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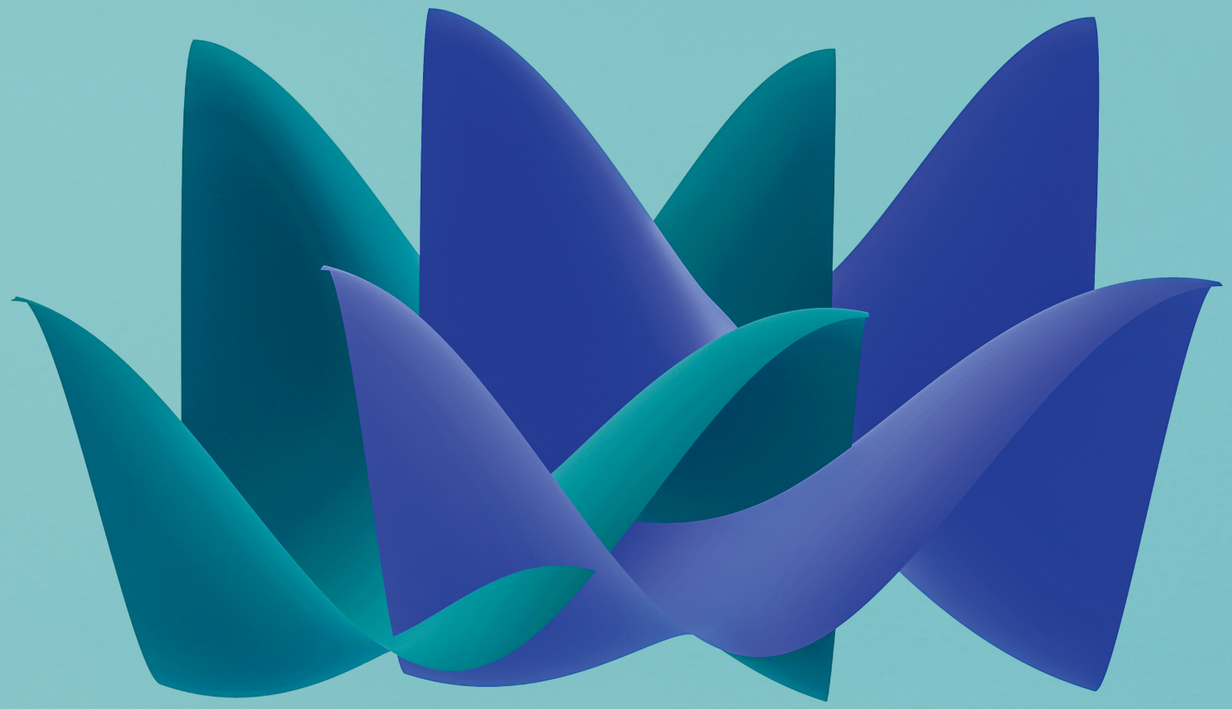

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AIMS AND SCOPE

The *Korean Journal of Community Nutrition* is the official peer-reviewed journal of the Korean Society of Community Nutrition. It was launched in 1996. The previous primary titles were Jiyeog sahoe yeong-yang hag-hoeji (pISSN 1226-0983) from vol. 1, no. 1 to vol 3. no. 5, and Daehan Jiyeok sahoe yeong-yang hakoeji (pISSN 1226-0983, eISSN 2287-1624) from vol. 4, no. 1 to vol. 27 no. 4. The English title (parallel tilte) was Korean Journal of Community Nutrition from vol. 4, no. 1 to vol. 27 no. 4. The *Korean Journal of Community Nutrition* has been the current primary title since October, 2022 (eISSN 2951-3126). The abbreviated title of the journal is *Korean J Community Nutr.* It is published bimonthly in February, April, June, August, October and December. It began to be published only as an e-journal from 2022.

BACKGROUND

KJCN was first published in March, 1996. Three issues were published in 1996, and then five issues per year was published from 1997 to 2001. Since 2002, KJCN has become a bimonthly journal. It is published in February, April, June, August, October and December. This work was supported by the Korean Federation of Science and Technology Societies(KOFST) grant funded by the Korean government. The abbreviated title of the journal is 'Korean J Community Nutr'.

DISTRIBUTION

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ABSTRACTING AND INDEXING

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Review

Research trends relating to body weight control: a systematic review and keyword network analysis of Korea Citation Index Journals (2004–2023)

Yunkyoung Oh[1], **Eunsil Her**[2,†]

[1]Professor, Department of Cosmetology, Changshin University, Changwon, Korea
[2]Professor, Department of Food and Nutrition, Changshin University, Changwon, Korea

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†Corresponding author:
Eunsil Her
Department of Food and Nutrition, Changshin University, 262 Paryong-ro, Masanhoewon-gu, Changwon 51352, Korea
Tel: +82-55-250-1203
Fax: +82-55-250-1201
Email: heres@cs.ac.kr

Objectives: Obesity rates are rapidly rising in Korea. Weight control is highly involved in obesity treatment. This study aimed to explore research trends related to weight control through keyword network analysis. By focusing on journals indexed in the Korea Citation Index (KCI), this study highlights trends specific to Korea, offering insights that reflect the country's unique cultural and policy contexts in weight control research.
Methods: This study collected keywords from weight control-related papers published in the KCI journal over the past 20 years. Keywords were cleaned through Textom (2024), and the relationships between key research issue frequency analysis, structural characteristics, and keywords were identified using Textom, UCINET6, and NetDraw.
Results: Over the past 20 years, 40 to 50 studies related to weight control have been conducted each year. *The Korean Journal of Community Nutrition* had the largest number of published articles. Keyword frequency analysis showed that 'obesity' had the highest frequency. And the analysis of degree centrality and betweenness centrality, the keyword 'obesity' ranked the highest. CONCOR analysis identified four clusters: preventive health care, health management, physical health, and personal development.
Conclusion: The results of this study showed that weight control research reflecting the characteristics of the times has been steadily progressing in relation to the rapidly increasing obesity in Korea, and when developing policies or setting research directions related to weight loss in the future, research should be conducted in a prospective manner by subdividing it according to groups and interests.

Keywords: big data; journal article; body weight

INTRODUCTION

Economic development has led to changes in dietary and lifestyle habits, increasing overweight and obese populations. Currently, obesity increases the risk of various metabolic diseases [1], increases the prevalence of chronic diseases [2], reduces the quality of life and has negative mental and psychological effects [3]. The World Health Organization has classified obesity as a disease that requires long-term treatment in 1996 [4]. The higher the body mass index and waist circumference, the higher the annual medical costs and the shorter the life expectancy compared to those of a normal weight [5].

As the risk of obesity becomes more recognized, interest in weight control is also increasing. The prevalence of obesity among Korean adults increased from 30.9% in 2013 to 37.2% in 2022, and in particular, the prevalence of obesity in men (37.7% in 2013 → 47.7% in 2022) increased faster compared to women (25.1% in 2013 → 25.7%). The rate of attempting weight loss was higher in women, with 61.9% for men and 71.8% for women in 2022 [6].

Maintaining a stable weight is about maintaining a balance between energy intake and energy expenditure [7]. Weight control is effective by creating a so-called negative energy balance by reducing energy intake and increasing energy expenditure. But indiscriminate dieting is popular due to expectations of weight control, the influence of mass media, and social and cultural obsession with thinness, which can lead to not only nutritional deficiencies but also mental problems, such as anorexia and bulimia [8, 9].

Regarding weight control, academic interest, and various studies are continuing in terms of diet, nutrition, exercise, and medicine. In particular, the number of papers in the field of food science and nutrition research related to weight control is increasing, expanding the scope of research to include diet therapy, nutrient intake related to weight control, and dietary behavior.

Recently, with the development of big data processing technology, it has become possible to efficiently analyze data and add new interpretations to existing data [10], and methods for examining research trends have become more diverse using network analysis. In the existing research trend analysis study, the researcher sets the analysis criteria and categorizes them. I have organized the research materials. This method has the advantage of being able to organize them systematically according to the researcher's intention, but it has the disadvantage of having concerns about the researcher's values interfering, which may hinder validity or generalization [11]. Additionally, while previous studies examining research trends have been performed using only surface-level analyses, such as the number of papers, research methods and subjects, and research topic classification through content analysis, network analysis has the advantage of focusing on relational characteristics formed by keywords, co-authors, and references of papers [12], allowing for more visual derivations and confirmations of analysis results. When analyzing research trends in network analysis, the text used is mainly extracted from the title, table of contents, abstract, author keywords (subject terms), and the main text [13]. Among these, keywords are not only important elements that characterize the content of the paper but are also used as index terms for information retrieval, making them suitable for analyzing research trends. Also, while existing cluster analysis mainly focuses on the characteristics of individual objects, CONCOR analysis repeatedly calculates correlations to derive structural equivalence, making it easier to understand relationships between keywords and providing insight [14].

Analyzing research trends is an important indicator for examining the academic development of the field, allowing for a comprehensive understanding of research results and suggesting developmental directions for future research. Until now, research trends on obesity related to exercise [15], research trends on obesity in children and adolescents [16], research on diet awareness using big data analysis [17], and a semantic network analysis of research trends on adolescent dietary life [18] have been actively conducted. However, there is currently no data on research trends related to weight control.

This study focuses on Korea Citation Index (KCI) journals to capture domestic research trends in weight control. The KCI database provides a comprehensive repository of academic work conducted within Korea, enabling an analysis tailored to the unique societal and cultural contexts of the country. Therefore, this study first examines the frequency of keyword appearance in studies published on the topic of weight control over the past 20 years to identify key research topics related to weight control research. In particular, by dividing the research period into 10-year units, we aim to derive differences in issues and research trends by era. We also examine the network patterns between these major keywords and the ranking of keywords with dominant central or mediating roles among keywords. These analysis results will allow us to more intuitively understand the relationships between keywords, and we will be able to develop new research topics on weight control in the future by combining keywords with strong centrality

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and mediating properties. Finally, we will cluster similar keywords through CONCOR analysis based on keyword correlations to easily understand the types of weight control research over the past 20 years and derive implications for research scope, research policy, and the possibility of convergence research. The research questions (RQ) of this study are as follows:

RQ1: What are the core research topics and the trends of research by period as seen from the keyword appearance frequency of "weight control"-related research published in KCI journals from 2004 to 2023 (divided by 10 years)?

RQ2: What are the structural characteristics and relationships between keywords as examined by network analysis (network properties, centrality, CONCOR) centered on keywords with high frequency of appearance in RQ1?

METHODS

Ethics statement

This study was a review article analyzing keywords of already published researches and was not a study on human subjects, so it was not subject to Institutional Review Board.

1. Study design

This was a systematic review. It was described according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement (https://www.prisma-statement.org/).

2. Data collection and cleaning

The data collection and cleaning process in presented in Fig. 1. Data were collected from the KCI (www.kci.go.kr) database on April 22, 2024, from articles conducted over the past 20 years with the keywords 'weight control OR weight management' (search period: January 1, 2004–December 31, 2023). A total of 1,336 articles were collected in the first round, and 1,147 were selected for the final analysis, excluding studies with off-topic studies and missing keywords or abstracts.

Data cleaning involved two phases. First, keywords were extracted from the collected 1,147 articles. A total of 2,063 keywords were extracted, including duplicates. Data were refined to ensure the accuracy of keyword network analysis and to interpret the results clearly. The collected keywords were analyzed using text mining with Textom (2024) and the Espresso K method, which account for compound nouns and proper nouns. 'Weight control' or 'Weight management', which were used as search terms, were judged to be difficult to give meaning to the structural properties and centrality analysis, so they were removed. Similar concepts (e.g., 'Food behavior', 'Eating behavior', 'Dietary behavior' → 'Dietary behavior') were unified into one keyword. 'Dietary behavior' and 'Nutrition education' were unified by removing spaces. This process was reviewed by three food science and nutrition experts.

3. Statistical analysis

The data collected through KCI was refined and frequency analyzed using the TEXTOM (2024) program, and network analysis, including centrality analysis, was

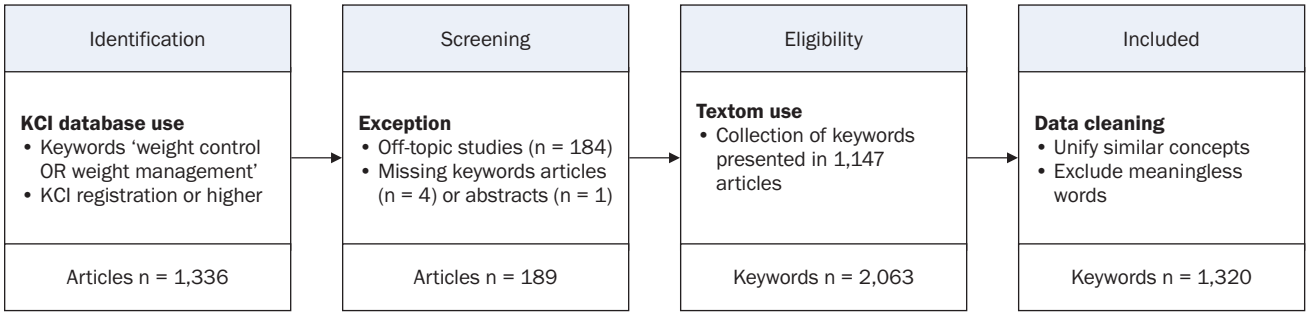

Fig. 1. Flow chart of data collection and cleaning process.
KCI, Korea Citation Index.

conducted using UCINET6. Frequency analysis was conducted on keywords related to weight control based on the refined data, and a 50 × 50 1-mode matrix data set was created. The specific procedure for keyword network analysis performed are as follows. First, the number of nodes, density, average connection distance, average connection strength, number of components, diameter, and network concentration were examined to identify structural properties among weight control-related keywords. Second, a single-sample mean difference test using the bootstrap method was conducted to statistically test the structural characteristics of the keyword network, such as density and centrality. Third, degree and betweenness centrality were analyzed to examine the centrality of keywords within the keyword network. Fourth, CONCOR analysis was conducted to identify the network structure of subgroups.

RESULTS

1. Trends in academic journal articles

Over the past 20 years, 40 to 50 academic journal articles on weight control have been published each year. The top 20 rankings of journals with the most publications related to weight control over the past 20 years are presented in Table 1. *The Korean Journal of Community Nutrition* (168 articles) had the largest number of published articles, followed by *The Journal of the Korean Society of Food Science and Nutrition, The Journal of Korea Academia-Industrial Cooperation Society, The Journal of Life Science, The Journal of Nutrition and Health*, and *The Korean Journal of Physical Education*. In the top 20, food and nutrition-related journals (Rank 1, 2, 5-1, 7, 13-1) accounted for the most with five; there were four physical activity-related journals (Rank 5-2, 17-1, 19-1, 19-2) and four medical and health-related journals (Rank 8, 9, 10, 11).

2. Keyword frequency analysis

The frequency analysis results for the extracted keywords showed that 'Obesity' was the most frequent keyword with 255 occurrences, which was more than twice as frequent as the second-ranked keyword 'Body mass index' (BMI), which was noted 102 times. This was followed by 'Exercise', 'Health', 'Diabetes mellitus', 'Body image', 'Dietary behavior', 'Dietary habit', 'Nutrient intake', 'Stress', and 'Body composition' (Table 2). Words related to factors affecting weight, such as 'Exercise', 'Dietary behavior', 'Stress', and 'Lifestyle'; words related to health indicators, such as 'Diabetes mellitus', 'Body composition', 'Hypertension', 'Metabolic syndrome', 'Blood lipid', and 'Leptin'; and words related to research subjects, such as 'Child', 'Infant', and 'College student', ranked in the top 50.

Relatively recent research trends were compared with previous research trends in Table 3 by dividing the last 20 years into 10-year periods, the first period (2004–2013) and the second period (2014–2023). As a result of examining the top 10 keywords according to the survey period, in the first period, 'Obesity' (134 times) appeared the most, followed by 'BMI', 'Exercise', 'Nutrient intake', 'Body image', 'Dietary behavior', 'Child',

Table 1. Number of published articles by journal

Rank	Journal name	Number	Rank	Journal name	Number
1	*The Korean Journal of Community Nutrition*	168	11	*Korean Journal of Family Medicine*	20
2	*Journal of the Korean Society of Food Science and Nutrition*	70	12	*The Korean Journal of Sport*	19
3	*Journal of Korea Academia-Industrial Cooperation Society*	52	13-1	*Journal of the East Asian Society of Dietary Life*	18
4	*Journal of Life Science*	34	13-2	*Journal of Wellness*	18
5-1	*Journal of Nutrition and Health*	32	13-3	*The Journal of the Korea Contents Association*	18
5-2	*The Korean Journal of Physical Education*	32	16	*Journal of Digital Convergence*	16
7	*The Korean Journal of Food and Nutrition*	31	17-1	*Exercise Science*	15
8	*Journal of Obesity & Metabolic Syndrome*	28	17-2	*Korean Journal of Health Psychology*	15
9	*Clinical and Experimental Pediatrics*	25	19-1	*Korean Journal of Sport Science*	14
10	*Korean Journal of Health Promotion*	21	19-2	*The Korean Society of Sports Science*	14

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Table 2. Frequency analysis related to weight control keyword

Rank	Keyword	Frequency	Rank	Keyword	Frequency	Rank	Keyword	Frequency	Rank	Keyword	Frequency
1	Obesity	255	14-1	Weight loss	42	27-1	Female	23	35-6	Cholesterol	19
2	BMI	102	14-2	Nutrition education	42	27-2	Self-esteem	23	35-7	Risk factor	19
3	Exercise	100	16	Diet	37	27-3	Blood lipid	23	42-1	Dance	18
4	Health	73	17	Infant	34	30	Self-efficacy	22	42-2	Age	18
5	Diabetes mellitus	59	18	Hypertension	31	31-1	College student	21	44	Body fat	17
6	Body image	58	19	Nutrition knowledge	30	31-2	Dietary attitude	21	45-1	Insulin	16
7	Dietary behavior	56	20	Depression	28	31-3	Physical activity	21	45-2	Antioxidant	16
8-1	Dietary habit	51	21-1	Health behavior	26	34	Leptin	20	47	Satisfaction	15
8-2	Nutrient intake	51	21-2	Physical fitness	26	35-1	Weight control behavior	19	48-1	Eating disorder	14
10-1	Stress	50	23-1	Metabolic syndrome	25	35-2	Appearance	19	48-2	High school student	14
10-2	Body composition	50	23-2	Body shape	25	35-3	Management behavior	19	48-3	Perception	14
12	Child	48	25-1	Lifestyle	24	35-4	Blood pressure	19			
13	Weight	47	25-2	Muscle	24	35-5	Training	19			

BMI, body mass index.

Table 3. Frequency of keywords related to weight control by research period

1st period (2004–2013)						2nd period (2014–2023)					
Rank	Keyword	Frequency	Rank	Keyword	Frequency	Rank	Keyword	Frequency	Rank	Keyword	Frequency
1	Obesity	134	11	Health	27	1	Obesity	121	11-1	Infant	18
2	BMI	72	12	Weight	26	2	Exercise	52	11-2	Weight loss	18
3	Exercise	48	13-1	Weight loss	24	3	Health	46	11-3	Muscle	18
4	Nutrient intake	42	13-2	Body composition	24	4	BMI	44	14-1	Body image	17
5	Body image	41	15	Nutrition knowledge	23	5-1	Stress	34	14-2	Dietary behavior	17
6	Dietary behavior	39	16	Blood lipid	21	5-2	Body composition	26	16-1	Appearance	14
7-1	Child	38	17	Hypertension	18	7-1	Weight	21	16-2	Female	14
7-2	Diabetes mellitus	38	18-1	Diet	16	7-2	Diabetes mellitus	21	18-1	Weight control behavior	13
7-3	Dietary habit	38	18-2	Stress	16	7-3	Diet	21	18-2	Hypertension	13
10	Nutrition education	30	18-3	Infant	16	10	Depression	18	18-3	Dietary habit	13

BMI, body mass index.

'Diabetes mellitus', 'Dietary habit', 'Nutrition education' in order. In the second period, 'Obesity' had the highest frequency, followed by 'Exercise', 'Health', 'BMI', 'Stress', 'Body composition', 'Weight', 'Diabetes mellitus', 'Diet', and 'Depression'.

3. The structural form of the network

The network structure was analyzed focusing on the

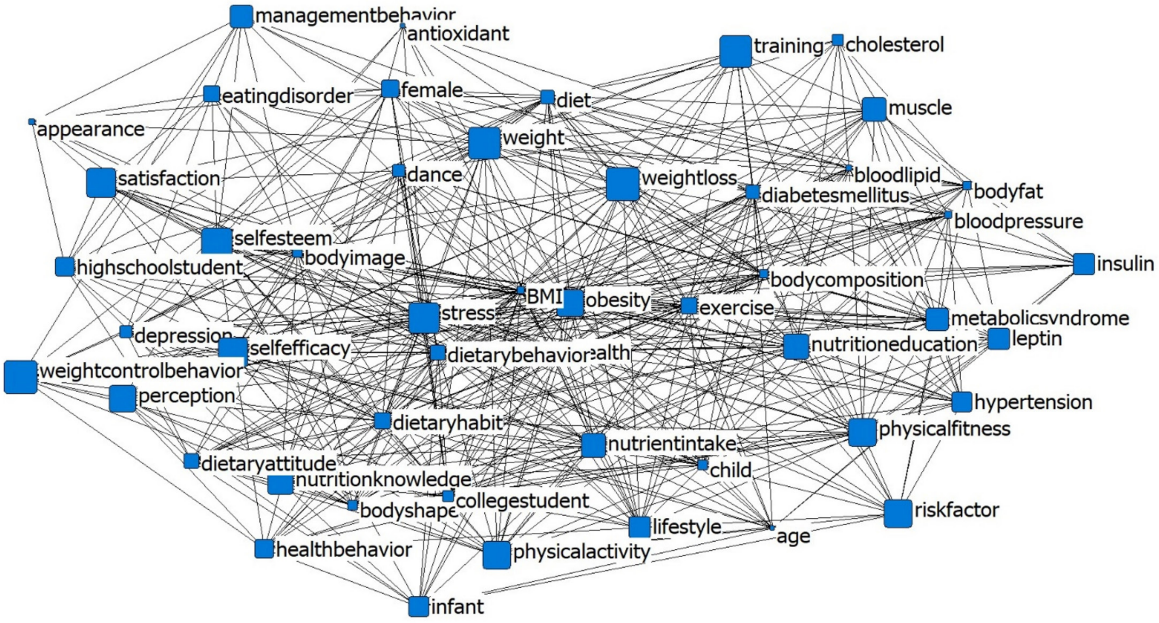

Fig. 2. The overall network of weight control keywords.
BMI, body mass index.

top 50 keywords by frequency, and visualized using NetDraw as shown in Fig. 2. The number of nodes was 50, density was 0.433, average connection strength was 21.240, average connection distance was 1.567, component was 1, diameter was 3, and network centrality was 54.8%. This shows that each keyword is associated with an average of 1.56 other keywords, and all keywords are connected with a maximum of three keywords. Using the bootstrap method to test the statistical significance of the entire network for weight control keywords revealed that the average of the sampling distribution was 1.1975, the standard error was 0.1983, and Z = 5.9765. The probability that the test statistic was observed to be higher than the absolute value of the Z-score was 0.0002, indicating that the relationships between data within the network were statistically significant at the 5% level.

4. Degree centrality and betweenness centrality analysis

Centrality analysis was conducted to examine the influence of major keywords on the network (Table 4). Degree centrality refers to the extent to which a keyword is directly connected to other keywords. A higher value indicates that the keyword has many connections and plays a central role in the overall network structure. As a result, 'Obesity' (0.959) > 'BMI' (0.898) > 'Health' (0.776) > 'Exercise' (0.714) = 'Stress' (0.714). Betweenness centrality is an indicator that measures how much a node acts as a mediator or intermediary in the network relationships between other nodes. The top 5 keywords with high rankings were 'Obesity' (0.075) > 'BMI' (0.059) > 'Health' (0.050) > 'Stress' (0.035) > 'Exercise' (0.027). There were some changes in the frequency rankings, but most of them were the same keywords as the degree centrality.

5. CONCOR analysis related to weight control

CONCOR analysis was performed to cluster studies with similar keywords related to weight control and identify their characteristics (Table 5). Cluster 1 includes keywords such as 'Weight control behavior', 'Satisfaction', 'Stress', 'Self-efficacy', 'Nutrition knowledge', and is named the 'Preventive healthcare' cluster. Cluster 2 includes keywords such as 'Weight loss', 'Weight', 'Risk factor', 'Lifestyle', and 'Health', and is named the 'Health management' cluster. Cluster 3 includes 'Training', 'Physical fitness', 'Obesity', and 'Metabolic syndrome', and is named the 'Physical health' cluster. Cluster 4 includes keywords such as 'Self-esteem', 'Management

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Table 4. Centrality for keywords related to weight control

Degree centrality						Betweenness centrality					
Rank	Keyword	Centrality	Rank	Keyword	Centrality	Rank	Keyword	Centrality	Rank	Keyword	Centrality
1	Obesity	0.959	11	Diabetes mellitus	0.551	1	Obesity	0.075	11	Self-esteem	0.017
2	BMI	0.898	12	Nutrient intake	0.531	2	BMI	0.059	12	Nutrient intake	0.015
3	Health	0.776	13	Self-esteem	0.531	3	Health	0.050	13	Weight loss	0.014
4	Stress	0.714	14	Weight loss	0.510	4	Stress	0.035	14	Diet	0.014
5	Exercise	0.714	15	Nutrition education	0.510	5	Exercise	0.027	15	Dietary habit	0.012
6	Dietary behavior	0.633	16	Diet	0.510	6	Weight	0.026	16	Female	0.011
7	Body image	0.592	17	Child	0.490	7	Dietary behavior	0.023	17	Nutrition education	0.011
8	Body composition	0.571	18	College student	0.490	8	Diabetes mellitus	0.021	18	Child	0.011
9	Dietary habit	0.571	19	Physical fitness	0.469	9	Body image	0.018	19	College student	0.010
10	Weight	0.959	20	Body shape	0.469	10	Body composition	0.018	20	Physical fitness	0.009

BMI, body mass index.

Table 5. CONCOR analysis of keywords related to weight control

Clusters	Keywords	Number
Preventive healthcare	Weight control behavior, Satisfaction, Stress, Self-efficacy, Nutrition knowledge, Perception, Physical activity, Nutrient intake, Infant, Health behavior, High school student, Dance, Dietary behavior, Dietary attitude, Dietary habit, Body shape, College student, BMI, Depression	19
Health management	Weight loss, Weight, Risk factor, Lifestyle, Health, Hypertension, Nutrition education, Diet, Diabetes mellitus, Exercise, Cholesterol, Child, Body fat, Blood lipid, Antioxidant, Age	17
Physical health	Training, Physical fitness, Obesity, Metabolic syndrome, Muscle, Leptin, Insulin, Blood pressure, Body composition	9
Personal development	Self-esteem, Management behavior, Female, Eating disorder, Appearance	5

BMI, body mass index.

behavior', and 'Female', and is named the 'Personal development' cluster.

DISCUSSION

Body weight is determined by energy intake and energy expenditure, and weight control requires changes in diet, physical activity, and behavior [19]. Analysis of journal article publication trends showed that research on weight control is being conducted in various aspects, such as fields of food science and nutrition, exercise, medicine, and health. In particular, food science and nutrition-related journals ranked highest in the number of published articles, as diet plays an important role in major strategies for weight management. The fact that the '*The Korean Journal of Community Nutrition*' ranked first shows that community-centered nutrition research plays an important role in weight control. This finding reflects the emphasis on nutrition research in Korea but should be interpreted with caution as the contribution of specific studies to weight control strategies requires further validation. The inclusion of four journals related to physical activity in the top 20 shows a high awareness that diet and physical activity are necessary for effective weight management. The high rank of medical and health-related journals also reflects the medical community's strong interest in understanding and solving weight-related problems. The analysis of publication

trends by year suggests that weight control continues to be an important research topic due to the need for effective intervention methods against the continuous increase in obesity rates in Korea [20].

Keyword frequency analysis results showed that research on the relationship between weight control and the prevention or treatment of major chronic diseases such as 'Obesity', 'Diabetes mellitus', 'Hypertension', and 'Metabolic syndrome', which are on the rise in Korea [20], is actively underway. There are many ways to determine weight status [21], and as a result of this study, BMI, which uses height and weight and is known to have a high correlation with body fat, was widely used in studies. Also, the necessity of 'Exercise', 'Dietary behavior', 'Dietary habit', and 'Nutrient intake' in practicing weight control was recognized, and research on these was actively conducted. The original meaning of weight control includes both gaining and losing weight through intentional efforts [22], but the results of this study showed that 'Weight loss' was the main concern. Additionally, this result shows a difference from the results of 'Exercise', 'Health', 'Menu', and 'Effect', which were obtained by collecting data using diet search terms on 'Naver' in one year (2015) [23]. This difference appears to be due to differences in analysis data. The prevalence of obesity among children and adolescents in Korea was 16.2% in the 8th National Health and Nutrition Examination Survey (2019–2021), which was significantly lower than the adult obesity rate (37.2% in 2022) [5]. Nevertheless, the fact that this study focused on the early years of life, such as 'Children' and 'Infants', reflects the need for early treatment due to the long-term negative effects of childhood obesity [24]. Therefore, it is necessary to actively utilize the research results in health and nutrition education in kindergartens and elementary schools as a policy. Meanwhile, research on adults with high obesity rates, especially those aged 40–49 and men, was insufficient, , so actual research on these subjects is needed.

A comparison of research trends over the past 20 years in two 10-year periods revealed a change in research focus, although 'Obesity', 'BMI', and 'Exercise' remained important research topics in both periods. The top keywords in the first period were 'Nutrient intake', 'Dietary behavior', and 'Dietary habit', which suggests that research on nutritional management related to weight control was actively conducted. However, in the second period, mental health factors such as 'Stress' and 'Depression' emerged as top keywords, which is thought to reflect the perception that obesity is a chronic disease that is difficult to manage without holistic treatment [25]. This suggests that mental health factors are increasingly being recognized as critical variables in obesity management within domestic studies. Therefore, when conducting research related to weight control in the future, integrated research on the holistic aspect needs to be actively conducted, and a holistic integrated treatment approach should also be attempted when establishing health policies related to obesity treatment.

In both centrality analyses, 'Obesity', 'BMI', 'Health', 'Exercise', and 'Stress' were the top five keywords. These keywords were also major keywords in frequency analysis. In particular, 'Obesity' ranked highest in both centrality indices, which means that 'Obesity' is closely connected to other keywords in the network and plays an important intermediary role between them. These results suggest that a deep understanding of obesity-related factors is needed for future weight control-related research and policy establishment.

Preventive health care (Cluster 1) in the CONCOR analysis includes psychological factors such as stress, self-efficacy, and depression, which suggests that research and policies on mental health management, especially for students, are needed in preventive health care. For effective health management in Cluster 2, multidisciplinary research on nutrition education, diet, exercise, and clinical trials should be conducted. Physical health (Cluster 3) refers to the fact that physical activity, such as strength training, plays an important role in the management of obesity and metabolic syndrome. Personal development (Cluster 4) refers to the aspect where an individual's psychological and emotional growth leads to management behavior and is linked to weight management. These results clarify the direction of research related to weight management according to target or interest, thereby enabling a more systematic and specific approach when establishing weight management strategies in Korea.

Limitations

This study had some limitations. First, since only the

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keywords of KCI-listed journal papers were analyzed, unpublished papers or papers different from the search terms may have been omitted. Second, there is a possibility that the researcher's subjectivity may have intervened in decision-making during the data cleaning process. Third, the analysis was limited to keywords, which may not fully capture the depth and context of each study. Fourth, the focus on KCI journals excludes international perspectives, potentially limiting the generalizability of the findings.

Conclusion

This study is significant in identifying the change process and structural relationships of research over the past 20 years through keyword network analysis related to weight control. The results of this study showed that weight control research reflecting the characteristics of the times has been steadily progressing in relation to the rapidly increasing obesity, and suggested that weight control research should be actively conducted in the future from an overall perspective related to weight loss in Korea. The results of the CONCOR analysis are expected to be helpful in segmenting groups when developing policies or setting research directions related to weight control. However, concrete evidence and examples of how these findings can be implemented into policies are still required.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

The data that support the findings of this study are openly available in "KCI" at https://www.kci.go.kr.

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Research Note

A pilot investigation of a combined food literacy and exercise program for college students: a one-group pre-post intervention study

Minjeong Jeong[1),2)], Jinhyun Kim[1),2)], Dahye Han[1),2)], Eunjin Jang[3)], Kyoungho Choi[4)], Sohyun Park[5),6),†]

[1)]Student, Department of Food Science and Nutrition, Hallym University, Chuncheon, Korea
[2)]Student, The Korean Institute of Nutrition, Hallym University, Chuncheon, Korea
[3)]Researcher, The Korean Institute of Nutrition, Hallym University, Chuncheon, Korea
[4)]Research Professor, Community Education Institute, Hallym University, Chuncheon, Korea
[5)]Associate Professor, Department of Food Science and Nutrition, Hallym University, Chuncheon, Korea
[6)]Associate Professor, The Korean Institute of Nutrition, Hallym University, Chuncheon, Korea

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†Corresponding author:
Sohyun Park
Department of Food Science and Nutrition, Hallym University, 1 Hallymdaehak-gil, Chuncheon 24252, Korea
Tel: + 82-33-248-2134
Fax: +82-33-256-3420
Email: sopark@hallym.ac.kr

Objectives: A campus-based intervention to enhance food literacy (FL) and establish exercise habits among college students was developed and the program's effectiveness was evaluated.

Methods: The 13-session program was developed based on the transtheoretical model and social cognitive theory. Junior and senior students majoring in food and nutrition and physical education were asked to participate as mentors, with freshmen and sophomores from varied majors as mentees. The program encompassed food, nutrition, and exercise lessons including cooking sessions. Data were collected via pre- and post-program surveys using a questionnaire consisting of items on FL and nutrition behaviors and physical fitness measurements.

Results: Among 39 participants (35.9% male, 64.1% female), the overall FL score increased significantly from 64.1 to 70.6 post-program (P = 0.001). Significant increases were observed in the nutrition and safety (P < 0.001), cultural and relational (P = 0.023), and socio-ecological (P = 0.001) domains, as well as knowledge (P = 0.001), self-efficacy (P = 0.013), attitude (P < 0.001), and behavior (P = 0.005) items in three domains of FL. Additionally, meal duration increased significantly (P = 0.007) and sit-up performance among female showed a meaningful change (P = 0.046). Changes in dietary behaviors significantly progressed (P = 0.015) while that in exercise habits approached a marginal significance (P = 0.053) after the intervention.

Conclusion: The results reveal positive changes in FL and some modifications in eating habits, although the program had limited effects on physical activity and fitness measurements. These findings suggest that strategic approaches to foster exercise behavior changes in college students are required. This pilot program can serve as foundational data for improving and expanding multicomponent health promotion programs for this population.

Keywords: food; literacy; students; nutrition; exercise

INTRODUCTION

College students are in a transitional phase from adolescence to adulthood [1, 2]. This intermediate developmental stage is characterized by increased physical and mental activities, independence, autonomy, and responsibility [3, 4]. Irregular eating habits formed during this phase can persist in adulthood and trigger diverse health problems in later life [5]. Therefore, it is crucial to establish appropriate eating habits in college students and ensure that they receive balanced diet [6]. However, many college students are uninterested in health-related issues and healthy habits. They often do not recognize the importance of balanced diet [7] but even when they do apprehend the significance, implementing such beneficial habits becomes challenging because of campus living environments, irregular personal routines, and economic difficulties [8, 9].

The social distancing measures imposed during the COVID-19 pandemic affected every population globally with limited outdoor activities, closed exercise facilities, and increased online classes for students. For college students, these measures resulted in poor nutrition and lack of physical activity [10] and adversely impacted their health, with consequences such as emotional stress, decreased immunity, and weight gain. College students tend to prioritize convenience and taste over health and nutritional value of their food choices and an increase in the consumption of high-calorie foods, delivery food, ready-to-eat meals, and processed foods has been observed since the pandemic [11-13]. In addition, an excessive intake of calories and sodium and imbalances in essential nutrients have been reported because of irregular meals, skipping breakfast, and high alcohol consumption among this population [11].

Physical activity helps reduce the risk of chronic diseases by lowering blood pressure and body fact and better controlling blood sugar, making it one of the most effective ways to prevent cardiovascular and mental diseases and improve overall fitness [14]. However, approximately 28% of adults worldwide and over half of the university students in South Korea do not meet the World Health Organization's physical activity guidelines, which recommend at least 150 minutes of moderate-intensity activity per week. The participation rate of Korean adults in physical activities has declined over the last seven years [15]. The physical activity of college students tends to decrease because of new living environments and increased time spent on academic and extracurricular activities, raising the risk of obesity and chronic disease [16-19]. Therefore, it is crucial to understand the patterns of physical activities in which college students engage and to actively encourage them to exercise regularly [20].

Food literacy (FL) encompasses the ability to select, understand, and utilize appropriate foods. FL plays a pivotal role in promoting healthy dietary choices and preventing chronic diseases [21-23] and its significance has grown substantially in recent years. Among young adults, enhanced FL is particularly crucial as it fosters healthy eating habits that support disease prevention and long-term health maintenance [24, 25]. While the importance of FL interventions among college students is well-recognized, research in this field, especially in South Korea, remains in its early stages. Furthermore, there is limited evidence on the effectiveness of FL interventions that incorporate exercise components. Understanding how complementary strategies, such as establishing regular exercise habits, can enhance the overall health outcomes of FL interventions among college students warrants further investigation [23, 26, 27].

Ko *et al.* [26, 27] designed a campus-based intervention program to strengthen FL in college students and support them in forming healthy eating habits. This program was developed to align with the campus environment and students' lifestyle patterns, aiming to improve FL and promote healthier eating habits among college students. The present study builds on this previous study and aims to develop a pilot multicomponent intervention program through hands-on experiences of all the aspects of FL and exercise training [28, 29]. The program tested whether it is feasible and acceptable for college students to combine FL and exercise components with the help of senior students in one curriculum during one semester.

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METHODS

Ethics statement

The written informed consent was obtained from all participants. This study was conducted with the approval of the Research Ethics Committee of Hallym University Institutional Review Board (HIRB-2021-009-3-RRRR).

1. Study design

This study was conducted as a one-group, pre-post intervention pilot study and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, available at https://www.strobe-statement.org/.

2. Intervention overview

This pilot study was conducted from September to December 2023, targeting 39 university students aged 19–29 who were enrolled at a university in Chuncheon, Gangwon Province. Participants were recruited from July to August 2023 via popular mobile apps frequently used by college students. The study initially recruited 40 applicants through online platforms, of whom 39 satisfied the eligibility criteria and provided informed consent, resulting in an effective recruitment rate of 97.5%. Among these, 35 participants completed the post-intervention assessments, yielding a final completion rate of 89.7%. Students with specific medical conditions or eating disorders requiring special dietary management or those who had difficulty engaging in general physical activities were excluded. The sample size was determined using the average FL score and standard deviation from the previous study [27], with calculations performed using G*power 3.1.9.7 software, accounting for a 10% dropout rate, an alpha of 0.05, and a power of 0.80. This study employed a one-group, pre-post intervention design to evaluate the effects of a pilot program aimed at improving FL and physical activity among college students. The survey was administered online through Google Forms, with a pre-survey and physical fitness assessment in September and a post-survey and physical fitness assessment in December. Participants were compensated with a gift certificate worth approximately 4,000 KRW when they completed post-intervention survey. The program was offered as a 3-credit interdisciplinary course through the Department of Food Science and Nutrition and the Department of Physical Education.

3. Program design

This study developed and implemented a program based on the transtheoretical model (TTM) and social cognitive theory (SCT). Based on SCT, practical sessions were organized with 3rd and 4th-year students enrolled in the Departments of Food and Nutrition and Physical Education as mentors and 1st and 2nd-year students majoring in various subjects as mentees. Each group comprised between six and seven members and the participant cohort was divided into a total of six groups. Mentors underwent three training sessions including a pre-orientation meeting and worked with instructors to design and execute group programs for mentees. The stage of change of every participant was assessed during the initial phase of the program and mentors offered tailored advice on nutrition and exercise based on the individual assessments. Mentors helped their mentees advance their self-efficacy through practical activities and conducted group activities to help mentees learn and reinforce new behaviors.

4. Intervention components and implementation

The 13 sessions of the intervention program are overviewed as follows. Session 1 oriented the participants to the program, and Session 2 covered balanced eating habits using a dietary guideline. A simple individual nutrition assessment using Nutrition Quotients survey questionnaire was implemented in Session 3 to diagnose the dietary habits of the participants and engage them in discussions on the desired dietary improvements [30, 31]. During Session 4, the participants were divided into two segments: one group made salads and learned about vegetarianism, animal welfare, and food storage and preparation, while another group participated in a yoga class. Session 5 reversed the focus of Session 4, alternating the cooking and exercise segments. In Session 6, the participants were encouraged to practice the contents from previous session as a group, with modification for their groups' own needs. Participants were invited to engage in a forest experience in Session 7 aimed at reducing their academic stress,

which included a board game centered on environmental conservation and tree planting activities. Session 8 featured a lecture by a sports expert on the principles of exercise and customized exercise methods for different body types. In Session 9, participants developed a meal plan based on dietary guidelines and participated in group cooking sessions led by peer mentors. This session also emphasized the importance of mindful eating, encouraging participants to increase the time spent on each meal. Session 10 included a lecture by an expert on emotional eating, and students learned how to keep meal record and address their emotions while choosing food. Sessions 11 and 12 required students to use exercise equipment as well as engage in biweekly group activities on zero-waste cooking. Session 13 concluded the program with a feedback session and a certificate ceremony (Table 1).

5. Measurements

The survey items of FL were from the 2021 Seoul Food Survey [32]. The questionnaire has been reported to have a Cronbach's alpha of 0.82 for internal consistency reliability and demonstrated construct validity through factor analysis in previous studies. The FL scale comprised 33 items classified into three domains: nutrition and safety (14 items), cultural and relational (8 items), and socio-ecological domain (11 items). The nutrition and safety domain assessed the ability of respondents to acquire, understand, and utilize knowledge related to food and nutrition, and cooking competency. The cultural and relational domains evaluated the interest and understanding participants exhibited toward food culture and probed their pursuit of enjoyment and meaning through food, their gastronomic curiosity, and their contribution to personal and community wellbeing through food. The socio-ecological aspect measured the ability of participants to understand and value diverse social and ecological outcomes related to food choices, including their awareness of food-related inequalities. This section also included items on environmental sustainability, animal welfare, fair trade, and the relationships between food choices and climate crisis. For each of the three domains, questions were further categorized into subcomponents of knowledge, self-efficacy, attitude and behavioral skills to capture changes in sub-elements of FL. Responses were rated on a five-point scale (1: strongly disagree, 5: strongly agree) [32].

Physical fitness assessments were conducted in accordance with the grading criteria established by the university's fitness experts at the Department of Physical Education, utilizing standardized tools and procedures to ensure reliability and validity. A total of 38 students participated in the pre-program assessment and 35 students completed the post-program assessment, with three dropouts due to personal injuries. Participants undertook four types of tests both before (September) and after (December) the intervention, measuring muscular endurance (sit-ups), explosive power (vertical jump), flexibility (sit-and-reach), and cardiorespiratory endurance (step test). Each assessment method was validated in peer-reviewed studies [33], and measurements were conducted using standardized procedures to ensure consistent and accurate results.

Participants performed as many sit-ups as possible in one minute starting from the signal, lying on a mat with their legs bent at an angle of 70°–80°, feet secured in ankle straps, and arms crossed over their chest. Sit-ups (HMS-103; HMS Medical Systems) were measured as repetitions per 60 seconds and recorded on a log. Participants stood on a measuring pad for the vertical jump, their feet shoulder-width apart, their knees bent at around 90°, and jumped vertically at the signal. They were required to land on the pad without bending their knees while they were in the air. The vertical jump was recorded in 0.1-second intervals using the equilibrium measurement device (HMS-108A; HMS Medical Systems). The sit-and-reach test required participants to sit barefoot with their legs extended and feet flexed. Participants were then asked to reach forward as far as possible and press the measurement device. Sit-and-reach (HMS-101; HMS Medical Systems) was measured in 0.1 cm increments. Finally, male participants used a box with 40 cm height and female participants used a box with 35 cm for the step test, stepping up and down in time with a Harvard step rhythm. After three minutes, the participants sat on the box for 3 minutes and 30 seconds and measured their pulse rate. Heart rates were recorded three times immediately after the exercise (1–1.5 minutes, 2–2.5 minutes, and 3–3.5 minutes). The measurement tools included the step box, a mobile

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Table 1. Overview of the pilot food literacy and exercise program for college students

Session[1)]	Topic	FL components or PA	Time	Content	Main in-class activity
Session 1	Introduction to food literacy and exercise program	All[2)]	1 hour	- Describing the flow of the health promotion program combining FL and exercise - Each group comprised 2 mentors and 3 or 4 mentees - Establishing individual and group goals	- Orientation to the health promotion program
Session 2	Dietary guidelines: components of healthy meals	NS	2 hours	- Discussion healthy bodies and the role of nutrition intake - Creating balanced diet using a food balance wheel	- Learning dietary guideline
Session 3	My nutritional status	NS	2 hours	- Using the NQ questionnaire to understand individual's food intake - Assessing my own food intake quality	- Simple nutrition assessment using NQ questionnaire
Session 4–5	Making a healthy meal: a bowl of salad	NS, CR	2 hours	- Making a salad bowl using sweet pumpkin and ricotta cheese - Increasing awareness of vegetarianism and animal welfare	- Learning about vegetarian diets and animal welfare
	Mind control through a yoga session	PA	90 minutes	- Learning about controlling stress through yoga	- Yoga practice
Session 6	Group cooking and exercising	NS, CR	2 hours	- Cooking and exercising in groups - Group meal planning using vegetarian and animal welfare products (Kito gimbap) - Engaging in yoga and physical activities	- Group sessions for cooking and exercising
Session 7	Mind control through forest experience	SE	1 day	- Field trip to the rural areas of the region - Board game activities - Tree planting	- Understanding environmental protection through a forest experience
Session 8	The exercise my body needs	PA	90 minutes	- Identify your body type - Understanding exercise methods	- Learning exercises suitable for specific body types
Session 9	Nutritional diets	NS, CR	2 hours	- Attending a lecture on nutrient-balanced diets - Designing a meal with balanced nutrients	- Cooking practice using meal plans
Session 10	Emotional eating	NS, CR	2 hours	- Writing diet logs - Understanding eating psychology	- Emotional eating and eating psychology
Session 11–12	Do you understand zero-waste?	SE	2 hours	- How to reduce food waste - Cooking a meal with minimal food waste	- Group cooking
	Creating exercise habits	PA	90 minutes	- Making habits of participating in physical activity	- Weight training
Session 13	Course completion ceremony	-	1 hour	- Sharing personal experiences of the course	- Group feedback
Additional activity	Mentor-mentee individual activities	PA	1 hour	- Mentor explains exercise methods and conducts group workouts (running, walking, basketball)	- Group exercise

FL, food literacy; PA, physical activity; NS, nutrition and safety FL; CR, cultural and relational FL; SE, socio-ecological FL; NQ, nutrition quotient.
[1)]The class is divided into two groups for session 4–5, 11–12.
[2)]All: nutrition and safety FL + cultural and relational FL + socio-ecological FL.

application used to guide the step test procedure, and a stopwatch. The physical efficiency index (PEI) of the participants was calculated through scores recorded in 0.1-point increments using the following formula [33]:

PEI = D / (2 × P) × 100
D: the duration of step exercise (seconds),
P: the sum of heart rates measured in three intervals (1–1.5, 2–2.5, 3–3.5 minutes).

Dietary and exercise activity sheets based on the TTM were designed for this study, and participants completed these sheets three times (in Sessions 1, 10, and 15). The developed activity sheets included the change stages of precontemplation, contemplation, preparation, action, and maintenance. Participants rated their level of agreement with each item on a 5-point scale (1: precontemplation, 5: maintenance).

6. Statistical analysis

Initially, this study measured the three subdomains of FL using a five-point scale. The responses were then recoded and standardized to a 4-point scale to make it easier to present as a 100-point scale. The overall tally was obtained by summing the scores from the three subdomains and then dividing this number by three to convert it to a 100-point scale. The Wilcoxon signed-rank test, a non-parametric test, was used to compare the pre- and post-intervention results and to assess the differences in mean FL and physical fitness scores based on the demographic characteristics of the participants. Statistical analysis was performed using Stata 17.0 (StataCorp LLC), with the significance level set at $P < 0.05$.

RESULTS

1. Sociodemographic characteristics

Table 2 presents the demographic characteristics of the study participants. The total sample of 39 college students included 14 male (35.9%) and 25 female (64.1%). Of them, 13 students (33.3%) were food and nutrition majors. In terms of living arrangements, 13 students (33.3%) lived independently, 12 (30.8%) lived with their families, and 12 (30.8%) resided in dormitories.

2. Changes in food literacy levels

Table 3 displays the pre- and post-intervention FL level changes according to subdomains. The overall FL score increased significantly from 64.1 points at the baseline to 70.6 points post-intervention ($P = 0.001$). Specifically, all subdomains showed statistically significant improvements: nutrition and safety ($P < 0.001$), cultural and relational ($P = 0.023$), and socio-ecological ($P = 0.001$). The subcomponents of FL also demonstrated significant improvements: knowledge ($P = 0.001$), self-efficacy ($P = 0.013$), attitude ($P < 0.001$), and behavior ($P = 0.005$).

3. Changes in eating habits

Table 4 shows the changes in eating habits from pre- and post-intervention assessments. Meal frequency and late-night snack consumption did not show significant changes. However, the frequency of eating breakfast with others increased from 1.3 times at the baseline to 1.4 times post-intervention, a statistically significant value ($P = 0.044$). Moreover, the average time spent on each meal increased significantly from 18.7 minutes at the baseline to 21.0 minutes post-intervention ($P = 0.007$). The meal venue analysis revealed no significant changes in visits to convenience stores ($P = 0.568$), use of delivery food ($P = 0.849$), restaurants ($P = 0.184$), catering ($P = 0.242$), ready-to-eat meals ($P = 0.822$), and home-cooked meals ($P = 0.766$).

4. Changes in physical activity and physical fitness

Table 5 displays the outcomes of the pre- and post-in-

Table 2. Sociodemographic characteristics of the participants

Characteristic	Participant (n = 39)
Total	39 (100)
Sex	
Male	14 (35.9)
Female	25 (64.1)
Department	
Food and nutrition	13 (33.3)
Others	26 (66.7)
Household types	
Living with family	12 (30.8)
Dormitory	12 (30.8)
One person households	13 (33.3)
Others	2 (5.1)

n (%).

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Table 3. Changes in food literacy scores from pre- and post-intervention assessments by sub-domains and sub-elements

Variable	Pre-intervention	Post-intervention	*P*-value[1]
All FL[2]	64.1 ± 12.6	70.6 ± 13.5	0.001
Nutrition and safety	67.9 ± 13.7	74.6 ± 13.0	< 0.001
Cultural and relational	63.2 ± 16.3	67.7 ± 15.5	0.023
Socio-ecological issues	61.1 ± 15.7	69.5 ± 17.4	0.001
Scores for sub-elements[3]			
Knowledge	20.4 ± 4.0	22.6 ± 4.6	0.001
Self-efficacy	19.7 ± 2.9	20.6 ± 2.8	0.013
Attitudes	52.5 ± 8.2	56.6 ± 8.4	< 0.001
Behavioral skills	25.5 ± 4.2	27.2 ± 4.3	0.005

Mean ± SD.
FL, food literacy.
[1]Wilcoxon signed-rank test for pre- and post-intervention comparisons effected for each group; $P < 0.05$.
[2]All FL score: This score encompasses the nutritional and safety, cultural and relational, and socio-ecological dimensions of FL.
[3]Subelements: The full FL domain was reclassified into four categories: knowledge, self-efficacy, attitude, and behavioral skills.

Table 4. Changes in eating habits from pre- and post-intervention assessments

Eating habit	Pre-intervention	Post-intervention	*P*-value[1]
Meal frequency (times per week)			
Breakfast	1.4 ± 2.0	1.5 ± 1.8	0.560
Lunch	4.6 ± 1.4	4.6 ± 1.4	0.964
Dinner	5.0 ± 1.1	5.1 ± 1.2	0.493
Frequency of eating with others (times per week)			
Breakfast	1.3 ± 0.5	1.4 ± 0.5	0.044
Lunch	1.3 ± 0.5	1.3 ± 0.5	>0.999
Dinner	1.1 ± 0.3	1.1 ± 0.3	0.964
Frequency of late-night snacking			
1 times per week	1.9 ± 0.8	2.0 ± 0.9	0.760
Average per-meal duration (min)	18.7 ± 7.0	21.0 ± 6.9	0.007
Meal location (times per week)			
Convenience store	2.6 ± 1.6	2.4 ± 1.4	0.568
Delivery food	1.5 ± 1.2	1.5 ± 1.3	0.849
Restaurant	2.5 ± 1.4	2.8 ± 1.7	0.184
Group catering	1.1 ± 1.8	0.8 ± 1.4	0.242
Ready-to-eat meals	1.6 ± 1.6	1.6 ± 1.8	0.822
Home-cooked meals	3.0 ± 3.0	3.1 ± 3.3	0.766

Mean ± SD.
[1]Wilcoxon signed-rank test for pre- and post-program comparisons effected for each group; $P < 0.05$.

tervention of physical activity and physical fitness test. No significant differences were observed in vigorous physical activity ($P = 0.064$), flexibility exercises ($P = 0.404$), or strength training ($P = 0.909$). Male did not show significant pre- and post-intervention changes ($P = 0.624$) in the sit-up test but female demonstrated a significant post-intervention increase ($P = 0.046$) in their physical fitness. Neither male ($P = 0.344$) nor female ($P = 0.526$) demonstrated statistically significant changes in the vertical jump test. Similarly, neither male ($P = 0.861$) nor female ($P = 0.427$) showed significant differences in the sit-and-reach test, and no significant changes were observed in the step test for both male ($P = 0.937$) and female ($P = 0.280$).

5. TTM-based stages of change in diet and exercise behavior

Table 6 presents the results of the TTM-based stages of change in diet- and exercise-related behavior before and after the intervention. The stage of change in dietary habits increased significantly from a baseline average of 2.7 to 3.1 post-intervention, indicating a shift from the contemplation stage to the preparation stage ($P = 0.015$). In contrast, the stage of change in exercise habits increased from 3.0 to 3.4, but this change approached statistical significance without advancing to the action stage, remaining within the preparation stage ($P = 0.053$). All 39 participants attended all scheduled sessions of the program, confirming its feasibility. After

Table 5. Changes in frequencies of physical activities and physical fitness from pre- and post-intervention assessments

Variable	Pre-intervention	Post-intervention	*P*-value[1)]
Physical activity (frequency per week)			
Intense physical activity[2)]	2.4 ± 1.8	1.8 ± 1.5	0.064
Flexibility exercise	2.1 ± 2.1	1.7 ± 1.7	0.404
Strength exercise	1.4 ± 1.9	1.3 ± 1.8	0.909
Physical fitness assessment			
Sit-ups (number/min)[3)]			
Male	45.5 ± 8.9	45.2 ± 10.6	0.624
Female	25.4 ± 6.3	27.8 ± 5.9	0.046
Vertical jump (sec)[4)]			
Male	30.2 ± 12.3	33.8 ± 8.0	0.344
Female	18.8 ± 4.5	19.3 ± 4.8	0.526
Sit-and-reach (cm)[5)]			
Male	3.9 ± 10.6	3.9 ± 8.6	0.861
Female	8.9 ± 10.6	8.1 ± 9.8	0.427
Step test (steps per min)[6)]			
Male	56.5 ± 6.7	58.2 ± 9.8	0.937
Female	60.5 ± 7.8	59.3 ± 7.1	0.280

Mean ± SD.
[1)]Wilcoxon signed-rank test for pre- and post-program comparisons effected for each group; $P < 0.05$.
[2)]Intense physical activity: Physical activities that are very strenuous or cause heavy breathing, such as running, swimming, cycling, and hiking.
[3)]A sit-up measurement device was used to count the number of sit-ups performed in one minute.
[4)]A Sargent jump tester was utilized to measure the vertical jump height and physical efficiency index (PEI) was calculated.
[5)]A flexibility tester was employed to measure flexibility via a sit-and-reach test.
[6)]A step test measurement device was used to obtain the values to calculate the PEI.

Table 6. Changes in values of the stages of change model[†] from pre- and post-activity assessments

Variable	Pre-intervention	Post-intervention	*P*-value[1)]
Dietary habits	2.7 ± 1.0	3.1 ± 1.0	0.015
Exercise	3.0 ± 1.2	3.4 ± 1.1	0.053

Mean ± SD.
[1)]Wilcoxon signed-rank test for pre- and post-activity comparisons effected for each group; $P < 0.05$.
[†]The average values of the stages of change model: 1 = precontemplation, 2 = contemplation, 3 = preparation, 4 = action, and 5 = maintenance.

the completion of the entire program, the satisfaction evaluation showed a high level of satisfaction, with an average score of 8.26 out of 10.

DISCUSSION

This pilot study aimed to develop and evaluate an intervention program focused on FL and physical exercise for college students in the Gangwon region, South Korea. College students need to receive proper nutrition education to form healthy eating habits and reduce the risks of chronic diseases later in life [7]. However, very few nutrition intervention programs are currently offered to college students in Korea, and research on FL is even more scarce [23]. This study is based on the previous study that designed and implemented FL improvement program for college students on campus [26, 27] and developed further to enhance FL and establish exercise habits in college students. In-depth interviews conducted by previous studies identified that existing programs did not adequately address the lack of cooking practice and the importance of exercise [27]. This study sought to bridge this gap by designing a pilot program incorporating more cooking practices and forming beneficial exercise habits with the help of peer groups. In addition, the program was conducted as a part of classes held on campus and was designed to enhance self-efficacy through mentor–mentee interactions over the course of a semester. The study aimed to test whether this multicomponent program can be feasible and acceptable among students and to test any impact on enhancements of FL and physical activities.

The general participant characteristics revealed that 33.3% lived independently, confirming that single-person households represented the primary living arrangement of college students. Previous studies have indicated that single-person households exhibit higher rates of skipping breakfast, eating out, and alcohol consumption than multi-person households [11, 34]. The 2021 Seoul Food Survey also disclosed that single-person households evinced lower scores in the nutrition and safety domain in FL scores than multi-person households [32, 35]. Currently, despite Seoul and other local governments have implemented relevant programs targeting single-person households, there is insufficient

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data evaluating their effectiveness [36, 37]. This study emphasizes the need for well-designed evaluation programs for FL among this population.

The analysis of FL levels by subdomain in this study revealed significant improvements across all three subdomains and their subcomponents among participants, consistent with previous studies showing that nutrition programs lead to improvements in FL domains [38]. Our previous study also successfully showed the increased knowledge and the overall score of FL among intervention participants. However, it is noteworthy that the previous program failed to show significant improvement when compared to control group [27]. Additionally, aside from knowledge, their study observed no significant changes in the domains of self-efficacy, attitude, and behavior. These results suggest that while targeted FL program could enhance food-related knowledge within the intervention group, more effort is needed to produce larger and more sustainable outcomes in terms of fostering self-efficacy, attitudes, and behaviors.

The study found that the participants did not increase their physical activity as much as expected after participating in the program. College students find it difficult to engage in physical activities because they lack the time and because of their paucity of knowledge about exercise [39]. Also, programs focusing on developing physical activity habits in college students remain scant. Therefore, it is important to develop programs and offer continuous monitoring support to help college students maintain regular exercise habits despite busy academic schedules.

According to the fitness assessment, only female showed a statistically significant improvement in sit-ups ($P = 0.046$) after the intervention. This may be due to female tend to be more influenced by social environment and support, which was one of the main strategies of this pilot program [40]. To effectively enhance fitness for both male and female, universities need to integrate sustainable exercise programs into their academic schedules, leveraging existing extracurricular activities, students-initiated events, and capstone projects [41,42]. Developing programs that promote healthy eating and exercise habits, along with continuous monitoring of their effectiveness, can help create a campus environment where students can participate in regular physical activities and improve their fitness despite their busy academic schedules.

This study confirmed that the stages of change for diet and exercise improved within a relatively short period after the 13-session intervention program, suggesting that such programs can initiate positive behavioral changes if provided for longer period of time. However, some participants remained in the preparation stage for both dietary and exercise changes and did not advance to the action stage. This stage is characterized by the intention to make changes without actions, making it likely that concrete behavioral changes may not follow. Previous studies emphasize that moving program participants from the preparation to the action stage often requires at least six months of sustained TTM-based interventions. This will reinforce behavioral changes and achieve substantial lifestyle modifications [43,44]. In this study, the 13-session TTM-based intervention program revealed significant improvements in the stages of dietary change, while the stages of exercise change showed a marginal significance. These results suggest that greater benefits could be achieved if continuous support and interventions are provided at each stage.

Limitations

One of the limitations of this study is that the pilot program was conducted with a small number of students from one university in the Gangwon region without control groups, making it difficult to generalize the results to college students nationwide and to confirm the causality of the effect. Although the 13-session health promotion program effectively improved overall FL score, it was limited in promoting the sustained practice of healthy behaviors. Additionally, while the study aimed to measure changes in physical ability through objective indicators, it has been confirmed that a long-term and rigorous study of at least six months is necessary to assess the impact of the intervention on physical activity. Despite of limitations, this study shows some potential that this type of multicomponent health promotion program can be implemented as a part of curriculum on college campus and the results are showing some potentials.

Conclusion

This 13-session of multicomponent intervention showed that curriculum-based intervention on college campus can be feasible and may be effective in improving FL and participants' motivation toward healthier food and exercise choices. It is meaningful that integrated nutrition and exercise interventions are still rare on college campuses. Specifically, this study demonstrated the improvement of FL among participants and the high completion rates. Findings indicate that while the intervention programs effectively enhance FL and dietary habits, additional strategies are necessary to promote changes in physical activity and fitness measurements. Future research should explore specific and effective strategies to improve dietary habits through enhanced FL and increase physical activity among larger group of college students.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

Research data is available upon a reasonable request to the corresponding author.

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Research Article

Nutritional content and healthiness in sweet and salty snacks and beverages popular in South Korea and the United States assessed by nutrition labels: a cross-sectional comparative study

Bo Jeong Gong[1], Segovia Lucas[2], Diewo Camara[3], Pauline E. Jolly[4], Chandrika Piyathilake[5], Taisun Hyun[6],†

[1]Doctoral Student, Department of Food and Nutrition, Chungbuk National University, Cheongju, Korea
[2]Bachelor of Arts, Latino Health Studies, Tufts University, Medford, MA, USA
[3]Bachelor of Science, Public Health, Ohio State University, Columbus, OH, USA
[4]Professor Emeritas, Department of Epidemiology, University of Alabama at Birmingham, Birmingham, AL, USA
[5]Professor Emeritas, Department of Nutrition Science, University of Alabama at Birmingham, Birmingham, AL, USA
[6]Professor, Department of Food and Nutrition, Chungbuk National University, Cheongju, Korea

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†Corresponding author:
Taisun Hyun
Department of Food and Nutrition, Chungbuk National University, 1 Chungdae-ro, Heungduk-gu, Cheongju 28644, Korea
Tel: +82-43-261-2790
Fax: +82-43-267-2742
Email: taisun@cbnu.ac.kr

Objectives: This study investigated the nutritional differences between sweet and salty snacks and beverages in South Korea (Korea) and the United States (US). Nutritional content and healthiness were determined using back- and front-of-package nutrition labeling (FoPNL) systems.

Methods: Three snack and three beverage categories popular in Korea and the US were selected. Statistical data were used to determine the top 10–15 best-selling products in each category in each country. The selected products included chips (n = 15), cookies (n = 10), chocolate (n = 13), carbonated drinks (n = 10), fruit juices/drinks (n = 10, 5/5), and energy drinks (n = 10). The study excluded products that were artificially sweetened. Nutritional information and percentages of fruit and vegetable content in each product were collected from brand websites and grocery stores in each country. The FoPNL system was used to assess the healthiness of the products, which included multiple traffic light labels, a Health Star Rating, and a Nutri-Score.

Results: Overall, Korean snacks contained significantly more protein, total fat, saturated fat, and cholesterol than US snacks. However, the US chips and carbonated drinks contained more sodium, while the US energy drinks contained more caffeine than Korean products. The serving size of US carbonated drinks was significantly larger than that of Korean drinks, whereas the serving size of US chips was smaller than that of Korean products. The FoPNL system classified the majority of products as 'less healthy.'

Conclusion: Our results suggest that Korean and US food manufacturers should improve the nutritional quality and/or serving size of commonly consumed food products. Policymakers in both countries should work to improve the presentation of nutrient information on nutrition labels to assist consumers in making healthier food choices.

Keywords: nutrition labeling; nutritional value; serving size; snacks

INTRODUCTION

Food choices and eating habits have changed dramatically in many countries around the world over the past several decades [1]. Similar to other developing nations, South Korea (Korea) has undergone a nutrition transition with economic growth, industrialization, urbanization, and globalization [2]. The traditional low-fat, high-fiber Korean diet has been replaced by processed foods high in fats and added sugars [3]. This dietary transition is particularly evident in beverage consumption, with non-alcoholic beverage intake increasing more than fourfold between 1998 and 2018 [3]. Additionally, snacks account for a larger proportion of daily calories, rising from 14% in 1998 to 19% in 2016–2018. Within these snacks, the contribution of calories from ultra-processed foods increased significantly from 31.8% to 62.6% over the same period [4]. These ultra-processed snacks are often high in calories, added sugar, fats, and sodium [5]. Therefore, excessive consumption of snacks, particularly sweet and salty snacks, can result in overconsumption of calories, sugars, fats, and sodium, which are known to increase the risk of obesity and metabolic diseases [5-7].

Efforts to reduce sodium and sugar intake are critical components of public health strategies worldwide [8, 9]. In Korea, various policies aimed at reducing sugar, fat, and sodium consumption have been implemented [10-12]. These initiatives focus on public education and collaboration with the food industry to reformulate products. Such policies have achieved measurable success, including a significant decrease in trans fat content in snack foods and a reduction in sodium intake among the Korean population. The Ministry of Food and Drug Safety (MFDS) in Korea continues to work with the food industry to further reduce sodium and sugar levels in processed foods. Similarly, in the United States (US), there was a marked reduction in the sodium content of packaged foods and beverages from 2000 to 2014 [13].

The World Health Organization recommends implementing nutrition labeling policies to help people make healthier food choices, with the goal of preventing obesity and noncommunicable diseases [14]. Studies have shown that reading nutrition labels is associated with improved diet quality [15-17]. Specifically, individuals who reported reading nutrition labels were more likely to practice healthier eating habits [18, 19]. However, a 2022 survey in Korea revealed notable gaps in nutrition label awareness and usage [20]. Although 57.6% of Korean adults reported being aware of nutrition labels, comprehension rates were substantially lower at 25.7%, and utilization of these labels during processed food selection was limited to 21.3% [20]. In both Korea and the US, nutrition labels are currently printed in small letters and numbers on the back of food packages [21]. Evidence suggests that the complexity of numerical information and its placement on the back of the package can make it difficult for consumers to understand and use the label effectively [22].

In an effort to help consumers make healthier food choices, easy-to-understand symbols and color-coded labels have recently been introduced on the front of the packages [23]. More than 30 countries have adopted voluntary or mandatory front-of-packages nutrition labeling (FoPNL) systems [24]. Generally, FoPNL can be categorized into nutrient-specific and summary indicator systems. The examples of FoPNL systems are presented in Fig. 1 [25, 26]. The multiple traffic light (MTL) nutrition label, a type of nutrient-specific system, is used in several countries, including the United Kingdom (UK) [25]. The MTL label employs traffic light colors (red, amber, green) to indicate high, medium, and low levels of fat, saturated fat, sugars, and salt, as shown in Fig. 1A. The use of MTL label has been shown to help consumers to make healthier food choices [27, 28]. Several other summary indicator systems have been developed based on formulas that take into account the nutritional composition of the product. The Health Star Rating (HSR) system, used in Australia and New Zealand, rates products from 0.5 stars (least healthy) to 5 stars (most healthy), as shown in Fig. 1B. The Nutri-Score (NS), developed in France and used in some European countries, displays an estimate of healthiness with letters from A (most healthy) to E (least healthy) in different colors, as illustrated in Fig. 1C. A is green, B is light green, C is yellow, D is amber, and E is red. The label shows all five letters in different colors, but the letter indicating the value of the product is made larger. Evidence supports FoPNL as an effective public health intervention, demonstrating positive impacts on both

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Fig. 1. Examples of front-of-package nutrition labeling.
Adapted from Department of Health and Social Care [25] and Food Standrards Australia New Zealand [26].

consumer food choices and industry-driven product reformulation [29, 30].

Some summary indicator systems, such as HSR and NS, can rank packaged foods based on their nutritional composition. Dunford *et al.* [31] reported considerable variability in the healthiness of packaged foods and beverages across countries using the HSR, with products in middle-income countries like China and India being less healthy than those in high-income countries like the US and the UK. While Korea has implemented policies to reduce trans fat, sodium, and sugar content in processed foods, no comparative analysis has been conducted to evaluate the nutritional quality of Korean snacks and beverages relative to similar products in other countries. This study aimed to compare the nutritional differences between sweet and salty snacks and beverages in Korea and the US. The comparison was based on the back-of-package nutrition labeling (BoPNL) data and the FoPNL systems, including MTL, HSR, and NS.

METHODS

Ethics statement

Ethics approval was not required as no human subjects were involved in this study.

1. Study design

This study was conducted as a cross-sectional study. It was described in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement, available at https://www.strobe-statement.org/.

2. Selection of snacks and beverages

The study compared snacks and beverages between Korea and the US. Snacks included three categories: chips, cookies, and chocolate, and beverages included three categories: carbonated drinks, fruit juice/drinks, and energy drinks [32, 33]. Korean products were selected based on brand sales ranking from retail point-of-sale data for major processed foods, as disclosed by the Korea Agro-Fisheries and Food Trade Corporation [34]. When a store brand which refers to a distributor's own brand was included in the top rankings, additional product was selected through Naver DataLab. This platform provides search volume data for keywords within specific categories over a given period. In this study, additional popular products were identified based on click trends in shopping categories, such as carbonated beverages, during 2023. The best-selling US products were selected based on the sales rankings released by Statista. When additional product selection by category was needed, the rankings of best-selling products from Amazon's website in July 2023 were used. The selected products included chips (n = 15), cookies (n = 10), chocolate (n = 13), carbonated drinks (n = 10), fruit juice/drinks (n = 10; 5/5), and energy drinks (n = 10) in each country. Artificially sweetened products were excluded.

3. Nutritional analysis of the products by the BoPNL

The nutrition information of selected products were collected from brand websites or grocery stores in each country. The most recent nutritional values per 100 g (or 100 mL) for energy (kcal), total carbohydrates (g), sugar (g), protein (g), total fat (g), trans fat (g), saturated fat (g), cholesterol (mg), and sodium (mg) as well as serving size were obtained. Trans fat content can be labeled as '0' if it is less than 0.2 g per serving in Korea and less than 0.5 g in the US. Due to the difficulty in estimating exact amounts, trans fat was excluded from the analysis. Additionally, the percentage of fruit and vegetable content in fruit juice/drinks was collected.

4. Assessment of the healthiness of the products by the FoPNL criteria

The healthiness of the products was assessed using the criteria of MTL, HSR, and NS. Products were classified by the number of red lights based on the MTL criteria. A healthiness score was calculated for each product following the method described by Sacks *et al.* [35]. One point was allocated for each green label, two points for each amber label, and three points for each red label. To calculate the total score, all four traffic-light labels were summed, resulting in a possible score range of 4 to 12 points for each product. A lower score indicated a healthier product, and products scoring 7 points or more were classified as 'less healthy'.

The HSR was calculated using a calculator based on the guide [36]. Each product was classified according to the HSR food category, and scored by considering the positive factors, such as protein, fiber, and fruit/vegetable/nut/legume (FVNL) content, and negative factors, such as energy, saturated fat, sugar, and sodium. A lower score reflects a healthier product. Products were assigned from 0.5 to 5.0 stars, with half-star increments based on their scores. Products with a HSR below 3.5 stars were classified as 'less healthy'.

The updated algorithm for calculating the NS has been described [37]. Positive points (0–10 points) were assigned for unfavorable variables such as energy, sugar, saturated fat, and sodium, while negative points (0–5 points) were assigned for favorable variables such as protein, fiber, and FVNL percentage. The final score ranged from –15, indicating highest nutritional quality, to 40, indicating lowest nutritional quality. The score was then converted to a corresponding color and letter grade. For general foods, scores ranging from –15 to –1 are categorized as dark green (A) for the best nutritional quality, 0 to 2 as light green (B), 3 to 10 as yellow (C), 11 to 18 as orange (D) and 19 to 40 as red (E) for the worst nutritional quality. For beverages, only water is allowed to be graded as A. The NS calculator for the updated algorithm was used to calculate product scores [38].

5. Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics 29 (IBM Co.). Continuous variables, such as nutrients and serving size, were presented as median, minimum, and maximum values. The Mann-Whitney U test was used to compare variables between the two countries. The frequency and percentage of products for the grades of MTL, HSR, and NS were calculated. A *P*-value of < 0.05 was considered statistically significant.

For data visualization, heatmaps and swarm plots were created using python (version 3.9, Python Software Foundation, 2021). In the swarm plots, data points were distributed horizontally to avoid overlapping data and to facilitate intuitive comparisons of differences between the two countries.

RESULTS

1. Nutritional content of snacks and beverages popular in Korea and the US

Nutritional content and serving sizes of sweet and salty snacks, including chips, cookies, and chocolate, are shown in Table 1. The median energy content per 100 g and serving sizes of 38 Korean and US snacks were similar: 526.1 kcal and 500.0 kcal, and 31.0 g and 30.0 g, respectively. Among the categories analyzed in this study, US chips had the highest median sodium content at 678.6 mg/100 g, and US chocolate had the highest median sugar content at 51.1 g/100 g. On the contrary, Korean chocolate had the highest total fats and saturated fats at 32.4 g/100 g and 17.5 g/100 g, respectively. Korean chips had significantly higher sugar ($P < 0.05$) and saturated fat ($P < 0.01$), but lower sodium ($P < 0.01$) per 100 g, compared to US chips. The median serving size of Korean chips was larger than that of US chips ($P < 0.01$). Korean cookies contained significantly higher energy ($P < 0.01$) and saturated fat ($P < 0.01$) per 100 g, but lower carbohydrates ($P < 0.05$) and sugar ($P < 0.05$) per 100 g than US cookies. Korean chocolate had higher energy ($P < 0.01$), protein ($P < 0.01$), fat ($P < 0.05$), saturated fat ($P < 0.01$), and cholesterol ($P < 0.05$) per 100 g than US chocolate. When the three snack categories were combined, Korean snacks were significantly higher in protein ($P < 0.01$), fat ($P < 0.05$), saturated fat ($P < 0.001$), and cholesterol ($P < 0.05$) per 100 g than US snacks.

The nutritional content and serving sizes of beverages, including carbonated drinks, fruit juice/drinks, and energy drinks, are shown in Table 2. Korean carbonated drinks were significantly lower in saturated fat ($P <$

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Table 1. Nutritional content per 100 g and serving size of sweet and salty snacks in South Korea and US

Variable	Chips		Cookies	
	KOR (n = 15)	US (n = 15)	KOR (n = 10)	US (n = 10)
Energy (kcal)	520.0 (466.7 to 765.0)	514.3 (392.9 to 571.4)	510.6 (480.8 to 587.0)	468.7 (421.1 to 561.4)**
Carbohydrates (g)	62.8 (50.0 to 71.4)	60.0 (53.6 to 71.4)	60.2 (33.3 to 76.9)	67.6 (57.9 to 73.5)*
Sugars (g)	5.0 (0.0 to 31.7)	1.8 (0.0 to 7.1)*1)	31.7 (8.3 to 38.0)	36.8 (24.0 to 41.2)*
Protein (g)	6.7 (3.3 to 13.3)	7.1 (1.8 to 13.0)	6.7 (1.9 to 8.5)	3.7 (2.6 to 7.1)
Total fat (g)	26.7 (18.3 to 38.0)	28.6 (8.9 to 35.7)	26.1 (13.3 to 39.1)	20.3 (15.8 to 31.6)
Saturated fat (g)	8.7 (4.8 to 14.0)	5.4 (0.0 to 20.0)**	15.1 (6.7 to 21.9)	8.0 (1.0 to 12.3)**
Cholesterol (mg)	0.0 (0.0 to 30.0)	0.0 (0.0 to 0.0)	13.1 (0.0 to 76.9)	0.0 (0.0 to 107.1)
Sodium (mg)	500.0 (50.0 to 700.0)	678.6 (321.4 to 1,171.4)**	274.6 (152.2 to 625.0)	349.1 (176.5 to 400.0)
Serving size (g)	30.0 (30.0 to 60.0)	28.0 (19.0 to 35.0)**	32.0 (22.0 to 52.5)	34.0 (25.0 to 57.0)
Variable	Chocolate		Snacks (total)	
	KOR (n = 13)	US (n = 13)	KOR (n = 38)	US (n = 38)
Energy (kcal)	550.0 (477.8 to 732.2)	500.0 (312.5 to 571.4)**	526.1 (466.7 to 765.0)	500.0 (312.5 to 571.4)
Carbohydrates (g)	58.8 (48.3 to 71.4)	60.6 (50.0 to 83.3)	60.0 (33.3 to 76.9)	64.3 (50.0 to 83.3)
Sugars (g)	46.2 (21.2 to 71.4)	51.1 (29.8 to 69.0)	27.5 (0.0 to 71.4)	33.8 (0.0 to 69.0)
Protein (g)	8.8 (5.8 to 11.8)	6.1 (1.5 to 9.5)**	6.9 (1.9 to 13.3)	6.1 (1.5 to 13.0)**
Total fat (g)	32.4 (22.2 to 44.6)	23.9 (0.0 to 35.7)*	28.1 (13.3 to 44.6)	24.6 (0.0 to 35.7)*
Saturated fat (g)	17.5 (11.1 to 28.6)	10.8 (0.0 to 20.0)**	13.5 (4.8 to 28.6)	7.9 (0.0 to 20.0)***
Cholesterol (mg)	14.7 (8.1 to 35.3)	8.3 (0.0 to 19.2)*	8.7 (0.0 to 76.9)	0.0 (0.0 to 107.1)*
Sodium (mg)	116.3 (60.0 to 463.0)	142.9 (47.6 to 316.7)	348.5 (50.0 to 700.0)	350.7 (47.6 to 1,171.4)
Serving size (g)	34.0 (15.0 to 56.0)	33.0 (26.0 to 58.7)	31.0 (15.0 to 60.0)	30.0 (19.0 to 58.7)

Median (minimum to maximum).
KOR, South Korea; US, United States.
1)*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Significant difference between Korea and US by the Mann-Whitney U test.

0.01), cholesterol ($P < 0.01$), and sodium ($P < 0.01$) per 100 mL, and serving sizes ($P < 0.05$) than US products. US fruit juice/drinks had significantly higher saturated fat and cholesterol than Korean products ($P < 0.01$ for both) even though the differences were small. US energy drinks contained significantly more caffeine than Korean energy drinks ($P < 0.01$). When the three categories were combined, US beverages had significantly higher saturated fat ($P < 0.001$) and cholesterol ($P < 0.001$) per 100 mL than Korean beverages, along with larger serving sizes ($P < 0.05$). However, Korean beverages contained significantly more total fat than US beverages ($P < 0.05$).

2. Healthiness of snacks and beverages assessed by MTL labels

The classification of snacks by the number of red traffic lights each product received using MTL labeling criteria is presented in Table 3. All products received at least one red light of the four nutrients: fat, saturated fat, sugar, and sodium. In both countries, 60% of chips had two red lights, and 70% of cookies had three red lights. Notably, all Korean chocolate had three red lights, whereas three out of 10 US chocolates had only one red light. Almost all sweet and salty snacks were classified as 'less healthy.'

The distribution of traffic light colors for nutrients in snacks and beverages is shown in Fig. 2. In both countries, red lights were most frequently observed for sugar, fat, and saturated fat, while amber lights were most common for sodium in snacks. The percentage of red lights for sugar was similar in Korean and US snacks. However, the percentages of red lights for fat and saturated fat were higher in Korean snacks compared to US snacks, whereas the percentage for sodium was higher in US snacks. For beverages, only the sugar content was compared between the two countries, as levels of fat, saturated fat, and sodium were generally low. Amber lights were the most common for sugar in beverages, and the percentage of red lights was higher in US beverages compared to Korean beverages.

Table 2. Nutritional content per 100 mL and serving size of beverages in South Korea and US

Variable	Carbonated drinks		Juice/fruit drinks	
	KOR (n = 10)	US (n = 10)	KOR (n = 10)	US (n = 10)
Energy (kcal)	44.3 (32.0 to 54.1)	42.0 (36.6 to 47.2)	42.6 (22.6 to 55.3)	43.8 (33.3 to 58.3)
Carbohydrates (g)	11.2 (8.0 to 13.5)	11.3 (9.0 to 12.8)	11.3 (5.6 to 13.7)	11.3 (8.8 to 15.4)
Sugars (g)	11.2 (8.0 to 13.0)	11.3 (9.0 to 12.8)	9.5 (5.1 to 12.6)	10.2 (7.1 to 14.6)
Protein (g)	0.0 (0.0 to 0.4)	0.0 (0.0 to 0.0)	0.0 (0.0 to 1.0)	0.0 (0.0 to 0.8)
Total fat (g)	0.0 (0.0 to 0.2)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.4)	0.0 (0.0 to 0.0)
Saturated fat (g)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)$^{**1)}$	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)**
Cholesterol (mg)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)**	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)**
Sodium (mg)	3.2 (0.0 to 9.6)	15.4 (8.3 to 20.0)**	13.9 (0.0 to 70.0)	4.2 (0.0 to 20.8)
FVNL (%)	-	-	70.0 (3.0 to 100.0)	57.5 (5.0 to 100.0)
Serving size (mL)	250.0 (215.0 to 355.0)	357.5 (222.0 to 500.0)**	200.0 (180.0 to 340.0)	240.0 (177.0 to 240.0)
Variable	Energy drinks		Beverages (total)	
	KOR (n = 10)	US (n = 10)	KOR (n = 30)	US (n = 30)
Energy (kcal)	47.2 (38.0 to 65.6)	45.1 (21.1 to 87.5)	45.5 (22.6 to 65.6)	44.7 (21.1 to 87.5)
Carbohydrates (g)	11.4 (9.0 to 16.3)	11.6 (5.1 to 22.5)	11.2 (5.6 to 16.3)	11.4 (5.1 to 22.5)
Sugars (g)	11.1 (8.7 to 15.9)	11.0 (4.6 to 22.5)	10.9 (5.1 to 15.9)	11.0 (4.6 to 22.5)
Protein (g)	0.3 (0.0 to 0.3)	0.0 (0.0 to 0.3)	0.0 (0.0 to 1.0)	0.0 (0.0 to 0.8)
Total fat (g)	0.0 (0.0 to 0.2)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.4)	0.0 (0.0 to 0.0)*
Saturated fat (g)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)***
Cholesterol (mg)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.1)	0.0 (0.0 to 0.0)	0.1 (0.0 to 0.1)***
Sodium (mg)	25.7 (0.0 to 76.9)	32.4 (0.0 to 154.2)	11.2 (0.0 to 76.9)	15.0 (0.0 to 154.2)
Caffeine (mg)	28.2 (13.0 to 42.0)	31.9 (24.0 to 45.1)**	-	-
Serving size (mL)	355.0 (250.0 to 355.0)	406.5 (237.0 to 473.0)	250.0 (180.0 to 355.0)	355.0 (177.0 to 500.0)*

Median (minimum to maximum).
KOR, South Korea; US, United States; FVNL, fruit/vegetable/nut/legume.
$^{1)*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. Significant difference between Korea and US by the Mann-Whitney U test.

Table 3. Classification of snacks by the number of red traffic light labels using MTL label criteria

Variable	No. of red traffic lights					Less healthy[1)]
	0	1	2	3	4	
Chips						
KOR (n = 15)	0 (0.0)	1 (6.7)	9 (60.0)	4 (26.7)	1 (6.7)	15 (100.0)
US (n = 15)	0 (0.0)	2 (13.3)	9 (60.0)	4 (26.7)	0 (0.0)	15 (100.0)
Cookies						
KOR (n = 10)	0 (0.0)	1 (10.0)	2 (20.0)	7 (70.0)	0 (0.0)	10 (100.0)
US (n = 10)	0 (0.0)	2 (20.0)	1 (10.0)	7 (70.0)	0 (0.0)	10 (100.0)
Chocolate						
KOR (n = 13)	0 (0.0)	0 (0.0)	0 (0.0)	13 (100.0)	0 (0.0)	13 (100.0)
US (n = 13)	0 (0.0)	3 (23.1)	1 (7.7)	9 (69.2)	0 (0.0)	11 (84.6)
Total						
KOR (n = 38)	0 (0.0)	2 (5.3)	11 (28.9)	24 (63.2)	1 (2.6)	38 (100.0)
US (n = 38)	0 (0.0)	7 (18.4)	11 (28.9)	20 (52.6)	0 (0.0)	36 (94.7)

n (%).
MTL, multiple traffic light; KOR, South Korea; US, United States
[1)]Green light = 1, amber light = 2, red light = 3 for fat, saturated fat, sugar, and sodium. Total possible score ranges from 4 to 12. Foods were considered less healthy if the score was ≥ 7.

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3. Healthiness of snacks and beverages assessed by HSR and NS

The distribution of HSR profile score and NS of snacks and beverages in Korea and the US is shown in Fig. 3. Korean chips and cookies had significantly higher HSR scores, indicating that they were less healthy than US chips and cookies. Most cookies and chocolate received 0.5 or 1 star. Only one US juice received 3 stars, while all other snacks and beverages received 2.5 stars or below. All products analyzed in this study were classified as 'less healthy', with HSR values below 3.5 out of 5.0 stars. There were no significant differences in the distribution of raw NS scores of snacks and beverages between Korea and the US.

When all three categories were combined, approximately 70% of Korean snacks and beverages had 0.5 stars, compared to 44.7% of US snacks (Fig. 4). For NS, more than 70% of snacks and beverages in both countries received an E grade, the least healthy rating, and especially, 94.7% of Korean snacks received an E grade. None of the analyzed products qualified for either an A or B grade.

DISCUSSION

We observed significant differences in the nutritional profile of popular snacks and beverages between Korea and the US. Overall, Korean sweet and salty snacks had significantly higher protein, fat, saturated fat, and cholesterol than US snacks. Conversely, US products had significantly larger serving sizes for carbonated drinks, and higher caffeine content in energy drinks than Korean counterparts.

It was unexpected that Korean snacks were significantly higher in fat and saturated fat compared to US snacks. The median fat and saturated fat content of US cookies were 20.3 g/100 g and 8.0 g/100 g, respectively, whereas Korean cookies contained 26.1 g/100 g and 15.1 g/100 g. In a previous study on Polish cookies [39], the mean fat content was 20.2 g and saturated fat was 9.1 g, similar to US products but lower than Korean products. The mean saturated fat content of Türkiye's chips and chocolate was 8.6 and 17.6 g, similar to those of Korean products [40]. Following successful reduction initiatives in Korea, most processed foods now report zero trans fat content per serving. However, reformulation strategies targeting a single nutrient may lead to unintended increases in other nutrients [41], with particular concern regarding the potential replacement of trans fats with saturated fats [42]. Therefore, reformulated products should be monitored comprehensively, focusing on multiple nutrients rather than a single nutrient. Furthermore, it is also important to pay attention to the quality of fat in food products as some oils, such as cold pressed

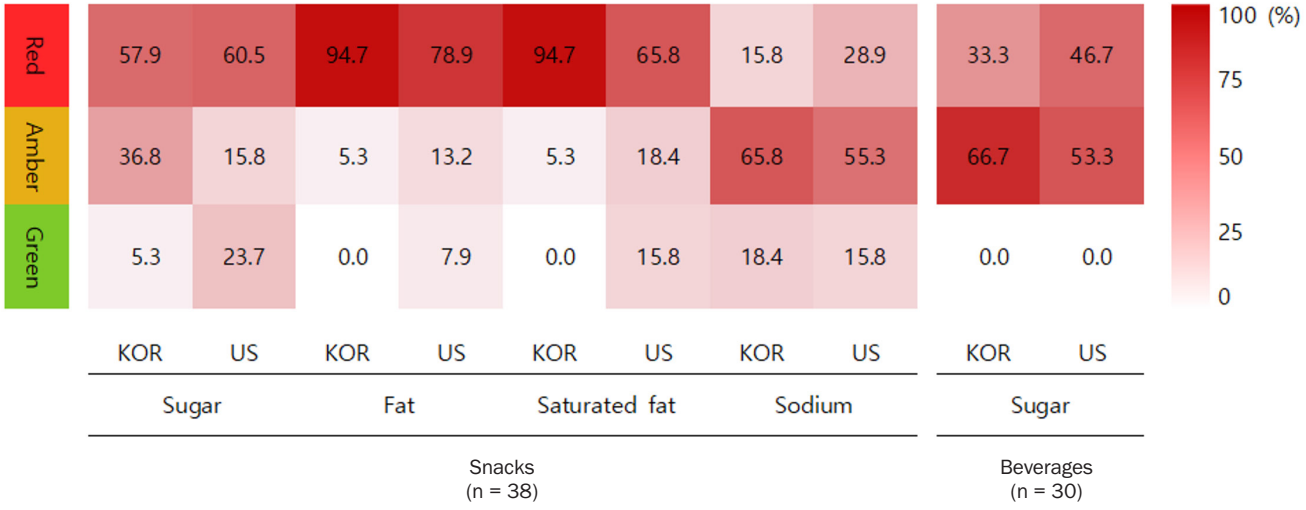

Fig. 2. Distribution of traffic light colors for nutrients in snacks and beverages.
KOR, South Korea; US, United States.

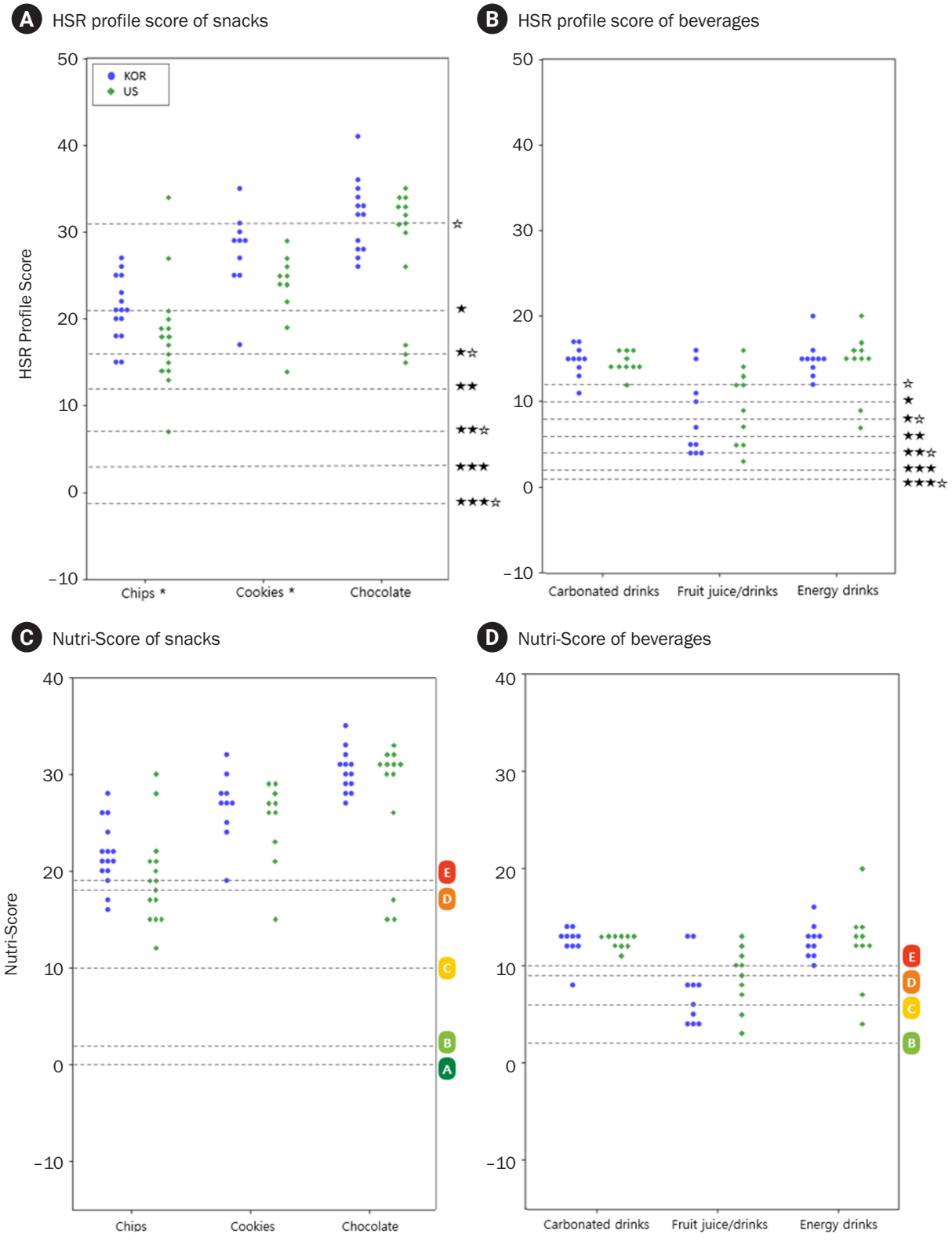

Fig. 3. Distribution of HSR profile score and Nutri-Score for each category of snacks and beverages.
HSR, Health Star Rating; KOR, South Korea; US, United States.
*$P < 0.05$, a significant difference between Korea and US by the Mann-Whitney U test.

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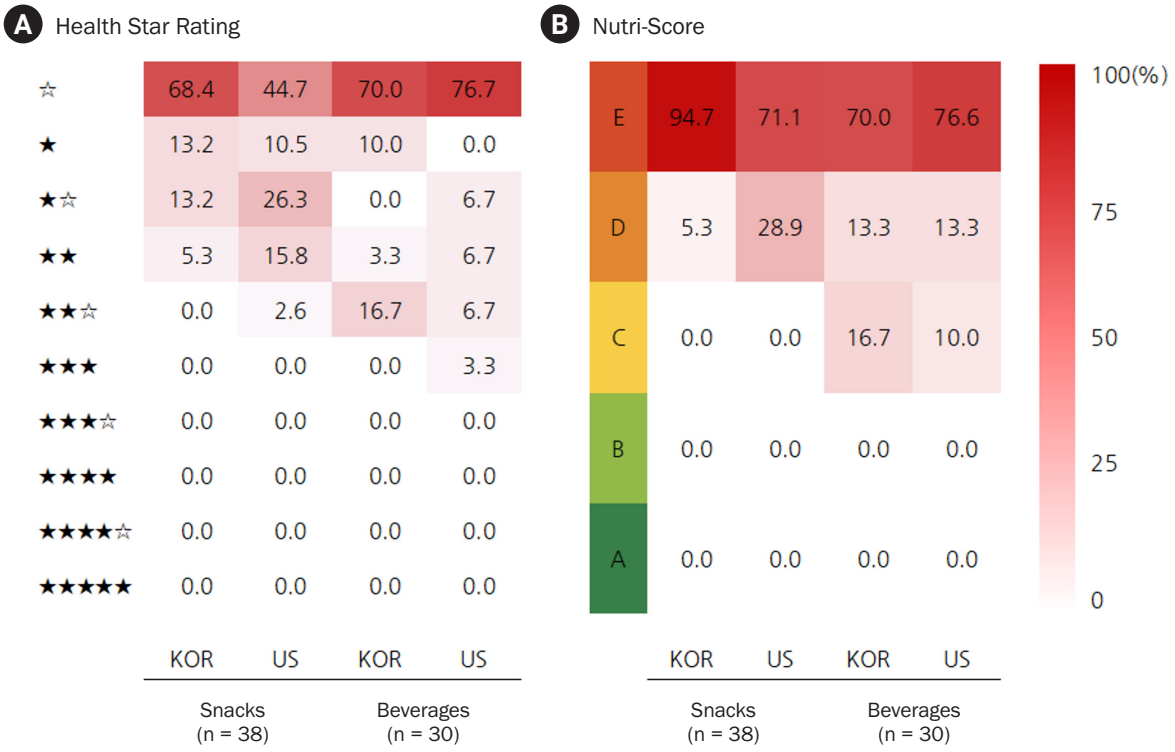

Fig. 4. Distribution of HSR and Nutri-Score grade for snacks and beverages.
KOR, South Korea; US, United States.

and extra virgin olive oils, have beneficial health effects over highly processed oils, such as refined sun flower and palm oil [43]. Monitoring the type and quality of fats used in food production is crucial for improving overall diet quality.

US chips and carbonated drinks had more sodium than Korean products. We found that US beverages contained much higher levels of sodium compared to the beverages of the same brand sold in Korea. Previous studies have also demonstrated that sodium contents in US products were higher than in other countries, even within the same brand [31, 44, 45]. These findings indicate that while US products have achieved notable decreases in sodium content [13], there remains potential for additional sodium reduction efforts.

The caffeine content in energy drinks was significantly lower in Korea than in the US. The MFDS in Korea has implemented regulatory policies to reduce excessive caffeine consumption, particularly among adolescents. Beverages containing more than 15 mg of caffeine per 100 mL must be labeled as high-caffeine beverages, with the total caffeine content clearly displayed. In addition, a pilot project was conducted to display warning messages about caffeine consumption on the shelves of high-caffeine beverages in convenience stores [46]. These policies may have contributed to the lower caffeine content found in Korean energy drinks compared to the US products.

Serving sizes for carbonated drinks were significantly larger in the US than in Korea, whereas serving sizes for chips were larger in Korea than in the US. Large serving sizes of foods and beverages, particularly energy-dense snacks, have been shown to increase energy intake, which may increase the risk of weight gain [47, 48]. Therefore, reducing the serving sizes of snacks and beverages could serve as an important policy to reduce obesity rates by regulating energy consumption.

In our study, more than 50% of 38 snacks in both countries received three of the four possible red lights according to MTL criteria, only 0.5 or one star by the HSR system, and more than 70% were graded E by the NS. Notably, more Korean snacks received lower grades

by HSR and NS compared to US snacks. A comparative study on the healthiness of packaged foods and beverages across countries using the HSR system found that the products in middle-income countries were less healthy compared to those in high-income countries [31]. They suggested that high-income countries like the US may have healthier packaged foods due to greater consumer demand for nutritious products, more health-focused policies and programs, and greater food industry initiatives to develop healthier products. Therefore, efforts should be made to improve the nutritional quality of packaged food products in Korea through policy initiatives, industry engagement, and consumer education programs.

Since 2009, Korea's MFDS has implemented nutritional standards to identify 'high-calorie, low-nutrient foods' among children's favorite foods to prevent childhood obesity and promote healthy eating habits [49]. However, this policy has several limitations. First, since the standards are based on serving size, manufacturers can avoid the 'high-calorie, low nutrient food' designation simply by adjusting serving size. For example, one standard for snacks is 'foods exceeding 17 g of sugar and less than 2 g of protein per serving'. Second, products can be exempt from the classification if they contain at least 2 g of protein per serving, even if they are high in calories, saturated fat, or sugar. This may explain why Korean snacks tend to have higher protein content compared to US snacks. When these standards were applied to the products in our study, only five US products and two Korean products among snacks were classified as 'high-calorie, low-nutrient foods'. Compared to other FoPNL, this standard does not seem to classify nutrient quality as strictly. Nevertheless, nearly all carbonated beverages, energy drinks, and fruit drinks except one or two in each category were classified as 'high-calorie, low-nutrient foods' because they are low in protein and high in sugar. Third, there is no requirement for this information to be displayed on product packaging. Therefore, the policy defining 'high-calorie, low-nutrient foods' is unlikely to significantly influence children's food choices or promote healthier eating habits. In addition, Korea introduced a voluntary MTL labeling system for children's foods in 2011 [23]. However, participation by food manufacturers has been limited. Therefore, effective strategies are needed to encourage manufacturers' participation in government policies aimed at both providing healthier food products and facilitating informed consumer choices.

Recently, the Biden-Harris Administration prioritized nutrition labeling in the National Strategy on Hunger, Nutrition, and Health, advocating for the implementation of a FoPNL [50]. In response, the Food and Drug Administration is currently proposing a FoPNL system for foods and beverages 'high-in' nutrients associated with chronic diseases [51]. This initiative is expected to help Americans more easily understand nutritional information on food products.

We compared the nutrient content and healthiness of snacks and beverages popular in Korea and the US and observed some statistically significant differences. Our results suggest that food manufacturers in Korea and the US may need to make positive changes regarding the quality and serving sizes of snacks and beverages to reduce the negative health effects of their consumption.

Limitations

Our study has some limitations. We only compared a limited number of products in each category, so it is difficult to ensure representativeness. However, we focused on best-selling products within each category, and the nutrient content of each category was comparable to the values published in other studies. Another limitation is that the nutrient content was extracted from product labels, which may not always accurately reflect the actual composition of the products. Further research studies with a larger number of snack and beverage items consumed in each country is needed to improve the scientific validity of our results.

Conclusion

Korean snacks overall had significantly higher levels of protein, total fat, saturated fat, and cholesterol compared to US snacks. Most snacks and beverages analyzed in this study were classified as 'less healthy' by MTL, HSR, and NS. Our findings suggest that both Korean and US food manufacturers should improve the nutritional quality and/or serving size of commonly consumed snacks and beverages. In addition, policymakers in both countries should work to improve the

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presentation of nutrient information on nutrition labels to assist consumers making healthier food choices.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

Research data is available upon request to the corresponding author.

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Research Article

Trends in growth and nutritional status of Korean toddlers and preschoolers: a cross-sectional study using 2010–2021 Korea National Health and Nutrition Examination Survey data

Annisa Turridha[1], **Jae Eun Shim**[2,†]

[1]Student, Department of Food and Nutrition, Graduate School, Daejeon University, Daejeon, Korea
[2]Professor, Department of Food and Nutrition, Daejeon University, Daejeon, Korea

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†Corresponding author:
Jae Eun Shim
Department of Food and Nutrition, Daejeon University, 62 Daehak-ro, Dong-gu, Daejeon 34520, Korea
Tel: +82-42-280-2469
Fax: +82-42-280-2468
Email: jshim@dju.kr

Objectives: We aimed to analyze trends in growth and nutrient intake patterns in Korean toddlers and preschoolers and generate data for international comparisons of early childhood growth status.
Methods: Overall, 3,661 children aged 1–4 years were included. This study used the data from the 5th–8th Korea National Health and Nutrition Examination Survey. The weight-for-height, height-for-age, weight-for-age, and body mass index-for-age z-scores of the participants were calculated using the World Health Organization 2006 child growth z-score reference cutoff points. The 24-hour recall method was used to determine dietary intake, which was assessed according to the Dietary Reference Intakes for Koreans. All statistical analyses were conducted and weighted according to a complex sample design.
Results: Most Korean toddlers and preschoolers demonstrated normal growth, with an increasing trend noted over the survey period. Concurrently, the prevalence of overweight decreased. The mean intake of energy from fat exhibited an upward trend, paralleling that of protein and fat. Conversely, the intake of several essential micronutrients declined. The prevalence of nutritional inadequacy showed significant variation throughout the survey period: the proportion of inadequacy in carbohydrate intake decreased, whereas those of iron, vitamin A, thiamin, niacin, and vitamin C increased.
Conclusion: South Korea is making significant progress in supporting toddlers and preschoolers, as evidenced by consistent increases in the proportion of children with normal growth and decreases in the prevalence of malnutrition. Future research should focus on exploring dietary patterns and analyzing specific food groups that are essential for promoting optimal growth and nutritional status in children.

Keywords: child; nutritional status; World Health Organization; growth charts

INTRODUCTION

Childhood is a critical period for growth and development that lays the foundation for health and well-being. Adequate nutrition during early childhood is essential for healthy growth and development [1]. In 2022, an estimated 45.0 million children aged < 5 years (6.8%) suffered from wasting, and 13.7 million (2.1%)

experienced severe wasting. Additionally, in 2019, at least 340 million children under 5, or one in every two, had micronutrient deficiencies [2, 3].

Malnutrition in early childhood can have severe and long-lasting consequences. Wasting in children weakens their immune system, making them more susceptible to illnesses and death. Those who survive often face growth restrictions and long-term developmental issues. Micronutrient deficiencies adversely affect survival, growth, immunity, and brain development [4-6]. Overweight or obese children are likely to suffer from low self-esteem, poor mental health, and a higher risk of noncommunicable diseases, such as cardiovascular disease, in adulthood [7]. Currently, 37 million children aged < 5 years globally are overweight, marking an increase of almost 4 million since the year 2000 [2]. South Korea has seen a rise in childhood obesity rates due to significant socioeconomic changes over the past few decades that have altered dietary patterns and lifestyle behaviors, affecting the growth and nutritional status of children [8]. The prevalence of obesity among children aged 2–18 years increased from 8.6% in 2001 to 9.8% in 2017 [9].

Changes in the stages of the nutrition transition have exacerbated disparities in nutrient intake across the population. The Korea National Health and Nutrition Examination Survey (KNHANES) data (2009–2011) indicated that children aged 1–5 years from lower-income households were more likely to have elevated weight-for-height and faced a higher risk of inadequate intake of micronutrients such as thiamin and vitamin C compared to their higher-income counterparts [10]. A study on calcium intake among Korean children and adolescents (aged 1–18 years) revealed that 75.0% experienced inadequate intake, with the prevalence increasing significantly from toddlers (45%–55%) to adolescents (78%–86%) [11].

Undernutrition in Korea appears to have been largely resolved and is now a primary concern in developing nations. However, continuous monitoring and analysis of growth trends and nutrient intake patterns among Korean children remains essential because of the dynamic nature of their dietary habits and lifestyle behaviors. We aimed to provide an updated and comprehensive analysis of these trends in Korean toddlers and preschoolers, contributing to the generation of internationally comparable data for cross-national research and policy insights.

METHODS

Ethics statement

Written informed consent was obtained from all participants and/or their guardians for the survey. The survey procedures and protocols were approved by the Institutional Review Board (IRB No. 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, 2013-07CON-03-4C, 2013-12EXP-03-5C, 2018-01-03-P-A, 2018-01-03-C-A, 2018-01-03-2C-A, 2018-01-03-5C-A). The survey was conducted in accordance with the guidelines outlined in the Declaration of Helsinki.

1. Study design

This cross-sectional study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (https://www.strobe-statement.org/).

2. Study subjects

This study used nationally representative data from KNHANES for the following periods: 5th (2010–2012), 6th (2013–2015), 7th (2016–2018), and 8th (2019–2021). Conducted by the Korea Disease Control and Prevention Agency, KNHANES serves as a national surveillance system tasked with evaluating the health and nutritional status of Koreans. It gathers comprehensive data regarding participants' demographic, social, health, and nutritional statuses through three primary surveys: a health interview, health examination, and nutrition survey [12].

The sampling plan utilized a stratified multistage clustered probability sampling design. This study concentrated on toddlers and preschoolers aged 1–4 years (n = 3,859). Participants lacking height, weight, household, or nutritional intake data (n = 162) and those with implausible energy intake (< 1st and > 99th percentile, n = 36) were excluded, yielding a final sample of 3,661 toddlers and preschoolers.

3. Anthropometric assessment

Height and weight were measured following a standardized protocol during health examinations. Participants

wore light clothing without shoes, and their weight was measured to the nearest 0.1 kg using a GL-6000-20 scale (G-Tech International Co., Ltd.). The height was measured to the nearest 0.1 cm. The caregivers were asked to remove the children's socks, shoes, and hair ornaments before the measurements. Children who could stand were measured using a seca 274 (seca), whereas those aged < 2 years were measured in the supine position using a seca 416 (seca). The World Health Organization (WHO) 2006 child growth z-score reference cutoff points were used to classify children's growth and nutritional status [13, 14]. The weight-for-height z-scores (WHZ), height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), and body mass index (BMI)-for-age z-scores (BAZ) were calculated using the WHO Anthro software (version 3.2.2; WHO) [15]. The WHO classification is as follows:

a. Nutritional status based on WHZ
Wasted: < –2
Normal: ≥ –2 to 2
Overweight: > 2
b. Nutritional status based on HAZ
Stunted: < –2
Not stunted: ≥ –2
c. Nutritional status based on WAZ
Underweight: < –2
Normal: ≥ –2 to 2
Overweight: > 2
d. Nutritional status based on BAZ
Wasted: < –2
Normal: ≥ –2 to 2
Overweight: > 2

4. Nutritional assessment

The nutritional survey employed a 24-hour recall method. Nutrient intake was evaluated based on age-specific intake reference values from the 2020 Dietary Reference Intakes for Koreans (KDRIs) and the 2010 KDRIs for vitamin A intake during the 5th and 6th surveys [16, 17]. The prevalence of nutrient inadequacy was determined as the percentage of children whose nutrient intake fell below the estimated average requirement (EAR). The EARs used in this study are shown in Table 1.

5. Statistical analysis

Sample weights were derived using a complex survey design, nonresponse rate, and post-stratification, then applied to all analyses to represent the Korean population. Data are presented as weighted percentages and standard errors (SE) for categorical variables, and weighted mean and SE for continuous variables. General characteristics were analyzed using the Rao–Scott chi-square test for categorical variables and analysis of variance for continuous variables, with subsequent Bonferroni testing if significant differences were detected. Complex sample analysis employed the Rao–Scott chi-square test to compare children's growth status distribution and nutrient intake below the EAR based on survey timing. Linear trends were analyzed using a General Linear Model for continuous variables and Logistic Regression for categorical variables to assess changes in

Table 1. Dietary reference intakes for Korean children aged 1–4 years

Nutrients	Age (year)	
	1–2	3–5
Total energy (kcal/d)	900	1,400
From protein (%)	7–20	7–20
From carbohydrate (%)	55–65	55–65
From fat (%)	20–35	15–30
Protein (g/d)	15	20
Carbohydrate (g/d)	100	100
Calcium(mg/d)	400	500
Phosphorus (mg/d)	380	480
Iron (mg/d)	4.5	5
Vitamin A		
7th–8th survey (μg RAE/d)	190	230
5th–6th survey (μg RE/d)	200	230
Thiamin (mg/d)	0.4	0.4
Riboflavin (mg/d)	0.4	0.5
Niacin (mg NE/d)	4	5
Vitamin C (mg/d)	30	35

All nutrient intakes were evaluated based on the 2020 dietary reference intakes for Koreans, except for vitamin A in the 5th–6th surveys, which were assessed using the 2010 dietary reference intakes for Koreans. The estimated average requirements (EAR) were used for all nutrients except total energy, which was compared with the estimated energy requirements (EER). Energy from the three macronutrients was compared with the acceptable macronutrient distribution range (AMDR).
RAE, retinol activity equivalent; RE, retinol equivalent; NE, niacin equivalent.

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consumption and growth status over time. All analyses were conducted using IBM SPSS software version 27 (IBM Co.). The level of statistical significance was set at $\alpha = 0.05$.

RESULTS

1. Sociodemographic characteristics

Table 2 summarizes the sociodemographic characteristics of the participants. The distribution trend over the survey period was observed for household income ($P < 0.001$). This study included toddlers and preschoolers, with 47.4% aged 1–2 years and 52.6% aged 3–4 years. The gender distribution showed that 51.4% of the participants were boys. Based on geographical distribution, more than half of the children (85.8%) resided in urban areas, whereas 14.2% lived in rural regions. Moreover, 40.6% of participants were from lower-income households, while 59.4% belonged to upper-income households. Household income trends indicated an increase in the upper-income category and a decrease in the lower income.

2. Nutritional characteristics

Anthropometric data revealed significant patterns of physical growth across the survey period, as shown in Table 3. Both height ($P < 0.01$) and weight ($P < 0.05$) significantly increased during the survey period. However, only height showed a consistent upward trend ($P < 0.001$), with an average value of 94.6 cm. Weight averaged 14.7 kg but did not show a clear upward trend. BMI analysis revealed a significant decrease ($P < 0.001$) over time, which was consistent with the observed decreasing trend ($P < 0.001$). The mean BMI was 16.3, indicating a reduction in BMI over the survey duration.

Statistically significant differences were noted in nutrient intake during the survey period. These differences were marked in total energy derived from protein ($P < 0.01$), carbohydrate ($P < 0.001$), and fat ($P < 0.001$), as well as in the intake of protein ($P < 0.01$), fat ($P < 0.001$), calcium ($P < 0.05$), phosphorus ($P < 0.01$), iron ($P < 0.001$), vitamin A ($P < 0.001$), thiamin ($P < 0.001$), riboflavin ($P < 0.001$), niacin ($P < 0.05$), and vitamin C ($P < 0.01$). Increasing trends were noted in the intake of total energy ($P < 0.05$), total energy derived from fat ($P < 0.001$), protein ($P < 0.05$), and fat ($P < 0.001$) during the survey period. Conversely, the total energy derived from carbohydrates ($P < 0.001$) and most micronutrients showed declining trends over time, especially phosphorus ($P < 0.001$), iron ($P < 0.001$), vitamin A ($P < 0.001$), thiamine ($P < 0.001$), niacin ($P < 0.001$), and vitamin C ($P < 0.001$).

Table 2. Sociodemographic characteristics of Korean children aged 1–4 years across survey periods (n = 3,661)

Variables	Survey period					*P*-value[1]
	Total	5th (2010–2012)	6th (2013–2015)	7th (2016–2018)	8th (2019–2021)	
Age (year)						0.072
1–2	47.4 (0.9)	51.1 (1.8)	47.1 (1.7)	46.9 (1.8)	43.9 (2.3)	
3–4	52.6 (0.9)	48.9 (1.8)	52.9 (1.7)	53.1 (1.8)	56.1 (2.3)	
Gender						0.931
Boy	51.4 (0.9)	52.4 (1.8)	51.4 (1.8)	50.8 (1.7)	50.9 (2.3)	
Girl	48.6 (0.9)	47.6 (1.8)	48.6 (1.8)	49.2 (1.7)	49.1 (2.3)	
Region						0.447
Urban	85.8 (1.2)	85.3 (2.3)	83.7 (2.6)	85.6 (2.7)	89.3 (1.9)	
Rural	14.2 (1.2)	14.7 (2.3)	16.3 (2.6)	14.4 (2.7)	10.7 (1.9)	
Household income[2]						< 0.001
Lower	40.6 (1.1)	47.8 (1.9)	36.3 (2.1)	41.4 (2.1)	36.5 (2.7)	
Upper	59.4 (1.1)	52.2 (1.9)	63.7 (2.1)	58.6 (2.1)	63.5 (2.7)	

% (SE).
All values were weighed and analyzed considering the complex sample design.
[1]By Rao–Scott chi-square test.
[2]Household income based on the KNHANES standards (lower: lower to middle lower, Upper: middle upper to upper).

Table 3. Nutritional characteristics of Korean children aged 1–4 years (n = 3,661)

Variables	Survey period					*P*-value[1]	*P*-trend[2]
	Total	5th (2010–2012)	6th (2013–2015)	7th (2016–2018)	8th (2019–2021)		
Anthropometry							
Height (cm)	94.6 ± 0.1	93.6 ± 0.3^{b}	94.4 ± 0.3^{b}	94.7 ± 0.3^{b}	96.0 ± 0.4^{a}	0.001	< 0.001
Weight (kg)	14.7 ± 0.0	14.7 ± 0.1^{b}	14.6 ± 0.1^{b}	14.5 ± 0.1^{b}	15.0 ± 0.1^{a}	0.041	0.135
BMI	16.3 ± 0.0	16.6 ± 0.0^{a}	16.2 ± 0.0^{b}	16.1 ± 0.0^{b}	16.2 ± 0.0^{b}	< 0.001	< 0.001
Nutrient intake							
Total energy (kcal/d)	1,216.4 ± 8.1	1,196.3 ± 17.4	1,204.7 ± 14.1	1,226.2 ± 14.0	1,243.6 ± 19.4	0.210	0.043
From protein (%)	13.6 ± 0.0	13.8 ± 0.1^{a}	13.3 ± 0.1^{b}	13.5 ± 0.1^{ab}	13.9 ± 0.1^{a}	0.009	0.545
From carbohydrate (%)	62.7 ± 0.1	63.9 ± 0.3^{a}	63.1 ± 0.3^{a}	63.3 ± 0.3^{a}	60.1 ± 0.4^{b}	< 0.001	< 0.001
From fat (%)	23.2 ± 0.1	22.5 ± 0.3^{b}	22.9 ± 0.2^{b}	22.6 ± 0.2^{b}	25.3 ± 0.3^{a}	< 0.001	< 0.001
Protein (g)	41.4 ± 0.3	41.2 ± 0.7^{ab}	40.0 ± 0.6^{b}	41.2 ± 0.5^{ab}	43.5 ± 0.9^{a}	0.005	0.029
Carbohydrate (g)	190.1 ± 1.3	190.4 ± 2.8	190.0 ± 2.4	193.5 ± 2.3	185.8 ± 3.0	0.114	0.500
Fat (g)	31.8 ± 0.3	30.4 ± 0.6^{b}	30.8 ± 0.5^{b}	31.3 ± 0.5^{b}	35.4 ± 0.8^{a}	< 0.001	< 0.001
Calcium(mg)	450.9 ± 5.5	483.0 ± 12.9^{a}	423.3 ± 9.5^{b}	457.4 ± 8.9^{a}	438.2 ± 12.0^{b}	0.035	0.066
Phosphorus (mg)	726.5 ± 5.9	781.8 ± 13.0^{a}	704.7 ± 10.5^{b}	704.9 ± 9.4^{b}	712.9 ± 14.6^{b}	0.001	< 0.001
Iron (mg)	6.7 ± 0.0	7.0 ± 0.1^{b}	8.0 ± 0.1^{a}	6.4 ± 0.1c	5.2 ± 0.2^{d}	< 0.001	< 0.001
Vitamin A (μg RAE)[3]	376.7 ± 6.9	441.8 ± 13.9^{a}	427.1 ± 16.6^{a}	324.8 ± 9.9^{b}	297.0 ± 12.6^{b}	< 0.001	< 0.001
Thiamin (mg)	0.86 ± 0.0	0.78 ± 0.0^{b}	1.0 ± 0.0^{a}	0.84 ± 0.0^{b}	0.70 ± 0.0^{c}	< 0.001	< 0.001
Riboflavin (mg)	1.0 ± 0.0	1.0 ± 0.0^{a}	0.92 ± 0.0^{b}	1.1 ± 0.0^{a}	1.1 ± 0.0^{a}	< 0.001	< 0.001
Niacin (mg NE)	7.5 ± 0.0	8.0 ± 0.1^{a}	7.7 ± 0.1^{a}	7.0 ± 0.1^{b}	7.2 ± 0.2^{b}	0.012	< 0.001
Vitamin C (mg)	63.5 ± 1.4	74.5 ± 3.3^{a}	68.7 ± 3.2^{a}	50.8 ± 1.8^{b}	58.9 ± 3.0^{b}	0.001	< 0.001

Mean ± SE. Values in rows with different superscripts are significantly different.
All values were weighed and analyzed considering the complex sample design.
BMI, body mass index; RAE, retinol activity equivalent; NE, niacin equivalent.
[1]By ANOVA ($P < 0.05$ followed by a Bonferroni test).
[2]By General Linear Model.
[3]5th & 6th survey measured vitamin A in RE (n = 2,101).

3. Dietary assessment

Table 4 shows notable variations in the prevalence of nutritional inadequacy for carbohydrate ($P < 0.05$), calcium ($P < 0.05$), iron ($P < 0.001$), vitamin A ($P < 0.001$), thiamin ($P < 0.001$), riboflavin ($P < 0.01$), niacin ($P < 0.001$), and vitamin C ($P < 0.001$). The prevalence of carbohydrate inadequacy decreased, whereas inadequacy in iron ($P < 0.001$), vitamin A ($P < 0.001$), thiamin ($P < 0.01$), niacin ($P < 0.001$), and vitamin C ($P < 0.01$) increased. The average number of micronutrients consumed below the EAR was 2.17. Among Korean children aged 1–4 years, the prevalence of micronutrient inadequacy based on EAR showed a statistically significant increasing trend over the survey periods ($P < 0.001$ for differences, P-trend = 0.006).

Trends in total energy and fat intake among Korean children aged 1–4 years were examined (Table 5). The proportion of children consuming less than the estimated energy requirement remained relatively stable over the survey period, ranging 46.1%–49.0%. However, the proportion of children consuming fat below the acceptable macronutrient distribution range (AMDR) decreased significantly from 27.1% in the 5th survey to 14.3% in the 8th survey ($P < 0.001$). Conversely, the proportion of children with excessive fat intake (above the AMDR) increased significantly from 11.2% in the 5th survey to 18.2% in the 8th survey ($P < 0.01$).

4. Growth assessment

Table 6 presents the distribution of growth status among Korean children, classified by WHO z-scores throughout the survey periods. The overall average HAZ score was approximately zero (–0.01), indicating normal height-for-age growth with slight improvements in subsequent

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Table 4. Trends in inadequate nutrient intakes based on EAR among Korean children aged 1–4 years (n = 3,661)

Variables	Survey period					*P*-value[1]	*P*-trend[2]
	Total	5th (2010–2012)	6th (2013–2015)	7th (2016–2018)	8th (2019–2021)		
Proportion of inadequay[3]							
Protein	3.3 (0.3)	3.5 (0.7)	4.3 (0.7)	2.7 (0.5)	2.4 (0.5)	0.181	0.102
Carbohydrate	7.2 (0.5)	8.6 (1.2)	8.7 (1.0)	6.1 (0.8)	5.0 (1.0)	0.024	0.006
Calcium	58.2 (1.0)	53.9 (2.0)	61.2 (1.8)	57.5 (1.8)	60.4 (2.6)	0.049	0.118
Phosphorus	12.8 (0.7)	10.2 (1.1)	14.4 (1.3)	13.9 (1.3)	12.8 (1.5)	0.090	0.175
Iron	32.1 (0.9)	30.0 (1.8)	18.6 (1.4)	30.7 (1.8)	53.3 (2.5)	< 0.001	< 0.001
Vitamin A[4]	31.8 (1.0)	25.3 (1.6)	24.4 (1.5)	38.1 (1.8)	41.4 (2.7)	< 0.001	< 0.001
Thiamin	10.5 (0.6)	13.3 (1.2)	2.6 (0.6)	9.3 (1.0)	18.4 (1.9)	< 0.001	0.003
Riboflavin	8.9 (0.6)	9.7 (1.1)	12.0 (1.2)	6.6 (0.9)	6.8 (1.2)	0.002	0.007
Niacin	20.3 (0.8)	15.8 (1.5)	17.9 (1.3)	23.1 (1.5)	25.4 (2.1)	< 0.001	< 0.001
Vitamin C	43.0 (1.0)	34.7 (2.0)	44.6 (1.9)	49.0 (1.8)	43.6 (2.5)	< 0.001	0.001
No. of inadequate micronutrient[5]	2.17 ± 0.0	1.92 ± 0.0^{c}	1.95 ± 0.0^{c}	2.28 ± 0.0^{b}	2.62 ± 0.0^{a}	< 0.001	0.006

% (SE) or Mean ± SE. Values in rows with different superscripts are significantly different.
All values were weighed and analyzed considering the complex sample design.
EAR, estimated average requirement.
[1]By Rao–Scott chi-square and ANOVA ($P < 0.05$ followed by a Bonferroni test).
[2]By Logistic Regression.
[3]The proportion of the population at higher risk of inadequacy was estimated as the proportion of children with intakes below the EAR.
[4]5th–6th survey used 2010 dietary reference intakes for Koreans with vitamin A measured in RE (n = 2,101), while 7th–8th surveys using 2020 dietary reference intakes for Koreans with vitamin A measured in RAE (n = 1,560).
[5]The number of micronutrients consumed below the EAR.

Table 5. Trends in energy and fat intake relative to EER and AMDR among Korean children aged 1–4 years (n = 3,661)

Variables	Survey period					*P*-value[1]	*P*-trend[2]
	Total	5th (2010–2012)	6th (2013–2015)	7th (2016–2018)	8th (2019–2021)		
Total energy							
< EER[3]	47.8 (1.0)	48.7 (1.8)	49.0 (1.8)	47.2 (1.8)	46.1 (2.3)	0.696	0.297
Fat energy							
< AMDR[4]	23.5 (0.8)	27.1 (1.7)	25.6 (1.5)	25.1 (1.5)	14.3 (1.8)	< 0.001	< 0.001
> AMDR[5]	12.7 (0.7)	11.2 (1.3)	11.0 (1.1)	11.4 (1.1)	18.2 (2.0)	0.001	0.005

% (SE).
All values were weighed and analyzed considering the complex sample design.
EER, estimated energy requirement; AMDR, acceptable macronutrient distribution range.
[1]By Rao–Scott chi-square.
[2]By Logistic Regression.
[3]< 900 kcal for 1–2 years and < 1,400 kcal for 3–4 years.
[4]< 20% for 1–2 years and < 15% for 3–4 years.
[5]> 35% for 1–2 years and > 30% for 3–4 years.

survey periods. The WAZ remained constant with minimal fluctuations, showing higher scores in the initial and final surveys. The WHZ and BAZ showed decreasing trends over time, suggesting a decline in the prevalence of overweight. This analysis underscores the generally stable growth patterns with notable reductions in overweight-related metrics (i.e., WHZ and BAZ) over time ($P < 0.01$).

Among the 3,661 children included in the studies, over 90% were categorized as having "Normal" growth, representing the majority of the study participants. The prevalence of wasting (WHZ < –2) ranged 0.35%–0.44%. Over time, the proportion of children with normal growth status increased, reaching its peak in the 7th

Table 6. Growth assessment of Korean children aged 1–4 years based on WHO z-score[1] classification of child growth (n = 3,661)

Growth assessment	Survey period					*P*-value[1]	*P*-trend[2]
	Total	5th (2010–2012)	6th (2013–2015)	7th (2016–2018)	8th (2019–2021)		
Weight–for–height z–score							
Mean score	0.46 ± 0.0	0.67 ± 0.0[a]	0.45 ± 0.0[b]	0.32 ± 0.0[b]	0.42 ± 0.0[b]	< 0.001	0.007[3]
Wasted (< –2)	0.35 (0.1)	0.27 (0.1)	0.33 (0.2)	0.44 (0.3)	0.35 (0.2)	0.010	< 0.001[4]
Normal (≥ –2 to 2)	93.6 (0.5)	90.6 (1.2)	94.5 (0.8)	94.9 (0.8)	94.5 (1.1)		
Overweight (> 2)	6.1 (0.5)	9.1 (1.2)	5.2 (0.8)	4.7 (0.7)	5.1 (1.0)		
Height–for–age z–score							
Mean score	–0.01 ± 0.0	–0.08 ± 0.0[b]	–0.02 ± 0.0[b]	–0.05 ± 0.0[b]	0.13 ± 0.0[a]	< 0.001	0.095
Stunted (< –2)	1.3 (0.2)	1.4 (0.4)	1.5 (0.4)	1.8 (0.5)	0.34 (0.2)	0.102	< 0.001
Not stunted (≥ 2 to >2)	98.7 (0.2)	98.6 (0.4)	98.5 (0.4)	98.2 (0.5)	99.7 (0.2)		
Weight–for–age z–score							
Mean score	0.33 ± 0.0	0.43 ± 0.0[a]	0.31 ± 0.0[b]	0.20 ± 0.0[b]	0.38 ± 0.0[a]	0.004	0.848
Underweight (< –2)	0.17 (0.1)	0.24 (0.2)	0.09 (0.1)	0.34 (0.2)	0	0.315	0.070
Normal (≥ –2 to 2)	96.0 (0.4)	95.1 (0.9)	96.8 (0.6)	96.3 (0.6)	95.5 (1.0)		
Overweight (> 2)	3.9 (0.4)	4.7 (0.8)	3.1 (0.6)	3.3 (0.6)	4.5 (1.0)		
BMI–for–age z–score							
Mean score	0.48 ± 0.0	0.69 ± 0.0[a]	0.46 ± 0.0[b]	0.34 ± 0.0[b]	0.42 ± 0.0[b]	< 0.001	0.002
Wasted (< –2)	0.40 (0.1)	0.27 (0.1)	0.33 (0.2)	0.44 (0.3)	0.59 (0.3)	0.001	< 0.001
Normal (≥ –2 to 2)	92.6 (0.5)	89.0 (1.2)	93.5 (0.9)	94.4 (0.8)	93.6 (1.1)		
Overweight (> 2)	7.0 (0.5)	10.8 (1.2)	6.2 (0.9)	5.2 (0.8)	5.8 (1.1)		

Mean ± SE or % (SE). Values in rows with different superscripts are significantly different.
All values were weighed and analyzed considering the complex sample design.
WHO, World Health Organization; BMI, body mass index.
[1]2006 WHO child growth z-score reference cutoff point.
[2]By Rao–Scott chi-square test or by ANOVA ($P < 0.05$ followed by a Bonferroni test).
[3]By General Linear Model.
[4]By Logistic Regression.

survey at 94.9%. The prevalence of overweight children (WHZ > 2) exhibited a significant decreasing trend ($P < 0.001$), peaking at 9.1% in the 5th survey, then declining to 5.2% in the 6th survey and 4.7% in the 7th survey, before slightly increasing to 5.1% in the 8th survey.

Children with not-stunted growth status (HAZ ≥ –2) were much more frequent than those with stunted conditions, with the prevalence of stunting (HAZ < –2) decreasing from 2010 to 2021 ($P < 0.001$). The estimated prevalence of stunting was 1.3%, marginally higher than other undernutrition categories, which all registered below 1%: underweight (WAZ < –2) at 0.17%, and wasting (BAZ < –2) at 0.40%. Overweight children ranged 3.9%–7.0% in the overall growth analysis.

The distribution of BAZ among Korean children indicated that the proportion classified as normal condition steadily increased from the 5th survey (89.0%) to the 7th survey (94.4%), but slightly declined in the 8th survey (93.6%). The prevalence of overweight children based on the BAZ ($P < 0.001$) showed a decreasing trend, with a peak of 10.8% in the 5th survey, declining to 6.2% in the 6th and 5.2% in the 7th surveys, and a slight increase to 5.8% in the 8th survey.

DISCUSSION

This study utilizes the WHO child growth z-score classification and nutrient intake data to provide a comprehensive overview of growth and nutrient intake trends among Korean toddlers and preschoolers. A total of 3,661 participants aged 1–4 years were included. Most Korean children generally exhibited normal growth, with an increasing trend observed over the survey period, accompanied by a decline in the prevalence of

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overweight children. An increasing trend was also noted in total energy intake, energy derived from fat, and consumption of macronutrients, particularly protein and fat. Anthropometric data collected during the survey period indicated significant trends in the physical growth of the population. However, a decreasing trend in the intake of several micronutrients, along with changes in macronutrient trends, suggests a potential shift in dietary patterns among Korean children.

While both height and weight showed significant increases, the decline in BMI suggests that energy and protein intake primarily supported linear growth (height) rather than contributing to overweight prevalence. This finding aligns with that of Puentes *et al.* [18], who found that an increase in energy intake, especially from protein sources, was a critical factor in promoting linear growth and weight gain among children aged 6–24 months in Guatemala and the Philippines, where chronic undernutrition is prevalent. Although Korean children generally do not experience chronic undernutrition, the observed trends in their height growth suggest that protein consumption plays a significant role in promoting linear growth and mitigating the prevalence of overweight in the context of relatively adequate nutrition. A systematic review of social protection programs indicated that while income transfers could positively impact height-for-age, the effect was minor and not statistically significant unless protein intake increased significantly [19]. This finding supports the idea that higher protein intake could promote increased height in children, as observed in this study. Proteins and amino acids are crucial for linear growth, facilitating tissue development, and supporting metabolic demand. Proteins enhance the production of hormones, such as insulin and insulin-like growth factor (IGF)-I, which promote skeletal growth through endochondral ossification. Amino acids also play a vital role in the normal growth and formation of the extracellular matrix by chondrocytes, which is essential for skeletal tissue formation [20, 21]. Fat is an important energy source for normal growth, brain development, and the absorption of fat-soluble vitamins, while also influencing growth-related hormones, such as growth hormone and IGF-I [20, 22].

This study identified several issues related to micronutrient intake among Korean toddlers and preschoolers. The number of inadequate micronutrients increased significantly during the study period. These data highlight the trend of declining micronutrient intake adequacy, particularly for iron, vitamin A, thiamine, niacin, and calcium. These findings indicate the need for targeted nutritional interventions and education to improve dietary patterns and address the increasing risk of micronutrient deficiency in Korean toddlers and preschoolers. Concurrently, the increased intake of protein and energy from fat ($P < 0.001$) suggests dietary shifts that may compromise the consumption of micronutrient-rich food sources. As children age, their calcium consumption increases because calcium is vital for bone development, especially during growth periods [23]. However, the declining trend in calcium intake with age appears to be linked to children's transition from a diet primarily centered on milk or formula to a more diverse diet, potentially reducing calcium-rich food sources [11].

The proportion of participants with inadequate intake of iron, vitamin A, thiamine, niacin, and vitamin C demonstrated an increasing trend. Globally, the prevalence of iron deficiency in children aged < 15 years rose by 5.52% between 1990 and 2019 [24]. Stevens *et al.* [5] observed that the prevalence of iron deficiency in Korean preschool children aged 6–59 months (32.1%) exceeded that in children in the UK (31%), Nepal (27%), and Mexico (18%). This study also noted deficiencies in micronutrients, such as vitamins A and C, which can impede iron absorption. Anemia, a frequent clinical outcome of iron deficiency, impairs children's cognitive development, delays motor development, and reduces their physical functioning and quality of life [25].

In accordance with the 2018 WHO-UNICEF classification and its predefined prevalence threshold [26], the incidence of wasting in Korea is considered very low, with a threshold of < 2.5% and an observed rate of 0.2%. In this study, 0.4% of the participants were classified as having wasting conditions (WHZ < –2). Children with overweight status (WHZ > 2) accounted for 5.1% of the participants and were categorized as medium according to the prevalence threshold. Interestingly, this prevalence was slightly lower than the model estimate of 5.4% reported in the 2023 Joint Child Malnutrition Estimates

(JME) [2]. The prevalence of stunting (HAZ < –2) in this study was 0.3%, which was lower than the 1.7% model estimate reported by the JME in 2023 [2].

The prevalence of wasting among Korean children aged < 5 years has remained low, ranging from 0.3% in 2010–2013 to 0.4% in 2017–2018, significantly lower than that in other Asian countries. In 2022, wasting prevalence was 5.0% in Japan, 2.3% in China (2013), 4.3% in Iran (2017), and 14.3% in Bangladesh (2014) [2, 27-29]. Korean children's growth, measured by BAZ scores, showed changes over the survey periods. The proportion of children with normal growth increased from the 5th to the 7th survey but slightly decreased in the 8th survey, while the overweight prevalence decreased overall but rose to 5.8% in the 8th survey. In contrast, overweight rates among children have significantly risen in other countries [30, 31]: Indonesia (6.2%–16.5% between 2003–2007), Germany (2.2%–3.0% between 2013–2018), Belgium (9.0%–12.9% between 1999–2006), Cyprus (14.1%–19.9% between 1999–2016), and Italy (25.4%–37.3% between 1999–2010). However, despite these trends, its prevalence in Korea remains relatively low.

The prevalence of overweight children declined from the 5th to the 7th survey but exhibited a slight increase in the 8th survey, likely attributable to the coronavirus disease 2019 pandemic during 2019–2021. Similar trends were observed in Austrian children under 14.4 years, with the prevalence of overweight rising from 16.7% to 20.7%. The pandemic has had significant health, social, and economic impacts, including increases in sedentary lifestyles and calorie consumption. Lockdowns, the prohibition of team sports, and restrictions on physical activity have contributed to a rise in overweight [32]. The prevalence of overweight among children aged < 5 years in Korea is relatively lower than that in other countries, such as Egypt, where the prevalence is 17% [33].

While the increasing trend of children with normal growth status across survey periods in Korea indicates a generally stable baseline in terms of health and nutrition, disparities influenced by socioeconomic factors, community well-being, healthcare effectiveness, and environmental conditions remain [34]. Studies have consistently shown that higher socioeconomic status (SES) is associated with better nutritional outcomes, such as increased consumption of healthy foods and adherence to dietary recommendations. Conversely, lower SES restricts food choices and elevates the risk of nutritional inadequacy [35, 36]. For instance, a Finnish study found higher fruit consumption among children from families with higher SES [36], while research from Indonesia, Australia, and Canada demonstrated a strong correlation between household income and the prevalence of childhood overweight [37-39]. In South Korea, children from low-income families tend to be overweight and deficient in micronutrients, whereas those from higher-income families generally have lower BMI and exhibit better adherence to dietary guidelines [10, 40]. These findings underscore the critical need for in-depth research to tackle health inequities driven by socioeconomic disparities and to develop targeted interventions for vulnerable populations.

Limitations

This study encountered several limitations. Firstly, the dietary data were collected using the 24-hour recall method, which might not accurately reflect the participants' usual intake. Additionally, since dietary information was obtained from primary caregivers, it might not fully encompass meals consumed outside the home, such as in kindergartens or daycare centers. Consequently, the data may not fully represent children's total food intake. Moreover, in Korea, nutrient intake standards are revised every 5 years. Although this study analyzed data spanning a 12-year period to observe trends in nutrient consumption and growth, the findings were compared only with the latest KDRIs. This approach was adopted to avoid inconsistencies in the trend analysis due to variations in the survey years not explicitly addressed. However, an exception was made for vitamin A, for which dietary assessment was based on both the 2010 and 2020 KDRIs, necessitated by the update of the standard unit for vitamin A in 2015. Despite these limitations, this research is of significant importance as it utilizes nationally representative data and explores long-term trends in growth and nutritional intake among the Korean population.

Conclusion

This study underscores the necessity of ongoing moni-

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toring and analysis of dietary patterns and growth trends in Korean children to tackle evolving dietary habits and lifestyle modifications. Although most Korean children exhibit normal growth, shifts in dietary patterns, such as increased energy intake from fat and reduced micronutrient consumption, are concerning. Future research should concentrate on detailed examinations of dietary patterns, including specific food groups and their association with SES, to pinpoint the factors that influence optimal nutrition in Korean children. Additionally, exploring the impact of micronutrient intake on growth patterns and related food behaviors can yield valuable insights. These initiatives are vital for crafting targeted interventions and policies that foster optimal nutrition and healthy growth in all children, thereby reducing disparities and combating malnutrition.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

The data that support the finding of this study are openly available and can be accessed at https://knhanes.kdca.go.kr/.

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Research Article

일차의료 연계 2형당뇨병 환자를 위한 영양교육 프로그램 적용 효과: pilot 중재연구

양혜림[1),*], 박유경[2),*], 이지현[3)], 임희숙[4)], 백희준[5)], 이혜진[6)], 박해란[7)], 이평화[8)], 정주연[9)], 김원경[10),†]

[1)]경희대학교 동서의학대학원 의학영양학과 학생
[2)]경희대학교 동서의학대학원 의학영양학과 교수
[3)]아주대학교병원 영양팀장
[4)]경희대학교 동서의학대학원 노인학과 고령서비스-테크 융합전공 부교수
[5)]한양여자대학교 식품영양과 조교수
[6)]대구시 공공보건의료지원단 부단장
[7)]양산시 보건소 영양사
[8)]한국건강증진개발원 주임전문원
[9)]한국건강증진개발원 팀장
[10)]신구대학교 식품영양학과 조교수

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†Corresponding author:
Won Gyoung Kim
Department of Food and Nutrition, Shingu College, 377 Gwangmyeong-ro, Jungwon-gu, Seongnam 13174, Korea
Tel: +82-31-740-1678
Fax: +82-31-740-1590
Email: nury86@shingu.ac.kr

*These authors contributed equally to this work.

Impact of a public health center nutrition education program on patients with type 2 diabetes in a primary care-based chronic disease management project: a pilot intervention study

Haerim Yang[1),*], Yoo Kyoung Park[2),*], Ji-hyun Lee[3)], Hee-Sook Lim[4)], Heejoon Baek[5)], Hyejin Lee[6)], Haeran Park[7)], Pyunghwa Lee[8)], Jooyoun Chung[9)], Won Gyoung Kim[10),†]

[1)]Graduate Student, Department of Medical Nutrition, Graduate School of East-West Medical Science, Kyung Hee University, Yongin, Korea
[2)]Professor, Department of Medical Nutrition, Graduate School of East-West Medical Science, Kyung Hee University, Yongin, Korea
[3)]Team Leader, Clinical Nutrition Team, Ajou University Hospital, Suwon, Korea
[4)]Associate Professor, AgeTech-Service Convergence Major, Department of Gerontology, Graduate School of East-West Medical Science, Kyung Hee University, Yongin, Korea
[5)]Assistant Professor, Department of Food and Nutrition, Hanyang Women's University, Seoul, Korea
[6)]Vice-Director, Daegu Public Health Policy Institute, Daegu, Korea
[7)]Dietitian, Yangsan Public Health Center, Yangsan, Korea
[8)]Associate Officer, Health Promotion Institute, Seoul, Korea
[9)]Team Manager, Health Promotion Institute, Seoul, Korea
[10)]Assistant Professor, Department of Food and Nutrition, Shingu College, Seongnam, Korea

Objectives: We investigated the impact of an advanced "Nutrition Education Program" on patients with Diabetes mellitus, type 2 from public health centers enrolled in a primary health care-based chronic disease management project. This 12-week dietary management program was developed by the Korea Health Promotion and Development Institute. We assessed if this program improved glycemic control and other health indicators through dietary and nutritional improvements.
Methods: Seventeen patients with Diabetes mellitus type 2 were enrolled in the "Nutrition Education Program." These patients were referred to public health centers for lifestyle management based on physician assessments at local clinics that were participating in a pilot project on primary health care-based chronic disease management. The participants attended the program comprising face-to-face basic, in-depth, and practical training sessions at the health center during the third, fifth, and seventh weeks, respectively. Anthropometric measurements, body composition analysis, blood biochemical characteristics, nutritional knowledge, and self-efficacy evaluation were performed before and after the program. Data were analyzed using SPSS ver. 28.0.
Results: The mean age of the participants was 62 years, and most participants were female (14, 82.4%). No significant changes in patients' anthropometric measurements or body composition were observed after the training. However, significant reductions were observed in the blood biochemical characteristics, including glycated hemoglobin, total cholesterol, and low-density lipoprotein levels. Additionally, patients' nutritional knowledge and self-efficacy scores increased significantly.
Conclusions: The "Nutrition Education Program" helped in improving glycemic control and other health indicators in patients with Diabetes mellitus type 2. Further research is required to objectively confirm the long-term and sustained effects of the program in a controlled study.
Trial Registration: Clinical Research Information Service Identifier: KCT0010010.

Keywords: primary health care; chronic diseases; diabetes mellitus, type 2; glycemic control; education

INTRODUCTION

당뇨병은 전 세계적으로 급증하고 있는 만성질환으로, 2019년에 4억 6,300만 명이었던 당뇨병 환자가 2045년에는 7억 8,320만 명에 이를 것으로 추정되고 있다[1]. 우리나라 또한 인구 고령화, 비만율 증가 등의 요인으로 당뇨병 환자가 점차 증가하고 있으며[2], 국내 만 19세 이상 성인 당뇨병 유병률은 2013년 11.9%에서 2022년 12.5%로 꾸준히 증가하고 있는 추세이다[3]. 2021년 국민건강통계에 따르면 성인 당뇨병 인지율은 66.6%이며, 혈당강하제 및 인슐린 치료를 받는 당뇨병 유병자는 62.4%이다. 그러나 당뇨병 치료자의 혈당 조절률(당화혈색소 6.5% 미만)은 25.0%로 인지율과 치료율에 비해 현저히 낮은 수치이다[4]. 이는 꾸준히 증가하고 있는 당뇨병에 대한 관리가 적절하게 이뤄지지 않는 것을 시사한다[5]. 따라서 효과적으로 당뇨병을 관리하기 위해서는 식사요법, 운동요법, 약물요법과 함께 생활습관 개선을 위한 지속적인 자가관리가 필수적이다[6]. 이 중 식사요법은 혈당 조절에서 가장 기본적인 치료로 간주되며, 올바른 식사요법을 실천하기 위해서는 영양교육이 필수적이다. 영양교육은 지속적인 자가관리와 함께 생활습관 개선을 통해서 혈당을 정상범위로 조절하는데 목적이 있다[7]. 하지만 일회성으로 제공되는 영양교육은 효과적인 결과를 얻기 어려우며 환자 스스로 혈당 관리와 생활습관을 개선시킨다는 것은 매우 어렵다. 이를 위해서는 지역사회의 포괄적인 공동 관리가 필요하다[8–10]. 또한 당뇨병은 적절한 관리가 되지 않을 경우 다양한 합병증이 발생하고 이로 인해 입원율과 진료비 증가를 초래한다[5, 11]. 이러한 문제는 사회적 경제적 부담을 더욱 가중시키고 있어, 효율적으로 당뇨병을 관리하기 위해서는 국가차원의 지속적이고 통합적인 관리도 필요하다[12].

1990년대 Wagner 등[13]이 지역사회 자원과 연계한 일차의료 중심의 만성질환 관리 모델(chronic care model, CCM)을 발표한 한 이후 전세계적으로 본 모델을 널리 이용하고 있다. CCM의 핵심적인 6가지 요소는 보건의료기관의 조직화, 의사결정 지원, 의료전달체계 설계, 임상정보 시스템 구축, 지역사회 자원과의 연계와 함께 환자 스스로 질환을 관리할 수 있는 자가관리 지원을 강조하였다[13]. 여러 연구에서 당뇨병 환자들에게 CCM을 적용한 결과 당화혈색소가 감소되어 당뇨병 환자 임상결과 및 치료과정에 유익한 영향을 미쳤다는 것을 알 수 있었으며[14], 현재 우리나라에서도 3차 의료기관의 의료 쏠림 문제를 해소하기 위해서 CCM을 기반으로 한 사업들이 있다[15].

국내에서도 일차의료 기관 기능 강화를 위해 '지역사회 일차의료 시범사업'과 '만성질환 수가 시범사업'을 진행해왔으며, 이 사업들의 한계점을 보완하고 강점을 통합하여 2019년부터 일차의료 만성질환 관리 시범사업이 진행되고 있다[16, 17]. 이 사업은 일차의료기관 중심으로 만성질환의 지속적·포괄적 관리체계 구축을 통한 환자 만족도, 삶의 질을 향상시키고 의료전달체계의 효율성을 높이는데 있으며, 근거 기반 치료를 통해, 당뇨병의 혈당 조절률 향상, 합병증 지연 및 예방에 목적을 두고 있다. 또한 의사와 케어 코디네이터(간호사 또는 영양사)의 협

력을 통한 팀 기반의 환자별 케어플랜을 수립하여, 질병관리와 생활습관 개선을 제공하여 환자 관리 활동을 강화하는데 중점을 둔다[18]. 그러나 현재 대부분의 당뇨병 영양교육은 3차 의료기관에서 시행되고 있는 추세이며, 환자들의 3차의료 기관 이용에 대한 의료쏠림 현상과 맞물려, 환자들 사이에서는 의료 서비스에 대한 불만이 증가하고 있는 현실이다[19-21]. 이러한 상황은 일차의료의 토대가 취약하여 지속적인 관리가 필요한 만성질환 관리에서 심각한 문제로 나타날 수 있다. 이러한 문제를 해결하기 위해 위축되어 있는 일차의료 강화를 위해 동네의원 중심으로 만성질환 관리 시범사업이 진행되고 있다[18, 22]. '우리나라 일차의료 만성질환 관리 이용자의 경험 분석: 포커스 그룹 인터뷰에 기초하여' 연구에서 환자들이 여러가지 생활습관 관리에 있어서 식습관 관리 방법에 요구도가 높았음을 보여주었다[23]. 이러한 결과는 일차의료에서 연계된 환자들을 위한 생활습관 개선을 위한 영양교육 프로그램이 부족한 실정으로 보건소 내 전문 인력을 활용하여 일차의료 연계 환자에게 영양교육 및 상담 서비스를 제공하는 영양교육 프로그램이 필요할 것이라고 사료된다.

따라서 본 연구의 목적은 2020년 한국건강증진개발원에서 개발한 '12주식생활 관리 프로그램에 활용하도록 고도화된 영양교육 프로그램'을 일차의료 기관과 보건소 간 연계를 통해 2형 당뇨병 환자들에게 적용하여, 식생활 및 영양문제 개선을 통해 혈당 조절률 향상과 다양한 건강 지표에 미치는 영향을 평가하고자 한다.

METHODS

Ethics statement

The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of Kyung Hee University (approval number: KHGIRB-21-474) and the Clinical Research Information Service (approval number: KCT0010010).

1. 연구설계

이 파일럿 중재연구는 CONSORT (Consolidated Standards of Reporting Trials) 2010 확장 가이드 라인(CONSORT 2010 extension for pilot and feasibility trials)에 따라 기술하였다.

2. 연구대상

연구 대상자는 본 연구의 목적을 이해하고 자발적으로 연구 참여에 동의한 만 19세 이상 2형당뇨병을 신규로 진단받은 환자이다. 대상자는 일차의료 만성질환 관리 시범사업에 참여한 경상남도 양산시 동네의원에 내원한 후, 의사 판단에 따라 약물치료 전 단계로 생활습관 관리가 필요한 자, 신장 관련 합병증이 없는 자로 보건소로 의뢰되었다. 약물치료를 받고 있거나 신장 관련 합병증이 있는 자는 연구 대상에서 제외하였으며, 제외 대상자, 연구에 참여를 하지 않은 미동의자 등에 대한 정보나 연구 대상자로 최종 확정된 환자들의 당뇨 관련 병력 이외의 정보는 동네의원에서 전달받지 못했다. 약 3개월 간의 모집기간을 걸쳐, 본 연구의 초기 대상자는 총 17명으로, 모두 연구 참여에 동의하였으며, 연구 기간 동안 중도탈락자나 미연계 환자는 없었다. 따라서 17명 모두 12주 식생활 관리 프로그램에 전원 참석하였고, 이들의 결과가 최종 분석에 포함되었다. 본 연구는 코로나 기간 내에 연구를 수행해야 하는 점에서 20명을 넘기지 않는 범위에서 파일럿 연구로 진행된 바, 대상자의 숫자가 충분하지는 않았으므로 대조군을 설정한 대규모 연구의 필요성이 있다.

3. 연구내용

1) 환자 연계 및 12주 식생활 관리 프로그램

동네의원에서 신규로 2형당뇨병을 진단받은 환자들 중 의사 판단 하에 약물 처방 전 단계로 생활습관 관리가 필요한 대상자들을 선별한 후 보건소와의 연계가 필요한 환자들을 케어 코디네이터가 보건소에 의뢰하였다. 케어 코디네이터는 대상자들에게 연계 절차에 대한 내용을 설명하고 동의를 얻은 후 연계를 진행하기 위해 의사가 서명한 의뢰서를 보건소로 전달하였다. 보건소에서는 의뢰된 환자에게 유선 연락(전화, 문자 등)을 하여 보건소 방문일자를 정하였다. 연계한 환자에게는 12주간의 식생활 관리 프로그램만을 제공하였다(Fig. 1). 12주 식생활 관리 프로그램은 한국건강증진개발원에서 개발한 2020 의원-보건소 연계 환자의 영양중심 당뇨병 프로그램을 사용하였다. 이 프로그램은 당뇨 관리를 위한 식사요법으로 기본·심화·실습 과정으로 구성 되어있으며, 소그룹(5인 이하) 집단교육과 개별(1:1) 상담, 환자 맞춤형 비대면 관리로 이루어져 있다. 소그룹 집단교육은 이론교육 2회, 실습교육 1회, 개별상담 2회로 구성되며, 환자 맞춤형 비대면 관리는 총 6회로 소셜 네트워킹 서비스(Social Networking Service)를 통해 진행되었다. 각 영양교육 프로그램은 각 영양교육 프로그램은 3주, 5주, 7주로 진행되었으며, 각 프로그램 마다 50분씩 진행되었다. 주차별 세부사항은 Table 1과 같다. 케어 코디네이터는 차수 별 영양교육 및 상담 종료 후 2주 이내로 회신서를 작성하여 동네의원에 교육 결과를 회신하였으며, 의사에게 신속히 알려야 할 사항이 있을 경우 즉시 회신 또는 유선 연락을 실시하였다.

2) 일반적인 특성

본 연구 대상자의 일반적인 특성인 성별, 연령, 비만도 분류는 교육 전에 조사하였다.

대한비만학회에서 정한 기준에 의해 체질량지수(body mass index, BMI)가 18.5 kg/m^2–22.9 kg/m^2 정상군, 23 kg/m^2–24.9 kg/m^2 과체중군, 25 kg/m^2 이상은 비만군으로 분류하였다.

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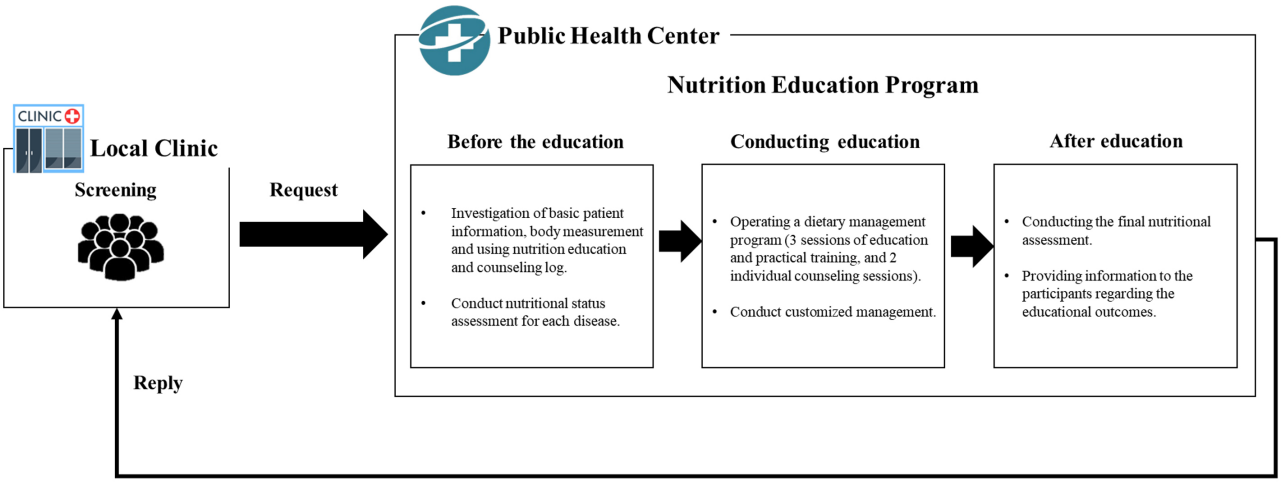

Fig. 1. Procedure for nutrition education program in collaboration between a clinic and public health center.

3) 신체계측 및 체성분 특성

대상자들의 신체계측 및 체성분 측정은 보건소 내에 있는 자원 메디칼 X-scan-plus 970 (Bioimpedance method; Jawon Medical)을 사용하여 체중(weight, kg), 체지방률(percentage of body fat, %), BMI (kg/m^2), 근육량(muscle mass, kg)을 측정하였고, 줄자를 이용하여 허리둘레(waist circumference, cm), 혈압은 혈압기기(ACCUNIQ BP210; ACCUNIQ)를 이용하여 수축기 혈압(systolic blood pressure, SBP, mmHg)과 이완기 혈압(diastolic blood pressure, DBP, mmHg)을 교육 전·후로 총 2회 측정하였다.

4) 혈액생화학적 특성

대상자들의 혈액채취는 임상병리사에 의해 교육 전·후로 총 2번 채취하였다. 채취한 혈액 샘플은 보건소 임상병리과에서 생화학 혈액분석기(Vitro 950, Ortho Clinical Diagnostics)를 사용하여 분석하였다. 대상자들의 혈액은 8시간 이상 금식 후 공복상태에서 공복혈당(fasting plasma glucose, mg/dL), 당화혈색소(hemoglobin A1c, %), 총 콜레스테롤(total cholesterol, mg/dL), 저밀도-콜레스테롤(low density lipoprotein [LDL]-cholesterol, mg/dL), 고밀도-콜레스테롤(high density lipoprotein [HDL]-cholesterol, mg/dL), 중성지방(triglyceride, mg/dL)을 채취하였다.

공복혈당(mg/dL)은 임상병리사가 정맥혈 5 μL를 채혈하여 보건소 임상병리과에서 생화학 혈액분석기를 사용하여 분석하였다.

당화혈색소(%)도 정맥혈 5 μL 채혈하여 고성능 액체 크로마토그래피(high performance liquid chromatography)로 분석하였다.

총 콜레스테롤(mg/dL), 저밀도-콜레스테롤(mg/dL), 고밀도-콜레스테롤(mg/dL), 중성지방(mg/dL)은 생화학 혈액분석기를 사용하여 분석하였다. 검사 후 남은 혈액은 즉시 폐기하였다.

5) 영양지식 평가

본 연구에서 영양평가를 위한 당뇨 영양지식을 측정하기 위해 Kang 등[24]이 개발한 영양지식 설문지와 Jung 등[25]이 개발한 설문지를 참고하여 한국건강증진개발원[26]에서 문항을 수정하여 개발한 영양지식 설문지를 영양평가 도구로 사용하였다. 설문조사는 교육 전·후로 총 2회 측정하였다. 당뇨병에 대한 일반적인 지식 영역(4문항), 합병증 영역(1문항), 저혈당 원인 증상 및 예방 영역(3문항), 식사에 관한 영역(2문항)인 총 10문항으로 이루어져 있으며, '맞다/아니다'를 O/X로 응답하도록 했다. 정답은 10점, 오답은 0점으로 간주하여 점수화 하여 총 100점으로 측정 점수 합이 높을수록 당뇨병에 대한 지식 정도가 높다는 것을 의미한다. 본 연구에서 이 도구의 신뢰도를 나타내는 Cronbach's alpha값은 전체 문항에 대해서 0.46이었다.

6) 자기효능감 평가

본 연구에서 자기효능감 측정하기 위해 Bijl 등[27]이 개발한 diabetes management self-efficacy scale 설문지와 Lee 등[28]이 개발한 자기효능감 설문지를 참고하여 한국건강증진개발원[26]에서 문항을 수정하여 개발한 자기효능감 설문지를 영양평가 도구로 사용하였다. 교육 전·후로 총 2회 진행하였다. 자기효능감 항목은 지속 치료 영역(1문항), 자기관리영역(7문항) 총 8문항으로 이루어져 있으며, Likert 척도로 '매우 자신 없다' 1점부터 '매우 자신 있다' 5점까지 선택할 수 있는 자가보고형 질문지이다. 총 합계는 40점으로 점수가 높을수록 일을 수행할 수 있는 능력에 대한 자기자신에 대한 신념이 높다는 것을 의미한다. 본 연구에서 이 도구의 신뢰도를 나타내는 Cronbach's alpha값은 전체 문항에 대해서 0.86이었다. 설문지의 타당도를 평가하

Table 1. 12-Week dietary lifestyle management program for diabetes patients

Week	Section	Content	Method
1	Pre-assessment and evaluation	• Conducting a nutritional status assessment • Subject basic information and dietary habits survey, etc.	Online
2	① Customized management	• Guidance for the first session of nutritional education • Encouragement for participation, and the like	Online
3[1)]	1st basic nutrition education	• Implementation of basic education [The Basic principles of dietary management for diabetic patients] - Diabetes mellitus etiology - The significance of dietary therapy - Diabetes and its complications - Eating a balanced diet regularly • Results of the first education and personalized management feedback	Face to face
4	② Customized management	• Guidance on the second session of nutritional education • Blood sugar check	Online
5[1)]	2nd in-depth nutrition education	• Conduct in-depth training [Blood glucose management in special circumstances] - When sick, when exercising, and blood sugar management - Symptoms and management of hypoglycemia - Considerations for popular folk remedies, etc. • Results feedback from the second session of education and personalized management	Face to face
6	③ Customized management	• Guidance on the third session of nutritional practicum education • Education content reminding	Online
7[1)]	3rd practical training[1)]	• Guidance for the Third Session of nutritional practical training [Diabetes taste testing event] - Portion control experiment with personal meal size - Exploring adequate meal portions for myself	Face to face
8	④ Customized management	• Personal consultation guide • Blood sugar check	Online
9	4th individual consultation	• Conduct individual education and counseling • Results feedback from the fourth session of counseling and personalized management	Online
10	⑤ Customized management	• Counseling content reminding • Question and answer session	Online
11	⑥ Customized management	• Personal consultation guide • Blood sugar check	Online
12	5th individual consultation	• Conducting individual education and counseling • The end of the program • Final management results feedback	Online

[1)]The weeks indicate the “nutrition education program” included in the dietary management program.

기 위해 KMO (Kaiser-Meyer-Olkin)와 Bartlett의 구형성 검정을 실시하였다. KMO 샘플 적절성 측정 값은 0.764로, 요인 분석을 수행하기에 적합한 수준으로 나타났다. 또한, Bartlett의 구형성 검정 결과에서도 유의미한 상관관계가 존재하는 것으로 나타났다.

4. 통계분석

본 연구에서 수집된 모든 데이터는 IBM SPSS Statistics version 28 (IBM Corp.)을 이용하여 분석하였다. 기술 통계값은 평균(mean)과 표준편차(standard deviation), n (%)로 표시하였다. 12주 식생활 관리 프로그램 교육 전·후의 신체계측 및 체성분, 혈액 생화학적 특성 그리고 영양지식, 자기효능감 데이터의 정

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규성은 Shapiro-Wilk 검정을 통해 5% 유의수준에서 확인하였다. 모든 데이터 자료 비교는 유의성 검증하기 위해 Wilcoxon 부호 순위 검정(Wilcoxon's signed-rank test)으로 분석하였다. 모든 통계분석 결과는 $P < 0.05$ 수준에서 유의성을 검증하였다.

RESULTS

1. 일반적인 특성

본 연구 대상자의 일반적인 특성은 Table 2와 같다. 연구에 참여한 대상자는 총 17명으로 남성 3명(17.6%), 여성 14명(82.4%)으로 여성이 많았다. 평균 연령은 62.71세였으며, 만 19세 이상 64세 이하 성인은 10명(58.8%), 65세 이상 노인은 7명(41.2%)으로 나타났다. 대한비만학회의 기준에 따라 비만도를 분류하였으며, 대상자들의 분포를 보면 정상범위 1명(5.9%), 과체중범위 11명(64.7%), 비만범위에 속하는 대상자는 5명(29.4%)이었다.

2. 신체계측 및 체성분 특성

대상자의 체성분 및 신체계측의 특성은 교육 전·후의 결과는 Table 3과 같다. 대상자들의 체중, BMI (kg/m^2), 허리둘레(cm) 및 체지방량(body fat mass, kg), 체지방률(%), 근육량(kg)은 교육 전·후에 유의미한 변화를 보이지 않았다. 또한 SBP (mmHg), DBP (mmHg)에서도 유의미한 변화가 없었다.

3. 혈액생화학적 특성

대상자의 혈액생화학적 특성은 교육 전·후의 결과는 Table 4와 같다. 당화혈색소 농도는 교육 전 6.5%에서 교육 후 6.4%로 0.15% 감소하여 통계적으로 유의미한 변화를 보였다($P < 0.05$). 이외에도 총 콜레스테롤 수치는 교육 전 166.4 mg/dL에서 교육 후 151.9 mg/dL으로 저밀도-콜레스테롤 수치는 82.6 mg/dL에서 56.9 mg/dL로 감소하였고, 통계적으로 유의미한 변화를 보였다($P < 0.05$). 그러나 공복혈당, 고밀도-콜레스테롤 및 중성지방 수치에서는 교육 전·후에 통계적으로 유의미한 변화가 관찰되지 않았다.

4. 당뇨병 영양교육 전·후 영양지식 평가

대상자의 영양지식 평가는 교육 전·후의결과는 Table 5와 같다. 영양지식은 총 100점 만점 기준으로, 교육 전에는 80.6점에서 교육 후 95.9점으로 점수가 유의미하게 상승하였다($P < 0.001$). Wilcoxon 부호 순위 검정 결과, 교육 후 점수가 전반적으로 상승하였다. 세부 문항 중 교육 전 정답 점수가 8점 이하로 정답 점수가 낮았던 5개의 문항들은 다음과 같으며, '당뇨병은 인슐린 결핍 혹은 부족에 의해 생긴다' 문항은 7.7점에서 10.0점으로 상승하였고, '당뇨병 치료에 식사나 운동보다 약이 더 중요하다' 문항은 5.3점에서 9.4점으로 유의미한 상승을 보였다. '당뇨병 환자는 음주 후 저혈당이 발생할 수 있으므로 혈당 검사와 식사를 거르지 않는다' 문항은 7.7점에서 10.0점으로 상승하였고, '잡곡밥은 쌀밥보다 더 많이 먹어도 된다' 문항은 7.1점에서

Table 2. Baseline characteristics of patients

Variable	Participant (n = 17)
Sex	
Male	3 (17.6)
Female	14 (82.4)
Age (year)	62.71 ± 6.56
19–64	10 (58.8)
≥ 65	7 (41.2)
Classification of obesity[1)]	
Normal	1 (5.9)
Overweight	11 (64.7)
Obesity	5 (29.4)

n (%) or Mean ± SD.
[1)]Normal, 18.5 kg/m^2–22.9 kg/m^2; overweight, 23 kg/m^2–24.9 kg/m^2; obesity, > 25 kg/m^2.

Table 3. Changes in anthropometric and body composition characteristics after diabetes education

Variable	Participant (n = 17)		*P*-value[1)]
	Before	After	
Weight (kg)	63.5 ± 10.3	63.7 ± 10.8	0.918
BMI (kg/m^2)	25.1 ± 2.3	25.1 ± 2.5	0.850
Waist circumference (cm)	88.3 ± 7.3	89.1 ± 8.1	0.582
Body fat mass (kg)	21.8 ± 5.8	21.0 ± 5.6	0.231
Percent body fat (%)	33.4 ± 3.9	33.1 ± 4.0	0.209
Muscle mass (kg)	38.4 ± 6.2	38.7 ± 6.4	0.378
SBP (mm/Hg)	117.7 ± 11.0	116.9 ± 13.5	0.850
DBP (mm/Hg)	71.2 ± 7.8	71.2 ± 19.0	0.314

Mean ± SD.
BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure.
[1)]Significance as determined by Wilcoxon's signed-ranks test ($P < 0.05$).

Table 4. Changes in blood biochemistry after diabetes education

Variable	Participant (n = 17)		*P*-value[1)]
	Before	After	
Fasting plasma glucose (mg/dL)	123.1 ± 21.0	119.8 ± 23.3	0.981
HbA1c (%)	6.5 ± 0.5	6.4 ± 0.5	0.029
Cholesterol			
Total cholesterol (mg/dL)	166.4 ± 49.7	151.9 ± 37.7	0.047
LDL-cholesterol (mg/dL)	82.6 ± 38.8	56.9 ± 22.4	0.014
HDL-cholesterol (mg/dL)	58.7 ± 16.3	61.1 ± 15.7	0.066
Triglyceride (mg/dL)	132.6 ± 64.4	175.6 ± 73.4	0.074

Mean ± SD.
HbA1c, hemoglobin A1c; LDL, low density lipoprotein; HDL, high density lipoprotein.
[1)]Significance as determined by Wilcoxon's signed-ranks test ($P < 0.05$).

Table 5. Changes in nutrition knowledge questionnaire after diabetes education

Nutrition knowledge	Participant (n = 17)		*P*-value[1)]
	Before	After	
Diabetes is caused by a deficiency or lack of insulin.	7.7 ± 4.4	10.0 ± 0.0	0.046
The medication is more crucial than diet or exercise in the treatment of diabetes.	5.3 ± 5.1	9.4 ± 2.4	0.008
If there are no specific symptoms, treatment may not be necessary for diabetes.	8.2 ± 3.9	10.0 ± 0.0	0.083
If blood sugar levels continue to rise, it can lead to visual impairment or impaired kidney function.	10.0 ± 0.0	10.0 ± 0.0	> 0.999
If there is a high risk of low blood sugar, it is possible to consume a pre-exercise snack.	10.0 ± 0.0	10.0 ± 0.0	> 0.999
After taking diabetes medication or receiving an insulin injection, if symptoms such as cold sweats, palpitations, hunger, fatigue, trembling hands, and headache occur, patients with diabetes should consume one tablespoon of sugar (15 g).	9.4 ± 2.4	10.0 ± 0.0	0.317
Maintaining a normal body weight is important for blood sugar control.	10.0 ± 0.0	10.0 ± 0.0	> 0.999
Diabetic patients should not forego blood sugar monitoring and meals, as hypoglycemia may occur after alcohol consumption.	7.7 ± 4.3	10.0 ± 0.0	0.046
Fruits and vegetables contribute to lowering blood sugar levels.	5.3 ± 5.1	7.1 ± 4.7	0.083
Mixed grain rice can be consumed in larger quantities compared to white rice.	7.1 ± 4.7	9.4 ± 2.4	0.046
Nutritional knowledge total score	80.6 ± 15.2	95.9 ± 6.2	< 0.001

Mean ± SD.
[1)]Significance as determined by Wilcoxon's signed-ranks test ($P < 0.05$).

9.4점으로 유의적으로 상승을 보였으며, '과일과 채소는 혈당을 낮추는 데 도움이 된다' 문항은 5.3점에서 7.1점으로 상대적으로 낮은 상승 경향을 보였다.

5. 당뇨병 영양교육 전·후 자기효능감 평가

대상자의 자기효능감 평가는 교육 전·후의 결과는 Table 6과 같다. 자기효능감 평가는 총점 40점 만점 기준으로, 교육 전 29.7점에서 교육 후 32.8점으로 유의미하게 증가하였다($P < 0.002$). Wilcoxon 부호 순위 검정 결과, 전반적인 자기효능감 점수가 교육 후 유의미하게 증가하였다. 세부 문항 중 '나는 혈압/혈당 조절을 위해 식사요법을 실천할 수 있다' 문항은 3.9점에서 4.1점으로 증가한 경향을 보였으나, 통계적으로 유의미한 변화는 없었다. 그러나 다른 여러 문항에서 유의미한 증가가 나타났다. '나는 식사량을 항상 일정하게 유지할 수 있다' 문항은 3.5점에서 4.2점으로, '나는 정기적으로 의원을 방문해 질병 상태 점검 및 합병증 검사를 받을 수 있다' 문항은 4.2점에서 4.4점으로, '나는 정상적인 혈압/혈당으로 유지할 수 있다'는 3.7점에서 4.1점으로, '나는 혈압/혈당 조절이 불량할 때 가족에게 도움을

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Table 6. Changes in self-efficacy after diabetes education

Component	Participant (n = 17)		*P*-value[1)]
	Before	After	
I can adhere to dietary practices for blood pressure and blood sugar control.	3.9 ± 1.0	4.1 ± 0.8	0.157
I can control the amount of meals and keep it constant.	3.5 ± 0.8	4.2 ± 0.8	0.002
I can visit the clinic regularly to check the condition of the disease and get a complication check.	4.2 ± 0.7	4.4 ± 0.6	0.046
I can maintain normal blood pressure and blood sugar levels.	3.7 ± 0.9	4.1 ± 0.8	0.035
I can keep my body weight constant.	3.9 ± 0.7	3.9 ± 0.7	> 0.999
I can manage stress or anxiety just as effectively as during normal times.	3.4 ± 0.8	3.8 ± 0.9	0.070
I can ask my family for help when I have poor blood pressure/blood sugar control.	3.5 ± 0.9	4.1 ± 0.7	0.015
I can always practice eating blandly.	3.8 ± 1.2	4.2 ± 0.9	0.023
Self-efficacy total score	29.7 ± 5.0	32.8 ± 5.2	0.002

Mean ± SD.
[1)]Significance as determined by Wilcoxon's signed-ranks test ($P < 0.05$).

요청할 수 있다'는 3.5점에서 4.1점으로, '나는 항상 싱겁게 먹기를 실천할 수 있다'는 3.8점에서 4.2점으로 유의미하게 증가하는 경향을 보였다.

DISCUSSION

본 연구는 2020년 한국건강증진개발원에서 개발한 '12주 식생활 관리 프로그램에 활용하도록 고도화된 영양교육 프로그램'이 실제로 일차의료에서 연계된 2형당뇨병 환자들에게 적용되었을 때 식생활 및 영양문제 개선을 통해 혈당 조절률 향상과 다양한 건강 지표에 미치는 효과를 실증한 최초의 연구이다.

연구결과 대상자들의 평균 나이는 62.71세였다. 본 연구에서 대상자들의 BMI 평균은 25.1 kg/m^{2}로 대한비만학회 기준에 따르면 비만 범위에 속한다[29]. 2형당뇨병 환자가 비만일 경우 합병증의 유병률이 증가하므로[30], 당뇨병으로 인한 합병증을 예방하기 위해서는 체중 조절이 필요하며 이를 위해 지속적인 자가관리를 통한 생활습관 개선이 필요하다[8]. 본 연구에서는 영양교육 프로그램 적용 전·후의 신체계측 및 체성분의 유의적인 차이는 나타나지 않았다. 이는 연구기간이 신체계측치의 변화를 유도하기에는 짧았던 것으로 판단된다.

당뇨 영양교육 프로그램의 궁극적인 목표는 교육을 통해 당뇨 관리를 잘 하게 되어 당뇨로 인한 합병증을 예방하는 것이다[31]. 이와 관련한 선행 연구 결과를 보면 Oh & Kim [32]의 연구 결과에서 고밀도-콜레스테롤과 중성지방은 유의한 변화는 없었고, 총 콜레스테롤, 저밀도-콜레스테롤 수치가 유의적인 차이는 없었으나 교육 후 감소한 경향을 보였다. 본 연구에서도 이와 같은 경향을 확인할 수 있었으며, 저밀도-콜레스테롤, 총 콜레스테롤 수치는 감소하여 통계적으로 유의미한 변화를 보였다. 반면, 고밀도-콜레스테롤, 중성지방 수치에서는 교육 전·후의 통계적으로 유의미한 변화가 관찰되지 않았다. 그러나 중성지방 수치의 경우 특정 대상자 1명(60대 남성)의 수치가 급격하게 증가하여 결과에 영향을 미친 것으로 보인다. 해당 대상자는 복부비만, 고혈압을 가지고 있으며, 당뇨환자에서 조절되지 않는 혈당은 인슐린 저항성과 연관되어 중성지방 수치 상승을 일으킬 수 있다[33]. 대상자는 교육 전보다 교육 후에 당화혈색소 수치가 증가하여 조절되지 않는 혈당이 중성지방 수치 변화에 영향을 미쳤을 것이라고 판단된다. 대상자의 약물복용, 과거력 등의 특성은 의원에서 전달받지 못해 구체적인 분석에 한계가 있었다. 향후 연구에서는 혈당 조절 관련 요인에 대한 추가적인 연구가 필요할 것이라고 사료된다. 반면 Yeo & Kim[34]의 연구 결과 총 콜레스테롤은 유의적인 차이는 없었지만 증가한 경향을 보였고, 고밀도-콜레스테롤 수치는 유의하게 증가하였다. 저밀도-콜레스테롤과 중성지방은 유의적인 변화는 없었으나, 감소한 경향을 보여 본 연구와 상이한 결과를 보였다[34]. 이는 선행연구와 본 연구의 교육 담당자, 프로그램 진행, 교육 시간의 차이에서 기인한 것으로 추정된다. Shin 등[9]의 연구 결과 고밀도-콜레스테롤 수치가 교육 직후에는 증가한 경향을 보였지만, 교육 후 3개월 후에는 변화가 없었다고 보고하였다. 본 연구 결과에서도 식생활 관리 프로그램 적용 직후 고밀도-콜레스테롤 수치가 유의적인 변화는 없었으나 약간 증가하여 Shin 등[9]의 연구 결과와 유사한 경향을 보였다. 결과들을 종합해 보면, 본 연구에서 사용된 영양교육 프로그램은 저밀도-콜레스테롤 수치를 감소시키고, 고밀도-콜레스테롤 수치를 약간 증가시키는 경향을 보여 심혈관계 질환 합병증 발생 위험을 줄일 수 있을 것으로 생각된다. 또한 영양교육뿐만 아니라 신체활동을 포함한 운동교육을 주기적으로 실시하는 것이 필요할 것으로 판단된다.

대한당뇨병학회에서는 성인 혈당 조절 목표를 공복혈당 80 mg/dL–130 mg/dL, 당화혈색소 6.5% 미만으로 하고 있다[35]. 본 연구 결과 교육 전 공복혈당 수치는 123.1 mg/dL ± 21.0 mg/dL에서 교육 후 119.8 mg/dL ± 23.3 mg/dL로 유의적인 차이는 없었으나, 약간 감소한 경향을 보였으며 이는 혈당 조절 목표 범위 내에서 조절되고 있다고 보여진다. 당화혈색소 수치는 교육 전 6.5% ± 0.5%에서 교육 후 6.4% ± 0.5%로 감소하여 대한당뇨병학회의 혈당 조절 목표 내 수준으로 변화되었다. 당화혈색소는 최근 2–3개월간의 평균 혈당 수치를 반영하는 지표로, 혈당 조절 상태를 평가하는데 널리 사용되고 있다. 당화혈색소는 만성합병증과 밀접한 관련이 있으며, 혈당 조절의 장기적인 상태를 반영하는 중요한 바이오마커로 간주된다[36]. 본 연구에서 관찰된 당화혈색소 수치의 감소는 효과적인 혈당 조절을 의미하며, 이는 만성 합병증 위험의 감소와 연관될 수 있다. 본 연구 결과는 기존의 여러 선행연구들과 일치하였다. Oh & Kim [32]의 연구, Shin 등[9]의 연구, Yeo & Kim [34]의 연구 모두, 영양교육과 생활습관 개선이 당화혈색소 수치 감소에 긍정적인 영향을 미쳤음을 보고하였다. 반면 Cheong 등[37]의 연구 결과는 고혈압 환자들에게는 혈압 조절에 효과가 있었으나, 당뇨병 환자의 경우 혈당 조절 효과가 확인되지 않았다. 이는 본 연구와 상이한 결과로 프로그램의 특성과 환경적 요인이 결과에 미치는 것으로 판단된다. 그러나 Song 등[8]의 연구 결과 당화혈색소 수치가 10%에서 7.9%로 유의적으로 감소하였고, 공복혈당 수치가 205 mg/dL에서 169 mg/dL로 유의적으로 감소하였다. Yuan 등[38]의 중재 연구는 2형당뇨병 환자 대상으로 진행하였다. 중재군은 8주 동안 주 1회 2시간의 자가관리 교육을 받았으며, 이후 4주간 자가관리를 실천하였다. 반면, 대조군은 영양관리만 받았으며, 연구 결과 중재군의 당화혈색소 수치는 0.2% 감소한 반면, 대조군에서는 유의미한 변화가 나타나지 않았다. 두 그룹 간의 당화혈색소 수치 변화는 통계적으로 유의미한 차이를 보였다. 동일 연구에서 혈당 수치는 중재군의 전·후 변화 및 중재군과 대조군의 혈당 변화 차이도 나타나지 않았다[38]. 이러한 결과는 당화혈색소 수치가 감소했다는 점에서 유사하다.

대조군이 포함된 연구는 중재의 효과를 보다 명확하게 규명할 수 있다는 장점이 있으며, 이는 중재 효과에 대한 신뢰성을 높일 수 있는 요소이다. 하지만 본 연구는 연구 설계상 대조군 없이 진행되었고, 선행연구는 대조군을 설정하여 교육의 효과를 명확하게 비교했다는 점에서 차이가 있다. 따라서 향후 연구에서는 대조군을 포함하여 프로그램의 효과를 보다 명확히 비교하는 것이 필요할 것으로 사료된다. 결과들을 종합해 보면 1–2회성의 영양교육이 아닌 구조화된 영양교육 프로그램이 당뇨병 환자들의 혈당 관리에 도움을 주는 것을 알 수 있었다. 따라서 일차의료에서 연계된 2형당뇨병 환자들에게 한국건강증진개발원에서 개발한 영양교육 프로그램을 적용하는 것이 효과적일 것으로 판단되며, 향후 지속적인 관리에 대한 영양교육 프로그램에 대한 평가가 필요할 것이라고 사료된다.

당뇨병 관리에 있어 지식 수준의 증가는 스스로 질환 관리에 대한 실행 능력을 향상시키고, 자가관리 이행을 촉진하여 당화혈색소 수치를 감소시켜 치료 및 예방에서 효과적인 관리가 가능하다[39, 40]. 본 연구 결과 당뇨병 영양지식 점수가 교육 전 80.6점에서 교육 후 95.9점으로 유의미하게 상승하였다. 본 연구 결과를 선행연구들과 비교해 보면 Kang 등[24]의 연구 결과 교육 전 16.7점에서 교육 후 17.8점으로 증가한 것으로 나타났다. 또한 Jung 등[25]의 연구 결과 교육 전 5.72점에서 교육 후 8.21점으로 유의하게 증가하여 본 연구 결과와 일치하였다. 이는 본 연구에 사용한 영양교육 프로그램이 영양지식 향상에 도움이 되고 올바른 식행동을 실천할 수 있도록 한다는 것을 시사한다. 그러나 문항 9번인 '과일과 채소는 혈당을 낮추는 데 도움이 된다' 문항은 교육 전 5점에서 교육 후 7점으로 다른 문항들에 비해서 점수가 상대적으로 낮은 것을 알 수 있었다. 이는 과일과 채소는 혈당에 미치는 영향이 서로 다르기 때문에 혈당을 낮추는 다른 과일과 채소를 동일하게 질문하여 대상자들이 응답 시 혼란을 일으킬 수 있으므로 차후 문항에서 채소를 제외하는 것을 고려해 볼 수 있다.

당뇨병 관리에 있어서 자기효능감 상승은 혈당 관리, 자기관리 이행에 효과적인 결과를 보였으며, 지속적인 관리를 위해서는 당뇨병에 대한 자신의 신념이 동반되어야 한다고 한다[41, 42]. 높은 자기효능감은 혈당 조절을 개선하여 합병증을 예방하고, 삶의 만족도와 삶의 질을 높일 수 있다[43]. 본 연구 결과 교육 전 자기효능감 점수가 29.7점에서 교육 후 32.8점으로 유의하게 상승하였으며, 선행연구와 비교하여 볼 때 Jung 등[25]의 연구 결과 교육 전 보다 교육 후에 유의한 개선이 되어 본 연구 결과와 일치하였다. 특히 본 연구에서는 문항 2번인 '식사량을 항상 일정하게 유지할 수 있다' 점수가 큰 폭으로 상승하였다. 이러한 결과는 '내가 먹을 밥 양 알맞게 담아보기', '나에게 적당한 식사량 알아보기'의 문항들은 실천적인 영양교육을 통해 영양지식의 점수도 증가하여 스스로 질환 관리에 대한 실행 능력이 향상되었다고 생각된다. 질환에 대한 지식의 증가는 스스로 실행할 수 있는 신념인 자기효능감의 증가로 이어질 수 있다[44]. 따라서 본 연구에 사용된 영양교육 프로그램은 당뇨병의 자기효능감 상승에 효과적이며, 이는 자가관리 능력에 향상에 기여할 것으로 사료된다. 앞으로도 영양교육 프로그램의 지속적 적용과 추가 연구를 통해 장기적인 효과를 검증할 필요가 있다고 판단된다.

Limitations

다만, 본 연구는 대조군 없이 연구가 진행되어 사전 및 사후평가의 변화가 영양교육에 의한 효과라고 단정하기 어렵다는 점이 가장 큰 제한점이며, 또한 일차의료 만성질환 관리 시범사업에 참여하는 의원에 다니는 환자 대상으로 선정하여 표본수가

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17명으로 적다는 점이다. 이로 인해 비모수적 통계 방법을 사용하여 분석했다는 점에서 신뢰성이 제한적일 수 있다. 향후 연구에서는 더 큰 표본을 대상으로 한 연구가 필요할 것이라고 사료된다. 두 번째 제한점으로는 자료 수집의 한계로 인해 성별, 연령, 비만도 분류의 자료만 수집하였으며, 혈당 조절에 영향을 미치는 금연, 음주 등은 수집하지 못하였다. 질환 관련 약물 및 합병증 그리고 유병기간도 의원에서 전달받지 못하였으며, 이는 향후 선행연구에서 제시한 혈당 조절에 미치는 관련 요인과 약물 및 합병증 그리고 유병기간들에 대한 추가적인 분석이 필요할 것으로 생각된다.

Conclusion

본 연구에서는 일차의료에서 연계된 2형당뇨병 환자에게 한국건강증진개발원에서 개발한 '12주 식생활 관리 프로그램에 활용하도록 고도화된 영양교육 프로그램'을 적용하여 식생활 및 영양문제 개선을 통해 혈당 조절률 향상과 다양한 건강 지표에 미치는 영향을 평가하였다. 연구결과 당화혈색소는 유의하게 감소하였고, 영양지식, 자기효능감 점수는 유의하게 증가하여 한국건강증진개발원에서 개발한 고도화된 영양교육 프로그램의 효과가 입증되었다. 향후에는 대조군을 포함한 연구 설계를 통해 장기적이고 지속적인 효과를 객관적으로 확인할 필요성이 있을 것으로 판단된다.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

Research data is available upon a reasonable request to the corresponding author.

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Research Article

리빙랩 기반 저당 식생활 실천 프로그램 개발 및 적용: 중재연구

김정현[1], 경민숙[2], 최슬기[3,†]

[1]배재대학교 식품영양학과 교수
[2]대전 서구 어린이·사회복지급식관리지원센터 팀장
[3]서울시립대학교 도시보건대학원 조교수

Development and application of a dietary program to reduce sugar intake using a living lab approach in Korea: an intervention study

Jung-Hyun Kim[1], Min Sook Kyung[2], Seul Ki Choi[3,†]

[1]Professor, Department of Food and Nutrition, Pai Chai University, Daejeon, Korea
[2]Manager, Daejeon-Seogu Children and Social Welfare Meal Management Support Center, Daejeon, Korea
[3]Assistant Professor, Graduate School of Urban Public Health, University of Seoul, Seoul, Korea

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†Corresponding author:
Seul Ki Choi
Graduate School of Urban Public Health, University of Seoul, 163 Seoulsiripdae-ro, Dongdaemun-gu, Seoul 02504, Korea
Tel: +82-2-6490-6757
Fax: +82-2-6490-6754
E-mail: skchoi@uos.ac.kr

Objectives: This study aimed to develop and apply a dietary program to reduce sugar intake among community residents using a Living Lab approach.

Methods: We developed and applied a community-based dietary program to reduce sugar intake. Participants were recruited from community organizations, including a children's food service management center, elementary to high schools, a university, a family center, a community health center, and an elderly welfare center. The dietary program was conducted in two phases; start and next levels. The start level included a pre-assessment of dietary behaviors and participation in educational platforms, whereas the next level included activities using educational platforms, tailored mission and feedback, and pre- and post-surveys. Extension educators at each community organization implemented the dietary program following organization-specific guidelines. Changes in participants' nutrition knowledge, dietary behaviors and perceptions, self-efficacy, intention to reduce sugar intake, and participants' program satisfaction were analyzed using paired t-tests.

Results: In total, 1,238 and 339 individuals participated in the start and next level, respectively. Participants reported significantly lower scores on dietary behavior items regarding drinking more juice or soft drinks after program participation (P = 0.009) and craving sweet foods (P = 0.046). They reported a higher intention to take interest in sugar content in food (P = 0.009) and lower-sugar recipes (P = 0.019), eat less food with high sugar content (P = 0.020), and drink water or sparkling water instead of soft drinks (P = 0.042). Nutrition knowledge did not significantly change after program participation. Program satisfaction significantly increased from the start level to the next level (P < 0.050).

Conclusion: This study showed the potential of using a Living Lab approach to implement community-wide dietary interventions. Further research is required to evaluate the effectiveness of the Living Lab approach in various community settings.

Keywords: nutrition education; sugars; diet, healthy

INTRODUCTION

생활 속 실험실, 살아있는 실험실 등으로 불리는 리빙랩(Living Lab)은 실제 일상생활 공간에서 사용자와 전문가가 협력하여 기술 혁신과 사회 문제의 혁신적인 해결책을 공동으로 창출하는 개방형 과학기술 연구 혁신 모델이다[1, 2]. 리빙랩은 전문가 중심의 전통적인 연구 방식에서 벗어나 사용자를 문제 해결의 중심에 두고, 사용자의 생활 환경에서 문제 해결을 위한 중재를 수행하고, 검증한다[2]. 리빙랩을 통해 대상자의 실제적인 욕구를 파악하고 대응함으로써, 중재의 효과성과 대상자 만족도를 높일 수 있으며[3], 중재 대상의 참여를 통해 복잡한 사회 문제에 대한 혁신적이고 지속가능한 해결방법을 도출할 수 있다[4]. 리빙랩은 지역사회 구성원의 적극적인 참여를 강조하고, 구성원과 연구자가 협력하여 사회 문제를 해결하는 것을 목적으로 한다는 측면에서 지역사회 영양학 분야 중재 연구에 자주 활용되는 지역사회 기반 참여연구(community-based participatory research, CBPR)와 유사하다[5]. CBPR은 기술을 활용하는 것이 필수적이지 않으나 리빙랩은 과학기술을 사회문제 해결에 활용하여 중재의 효과를 높이고자 하는 측면에서 CBPR을 확장한 방법론이라고 할 수 있다[6]. 리빙랩은 사회 혁신을 위한 새로운 패러다임으로 자리잡고 있으며, 복잡한 사회문제에 대한 혁신적이고 지속가능한 해결책을 도출하는 데 기여하고 있다.

리빙랩은 실제 생활 현장에서 사용자와 전문가의 협력으로 혁신을 공동창조(co-creation)하기 위해 탐색, 실험, 평가의 단계로 수행된다. 탐색 단계는 아이디어를 발굴하고 개념화하는 단계로, 사용자의 행태를 분석하여 문제를 정의하고, 문제의 원인을 발견한다. 실험 단계에서 문제를 해결할 수 있는 서비스나 제품을 개발하고 실제 환경에서 사용자에게 시험하여, 사용자들의 행동이나 인식의 변화를 분석한다. 이를 통해 실제 환경에서 서비스나 제품을 사용할 때 발생할 수 있는 문제를 확인하고, 사용자의 피드백을 수집하고 분석한다. 평가 단계에서는 실험 단계에서 수집된 피드백을 바탕으로 서비스나 제품을 보완하고, 실제 생활에서 작용할 수 있도록 개선한다. 리빙랩의 전 과정은 공급자(또는 전문가)와 사용자가 공동으로 진행한다[7, 8].

리빙랩은 활동 주체에 따라 기업·정부·연구기관·사용자 주도형으로 분류할 수 있다[9]. 기업 주도형 리빙랩은 기업의 상품과 서비스 개발을, 정부 주도형은 사회문제 해결을 목적으로 하는 경우가 많다. 반면 대학, 연구소 등이 혁신을 주도하는 연구기관 주도형은 리빙랩 활동을 통해 도출된 기술이나 연구 성과의 활용과 성과 확산, 지속가능한 활동에 중점을 둔다. 사용자 주도형 리빙랩은 지역사회 구성원이 주도적으로 지역사회 문제의 해결 방안을 모색한다. 사용자 주도형 리빙랩은 비전문가가 주도하므로 리빙랩 운영과 기술 개발의 전문성이 타 유형의 리빙랩과 비교하여 상대적으로 부족하다. 이러한 단점을 보완하기 위해 다양한 유형의 리빙랩을 융합하고, 지역사회가 능동적으로 참여하는 주민 참여형 리빙랩이 증가하고 있다.

리빙랩이 사용자 주도적으로 사회문제를 해결하는 새로운 방법론으로 주목받으면서, 다양한 분야에서 리빙랩을 활용하고 있다. 특히 사용자의 일상에 큰 영향을 미치는 건강 문제의 해결을 위하여 보건의료 분야에서 리빙랩의 활용이 증가하고 있다. 국내 보건의료분야에서는 고령자의 근골격계 건강 문제 해결[10], 건강증진을 위한 정보통신 기술 적용[11], 건강 보조용품의 개발[12], 건강교육[13] 등을 위한 여러 리빙랩 연구가 이루어졌다. 리빙랩은 인구집단별, 생애주기별로 다양한 식생활 형태를 가진 사용자의 욕구를 반영할 수 있으므로 식생활 개선을 위한 중재에 적용할 수 있는 잠재력이 있으나 국내외에서 리빙랩을 적용한 식생활 개선 중재는 다른 분야에 비해 상대적으로 적다. 국내에서 식생활 개선을 위한 활동에 리빙랩을 활용한 사례가 일부 있으나, 대부분 언론 기사로만 결과가 알려졌으며, 연구 성과로 발표된 경우가 드물어[14, 15], 식생활 개선을 위한 리빙랩 활동의 과정과 결과에 대한 공유가 부족하다.

이에 본 연구는 리빙랩을 활용한 지역사회 기반의 저당 식생활 실천 프로그램(이하 리빙랩 프로그램)을 개발, 적용하고 효과를 평가하여 적용 가능성을 파악하였다. 본 연구에서 개발한 리빙랩 프로그램은 지역사회 구성원의 당류 섭취 문제를 보고한 선행연구[16]를 바탕으로 다양한 생애주기의 지역사회 구성원이 바람직한 당 섭취의 중요성에 대해 인식하고, 당류 섭취 감소를 포함하여 전반적으로 식생활을 개선하도록 하는 것을 목표로 한다. 본 연구의 리빙랩 프로그램은 연구기관 주도형과 사용자 주도형 리빙랩을 융합한 주민참여형 리빙랩으로, 지역사회 구성원의 생애주기별 다양한 수요에 맞는 저당 식생활 실천 방안을 제시했다. 이를 통해 지역사회를 중심으로 식생활 개선 활동이 이루어지도록 하였으며, 리빙랩 참여를 통해 저당 식생활과 관련된 지식, 인식, 행동, 자기효능감, 저당 식생활 실천 의도에 긍정적인 변화가 나타날 것으로 예상했다.

METHODS

Ethics statement

The study design and survey instruments were reviewed and approved by the Pai Chai University Institutional Review Board (PCU IRB No.2-1040766-AB-N-01-S-2023-11).

1. 연구 설계

본 연구는 저당 식생활 실천 프로그램을 개발하여 적용한 다기관 단일군 중재연구로 2023년 9월부터 11월까지 대전광역시 7개 기관에서 수행되었다. 연구에 대한 기술은 비무작위 건강행동 연구에 대한 작성 지침인 Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) 가이드라인을 따랐다[17].

2. 연구 대상

리빙랩 프로그램은 대전광역시 A구 소재 어린이급식관리지원센터, 초·중·고등학교, 대학교, 가족센터(사회복지시설), 노인복지관, 보건소의 이용자를 대상으로 수행되었다. 어린이급식관리지원센터를 통해 영유아와 어린이가 프로그램에 참여하였으며, 초·중·고등학교, 대학교를 통해 해당 학교의 재학생이 참여하였다. 가족센터는 다양한 유형의 가족(1인 가구, 다문화가정, 한부모가정, 조손가정 등)이 이용하므로, 가족센터를 통해 여러 생애주기의 사람들이 참여했으며, 노인복지관을 통해 경로식당 이용 노인이 프로그램에 참여하였다. 보건소에서는 임산부와 대사증후군 관리 대상자가 프로그램에 참여하였다. 대상자 모집 시 목표 인원을 사전에 설정하지 않고, 해당 기관의 이용자가 최대한 많이 참여하도록 모집하였다.

3. 리빙랩 활용 지역사회 기반 저당 식생활 실천 프로그램 개발 및 적용

1) 프로그램 구성 요소

다양한 지역사회 기관의 특성에 맞게 리빙랩 프로그램을 운영할 수 있도록 운영 지침을 개발하고 적용하였다. 기관마다 프로그램의 운영 방식이 다르지만 공통적으로 온라인 플랫폼 및 소통채널, 교육자료, 자가 식생활진단, 저당 레시피북을 이용했다. 온라인 플랫폼은 참여자가 리빙랩 프로그램의 콘텐츠를 활용할 수 있는 메타버스 플랫폼과 리빙랩 홈페이지를 포함한다. 이 중 메타버스 플랫폼(로블록스, 제페토)은 주로 초등학생과 중학생을 대상으로 하여, 해당 연령대 대상자의 참여도와 집중도를 높일 수 있도록 설계했다. 플랫폼 내에서 각종 이벤트를 진행함으로써 사용자의 흥미를 유도하고, 맞춤형 콘텐츠를 제공함으로써 사용자별 최적화된 관리를 할 수 있었다. 프로그램 관련 공지와 정보를 전달하고, 대상자에게 피드백을 제공하는 소통채널로 카카오톡 채널, 이메일, 문자, 전화를 활용했다. 교육자료는 선행연구[16]에서 개발한 책자와 실천 영상을 활용하였다. 또한 저당 레시피북 '덜 달게·더 맛있게·더 든든하게 당당한 레시피', 식습관 점검 체크리스트 '당당한 Check Step'을 리빙랩 프로그램에 활용하였다[16].

2) 확장교육자(extension educator)

리빙랩은 각 참여자의 생활환경 내에서 중재가 이루어지므로 효과적인 리빙랩 운영을 위해서는 지역사회, 중재 기관, 가정의 연계 체계를 이용한 통합적인 교육과 관리 체계가 필요하다. 리빙랩 프로그램의 수행과 통합적 관리를 위해 지역사회의 각 기관에 소속되어 프로그램을 주도적으로 수행하는 담당자를 확장교육자로 지정하였다. 확장교육자는 리빙랩에서 수행할 교육 프로그램을 함께 개발하고, 대상자에게 교육을 제공했다. 구체적으로는 참여자의 식습관 진단, 코칭, 동기 부여, 맞춤형 지침 제공, 참여 독려, 소통 등을 통해 참여자의 식생활 관리에 도움을 주었다. 초, 중등학교에서는 담임교사, 영양교사, 방과 후 교사가, 대학교는 식생활 및 건강관리 관련 담당 교수, 보건소 등 연계기관의 사업 담당자, 보건소는 영양사 또는 사업 담당 간호사, 운동사, 복지관은 사회복지사와 영양사가 확장교육자의 역할을 하였다.

3) 리빙랩 프로그램 운영 과정

리빙랩 프로그램은 온라인 플랫폼을 체험하는 스타트레벨과 온라인 플랫폼 이용과 함께 대면 식생활 교육, 교육과 연계된 미션을 실천하는 넥스트레벨로 구분하여 운영하였다. 프로그램의 세부적인 운영 방식은 수행기관의 특성에 따라 다르나, 공통적으로 참여 기관을 통해 대상자를 모집하고, 사전 식습관 진단을 수행했으며, 온라인 플랫폼 및 대면 교육을 통한 저당 식생활실천 프로그램 운영, 사후 조사, 프로그램 확산 활동이 이루어졌다. 어린이급식관리지원센터에서 리빙랩 프로그램을 운영한 사례는 다음과 같다.

① 스타트레벨

어린이급식관리지원센터는 등록된 기관(어린이집, 유치원, 아동 복지시설 등)에 이메일을 통해 리빙랩 프로그램을 홍보하였다. 각 기관은 기관 이용자에게 프로그램을 안내하고 참여자를 모집했다. 참여자들은 리빙랩 웹사이트, 로블록스, 제페토 중 참여자가 원하는 플랫폼을 통해 건강 식생활 콘텐츠를 체험했다. 플랫폼 체험 전 설문조사를 통해 참여자의 식습관을 진단하고, 체험 후 플랫폼 및 프로그램 만족도 조사를 수행했다.

② 넥스트레벨

스타트레벨의 참여자(보호자)에게 넥스트레벨에 참여할 수 있는 링크를 문자로 전달하여, 플랫폼을 통해 프로그램 사전 설문조사에 참여하도록 하였다. 각 기관은 넥스트레벨 참여자를 대상으로 당류 섭취를 줄이기 위한 실천교육을 수행하였고, 가정에서 저당 식생활을 실천할 수 있도록 교육 자료와 활동지를 배포하였다. 또한 참여자들이 당류 섭취 감소 실천 미션을 선택해서 수행하도록 했다. 미션은 당류 저감화 영상 보기, 당류 섭취 체크리스트 확인하기, 당 저감 레시피 따라하기를 포함하며, 미션 수행 후 인증사진을 카카오톡 채널로 제출하면 개별 피드백과 함께 미션 완료 스티커를 제공했다. 넥스트레벨 참여자는 온라인 플랫폼으로 프로그램 사후 설문조사와 만족도 조사에 응답했다. 어린이급식관리센터는 참여 기관을 통해 프로그램 수료자에게 수료증과 기념품을 제공했다. 또한 프로그램 우수사례를 센터 소식지, 가정통신문, 카드뉴스 등을 통해 배포하여 저당 식생활 인식 개선과 리빙랩 프로그램의 지역사회 확산을 유도하였다.

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4. 조사 도구 및 자료 수집

리빙랩 프로그램 참여자를 대상으로 한 모든 조사는 리빙랩 웹사이트의 설문조사 시스템을 활용하여 온라인 조사로 이루어졌다. 참여자가 스스로 응답을 할 수 없는 경우 보호자가 대신 조사 문항에 응답하였다. 조사 도구는 선행연구에서 개발한 문항을 활용했다[18-20]. 프로그램 참여자의 음식의 단맛 선호도(매우 좋아한다–매우 좋아하지 않는다)와 평소 음식을 달게 먹는 정도(아주 달게 먹는 편–전혀 달지 않게 먹는 편)는 5점 리커트 척도로 스타트레벨과 넥스트레벨 참여 전에 각각 측정하였다. 넥스트레벨 참여 전·후에 당류 섭취와 관련한 영양지식을 13문항으로 묻고, 정답인 경우 1점, 오답인 경우 0점을 부여했다. 영양지식 점수의 범위는 0–13점이다. 또한 당류 섭취 관련 행동과 인식(10문항), 당류 섭취를 포함한 식사 자기효능감(20문항), 당류 저감 실천 의도(18문항)와 관련된 지시문을 제시하고, 참여자들의 생각 또는 행동과 가장 가까운 항목을 5점 리커트 척도(1: '매우 그렇지 않다' 부터 5: '매우 그렇다')를 이용하여 응답하도록 하였다. 모든 지시문이 점수가 높을수록 당류 섭취 감소를 나타낼 수 있도록, 필요한 경우 역코딩을 하여 점수를 환산했다. 조사도구의 신뢰도를 크론바흐 알파로 측정한 결과 영양지식 0.714. 당류 섭취 관련 행동과 인식 0.911, 식사 자기효능감 0.937, 당류 저감 실천 의도 0.960이었다. 또한 스타트레벨과 넥스트레벨 참여 후에 프로그램 만족도(전반적 만족도, 프로그램 내용, 프로그램 내용 흥미도, 제공 자료, 운영 시간, 운영 횟수, 운영 방법, 운영 환경, 참여 즐거움)와 향후 프로그램 참여 의사, 프로그램 참여 후 건강한 식생활 실천 노력 정도를 5점 리커트 척도(1: '매우 그렇지 않다' 부터 5: '매우 그렇다')로 측정하였다.

5. 통계 분석

설문조사 자료의 분석은 SPSS ver. 26 (IBM Corp.)을 이용하였다. 리빙랩 프로그램 참여자의 특성은 기술통계 분석을 이용하여 빈도와 비율을 제시했다. 사전, 사후조사에 모두 참여한 62명의 당류 섭취 관련 영양지식, 당류 섭취 관련 평소 행동과 인식, 당류 섭취를 포함한 식사 효능감, 당류 저감 실천의도의 각 문항의 평균을 대응표본 t 검증(paired t-test) 분석으로 비교하여 프로그램 참여 전후 변화를 분석하였다. 또한 스타트레벨과 넥스트레벨에 모두 참여한 113명을 대상으로 조사한 스타트레벨 참여 후와 넥스트레벨 참여 후의 프로그램 만족도를 대응표본 t 검증을 통해 비교하였다. 모든 분석은 $P < 0.05$에서 통계적 유의성을 검정하였다.

RESULTS

1. 프로그램 참여자의 특성

리빙랩 프로그램 참여자의 특성은 Table 1과 같다. 리빙랩 프로그램의 스타트레벨에 1,238명, 넥스트레벨에 339명이 참여하여 스타트레벨 참여자 중 넥스트레벨까지 지속적으로 참여한 대상은 약 27.4%였다. 스타트레벨과 넥스트레벨 모두 가족센터를 통해 참여한 대상이 가장 많았으며(스타트레벨: 39.1%, 넥스트레벨 53.7%), 대학교(스타트레벨: 19.0%, 넥스트레벨 15.9%), 어린이급식관리지원센터(스타트레벨: 17.0%, 넥스트레벨 15.6%)의 순이었다. 참여 대상자는 스타트레벨에서는 1–19세(32.9%), 20–29세(29.5%), 30–49세(28.0%)의 순으로 많았으나, 넥스트레벨은 30–49세가 38.7%로 가장 많고, 1–19세(35.0%),

Table 1. General characteristics of Living Lab participants

Variable	Start level participants (n = 1,238)	Next level participants (n = 339)
Organization		
Center for children's food-service management	211 (17.0)	53 (15.6)
Elementary, middle, and high school	142 (11.5)	11 (3.2)
University	235 (19.0)	54 (15.9)
Family center	484 (39.1)	182 (53.7)
Community health center	151 (12.2)	33 (9.7)
Elderly welfare center	15 (1.2)	6 (1.8)
Age (year)[1]		
1–19	406 (32.9)	116 (35.0)
20–29	364 (29.5)	47 (14.2)
30–49	345 (28.0)	128 (38.7)
50–69	103 (8.4)	37 (11.2)
70+	15 (1.2)	3 (0.9)
Preference for sweet flavors in foods[2]		
Strongly like	178 (14.4)	31 (9.4)
Like	519 (42.1)	102 (31.0)
Neutral	365 (29.6)	101 (30.7)
Dislike	136 (11.0)	76 (23.1)
Strongly dislike	35 (2.8)	19 (5.8)
Sweetness of foods in usual diets[3]		
Very sweet	17 (1.4)	10 (3.1)
Somewhat sweet	249 (20.2)	54 (16.5)
Medium	618 (50.1)	154 (47.1)
Not very sweet	286 (23.2)	90 (27.5)
Not at all sweet	63 (5.1)	19 (5.8)

n (%).
[1]Missing; five for start level participants and eight for next level participants.
[2]Missing; five for start level participants and eleven for next level participants.
[3]Missing; five for start level participants and twelve for next level participants.

20–29세(14.2%)의 순이었다. 음식의 단맛을 좋아하는 참여자의 비율은 스타트레벨(매우 그렇다 + 그렇다 56.5%)이 넥스트레벨(40.4%)보다 높아, 단맛 선호도가 상대적으로 낮은 대상자들이 리빙랩 프로그램에 지속적으로 참여하는 것으로 나타났다. 또한 스타트레벨 참여자들이 넥스트레벨 참여자보다 평소에 달게 먹는다는 응답한 비율이 높아(매우 달게 먹는 편 + 달게 먹는 편: 스타트레벨 21.6%, 넥스트레벨 19.6%), 상대적으로 달지 않게 먹는 편인 대상자들이 리빙랩에 지속적으로 참여한 것으로 나타났다.

2. 프로그램 참여 후 당류 섭취 관련 영양지식, 행동과 인식, 자기효능감, 당류 섭취 저감 의도의 변화

리빙랩 프로그램의 사전, 사후 조사에 모두 응답한 참여자 62명의 당류 섭취 관련 영양지식, 행동과 인식, 자기효능감, 당류 섭취 저감 의도의 프로그램 참여 전·후 비교 결과는 Table 2와 같다. 당류 섭취와 관련된 영양지식은 리빙랩 프로그램 참여 전(9.37 ± 1.90)에 비해 참여 후(9.57 ± 1.56) 증가하였으나 통계적으로 유의한 차이는 없었다. 당류 섭취 관련 행동과 인식을 측정한 10문항 중 두 문항에서 통계적으로 유의한 변화가 있었다. '물 대신 주스와 탄산음료를 더 많이 마신다' 문항의 평균 점수가 프로그램 참여 전(2.29 ± 1.22)보다 참여 후(1.89 ± 0.93) 유의하게 감소하였다(P = 0.009). 또한 '단 음식을 더 많이 먹고 싶지 않다' 문항의 평균 점수는 프로그램 참여 전(2.45 ± 1.05)보다 참여 후(2.73 ± 0.98) 유의하게 증가했다(P = 0.046). 식생활 관련 자기효능감은 '맛있는 음식이 눈 앞에 있을 때 먹지 않고 참을 수 있다' (참여 전 3.16 ± 1.04, 참여 후 3.47 ± 0.88, P = 0.025), '특별한 날 음식을 많이 먹지 않을 수 있다' (참여 전 3.02 ± 1.11, 참여 후 3.36 ± 1.01, P = 0.034)의 두 항목에서 프로그램 참여 후 통계적으로 유의한 긍정적인 변화가 나타났다. 당류 줄이기 실천 의도 관련 18문항 중 4문항에서 프로그램 참여 후 통계적으로 유의한 변화가 있었다. 프로그램 참여자들은 참여 전에 비해 참여 후 음식의 당류에 대한 관심 의향(참여 전 3.53 ± 1.04, 참여 후 3.94 ± 0.87, P = 0.009), 당류 저감 조리방법에 대한 관심 의향(참여 전 3.74 ± 1.01, 참여 후 4.07 ± 0.70, P = 0.019), 당류가 많이 사용되는 음식 섭취 감소 의도(참여 전 3.77 ± 0.78, 참여 후 4.03 ± 0.60, P = 0.020), 탄산음료 대신 물이나 탄산수 섭취 의도(참여 전 3.98 ± 0.93, 참여 후 4.23 ± 0.76, P = 0.042)가 유의하게 증가했다.

3. 프로그램 만족도

스타트레벨과 넥스트레벨에 모두 참여한 112명의 프로그램 만족도는 Table 3과 같다. 프로그램 만족도의 모든 항목에서 참여자들은 스타트레벨보다 넥스트레벨 참여 만족도가 유의하게 높았다(P < 0.05). 또한 스타트레벨 참여 시보다 넥스트레벨에 참여했을 때, 향후 프로그램에 참여할 의향이 유의하게 높았으며(스타트레벨 3.75 ± 1.00, 넥스트레벨 4.18 ± 0.82, P < 0.001), 프로그램 참여 후 건강한 식생활을 위해 더욱 노력한 것으로 나타났다(스타트레벨 3.98 ± 0.84, 넥스트레벨 4.35 ± 0.74, P < 0.001).

DISCUSSION

본 연구는 지역사회 구성원의 당류 섭취를 줄이기 위한 목적의 리빙랩 기반 저당 식생활 실천 프로그램을 개발하고, 지역사회 내 다양한 기관에서 운영하여 프로그램의 효과를 평가했다. 이를 통해 지역사회 기반 식생활 실천 프로그램에 리빙랩 접근 방

Table 2. Comparison of knowledge, dietary behavior and perception, self-efficacy, and intention to reduce sugar intake before and after the Living Lab program

Item[1)]	Pre-test (n = 62)	Post-test (n = 62)	*P*-value
Nutrition knowledge about sugar intake[2)]	9.37 ± 1.90	9.57 ± 1.56	0.447
Dietary behavior and perception about sugar			
I have times of the day when I feel sluggish and lethargic.	3.29 ± 1.14	3.29 ± 1.01	> 0.999
I have days when I feel low energy and irritable for no reason.	3.29 ± 1.06	3.16 ± 1.01	0.375
I occasionally crave very sweet foods.	3.36 ± 1.06	3.50 ± 0.88	0.309
When I see other people eating sweets, I want them too.	2.92 ± 1.11	2.94 ± 1.01	0.918
I cannot concentrate without sweets.	2.27 ± 1.03	2.23 ± 0.97	0.717
I look for sweet food and snack even after a meal.	2.66 ± 1.16	2.82 ± 1.07	0.290
I always have sweet treats around.	2.73 ± 1.06	2.66 ± 1.10	0.610
I drink more juice or soft drinks than water.	2.29 ± 1.22	1.89 ± 0.93	0.009
I eat sweet foods when I am stressed.	2.63 ± 1.19	2.66 ± 1.17	0.842
I do not want to eat more sweet foods.	2.45 ± 1.05	2.73 ± 0.98	0.046

(Continued to the next page)

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Table 2. Continued

Item[1)]	Pre-test (n = 62)	Post-test (n = 62)	*P*-value
Dietary self-efficacy			
I can eat three meals a day at regular times.	3.26 ± 1.06	3.40 ± 0.98	0.302
I can avoid eating sweet foods or snacks after a meal.	3.61 ± 0.91	3.69 ± 0.97	0.497
I can eat slowly, keeping pace with others.	3.57 ± 1.05	3.79 ± 0.83	0.056
I can always eat just the right amount without eating too much.	3.69 ± 0.84	3.71 ± 0.80	0.890
I can eat food without salt.	3.31 ± 1.10	3.50 ± 0.86	0.159
I can avoid snacking after dinner.	3.50 ± 0.95	3.73 ± 0.91	0.104
I can choose baked or steamed foods instead of fried foods.	3.73 ± 0.81	3.87 ± 0.80	0.296
I can choose fruits instead of candy or chips and cookies.	3.94 ± 0.70	3.94 ± 0.70	> 0.999
I am confident to choose yogurt instead of ice cream.	3.89 ± 0.93	3.90 ± 0.76	0.904
I can choose plain milk or water to drink instead of soft drinks.	4.03 ± 0.87	4.05 ± 0.80	0.890
I can distinguish between foods high in sugar and foods low in sugar by reading the nutrition labels.	3.81 ± 1.09	3.90 ± 0.69	0.381
I can choose not to eat while watching TV or reading a book.	3.81 ± 0.88	3.61 ± 0.98	0.208
I can say no when offered tasty food.	3.26 ± 1.13	3.57 ± 1.00	0.071
I can avoid eating a lot of food on special occasions such as birthdays, holidays, etc.	3.02 ± 1.11	3.36 ± 1.01	0.034
I can resist eating when tasty food is in front of me.	3.16 ± 1.04	3.47 ± 0.88	0.025
I can resist eating food as soon as I get home.	3.44 ± 1.11	3.68 ± 0.92	0.141
I can resist eating food when I am bored.	3.52 ± 0.88	3.73 ± 0.71	0.091
I can resist eating food when I am angry.	3.71 ± 1.00	3.71 ± 0.95	> 0.999
I can resist eating food when I am anxious or nervous.	3.79 ± 0.96	3.86 ± 0.87	0.666
I can resist eating food when I feel depressed.	3.65 ± 1.06	3.77 ± 0.86	0.409
Intention to reduce sugar intake			
I am concerned about the sugars in the foods.	3.53 ± 1.04	3.94 ± 0.87	0.009
I will be healthier if I eat less sugar.	4.08 ± 0.86	4.13 ± 0.80	0.643
I will buy fresh foods rather than processed and instant foods.	3.95 ± 0.91	4.05 ± 0.82	0.490
I will ask for less sweetened food when eating out.	3.52 ± 0.99	3.56 ± 0.99	0.273
I will choose foods with natural flavors and aromas instead of sugary and salty foods.	3.81 ± 0.99	3.95 ± 0.84	0.289
I will be interested in lower sugar recipes.	3.74 ± 1.01	4.07 ± 0.70	0.019
I believe that attempts and interest in reducing sugar intake can lead to social change.	3.87 ± 0.76	4.03 ± 0.83	0.207
I will reduce sugar or replace it with natural or artificial sweeteners when I cook.	3.87 ± 0.78	4.00 ± 0.81	0.306
I will eat less food with high sugar such as stewed, stir-fried, grilled, or steamed dishes that use high level of sugar, corn syrup, and ketchup.	3.77 ± 0.78	4.03 ± 0.60	0.020
I will drink water or sparkling water instead of soft drinks.	3.98 ± 0.93	4.23 ± 0.76	0.042
I will not add sugar or syrup to my coffee or tea.	3.83 ± 1.14	4.13 ± 0.78	0.081
I will eat fresh fruit and vegetables.	4.02 ± 0.93	4.10 ± 0.92	0.512
I will choose foods without added sugar for dessert, such as fruit, milk, and unsweetened yogurt.	3.97 ± 0.87	4.15 ± 0.81	0.174
I will eat fresh fruit for snacks instead of sweets, bread, rice cakes, or ice cream.	3.95 ± 0.88	3.92 ± 0.98	0.813
I will not use sugar, honey, corn syrup, or syrup at the table.	3.79 ± 0.96	4.05 ± 0.91	0.077
I will choose low- or no-sugar products.	3.94 ± 0.74	4.00 ± 0.75	0.590
I will read nutrition labels and choose foods that are low in sugar.	3.98 ± 0.56	4.05 ± 0.76	0.484
I will use lower sugar recipes when I cook.	3.77 ± 0.78	3.95 ± 0.86	0.132

Mean ± SD.

P-value by paired t-test.

[1)]All items, excluding nutrition knowledge, was measured using a 5-point Likert scale from "strongly agree" (scored 1) to "strongly disagree" (scored 5).

[2)]Thirteen items were used to assess participants' nutrition knowledge about sugar intake. One point was given for each correct answer (total score: 0–13).

Table 3. Participants' program satisfaction

Item	Strat level participants (n = 112)	Next level participants (n = 112)	*P*-value
Satisfaction[1)]			
Overall satisfaction	3.86 ± 0.93	4.22 ± 0.74	0.001
Program content	3.83 ± 0.89	4.20 ± 0.77	0.001
Interest in program content	3.82 ± 0.91	4.21 ± 0.78	0.001
Provided materials	3.94 ± 0.84	4.25 ± 0.80	0.005
Program hours	3.84 ± 0.87	4.09 ± 0.82	0.027
Program frequency	3.79 ± 0.85	4.07 ± 0.81	0.011
Program operation method	3.86 ± 0.87	4.09 ± 0.80	0.037
Program operation environment	3.84 ± 0.88	4.11 ± 0.81	0.018
Enjoyment of program participation	3.69 ± 0.94	4.28 ± 0.84	< 0.001
Willingness to participate in future program[2)]	3.75 ± 1.00	4.18 ± 0.82	< 0.001
Efforts to have healthy diets after program participation[3)]	3.98 ± 0.84	4.35 ± 0.74	< 0.001

Mean ± SD.
P-value by paired t-test.
[1)]Measured using a 5-point Likert scale from "very dissatisfied" (scored 1) to "very satisfied" (scored 5).
[2)]Measured using a 5-point Likert scale from "very unlikely" (scored 1) to "very likely" (scored 5).
[3)]Measured using a 5-point Likert scale from "not at all" (scored 1) to "very high" (scored 5).

식의 적용 가능성을 살펴보고자 하였다.

이 연구에서 개발한 리빙랩 프로그램은 전문가 주도의 중재가 아닌, 대상자의 생활 환경 내에서 구성원의 주도로 식생활 개선 활동이 이루어진다. 전문가 주도의 중재는 인력의 제한으로 동시에 여러 환경에서, 많은 대상자에게 중재를 수행하는 데 한계가 있다. 본 연구에서 수행한 프로그램은 다양한 대상자의 생활 환경에서 중재가 이루어지므로 단기간에 1,200명 이상의 다양한 생애주기의 사람들이 프로그램에 참여할 수 있었다. 많은 지역사회 기반 식생활 중재 연구는 특정 생애주기의 대상만을 포함하거나 교육 수행 및 대상자 맞춤형 중재 제공의 어려움으로 중재 대상의 수가 제한적이다[21]. 기관의 특성에 맞게 중재를 수행할 수 있는 리빙랩 접근방식은 다양한 지역사회 구성원을 식생활 중재의 대상으로 포함할 수 있는 장점이 있다. 그러나 리빙랩 접근법이 대상자의 지속적인 프로그램 참여를 보장하지 않는다. 본 연구에서도 리빙랩 온라인 플랫폼 이용 후 다음 단계(넥스트레벨)까지 지속적으로 참여한 대상자는 전체 참여자의 1/3 미만이었다. 특히 사후 조사까지 완료한 참여자는 초기 참여자의 5% (n = 62)에 불과하여 리빙랩 프로그램의 효과를 면밀히 평가하는 것이 불가능했다. 리빙랩 접근 방식을 이용한 프로그램 참여자의 중도 탈락에 영향을 미치는 요인은 긴 참여기간, 적용하는 기술의 복잡성, 프로그램 효과 부족, 참여자의 시간적, 물리적 제약, 시간 경과에 따른 참여 동기 감소 등인 것으로 알려져 있다[22, 23]. 본 연구에서 적용한 리빙랩 프로그램은 스타트레벨과 넥스트레벨의 두 단계로 이루어져, 참여자가 프로그램의 중요성이나 효과를 인식하지 못할 경우 다음 단계에 참여하지 않을 가능성이 높았다. 실제로 넥스트레벨까지 참여한 대상자는 스타트레벨 참여자보다 단맛 선호도가 낮았다. 식생활 개선 프로그램은 단기간에 효과를 나타내기 어려우므로, 단맛을 선호하는 사람들이 지속적으로 프로그램에 참여하도록 추가적인 지지가 필요할 것이다. 따라서 효과적인 식생활 개선 리빙랩 프로그램의 운영을 위해 리빙랩 참여 조직의 리더십과 지원이 필수적이다[24]. 특히 리빙랩 참여 조직의 리더들은 프로그램의 목표와 중요성을 이해하고, 구성원들에게 이를 효과적으로 전달하며, 지속적인 참여를 독려할 수 있는 환경을 조성해야 한다. 향후 운영하는 리빙랩 기반 식생활 프로그램은 참여 조직 리더 대상 교육 프로그램과 동기 부여 전략을 포함하여, 대상자의 지속적인 참여를 유도하는 방안을 마련하는 것이 필요할 것이다. 이는 리빙랩 기반 식생활 프로그램의 장기적인 효과에도 긍정적인 영향을 미칠 수 있을 것이다.

비록 소수의 참여자만이 사전·사후조사에 모두 응답하였으나, 이들을 대상으로 평가한 결과 리빙랩 기반 저당 식생활 실천 프로그램은 당류 섭취 감소 및 저당 식생활 실천에 긍정적인 효과가 있는 것으로 나타났다. 넥스트레벨에 참여한 대상자들은 참여 전과 비교하여, 참여 후 음식에 포함된 당류와 당류 저감 조리 방법에 관심을 가질 의향과 당류를 많이 사용한 음식의 섭취 감소 의도가 증가했다. 특히 주스나 탄산음료 대신 물을 마시려는 행동 의도와 함께 실제 실천 행동도 증가하여, 본 연구에서 개발한 프로그램이 저당 음료 선택을 증가시키는 효과가 있는 것으로 나타났다. 영양 정보 제공과 함께 실생활에서 실천할 수 있는 활동을 포함하는 식생활 프로그램이 교육 또는 정보만 제공하는 프로그램보다 식생활 개선에 효과적인 것으로 알려져 있다[25, 26]. 본 연구 역시 대상자들이 넥스트레벨에 참여하면서 실제 식

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생활 변화를 만들기 위한 미션을 수행하고, 이에 대한 피드백을 받는 과정에서 참여자들의 당류 섭취 감소 의도와 실제 행동이 강화된 것으로 보인다. 또한 넥스트레벨 참여자들은 당류 섭취 뿐만 아니라 전반적인 식생활에 대한 자기효능감이 증가하였다. 선행연구는 대상자들의 식생활에 대한 지속적인 피드백은 행동 변화 동기를 증진시키고, 이를 통해 건강 식생활 실천의 자기효능감이 증가한다고 보고하였다[27, 28]. 넥스트레벨에서 수행한 미션에 대한 피드백이 참여자의 전반적인 식생활 개선에 도움이 되었을 것이다. 향후 수행할 건강 식생활 프로그램은 참여자가 겪을 수 있는 다양한 식생활 문제에 대한 지속적인 모니터링과 피드백을 포함하는 것이 필요할 것이다.

그러나 본 연구의 프로그램 평가 결과 참여 전·후 유의한 변화가 없는 당류 섭취 관련 행동이나 인식, 자기효능감 문항이 많았다. 효과평가를 위한 사전, 사후 조사는 넥스트레벨 참여 전·후에 측정했다. 사전조사는 이미 스타트레벨을 참여한 후에 측정했으므로, 본 연구에서 보고한 결과는 스타트레벨 참여로 당류 섭취 관련 행동, 인식 등이 변화한 후에 나타난 넥스트레벨의 효과이다. 스타트레벨 이전의 당류 섭취 관련 상태와 비교한다면 넥스트레벨까지 참여했을 때의 효과가 더 클 것으로 예상하지만 해당 연구 설계로 평가하지 못했다. 향후 수행하는 리빙랩 프로그램은 프로그램 참여 전 대상자의 상태를 측정하여 프로그램의 전체적인 효과를 측정하는 것이 필요하다.

리빙랩 프로그램 참여자의 만족도는 스타트레벨만 참여했을 때보다 넥스트레벨에 참여했을 때 유의하게 증가했다. 실천 미션과 피드백을 포함한 넥스트레벨의 추가적인 활동과 함께 온라인 플랫폼 이용 역량이 프로그램 만족도와 관련 있는 것으로 생각된다. 스타트레벨과 넥스트레벨 참여 과정 모두 리빙랩 온라인 플랫폼 이용을 포함한다. 본 연구에서 개발한 리빙랩 온라인 플랫폼은 대상자의 특성과 선호도를 반영하기 위해 다양한 형태로 개발되었으나, 일부 대상자들은 온라인 플랫폼의 사용에 익숙하지 않을 수 있다. 연구 결과에 보고하지 않았으나 프로그램 참여자를 대상으로 온라인 플랫폼 사용 경험에 대해 조사한 결과 고연령층이 저연령층에 비해 전반적인 만족도가 상대적으로 낮았다. 그러나 넥스트레벨까지 지속적으로 프로그램에 참여하는 경우, 온라인 플랫폼 이용 경험 만족도가 유의하게 증가했다. 이는 지속적인 참여를 통해 온라인 플랫폼 이용에 능숙해지면서 자기효능감이 증가했기 때문인 것으로 보인다. 많은 리빙랩이 정보통신기술을 활용하여 생활의 변화를 도모하고 있으나, 사용자의 디지털 역량을 고려하지 않은 기술의 적용은 오히려 프로그램 지속적인 참여와 만족도에 부정적인 영향을 미칠 수 있다[22, 23]. 기술을 적용한 리빙랩 프로그램을 운영할 때는 프로그램의 목적을 달성하기 위한 구성요소(예: 당류 섭취 저감을 위한 영양교육, 조리교육 등)와 함께 리빙랩에 적용되는 기술을 활용하는 역량을 증진시킬 수 있는 요소(예: 디지털 리터러시 교육 등)가 포함되어야 할 것이다.

본 연구에서 개발한 리빙랩 프로그램은 지역사회 주도 식생활 중재에 리빙랩 접근법을 적용할 수 있음을 보였다. 본 연구는 리빙랩 프로그램을 다양한 기관에서 수행할 수 있도록 기관별 특성을 반영한 지침을 개발하고, 교육과 정보 제공 등의 프로그램의 실질적인 운영을 확장교육자가 담당하도록 했다. 이를 통해 소속 기관과 구성원의 특성에 대해 이해도가 높은 확장교육자가 기관의 특성에 맞는 프로그램을 개발하고, 프로그램 수행 중 발생하는 문제에 대해 참여자들이 더 나은 의사결정을 할 수 있도록 지원했다. 전문가 주도의 중재는 프로그램 종료 후 전문가가 떠났을 때 프로그램의 효과가 지속되지 않을 수 있다. 지역사회 기관에 소속된 확장교육자는 지속적으로 식생활 중재 활동을 수행하고, 기관과 구성원의 행동 변화 양상에 맞추어 프로그램을 개선 및 발전시킬 수 있으므로 프로그램의 지속가능성을 보장할 수 있다. 또한 확장교육자는 지역사회와 밀접하게 협력하여 구성원의 식생활 변화와 개선을 도출하는 역할과 프로그램에서 수집된 자료를 분석함으로써 추후 프로그램의 발전과 개선을 이끌어내는 역할을 할 수 있다. 확장교육자의 역할을 확대하고 식생활 중재의 장기적인 효과성을 높이기 위해 기관별 특성을 고려한 확장교육자를 위한 교육과 훈련이 개발되고 주기적으로 수행되어야 할 것이다.

Limitations

본 연구의 제한점은 다음과 같다. 첫째, 리빙랩 접근 방식을 활용하여 다양한 기관에서 프로그램을 운영하였으므로, 기관마다 서로 다른 방식으로 프로그램을 운영했다. 프로그램의 운영 횟수, 운영 시간, 이용 플랫폼 등의 차이가 프로그램의 효과에 영향을 미칠 수 있으나 본 연구는 운영 방식의 차이를 프로그램 효과성 평가에 반영하지 않았다. 둘째, 본 연구에서 활용한 조사도구는 선행연구에서 개발한 문항을 활용했으나, 본 연구의 다양한 생애주기 대상자 모두에게 타당도가 검증되지 않았다. 셋째, 통계적 검정력을 확보하기 위한 대상자의 수를 사전에 설정하지 않고 대상자를 모집했다. 본 연구는 다양한 지역사회 기관에 리빙랩 프로그램을 적용하는 것을 목적으로 했으므로, 사전에 참여자의 수를 정하지 않고 여러 기관의 이용자가 참여하도록 하였다. 넷째, 프로그램의 사후조사까지 완료한 대상자가 적어 대상자 특성별로 프로그램의 효과를 비교할 수 없었다. 대조군이 없는 것 또한 프로그램 효과성 평가의 제약 요인이다. 향후 효과평가를 위해 사전에 적정 참여자의 수를 설정하고, 대조군을 설정하고, 충분한 참여자가 프로그램의 모든 구성 요소를 완수할 수 있도록 설계한 프로그램을 운영하여, 리빙랩 기반의 식생활 프로그램의 효용성에 대한 정밀한 평가가 필요할 것이다.

Conclusion

리빙랩을 적용한 식생활 프로그램은 지역사회 구성원의 다양한 요구도를 반영하고, 구성원의 특성에 따라 각기 다른 식환경 및

식생활 문제에 대응할 수 있는 잠재력이 있다. 본 연구는 지역사회의 다양한 기관에서 확장교육자를 활용하여 운영한 리빙랩 프로그램이 당류 섭취 감소에 긍정적인 영향을 미칠 수 있음을 보였다. 본 연구에서 수행한 리빙랩 프로그램 사례는 향후 식생활 개선 관련 리빙랩의 개발 및 활용을 위한 기초자료로 사용할 수 있을 것이다. 본 연구에서 개발한 리빙랩 기반 저당 식생활 실천 프로그램이 지역사회에 확산하고 정착하기 위해 각 지역사회 기관에서 적용할 수 있는 보다 체계적이고 효과적인 전략이 개발되어야 할 것이다. 이를 위해 다양한 리빙랩 후속 연구가 요구되며, 장기적으로는 리빙랩 접근법을 활용한 지속가능한 식생활 중재 전략 마련이 필요하다.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

Data are available from the corresponding author on reasonable request and with permission of the funding agency.

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Research Article

텍스트마이닝을 이용한 학교 급식 메뉴의 동시출현 네트워크 패턴 분석: 2021–2023년 나이스 급식정보 개방 포털 급식식단 데이터를 활용한 탐색적 연구

강혜연[1], 김지미[2,†]

[1]경희대학교 조리외식경영학 박사
[2]국립창원대학교 식품영양학과 조교수

Co-occurrence network and pattern of school lunch using big data and text-mining using data from the 2021–2023 school meal menu information on the NEIS open educational information portal: an exploratory study

Hyeyun Kang[1], Jimi Kim[2,†]

[1]Ph.D, Culinary Science & Foodservice Management, Kyung Hee University, Seoul, Korea
[2]Assistant Professor, Department of Food and Nutrition, Changwon National University, Changwon, Korea

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†Corresponding author:
Jimi Kim
Department of Food and Nutrition, Changwon National University, 20 Changwondaehak-ro, Uichang-gu, Changwon 51140, Korea
Tel: +82-55-213-3514
Fax: +82-55-281-7480
E-mail: jmkim206@cwnu.ac.kr

Objectives: This study aimed to use big data from elementary, middle, and high school lunches to determine the primary food groups and menu items that contribute to lunch meals through text-mining and investigate the variations in food groups and menu composition patterns across different grade levels.

Methods: Between 2021 and 2023, a total of 7,892,456 lunch menus from 17 cities and provinces in South Korea were analyzed using big data from the National Education Information System (NEIS) system. After undergoing text preprocessing for text-mining, the collected menus were classified into 34 food groups based on primary ingredients and cooking methods, excluding the types of rice and kimchi. Subsequently, analyses of term frequency, term frequency-inverse document frequency (TF-IDF), centrality, and co-occurrence networks were performed on the food group and menu data.

Results: According to the TF-IDF, the most frequent food group across all grade levels was soup and seasoned vegetables, whereas milk was the most frequently provided menu. As the grade level increased, the frequency of grilled and fried food increased. In elementary schools, fruits exhibited the highest centrality, whereas soup had the highest centrality in middle and high schools. Co-occurrence frequency revealed that the soup-fruit combination was the most common in elementary schools, whereas soup and seasoned vegetables were most frequently paired in middle and high schools. The co-occurrence network of food groups and menus further indicated that menus regularly provided as standard meals and those frequently offered as special meals formed distinct communities.

Conclusion: This study investigated the food groups and menu provision patterns in school meals through text-mining techniques applied to large-scale school lunch. The findings may contribute in enhancing the quality of nutritional management, school foodservice, and menu composition of school meal programs.

Keywords: school foodservice; school lunch; big data; data mining; co-occurrence network

INTRODUCTION

학교 급식은 학생들의 건강과 발달에 큰 영향을 미치는 주요 영양 공급원으로 성장기 아동과 청소년의 식습관 형성에 중요한 역할을 한다[1]. 청소년기에 형성된 식습관은 성인기까지 영향을 미치므로 학교 급식을 통해 균형 잡힌 영향을 제공하는 것은 장기적인 건강 증진에 필수적이다. 교육부의 2023학년도 학교 급식 실시 현황 자료에 따르면 우리나라 전국의 초등학교, 중학교, 고등학교, 특수학교를 포함한 12,038개교에서는 전면 급식을 제공하고 있으며 매년 평균 526만 명의 학생들이 이용하고 있다[2]. 국내 학교 급식은 지역과 학교급에 따라 다양한 음식군과 메뉴를 제공하고 전통적인 식단 요소와 현대적인 식사 선호도를 반영하는 것이 특징이다[3]. 학교 급식의 구성은 시대의 흐름에 맞춰 제공되는 식품과 조리법이 다양해짐에 따라 메뉴의 종류가 늘어나고 동시에 식단의 다양성을 나타내고 있다[4]. 이에 학교급에 따른 급식의 구성 음식군과 메뉴를 다각적인 측면에서 분석하는 것은 학교 급식의 질을 향상 시키고 학생들의 건강한 식습관을 장려하는데 기초 자료로 활용될 수 있다.

빅데이터를 활용한 연구는 의학, 경영학, 소비자학 등 다양한 분야에서 사용되고 있다. 규모가 방대하고 수치 데이터뿐만 아니라 텍스트를 포함한 비정형 대규모 자료를 기반으로 수행된다[5]. 텍스트마이닝(text-mining)은 자연어 처리 기술을 활용하여 텍스트 기반 데이터에서 기존에 규명되지 않은 패턴, 지식, 새로운 정보를 추출하는 방법이다[6]. 텍스트마이닝을 포함하여 다양한 분석 기법이 개발됨에 따라 빅데이터의 대용량 데이터 처리가 가능해졌고 텍스트를 양적 데이터로 변환하여 통계적 분석 기법을 적용해 유용한 결과를 탐색하는 다양한 연구가 수행되고 있다[7]. 그러나, 학교 급식과 관련된 분야에서 전국의 학교 급식 메뉴를 다년간에 걸쳐 수집하고 빅데이터를 활용하여 텍스트마이닝 기반의 주요 음식군과 메뉴 키워드를 중심으로 초등학교, 중학교, 고등학교 학교급에 따라 급식 구성의 특징과 패턴을 분석한 연구는 드문 실정이다. 최근 3년간의 학교 급식 데이터를 활용하여 전국 학교 점심 식단 중 다빈도 제공 메뉴의 빈도 수를 조사하고 변화 추이를 분석한 연구[8]가 발표되었으나 본 연구에서는 초등학교, 중학교, 고등학교 학교급에 따라 제공되는 메뉴와 식품군의 중심성을 바탕으로 동시출현 네트워크와 조합 패턴 분석을 수행함으로써 식단내 메뉴와 식품군 간의 관계 분석에 차별성을 목적으로 하였다.

학교 급식에서 제공되는 음식군과 메뉴 그리고 그들의 조합은 학생들의 성장 단계에 따른 영양 요구를 충족하기 위해 구성되어야 한다. 선행 연구에서는 주로 급식의 영양소 공급량 및 섭취량[9-13], 학교 급식 제공 메뉴의 특성[14], 기호도 및 만족도 등을 수행하였다[15-17]. 특히, 학교급에 따라 중심적으로 제공되는 음식군과 메뉴를 바탕으로 이들 간의 조합이 어떤 패턴을 형성하는지에 대한 심층적인 분석이 상대적으로 부족하다. 학교급에 따른 급식 내 주요 음식군과 메뉴의 동시출현 관계와 중심성을 분석함으로써 학교 급식에서 중요한 역할을 하는 음식군과 메뉴 기반의 식단 구성 패턴을 이해할 수 있다. 이를 통해 학교 급식이 학생들의 균형 잡힌 영양 공급과 건강한 식습관 형성에 기여할 수 있을 것으로 사료된다.

본 연구는 전국 17개 시도 초등학교, 중학교, 고등학교의 학교 급식 식단 관련 빅데이터 기반의 텍스트마이닝을 활용하여 제공되는 음식군 및 메뉴 항목의 빈도, 중심성, 동시출현 관계를 분석함으로써 학교급에 따른 급식 구성의 특징과 패턴을 파악하고자 한다. 이를 통해 학교급에 따라 차별화된 급식 제공 방식이 학생들의 영양 요구에 어떻게 부합되는지 탐색하고자 한다. 연구 목적은 크게 세가지로 구분할 수 있다. 첫째, 초등학교, 중학교, 고등학교 급식에서 제공되는 주요 음식군과 개별 메뉴 항목의 빈도를 분석하여 학교급에 따른 구성 차이를 파악한다. 둘째, 음식군 및 메뉴의 네트워크 분석을 통해 학교급에 따라 급식에서 중심적인 역할을 하는 음식군과 메뉴를 도출하고 급식 구성의 핵심 요소를 식별한다. 셋째, 주요 음식군과 메뉴 간의 동시출현 패턴을 분석하여 학교급에 따른 급식에서 중요한 음식군 및 메뉴 간의 조합을 탐색하고 이러한 조합이 학생들의 영양 요구에 부합하는지 평가한다.

METHODS

Ethics statement

This study utilized fully anonymized, publicly available datasets. The data used in this research do not contain any personally identifiable information and were anonymized and made publicly accessible by the data provider. As this study uses anonymized, publicly available data, it does not require approval from an Institutional Review Board. The use of the data adhered to the ethical guidelines and terms of use provided by the data provider. Before conducting the study, the terms of use were thoroughly reviewed and strictly followed.

1. 연구설계

본 연구는 탐색적 조사연구로 학교 급식 데이터의 동시출현 네트워크와 패턴을 분석하기 위해 교육행정정보시스템 나이스(National Education Information System, NEIS) 교육정보 공개 포털 제공 자료로부터 기초 자료를 수집하고 분석하였다.

2. 자료수집 및 과정

본 연구에서는 초등학교, 중학교, 고등학교 학령에 따른 급식 중 점심 식사를 중심으로 다빈도 음식군과 메뉴를 추출하여 학교급에 따른 특징적인 식단 구성 패턴을 비교하고자 하였다. 연구에 사용된 데이터는 17개 시도 교육청 및 교육부가 제공하는

NEIS 교육정보 개방 포털(open.neis.go.kr)의 급식 식단 데이터를 활용하였다. 2021년 1월 1일부터 2023년 12월 31일까지 배식된 전국 17개 시도의 점심 급식 식단 총 7,892,459건의 데이터를 수집하였다.

텍스트마이닝 기법을 활용하여 급식 식단의 메뉴명 키워드를 중심으로 빅데이터 분석을 실시하였다. 수집된 비정형 텍스트 데이터는 Python 3.12 프로그램(Python Software Foundation)을 사용하여 전처리 과정을 수행하였고 본 연구 주제와 관련성이 없는 불용어(완제품, 자율 등), 유치원 및 특수학교 데이터(665,569건), 중복 데이터(5,006건)를 제거하였다. 학교 급식 식단의 기본 구성은 일반반상, 일품반상, 면상으로 분류한다. 반상에 포함되는 일반반상과 일품반상의 식단은 밥, 국, 반찬으로 구성된 3첩 반상을 기본으로 한다. 반찬은 주찬(고기·생선·달걀·콩류), 부찬(채소류), 김치 각각 1가지를 기본 구성으로 한다. 과일 및 후식류와 우유 및 유제품류는 선택적으로 추가 제공된다. 학교 급식에서 밥류와 김치류는 일품반상 및 면상이 제공되는 경우를 제외하고 대부분의 식단에 포함되는 보편적인 메뉴이다. 이러한 이유로 예비 선행 연구 수행 결과, 밥류와 김치류는 다른 음식군 및 메뉴와의 동시출현 빈도가 높아 본 연구의 주된 목적 중 하나인 음식군과 메뉴 간의 연결 구조 분석을 어렵게 하는 요인으로 작용하였다. 따라서 본 연구에서는 밥류와 김치류를 분석 대상에서 제외하였다. 반면, NEIS 교육정보 개방 포털의 급식 식단 데이터에서 제공되는 메뉴 중 우유는 Lee 등[8]의 연구에서 언급된 바와 같이 우유급식으로 제공된 것인지 점심 급식의 후식(초코 우유, 딸기 우유, 바나나 우유 등)으로 제공된 것인지 명확히 구분하기 어려워 분석에 포함하였다. 현재의 데이터에서 구분이 어려울 뿐만 아니라 우유 급식 또한 학생들의 영양 섭취 및 건강 증진과 관련하여 학교 급식과 동일한 목적을 지향하고 있으므로 본 분석에서는 우유를 포함하였다. 분석에서 사용되는 용어의 통일을 위해 메뉴명의 불필요한 용어를 제거함으로써 정규화(삼색수제비국 → 수제비국, 꼬치어묵국 → 어묵국 등) 과정을 수행하였다. 요리의 주재료 및 조리법에 따른 음식군 그룹화는 질병관리청 제9기 1차년도(2022) 영양조사 코드자료집 KDCA (Korea Disease Control and Prevention Agency, 2024)[18]의 음식 그룹을 기반으로 하고 조리법과 재료의 종류에 따라 세분화하여 분류하였다[8]. 결과적으로 총 34개의 그룹(곡류, 서류, 떡류, 면류, 만두류, 국류, 탕류, 찌개류, 전골류, 구이류, 볶음류, 전류, 적류, 부침류, 찜류, 조림류, 튀김류, 생채류, 숙채류, 샐러드류, 무침류, 장아찌류, 절임류, 장류, 양념류, 과일류, 우유류, 발효음료류, 빙과류, 다류, 과채음료류, 빵류, 과자류, 죽·스프류)으로 구분하였다.

3. 텍스트마이닝 분석

전국 17개 시도의 초등학교, 중학교, 고등학교 점심 급식 식단 빅데이터의 비정형 데이터에서 의미 있는 키워드를 발견하기 위해 수집된 텍스트에서 특정 단어의 빈도수(term frequency, TF)와 데이터 내의 특정 단어 빈도수의 가중치를 고려하고 키워드의 중요성을 나타내는 term frequency-inverse document frequency (TF-IDF) 분석을 수행하였다. 선행연구의 분석법을 참고하여 본 연구에서는 주요 상위 키워드 20개를 추출하였다[19, 20]. 이는 후속 연구로 계획된 동시출현빈도 조사를 위한 절차의 일환으로 단순히 키워드 빈도를 기반으로 한 추출법과 달리 메뉴와 식품군 간의 동시출현 관계를 고려한 방식을 반영하였다.

텍스트 네트워크 분석을 위해 빈도(frequency)와 위세 중심성(eigenvector centrality) 방법을 사용하였다. 빈도가 높은 단어일수록 급식 식단에서 동시에 등장한 주요 메뉴라는 의미이고 네트워크에서 빈도는 노드가 동시에 출현하는 횟수를 나타낸다. 위세 중심성은 네트워크의 중심에서 노드가 위치하는 정도를 의미하고 해당 메뉴의 중요도 및 노드와 연결된 이웃 노드들의 중심성을 고려하면서 연결의 질적인 영향력을 반영한다[21]. 네트워크 분석에서 형성된 커뮤니티 구조의 식별을 위해 모듈성(modularity)을 평가 지표로 사용하였다[22]. 동시출현빈도 분석은 전체 텍스트 내 특정 범위에서 노드들이 함께 출현하는 주요 단어들의 연관성을 분석하는 방법으로 본 연구에서는 점심 급식 식단에서 동시에 출현하는 주요 음식들의 연관성을 측정하였다. 네트워크 시각화 분석을 위해 Networks package 3.2.1을 사용하였다. 본 연구에서는 학교급식 내 주요 음식군 및 메뉴 간의 연관성을 분석하고 각 음식군 및 메뉴의 동시출현 가능성에 대한 정보를 바탕으로 학교급에 따른 급식 식단 메뉴 구성의 특징과 식단 패턴을 분석하였다.

RESULTS

1. 음식군 빈도 및 TF-IDF 분석

학교 급식 점심 식단 텍스트 데이터에서 학교급에 따라 초등학교 336,277개, 중학교 260,455개, 고등학교 307,308개의 메뉴가 추출되었다. 추출된 메뉴들은 34개의 음식군으로 분류하였으며 학교급에 따른 음식군의 상위 키워드 빈도 및 TF-IDF 빈도 분석 결과는 Table 1과 같다. TF-IDF 분석을 통해 추출된 상위 20개의 음식군 키워드를 살펴보면 모든 학교급에서 국류가 가장 높은 순위를 나타냈다. 이어서 초등학교는 과일류, 무침류, 우유류, 구이류 순으로 나타났고 중학교는 무침류, 과일류, 구이류, 볶음류 순, 고등학교는 무침류, 구이류, 볶음류, 과일류 순으로 도출되었다. 이 순서는 학교급에 따른 음식군의 단순 빈도 분석 결과에서도 동일하게 나타났으며 가중치를 고려했을 때에도 학교 급식 메뉴 구성에 있어 자주 활용됨을 확인 할 수 있었다. 우유류의 TF-IDF는 초등학교에서 0.392로 네번째로 높게 나타났으나 중학교에서는 0.124로 14위, 고등학교에서는 0.129로 13위 순위를 나타냈다. 반면, 튀김류와 면류의 TF-IDF는 초등학교에서 0.182 (7위)와 0.127 (12위)로 나타났으나 중학

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Table 1. Frequency of food groups on school lunch by subset of school age

No.	Elementary school				Middle school				High school			
	Group	Frequency	%	TF-IDF	Group	Frequency	%	TF-IDF	Group	Frequency	%	TF-IDF
1	Soup	1,279,497	11.1	0.437	Soup	595,318	11.9	0.500	Soup	908,140	11.8	0.508
2	Fruit	1,256,606	10.9	0.430	Seasoned vegetable	517,970	10.3	0.435	Seasoned vegetable	735,925	9.5	0.412
3	Seasoned vegetable	1,148,475	10.0	0.393	Fruit	382,468	7.6	0.321	Grilled food	554,011	7.2	0.310
4	Milk and dairy products	1,146,110	10.0	0.392	Grilled food	355,091	7.1	0.298	Stir-fried food	509,285	6.6	0.285
5	Grilled food	784,832	6.8	0.268	Stir-fried food	334,488	6.7	0.281	Fruit	501,085	6.5	0.280
6	Stir-fried food	775,783	6.7	0.265	Fried food	271,740	5.4	0.228	Fried food	410,993	5.3	0.230
7	Fried food	532,360	4.6	0.182	Noodles	199,865	4.0	0.168	Noodles	310,852	4.0	0.174
8	Tang	429,235	3.7	0.147	Steamed food	184,852	3.7	0.155	Steamed food	274,114	3.6	0.153
9	Steamed food	383,934	3.3	0.131	Tang	180,740	3.6	0.152	Fermented beverages	268,300	3.5	0.150
10	Stew	378,549	3.3	0.129	Stew	177,514	3.5	0.149	Fruit and vegetable beverages	263,469	3.4	0.147
11	Braised food	376,426	3.3	0.129	Fruit and vegetable beverages	160,102	3.2	0.134	Stew	263,358	3.4	0.147
12	Noodles	372,257	3.2	0.127	Fermented beverages	158,369	3.2	0.133	Sauce	257,826	3.3	0.144
13	Fermented beverages	277,293	2.4	0.095	Braised food	151,771	3.0	0.127	Milk and dairy products	231,230	3.0	0.129
14	Jang	243,498	2.1	0.083	Milk and dairy products	147,801	2.9	0.124	Braised food	230,715	3.0	0.129
15	Fruit and vegetable beverages	215,328	1.9	0.074	Sauce	134,371	2.7	0.113	Salad	223,294	2.9	0.125
16	Raw vegetable	206,423	1.8	0.071	Salad	119,857	2.4	0.101	Tang	223,277	2.9	0.125
17	Sauce	197,113	1.7	0.067	Jang	116,290	2.3	0.098	Pickles	177,715	2.3	0.099
18	Snack	186,911	1.6	0.064	Snack	112,496	2.2	0.094	Snack	174,582	2.3	0.098
19	Cooked vegetable	184,827	1.6	0.063	Pickles	95,697	1.9	0.080	Jang	153,197	2.0	0.086
20	Salad	175,332	1.5	0.060	Raw vegetable	93,961	1.9	0.079	Bakery	138,757	1.8	0.078

Only frequencies of top 20 are listed.
TF-IDF, term frequency-inverse document frequency.

교에서는 튀김류 0.228 (6위) 및 면류 0.168 (7위)을 확인할 수 있었고 동일한 순위로 고등학교에서도 튀김류 0.230 (6위) 및 면류 0.174 (7위)가 나타나며 초등학교와 비교했을 때 상대적으로 높은 순위를 보였다. 과채음료류의 TF-IDF는 초등학교에서 0.074 (15위), 중학교에서 0.134 (11위), 고등학교에서 0.147 (10위)로 높은 순위를 나타냈다.

2. 메뉴 빈도 및 TF-IDF 분석

학교급에 따른 급식 식단 데이터에서 메뉴명의 상위 빈도 및 TF-IDF 분석 결과는 Table 2와 같다. 모든 학교급에서 우유의 제공 빈도가 가장 높게 나타나 중요한 메뉴임을 알 수 있었다. 특히 초등학교는 우유의 TF-IDF가 0.858로 매우 높게 나타났다. 중학교 및 고등학교에서 우유의 제공 빈도수는 각각 108,694건과 154,095건으로 가장 빈도가 높은 메뉴지만 TF-IDF 값은 각각 0.350 및 0.324로 초등학교에 비해 급식에서 활용 중요도가 낮았다. 학교급에 따라 높은 TF-IDF를 나타내는 상위 5개의 메뉴를 살펴보면 초등학교에서는 우유, 사과, 요구르트, 파인애플, 오이무침 순이었고, 중학교에서는 우유, 요구르트, 사과, 오이무침, 쌈장으로 나타났다. 고등학교에서는 우유, 요구르트, 사과, 요거트, 케첩으로 나타났다. 초등학교 및 중학교의 학교급식 메뉴와 달리 고등학교에서 상위에 추출된 메뉴 중 케첩과 달걀프라이가 각각 0.153과 0.097로 상위 TF-IDF를 나타냈다(Supplementary Table 2). 반면 멜론, 수박, 키위, 딸기와 같은 과일 메뉴는 초등학교에서만 상위 20개 메뉴에 포함되었다.

3. 음식군과 메뉴의 연결 중심성 분석

동시출현 네트워크 분석에 앞서 학교급에 따라 추출된 음식군

Table 2. Frequency of menu on school lunch by subset of school age

No.	Elementary school			Middle school			High school		
	Menu	Frequency	TF-IDF	Menu	Frequency	TF-IDF	Menu	Frequency	TF-IDF
1	Milk	1,113,450	0.858	Milk	108,694	0.350	Milk	154,095	0.324
2	Apple	187,647	0.145	Liquid yogurt	79,981	0.257	Liquid yogurt	120,374	0.253
3	Liquid yogurt	160,359	0.124	Apple	52,226	0.168	Apple	79,639	0.168
4	Pineapple	128,212	0.099	Cucumber salad	50,645	0.163	Yogurt	75,105	0.158
5	Cucumber salad	107,464	0.083	Ssam-jang	48,722	0.157	Ketchup	72,714	0.153
6	Beef and seaweed soup	106,029	0.082	Pineapple	44,342	0.143	Cucumber salad	71,523	0.150
7	Cherry tomato	101,184	0.078	Tteokbokki	44,253	0.142	Grilled laver	71,273	0.150
8	Ssam-jang	97,538	0.075	Beef and seaweed soup	41,630	0.134	Pickled radish	68,649	0.144
9	Melon	94,833	0.073	Yogurt	39,786	0.128	Ssam-jang	64,547	0.136
10	Banana	94,158	0.073	Seasoned bean sprout	38,322	0.123	Seasoned bean sprout	61,799	0.130
11	Tteokbokki	93,382	0.072	Sausage stew	37,437	0.120	Fishcake soup	60,297	0.127
12	Watermelon	87,822	0.068	Fishcake soup	36,721	0.118	Stir-fried rice cake	59,078	0.124
13	Seasoned bean sprout	87,563	0.067	Grilled laver	35,403	0.114	Beef and seaweed soup	55,377	0.116
14	Seasoned spinach	83,559	0.064	Pickled radish	33,432	0.108	Beverage	54,650	0.115
15	Seasoned mung bean sprout	80,611	0.062	Green onion egg soup	31,975	0.103	Pineapple	54,198	0.114
16	Fishcake soup	78,591	0.061	Seasoned spinach	30,890	0.099	Green onion egg soup	54,182	0.114
17	Grilled laver	77,699	0.060	Pork back-bone stew	30,858	0.099	Sausage stew	51,475	0.108
18	Yukgaejang	77,549	0.060	Yukgaejang	30,729	0.099	Banana	50,903	0.107
19	Stir-fried dried anchovies	76,318	0.059	Braised chicken	30,655	0.099	Seasoned mung bean sprout	46,930	0.099
20	Kiwi	76,009	0.059	Seasoned mung bean sprout	30,566	0.098	Seasoned spinach	46,332	0.097

Only frequencies of top 20 are listed.
TF-IDF, term frequency-inverse document frequency.

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의 상위 키워드 간 연결 중심성 분석 결과는 Table 3과 같다. 초등학교에서 음식군의 연결 중심성 결과는 Table 1의 TF-IDF 결과와 다르게 도출되었다. 과일류의 중심성은 0.420으로 국류 0.415보다 높게 나타났고 우유류는 0.407로 무침류 0.382보다 높았다. 이어서 구이류 0.276의 순서로 초등학교 음식군의 중심성이 나타났다. 반면 중학교에서는 음식군 상위 5개의 중심성 결과가 국류(0.451), 무침류(0.416), 과일류(0.337), 구이류(0.306), 볶음류(0.288) 순서로 앞선 TF-IDF의 순위와 동일했다. 고등학교에서는 국류(0.456), 무침류(0.394), 구이류(0.312)가 높은 중심성을 보였고 이어서 TF-IDF 순서와 다르게 과일류(0.294)가 볶음류(0.290) 보다 높았다. 면류는 중학교와 고등학교에서 TF-IDF 순위가 각각 7위와 8위였으나 키워드 간 연결 중심성에서는 중학교 8위(0.155), 고등학교 10위(0.161)로 다소 낮게 나타났다. 학교급에 따라 추출된 상위 메뉴 키워드 간의 연결 중심성 결과는 Table 4와 같다. 메뉴 상위 5개의 연결 중심성 결과는 모든 학교급에서 TF-IDF의 순위와 다르게 나타났다. 상위 5개의 메뉴를 살펴보면 초등학교에서는 우유(0.638), 사과(0.240), 파인애플(0.183), 요구르트(0.172), 쌈장(0.156)의 순서였고, 중학교에서는 우유(0.402), 요구르트(0.263), 쌈장(0.260), 사과(0.207), 상추쌈(0.198)의 순서였으며, 고등학교에서는 우유(0.412), 사과(0.251), 요구르트(0.242), 김구이(0.237), 케첩(0.210)의 순으로 각각 높게 도출되었다. 특히 우유는 중학교(0.402)와 고등학교(0.412)에 비해 초등학교(0.638)에서 높은 연결 중심성을 나타냈다. Table 2의 TF-IDF 순서 결과와 다르게 초등학교와 중학교에서 쌈장이 상위로 추출되었고 고등학교에서는 김구이가 0.237로 높게 나타났다. Table 4에서는 TF-IDF 상위 20개의 키워드 메뉴에서 추출되지 않았던 숭늉(0.166)과 김치볶음(0.149)이 고등학교 메뉴에서 각각 9위와 13위로 높게 나타났다.

4. 음식군과 메뉴의 동시출현빈도 및 네트워크 분석

학교급에 따른 음식군 간의 상호 연결망을 알아보기 위해 군집화를 위한 동시출현빈도 분석을 실시하였고 결과는 Table 5와 같다. 동시출현빈도에서 초등학교는 국류-과일류가 가장 높은 빈도를 보였고 중학교와 고등학교는 무침류-국류의 빈도가 가장 높았다. 초등학교에서는 앞서 진행된 TF-IDF 및 연결 중심성 결과와 유사하게 우유류와 군집화를 이루는 음식군들이 높게 나타났다. 상위 5개의 동시출현빈도 결과를 살펴보면 초등학교는 국

Table 3. Centrality of food groups on school lunch by subset of school age

No.	Elementary school		Middle school		High school	
	Group	Centrality	Group	Centrality	Group	Centrality
1	Fruit	0.420	Soup	0.451	Soup	0.456
2	Soup	0.415	Seasoned vegetable	0.416	Seasoned vegetable	0.394
3	Milk and dairy products	0.407	Fruit	0.337	Grilled food	0.312
4	Seasoned vegetable	0.382	Grilled food	0.306	Fruit	0.294
5	Grilled food	0.276	Stir-fried food	0.288	Stir-fried food	0.290
6	Stir-fried food	0.266	Fried food	0.242	Fried food	0.246
7	Fried food	0.192	Steamed food	0.182	Steamed food	0.179
8	Steamed food	0.149	Noodles	0.155	Sauce	0.172
9	Tang	0.148	Tang	0.150	Fermented beverages	0.170
10	Braised food	0.143	Stew	0.147	Noodles	0.161
11	Stew	0.129	Fermented beverages	0.145	Fruit and vegetable beverages	0.157
12	Noodles	0.122	Milk and dairy products	0.144	Stew	0.143
13	Jang	0.100	Braised food	0.142	Braised food	0.142
14	Fermented beverages	0.091	Fruit and vegetable beverages	0.137	Milk and dairy products	0.142
15	Raw vegetable	0.079	Sauce	0.133	Salad	0.135
16	Sauce	0.078	Jang	0.120	Tang	0.121
17	Cooked vegetable	0.072	Snack	0.108	Snack	0.113
18	Fruit and vegetable beverages	0.069	Salad	0.103	Jang	0.106
19	Snack	0.067	Raw vegetable	0.092	Pickles	0.106
20	Salad	0.059	Pickles	0.086	Bakery	0.086

Only frequencies of top 20 are listed.

Table 4. Centrality of menu on school lunch by subset of school age

No.	Elementary school		Middle school		High school	
	Group	Centrality	Group	Centrality	Group	Centrality
1	Milk	0.638	Milk	0.402	Milk	0.412
2	Apple	0.240	Liquid yogurt	0.263	Apple	0.251
3	Pineapple	0.183	Ssam-jang	0.260	Liquid yogurt	0.242
4	Liquid yogurt	0.172	Apple	0.207	Grilled laver	0.237
5	Ssam-jang	0.156	Lettuce wraps	0.198	Ketchup	0.210
6	Cucumber salad	0.154	Cucumber salad	0.196	Yogurt	0.204
7	Banana	0.143	Tteokbokki	0.178	Banana	0.183
8	Beef and seaweed soup	0.143	Seasoned bean sprout	0.168	Ssam-jang	0.172
9	Cherry tomato	0.138	Pineapple	0.163	Scorched rice soup	0.166
10	Tteokbokki	0.131	Beef and seaweed soup	0.148	Cucumber salad	0.161
11	Melon	0.129	Fishcake soup	0.146	Seasoned bean sprout	0.153
12	Seasoned bean sprout	0.125	Grilled laver	0.145	Fruit and vegetable beverage	0.149
13	Watermelon	0.120	Yogurt	0.142	Stir-fried kimchi	0.149
14	Seasoned spinach	0.118	Pickled radish	0.133	Fried egg	0.145
15	Seasoned mung bean sprout	0.116	Sausage stew	0.130	Fishcake soup	0.142
16	Stir-fried dried anchovies	0.111	Cherry tomato	0.124	Pickled radish	0.141
17	Grilled laver	0.110	Braised chicken	0.123	Lettuce wraps	0.134
18	Kiwi	0.110	Auk-doenjangguk	0.123	Tteokbokki	0.131
19	Yukgaejang	0.109	Seasoned spinach	0.122	Pineapple	0.130
20	Lettuce wraps	0.107	Stir-fried dried anchovies	0.121	Beef and seaweed soup	0.118

Only frequencies of top 20 are listed.

류-과일류(448,605건), 과일류-우유류(445,365건), 국류-우유류(438,027건), 국류-무침류(415,396건), 무침류-과일류(394,341건) 순으로 높게 나타났다. 중학교는 무침류-국류(187,362건), 국류-과일류(132,327건), 국류-구이류(129,315건), 볶음류-국류(124,532건), 무침류-과일류(114,626건) 순으로 나타났다. 고등학교는 무침류-국류(271,969건), 구이류-국류(199,563건), 국류-볶음류(196,233건), 국류-과일류(168,121건), 무침류-구이류(150,171건) 순이었다. 음식군의 연결 중심성과 동시출현빈도를 고려하여 시각화한 네트워크는 Fig. 1과 같다. 네트워크 연결망 내 키워드의 크기는 연결 중심성 지수를 이용하여 값이 클수록 키워드의 노드 크기도 크게 나타나고 음식군 간의 동시출현빈도가 높을수록 음식군 키워드 간의 엣지 연결선이 짙게 나타난다. 동시출현 네트워크 분석 결과, 초등학교는 크게 3개의 군집화를 이루는데 1) 과일류-국류-우유류-무침류-구이류-볶음류 등, 2) 튀김류-면류-발효음료류-양념류-과자류-샐러드류 등, 3) 장류-생채류-숙채류의 패턴을 나타냈다. 중학교에서도 3개의 군집화를 보였고 1) 국류-무침류-과일류-구이류-볶음류 등, 2) 튀김류-면류-발효음료류-양념류-샐러드류 등, 3) 우유류-과채음료류-과자류 등의 패턴 형성을 나타냈다. 고등학교에서는 3개의 군집화 형성을 보였는데 1) 국류-무침류-구이류-과일류-볶음류 등, 2) 튀김류-양념류-면류-과채음료류-우유류, 3) 장류-생채류-숙채류의 패턴을 보였다. 학교급에 따른 군집화 구성을 살펴보면 급식 구성이 크게 일반식과 특별식(일품반상, 면상)의 패턴으로 형성됨을 알 수 있었다.

학교급에 따른 메뉴 키워드 간의 동시출현빈도 분석 결과는 Table 6과 같다. 초등학교에서는 이전 TF-IDF 및 연결 중심성 결과와 유사하게 사과-우유(61,451건)가 가장 높은 동시출현빈도를 나타냈다. 이어서 파인애플-우유(48,200건), 요구르트-우유(41,079건), 우유-바나나(38,419건), 우유-오이무침(35,900건) 순서로 상위 빈도를 나타냈다. 반면 쌈장-상추쌈 조합은 중학교(13,685건)와 고등학교(21,436건)에서 모두 높은 동시출현빈도를 보였다. 이어 중학교에서는 소고기미역국-잡채(5,401건), 사과-우유(4,976건), 떡볶이-어묵국(4,404건), 요구르트-우유(4,202건)가 높게 나타났다. 고등학교에서는 사과-우유(11,441건), 우유-바나나(11,435건), 우유-숭늉(10,394건), 우유-김구이(8,532건) 순서로 나타났다. 초등학교의 동시출현빈도 상위 20위 목록에서 상추쌈-쌈장(14위)을 제외하고 모두 우유와 함께 동시출현 조합이 높게 나타났다. 반면 중학교에서부터 상위 5개를 제외한 동시출현 메뉴 조합에서 우유와 함께 동시출현 조합이 되지 않은 경우가 나타나는데 단무지-요구르트

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Table 5. Co-occurrence frequency of food groups on school lunch by subset of school age

No.	Elementary school			Middle school			High school		
	Group 1	Group 2	Frequency	Group 1	Group 2	Frequency	Group 1	Group 2	Frequency
1	Soup	Fruit	448,605	Seasoned vegetable	Soup	187,362	Seasoned vegetable	Soup	271,969
2	Fruit	Milk and dairy products	445,365	Soup	Fruit	132,327	Grilled food	Soup	199,563
3	Soup	Milk and dairy products	438,027	Soup	Grilled food	129,315	Soup	Stir-fried food	196,233
4	Soup	Seasoned vegetable	415,396	Stir-fried food	Soup	124,532	Soup	Fruit	168,121
5	Seasoned vegetable	Fruit	394,341	Seasoned vegetable	Fruit	114,626	Seasoned vegetable	Grilled food	150,171
6	Seasoned vegetable	Milk and dairy products	368,855	Seasoned vegetable	Grilled food	105,835	Fried food	Soup	145,500
7	Soup	Grilled food	291,552	Soup	Fried food	92,022	Seasoned vegetable	Fruit	133,278
8	Soup	Stir-fried food	283,887	Soup	Steamed food	79,551	Soup	Steamed food	116,157
9	Fruit	Stir-fried food	264,892	Seasoned vegetable	Fried food	78,621	Seasoned vegetable	Stir-fried food	109,747
10	Grilled food	Fruit	263,411	Fruit	Grilled food	77,878	Seasoned vegetable	Fried food	109,738
11	Grilled food	Milk and dairy products	242,703	Seasoned vegetable	Stir-fried food	75,176	Soup	Fermented beverages	107,539
12	Seasoned vegetable	Grilled food	240,473	Stir-fried food	Fruit	73,638	Grilled food	Fruit	102,065
13	Stir-fried food	Milk and dairy products	233,425	Seasoned vegetable	Tang	68,340	Soup	Fruit and vegetable beverages	98,699
14	Soup	Fried food	192,776	Seasoned vegetable	Steamed food	64,363	Grilled food	Stir-fried food	97,096
15	Fried food	Fruit	182,157	Seasoned vegetable	Stew	64,162	Seasoned vegetable	Stew	91,207
16	Seasoned vegetable	Stir-fried food	171,320	Stir-fried food	Grilled food	62,342	Seasoned vegetable	Steamed food	90,475
17	Fried food	Milk and dairy products	167,769	Soup	Fermented beverages	61,692	Fruit	Stir-fried food	90,277
18	Fruit	Tang	166,684	Fruit	Fried food	59,691	Soup	Sauce	88,252
19	Fried food	Seasoned vegetable	165,025	Soup	Fruit and vegetable beverages	59,447	Fried food	Sauce	85,394
20	Soup	Steamed food	163,976	Soup	Milk and dairy products	54,019	Soup	Braised food	83,927

Only frequencies of top 20 are listed.

(3,775건), 쌈장-된장찌개(3,009건), 요구르트-달걀파국(2,992건), 떡볶이-단무지(2,881건), 오이무침-요구르트(2,788건), 단무지-달걀파국(2,684건)이 포함되었다. 이와 유사하게 고등학교에서도 요구르트-단무지(6,819건), 떡볶이-어묵국(6,713건), 단무지-달걀파국(5,318건), 쌈장-된장찌개(4,694건), 요구르트-달걀파국(4,655건), 사과-김구이(4,051건), 오이무침-요구르트(4,021건)가 포함되었다. 메뉴의 연결 중심성과 동시출현빈도를 고려하여 시각화한 네트워크는 Fig. 2와 같다. 초등학교에서는 총 3개의 메뉴 군집이 형성되었는데 1) 우유-오이무침-바나나-수박-시금치무침 등, 2) 사과-파인애플-떡볶이-멜론-콩나물무침 등, 3) 요구르트-쌈장-소고기미역국-방울토마토-숙주무침-멸치볶음 등의 패턴을 보였다. 중학교에서는 1) 우유-사과-오

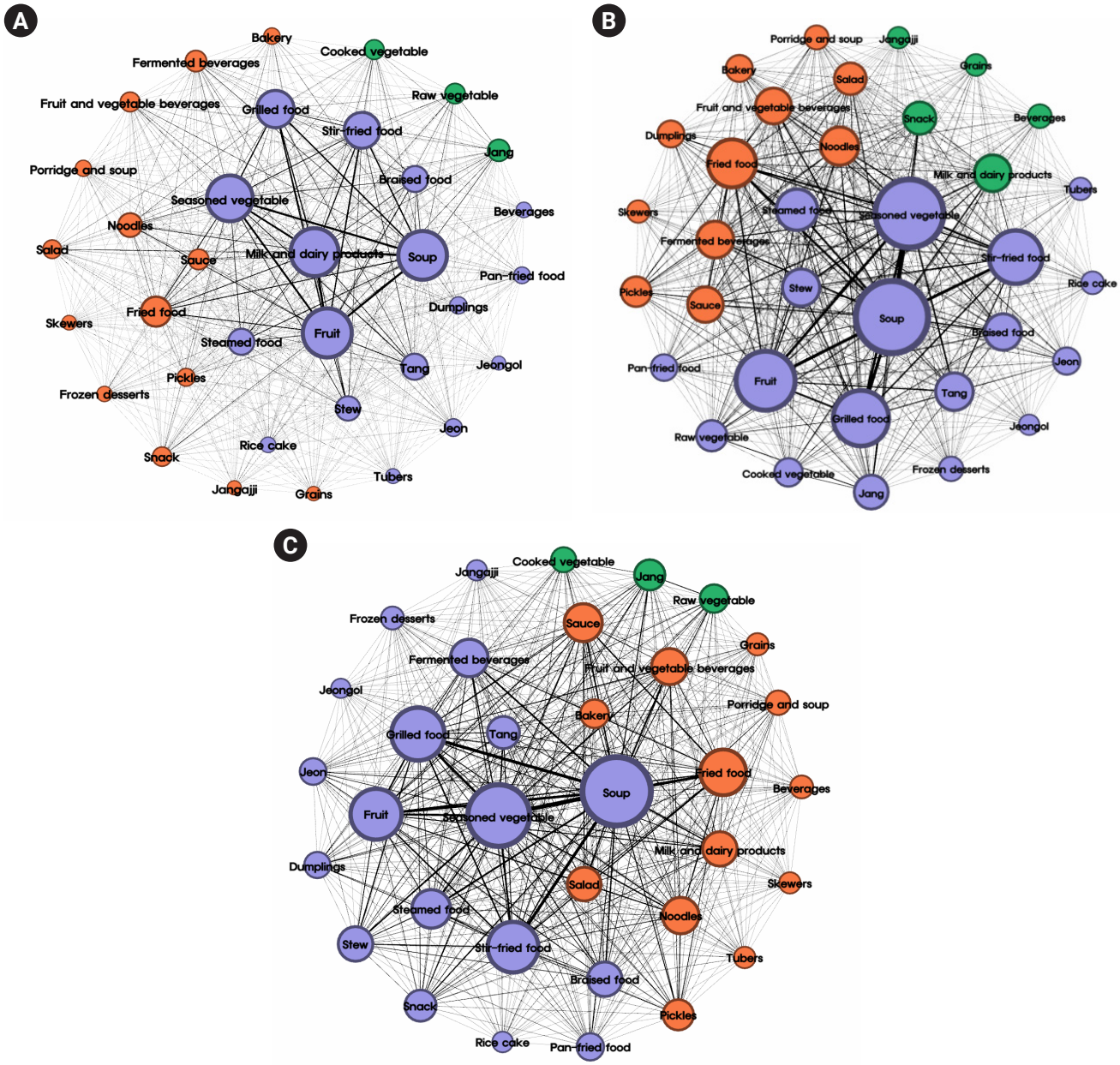

Fig. 1. Co-occurrence network of food groups on school lunch by subset of school age. (A) Elementary school, (B) middle school, (C) high school.

이무침-콩나물무침-김구이 등, 2) 요구르트-떡볶이-어묵국-단무지 등, 3) 쌈장-상추쌈-파인애플-아욱된장국 등, 4) 소고기미역국-잡채로 총 4개의 메뉴 기반 식단 패턴 군집을 형성하였다. 고등학교에서는 1) 우유-사과-김구이-케첩-요거트-바나나 등, 2) 요구르트-오이무침-과채류음료-달걀프라이-어묵국-단무지 등, 3) 쌈장-콩나물무침-상추쌈-파인애플 등의 총 3개의 식단 패턴 군집을 나타냈다.

DISCUSSION

본 연구는 텍스트마이닝 기법을 활용하여 전국 17개 시도 초등학교, 중학교, 고등학교 급식 중 점심 식단에서 학교급에 따라 선호되는 주요 음식군 및 메뉴 키워드를 추출하고 동시출현 네트워크 분석을 통해 급식 식단 메뉴 구성의 특징과 패턴을 탐색했다.

음식군의 빈도 분석에서 국류, 과일류, 무침류가 모든 학교급

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Table 6. Co-occurrence frequency of menu on school lunch by subset of school age

No.	Elementary school			Middle school			High school		
	Menu 1	Menu 2	Frequency	Menu 1	Menu 2	Frequency	Menu 1	Menu 2	Frequency
1	Apple	Milk	61,451	Ssam-jang	Lettuce wraps	13,685	Ssam-jang	Lettuce wraps	21,436
2	Pineapple	Milk	48,200	Beef and seaweed soup	Japchae	5,401	Apple	Milk	11,441
3	Liquid yogurt	Milk	41,079	Apple	Milk	4,976	Milk	Banana	11,435
4	Milk	Banana	38,419	Tteokbokki	Fishcake soup	4,404	Milk	Scorched rice soup	10,394
5	Milk	Cucumber salad	35,900	Liquid yogurt	Milk	4,202	Milk	Grilled laver	8,532
6	Cherry tomato	Milk	35,274	Pickled radish	Liquid yogurt	3,775	Liquid yogurt	Pickled radish	6,819
7	Milk	Ssam-jang	33,315	Banana	Milk	3,630	Milk	Ketchup	6,782
8	Milk	Melon	33,239	Cucumber salad	Milk	3,483	Tteokbokki	Fishcake soup	6,713
9	Milk	Beef and seaweed soup	33,182	Pineapple	Milk	3,211	Tteokbokki	Pickled radish	6,562
10	Watermelon	Milk	32,555	Cherry tomato	Milk	3,168	Milk	Yogurt	6,283
11	Tteokbokki	Milk	29,559	Ssam-jang	Soybean paste stew	3,009	Milk	Fruit and vegetable beverage	5,925
12	Milk	Kiwi	29,267	Liquid yogurt	Green onion egg soup	2,992	Pickled radish	Green onion egg soup	5,318
13	Milk	Seasoned bean sprout	27,681	Tteokbokki	Pickled radish	2,881	Milk	Cherry tomato	5,245
14	Lettuce wraps	Ssam-jang	26,665	Beef and seaweed soup	Milk	2,864	Milk	Fried egg	5,039
15	Milk	Seasoned spinach	26,576	Cucumber salad	Liquid yogurt	2,788	Ssam-jang	Soybean paste stew	4,694
16	Milk	Seasoned mung bean sprout	26,547	Pickled radish	Green onion egg soup	2,684	Liquid yogurt	Green onion egg soup	4,655
17	Milk	Yukgaejang	25,977	Tteokbokki	Milk	2,658	Milk	Stir-fried kimchi	4,512
18	Milk	Grilled laver	25,573	Seasoned mung bean sprout	Milk	2,620	Milk	Pineapple	4,144
19	orange	Milk	25,478	Ssam-jang	Milk	2,591	Apple	Grilled laver	4,051
20	Milk	Strawberry	25,413	Grilled laver	Milk	2,583	Cucumber salad	Liquid yogurt	4,021

Only frequencies of top 20 are listed.

에서 상위 항목으로 나타났다. 빈도 분석 결과와 유사하게 음식군 네트워크의 중심성 결과에서도 국류와 무침류가 모든 학교급에서 높게 나타났다. 이는 모든 학교 급식에서 국류와 무침류가 급식 내 주요 구성 요소로서 중요한 역할을 의미한다. 16개 시도 초등학교, 중학교, 고등학교에서 제공된 식단에서 국 및 찌개류가 87.6%의 비율을 차지하고 이 중 국류는 72.4%로 높게 나타났다[23]. 한국 급식 문화에서 국류는 전통적인 식단 구성 요소로 중심적인 역할을 하고 있다. 그러나, 성장기 어린이와 청소년의 높은 국류 섭취는 나트륨 섭취량 증가와 관련이 있고 나아가 청소년기의 질병 발생 위험 가능성을 나타낸다[24, 25]. 각 시도 교육청에서는 국 및 찌개류 내 나트륨 섭취 저감화를 위해 '국 자율의 날'을 지정하고 학생들의 자율 배식 형태로 운영할 수 있도록 권고하고 있다. 국류와 함께 무침류가 높은 중심성을 보이는 것은 무침의 주재료인 채소를 활용한 메뉴의 빈도가 높은 것을 의미한다. 전국 초등학교의 코로나 시기 전후 급식 메뉴별 제공 횟수 비교에 따르면 무침류 중 오이무침 메뉴는 전체의 5.9%로 높은 제공 횟수를 나타냈다[26]. 이는 본 연구 결과와 유사하며 무침류의 사용이 급식 식단 구성에서 균형 잡힌 영양 공급을 위한 식단 설계의 일환으로 사료된다. 높은 빈도와 중심성을 바탕으로 음식군 및 메뉴의 동시출현 패턴에서

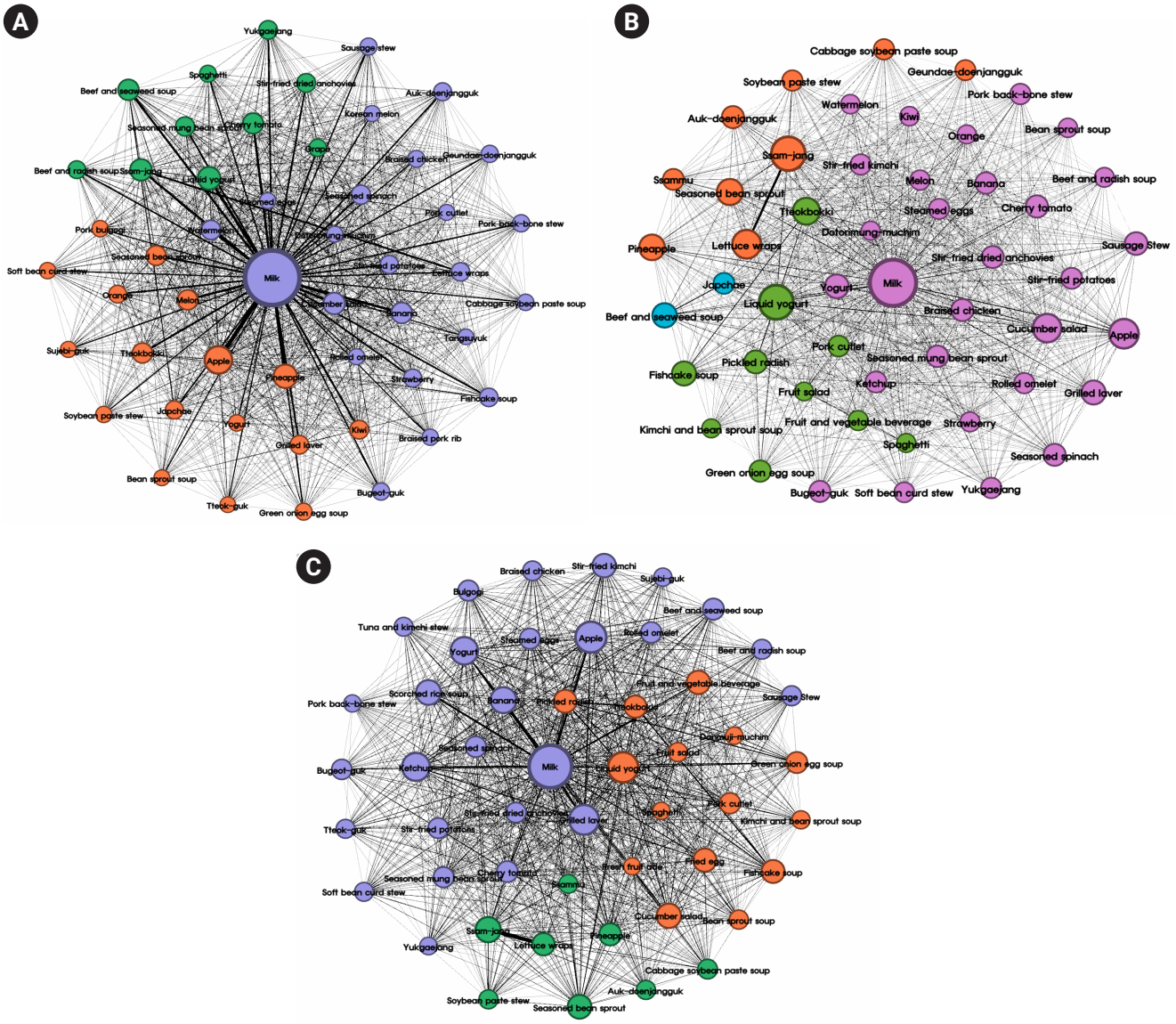

Fig. 2. Co-occurrence network of menu on school lunch by subset of school age. (A) Elementary school, (B) middle school, (C) high school.

도 모든 학교급에서 국류와 다양한 과일류, 무침류, 구이류 메뉴의 조합이 가장 자주 제공되고 있음을 나타냈다.

학교급에 따른 차이점을 비교할 때, 초등학교에서는 우유 및 유제품류의 빈도가 높고 중학교와 고등학교에서는 상대적으로 구이류와 볶음류가 높게 나타났다. 음식군에 이어 주요 메뉴 항목에서도 우유는 모든 학교급에서 가장 높은 TF-IDF를 나타냈는데, 특히 초등학교에서 가장 높게 나타났다. 이는 나이와 성장 발달 단계에 따라 학생들의 영양 요구량과 기호도를 반영한 결과로 사료된다. Chang & Kim [27]에 따르면 2020년 초등학교의 우유 급식 비율은 41.0%, 중학교 17.3%, 고등학교 15.9%로 중학교와 고등학교에 비해 초등학교에서 높은 비율로 시행되고 있다. 초등학교 급식에서 우유 및 유제품의 제공 빈도가 높은 것은 성장기 어린이에게 필요한 칼슘과 동물성 단백질 등을 충분히 공급할 수 있도록 급식에서 자주 활용되고 있음을 나타낸다. 반면, 중학교와 고등학교 급식에서 구이류와 볶음류는 초등학교에 비해 높은 빈도와 중심성을 나타냈다. 이러한 결과는 성장기 후반에 요구되는 에너지와 영양 보충을 고려함과 동시에 고학년 학생들의 기호를 반영한 다양한 조리 형태의 식단 구성이 이루어지고 있음을 유추해 볼 수 있다. 지역별 고등학생 급식 식단의 선호 메뉴 기호도 연구에서 볶음류와 튀김류가 가

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장 높은 기호도를 나타내는 음식군으로 나타났다[16, 28]. 학생의 기호도는 급식 식단 구성시 중요하게 고려되는 요인으로 중학교 및 고등학교에서 볶음류와 튀김류의 선호도가 높음에 따라 다른 음식군에 비해 자주 활용된다[29]. 본 연구의 관련된 메뉴 항목에서 중학교 및 고등학교 급식 식단 중 돈가스 메뉴가 높은 TF-IDF를 보였고, 돈가스 메뉴는 청소년부터 성인까지 높은 선호도를 바탕으로 급식 식단에서 자주 제공되는 메뉴로 활용되고 있다[15, 30, 31].

학교급에 따라 급식 메뉴의 동시출현 패턴 분석 결과, 메뉴 구성에 있어 초등학교에서는 우유와 사과, 바나나 등의 과일이 함께 제공되고 고등학교에서는 상추쌈과 쌈장을 조합한 메뉴의 구성이 특징적이었다. 이러한 메뉴 조합은 각각 성장기 아동 및 청소년의 영양 요구와 식사 기호도를 반영한 결과로 사료된다. 초등학교 급식에서 우유와 과일이 함께 제공되는 것은 성장기에 필수적인 다양한 비타민과 무기질 섭취를 도모하고 정제당류 저감화의 전략으로 볼 수 있다. Lee 등[26]에 따르면 코로나 발생 이전에 비해 초등학교 급식에서 오렌지, 키위 등과 같은 과일류의 제공 횟수가 유의적으로 더 증가했음을 나타냈다. 뿐만 아니라 학교 급식 기본 지침에 따르면 학생들의 당류 저감화를 위해 당 함량이 높은 가공 음료 및 빵류와 케이크류 등의 완제품 대신 과일류의 급식 식단 제공을 권고하고 있다[32, 33]. 중학교와 고등학교 급식에서 높은 동시출현 패턴 구성을 보인 조합은 상추쌈-쌈장-콩나물무침-된장찌개 메뉴 구성으로 급식 식단에서 상추쌈과 쌈장 조합을 기반으로 쌈밥 상차림의 기본 구성에 다양한 육류 등의 주반찬이 추가되어 제공되고 있음을 나타낸다. 고학년 학생일수록 쌈장과 같은 장류 및 소스류의 선호도가 높게 나타나고 급식 식단 메뉴에서 다양하게 활용되고 있다. 본 연구에서 모든 학교급의 상위 빈도 메뉴를 비교했을 때, 케첩 메뉴가 고등학교 급식에서 높은 빈도와 중심성을 나타냈다. 이는 학교 급식의 메뉴 구성이 시대의 흐름에 따라 서양식 메뉴의 제공 비율이 증가하고 학생들의 자기주도적 메뉴 선택에 따라 기호도가 높은 음식의 선호와 관련이 있다[4]. 그러나, 케첩 등을 포함한 소스류는 당 함량이 유의적으로 높아 학령기 청소년의 비만과 같은 질병 발생 위험성을 야기할 수 있다[13, 34]. 당 뿐만 아니라 학년이 올라갈수록 소스류를 통한 나트륨의 섭취도 증가하여 각 지역 교육청의 학교 급식 운영에서는 학생들의 건강을 위한 당 및 나트륨 저감화를 위해 다양한 급식 식단 구성 운영 방안을 제안하고 있다[10, 11]. 결과적으로 학교급별 동시출현 네트워크 분석을 통해 초등학교에서는 우유 및 과일류를 중심으로 다양한 메뉴가 결합되어 건강 지향적 영양 관리가 잘 이행되고 있음을 보여주고 중학교 및 고등학교는 기호도에 맞춰 장류 및 다양한 양념류 및 소스류를 포함한 식단 패턴을 형성하고 있음을 알 수 있다. 이를 통해 학교 급식의 연령별, 학교급별 특성을 반영한 맞춤형 급식 정책 개발의 기초자료로 활용될 수 있음을 기대할 수 있다.

Limitations

본 연구 결과를 해석함에 있어 몇가지 한계를 유념할 필요가 있다. 첫째, 비록 분석된 데이터가 전국 17시도 초등학교, 중학교, 고등학교 지역의 급식 식단을 포함하지만 수집된 기간은 최근 3년으로 도출된 결과를 일반화하는데 제한이 있다. 본 연구 결과를 바탕으로 교육행정정보시스템을 통해 실시간으로 축적되는 학교 급식 식단 메뉴 데이터를 활용함으로써 대규모 빅데이터 수집을 통해 결과의 타당도와 신뢰도 분석을 수행할 수 있다. 둘째, 본 연구의 급식 식단 정보는 영양사 및 영양교사가 설계한 식단으로 학생들의 기호도나 만족도를 직접 반영하지 못한 한계가 있다. 셋째, 활용된 급식 식단 정보는 학생들에게 제공된 식단 구성 메뉴로 실제 섭취량을 측정할 수 없는 제한점이 있다. 향후 급식 식단의 잔반량 측정을 통해 섭취량을 고려한다면 급식 식단을 통해 학생들의 영양소 섭취량과의 연관성도 살펴볼 수 있을 것으로 사료된다. 넷째, NEIS의 식단에 포함된 우유가 우유급식인지 점심 급식의 후식류로 제공되는 것인지 명확히 구분하는데 한계가 있다. 추후 우유급식 데이터와 점심 급식 식단 데이터가 분리되어 관리가 된다면 보다 명확하고 정교한 결과 해석이 가능할 것이다. 이러한 제한점에도 불구하고 본 연구는 빅데이터 기반의 텍스트마이닝을 통해 주요 음식군과 메뉴 키워드를 바탕으로 학교급에 따른 식사 구성 패턴의 특징을 비교한 종합적인 탐색 연구로서 가치가 있다.

빅데이터와 텍스트마이닝을 바탕으로 학교 급식의 주요 구성 음식군과 메뉴를 추출하고 식단의 특징적인 패턴을 이해함으로써 학교급 맞춤 급식 정책 수립 및 개선에 기여할 수 있을 것으로 기대한다. 급식 식단 내 주요 음식군과 메뉴의 조합에 대한 분석 결과는 학교급에 따라 성장기 어린이와 청소년의 필수적인 영양소 공급 전략을 제시하는 필요한 실용적인 자료를 제공할 수 있다. 나아가 균형 잡힌 식단 구성의 필요성을 강조함으로써 학생들의 건강한 식습관 형성에 기여할 수 있을 것이다.

Conclusion

본 연구는 2021년부터 2023년까지 전국 17개 시도 초등학교, 중학교, 고등학교 학교 급식 빅데이터를 활용하여 점심 급식을 구성하는 주요 음식군과 메뉴를 텍스트마이닝을 통해 추출하고 학교급에 따른 식단 구성의 패턴 특징을 동시출현 네트워크 분석을 활용해 비교하였다. 모든 학교급에서 국류와 나물류가 높은 빈도로 제공되는 음식군으로 나타났고, 초등학교에서는 우유 및 유제품류가 중학교 및 고등학교에서는 구이류와 볶음류가 상대적으로 높게 나타났다. 메뉴 항목 중 우유는 모든 학교급에서 가장 높은 빈도로 제공되었다. 초등학교 급식 식단에서는 과일류가 가장 높은 중심성을 나타내었고 그 다음으로 국류와 우유 및 유제품류가 뒤이어 나타났다. 중학교와 고등학교에서는 국류와 무침류가 가장 높은 중심성을 보였으나 초등학교에 비해 구이류와 볶음류가 상대적으로 높은 중심성을 나타냈

다. 동시출현 패턴 분석을 통해 초등학교에서는 국류와 과일류 조합이 자주 나타나고 중학교 및 고등학교에서는 국류와 무침류의 조합이 높은 빈도로 제공됨으로써 특정 메뉴 간의 조합이 추출되었다. 위 결과를 바탕으로 학생들의 건강 증진을 도모하고 다양한 메뉴 기간의 학교 급식 식단 설계의 유용한 기반 자료로 활용될 수 있을 것으로 기대한다.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

The dataset is publicly accessible via the NEIS open educational information portal (open.neis.go.kr).

SUPPLEMENTARY MATERIALS

Supplementary Table 2. Frequency of foods on school lunch by subset of school age.

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Research Article

한국 중년 성인의 지방 에너지 섭취비율에 따른 혈액 생화학적 특성, 영양소 섭취, 만성질환 위험도: 제7기(2016–2018) 국민건강영양조사 자료를 이용한 횡단연구

정가현[1], 김숙배[2,†]

[1]농촌진흥청 국립농업과학원 농식품자원부 연구원
[2]전북대학교 식품영양학과·인간생활과학연구소 교수

Biochemical characteristics, nutrient intakes, and chronic disease risk according to the dietary fat energy ratio in middle-aged Korean: a cross-sectional study using data from the 7th (2016–2018) Korean National Health and Nutrition Examination Survey

Ga-Hyeon Jeong[1], Sook-Bae Kim[2,†]

[1]Researcher, Department of Agro-Food Resources, National Institute of Agricultural Sciences, Rural Development Administration, Wanju, Korea
[2]Professor, Department of Food Science & Human Nutrition, Research Institute of Human Ecology, Jeonbuk National University, Jeonju, Korea

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†Corresponding author:
Sook-Bae Kim
Department of Food Science & Human Nutrition, Jeonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju 54896, Korea
Tel: +82-63-270-3823
Fax: +82-63-270-3854
Email: sbkim@jbnu.ac.kr

Objectives: This study aimed to examine health-related characteristics and chronic disease risk in middle-aged Koreans based on their fat energy intake ratio.

Methods: We analyzed data from 7,274 Koreans aged 40–64 years using the 7th (2016–2018) Koreans National Health and Nutrition Examination Survey. Participants were classified into three groups based on their fat energy intake ratio: insufficient (< 15%), adequate (15%–30%), and excessive (> 30%). We assessed their socio-demographic characteristics; lifestyle characteristics; biochemical characteristics; quantitative and qualitative nutrient intakes, measured using dietary reference intakes for Koreans and index of nutrition quality (INQ); and chronic disease risk.

Results: Significant differences were observed between the groups in age, sex, income, education, and residence region. The insufficient group had the highest proportion of older adults, male, lower income, rural residents, and lower education levels. The groups differed significantly in lifestyle characteristics, with the insufficient group having the highest rates of no walking, heavy drinking, smoking, and poor subjective health perception. Biochemical characteristics in the insufficient group exhibited the lowest levels for fasting blood glucose, hemoglobin A1c, and triglycerides. Significant differences were found in both the quantitative and qualitative intake of nutrients. The insufficient group had the lowest intake of most nutrients except fiber, whereas the excessive group had the lowest fiber intake. Based on

the INQ, vitamin A and Ca were the lowest in the insufficient group, and vitamin C and folic acid were the lowest in the excessive group. The risk of diabetes mellitus and metabolic syndrome was highest in the deficient group, and the risk of liver cirrhosis was highest in the excessive group.

Conclusion: Insufficient or excessive fat energy intake ratio negatively affects nutrient intake and chronic disease risk. Fat energy intake of 15%–30% is important for improving nutrient intake and managing chronic diseases, such as diabetes mellitus, metabolic syndrome, and liver cirrhosis. We suggest that education and an appropriate social environment are necessary to ensure this fat energy intake.

Keywords: middle aged; fats; Korean National Health and Nutrition Examination Survey; diabetes mellitus; liver cirrhosis

INTRODUCTION

우리나라는 빠른 속도로 고령화가 진행되고 있으며, 이에 따라 고령인구의 증가와 함께, 만성질환 유병률과 사망자수 또한 급격히 증가하고 있는 추세이다[1]. 만 30세 이상 성인 2명 중 1명은 비만, 고혈압, 당뇨병, 고콜레스테롤혈증 중 하나를 가지고 있으며, 23.6%는 둘 이상, 7.9%는 셋 이상의 복합적인 만성질환을 가지고 있는 것으로 나타났다[2]. 또한 사망원인 상위 10위 중 8개가 만성질환으로, 전체 사망의 79.9%를 차지하고 있다[3].

불균형한 식생활이 만성질환의 원인으로 보고되면서, 식이섭취와 만성질환의 관련성에 대한 관심이 증가하고 있다[4]. 특히, 지방의 과도한 섭취는 비만 위험을 높이며, 심혈관 질환, 당뇨병, 암과 같은 만성질환의 유병과 관련이 있는 것으로 알려져 있다[5, 6]. 우리나라 성인의 지방 에너지 섭취비율은 꾸준히 증가하고 있으며[7], 이와 함께 포화지방산으로부터 섭취하는 에너지 비율 또한 증가하고 있다[8], 포화지방산의 과도한 섭취는 심혈관 질환의 위험 요인인 혈중 총 콜레스테롤과 low density lipoprotein (LDL)-콜레스테롤 수치를 높이고, 트랜스지방산의 섭취는 LDL-콜레스테롤을 높일 뿐만 아니라, high density lipoprotein (HDL)-콜레스테롤을 낮추는 것으로 보고되었다[9]. 또한 지방 섭취 제한은 상대적으로 탄수화물 섭취를 증가시켜, 혈중 중성지방과 총 콜레스테롤 상승, HDL-콜레스테롤 감소를 초래할 수 있다. 이는 혈당 조절을 악화시켜, 당뇨병의 위험을 증가시키고, 심혈관질환의 위험 또한 높일 수 있는 것으로 보고되었다[6, 7]. 이와 같이 만성질환 예방과 관리에 있어서, 적정수준의 지방 섭취가 중요하여, 2020 한국인 영양소섭취기준 (dietary reference intakes for Koreans) [7]에서 에너지 불균형으로 인해 나타나는 만성 질환에 대한 위험을 감소시키기 위한 지방의 에너지적정비율을 15%–30%로 제시하였다.

지방 섭취와 관련된 선행연구를 살펴보면, 식이 지방 종류에 따른 심혈관 질환과의 관련 연구[10], 총 지방 섭취량과 당뇨병과의 관련 연구[11], 폐경 여성에서 저지방 식사의 사망 위험 감소효과를 보고한 연구[12], 과체중 및 비만에서 포화지방산 섭취가 간에서의 지방 축적에 미치는 영향을 살펴본 연구[13] 등이 있다. 그러나 중년 성인을 대상으로 한 연구는 부족하며, 대부분 총 지방 섭취량과 지방산 종류와 관련된 연구이며, 지방에너지 적정비율을 기준하여, 살펴본 연구는 미미한 실정이다.

최근 국민건강영양조사 자료를 활용하여, 생애주기별 영양섭취, 질병 유병을 분석하는 다양한 연구들이 진행되고 있으며, 국민의 영양과 건강개선을 위한 기초자료로 활용되고 있다. 국민건강영양조사를 활용한 지방 섭취 관련을 선행 연구를 살펴보면, 거주 지역별 지방산 섭취 수준과 급원식품, 대사질환의 관련성 연구[14], n-3 지방산 섭취와 심혈관질환 위험도와의 관련성 연구[15], 지방산 섭취와 복부비만 및 고혈당과의 관련성 연구[16], 지방 에너지 섭취비율에 따른 대사증후군 위험도를 살펴본 연구[17] 등이 있다. 그러나 국민건강영양조사를 활용한 연구에서도 대부분 지방 섭취량과 지방산 종류 연구이며, 지방에너지 적정비율 연구로는 대사증후군 위험성과의 관련을 본 연구 정도로, 매우 미미한 실정이다. 따라서 고령인구와 만성질환 유병이 크게 증가하고 있으며, 지방 섭취가 꾸준히 증가하고 있는 현 시점에서, 지방 섭취 관련 연구로서, 지방에너지 섭취비율과 영양소 섭취, 만성질환과의 관련성을 살펴보는 것은 매우 의미 있을 것으로 사료된다.

이에 본 연구는 국민건강영양조사를 활용하여, 중년 성인대상, 한국인 영양소 섭취기준 지방 에너지적정비율을 기준으로 하여, 적정비율 섭취 여부에 따른 인구사회학적 특성, 생활습관적 특성, 혈액 생화학적 특성, 영양소 섭취, 만성질환 위험도를 살펴봄으로써, 중년기 올바른 영양섭취, 만성질환 예방 및 관리를 위한 방안을 마련하는데 기초자료를 제공하고자 하였다.

METHODS

Ethics statement

The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of Korea Disease Control and Prevention Agency (approval number: 2018-01-03-P-A) and was exempted from IRB review based on Bioethics and Safety Act in 2016 and 2017.

1. 연구설계

본 연구는 횡단연구로 설계되었으며, Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) 보고 지침을 참고하여 기술하였다(https://www.strobe-statement.org/).

2. 연구대상 및 자료수집

제7기(2016–2018) 국민건강영양조사 원시자료를 활용하였다. 연구 대상자는 중년 성인(만 40–64세) 중 일반 및 건강행태조사, 건강검진조사, 영양조사에 모두 참여한 자로서, 지방 섭취 결측자, 하루 에너지 500 kcal 미만 섭취자, 5,000 kcal 이상 섭취자, 임신부, 수유부를 제외한 총 7,274명이었다. 2020 한국인 영양소 섭취 기준[7]에서 제시한 성인 지방 에너지적정비율 15%–30% 기준에 따라, 부족군(< 15% 섭취), 적정군(15%–30% 섭취), 과잉군(> 30% 섭취)으로 분류하였다[17]. 부족군 2,782명(38.2%), 적정군 3,773명(51.9%), 과잉군 719명(9.9%)이었다. 지방 에너지 섭취비율은 개인별 24시간 회상조사에 의해 도출된 지방 섭취량에 9 kcal을 곱한 후, 총 에너지 섭취량으로 나누어 계산하였다.

3. 연구내용 및 방법

1) 인구사회학적 특성

연령, 성별, 소득수준, 거주 지역, 교육수준, 결혼 여부를 살펴보았다. 연령은 40–49세, 50–59세, 60–64세로 분류하였다. 소득수준은 개인의 소득 사분위수로 상, 중상, 중하, 하로 분류하였다. 거주 지역은 동에 거주하면 도시지역으로, 읍 또는 면에 거주하면 농촌지역으로 분류하였다. 교육수준은 초등학교 졸업 이하, 중학교 졸업, 고등학교 졸업, 대학교 졸업 이상으로 분류하였다. 결혼 여부는 기혼, 미혼으로 분류하였다[17, 18].

2) 생활습관적 특성

걷기, 음주, 흡연, 주관적 건강인식을 살펴보았다. 걷기는 전혀 하지 않음, 주 1–3일, 주 4–6일, 매일로 분류하였다. 음주는 1회 음주량에 따라 0잔, 1–2잔, 3–6잔, 7잔 이상으로 분류하였다. 흡연은 현재흡연자, 과거흡연자, 비흡연자로 분류하였다. 주관적 건강인식은 좋음(매우 좋음 포함), 보통, 나쁨(매우 나쁨 포함)으로 분류하였다[19–21].

3) 혈액 생화학적 특성

공복혈당, 당화혈색소, 혈중 요소질소, 혈중 크레아티닌, 중성지방, 총 콜레스테롤, HDL-콜레스테롤, 헤모글로빈을 살펴보았으며, 판정 기준에 따라 구간별 백분율로 나타냈다[18, 22–25].

4) 에너지 및 영양소 섭취

에너지, 다량영양소(탄수화물, 단백질, 식이섬유), 비타민(비타민 A, 티아민, 리보플라빈, 니아신, 엽산, 비타민 C), 무기질(칼슘, 인, 철, 칼륨, 나트륨)의 양적 질적 섭취를 평가하였다[18]. 양적 섭취는 2020 한국인 영양소 섭취기준[7]의 에너지필요추정량, 평균필요량, 권장섭취량, 충분섭취량, 상한섭취량, 만성질환위험감소섭취량을 기준으로 구간별 백분율을 살펴보았다. 질적 섭취는 권장섭취량 기준이 설정되어 있는 탄수화물, 단백질, 비타민 A, 비타민C, 티아민, 리보플라빈, 니아신, 엽산, 칼슘, 인, 철의 영양밀도지수(index of nutrition quality, INQ)를 살펴보았다[18].

5) 만성 질환 위험도

만성질환 (이상지질혈증, 뇌졸중, 심근경색증/협심증, 고혈압, 당뇨병, 암, 간경변증, 대사증후군, 비만)의 위험도를 살펴보았다[11, 13, 17]. 대사증후군은 National cholesterol education program adult treatment panel III 진단기준을 이용하였으며[26, 27], 비만은 대한비만학회에서 제시한 기준을 이용하였다[28]. 그 외 질환은 검진조사 자료 중 의사진단 변수를 사용하였다. 위험도는 적정군을 1.0으로 하여, 부족군 및 과잉군의 오즈비(odds ratio)를 살펴보았다.

4. 자료 분석

자료는 SPSS Statistics 28.0 (IBM Corp.)을 이용하여 가중치, 층화변수, 집락변수를 고려한 복합표본 분석을 실시하였다. 범주형 변수는 빈도와 백분율로 제시하였고, 카이제곱 검정을 실시하였다. 연속형 변수는 평균과 표준편차로 제시하였고, 세 군간 유의한 차이가 있는 경우, Bonferroni 검정으로 사후 비교를 실시하였다. 만성질환 발병 위험도를 살펴보기 위해 로지스틱 회귀분석을 실시하였으며, 오즈비와 95% 신뢰구간을 제시하였다. 로지스틱 회귀분석시 만성질환 유병에 영향을 미치는 연령, 성별을 보정하였다. 모든 분석의 유의수준은 $P < 0.05$로 하였다.

RESULTS

1. 인구사회학적 특성

조사대상자의 인구사회학적 특성은 Table 1과 같다. 연령, 성별, 소득수준, 거주지역, 교육수준에서 세 군 간 유의적 차이를 보

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Table 1. Socio-demographic characteristics by dietary fat energy ratio

Variable	< 15%	15%–30%	> 30%	Total	χ^2	*P*
Age (years)	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	194.865	< 0.001
40–49	34.3	47.0	56.6	43.3		
50–59	46.7	41.6	35.4	42.8		
60–64	19.0	11.5	8.0	13.8		
Sex	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	9.176	0.030
Male	51.1	49.2	44.8	49.4		
Female	48.9	50.8	55.2	50.6		
Personal income	(n = 2,779)	(n = 3,765)	(n = 719)	(n = 7,263)	46.856	< 0.001
Low	28.3	21.6	22.3	24.1		
Middle-low	24.7	25.3	24.5	25.0		
Middle-high	24.3	26.7	25.1	25.7		
High	22.7	26.5	28.2	25.3		
Residence region	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	73.814	< 0.001
Urban	81.6	88.6	89.7	86.2		
Rural	18.4	11.4	10.3	13.8		
Education level	(n = 2,647)	(n = 3,606)	(n = 687)	(n = 6,940)	374.793	< 0.001
≤ Elementary	16.1	6.5	4.0	9.7		
Middle	15.3	8.6	8.2	11.0		
High	38.6	38.6	32.0	37.9		
≥ College	30.0	46.3	55.8	41.3		
Marital status	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	2.597	0.428
Married	94.2	95.0	94.0	94.6		
Unmarried	5.8	5.0	6.0	5.4		

%.
All estimates were produced using a complex sample analysis with integrated sample weight to represent the Korean population.

였다. 연령은 40대(40–49세)가 세 군 중 과잉군(56.6%)에서 가장 많았으며, 60대(60–69세)가 부족군에서 가장 많았다. 성별에서, '여성'이 세 군 중 과잉군(55.2%)에서 가장 많았다. 소득수준은 '하'가 세 군 중 부족군(28.3%)에서 가장 많았고, '상'은 세 군 중 과잉군(28.2%)에서 가장 많았다. 거주 지역에서는, '도시지역'이 세 군 중 과잉군(89.7%)에서 가장 많았으며, '농촌지역'은 세 군 중 부족군(18.4%)에서 가장 많았다. 교육수준은 '대졸 이상'이 세 군 중 과잉군(55.8%)에서 가장 많았으며, '초졸 이하'가 부족군(16.1%)에서 가장 많았다.

2. 생활습관적 특성

조사대상자의 생활습관적 특성은 Table 2와 같다. 걷기, 음주, 흡연, 주관적 건강인식에서 세 군 간 유의적 차이를 보였다. 걷기는 '매일'이 세 군 중 부족군(24.4%)에서 가장 적었다. 음주는 '1회 7잔 이상'이 세 군 중 부족군(24.4%)에서 가장 많았다. 흡연은 '비흡연자'가 세 군 중 부족군(54.6%)에서 가장 적었다. 주관적 건강인식은 '나쁨'이 세 군 중 부족군(19.3%)에서 가장 많았으며, '좋음'은 세 군 중 과잉군(32.2%)에서 가장 많았다.

3. 혈액 생화학적 특성

조사대상자의 혈액 생화학적 특성은 Table 3과 같다. 공복혈당, 당화혈색소, 중성지방에서 세 군 간 유의적 차이를 보였다. 공복혈당에서 '정상'이 세 군 중 부족군(56.4%)에서 가장 적었다. 당화혈색소도 '정상'이 세 군 중 부족군(58.9%)에서 가장 적었다. 중성지방도, '정상'이 세 군 중 부족군(62.4%)에서 가장 적었다.

4. 에너지 및 영양소 섭취

1) 양적 섭취

조사대상자의 에너지 및 영양소의 양적 섭취는 Table 4와 같다. 에너지는 '필요추정량 미만 섭취자 비율'이 세 군 중 부족군(61.1%)에서 가장 많았다. 탄수화물은 '평균필요량 미만 섭취자 비율'이 세 군 중 부족군(0.5%)에서 가장 적었다. 그 외 영양소에 있어서, '평균필요량 미만 섭취자 비율'이 세 군 중 부족군(단백질 31.3%, 비타민 A 85.2%, 티아민 33.0%, 리보플라빈 50.9%, 니아신 54.2%, 엽산 53.5%, 비타민 C 74.0%, 칼슘 78.5%, 인 16.9%, 철 28.0%)에서 가장 많았다. 칼륨, 나트륨에 있어서 '충분섭취량 미만 섭취자 비율'이 세 군 중 부족군(칼륨 73.5%, 나

Table 2. Lifestyle characteristics by dietary fat energy ratio

Variable	< 15%	15%–30%	> 30%	Total	χ^2	*P*
Walking	(n = 2,646)	(n = 3,605)	(n = 689)	(n = 6,940)	31.822	< 0.001
Everyday	24.4	26.1	29.6	25.8		
4–6 (days/week)	23.7	26.7	25.2	25.5		
1–3 (days/week)	30.8	30.2	31.0	30.5		
Never	21.1	17.0	14.2	18.2		
Alcohol intake (glass)	(n = 2,755)	(n = 3,743)	(n = 716)	(n = 7,214)	36.006	< 0.001
0	23.5	21.3	20.0	22.0		
1–2	25.0	28.2	31.5	27.4		
3–6	27.1	30.4	26.8	28.9		
≥ 7	24.4	20.0	21.6	21.8		
Smoking	(n = 2,753)	(n = 3,740)	(n = 716)	(n = 7,209)	14.914	0.042
Nonsmoker	54.6	56.9	61.0	56.5		
Ex-smoker	21.5	22.1	20.3	21.7		
Current smoker	23.9	21.0	18.6	21.8		
Subjective health perception	(n = 2,655)	(n = 3,616)	(n = 690)	(n = 6,961)	50.070	< 0.001
Good	24.9	30.8	32.2	28.8		
Normal	55.9	54.8	55.3	55.2		
Bad	19.3	14.4	12.5	16.0		
Married	94.2	95.0	94.0	94.6		
Unmarried	5.8	5.0	6.0	5.4		

%.
All estimates were produced using a complex sample analysis with integrated sample weight to represent the Korean population.

트륨 14.3%)에서 가장 많았다. 반면, 식이섬유에 있어서, '충분 섭취량 미만 섭취자 비율'이 세 군 중 과잉군(54.8%)에서 가장 많았다.

2) 질적 섭취

조사대상자의 영양소의 질적 섭취는 Table 5와 같다. 전체 조사대상자 INQ를 살펴보면, 탄수화물, 단백질, 티아민, 리보플라빈, 인, 철은 모든 군에서 1.0 이상이었다. 비타민 A, 비타민 C, 칼슘은 0.75 이하였다. 세 군 간 차이를 살펴보면, 단백질, 비타민 A, 티아민, 리보플라빈, 니아신, 칼슘, 인의 INQ가 세 군 중 부족군에서 가장 낮았다. 반면, 탄수화물, 비타민 C, 엽산의 INQ가 세 군 중 과잉군에서 가장 낮았다.

5. 만성질환 발병 위험도

조사대상자의 만성질환 발병 위험도는 Table 6과 같다. 당뇨병, 간경변증, 대사증후군에서 세군 간 유의적인 차이를 보였다. 당뇨병은 정상군 대비 부족군 1.43, 과잉군 0.94였다. 간경변증은 정상군 대비 부족군 3.62, 과잉군 5.83이었다. 대사증후군은 정상군 대비 부족군 1.28, 과잉군 1.13이었다.

DISCUSSION

본 연구는 제7기(2016–2018) 국민건강영양조사 자료를 이용하여 만 40–64세 중년 성인을 대상으로 한국인 영양소 섭취기준 지방 에너지 적정섭취 여부에 따라, 부족군(< 15%), 적정군(15%–30%), 과잉군(> 30%)으로 나누어, 인구사회학적 특성, 생활습관적 특성, 혈액 생화학적 특성, 에너지 및 영양소의 양적·질적 섭취, 만성질환 발병 위험도를 살펴보았다.

인구사회학적 특성을 살펴보면, 연령에 있어서, 지방 에너지 섭취비율 30% 이상인 과잉군에서 연령대가 낮았다. 우리나라 성인 지방 섭취를 평가한 Song & Shim [8] 연구에서, 연령이 증가할수록 지방과 단백질 에너지 섭취비율은 감소하였고, 탄수화물 에너지 섭취비율은 증가하였다고 보고하여, 본 연구 결과와 유사하였다. 따라서 연령의 증가에 따른 에너지영양소 섭취 불균형을 초래할 수 있어, 중년 성인을 대상으로 지방 에너지 섭취비율을 적정 수준 섭취를 위한 영양교육이 필요할 것으로 생각된다. 성별에 있어서, 지방 에너지 섭취비율이 증가할수록 여성의 비율이 높아지는 결과를 보였다. Guasch-Ferré 등[11] 연구에서, 총 지방 섭취량을 4분위로 나누었을 때, 1분위와 비교하여 4분위에서 여성의 비율이 더 높아, 본 연구 결과와 유사하였다. 이는 남성보다 여성에서 지방의 과잉 섭취 위험이 있음

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Table 3. Biochemical characteristics by dietary fat energy ratio

Variable	< 15%	15%–30%	> 30%	Total	χ^2	*P*
FPG (mg/dL)	(n = 2,709)	(n = 3,693)	(n = 702)	(n = 7,104)	21.245	0.005
Diabetes (> 100)	10.3	7.7	7.6	8.6		
Prediabetes (70–100)	33.4	31.3	30.5	32.0		
Normal (< 70)	56.4	61.0	61.9	59.4		
HbA1c (%)	(n = 2,700)	(n = 3,690)	(n = 699)	(n = 7,089)	22.154	0.003
Diabetes (≥ 6.5)	11.3	8.1	7.7	9.2		
Prediabetes (5.7–6.4)	29.8	29.9	29.1	29.8		
Normal (< 5.7)	58.9	62.0	63.3	61.0		
BUN (mg/dL)	(n = 2,709)	(n = 3,693)	(n = 702)	(n = 7,104)	1.355	0.870
High (> 22)	8.0	8.5	7.7	8.2		
Normal (4–22)	92.0	91.5	92.3	91.7		
Creatinine (mg/dL)[1)]	(n = 2,709)	(n = 3,693)	(n = 702)	(n = 7,104)	4.997	0.376
High (> 1.2/1.1)	2.4	1.9	1.4	2.0		
Normal (0.6–1.2/0.5–1.1)	96.5	97.2	97.9	97.0		
Low (< 0.6/0.5)	1.2	0.9	0.7	1.0		
Triglyceride (mg/dL)	(n = 2,709)	(n = 3,693)	(n = 702)	(n = 7,104)	34.835	< 0.001
Very high (≥ 500)	2.4	2.0	2.2	2.2		
High (200–499)	20.8	15.6	16.0	17.5		
Borderline (150–199)	14.4	14.3	13.4	14.3		
Normal (< 150)	62.4	68.1	68.3	66.1		
Total-cholesterol (mg/dL)	(n = 2,709)	(n = 3,693)	(n = 702)	(n = 7,104)	5.373	0.417
High (≥ 240)	12.5	13.0	12.9	12.8		
Borderline (200–239)	33.7	36.0	33.8	34.9		
Normal (< 200)	53.8	51.0	53.3	52.3		
HDL-cholesterol (mg/dL)	(n = 2,709)	(n = 3,690)	(n = 702)	(n = 7,101)	11.781	0.059
High (≥ 60)	20.0	21.9	23.6	21.4		
Borderline (40–59)	59.5	60.3	58.7	59.9		
Low (< 40)	20.6	17.8	17.8	18.8		
Hemoglobin (g/dL)[1)]	(n = 2,700)	(n = 3,690)	(n = 699)	(n = 7,089)	3.672	0.591
High (> 17.5/16)	0.9	1.1	1.2	1.0		
Normal (13.5–17.5/12–16)	91.2	89.8	90.7	90.4		
Low (< 13.5/12)	8.0	9.0	8.2	8.6		

%.
All estimates were produced using a complex sample analysis with integrated sample weight to represent the Korean population.
[1)]The reference values for each variable are presented separately for males and females.
FPG, fasting plasma glucose; HbA1c, glycated hemoglobin; BUN, blood urea nitrogen; HDL-cholesterol, high density lipoprotein-cholesterol.

을 보여준다. 따라서 특히 중년 여성에 있어서 지방의 적정수준 섭취 교육을 강조해야 할 것으로 보인다. 소득수준은 지방 에너지 섭취비율이 부족군에서 소득수준이 낮음을 보였다. Moon & Lee [29] 연구에서, 지방 에너지 섭취비율이 높은 집단에서, 소득수준이 높은 것으로 나타나, 본 연구의 결과와 유사하였다. 따라서 소득수준이 낮은 집단에 있어서, 지방 에너지 섭취 부족에 대한 교육 및 개선 방안이 필요할 것으로 생각된다. 거주지역은 지방 에너지 섭취비율이 증가할수록 도시지역에 거주하는 비율이 증가하였다. Song & Shim [14] 연구에서, 중년의 경우, 도시 지역이 농촌 지역보다 지방 에너지 섭취비율이 높다고 보고하여, 본 연구 결과와 유사하였다. 이는 도시지역 거주자의 지방 에너지 과잉 섭취를 적정수준으로 낮추는 교육이 필요할 것으로 여겨진다. 교육수준은 지방 에너지 섭취비율이 부족군에서 교육수준이 더 낮은 결과를 보였으며, 이는 중년 남성 대상 Her [17]의 연구 결과와 유사하였다. 이는 교육수준이 낮은 집단에 대한 지방 에너지 섭취비율이 부족하지 않도록 교육해야 하며, 교육수준이 높은 집단에 있어서는, 지방 에너지 섭취비율이 과잉되지 않도록 교육하는 것이 필요하다.

Table 4. Quantitative nutrient intakes by dietary fat energy ratio

Variable	< 15%	15%–30%	> 30%	Total	χ^2	*P*
Energy	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	52.267	< 0.001
< EER	61.1	56.4	46.4	57.1		
≥ EER	38.9	43.6	53.6	42.9		
Carbohydrate	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	72.487	< 0.001
< EAR	0.5	0.7	3.1	0.9		
≥ EAR and < RNI	2.7	2.3	5.7	2.8		
≥ RNI	96.8	97.0	91.2	96.3		
Protein	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	426.653	< 0.001
< EAR	31.3	14.5	9.5	20.1		
≥ EAR and < RNI	17.9	14.8	9.1	15.4		
≥ RNI	50.9	70.7	81.4	64.5		
Fiber	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	11.648	0.012
< AI	51.1	48.5	54.8	50.0		
≥ AI	48.9	51.5	45.2	50.0		
Vitamin A	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	249.593	< 0.001
< EAR	85.2	71.7	63.4	75.7		
≥ EAR and < RNI	8.9	15.5	17.8	13.3		
≥ RNI and < UL	5.9	12.5	17.5	10.6		
≥ UL	0.0	0.3	1.3	0.3		
Thiamin	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	64.254	< 0.001
< EAR	33.0	25.8	27.7	28.6		
≥ EAR and < RNI	17.8	15.4	14.3	16.1		
≥ RNI	49.2	58.8	58.0	55.2		
Riboflavin	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	900.708	< 0.001
< EAR	50.9	21.7	11.2	31.2		
≥ EAR and < RNI	12.4	10.3	6.3	10.7		
≥ RNI	36.7	68.0	82.5	58.1		
Niacin	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	297.528	< 0.001
< EAR	54.2	38.3	29.2	43.2		
≥ EAR and < RNI	21.2	23.8	19.6	22.5		
≥ RNI and < UL	23.7	36.5	47.7	32.9		
≥ UL	0.9	1.4	3.6	1.4		
Folate	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	52.370	< 0.001
< EAR	53.5	45.7	50.4	49.0		
≥ EAR and < RNI	18.3	18.2	17.9	18.2		
≥ RNI and < UL	27.6	35.6	31.3	32.3		
≥ UL	0.6	0.5	0.4	0.5		
Vitamin C	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	14.133	0.033
< EAR	74.0	70.2	70.3	71.6		
≥ EAR and < RNI	9.7	12.1	11.1	11.1		
≥ RNI	16.3	17.7	18.6	17.3		
Ca	(n = 2,768)	(n = 3,710)	(n = 696)	(n = 7,174)	254.991	< 0.001
< EAR	78.5	60.3	60.0	66.9		
≥ EAR and < RNI	10.7	18.1	19.7	15.5		
≥ RNI and < UL	10.5	21.2	19.9	17.1		
≥ UL	0.3	0.5	0.5	0.4		

(Continued to the next page)

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Table 4. Continued

Variable	< 15%	15%–30%	> 30%	Total	χ^2	*P*
P	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	242.030	< 0.001
< EAR	16.9	7.2	4.6	10.5		
≥ EAR and < RNI	11.3	7.6	6.1	8.8		
≥ RNI	71.8	85.3	89.2	80.7		
Fe	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	31.844	0.002
< EAR	28.0	22.9	22.5	24.8		
≥ EAR and < RNI	15.8	15.2	14.6	15.4		
≥ RNI and < UL	55.7	61.6	62.5	59.6		
≥ UL	0.4	0.2	0.4	0.3		
K	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	24.960	< 0.001
< AI	73.5	68.3	66.4	70.0		
≥ AI	26.5	31.7	33.6	30.0		
Na	(n = 2,782)	(n = 3,773)	(n = 719)	(n = 7,274)	69.401	< 0.001
< AI	14.3	10.0	11.6	11.7		
≥ AI and < CDRR	20.6	15.7	15.3	17.4		
≥ CDRR	65.1	74.4	73.1	70.9		

%.
All estimates were produced using a complex sample analysis with integrated sample weight to represent the Korean population.
EER, estimated energy requirement; EAR, estimated average requirement; RNI, recommended nutrition intake; AI, adequate intake; UL, tolerable upper intake level; CDRR, chronic disease risk reduction intake.

Table 5. Qualitative nutrient intakes by dietary fat energy ratio

Variable	< 15% (n = 2,782)	15%–30% (n = 3,773)	> 30% (n = 719)	Total (n = 7,274)	*F*	*P*
INQ						
Carbohydrate	2.71 ± 0.01[a]	2.38 ± 0.01[b]	1.80 ± 0.02[c]	2.29 ± 0.01	754.096	< 0.001
Protein	1.19 ± 0.01[c]	1.36 ± 0.01[b]	1.43 ± 0.02[a]	1.33 ± 0.01	147.364	< 0.001
Vitamin A	0.49 ± 0.01[c]	0.64 ± 0.01[b]	0.74 ± 0.04[a]	0.62 ± 0.01	69.386	< 0.001
Vitamin C	0.75 ± 0.02[a]	0.70 ± 0.02[a]	0.62 ± 0.03[b]	0.69 ± 0.01	8.539	< 0.001
Thiamin	1.18 ± 0.01[b]	1.25 ± 0.01[a]	1.26 ± 0.03[a]	1.23 ± 0.01	12.682	0.016
Riboflavin	1.04 ± 0.01[c]	1.33 ± 0.01[b]	1.47 ± 0.02[a]	1.28 ± 0.01	310.485	< 0.001
Niacin	0.91 ± 0.01[c]	0.97 ± 0.01[b]	1.03 ± 0.02[a]	0.97 ± 0.01	28.677	< 0.001
Folate	0.94 ± 0.01[a]	0.95 ± 0.01[a]	0.83 ± 0.02[b]	0.90 ± 0.01	25.261	< 0.001
Ca	0.68 ± 0.01[c]	0.80 ± 0.01[a]	0.76 ± 0.02[b]	0.75 ± 0.01	53.135	< 0.001
P	1.52 ± 0.01[b]	1.69 ± 0.01[a]	1.70 ± 0.02[a]	1.64 ± 0.01	89.699	< 0.001
Fe	1.31 ± 0.02	1.34 ± 0.01	1.30 ± 0.02	1.32 ± 0.01	1.697	0.361

Mean ± SD.
All estimates were produced using a complex sample analysis with integrated sample weight to represent the Korean population.
Different superscript letters in a row indicate significant difference at α = 0.05 based on a Bonferroni multiple comparison.
INQ, index of nutrition quality.

생활습관적 특성을 살펴보면, 지방 에너지 섭취비율이 높을 때, 다른 군에 비해 매일 걷는 비율이 높았고, 전혀 걷지 않는 비율은 낮았다. Yuan 등[30] 연구에서, 지방 섭취량을 4분위로 나누어 신체활동 수준을 조사한 결과, 지방 섭취 분위수가 높을수록 신체활동을 더 많이 하는 것으로 나타나, 본 연구 결과와 유사하였다. 신체활동 부족은 만성질환으로 인한 사망 위험을 높이는 위험요인으로 보고되었으며[31], Kraus 등[32]은 신체활동이 모든 원인에 의한 사망 및 심혈관질환의 위험을 감소시키는 것으로 보고하였다. 따라서 지방 에너지 섭취비율이 적정 수준보다 낮은 군에서, 지방 에너지 섭취 증가와 더불어, 신

Table 6. Odds ratio for chronic disease by dietary fat energy ratio

Variable	< 15% (n = 2,782)	15%–30% (n = 3,773)	> 30% (n = 719)	*P*
Dyslipidemia	1.03 (0.89–1.20)[1,2)]	1.00 (reference)	0.99 (0.77–1.26)	0.908
Stroke	1.50 (0.90–2.40)	1.00	1.62 (0.74–3.57)	0.222
Myocardial infarction/angina	1.49 (0.96–2.33)	1.00	0.98 (0.44–2.20)	0.182
Hypertension	1.15 (0.98–1.34)	1.00	1.01 (0.78–1.32)	0.231
Diabetes	1.43 (1.16–1.76)	1.00	0.94 (0.63–1.42)	0.002
Cancer	1.25 (0.72–2.15)	1.00	0.37 (0.10–1.31)	0.117
Cirrhosis	3.62 (1.35–9.73)	1.00	5.83 (1.24–27.39)	0.027
Metabolic syndrome	1.28 (1.12–1.45)	1.00	1.13 (0.91–1.41)	0.001
Obesity	0.97 (0.86–1.10)	1.00	1.19 (0.98–1.44)	0.156

[1)]Odds ratio and 95% confidence interval were calculated using logistic regression analyses.
[2)]Adjusted for age and sex.

체활동을 증가시키기 위한 노력이 필요하다고 사료된다. 음주량은 지방 에너지 섭취비율이 부족군에서 1회 음주량이 더 많았다. Guasch-Ferré 등[11] 연구에서, 총 지방 섭취량이 낮을수록 음주량이 많은 것으로 나타나, 본 연구 결과와 유사하였다. 음주 또한 만성질환의 위험을 높이는 위험요인으로 보고되었으며[31], Lee 등[20] 연구에서, 남성 2잔, 여성 1잔 이상 만으로도, 전혀 마시지 않는 것에 비해, 고혈압 위험이 증가된다고 보고하였다. 따라서 지방 에너지 섭취비율이 15% 미만 부족군에서, 음주량을 줄이는 교육 및 방안이 필요할 것으로 사료된다. 흡연에서는 부족군에서, 현재 흡연자 비율이 다른 군에 비해 높았다. 중년 남성을 대상으로 한 Her [17]의 연구에서, 지방 에너지 섭취비율이 낮은 군에서 현재 흡연자 비율이 높다고 보고하여, 본 연구 결과와 유사하였다. 흡연은 만성질환의 위험을 높이는 것으로 잘 알려져 있다[31]. Pan 등[33]은, 비흡연자에 비해 현재 흡연자의 당뇨병 위험이 1.37배 높았으며, 비흡연자에 비해 과거흡연자는 1.14배 높았으며, 금연 기간이 길어질수록 당뇨병 위험이 감소하는 것으로 보고하였다. 따라서 지방 에너지 섭취가 15% 미만 부족군에서 지방 섭취를 높이는 교육과 함께 금연 교육이 필요할 것으로 사료된다. 주관적 건강인식은 부족군에서 주관적 건강인식이 더 나쁜 것으로 나타났다. 중년 여성 대상 Lee & Lee [34] 연구에서, 주관적 건강인식이 낮은 군이 높은 군보다 지방 에너지 섭취비율이 낮아, 본 연구 결과와 유사하였다. Choi [35]는 주관적 건강인식은 실제 건강상태를 잘 반영하는 지표이며, 고혈압, 당뇨병, 암, 심장질환, 뇌혈관질환 등의 질병을 유의하게 예측한다고 보고하였다. 따라서 지방 에너지 섭취가 15% 미만인 중년 대상, 지방 에너지 섭취비율 증가와 함께, 실질적인 건강관리도 함께 하여, 주관적 건강인식을 높이는 다각적인 방안이 필요할 것으로 사료된다.

혈액 생화학적 특성을 살펴보면, 공복혈당에서 부족군이 당뇨 전 단계 및 당뇨병에 해당하는 비율이 높았다. 중년 남성을 대상으로 한 Her [17]의 연구에서, 지방 에너지 섭취비율이 15% 미만인 군에서, 공복혈당 100 mg/dL 이상 해당자의 비율이 가장 높아, 본 연구의 결과와 유사하였다. 당화혈색소는 지방 에너지 섭취비율이 부족군이 당뇨병 진단에 해당하는 비율이 높아, 공복혈당의 결과와 유사하였다. Guasch-Ferré 등[11]은 총 지방 섭취량이 낮을수록, 탄수화물 에너지 섭취비율은 높았으며, 공복혈당 또한 높았다고 보고하였다. 지방 섭취가 낮으면 상대적으로 탄수화물 섭취가 높아져, 혈당 조절에 부정적인 영향을 미쳤을 것으로 보인다. 따라서 바람직한 혈당 조절을 위해 지방 에너지 섭취비율을 적정 수준 섭취하도록, 교육하는 것이 중요하다고 생각된다. 중성지방 기준에 의한 고중성지방혈증도 부족군에서 높았다. 중년 남성 대상 Her [17] 연구에서, 지방 에너지 섭취비율 15% 미만인 군에서, 중성지방 수치가 정상보다 높은 대상자가 많았다고 보고하여, 본 연구 결과와 유사하였다. 이는 지방 에너지 섭취비율 15% 미만 부족군에서 고중성지방혈증의 위험이 높아짐을 시사하며, 적정수준 섭취를 위한 영양교육이 매우 중요하다고 사료된다.

에너지, 탄수화물, 단백질, 식이 섬유의 양적 섭취를 살펴보면, 에너지는 부족군에서 에너지필요추정량 미만 섭취자의 비율이 60%를 넘어 에너지 섭취 부족의 위험이 있다고 생각된다. 이와 관련하여 Moon & Lee [29] 연구에서, 지방 에너지 섭취비율 15% 미만으로 섭취하는 군이, 다른 군에 비해 에너지 권장량 75% 미만으로 섭취하는 비율이 유의적으로 높아, 본 연구 결과와 유사하였다. 섭취한 에너지보다 소비된 에너지가 높으면 신체 성장 및 건강 유지를 위해 필요한 에너지가 부족하여, 체 소모가 일어나게 되며, 이는 중년기에 있어서, 면역 및 감염성질환 등의 위험을 증가시킬 수 있다[7]. 따라서 지방 에너지 섭취비율이 적정 수준 미만인 군에 있어서, 에너지 섭취 증가를 교육 및 방안 마련이 필요하다고 사료된다. 탄수화물은 지방 에너지 섭취비율이 높아질수록 평균필요량 미만 섭취자의 비율이 증가하였다. 중년 남성을 대상으로 한 Her [17]의 연구에서, 지방 에너지 섭취비율이 증가할수록 평균 탄수화물 섭취량이 감소한 결과와 유사하였다. 이는 지방 에너지 섭취비율이 증가할수록 탄수화물로부터 얻는 에너지가 감소되어, 탄수화물 섭취

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량 또한 감소되었기 때문으로 생각된다. 따라서 지방 에너지 섭취비율 30% 이상 과잉군을 대상으로, 탄수화물 섭취 증가를 통해 지방 에너지 섭취비율을 낮추는 식사 교육이 필요하다고 생각된다. 단백질은 부족군에서, 평균필요량 미만 섭취자 비율이 세 군 중 가장 높았다. Moon & Lee [29]의 연구에서, 지방 에너지 섭취비율이 낮을수록 단백질 권장량의 75% 미만으로 섭취하는 비율이 높았다고 보고하여, 본 연구와 유사한 결과를 보였다. 중년기 단백질 섭취 부족은 면역력 저하, 근감소증, 대사조절 이상 등의 건강문제를 일으킬 수 있으므로[7], 지방 에너지 섭취 15% 미만 부족군에서 충분한 양질의 단백질 섭취를 위한 방안 마련이 필요하다고 생각된다. 식이섬유는 과잉군에서 충분섭취량 미만 섭취자 비율이 50% 이상으로 세 군 중 가장 많았다. 총 지방 섭취량을 4분위로 나누어, 식이섬유 섭취량을 살펴본 Guasch-Ferré 등[11]의 연구에서, 1분위수에 비교하여 4분위수에서 식이섬유 섭취량이 유의적으로 낮은 것으로 나타나, 본 연구 결과와 유사하였다. 지방 에너지 섭취비율 30% 이상 과잉군에서 식이섬유의 섭취를 높이는 것이 필요하며, 식이섬유가 풍부한 식품 섭취를 통하여 지방 에너지 섭취비율을 낮출 수 있을 것으로 생각된다.

비타민, 무기질의 양적 섭취를 살펴보면, 비타민 A는 지방 에너지 섭취비율이 낮은군에서 평균필요량 미만 섭취자 비율이 높아, Moon & Lee [29]의 연구 결과와 유사하였다. 한편 비타민 A의 평균필요량 미만 섭취자의 비율이 모든 군에서 60% 이상을 보인 것으로 나타나, 중년 성인에 있어서 비타민 A 섭취량 증가를 위한 방안 마련이 시급함을 보여주었다. 티아민은 평균필요량 미만 섭취자 비율이 적정군에서 가장 낮았고, 과잉군, 부족군 순으로 많아, 지방 에너지 섭취의 적정 수준이 탄수화물의 적정 수준 섭취와 관련이 있으며, 이는 티아민 섭취에도 영향을 미치는 것으로 생각된다. 리보플라빈과 니아신은 다른 군에 비해 부족군에서 평균필요량 미만 섭취자 비율이 50%를 넘어 결핍의 위험이 있는 것으로 생각되며, 이들 영양소 섭취량의 증가를 위한 방안 마련이 필요하다고 생각된다. 엽산은 부족군과 과잉군에서 평균필요량 미만 섭취자 비율이 50% 이상으로 높아 엽산 결핍의 위험이 높다고 생각된다. 체내 엽산 부족은 혈장 호모시스테인을 증가시키며, 이는 심혈관질환과 뇌졸중의 위험요인이 되므로[5] 엽산 섭취를 충분하게 하는 것은 심뇌혈관질환의 예방 및 관리에 있어 중요할 것으로 생각된다. 따라서 지방 에너지 섭취비율 30% 이상 과잉군, 혹은 15% 미만 부족군에서, 엽산 섭취량을 늘리기 위한 방안 마련이 필요할 것으로 생각된다. 비타민 C는 모든 군에서 평균필요량 미만 섭취자 비율 70% 이상을 보여 중년 성인에서 특히 지방 에너지 섭취비율이 부족군에 있어서, 비타민 C 섭취량 증가에 대한 방안 마련이 시급함을 보여주었다. 비타민 C는 항 산화작용, 콜라겐 합성, 신경전달물질 합성, 면역 기능 등에 관여하여 그 섭취가 매우 중요하므로[36], 비타민 C 섭취 상태 개선은 질병 예방 및 관리에 있어서 중요할 것으로 생각된다. 칼슘은 평균필요량 미만 섭취자 비율이 78.5%로 세 군 중 부족군에서 가장 높았으며, 부족군 뿐 아니라 적정군, 과잉군에서도 60% 이상으로 높아 칼슘 결핍 위험이 높은 것으로 나타났다. 칼슘은 중년 여성의 위험 질환인 골다공증과 연관되어 있어, 그 섭취가 더욱 중요하다[34]. 따라서 중년 성인에서 칼슘 섭취 증가를 위한 방안 마련이 절실하다. 인과 철은 세 군 모두에서 권장섭취량 이상 상한섭취만 미만 섭취자의 비율이 가장 높아, 비교적 부족할 위험이 적은 것으로 보인다. 하지만, 지방 에너지 섭취비율 부족군에서 평균필요량 미만 섭취자의 비율이 적정군, 과잉군에 비해 매우 높았다. 따라서 지방 에너지 섭취비율이 15% 미만 부족군 대상, 인과 철의 섭취량을 권장섭취량 수준으로 섭취하는 교육이 필요하다고 생각된다. 칼륨은 부족군에서 충분섭취량 미만 섭취비율이 가장 높았을 뿐 아니라, 적정군, 과잉군에서도 65% 이상이었다. 중년 성인에 있어서, 칼륨은 혈압 조절 등 중요한 역할을 하므로[36], 부족되지 않도록 권장섭취량 수준의 섭취 증가를 위한 방안 마련이 필요할 것으로 생각된다. 나트륨은 만성질환 위험감소를 위한 섭취량 이상 섭취자의 비율이 적정군에서 가장 높았으며, 모든 군에서 60% 이상으로 높았다. 나트륨의 과도한 섭취는 고혈압, 심혈관계질환, 위암 등 여러 만성질환의 위험을 증가시킬 수 있으므로[36] 중년 성인에 있어서 나트륨 섭취 저감을 위한 대책 마련이 중요할 것으로 생각된다.

영양소의 질적 섭취를 살펴보면, 탄수화물, 단백질, 티아민, 리보플라빈, 인, 철은 INQ가 1.0 이상인 바, 이들 영양소의 섭취는 질적으로 양호한 것으로 보인다[37]. 비타민 A, 비타민 C, 칼슘은 INQ가 0.75 이하로 나타나, 이들 영양소의 섭취는 질적으로 좋지 않은 것으로 보인다. 이들 영양소에 대한 질적 섭취를 높이는 방안이 필요할 것이다. 각 군별 질적 향상이 시급한 영양소를 살펴보면, 부족군은 비타민 A, 칼슘, 과잉군은 비타민 C의 질적 섭취 향상이 절실하다고 나타났다. 지방 섭취비율에 따른 부족군, 과잉군별 해당 영양소의 좋은 급원식품에 대한 교육 등이 필요하다고 사료된다.

만성질환 발병 위험도를 살펴보면, 이상지질혈증, 뇌졸중, 심근경색증/협심증, 고혈압 위험도에서 유의적인 차이를 보이지 않았다. Mazidi 등[38]의 연구에서, 총 지방 섭취량을 4분위로 나누었을 때, 4분위수와 비교하여 1분위수에서 심혈관질환 위험이 유의적으로 높다고 하였다. 총 지방 섭취량을 4분위로 나누어 고혈압 위험도를 살펴본 Yuan 등[30]의 연구에서도, 총 지방 섭취 분위수가 낮을수록, 고혈압의 위험이 유의적으로 낮아짐을 보고하여, 본 연구 결과와 다소 다른 결과를 보였다. 이는 본 연구는 지방 에너지 섭취비율에 정상군 대비 부족군, 과잉군의 위험도를 살펴보았으나, Mazidi 등[38], Yuan 등[30]의 연구는 총 지방 섭취량을 4분위로 나누어 총 지방 섭취량에 대한 위험도를 살펴본 점, 특히 Yuan 등[30]의 연구에서, 가장 낮은 지방 섭취량을 보인 1분위가 지방에너지 섭취가 30.5%, 4분위가 지방에너

지섭취 45.5%를 보여, 전체 연구대상자의 지방 섭취가 모두 높았던 점으로 인해, 본 연구와는 다소 다른 결과를 보였을 것으로 생각된다. 따라서 지방 에너지 섭취비율에 따른 만성질환 위험도 관련하여, 추가적인 후속 연구가 필요하다고 생각된다. 또한 Mazidi 등[38]의 연구에서, 포화지방산 섭취 증가는 심혈관계질환과 뇌졸중 위험 증가, 다가불포화지방산 섭취 증가는 심혈관계질환과 뇌졸중 위험 감소와 유의적 연관성이 있는 것으로 보고 한 바, 추후 다양한 지방산의 종류에 따른 만성질환 위험도를 살펴보는 연구도 이뤄져야 할 것이다. 당뇨병은 적정군 대비 부족군에서 위험도가 1.43배 높았다. 이는 지방 에너지 섭취비율이 낮을 때, 탄수화물 섭취의 증가로 혈당 상승에 영향을 미친다고 보고한 Her [17]의 연구를 바탕으로, 지방 에너지 15% 미만 섭취는 당뇨병 위험을 증가시키는 것으로 사료된다.

간경변증은 부족군 3.62배, 과잉군 5.83배로 높아, 지방 에너지 섭취비율의 적정 수준을 벗어나는 것은 간경변증의 위험을 크게 높일 수 있음을 보여주었다. 지금까지 지방 섭취에 따른 간경변증의 위험을 살펴본 연구는 미미하였지만, Rosqvist 등[13]과 Luukkonen 등[39]의 연구에서, 포화지방산의 과도한 섭취는 간의 지방 축적을 유의미하게 증가시키는 것으로 보고하였다. 지방이 간에 5%를 초과하여 축적된 상태인 지방간은 정도가 심해지면 간경변증으로 진행할 수 있어[25] 간경변증 예방을 위해, 지방 에너지 15%–30%로 섭취하는 것이 매우 중요하다고 생각된다. 대사증후군은 적정군과 비교하여, 부족군 1.28배, 과잉군 1.13배로 증가하였다. Her [17]와 Lee & Kwon [40]의 연구에서, 지방 에너지 섭취비율 15% 이상 25% 미만인 군에 비해, 15% 미만 군과 25% 이상 군에서, 대사증후군 위험도가 다소 높았으나, 통계적으로 유의미하지는 않았다. 그러나 낮은 HDL-콜레스테롤, 높은 수축기혈압과 같은 대사증후군의 위험요인에는 유의적으로 영향을 미치는 것으로 보고되어[40], 대사증후군 위험 감소를 위해 지방 에너지 15%–30%를 섭취하는 것이 중요할 것으로 생각된다. 비만은 본 연구에서 각 군간 유의미한 차이를 보이지는 않았으나, Wang 등[41]의 연구에서, 지방 에너지 섭취비율을 30% 초과하여 섭취하는 것은 과체중 및 비만의 위험을 13.2% 증가시키는 것으로 보고되어, 비만을 예방하기 위해 지방 에너지 섭취가 30%를 초과하지 않도록 하는 것이 중요하다고 생각된다.

Limitations

본 연구는 국민건강영양조사라는 단면연구를 이용하였기 때문에, 지방 에너지 섭취비율에 따른 관련 요인 들과의 인과관계를 설명하기 어려우며, 또한 24시간 회상조사법을 이용하여 식이섭취 조사를 하였기 때문에, 조사대상자의 일상적인 식생활과 영양섭취 상태를 반영한 것으로 보기 어렵다는 제한 점을 가지고 있다. 따라서 지방 에너지 섭취에 영향을 미치는 다각적인 요소를 규명하기 위한 후속 연구가 이뤄져, 중년 성인의 지방 섭취 개선을 위한 보다 구체적이고, 실질적인 방안 마련이 필요하다고 사료된다.

Conclusion

본 연구 결과, 우리나라 중년 성인대상 지방 에너지 적정비율 15%–30% 섭취를 위한 교육 및 환경조성을 위한 방안마련이 필요하다고 사료된다. 방안 마련 시, 연령, 성, 거주지역, 교육 정도, 소득 수준을 고려해야 할 필요가 있으며, 대상자의 지방에너지 섭취비율에 따라 맞춤 방안이 필요하다고 사료된다. 지방 에너지 15% 미만 섭취자는 지방에너지 섭취 증가와 함께, 신체활동, 음주, 흡연관련 교육과 주관적 건강인식을 높일 수 있는 방안이 마련되어야 할 것이다. 또한 전체 영양소의 양적 섭취, 비타민 A와 칼슘의 질적 섭취를 높이는 방안이 필요하며, 공복혈당, 당화혈색소를 낮추는 방안, 당뇨병, 대사증후군, 간경변증 예방 및 관리 방안 마련도 필요하다. 지방 에너지 30% 이상 섭취자는, 지방에너지 섭취 감소와 함께, 식이섬유의 양적 섭취, 비타민 C, 엽산의 질적 섭취를 높이는 방안이 필요하며, 대사증후군과 특히 발병위험도가 매우 높은 간경변증 예방 및 관리대책 마련이 필요하다고 사료된다.

CONFLICT OF INTEREST

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

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DATA AVAILABILITY

The data that support the findings of this study are openly available in the Korea National Health and Nutrition Examination Survey at http://knhanes.kdca.go.kr.

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Instructions for authors

KJCN
Korean Journal of Community Nutrition

Revised in October 15, 2024

1. GENERAL INFORMATION

The *Korean Journal of Community Nutrition* (KJCN), the official journal of the Korean Society of Community Nutrition, is a peer-reviewed, open access journal. It is published bimonthly in February, April, June, August, October and December. KJCN aims to publish original research articles and reviews covering all aspects of community nutrition. The journal also welcomes research notes and educational materials that provide a wide range of findings of community nutrition field. Topics of interest include nutrition throughout the life cycle, nutrition assessment, nutrition education, nutritional epidemiology, dietary behavior, clinical nutrition, international nutrition, nutrition policy, food service management, food culture and other topics related to the improvement of human nutritional status.

2. AUTHORS' QUALIFICATIONS

It is essential that at least one author of the manuscript is a member of the Korean Society of Community Nutrition. Exceptions will be made when the Editorial Committee invites authors and when researchers affiliated with institutions outside Korea submits.

3. TYPES OF MANUSCRIPTS

1) **Research articles:** Research articles are reports of original research in the area of community nutrition.
2) **Reviews:** Reviews provide concise and precise updates on the latest progress made within the scope of the journal. Systematic reviews should follow the PRISMA guidelines.
3) **Research notes:** Research notes discuss new ideas, research methods, or policy issues relevant to community nutrition.
4) **Educational materials:** Educational materials describe contents of nutrition education program, its application or new approaches to nutrition education.

4. RESEARCH AND PUBLICATION ETHICS

1) **Duplicate publication:** The manuscript must be original and not published or submitted for publication in other scientific journals.
2) **Authorship:** All authors listed in a manuscript must have contributed substantially to the research design, collection and analysis of data, or preparation of the manuscript. And they should agree to be responsible for investigating and solving research-related problems.
3) **Protection of human subjects:** Research carried out on human subjects must be in compliance with the Helsinki Declaration, and authors should specify that it was reviewed and approved by an Institutional Review Board (IRB).
4) **Conflicts of interest:** Authors must disclose any financial or personal relationships with the company or organization sponsoring the research.
5) **Adherence to the ethics guidelines:** Authors should adhere to the research ethics regulations and guidelines of Korean Society of Community Nutrition. For the policies on the research and publication ethics not stated in these instructions, international standards of publication ethics for editors and authors (http://publicationethics.org/international-standards-editorsand-authors) can be applied.
6) **Copyright:** Copyright of the published article belongs to the Korean Society of Community Nutrition. A copyright transfer form should be signed by all author(s) and sent when the manuscript is submitted.
7) **Preprints:** The journal does not accept research articles that have been shared as preprints.

5. CONSIDERATION OF SEX/GENDER

In all studies, sex (a biological variable) or gender (a socio, cultural, and psychological trait) should be factored into research designs and analyses and reported in a manuscript as follows.

- Sex and gender should be described separately and correctly.
- Both sexes/genders should be included in the human studies, and the differences between the sexes/genders should be analyzed and reported.
- If only one sex/gender is reported, or included in the

study, the reason the other sex/gender is not reported or included should be explained based on reasonable and scientific basis.

6. SUBMISSION

A manuscript file without authors' information must be submitted through our online submission system (https://submit-kjcn.or.kr) by the corresponding author. In addition, authors should remember to upload the author's information separately. This includes the title page, copyright transfer agreement signed by all authors, IRB approval, and author checklist. You can upload these documents to the "Attachment" section on the submission site.

7. PEER REVIEW

A submitted manuscript without authors' information is sent to two independent reviewers selected by an editor-in-chief or an editor. Reviewers review the manuscript in detail according to the KJCN review guidelines. The editor-in-chief then makes an initial decision based on the reviewers' comments and notifies the corresponding author of the decision within six weeks of receipt of a manuscript. One additional reviewer can be appointed when the two reviewers' comments are not in agreement.

8. MANUSCRIPT PREPARATION

1) **General:** Text must be written in Korean or English using MS Word program. The designated font style for English is Times New Roman in 11-point and the text should be 200%-spaced or double-spaced. Each page must be numbered beginning with the abstract page. Manuscripts are to have line numbers in the left margin.
2) **Title page:** The title page should include the following:
   - The type of manuscript (research articles, reviews, research notes, and educational materials)
   - The running head summarizing in Englisgh (50 characters or less including spaces)
   - Titles should be written in sentence case (only the first word of the text and proper nouns are capitalized). For observational studies (cross-sectional, case-control, or prospective cohort), clinical trials, systematic reviews, or meta-analyses, the subtitle should include the study design.
   - The names and affiliations, positions of all authors

A corresponding author should be marked with "†" at the end of the name. If some of the authors have different affiliations, superscript 1), 2), 3) should be placed at the end of each author's name in this order and the same number should be placed in front of the affiliation. 1), 2), 3) are attached in the same order, even if they belong to the same organization but have different positions.

The position of the researcher (professor, lecturer, student, researcher, etc.) should be listed in front of the affiliation. If there is no position and title, only the name is given. For minors who are not currently affiliated, submit the final affiliation, position, and school year separately.

<Example>
Youngok Kim[1)], Jin-Sook Yoon[2)†], Kil-dong Hong[3)], Na-ra Kim[4)]
[1)]Professor, Department of Food and Nutrition, Dongduk Women's University, Seoul, Korea
[2)]Professor, Department of Food and Nutrition, Keimyung University, Daegu, Korea
[3)]Student, Graduate School of Education, Keimyung University, Daegu, Korea
[4)]Student, OO High School, Daegu, Korea

- The name, address, telephone number, fax number, and email address of the corresponding author in English. Country code is also indicated for telephone and fax numbers.

<Example>
Kil-dong Hong
... ... (address)
Tel: +82-2-749-0747
Fax: +82-2-749-0746
Email: kjcn45@koscom.or.kr

- ORCID (https//orcid.org/)
  All authors should register their affiliation and position at ORCID. When author identification is required, this information can be used. ORCID numbers of all authors should be indicated without blinding.

<Example>
Kil-Dong Hong https://orcid.org/****-****-****-****

• Funding

When there is no funding associated with the manuscript, “None” should be stated.

<Example>

This research was supported by a grant from the National Research Foundation of Korea (Grant No. ***).

3) Arrangement of research articles: Each manuscript should be divided into the following sections in the order: Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, References, followed by Tables and Figures. These section headings and subheadings should be written in English. In case of educational materials, the contents of the results and discussion can be composed of contents, evaluation, and implications. In the case of a review, unlike the structure of a research articles, it can be described as an introduction, body, and conclusion. However, a scoping review or a systematic review should follow the structure of the research articles.

The journal encourages authors to describe the study according to the reporting guidelines relevant to their research design, such as those outlined by the EQUATOR Network (http://www.equator-network.org/home/) and the United States National Institutes of Health/ National Library of Medicine (http://www.nlm.nih.gov/services/research_report_guide.html).

• Ethics Statement

Authors should present an “Ethics statement” immediately after the heading “Methods”. In case of reviews, research notes and educational materials, “Ethics statement” should be presented after introduction section.

<Example>

The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number).]

<Example>

Obtainment of informed consent was exempted by the institutional review board.

• Study Design

Authors should present the study design (e.g., descriptive analysis, randomized controlled trial, cohort study, or meta-analysis) and any reporting guidelines referenced in the "Methods" section.

<Example>

This was a cross-sectional study. It was described according to the STROBE statement (https://www.strobe-statement.org/).

• Discussion

Authors should interpret the results and provide the Limitations and Conclusion in the latter part of the “Discussion” section.

• Conflict of Interest

<Example>

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

<Example>

Kildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest.

• Acknowledgments

Describe the person who helped write the thesis or research but was not appropriate as an author.

<Example>

We thank the physicians who performed the sample collection.

• Data Availability

Authors should provide a data availability statement. Providing access to research data is optional.

<Example>

The data that support the findings of this study are openly available in [repository name e.g “KNHANES”] at http://doi.org/[doi].

4) Abstract: A structured abstract of 250~300 words must be written in English under the following headings: Objectives, Methods, Results, and Conclusion. Abstracts should be accompanied by keywords in English.

5) Keywords: A Three to five keywords are recommended with one or two words except for technical terms. The terminology should be listed, in principle, in MeSH (www.nlm.nih.gov/mesh/MBrowser.html). Keywords are written in lowercase letters except for proper nouns,

and keywords are separated by a semicolon (;).

6) **Abbreviations:** All abbreviations must be defined in parentheses at first mention in the text. Abbreviations used in a table or figure should be defined in their respective table footnote or figure legend.

7) **Numbers and measurements:** Numbers should be presented in Arabic numerals. For most measurements, the International System of Units (SI) is recommended. The unit symbol should be placed after the numerical value and a space should be left between the numerical value and the unit symbol except %, ˚C.

8) **References**

- References should be numbered consecutively in the order in which they appear in the text using Arabic numerals in brackets.
- When more than one reference is cited at the same point in the text, they are included in the same bracket as below.

<Example>
[1-3] or [4, 7]

- When the authors' names of the references are inserted in the text, the last names of the authors are given in English. When the reference has two authors, both authors' names should be joined by '&,' and when the reference has more than two authors, the first author's name should be given followed by *'et al'*.

<Example>
Kim [2], Park & Lee [5], Brown *et al*. [7]

- Reference list should be given in English in numerical order corresponding to the order of citation in the text.
- References should follow the National Library of Medicine (NLM) style guide (http://www.nlm.nih.gov/citingmedicine).
- Abbreviations of journal names should be written according to the international rules for the abbreviation (https://www.ncbi.nlm.nih.gov/journals) or KoreaMed (https://www.koreamed.org/JournalBrowserNew.php).
- Master's thesis and doctoral dissertation should be cited less than three.

(1) Journal articles

① *Published journal articles*

Authors. Article title. Journal title Year of publication; Volume(Issue): Start page-Last page.

<Example> Mo YJ, Kim SB. Sodium related recognition, dietary attitude and education needs of dietitians working at customized home visiting health service. Korean J Community Nutr 2014; 19(6): 558-567.

When an article has more than six authors, the names of the first six authors should be given followed by 'et al.'

<Example> Yon MY, Lee HS, Kim DH, Lee JY, Nam JW, Moon GI et al. Breast-feeding and obesity in early childhood - based on the KNHANES 2008 through 2011-. Korean J Community Nutr 2013; 18(6): 644-651.

② *Forthcoming journal articles*

Authors. Article title. Journal title Year of publication. Forthcoming.

<Example> Kim YS, Lee HM, Kim JH. Sodium-related eating behaviors of parents and its relationship to eating behaviors of their preschool children. Korean J Community Nutr 2015. Forthcoming.

(2) Books

① *Entire books*

Authors. Title. Edition. Publisher; Year of publication. p. Start page-Last page.

<Example> Park YS, Lee JW, Seo JS, Lee BK, Lee HS, Lee SK. Nutrition education and counselling. 5th ed. Kyomunsa; 2014. p. 32-55.

<Example> Ministry of Health and Welfare (KR), The Korean Nutrition Society. Dietary reference intakes for Koreans 2020: Minerals. Ministry of Health and Welfare; 2020. p. 25-46.

② *Book chapter*

Chapter authors. Chapter title. In: Editor names, editors. Book title. Edition. Publisher; Year of publication. p. Start page-Last page.

<Example> Tamura T, Picciano MF, McGuire MK. Folate in pregnancy and lactation. In: Bailey LB, editor. Folate in Health and Disease. 2nd ed. CRC press; 2010. p. 111-131.

③ *Translated books*

Translators. Translated title(translated version). Edition. Original language originally written by authors. Publisher; Year of publication. p. Start page-Last page.

<Example> Mo SM, Kwon SJ, Lee KS. Do you know dining table of children? (translated version). 1st ed. Japanese original written by Adachi M. Kyomunsa; 2000. p. 20-22.

(3) Scientific reports

Authors. Report title. Performing organization; Year of publication Month of publication. Report No. Report number.

<Example> Lee YM. A study on development of food safety and nutrition education program for preschooler. Ministry of Food and Drug Safety; 2013 Nov. Report No. 13162consumer110.

(4) Thesis and dissertaion

Author. Title. [Book type]. Publisher; Year of publication. master's thesis for master degree, dissertation for doctoral degree

<Example> Ahn SY. The perception of sugar reduction in nutrition teachers or dieticians in charge of school meals and their use of added sugar in Seoul. [master's thesis]. Sookmyung Women's University; 2014.

(5) Conference papers

Authors of paper. Title of paper. Proceedings of Conference title; Year Month Day; Place of conference: p. Start page-Last page.

<Example> Shim JE. Infant and child feeding practices for development of healthy eating habits. Proceedings of 2014 Annual Conference of the Korean Society of Community Nutrition; 2014 Nov 14; Seoul: p. 195-213.

(6) Articles in magazine or newspaper

① *Magazine articles*

Author. Article title. Magaxine title. Year Month: Page.

<Example> Lee BM. Nutrition treatment of hereditary metabolic diseases. Nutrition and Dietetics. 2013 Dec: 12-19.

② *Newspaper articles*

Author or Organization. Article title. Newspaper title. Year Month Day; Section: Page.

<Example> Lee JH. Sodium reduction need to readjust policy. Food and Beverage News. 2014 Sep 29; Sect. A: 1.

(7) Materials on the internet

① *Web sites*

Author or Organization. Title [Internet]. Publisher; Year [cited Year Month Day]. Available from: electronic address

<Example> The Korean Society of Community Nutrition. Nutrient story [Internet]. The Korean Society of Community Nutrition; 2007 [cited 2015 May 12]. Available from: http://www.dietnet.or.kr/

② *Web page*

Author or Organization. Title [Internet]. Publisher; Year [updated Year Month Day; cited Year Month Day]. Available from: electronic address

<Example> Ministry of Food and Drug Safety. Winter food poisoning, be careful of norovirus [Internet]. Ministry of Food and Drug Safety; 2014 Nov 14 [updated 2014 Dec 11; cited 2015 Feb 1]; Available from: http://www.mfds.go.kr/fm/article/view.do?articleKey=1245&searchTitleFlag=1&boardKey=4&menuKey=167&currentPageNo=1

9) Tables and Figures: Tables and Figures must be written in English, and limited to a maximum of 10 altogether. Each table and figure should be prepared on a separate page and placed at the end of the text according to the order cited in the text. Citation of tables or figures in the text is as Table 1 or Fig. 1. Vertical lines are not used in tables. A title should be placed at the top of a table or at the bottom of a figure. The footnotes of the table are presented on Arabic numerals as superscripts 1), 2), 3). In case of indicating levels of significance, *P*-values should be presented in the body of each table, and if necessary, symbols can be used as *, **, ***, etc. To indicate the result of multi-range tests, letters such as a, b, c, etc. can be used.

9. PUBLICATION

Once the review process is completed, the manuscript cannot undergo any modifications in their contents or changes of the authors. PDF page proofs will be emailed

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Tel: +82-2-749-0747
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Email: kjcn45@koscom.or.kr

The code of research ethics of the Korean Society of Community Nutrition

Enactment Jan 21, 2008
1st revision April 19, 2010
2nd revision March 28, 2014
3rd revision February 28, 2020

I. GENERAL RULES

1. Title

This code is titled as 'The Code of Research Ethics of the Korean Society of Community Nutrition.'

2. Purpose

The purpose of the code is to establish the standard for the research ethics observed by the members of the Korean Society of Community Nutrition and the contributors to the Korean Journal of Community Nutrition, and determine the establishment and operation of the Committee on the Research Ethics (hereafter the 'Committee') for fair and systematic verification in the case of the scientific misconduct.

II. ETHICS CODE FOR A RESEARCHER

3. Integrity of Researcher

A researcher should conduct research and publish research results with research integrity.

4. Inclusion of Scientific Misconduct

(1) Fabrication refers to the act of creating, documenting, or reporting the data or the research results that do not exist.
(2) Falsification refers to the act of creating the documentation that do not match study results by manipulating the research materials, equipment, or procedures or changing or omitting data or research results.
(3) Plagiarism refers to steal others' ideas, procedures, results, or records without legitimate authorization.
(4) The improper authorship refers to the act which confers authorship on the person without any academic contribution due to gratitude or seniority, or does not reward with authorship without proper cause to the person who academically contributes or devotes the research contents or results.
(5) It includes the acts which seriously exceed generally accepted criteria.

5. Prohibition of Duplicate Submission or Duplicate Publication of Research Product

A researcher should not submit or publish the same research results in two different places.

6. Authorship

Contributors who have made substantive intellectual contributions to a paper are given credit as author and authorship is based on the following four criteria.
(1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
(2) Drafting the work or reviewing it critically for important intellectual content; AND
(3) Final approval of the version to be published; AND
(4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

7. Record of Published Work

(1) An author should accept the credit for only the accomplishments of the research he/she conducted or contributed to and take responsibility for them.

(2) The order of the authors (including translators) of articles or other publications should be determined with fairness according to the extent of the contribution to research regardless of relative positions. Simply being in a particular position should not guarantee a credit as a co-author, the first author, or a corresponding author. Neither the act of not crediting the sufficient contribution to research with authorship can be justified. When the contribution to research is low, a statement of appreciation is expressed in a footnote, a preface, or an acknowledgement.

8. Citation and Reference

(1) An author who cites academic materials should make efforts to describe them accurately and state their sources clearly. The materials that are obtained from personal communication can be cited with the permission from the researcher who provides information.

(2) When an author cites or makes a reference to others' words, he/she should state the fact in a footnote, and distinguish them from his/her original thoughts or results of interpretation.

9. Role and Ethics for a Journal Editor

(1) An editor should request a reviewer with expertise in the field, objectivity, and impartial judgment for the evaluation of submitted manuscripts.

(2) An editor should not disclose the information about the author or the content of the manuscript until the submitted manuscript is decided to be published.

10. Role and Ethics for a Reviewer

(1) A reviewer should evaluate the manuscript under review with commitment and impartiality within a specified period and notify a journal editor of results.

(2) A reviewer should notify a journal editor immediately of the intention to resign from reviewing a manuscript when he/she believes oneself to be unsuitable for reviewing the manuscript.

(3) A reviewer should evaluate a manuscript with objective criteria and impartiality without consideration of one's academic beliefs or personal relationship with its author. A reviewer should not reject a manuscript without logical reasons or on the reason that it is in conflict with his/her own view or interpretation, and rate a manuscript without reading it thoroughly.

(4) A reviewer should respect an author's personality and individuality as an intellectual and use comments in a polite and gentle manner as much as possible, and should not use degrading or insulting expressions.

(5) A reviewer should maintain confidentiality of a manuscript under review and should not cite the content of a manuscript prior to its publication.

III. ESTABLISHEMENT AND OPERATION OF THE COMMITTEE

11. Function of the Committee

The Committee reviews and decides the issues below related to the research ethics of the members of the Korean Society of Community Nutrition.

1. The establishment of the research ethics
2. The prevention and investigation on the scientific misconduct
3. Whistleblower protection and confidentiality
4. Verification on the violation of the research ethics, process of the verification results and follow-up measures
5. Restoration in the honor of the examinee
6. Other issues imposed by the chair of the Committee

12. Organizing Principles of the Committee

The Committee consists of 5 members. The committee is chaired by the President of the Society and the Editor-in-chief serves as the associate chair of the committee. The other three are appointed by the President of the Society with the recommendation from the Executive Board.

13. Report and Receipt of the Scientific Misconduct

The whistle-blower may provide the information to the secretariat of the editorial board in the Korean Society of Community Nutrition directly or through the telephone, written document or e-mail on the real name. However, if the contents and evidence of the misconduct are specific, the report provided by an anonymous informant is considered as the case by the real-name person.

14. Authority for Verification and Recommendation of the Committee

The Committee is authorized to conduct an investigation about the allegation of the violation of the ethics code using a wide range of evidence from informants, the person under investigation, witnesses, and reference materials. The committee reviews and decides the status of violation of the ethics code based on the results of investigation, and recommends appropriate sanctions to the president based on the decision.

15. Verification Process of the Committee

The verification process for the act of violation of research ethics proceeds in the order of preliminary inquiry, investigation, and judgment. The investigation should be completed within 6 months. However, when the investigation is unlikely to be completed within the time frame, the investigation period may be extended with the committee chair's approval. When an informant or the person under investigation disagrees with the decision, he/she may file an appeal within 30 days from receiving notification, and the Committee may conduct reinvestigation if necessary.

16. Assurance of Opportunity to Be Heard

The member who is alleged to violate the Code of Research Ethics should be given a written notice of the overview of the issue under investigation. He/she is guaranteed to have an opportunity to submit a letter of explanation, and as long as he/she whishes, an opportunity to attend one or more of the Committee meetings in the investigation procedure and provide an oral explanation.

17. Confidentiality Duty for a Member of the Committee

A member of the Committee shall not disclose the identification of the reporter and the member suspected of the research ethics violation until the final decision is confirmed by the society.

18. Disciplinary Procedures and Content

In the event of proposed disciplinary measures by the Ethics Committee, the committee chair convenes the Executive Board and makes a final decision on the status and the content of discipline. The member who is determined to have violated the Code of Research Ethics may be given disciplines including warning, ban on manuscript submission for a specified period, and suspension or cancellation of membership depending on the severity of the issue, and the article may be retracted and the results may be disclosed if necessary.

19. Revision of the Code of Research Ethics

Revision procedure of the Code of Research Ethics follows the revision procedure of the code of the Society.

Author's checklist

Revised in October 15, 2024

Authors' quick submission checklist

(※ Please include the checklist when submitting the manuscript to the submission site.)

Category		Items to review	Check
Title page	1. Title	- Spelling and typographical errors in paper titles. - Titles should be written in sentence case, with only the first word of the text and proper-nouns capitalized. The study design should be included in the title or subtitle. e.g., Development and Effectiveness Evaluation of the STEAM Education Program on Food Groups for Kindergarteners -> Development and effectiveness evaluation of the STEAM education program on food groups for kindergarteners: a non-randomized controlled study e.g., Program Evaluation using the RE-AIM Framework: A Systematic Review and Application to a Pilot Health Promotion Program for Children -> Evaluation of the pilot health promotion program for children: a systematic review	
	2. Author Information	- Include all author titles and affiliations, and indicate the position before the affiliation	
	3. Submission	- The title page, the copyright transfer agreement, and IRB approval are all included when submitting your paper to the submission site by uploading them to the 'Attachment' section. - Remove the cover page including author information from the submitted paper before submitting	
	4. ORCID	- ORCID should be stated for all authors e.g., Gildong Hong: https://orcid.org/https://orcid.org/0000-0000-0000-0000	
	5. Funding	e.g., This research was supported by a grant from the National Research Foundation of Korea (Grant No. 000). - When there is no funding associated with the manuscript, 'None.' should be stated.	
Abstract	1. Structure	- Objectives-Methods-Results-Conclusion	
	2. Keywords	- Three to five keywords are recommended with one or two words except for technical terms. - The terminology should be listed, in principle, in MeSH (www.nlm.nih.gov/mesh/MBrowser.html). - Keywords are written in lowercase letters except for proper nouns, and keywords are separated by a semicolon (;).	
	3. Abbreviations	- Abbreviations should only be used if they are repeatedly used throughout the abstract. If an abbreviation is not used after it has been defined, use the full name instead - Define an abbreviation the first time it appears in the abstract	
Main body	1. Structure	- Title page, Abstract, Introduction, Methods (including ethics statement), Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability References, Tables, and Figures - Include 'Study Design' in Method, subheadings in Results, and 'Limitations' and 'Conclusion' in Discussion - Upload tables and figures as a single file and do not separate them	
	2. Statistical software	- Enter the correct type and version of statistical software e.g., IBM SPSS Statistics 25 (IBM Corp.) e.g., SAS 9.4 (SAS Institute)	
	3. Ethics Statement	- Authors should present an "Ethics Statement" immediately after the heading "Methods". In case of reviews, research notes and educational materials, "Ethics statement" should be presented after introduction section e.g., The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number: ***). *IRB approval statement will be included in the final version, but do not include specific IRB information (e.g., institution name) when submitting. e.g., Obtainment of informed consent was exempted by the institutional review board.	

(continued to the next page)

(Continued)

Category		Items to review	Check
	4. Conflict of Interest	- Conflict of interest must be stated. e.g., There are no financial or other issues that might lead to conflict of interest. e.g., Gildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest. *Author information will be included in the final version but do not include it when submitting.	
	5. Acknowledgments	- List individuals who contributed to the writing or research, but do not meet the criteria for authorship. e.g., We thank the physicians who performed the sample collection. *This information will be included in the final version, but do not include it when submitting.	
	6. Data Availability	- Authors should provide a data availability statement. Providing access to research data is optional. e.g., The data that support the findings of this study are openly available in [repository name e.g "KNHANES"] at http://doi.org/[doi].	
	7. References	- Notation method: [1], [2, 5], [15-20], etc. without spaces before square brackets, when adding commas between references, add a space after commas. e.g., research on something [1] or Kim & Lee's research [2, 5] - References in the text should be listed in numerical order - The number of citations for the type of dissertation should not exceed 3. - Verify that the reference adheres to the KJCN guidelines	
	8. Other indications such as units	- Write numbers and units with a space (50 kg, 600 kcal), but attach % and °C. - g/dl (X), g/dL (O) - When indicating P-value, use capital, italic P: e.g., *P*-value - Use a en-dash "–" to indicate a range of numbers: e.g., 20–25 - Use comma notation to separate thousands (this also applies to text and tables): For example, 65,450,000.	
	9. Tables, figures	- Capitalize only the first letter of table and figure titles - Capitalize only the first letter of variables in the table - Use lowercase 'n' in tables and figures. - Additional checklists for tables and figures can be found in the section below.	

*Examples shown in the tables are based on recent publication, 2024.

GUIDELINE FOR TABLES AND FIGURES

Please adhere the following guidelines for tables and figures.

1. To indicate the total number of items outside of the table's body, include it in parentheses at the end of the table's title. For example, "Sociodemographic characteristics of children (n = 80)"
2. The table heading should provide a descriptive title for the values presented, rather than simply using "Mean ± SD" as the title.
3. When describing the contents of the table in the text:
   ① To present an average value, use Mean ± SD or Mean ± SE, and be mindful of spacing (e.g., 22.0 ± 2.3, with a space before and after the '±' symbol)
   ② Units should be written in parentheses within the table (e.g., Energy (kcal/day)) instead of next to it (Energy, kcal/day)
4. Footnotes or legends explanations for tables or figures should be written in English
5. The footnotes or legends should be arranged in the following order: Values displayed as statistical outcomes, statistical analysis method, indication of significance, etc.
   ① The presentation of values of statistical outcomes, such as n (%), Mean ± SD, n (%) or Mean ± SD, etc, are displayed in the first line of the footnote without comment numbers.
   ② Statistical analysis method and significance indication - Both statistical analysis methods and significance are discussed. - Post-hoc analysis results can only be presented when the ANOVA test yields significant results.
   ③ The full name of any abbreviations used in the title or table body should be provided in the footnote.
   ④ Any other content that requires explanation should be accompanied by corresponding comment numbers, following the submission guidelines. Verify that the comment numbers match the numbers indicated in the table body.

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투고규정

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Korean Journal of Community Nutrition

(2024년 10월 15일 개정)

1. 학회지의 특성

본 학회지는 대한지역사회영양학회의 학술지로서, 전문가 심사를 거친 논문만을 게재하고, 논문 전문은 학회 홈페이지를 통해 공개된다. 학회지는 2개월마다(2월, 4월, 6월, 8월, 10월, 12월) 발행되며, 발행일은 발간월의 마지막날이다. 생애주기영양, 영양판정,영양교육, 영양역학, 식행동, 임상영양, 국제영양, 영양정책,급식및 외식 관리, 식문화와 기타 지역사회영양학 분야의 연구논문(research articles), 종설(reviews), 연구단보(research notes), 교육자료(educational materials) 등을 게재할 수 있다.

2. 투고 자격

저자 중 적어도 1명이 대한지역사회영양학회 회원이어야 투고할수 있으며, 비회원의 경우 편집위원회에서 위촉 또는 국외 기관에 소속된 저자가 투고할 시 가능하다.

3. 원고의 종류

1) **연구논문:** 지역사회영양학 분야의 새로운 논문
2) **종설:** 특정 주제에 대하여 간결하고 정확하게 최신문헌 및 견해를 기술한 논문, 체계적인 문헌고찰은 PRISMA 가이드라인을 따라야 함
3) **연구단보:** 지역사회영양학과 관련된 새로운 아이디어, 연구방법, 정책적 이슈 등에 대한 토의 보고
4) **교육자료:** 영양교육 프로그램의 내용과 활용, 또는 새로운 교육 접근방법 등에 관한 논문

4. 연구 및 출판윤리

1) **이중게재:** 원고는 다른 학회지에 발표되거나 투고되지 않은것이어야 한다.
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3) **피험자 보호:** 연구의 대상이 사람인 경우 헬싱키 선언에 입각하여 피험자를 보호하여야 하며, 연구를 수행하기 전 기관생명윤리위원회(Institutional Review Board; IRB)의 승인을 받아야 한다.
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7) **프리프린트(preprint):** 본 학회지는 프리프린트로 사전 공유된 연구논문을 허용하지 않는다.

5. 성(SEX)/젠더(GENDER)에 대한 고려

논문에서 결과에 영향을 줄 수 있는 인자로 생물학적 성(sex) 또는 사회문화적 성인 젠더(gender)를 인식하고 이에 대한 아래 내용을 논문에 포함하여야 한다.

- 성별 기술에서 성(sex)과 젠더(gender)를 구분하여 올바르게 기술한다.
- 연구 대상에 남성과 여성을 대상으로 포함하여 연구하고 그 결과를 비교분석하여 논문을 발표한다.
- 단일 성을 대상으로 연구한 경우는 학술적으로 타당한 근거를 제시한다.

6. 논문투고

교신저자는 온라인투고시스템(https://submit-kjcn.or.kr)으로 저자정보가 삭제된 원고파일을 제출한다. 저자정보가 포함 된 표지, 모든 저자의 서명이 작성된 IRB 승인서 사본, 저자체크리스트는 온라인 투고사이트 '첨부파일'에 업로드 한다.

7. 전문가 심사

편집이사 또는 편집위원은 저자정보가 삭제된 투고논문을 두 명의 전문가에게 심사하도록 보내고, 심사자는 대한지역사회영양학회지의 심사규정에 따라 심사한다. 편집이사는 심사자의 의견에 따라 첫 번째 결정을 내리고 6주 안에 교신저자에게 알린다.

두 명의 심사자의 의견이 다를 때에는 또 다른 심사자에게 심사하도록 한다.

8. 원고 작성법

1) 원고 작성: 원고는 MS 워드를 사용하여 한글 또는 영문으로 작성한다. 글자 크기는 11 point, 행간은 200% 또는 2줄 간격으로 하며, 영문 글꼴은 Times New Roman으로 한다. 영문초록을 1쪽으로 하여 쪽번호를 표기하며, 원고 왼쪽 여백에 줄 번호를 매긴다.

2) 표지: 다음의 내용을 포함한다.

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- 압축한 제목(Running head)은 공백 포함 50자 이내의 영문으로 기재
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- 저자, 소속 및 직위를 국문과 영문으로 기재, 단 영문논문의 경우 영문으로만 기재

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〈예〉

Youngok Kim[1], Jin-Sook Yoon[2]†, Kil-dong Hong[3], Na-ra Kim[4]

[1]Professor, Department of Food and Nutrition, Dongduk Women's University, Seoul, Korea

[2]Professor, Department of Food and Nutrition, Keimyung University, Daegu, Korea

[3]Student, Graduate School of Education, Keimyung University, Daegu, Korea

[4]Student, OO High School, Daegu, Korea

- 교신저자의 성명, 주소 및 전화번호, 팩스번호, 전자우편주소를 영문으로 기재. 전화와 팩스번호는 국가코드도 표기

〈예〉

Kil-dong Hong

… …(주소표기)

Tel: +82-2-749-0747

Fax: +82-2-749-0746

Email: kjcn45@koscom.or.kr

- ORCID (https//orcid.org/)

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〈예〉

Kil-Dong Hong https://orcid.org/****-****-****-****

- 연구지원내역(Funding)

  해당하는 내용이 없더라도 'None.' 으로 기재한다.

〈예〉

This research was supported by a grant from the National Research Foundation of Korea (Grant No. ***).

3) 원고의 구성: 원고의 부제목은 모두 영문으로 작성하고, 구성은 다음과 같다. Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability, References, Tables, Figures 순으로 한다. 단, 교육자료의 경우 결과와 고찰의 내용을 콘텐츠(Contents), 평가(Evaluation), 시사점(Implications) 등의 내용으로 구성할 수 있다. 종설의 경우 연구논문의 구성과 달리 서론, 본론, 결론의 구성으로 기술할 수 있다. 그러나 주제범위 고찰(scoping review)이나 체계적 고찰(systematic review)은 연구논문의 구성을 따라야 한다.

  본 학회지는 EQUATOR 네트워크(http://www.equator-network.org/home/)와 미국국립보건원/국립의학도서관(http://www.nlm.nih.gov/services/research_report_guide.html)에서 안내하는 보고지침에 따라 원고를 구성하도록 권장한다.

- 연구윤리(Ethics Statement)

  저자는 "방법(Method)" 연구윤리에 관해 영문으로 기술

해야 한다. 부제목 바로 아래에 제시하며 종설, 연구노트, 교육자료 등의 경우에는 서론 뒤(본론 전)에 제시한다.

〈예〉
The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number: IRB승인번호).
〈예〉
Obtainment of informed consent was exempted by the institutional review board.

• 연구설계(Study design)
저자는 "방법(Methods)" 연구설계에 연구설계(기술분석, 무작위 대조연구, 코호트 연구 또는 메타 분석 등) 및 참고한 보고지침을 제시한다.

〈예〉 This was a cross-sectional study. It was described according to the STROBE statement (https://www.strobe-statement.org/).

• 고찰(Discussion)
저자는 결과를 해석하고 "고찰(Discussion)"의 후반부에 Limitations 및 Conclusion을 제시한다.

• 이해상충(Conflict of Interest)

〈예〉
There are no financial or other issues that might lead to conflict of interest.
〈예〉
Kildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest.

• 감사의 글(Acknowledgments)
논문작성이나 연구를 도왔지만 저자로서 적절하지 않은 분 등을 기술한다.

〈예〉
We thank the physicians who performed the sample collection.

• 데이터가용성(Data Availability)
저자는 데이터가용성에 대한 설명을 작성해야하며, 데이터에 대해 접근을 허용하는 것은 선택사항이다.

〈예〉
The data that support the findings of this study are openly available in [repository name e.g "KNHANES"] at http://doi.org/[doi].

4) **영문초록:** 영문초록은 목적(Objectives), 연구방법(Methods), 결과(Results), 결론(Conclusion)의 소제목으로 구분하여 250~300단어로 작성한다. 초록 아래쪽에 주제어(Keywords)를 영문으로 표기한다.
5) **키워드:** 전문 용어를 제외한 1~2개의 단어로 구성된 3~5개의 키워드를 기재한다. 해당 키워드는 MeSH(https://meshb.nlm.nih.gov/search) 에 검색되는 단어로 작성한다. 키워드는 고유명사를 제외하고 모두 소문자로 표기하며, 구분 기호는 세미콜론(;)으로 작성한다.
6) **약어:** 제일 처음 나오는 곳에 완전한 이름을 먼저 표기한 후 괄호 안에 약어를 표기하며, 표 또는 그림에 사용된 약어는 각주 또는 그림 설명에서 설명한다.
7) **수량 및 단위:** 수량은 아라비아 숫자로, 도량단위는 SI 단위를 권장한다. %, ℃를 제외한 모든 단위는 숫자와 띄어쓴다.
8) **참고문헌**
• 본문 중에는 인용된 순서대로 [ ] 안에 번호로 기재한다.
• 본문의 한 문장에서 여러 개의 참고문헌을 인용할 때에는 다음과 같이 기재한다.

〈예〉 Kim [3]은, Park & Lee [5]는, Brown 등[7]은

• 본문 중에 참고문헌의 저자를 기재하는 경우 영문 last name을 표기한다. 저자가 2명일 경우에는 두 저자 사이에 &를 삽입하고, 3인 이상일 때는 제 1저자만 표기하고 "등"을 쓴다.

〈예〉 Kim [3]은, Park & Lee [5]는, Brown 등[7]은

• 참고문헌 목록은 인용된 순서에 따라 아라비아 숫자와 함께 영문으로 표기한다.
• The National Library of Medicine (NLM) 표준체제(http://www.nlm.nih.gov/citingmedicine)를 따라 작성한다.
• 학회지명은 약어로 표기하되 국제 약어 관례(PubMed 등재지 검색 사이트 http://www.ncbi.nlm.nih.gov/journals) 또는 KoreaMed 등재지 검색 사이트(http://www.koreamed.org/JournalBrowserNew.php)를 참고한다.
• 학위논문은 필요한 경우 3개 이내로 인용한다.

(1) 학술지

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9) 표 또는 그림

표와 그림은 영문으로 작성하며, 합하여 10개 이내로 하고, 한 장에 하나씩 작성하여 인용된 순서대로 본문 뒤에 첨부한다. 본문에 인용할 때는 Table 1 또는 Fig. 1 등으로 표기한다. 표 작성 시에는 종선은 사용하지 않는 것을 원칙으로 하며, 표의 제목은 표의 상단에, 그림의 제목은 그림의 하단에 기재한다. 각주는 1), 2), 3) 등으로 나타내고 하단에 그 내용을 표시한다. 단, 통계분석의 유의성 표시는 표 본문에 *P*-values를 제시하는 것으로 하고, 필요한 경우 *, **, *** 등으로, 다중 범위 검정에서는 a, b, c 등으로 사용한다.

9. 출판

심사가 끝난 논문은 내용이나 저자를 바꿀 수 없다. 교신저자는 교정본 PDF 파일을 e-mail로 받으면 3일 이내에 교정하여 보내야 한다. 원하는 저자에 한하여 게재된 논문의 별쇄본 20부를 제공한다. 저자는 게재된 논문의 게재료로 원고 편집비, 참고문헌 교정비, 파일 가공비 등 소요되는 비용을 부담한다. 단, 심사과정이 시작된 이후 논문을 철회한 경우에는 논문의 심사 단계에서 발생한 심사료 비용을 부담한다. 본 규정에 명시되지 아니한 사항은 편집위원회의 심의를 거쳐 결정한다.

논문투고와 출판 관련 모든 문의사항은 편집사무실로 연락한다.

주소: 서울시 용산구 새창로 213-12, 현대하이엘 904호
전화: 02-749-0747
팩스: 02-749-0746
이메일: kjcn45@koscom.or.kr

대한지역사회영양학회지 연구윤리규정

제정 2008. 1. 21
1차 개정 2010. 4. 19
2차 개정 2014. 3. 28
3차 개정 2020. 2. 28

제1장 총칙

제1조 (명칭)
이 규정은 “대한지역사회영양학회 연구윤리규정”이라 한다.

제2조 (목적)
이 규정은 대한지역사회영양학회 회원 및 대한지역사회영양학회지 투고자가 지켜야 할 연구윤리의 기준을 확립하고, 연구부정행위 발생 시 공정하고 체계적인 검증을 위한 연구윤리위원회(이하 “위원회”라 한다)의 설치 및 운영에 관한 사항을 규정함을 목적으로 한다.

제2장 연구자의 윤리규정

제3조 (연구의 진실성)
연구자는 연구의 진실성을 준수하여 연구를 수행하고 그 결과를 발표하여야 한다.

제4조 (연구부정행위의 범위)
연구부정행위는 다음 각 호와 같다.
1. 위조란 존재하지 않는 데이터나 연구 결과를 만들어 내고 이를 기록하거나 보고하는 행위를 의미한다.
2. 변조란 연구자료, 장비 또는 과정을 조작하거나, 데이터나 연구 결과를 변경하거나 생략하여 연구 기록이 연구결과와 부합하지 않게 하는 행위를 의미한다.
3. 표절이란 정당한 권한 없이 타인의 아이디어, 과정, 결과 또는 기록을 도용하는 것을 의미한다.
4. 부당한 논문저자 표시란 연구내용 또는 결과에 대하여 학문적으로 공헌 또는 기여를 한 사람에게 정당한 이유없이 논문저자 자격을 부여하지 않거나, 학문적으로 공헌 또는 기여를 하지 않은 자에게 감사의 표시 또는 예우 등을 이유로 논문저자 자격을 부여하는 행위를 말한다.
5. 기타 통상적으로 용인되는 범위를 심각하게 벗어난 행위를 포함한다.

제5조 (연구물의 중복 투고 및 이중 게재금지)
연구자는 연구결과를 중복 투고 및 이중 게재 하지 않아야 한다.

제6조 (저자됨)
저자는 출판하는 논문의 연구에 지적인 공헌을 한 자로서 다음 각 호의 자격을 모두 충족하여야 한다.
1. 연구의 구상이나 설계 또는 자료의 수집이나 분석이나 해석을 하는 데 있어서 상당한 공헌을 한 자
2. 논문의 초안을 작성하거나 주요 내용을 검토한 자
3. 출간될 원고를 최종 승인한 자
4. 연구의 정확성이나 무결성과 관련된 문제를 적절히 조사하고 해결하는 것에 책임이 있음을 동의한 자

제7조 (출판 업적의 명기)

① 저자는 자신이 행하거나 기여한 연구에 대해서만 업적을 인정받으며 그에 대한 책임을 진다.

② 논문이나 기타 출판의 저자(역자 포함)의 순서는 상대적 지위에 관계없이 연구에 기여한 정도에 따라 공정하게 정해져야 한다. 단순히 특정 직책으로 인하여 공동저자, 제1저자, 또는 교신저자가 될 수 없다. 연구에 충분히 기여했음에도 저자로 인정되지 않는 행위 또한 정당화될 수 없다. 연구에 대한 기여도가 낮을 경우 각주, 서문, 사의 등에서 사사의 글로 표시한다.

제8조 (인용 및 참고 표시)

① 저자가 학술 자료를 인용할 경우에는 정확하게 기술하도록 노력해야 하고 출처를 명확히 밝혀야 한다. 개인적인 접촉으로 얻은 자료의 경우에는 정보를 제공한 연구자의 동의를 받은 후 인용할 수 있다.

② 저자가 타인의 글을 인용하거나 참고할 경우에는 각주를 통해 인용 및 참고 여부를 밝혀야 하며, 선행연구의 결과인 부분과 저자의 독창적인 견해 또는 해석의 결과인 부분이 구분될 수 있도록 하여야 한다.

제9조 (논문 편집위원회의 역할및 윤리)

① 편집위원은 투고된 논문을 해당 분야의 전문적 지식과 객관적이고 공정한 판단 능력을 지닌 심사위원에게 평가 하도록 의뢰하여야 한다.

② 편집위원은 투고된 논문의 게재가 결정될 때까지는 저자에 대한 사항이나 논문의 내용을 공개하지 않아야 한다.

제10조 (논문 심사위원의 역할및 윤리)

① 심사위원은 심사 대상 논문을 심사규정이 정한 기간 내에 성실하고 공정하게 평가하고 결과를 편집위원에게 통보하여야 한다.

② 심사위원은 자신이 논문의 내용을 평가하기에 적임자가 아니라고 판단될 경우에는 편집위원에게 즉시 사퇴의사를 통보하여야 한다.

③ 심사위원은 심사 대상 논문을 개인적인 학술적 신념이나 저자와의 사적인 친분 관계를 떠나 객관적 기준에 의해 공정하게 심사하여야 한다. 충분한 근거를 명시하지 않은 채 논문을 탈락시키거나, 심사자 본인의 관점이나 해석과 상충된다는 이유로 논문을 탈락시켜서는 안 되며, 심사 대상 논문을 제대로 읽지 않은 채 평가하지 않아야 한다.

④ 심사위원은 전문 지식인으로서의 저자의 인격과 독립성을 존중하여야 하고, 평가의견은 가급적 정중하고 부드러운 표현을 사용하며 저자를 비하하거나 모욕적인 표현을 해서는 안 된다.

⑤ 심사위원은 심사 대상 논문에 대한 비밀을 지켜야 하며, 논문이 게재된 학술지가 출판되기 전에 논문의 내용을 인용해서는 안 된다.

제3장 연구윤리위원회의 설치와 운영

제11조 (위원회의 기능)

위원회는 대한지역사회영양학회 회원의 연구윤리와 관련된 다음 각 호의 사항을 심의, 의결한다.

1. 연구윤리 확립에 관한 사항
2. 연구부정행위의 예방, 조사에 관한 사항
3. 제보자 보호와 비밀유지에 관한 사항
4. 연구윤리 위반 검증 및 검증결과 처리와 후속조차에 관한 사항
5. 피조사자 명예회복 조치에 관한 사항
6. 기타 위원회 위원장이 부여하는 사항

제12조 (위원회의 구성)

위원회는 위원 5인 이상으로 구성하며, 위원장은 학회장으로 하고 부위원장은 편집이사로 하며 그 외 3인은 상임 이사회의 추천을 받아 학회장이 임명한다.

제13조 (연구부정행위의 제보 및 접수)

제보자는 대한지역사회영양학회 편집위원회 사무국에 직접 또는 전화, 서면, 전자우편 등으로 제보할 수 있으며 실명으로 제보해야 한다. 단, 익명제보라 하더라도 구체적인 연구부정행위의 내용과 증거를 포함하여 제보한 경우 이를 실명제보에 준한다.

제14조 (위원회의 검증 및 심의 권한)
위원회는 윤리규정 위반으로 보고된 사안에 대하여 제보자, 피조사자, 증인, 참고인 및 증거자료 등을 통하여 폭넓게 조사를 실시할 수 있고, 그러한 조사 결과에 따라 윤리규정 위반여부를 심의·판정한다.

제15조 (위원회의 검증 절차)
연구윤리 위반행위에 대한 검증절차는 예비조사, 본조사, 판정의 단계로 진행하며 모든 조사 일정은 6개월 이내에 종료되어야 한다. 단, 이 기간 내에 조사가 이루어지기 어렵다고 판단될 경우에는 위원장의 승인을 거쳐 조사 기간을 연장할 수 있다. 제보자 또는 피조사자가 판정에 불복할 경우에는 통보를 받은 날로부터 30일 이내에 이의신청을 할 수 있으며, 윤리위원회에서 이를 검토하여 필요한 경우 재조사를 실시할 수 있다.

제16조 (소명기회의 보장)
연구윤리규정 위반으로 보고된 회원에게는 조사대상이 된 사안의 개요를 서면 통지하고 정해진 기간 내에 소명서를 제출할 기회를 보장하고 본인이 희망하는 경우 본 조사 절차 중 1회 이상 윤리위원회의 회의에 출석하여 구술로 해명할 수 있는 기회를 주는 등 충분한 소명 기회를 주어야 한다.

제17조 (연구윤리위원의 비밀 보호 의무)
연구윤리위원은 제보자의 신원을 노출시켜서는 안 되며, 학회의 최종 결정이 내려질 때까지 연구윤리규정 위반으로 보고된 회원의 신분을 공개해서도 안 된다.

제18조 (징계의 절차 및 내용)
위원회의 징계 건의가 있을 경우, 위원장은 상임이사회를 소집하여 징계 여부 및 징계 내용을 최종적으로 결정한다. 연구윤리규정을 위반했다고 판정된 회원에 대해서는 사안의 경중을 고려하여 경고, 일정기간의 논문투고금지, 회원자격의 정지 또는 박탈 등의 징계를 할 수 있으며, 필요한 경우 논문 게재 취소와 그 결과를 공개할 수 있다.

제19조 (연구윤리규정의 개정)
연구윤리규정의 개정 절차는 본 학회의 규정 개정절차에 준한다.

자가점검표

(2024년 10월 15일 개정)

[논문 투고 전 저자 확인사항]
(※ Check 후 투고사이트에 함께 제출합니다.)

구분		확인사항	Check
논문표지	1. 제목	- 논문제목 철자 및 오타 - 영문 제목은 기본적으로 소문자로 작성(단, 문장의 첫 단어와 고유 명사는 대문자로 작성) 관찰 연구(단면조사연구, 환자-대조군 연구 또는 전향적 코호트 연구), 임상 연구, 체계적 문헌고찰 또는 메타 분석의 경우; 제목 또는 부제목에 연구디자인 제시 예) Development and Effectiveness Evaluation of the STEAM Education Program on Food Groups for Kindergarteners -〉 Development and effectiveness evaluation of the STEAM education program on food groups for kindergarteners: a non-randomized controlled study 예) Program Evaluation using the RE-AIM Framework: A Systematic Review and Application to a Pilot Health Promotion Program for Children -〉 Evaluation of the pilot health promotion program for children: a systematic review	
	2. 저자정보	- 저자, 소속 및 직위를 국문과 영문으로 기재, 단 영문논문의 경우 영문으로만 기재, 영문 기재시 소속 앞으로 직위 표기 - 저자 중 1인 이상은 학회 회원일 것. 단, 비회원의 경우 편집위원회에서 위촉 또는 국외 기관에 소속된 저자가 투고할 시 가능	
	3. 제출	- 논문표지는 본 체크리스트 및 저작권이전동의서, IRB승인서와 함께 투고사이트 '첨부파일'에 업로드 (투고사이트에 논문 제출시 동시 제출, 투고논문에는 표지부분 삭제)	
	4. ORCID	- 모든 저자의 ORCID 기술 예) Gildong Hong: https://orcid.org/0000-0000-0000-0000	
	5. Funding (연구지원내역)	예) This research was supported by a grant from the National Research Foundation of Korea (Grant No. 000). - 해당하는 내용이 없더라도 'None.' 으로 기재	
영문초록	1. 작성순서	- Objectives-Methods-Results-Conclusion 의 순서	
	2. 키워드	- 전문 용어를 제외한 1~2개의 단어로 구성된 3~5개의 키워드 기재 - 키워드는 MeSH (https://meshb.nlm.nih.gov/search)에 검색되는 단어로 작성 - 키워드는 고유명사를 제외하고 모두 소문자로 표기하며, 구분 기호는 세미콜론(;)으로 작성	
	3. 약어사용	- 약어를 정의하고, 그 약어가 논문에서 더 이상 사용되지 않는다면 약어 사용할 필요 없음. 전체 명칭 (full name)으로 작성 - 약어를 두 번 이상 본문에서 사용할 경우, 맨 처음 약어가 등장할 때 전체 명칭에 대해 약어 정의	
논문본문	1. 작성순서	- 원고의 부제목은 모두 영문으로 작성 Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability, References, Tables, Figures 순서로 작성 - Method의 Study design, Results의 소제목, Discussion의 Limitations, Conclusion 반드시 작성 - 투고 시 표, 그림을 포함하여 하나의 파일로 업로드	
	2. 통계 패키지 정보 기입	- 종류 및 버전 정확히 기입 예) IBM SPSS Statistics 25 (IBM Corp.) 예) SAS 9.4 (SAS Institute)	
	3. Ethics Statement (연구윤리)	- 저자는 "방법(Method)" 부제목 바로 아래에 연구윤리에 관해 영문으로 기술. 종설, 연구노트, 교육자료 등의 경우에는 서론 뒤(본론 전)에 영문으로 제시. 예) The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number: ***). *IRB 기관표시는 최종본에 기재(투고시 내용 삭제후 업로드) 예) Obtainment of informed consent was exempted by the institutional review board.	
	4. Conflict of Interest (이해상충)	예) There are no financial or other issues that might lead to conflict of interest. 예) Gildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest. *저자정보는 최종본에 기재(투고시 내용 삭제후 업로드)	

(continued to the next page)

(Continued)

구분		확인사항	Check
	5. Acknowledgments (감사의 글)	– 논문작성이나 연구를 도왔지만 저자로서 적절하지 않은 분 등을 기술. 예) We thank the physicians who performed the sample collection. *관련내용은 최종본에 기재(투고시 내용 삭제후 업로드)	
	6. Data Availability (데이터가용성)	– 저자는 데이터가용성에 대한 설명을 작성해야하며, 데이터에 대해 접근을 허용하는 것은 선택사항 예) The data that support the findings of this study are openly available in [repository name e.g "KNHANES"] at http://doi.org/[doi].	
	7. 참고문헌	– 표기방법: 대괄호[ ] 앞 띄어쓰기 없이 [1], [2, 5], [15–20] 등 표기, 문헌 사이 쉼표 추가시, 쉼표 뒤 띄어쓰기 예) ~에 관한 연구[1] 또는 Kim & Lee의 연구[2, 5] – 본문 내 참고문헌의 인용이 번호순으로 되어 있는지 확인 – 학위 논문 인용은 3개 이내로 제한 – 참고문헌 표기 규정에 맞는지 확인	
	8. 단위 등 기타 표시	– 숫자와 단위 띄어쓰기(50 kg, 600 kcal), 단, %, ℃ 붙임 – g/dl(X), g/dL(O) – P값 표기 시 : P 대문자, 기울임체 : 예) *P*–value – 숫자 등의 범위 표기 시 '–'를 사용: 예) 20–25 – 천 단위 쉼표 표기(본문, 표에도 적용): 예) 65,450,000	
	9. 표, 그림	– 표와 그림 제목: 첫 글자만 대문자 – 표에서 변수들 영문 표기시 : 첫 글자만 대문자 – 표와 그림에서 n을 소문자로 표기 – 투고규정에 따르며 그 외 형식은 별첨한 가이드라인에 따름	

*예시는 2024년도 최근 게재논문을 참고.

[논문 투고 전 저자 확인사항_표와 그림]

표와 그림 작성 시 다음의 사항을 유의하여 주시기 바랍니다.

1. 자료의 전체 수를 표 본문의 내용 밖으로 표시하고자 할 때는 표 제목 끝의 괄호 안에 제시
   예) Sociodemographic characteristics of children (n = 80)

2. 표 본문의 제목줄(table head)은 가능하면 제시된 값을 설명하는 것으로 하고, 단순히 Mean ± SD 등 만을 제목으로 하는 것을 지양함

3. 표 본문의 내용 작성 시
- 평균값을 제시하는 경우 Mean ± SD, Mean ± SE 으로 사용, 띄어쓰기 확인
  예) 22.0 ± 2.3 : ' ± ' 앞뒤로 띄어쓰기
- 표에서 단위는 괄호 안에 넣어서 표기
  예) Energy (kcal/day) (O)
  Energy, kcal/day (X)

4. 표와 그림을 설명하는 주석은 모두 영문으로 표기

5. 주석의 기술 순서는 가능하면 자료의 형태, 통계분석 방법 및 유의성 표시, 기타의 순서로 작성함
   1) 자료의 형태 제시
      예) n (%), Mean ± SD, n (%) or Mean ± SD 등 주석 번호 없이 첫줄에 제시
   2) 통계분석 방법 및 유의성 표시
      ① 통계적 유의성 뿐 아니라 통계분석 방법도 함께 제시함
      ② 사후검정 결과는 분산분석 등의 유의확률 제시가 선행되어야 함
   3) 약어를 사용한 경우 전체 명칭(full name)을 주석으로 제시함
   4) 기타 설명이 필요한 내용은 이후 투고규정에 따라 순서대로 번호를 달고 각주로 제시하며 표 본문에 표기한 번호와의 일치여부 확인