% were women (Table 1). There were no significant differences in age or sex according to the stages of change. The weight and body mass index of the action stage in women were significantly lower than those in the pre-action stage ($P < 0.01$, $P < 0.05$, respectively). Approximately 27.6% of the participants were enrolled in the College of Social Science, followed by the College of Natural Science (25.4%) and the College of Humanities (22.2%). Approximately 29.6% of the participants were seniors and 21.1% were graduate students. Sixty-three percent of the participants lived with family members, whereas 37% lived in dormitory rooms or boarding houses. College attendance, grade, and residence type did not differ significantly according to the stages of change group. The distribution of the stages of change according to sex was not significantly different (Table 2).

2. Outcome expectations by the stages of change in adequate sodium intake

The total score for outcome expectations regarding adequate sodium intake (possible score: 14–70) was 43.6 (62.3/100, Table 3). The total score was higher in the action stage than that in the pre-action stage ($P < 0.001$), suggesting more favorable expectations of eating adequate sodium in this group. Participants in the action stage agreed less with the disadvantages of eating sodium adequately than those in the pre-action stage ($P < 0.001$). More specifically, participants in the action stage perceived fewer disadvantages of eating adequate sodium than those in the pre-actin stage, such as 'making me eat less of my favorite foods' ($P < 0.001$), 'foods and snacks are not delicious' ($P < 0.001$), 'difficult to reduce sodium alone when I eat with family members or friends' ($P < 0.01$), 'limitations in choosing processed foods' ($P < 0.05$), and 'difficult to choose a menu when I eat out' ($P < 0.05$). None of the six items regarding the advantages of eating sodium differed significantly according to the stages of change group.

3. Self-efficacy by the stages of change in adequate sodium intake

The total self-efficacy score (possible score: 13–65) was 43.0 (66.2/100). Participants in the action stage scored significantly higher on total self-efficacy ($P < 0.001$), as well as on the subscales of self-efficacy for healthy eating behaviors ($P < 0.001$) and sodium intake control ($P < 0.01$, Table 4).

Ten of the self-efficacy items differed significantly according to the stages of change group. Those in the action stage perceived more self-efficacy in 'choosing natural foods rather than instant foods or convenience foods' ($P < 0.001$), 'changing eating habits to reduce sodium intake step by step' ($P < 0.001$), 'cooking foods

Table 1. General characteristics of participants by stages of change in adequate sodium intake

Variable	Stages of change in adequate sodium intake			χ^2 or t[1)]
	Total (n = 351)	Pre-action stage (n = 271)	Action stage (n = 80)	
Age (year)	23.6 ± 3.7	23.6 ± 3.5	23.3 ± 4.3	0.5
Sex				
Men	147 (41.9)	117 (43.2)	30 (37.5)	0.8
Women	204 (58.1)	154 (56.8)	50 (62.5)	
Height (cm)	167.3 ± 8.8	167.6 ± 8.9	166.5 ± 8.4	0.9
Men	176.1 ± 4.4	176.1 ± 4.6	175.7 ± 3.5	0.4
Women	161.3 ± 5.2	161.1 ± 5.3	161.0 ± 4.8	0.2
Weight (kg)	62.0 ± 12.1	62.7 ± 12.0	59.4 ± 12.4	2.1*
Men	72.4 ± 8.7	72.4 ± 8.4	71.9 ± 9.7	0.2
Women	54.5 ± 8.2	55.3 ± 8.5	51.9 ± 6.4	2.6**
Body mass index (kg/m^2)	21.9 ± 2.9	22.1 ± 2.8	21.2 ± 3.1	2.4*
Men	23.3 ± 2.7	23.3 ± 2.5	23.3 ± 3.3	0.3
Women	21.0 ± 2.7	21.3 ± 2.8	20.0 ± 2.3	2.8*
Attending college				
Humanities	78 (22.2)	64 (23.6)	14 (17.5)	8.3
Social science	97 (27.6)	74 (27.3)	23 (28.8)	
Natural science	89 (25.4)	67 (24.7)	22 (27.5)	
Business/information technology	35 (10.0)	28 (10.3)	7 (8.8)	
Art & design	12 (3.4)	12 (4.4)	0 (0.0)	
Others	40 (11.4)	26 (9.6)	14 (17.5)	
Grade				
Freshmen	48 (13.7)	37 (13.7)	11 (13.8)	1.4
Sophomores	66 (18.8)	51 (18.8)	15 (18.8)	
Juniors	59 (16.8)	43 (15.9)	16 (20.0)	
Seniors	104 (29.6)	84 (31.0)	20 (25.0)	
Graduate students	74 (21.1)	56 (20.7)	18 (22.5)	
Residence type				
Living with family members	221 (63.0)	171 (63.1)	50 (62.5)	4.0
Dormitory rooms	36 (10.3)	32 (11.8)	4 (5.0)	
Boarding house	94 (26.7)	68 (25.1)	26 (32.5)	

Mean ± SD or n (%).
[1)]χ^2 value or *t* value was determined using a χ^2-test or *t*-test.
*P < 0.05, **P < 0.01.

with low sodium' (P < 0.01), 'finding information and practicing methods for reducing sodium intake' (P < 0.01), 'using less seasoning on the table' (P < 0.01), 'checking nutrition labeling and choosing low-sodium foods' (P < 0.01), 'choosing snacks with less sodium or fruits instead of salty snacks' (P < 0.01), and 'choosing a low sodium menu when I eat out' (P < 0.05). In addition, self-efficacy of 'having meals composed of diverse foods regularly' (P < 0.01), and 'eating vegetables when I have meals' (P < 0.01) were significantly higher in the action stage than those in the pre-action stage.

Table 2. Distribution of the stages of change in adequate sodium intake by sex

Variable	Sex	
	Men (n = 147)	Women (n = 204)
Stages of change in adequate sodium intake		
Precontemplation	46 (31.3)	71 (34.8)
Contemplation	51 (34.7)	53 (26.0)
Preparation	20 (13.6)	30 (14.7)
Action	9 (6.1)	18 (8.8)
Maintenance	21 (14.3)	32 (15.7)
χ^2[1)]	3.4	

n (%).
[1)]χ^2 value was determined using a χ^2-test.

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Table 3. Outcome expectations of participants by stages of change in adequate sodium intake

Variable	Stages of change in adequate sodium intake			F[1]
	Total (n = 351)	Pre-action stage (n = 271)	Action stage (n = 80)	
Advantages of eating adequate sodium				
1. It will help me keep blood pressure normal.[2]	3.9 ± 0.8	3.9 ± 0.8	4.0 ± 0.6	0.6
2. It will help me control body weight.	3.8 ± 0.8	3.8 ± 0.8	3.9 ± 0.7	0.1
3. It will prevent chronic diseases.	4.0 ± 0.7	4.0 ± 0.7	4.0 ± 0.7	0.4
4. It will help me to have a nutritious meal.	3.9 ± 0.7	3.9 ± 0.8	3.9 ± 0.7	0.2
5. It will be good for my skin.	3.8 ± 0.8	3.8 ± 0.8	3.9 ± 0.8	0.4
6. It will help to remove swelling.	4.2 ± 0.8	4.2 ± 0.8	4.2 ± 0.8	0.3
Disadvantages of eating adequate sodium				
7. It will be difficult to choose a menu when I eat out.	3.9 ± 0.9	4.0 ± 0.9	3.7 ± 1.0	5.0*
8. The foods and snacks are not delicious.	3.2 ± 1.1	3.3 ± 1.1	2.8 ± 0.9	19.2***
9. It will make me spend more time on cooking foods than using meal kit.	3.4 ± 1.1	3.4 ± 1.1	3.2 ± 1.0	1.7
10. It is difficult for me to cook.	2.9 ± 1.1	3.0 ± 1.1	2.7 ± 0.9	3.5
11. It will make me pay more money on the meal or snack.	3.0 ± 1.1	3.0 ± 1.1	3.0 ± 1.1	0.0
12. It is difficult to reduce sodium alone when I eat with family members or friends.	3.9 ± 1.0	4.0 ± 0.9	3.6 ± 1.0	7.6**
13. It will make me eat less of my favorite food.	3.6 ± 0.9	3.7 ± 0.8	3.2 ± 1.1	20.2***
14. There are limitations in choosing processed foods.	4.1 ± 0.8	4.2 ± 0.8	3.9 ± 0.9	5.7*
Advantages of eating adequate sodium[3]	24.0 ± 3.6	23.9 ± 3.7	24.1 ± 3.0	0.0
Disadvantages of eating adequate sodium[4]	28.3 ± 5.2	28.9 ± 5.1	26.4 ± 5.1	13.8***
Total score[5]	43.6 ± 5.6	43.0 ± 5.3	45.7 ± 6.0	13.0***

Mean ± SD.
[1]F value using analysis of covariance (ANCOVA) with covariate of weight.
[2]Each item was measured using 5-point Likert scales (1: strongly disagree, 5: strongly agree).
[3]Score of six items (1–6), possible score: 6–30. Higher scores indicated greater agreement with the advantages of eating adequate sodium.
[4]Score of eight items (7–14), possible score: 8–40. Higher scores indicated greater agreement with the disadvantages of eating adequate sodium.
[5]Total score of 14 items, possible score: 14–70. To calculate the total score, the disadvantages of eating adequate sodium (7–14) were scored inversely.
*P < 0.05, **P < 0.01, ***P < 0.001.

4. Eating environment by the stages of change in adequate sodium intake

The total score of the eating environment (possible score: 0–40) was 22.9 (57.3/100), and there was no significant difference between the stages of change group (Table 5). The subscale-level analysis revealed that the physical environment score was higher in the action stage (P < 0.05), while the social environment score was higher in the pre-action stage (P < 0.01). This indicates that participants in the action stage received more support from the physical environment to ensure adequate sodium intake. More specifically, participants in the action stage scored higher on the home as the environment for adequate sodium intake (P < 0.01), while participants in the pre-action stage scored higher on the support from 'professionals' (P < 0.01), and 'friends' (P < 0.01) for adequate sodium intake than the counterparts.

5. Eating behaviors by the stages of change in adequate sodium intake

The total score for eating behaviors (possible score: 25–100) was 61.2 (not presented in Table 6). Participants in the action stage scored significantly higher on eating behaviors, suggesting better eating behaviors than those in the pre-action stage (P < 0.001, Table 6). Subscale-level analysis showed that those in the action stage also scored significantly higher on general eating behaviors (P < 0.001) and behaviors related to checking sodium intake (P < 0.001), whereas they scored significantly lower on behaviors that increased sodium intake (P <

Table 4. Self-efficacy of participants by stages of change in adequate sodium intake

Variable	Stages of change in adequate sodium intake			F[1]
	Total (n = 351)	Pre-action stage (n = 271)	Action stage (n = 80)	
Self-efficacy for healthy eating behaviors				
1. I can have meals composed of diverse foods regularly.[2]	3.0 ± 1.0	2.9 ± 1.0	3.4 ± 1.0	10.0**
2. I can eat vegetables when I have meals.	3.5 ± 1.0	3.5 ± 1.0	3.8 ± 0.9	7.7**
3. I can check nutrition labeling and choose low-sodium foods when I purchase processed foods.	3.1 ± 1.0	3.0 ± 1.0	3.4 ± 1.1	8.0**
4. I can choose natural foods rather than instant foods or convenience foods.	3.1 ± 1.0	2.9 ± 1.0	3.5 ± 1.0	18.5***
5. I can find information and practice methods for reducing sodium intake.	3.0 ± 1.0	2.9 ± 1.0	3.4 ± 1.0	10.2**
6. I can cook foods with low sodium.	3.1 ± 1.0	3.0 ± 1.0	3.5 ± 0.9	12.1**
7. I can change my eating habits to reduce sodium intake step by step.	3.3 ± 0.9	3.2 ± 0.9	3.7 ± 0.7	14.9***
Self-efficacy for sodium intake control				
8. I can eat adequate amounts of meals.	3.4 ± 1.0	3.3 ± 1.0	3.6 ± 1.0	1.4
9. I can eat less when I have the soup or stew.	3.7 ± 1.0	3.7 ± 1.0	3.8 ± 1.0	0.4
10. I can use less seasoning (salt, soy sauce, etc.) on the table when I eat out or have meals.	3.5 ± 1.0	3.4 ± 1.0	3.8 ± 0.8	8.9**
11. I can choose a low sodium menu when I eat out.	3.0 ± 0.9	2.9 ± 0.9	3.2 ± 1.0	6.1*
12. I can put less seasoning when I use processed foods or instant foods (ramen, udon, etc.).	3.1 ± 1.1	3.0 ± 1.1	3.3 ± 1.1	3.0
13. I can choose snacks with less sodium or fruits instead of salty snacks (chips, salty snacks).	3.5 ± 1.0	3.5 ± 1.0	3.8 ± 0.8	7.8**
Self-efficacy for healthy eating behaviors[3]	22.5 ± 4.9	21.8 ± 4.8	24.8 ± 4.5	24.9***
Self-efficacy for sodium intake control[4]	20.5 ± 4.2	20.1 ± 2.4	21.8 ± 3.9	8.8**
Total score[5]	43.0 ± 8.2	41.9 ± 8.1	46.7 ± 7.4	20.8***

Mean ± SD.
[1]F value by ANCOVA with covariate of weight.
[2]Each item was measured on a 5-point Likert scale (1: very difficult, 5: very easy). Higher scores indicated higher self-efficacy.
[3]Score of seven items (1–7), possible score: 7–35. Higher scores indicated higher self-efficacy for healthy eating behaviors.
[4]Score of six items (8–13), possible score: 6–30. Higher scores indicated higher self-efficacy for sodium intake control.
[5]Total score of 13 items, possible score: 13–65.
*P < 0.05, **P < 0.01, ***P < 0.001.

0.001) compared to those in the pre-action stage.

Fourteen of twenty-five items were significantly different according to the stages of change. Among the general eating behaviors, percentages of those having eating behaviors more frequently, including 'eating 1–2 vegetables or vegetable side dishes at each meal' (P < 0.01), 'having 1–2 protein foods at each meal' (P < 0.05), and 'having breakfast' (P < 0.05), was significantly higher in the action stage than the pre-action stage. Participants in the action stage also performed behaviors more likely, such as 'using low-sodium foods' (P < 0.001) and 'choosing bland foods at restaurants' (P < 0.05). Participants in the action stage than the pre-action stage performed behaviors related to sodium intake less likely, such as 'eating hamburger, pizza or fried chicken' (P < 0.001), 'eating out or using delivery foods' (P < 0.001), 'eating instant foods' (P < 0.001), 'eating processed foods' (P < 0.01), 'eating all the liquid of soup, jjigae or noodles' (P < 0.01), and 'adding salt or soy sauce when the food or soup is bland' (P < 0.05).

6. Relationship between the factors and the stages of change in adequate sodium intake

The correlation of factors at the total score level with the five stages of change in adequate sodium intake by sex are presented in Table 7. In men, the stages of change showed a significant positive correlation with eating behaviors (ρ = 0.273, P < 0.01), self-efficacy (ρ = 0.210, P

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Table 5. Eating environment of participants by stages of change in adequate sodium intake

Variable	Stages of change in adequate sodium intake			F[1]
	Total (n = 351)	Pre-action stage (n = 271)	Action stage (n = 80)	
Social environment				
1. My parents think I should not eat salty foods.[2]	3.4 ± 1.3	3.5 ± 1.2	3.2 ± 1.4	1.9
2. My siblings think I should not eat salty foods.	2.5 ± 1.4	2.6 ± 1.4	2.3 ± 1.3	1.2
3. Friends think I should not eat salty foods.	2.4 ± 1.2	2.5 ± 1.2	2.0 ± 1.2	9.2**
4. Professionals (doctors, dietitians, etc.) think I should not eat salty foods.	2.9 ± 1.5	3.0 ± 1.5	2.3 ± 1.6	11.1**
Physical environment				
5. Home is the environment that I can have meals or snacks that are not salty.	3.6 ± 1.0	3.5 ± 1.0	3.9 ± 1.0	8.2**
6. School is the environment that I can have meals or snacks that are not salty.	2.8 ± 1.1	2.8 ± 1.1	3.0 ± 1.1	2.1
7. Eating out is the environment that I can have meals or snacks that are not salty.	2.2 ± 1.0	2.1 ± 1.0	2.3 ± 0.9	2.3
8. I encountered campaigns or educations on adequate sodium intake at schools.	2.8 ± 1.3	2.8 ± 1.3	2.7 ± 1.2	0.1
Social environment[3]	11.3 ± 4.4	11.7 ± 4.2	9.9 ± 4.7	8.0**
Physical environment[4]	11.5 ± 2.8	11.4 ± 2.8	12.1 ± 2.6	4.2*
Total score[5]	22.9 ± 5.5	23.1 ± 5.6	22.0 ± 5.2	1.4

Mean ± SD.
[1]F value by ANCOVA with covariate of weight.
[2]Each item is measured by 5-point Likert scale (1: strongly disagree, 5: strongly agree). There was also a category of 'do not apply' (0).
[3]Score of four items (1–4), possible score: 0–20. Higher scores indicated a greater influence of the social environment.
[4]Score of four items (5–8), possible score: 0–20. Higher scores indicated greater support from the physical environment.
[5]Total score of 8 items, possible score: 0–40.
*P < 0.05, **P < 0.01.

< 0.05), and outcome expectations (ρ = 0.166, P < 0.05), although the correlation coefficient was not high. Similarly, the stages of change in women were more positively correlated with self-efficacy (ρ = 0.347, P < 0.01), and eating behaviors (ρ = 0.343, P < 0.01) than outcome expectations (ρ = 0.229, P < 0.01).

The correlations of the factors at the subscale level with the five stages of change are shown in Table 8. In men, the stages of change in adequate sodium intake were significantly associated with four of nine subscales, showing a relatively high correlation with the behaviors related to sodium check (ρ = 0.454, P < 0.01), followed by self-efficacy for healthy eating behaviors (ρ = 0.247, P < 0.01). As in men, the stages of change in women were significantly correlated with the behaviors related to sodium check (ρ = 0.364, P < 0.01), and self-efficacy for healthy eating behaviors (ρ = 0.380, P < 0.01). Furthermore, the stages of change in women were also positively correlated with general eating behaviors (ρ = 0.270, P < 0.01) and physical environment (ρ = 0.237, P < 0.01), and negatively correlated with the disadvantages of eating adequate sodium (ρ = –0.286, P < 0.01) and behaviors related to sodium intake (ρ = –0.239, P < 0.01).

DISCUSSION

This study examined whether there were differences in outcome expectations, self-efficacy, eating environment, and eating behaviors according to the stages of change in adequate sodium intake. In this study, a high proportion of participants (77.2%) were classified in the pre-action stage. We attempted to measure the stages of change as accurately as possible by following the measurement of the stages of change suggested in the TTM and by suggesting an adequate level of sodium intake according to the WHO guidelines [5, 19]. Similar to our study, Tamaki *et al.* [22] reported that a high percentage of participants (84.8%) were assigned to the pre-action stage (precontemplation to preparation stages) in the stages of change to reduce salt intake in a study with a

Table 6. Eating behaviors of participants by stages of change in adequate sodium intake

Variable	Stages of change in adequate sodium intake								χ^2 or F[1]
	Pre-action stage (n = 271)				Action stage (n = 80)				
	0–1 days/week	2–3 days/week	4–5 days/week	6–7 days/week	0–1 days/week	2–3 days/week	4–5 days/week	6–7 days/week	
General eating behaviors									
1. Eat a variety of foods at meals.[2]	38 (14.0)	118 (43.5)	81 (29.9)	34 (12.5)	8 (10.0)	30 (37.5)	25 (31.1)	17 (21.3)	4.5
2. Eat adequate amounts of foods.	10 (3.7)	74 (27.3)	108 (39.9)	79 (29.2)	4 (5.0)	12 (15.0)	30 (37.5)	34 (42.5)	7.8
3. Eat meals regularly.	38 (14.0)	74 (27.3)	107 (39.5)	52 (19.2)	6 (7.5)	18 (22.5)	33 (41.3)	23 (28.8)	5.3
4. Have breakfast.	136 (50.2)	58 (21.4)	45 (16.6)	32 (11.8)	29 (36.3)	15 (18.8)	19 (23.8)	17 (21.3)	8.4*
5. Eat grain foods 3 times a day.	57 (21.0)	97 (35.8)	71 (26.2)	46 (17.0)	20 (25.0)	26 (32.5)	22 (27.5)	12 (15.0)	0.8
6. Eat 1–2 protein foods at each meal.	29 (10.7)	105 (38.7)	84 (31.0)	53 (19.6)	2 (2.5)	23 (28.8)	36 (45.0)	19 (23.8)	10.4*
7. Eat 1–2 vegetables/vegetable side dishes at each meal.	55 (20.3)	114 (42.1)	72 (26.6)	30 (11.1)	15 (18.8)	18 (22.5)	29 (36.3)	18 (22.5)	14.2**
8. Eat fruit or drink fruit juice 1–2 times a day.	97 (35.8)	106 (39.1)	49 (18.1)	19 (7.0)	24 (30.0)	27 (33.8)	17 (21.3)	12 (15.0)	5.8
9. Eat dairy products more than once a day.	85 (31.4)	100 (36.9)	60 (22.1)	26 (9.6)	16 (20.0)	31 (38.7)	20 (25.0)	13 (16.3)	5.5
Variable	Strongly disagree	Disagree	Agree	Strongly agree	Strongly disagree	Disagree	Agree	Strongly agree	χ^2 or F[1]
Behaviors related to sodium intake									
10. I often eat dried fish or salted fish.[3]	72 (26.6)	120 (44.3)	71 (26.2)	8 (3.0)	25 (31.3)	32 (40.0)	22 (27.5)	1 (1.3)	1.4
11. I often eat processed foods such as ham, sausage and canned foods.	26 (9.6)	98 (36.2)	119 (43.9)	28 (10.3)	19 (23.8)	32 (40.0)	22 (27.5)	7 (8.8)	14.1**
12. I often eat instant foods such as ramen and retort foods.	26 (9.6)	56 (20.7)	128 (47.2)	61 (22.5)	19 (23.8)	27 (33.8)	29 (36.3)	5 (6.3)	24.4***
13. I often eat hamburger, pizza or fried chicken.	32 (11.8)	67 (24.7)	135 (49.8)	37 (13.7)	22 (27.5)	35 (43.8)	18 (22.5)	5 (6.3)	30.9***
14. I add salt or soy sauce when the food or soup is bland.	58 (21.4)	85 (31.4)	98 (36.2)	30 (11.1)	27 (33.8)	31 (38.8)	19 (23.8)	3 (3.8)	11.2*
15. I mostly eat all the liquid of soup, jjigae, or noodles.	56 (20.7)	94 (34.7)	81 (29.9)	40 (14.8)	30 (37.5)	21 (26.3)	25 (31.3)	4 (5.0)	13.2**
16. I frequently eat soup, jjigae, jeongol, and tang.	20 (7.4)	80 (29.5)	138 (50.9)	33 (12.2)	13 (16.3)	29 (36.3)	33 (41.3)	5 (6.3)	9.2*
17. I often eat out or use delivery foods (2–3 times a week).	31 (11.4)	51 (18.8)	136 (50.2)	53 (19.6)	20 (25.0)	31 (38.8)	23 (28.8)	6 (7.5)	29.9***
18. I eat lots of Kimchi.	45 (16.6)	93 (34.3)	100 (36.9)	33 (12.2)	10 (12.5)	26 (32.5)	34 (42.5)	10 (12.5)	1.2
19. I usually eat fried foods, pan-fried dishes, sliced raw fish with plenty of soy sauce or red pepper paste.	55 (20.3)	88 (32.5)	93 (34.3)	35 (12.9)	25 (31.3)	30 (37.5)	22 (27.5)	3 (3.8)	9.3*
20. I often eat foods stewed in soy sauce or stir-fry foods as a side dish.	21 (7.7)	83 (30.6)	146 (55.0)	18 (6.6)	10 (12.5)	31 (38.8)	34 (42.5)	5 (6.3)	4.6
21. I often use sauce when I eat.	49 (18.1)	104 (38.4)	93 (34.3)	25 (9.2)	26 (32.5)	30 (37.5)	19 (23.8)	5 (6.3)	8.8*
22. I often eat chips or crackers for snack.	52 (19.2)	109 (40.2)	83 (30.6)	27 (10.0)	24 (30.0)	33 (41.3)	20 (25.0)	3 (3.8)	6.8
Behaviors related to sodium check									
23. I often choose bland foods at restaurants.	43 (15.9)	143 (52.8)	72 (26.6)	13 (4.8)	9 (11.3)	31 (38.8)	36 (45.0)	4 (5.0)	10.1*
24. I check the sodium content when I purchase the processed foods.	133 (49.1)	83 (30.6)	44 (16.2)	11 (4.1)	36 (45.0)	19 (23.8)	17 (21.3)	8 (10.0)	6.1
25. I use low-sodium foods.	103 (38.0)	117 (43.2)	43 (15.9)	8 (3.0)	18 (22.5)	23 (28.8)	33 (41.3)	6 (7.5)	29.1***
General eating behaviors[4]	21.2 ± 4.9				23.4 ± 5.0				12.9***
Behaviors related to sodium intake[5]	32.4 ± 5.7				28.1 ± 6.5				29.9***
Behaviors related to sodium check[6]	5.7 ± 1.9				6.7 ± 2.1				16.0***
Total score[7]	59.6 ± 7.9				67.0 ± 10.7				43.4***

n (%) or Mean ± SD.
[1]χ^2 value using χ^2-test or F value using ANCOVA with covariate of weight.
[2]Items 1–9 were measured using a 4-point scale (1: 0–1 days/week, 4: 6–7 days/week).
[3]Items 10–25 were measured using a 4-point Likert scale (1: strongly disagree, 4: strongly agree).
[4]Score of nine items (1–9), possible score: 9–36. Higher scores indicated more desirable eating behaviors.
[5]Score of 13 items (10–22), possible score: 13–52. Higher scores indicated behaviors that increased sodium intake.
[6]Score of three items (23–25), possible score: 3–12. Higher scores indicated that a subject checks more sodium in foods.
[7]Total score of 25 items; possible score: 25–100. Thirteen items (10–22) were scored in reverse order.
*P < 0.05, **P < 0.01, ***P < 0.001.

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Table 7. Correlation of the total score of factors with the stages of change in adequate sodium intake by sex

Variable	Total score of factors			
	Outcome expectations[1]	Self-efficacy[2]	Eating environment[3]	Eating behaviors[4]
Stages of change[5]				
Men (n = 147)	0.166*[6]	0.210*	0.138	0.273**
Women (n = 204)	0.229**	0.347**	0.023	0.343**
Total (n = 351)	0.203**	0.292**	0.082	0.318**

[1]Possible scores: 14–70.
[2]Possible scores: 13–65.
[3]Possible score: 0–40.
[4]Possible score: 25–100.
[5]Measured on a 5-point scale from the pre-contemplation stage (1) to the maintenance stage (5).
[6]Spearman's correlation coefficient.
*P < 0.05, **P < 0.01.

Table 8. Correlation of the subscale score of factors with the stages of change in adequate sodium intake by sex

Variable	Subscale of factors								
	Advantages of eating adequate sodium[1]	Disadvantages of eating adequate sodium[2]	Self-efficacy for healthy eating behaviors[3]	Self-efficacy for sodium intake control[4]	Social environment[5]	Physical environment[6]	General eating behaviors[7]	Behaviors related to sodium intake[8]	Behaviors related to sodium check[9]
Stages of change[10]									
Men (n = 147)	−0.036[11]	−0.187*	0.247**	0.137	0.077	0.197*	0.156	−0.132	0.454**
Women (n = 204)	−0.050	−0.286**	0.380**	0.198**	−0.107	0.237**	0.270**	−0.239**	0.364**
Total (n = 351)	−0.049	−0.248**	0.328**	0.177**	−0.028	0.217**	0.222**	−0.199**	0.390**

[1]Possible score: 6–30.
[2]Possible scores: 8–40.
[3]Possible scores: 7–35.
[4]Possible scores: 6–30.
[5]Possible score: 0–20.
[6]Possible score: 0–20.
[7]Possible score: 9–36.
[8]Possible scores: 13–52.
[9]Possible score: 3–12.
[10]Measured on a 5-point scale from the pre-contemplation stage (1) to the maintenance stage (5).
[11]Spearman's correlation coefficient.
*P < 0.05, **P < 0.01.

large sample of Japanese adults. Ahn *et al.* [16] reported that 47.3% of restaurant staff belonged to the precontemplation or contemplation stage of reducing sodium intake when cooking, which was lower than that in our study (63.0%). This suggests that the differences in the distribution of the stages of change depend on the characteristics of the participants or the behaviors examined.

The overall outcome expectations in the action stage were more favorable than those in the pre-action stage (P < 0.001). This was mainly due to the difference in expectations regarding the disadvantages of eating adequate sodium, such as the distaste for foods with less sodium, giving up eating one's favorite foods, difficulty in reducing sodium alone while having meals with others, and restrictions in choosing processed foods or menus at restaurants. Consistent with this study, a previous study found that misconceptions and beliefs about the importance of salt taste were related to discretionary salt use (e.g., salt use at the table and in cooking) [23]. Based on the study results, nutrition education for those in the pre-action stage should aim to decrease negative expectations of eating adequate levels of sodium. This might be achieved through methods such as

persuading negative expectations (e.g., distaste), menu planning, cooking using natural ingredients or seasonings, and consequently decreasing the threshold for salty taste. Okube & Kimani [24] reported that patients with metabolic syndrome improved their beliefs about the disadvantages of adopting a healthy lifestyle after receiving health education, suggesting that education is effective in modifying negative beliefs. In our study, the participants in both groups felt similarly on the benefits of consuming an adequate levels of sodium. In contrast, a study with Korean consumers showed that a higher percentage of participants in the action or maintenance stage compared to the pre-action stage perceived the health benefits of reducing sodium intake (e.g., decreasing blood pressure, prevention of stroke, and heart disease) [15].

Self-efficacy is important in explaining the stages of change in adequate sodium intake. Consistent with our study, Ahn *et al*. [14] reported that self-efficacy for sodium reduction methods in cooking in the action stage was higher than that in the pre-action stage in foodservice workers at childcare centers. Another study reported that self-efficacy was higher in the maintenance stage of reduced sodium intake, followed by the action and pre-action stage [15]. These findings suggest that nutrition education should incorporate strategies to increase self-efficacy. This might be achieved by building skills such as cooking with less sodium, reading nutrition labels for choosing processed foods with low sodium, finding information and practicing methods to reduce sodium intake, and substituting low-sodium foods with high-sodium foods. Self-efficacy in reducing sodium intake might also be increased by encouraging desirable behaviors step-by-step.

In this study, participants in the action stage were less likely to engage in behaviors that increased sodium intake, such as eating processed or instant foods, eating out or using delivery foods, and eating all the liquids of soup or noodles. Conversely, those in the action stage were more likely to consume low-sodium foods, choose bland foods at restaurants, and engage in desirable behaviors more frequently. A study on college students also found that the high sodium intake group was more likely to engage in behaviors related to sodium intake [25]. Consistent with our study, Hwang *et al*. [26] reported that children and adolescents in the precontemplation or contemplation stage to eat blandly performed dietary behaviors related to high salt intake more frequently than those in the action or maintenance stage. Nutrition education should be developed to change specific eating behaviors related to sodium intake, as well as general eating behaviors. Modification of eating behaviors can be achieved through the process of monitoring eating behaviors, goal setting, substitution of behaviors, and shaping desirable eating behaviors.

It seems that the association of eating environment with the stages of change was weaker than the other variables examined in this study. However, the pre-action stage received more pressure from significant others to eat less salty foods than the action stage. The majority in the pre-action stage might not think about eating sodium adequately, resulting in more pressure from significant others for healthy eating behavior. In contrast, the physical environment of the action stage was more supportive of eating adequate levels of sodium. Similarly, the recognition of a supportive environment for reducing sodium intake and recognition of sodium labeling on processed foods or foods in restaurants were higher in the maintenance or action stage than those in the pre-action stage, suggesting the importance of a supportive environment in the stages of change to reduce sodium intake [15, 16]. Based on the findings of this study, it is necessary to make the physical environment more supportive of reducing sodium intake for those in the pre-action stage. This might be achieved by providing information regarding the sodium content of foods at schools or restaurants, providing low-sodium menus at home or restaurants, and serving sauce separately rather than providing seasoned foods.

Correlation analysis showed that the stages of change in eating adequate sodium were associated with the subscales of the variables, and there were some differences in the degree of correlation by sex. For both men and women, behaviors related to sodium check (e.g., checking the sodium content of processed foods, and using low-sodium foods) were quite important in the stages of change to eat adequate sodium, suggesting the necessity of emphasizing these behaviors in the nutrition education of university students or young adults. The relationship between cognition (i.e., disadvantages,

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subscales of self-efficacy) or environment and the stages of change in adequate sodium intake among men was not high. In contrast, the stages of change in women were related to the subscales of variables such as cognition, behavior, and physical environment to a certain degree. Similarly, a previous study reported differences in health beliefs or behaviors related to salt consumption according to sex; adult women were more aware of the benefits of reducing sodium intake and more likely to reduce the consumption of processed foods than men [27]. The study findings suggest that nutrition education should be developed by considering the characteristics of the participants (e.g., sex). Nutrition education for young adult women can be planned using multiple paths to highlight the disadvantages of eating adequate sodium, increase self-efficacy, change behaviors related to sodium checks or sodium intake, and provide a more supportive physical environment for adequate sodium intake. Nutrition education for men might need a relatively simpler strategy, including providing tips to try or practice eating sodium adequately (e.g., reading nutrition labels, and choosing low-sodium foods).

Limitations

This study had some limitations. In assessing the stages of change, we suggested an appropriate level of sodium consumption to help the participants understand adequate sodium intake. However, there were also limitations as to how accurately participants recognized the adequate level of sodium intake, considering that sodium intake is a somewhat complex behaviors compared with other dietary behaviors (e.g., consuming five servings of vegetables per day). The participants were students recruited from universities in Seoul, Korea; thus, the findings may not be generalizable to other groups of young adults. Furthermore, this study was a cross-sectional survey, and it was difficult to explain the causal relationships between the variables. Despite these limitations, this study suggested that factors, including outcome expectations, self-efficacy, eating behaviors, and eating environment, were significantly different according to the stages of change in adequate sodium intake.

Conclusion

This study provides information for developing nutrition education or counseling, customizing needs according to the stages of change in adequate sodium intake. Nutrition education should be planned to motivate young adults in the pre-action stage to consider changes in sodium intake adequately. It is necessary to improve the negative expectations of eating adequate sodium, employ methods to increase self-efficacy, and gradually engage in desirable eating behaviors. Furthermore, the physical environment of the pre-action stage must be changed to reduce sodium intake. For those in the action stage, methods to help maintain desirable eating behaviors should be employed. Nutrition education might also be planned considering the sex of young adults. For women, multiple paths might be useful, whereas a simple strategy (e.g., providing tips to try) might be employed for men.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

The participants of this study did not provide written consent for their data to be shared publicly. Due to the sensitive nature of the research, supporting data is not available.

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