

# Shift Work and Dietary Behaviors Among Korean Workers

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## Abstract

**Background:** Shift work is associated with irregular dietary habits and poor nutritional intake, increasing the risk of chronic diseases. This study aimed to assess dietary quality and nutritional intake according to shift work status among Korean adult workers.

**Methods:** Data from 15,121 adult workers aged  $\geq 20$  years from the Korea National Health and Nutrition Examination Survey (KNHANES) conducted between 2013 and 2021 were analyzed. Dietary quality was evaluated using the Korean Healthy Eating Index (KHEI), and shift work status was determined by self-reported working hours. Associations between shift work and dietary quality were assessed using multivariable logistic regression, accounting for the complex survey design. Stratified analyses by gender were also conducted.

**Results:** Shift workers showed no significant difference in overall dietary quality compared to day workers (OR=0.91, 95% CI: 0.80–1.04). However, shift workers more frequently skipped breakfast (OR=0.78, 95% CI: 0.68–0.89) and consumed fewer fresh fruits (OR=0.86, 95% CI: 0.75–0.98), vegetables excluding kimchi/pickles (OR=0.89, 95% CI: 0.79–0.99), and protein-rich foods (OR=0.87, 95% CI: 0.77–0.99). Conversely, shift workers had better adherence to recommended sodium intake (OR=1.19, 95% CI: 1.06–1.34). Gender-stratified analysis revealed lower fruit intake among male shift workers and more frequent breakfast skipping and lower fruit/protein intake among female shift workers.

**Conclusion:** Among Korean adult workers, shift work was associated with unfavorable dietary patterns, characterized by increased breakfast skipping and lower intake of fruits, vegetables, and protein-rich foods. Tailored strategies to improve meal regularity and dietary balance are recommended for managing the health of shift workers.

**Keywords:** Shift work; Dietary quality; Korean Healthy Eating Index

## Key Points

Shift work was linked to unfavorable dietary behaviors, including frequent breakfast skipping and reduced intake of fruits, vegetables, and protein-rich foods.

Overall dietary quality did not differ significantly between shift and day workers, but specific nutritional vulnerabilities were evident.

Gender-specific patterns were identified: male shift workers consumed fewer fruits, while female shift workers skipped breakfast more often and consumed less fruit and protein.

These findings suggest the need for targeted, gender-specific nutritional interventions for shift workers.

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## Introduction

Shift work has increasingly become a common employment type worldwide due to the need for sustained production and a flexible labor force [1-3]. Approximately 20% of the global workforce engages in shift work, with higher rates of night work reported in Europe and the United States [4]. Shift work includes various schedules such as evening, night, rotating, and 24-hour shifts [5], which can disrupt workers' sleep and eating rhythms. In South Korea, more than 10% of the workforce is engaged in shift work, highlighting its significance not only for maintaining continuous societal operations but also for its potential adverse effects on workers' health [6].

Previous studies have reported a growing number of associations between shift work and dietary behaviors related to chronic metabolic diseases, such as obesity, diabetes, and cardiovascular disease [7-10]. Although many studies have examined the dietary habits of shift workers, most have focused on conventional dietary assessment methods, including total energy intake, intake of individual nutrients (e.g., protein, fat, carbohydrates), irregular meal timing (especially breakfast skipping and late-night eating), and the frequency of consuming major food groups (e.g., fruits, vegetables, and dairy products) [9, 11-15]. Recently, however, there has been a growing trend toward utilizing comprehensive dietary assessment tools, such as the Dietary Inflammatory Index (DII) and the Healthy Eating Index (HEI), to evaluate dietary patterns and their relevance to disease prevention [11]. Given the strong association between shift work and chronic metabolic disease, dietary assessments should reflect multiple dimensions, including adequacy, moderation, and balance. Nonetheless, few studies have specifically targeted shift workers using such comprehensive dietary assessment indices.

Therefore, this study aimed to comprehensively assess adherence to recommended dietary patterns, including dietary adequacy, moderation, and balance among Korean shift workers, using the Korean Healthy Eating Index (KHEI) [16], a validated assessment tool specifically developed to reflect the unique dietary characteristics of the Korean population.

## Methods

## Study population

The Korea National Health and Nutrition Examination Survey (KNHANES), conducted by the Korea Disease Control and Prevention Agency (KDCA), is an annual, nationwide cross-sectional survey designed to assess the health and nutritional status of the South Korean population. It employs a stratified, multistage probability sampling method and a multistage cluster sampling design, where administrative regions serve as the primary sampling units and households within these regions serve as the secondary sampling units, ensuring a nationally representative sample. Data collection includes health examinations and interviews conducted in mobile examination units, as well as household-based nutrition surveys, providing high-quality, representative data for public health research and policymaking [17]. In this study, among the initial 69,776 participants from KNHANES phases VI to VIII (2013–2021), we excluded individuals who were younger than 20 years, lacked survey weights, had missing data on key variables (household income, education level, occupation, working hours, nutritional intake, and obesity status), or reported their occupation as students, homemakers, or ‘unknown.’ Consequently, the final analysis included data from 24,710 workers aged  $\geq 20$  years.

## Dietary quality assessment the Korean Healthy Eating index (KHEI)

In this study, the KHEI was used to evaluate the overall dietary quality of participants. KHEI is an index developed based on data from the KNHANES and consists of three components: adequacy, moderation, and balance [16, 18]. The adequacy component assesses the intake of essential food groups, including mixed grains, fruits, vegetables, meat/fish/eggs/legumes, dairy products, and others, with a total of eight items. Scores are assigned based on adherence to recommended intake levels. The moderation component evaluates dietary factors that may negatively impact health, such as saturated fat, sodium, and sugar-sweetened beverages (three items), with points deducted for excessive intake. The balance component assesses the ratio of macronutrient intake, specifically carbohydrate-to-fat ratio and total energy intake, to reflect optimal nutritional balance. Each item is scored on a scale of 0–5 or 0–10 points, and the total KHEI score is calculated by summing the scores of all 14 components, ranging from 0 to 100 points. Higher scores indicate better overall dietary quality [16]. To classify participants based on

123 dietary quality, we initially considered a quantile-based classification using KHEI total scores. However,  
124 due to the narrow scoring range of individual components and the clustering of values around specific  
125 points, precise quantile classification was challenging [18]. To address this issue and ensure a more  
126 evenly distributed grouping, a rank-based ntile method was applied. Based on this classification, we  
127 designated the highest quartile (Q4) as a proxy for relatively healthy dietary practices. While this does  
128 not imply that all individuals in Q4 followed an ideal or clinically optimal diet, they had the most  
129 favorable dietary patterns within the distribution of our study population, as measured by KHEI.  
130 Therefore, in this study, the term “healthy diet” specifically refers to participants categorized in the  
131 highest quartile (Q4) of the KHEI total scores. This categorization represents relatively healthier dietary  
132 behaviors within our study population rather than absolute adherence to ideal dietary guidelines.  
133 Participants in Q4 demonstrated dietary patterns closer to recommended standards in terms of adequacy,  
134 moderation, and balance compared to those in lower quartiles.

### 136 **Shift work**

137 Shift work status was assessed using a self-reported questionnaire. The analysis included wage workers  
138 with at least 20 working hours per week. Participants were classified based on their responses to two  
139 questions: "Do you primarily work during daytime hours (6 AM to 6 PM)?" and "Do you work during  
140 other time periods?". Those who responded "I primarily work during daytime hours (6 AM to 6 PM)"  
141 were categorized as day workers, whereas those who reported working fixed evening shifts (2 PM to  
142 11 PM), fixed night shifts (9 PM to 8 AM the next day), regular day-night rotating shifts, 24-hour  
143 rotating shifts, split shifts (two or more shifts per day), or irregular rotating shifts were classified as  
144 shift workers [19, 20].

### 146 **Covariates**

147 Our analysis considered the following covariates: age, sex, income level, education level, marital status,  
148 occupation classification, working hours, residential area and body mass index (BMI). Income level  
149 was categorized into four groups based on survey responses: low, lower middle, upper middle, and high.

Education level was classified as less than elementary school, middle school, high school, and college or higher. Marital status was categorized as single or married. Occupation classification was divided into white-collar, pink-collar, blue/green-collar [15]. Working hours were categorized as  $\leq 52$  hours, and  $> 52$  hours per week, in accordance with the statutory limit set by Korean labor Act. [20-22]. Based on administrative classifications, residential areas were categorized as urban for ‘dong’ regions and rural for ‘eup’ or ‘myeon’ regions. BMI ( $\text{kg}/\text{m}^2$ ) was categorized as  $< 18.5$ ,  $18.5\text{--}24.9$ , and  $\geq 25$ .

### Statistical analysis

We performed a comprehensive descriptive analysis to elucidate the characteristics of the study subjects. Categorical and continuous variables are presented as frequencies with percentages and mean values with standard deviations, respectively. Student’s t-test and the chi-square ( $\chi^2$ ) test were used to assess normally distributed continuous and categorical variables, respectively.

Additionally, to examine differences in the total and component scores of the KHEI according to work type, we categorized both the total KHEI score and each component score into quartiles (Q1–Q4) and conducted descriptive analyses. This allowed us to evaluate how the distributions of the KHEI total and subcomponent scores varied by work type. Furthermore, survey-weighted logistic regression analysis was performed with dietary quality as the outcome variable and work type as the exposure variable. Dietary quality was categorized as ‘less adequate diet’ for groups Q1–Q3 and ‘healthy diet’ for group Q4. Daytime work was set as the reference group, and shift work was set as the exposed group. This analysis assessed the association between shift work status and the likelihood of maintaining a healthy diet. A sensitivity analysis was conducted to evaluate gender-based differences in outcomes by stratifying the analysis by gender. All models were adjusted for age, sex, income level, education level, marital status, occupation classification, working hours, residential area and body mass index (BMI).

We fitted survey logistic regression models to estimate odds ratios (ORs) and their corresponding 95% confidence intervals (CIs). All statistical analyses and visualizations were performed using R software (version 4.3.0). The complex survey design and the survey weights



differences were observed in total score, breakfast consumption, total fruit intake, fresh fruit intake, total vegetable intake, vegetable intake excluding kimchi and pickles, and meat/fish/egg/bean intake, with daytime workers showing higher scores than shift workers.

The results of the survey logistic regression analysis (Table 3) showed that shift workers were not significantly different from daytime workers in maintaining a "healthy diet" (Q4) based on the total KHEI score (OR=0.91, 95% CI: 0.80-1.04, P=0.197). However, regarding breakfast consumption, shift workers were significantly less likely to maintain a "healthy diet" (OR=0.78, 95% CI: 0.68-0.89, P<0.001). They were also significantly less likely to maintain a "healthy diet" in terms of fresh fruit intake (OR=0.86, 95% CI: 0.75-0.98, P<0.05), vegetable intake excluding kimchi and pickles (OR=0.89, 95% CI: 0.79-0.99, P<0.05), and meat, fish, eggs, and beans intake (OR=0.87, 95% CI: 0.77-0.99, P<0.05). In contrast, sodium intake was significantly higher among shift workers than among daytime workers in maintaining a "healthy diet" (OR=1.19, 95% CI: 1.06-1.34, P<0.01). Overall, the findings of this study indicate that shift workers generally exhibit unfavorable dietary patterns, characterized particularly by a higher rate of breakfast skipping and lower intake of fresh vegetables, fruits, and protein-rich foods.

According to the results shown in Table 4, the association between work type and dietary quality differed by sex. Among males, shift workers were significantly less likely to maintain a "healthy diet" regarding total fruit intake (OR=0.80, 95% CI: 0.66–0.97,  $P<0.05$ ), and had a significantly lower likelihood of adequate sodium intake, meaning they tended to consume excessive sodium (OR=1.23, 95% CI: 1.03–1.48,  $P<0.05$ ). Among females, shift workers were significantly less likely to maintain a "healthy diet" in terms of breakfast consumption (OR=0.64, 95% CI: 0.52–0.78,  $P<0.001$ ), fresh fruit intake (OR=0.79, 95% CI: 0.66–0.94,  $P<0.05$ ), and meat, fish, eggs, and beans intake (OR=0.84, 95% CI: 0.67–0.98,  $P<0.05$ ). Similarly, female shift workers were significantly less likely to have adequate sodium intake, indicating a higher sodium consumption compared to daytime workers (OR=1.17, 95% CI: 1.00–1.36,  $P<0.05$ ).

## Discussion

This study analyzed differences in dietary quality (total KHEI score) and specific nutrient intake according to work type (shift vs. daytime work) among Korean workers. While there was no significant difference in overall dietary quality, shift workers were more likely to skip breakfast and had lower intake of fresh vegetables and fruits (excluding kimchi and pickles), as well as protein-rich foods. In sex-stratified analyses, male shift workers consumed fewer fruits but had more adequate sodium intake compared to daytime workers. Female shift workers showed a higher rate of breakfast skipping and lower intake of fresh fruits and protein-rich foods, but also maintained relatively favorable sodium intake. Overall, while shift workers exhibited unfavorable dietary behaviors in certain areas, they showed more favorable patterns in specific nutrients, such as sodium intake.

Previous studies have reported that shift workers tend to have overall less healthy dietary habits compared to daytime workers [23-25]. For instance, a study conducted in Turkey found that shift workers had significantly lower HEI-2010 scores than daytime workers (52.6 vs. 55.9,  $p = 0.016$ ), and that their triglyceride and postprandial blood glucose levels were higher [22]. However, in the present study, while no significant difference was observed in the total KHEI score, shift workers showed significantly lower intakes of vegetables and fruits compared to daytime workers. These findings suggest that although overall dietary quality may appear similar, specific components such as fruit and vegetable intake differ meaningfully by work schedule. These results indicate that the dietary behaviors of shift workers should not be uniformly characterized as unhealthy, as specific food choices may vary and influence overall patterns.

Meanwhile, a previous study on night-shift nurses reported that shift workers consumed  $166 \pm 55.5$  kcal less energy per day on average than daytime workers ( $p = 0.002$ ), with higher proportions of protein, carbohydrates, and dietary fiber intake, and lower proportions of fat and alcohol [13]. In contrast, our study found that shift workers consumed fewer protein-rich foods, but had more adequate sodium intake than their daytime counterparts. In particular, female shift workers showed a higher tendency to skip breakfast and consumed less fresh fruit and protein-rich foods, but exhibited more favorable sodium intake. These sex-specific differences are consistent with previous literature. A study

conducted in Finland found that male shift workers had significantly lower intake of fruits ( $p = 0.049$ ) and vegetables ( $p < 0.001$ ) compared to male daytime workers, while no such differences were observed among female workers [26].

While previous studies have assessed diet quality based on HEI scores or selected nutrients, this study conducted a more comprehensive analysis using the KHEI, which reflects the dietary characteristics of the Korean population. The KHEI evaluates diet quality across 14 components in three domains: adequacy of recommended food intake, moderation of restricted food intake, and balance of energy intake, providing a multidimensional assessment. Based on this approach, the study analyzed not only the total score but also differences in specific components, identifying detailed differences in diet quality between shift and daytime workers and highlighting areas that require improvement. Furthermore, unlike prior studies that uniformly interpreted shift workers' diets as unfavorable, this study showed that healthy food choices also exist within the shift worker group, revealing the diversity and potential for improvement in their dietary behaviors.

However, the KHEI used in this study has several limitations. First, it is calculated based on a single 24-hour dietary recall, which may not fully reflect an individual's usual dietary habits, and the results may be over- or underestimated due to temporary intake. Second, due to limitations of the KNHANES data, some nutrients such as added sugar had to be indirectly estimated through the intake of sugar-containing foods. In addition, since the KHEI is based on cross-sectional data, it does not reflect changes in dietary patterns over time. Furthermore, as the KNHANES is a series of independent cross-sectional surveys conducted annually, the analysis does not account for potential changes in working environments or dietary behaviors over time. Nevertheless, the KHEI is a useful tool developed to reflect Korean dietary patterns and can be applied to nationally representative data such as KNHANES [16]. By comprehensively evaluating food groups, nutrients, and eating behaviors, the KHEI allows for a multidimensional assessment of diet quality. In this study, it was particularly effective in identifying specific components where dietary differences between shift and daytime workers were observed.

## Conclusion

This study highlights that Korean shift workers, despite having similar overall dietary quality compared to day workers, exhibit unfavorable dietary behaviors such as more frequent breakfast skipping and lower intakes of fruits, vegetables, and protein-rich foods. Additionally, gender-stratified analyses suggest specific dietary patterns, including lower fruit intake among male shift workers and increased breakfast skipping and lower fruit and protein intake among female shift workers. These findings underscore the need for targeted nutritional strategies and gender-specific interventions to promote balanced and healthier dietary practices among shift workers, ultimately aiming to reduce their risks of chronic metabolic diseases. These findings highlight the need for targeted nutrition strategies and gender-specific interventions to promote balanced and healthy eating habits among shift workers and thereby reduce the risk of chronic metabolic disease.

## Author Contributions

Chung Ho Kim: Conceptualization, Methodology, Data curation, Formal analysis, Drafting of the manuscript.

Wanhyung Lee: Conceptualization, Supervision, Methodology, Critical revision of the manuscript, Project administration.

## Data Availability

The data underlying this article are available from the Korea National Health and Nutrition Examination Survey (KNHANES) conducted by the Korea Disease Control and Prevention Agency (KDCA). Access to KNHANES data requires application through the KDCA website (<https://knhanes.kdca.go.kr/knhanes/eng/main.do>) in accordance with their data sharing policy.

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| Characteristic           | Shift work<br>( <i>n</i> = 2,284) | Daytime work<br>( <i>n</i> = 12,837) | <i>P</i> -value  |
|--------------------------|-----------------------------------|--------------------------------------|------------------|
| Age (years)              | 44.7 ± 14.2                       | 44.6 ± 12.5                          | <b>0.703</b>     |
| Age (years) <sup>a</sup> | 44 (33-56)                        | 44 (35-54)                           | <b>0.776</b>     |
| Sex                      |                                   |                                      | <b>&lt;0.001</b> |
| Male                     | 1,294 (56.7)                      | 6,623 (51.6)                         |                  |
| Female                   | 990 (43.3)                        | 6,214 (48.4)                         |                  |
| Household income         |                                   |                                      | <b>&lt;0.001</b> |
| Lowest quartile          | 469 (20.5)                        | 2,312 (18.0)                         |                  |
| lower middle             | 622 (27.2)                        | 3,157 (24.6)                         |                  |
| Upper middle             | 651 (28.5)                        | 3,529 (27.5)                         |                  |
| High                     | 542 (23.8)                        | 3,839 (29.9)                         |                  |
| Education                |                                   |                                      | <b>&lt;0.001</b> |
| Elementary school        | 184 (8.1)                         | 984 (7.7)                            |                  |
| Middle school            | 179 (7.8)                         | 827 (6.4)                            |                  |
| High school              | 968 (42.4)                        | 4,000 (31.2)                         |                  |
| College or higher        | 953 (41.7)                        | 7,026 (54.7)                         |                  |
| Marital status           |                                   |                                      | <b>&lt;0.001</b> |
| Single                   | 595 (26.1)                        | 2,584 (20.1)                         |                  |
| Married                  | 1,689 (73.9)                      | 10,253 (79.9)                        |                  |
| Occupation               |                                   |                                      | <b>&lt;0.001</b> |
| White-collar             | 1,160 (50.8)                      | 7,959 (62.0)                         |                  |
| Pink-collar              | 197 (8.6)                         | 897 (7.0)                            |                  |
| Blue/Green-collar        | 927 (40.6)                        | 3,981 (31.0)                         |                  |
| Working hours            |                                   |                                      | <b>&lt;0.001</b> |
| ≤52                      | 1,715 (75.1)                      | 10,939 (85.2)                        |                  |
| >52                      | 569 (24.9)                        | 1,898 (14.8)                         |                  |
| Residential area         |                                   |                                      | <b>&lt;0.05</b>  |
| Urban                    | 1,970 (86.3)                      | 10,818 (84.3)                        |                  |
| Rural                    | 314 (13.7)                        | 2,019 (15.7)                         |                  |
| BMI (kg/m <sup>2</sup> ) |                                   |                                      | <b>0.607</b>     |
| < 18.5                   | 95 (4.2)                          | 491 (3.8)                            |                  |
| 18.5-24.9                | 1,388 (60.7)                      | 7,917 (61.7)                         |                  |
| ≥ 25                     | 801 (35.1)                        | 4,429 (34.5)                         |                  |

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Data are presented as mean  $\pm$  SD or N (%).

376 <sup>a</sup> median (Q1-Q4)

377 Table 2. Comparison of Dietary quality by work type.

| Components                                            | Shift work<br>( <i>n</i> = 2,284) | Daytime work<br>( <i>n</i> = 12,837) | <i>P</i> -value  |
|-------------------------------------------------------|-----------------------------------|--------------------------------------|------------------|
| <b>Total score</b>                                    |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 638 (27.9)                        | 3,143 (24.5)                         |                  |
| Q2                                                    | 564 (24.7)                        | 3,216 (25.1)                         |                  |
| Q3                                                    | 570 (25.0)                        | 3,210 (25.0)                         |                  |
| Q4                                                    | 512 (22.4)                        | 3,268 (25.4)                         |                  |
| <b>Have breakfast</b>                                 |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 572 (25.0)                        | 3,209 (25.0)                         |                  |
| Q2                                                    | 666 (29.3)                        | 3,114 (24.3)                         |                  |
| Q3                                                    | 547 (23.9)                        | 3,233 (25.2)                         |                  |
| Q4                                                    | 499 (21.8)                        | 3,281 (25.5)                         |                  |
| <b>Mixed grains intake</b>                            |                                   |                                      | 0.360            |
| Q1                                                    | 579 (25.4)                        | 3,202 (24.9)                         |                  |
| Q2                                                    | 584 (25.6)                        | 3,196 (24.9)                         |                  |
| Q3                                                    | 537 (23.4)                        | 3,243 (25.3)                         |                  |
| Q4                                                    | 584 (25.6)                        | 3,196 (24.9)                         |                  |
| <b>Total fruits intake</b>                            |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 663 (29.0)                        | 3,118 (24.3)                         |                  |
| Q2                                                    | 594 (26.0)                        | 3,186 (24.8)                         |                  |
| Q3                                                    | 514 (22.5)                        | 3,266 (25.5)                         |                  |
| Q4                                                    | 513 (22.5)                        | 3,267 (25.4)                         |                  |
| <b>Fresh fruits intake</b>                            |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 649 (28.4)                        | 3,132 (24.4)                         |                  |
| Q2                                                    | 605 (26.5)                        | 3,175 (24.7)                         |                  |
| Q3                                                    | 532 (23.3)                        | 3,248 (25.3)                         |                  |
| Q4                                                    | 498 (21.8)                        | 3,282 (25.6)                         |                  |
| <b>Total vegetables</b>                               |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 620 (27.1)                        | 3,161 (24.6)                         |                  |
| Q2                                                    | 555 (24.3)                        | 6,225 (25.1)                         |                  |
| Q3                                                    | 532 (23.3)                        | 3,248 (25.3)                         |                  |
| Q4                                                    | 577 (25.3)                        | 3,203 (25.0)                         |                  |
| <b>Vegetables intake excluding kimchi and pickles</b> |                                   |                                      | <b>&lt;0.001</b> |
| Q1                                                    | 641 (28.1)                        | 3,140 (24.4)                         |                  |
| Q2                                                    | 550 (24.1)                        | 3,230 (25.2)                         |                  |

|                                                       |            |              |                  |
|-------------------------------------------------------|------------|--------------|------------------|
| Q3                                                    | 562 (24.6) | 3,218 (25.1) |                  |
| Q4                                                    | 531 (23.2) | 3,249 (25.3) |                  |
| <b>Meat, fish, eggs and beans intake</b>              |            |              | <b>&lt;0.001</b> |
| Q1                                                    | 674 (29.5) | 3,107 (24.2) |                  |
| Q2                                                    | 548 (24.0) | 3,232 (25.2) |                  |
| Q3                                                    | 546 (23.9) | 3,234 (25.2) |                  |
| Q4                                                    | 516 (22.6) | 3,264 (25.4) |                  |
| <b>Milk and milk products intake</b>                  |            |              | <b>&lt;0.001</b> |
| Q1                                                    | 623 (27.3) | 3,158 (24.6) |                  |
| Q2                                                    | 590 (25.8) | 3,190 (24.9) |                  |
| Q3                                                    | 523 (22.9) | 3,257 (25.4) |                  |
| Q4                                                    | 548 (24.0) | 3,232 (25.1) |                  |
| <b>Percentage of energy from saturated fatty acid</b> |            |              | 0.712            |
| Q1                                                    | 561 (24.6) | 3,220 (25.1) |                  |
| Q2                                                    | 580 (25.4) | 3,200 (24.9) |                  |
| Q3                                                    | 587 (25.7) | 3,193 (24.9) |                  |
| Q4                                                    | 556 (24.3) | 3,224 (25.1) |                  |
| <b>Sodium intake</b>                                  |            |              | 0.091            |
| Q1                                                    | 557 (24.4) | 3,224 (25.1) |                  |
| Q2                                                    | 549 (24.0) | 3,231 (25.2) |                  |
| Q3                                                    | 559 (24.5) | 3,221 (25.1) |                  |
| Q4                                                    | 619 (27.1) | 3,161 (24.6) |                  |
| <b>Percentage of energy from sweets and beverages</b> |            |              | 0.530            |
| Q1                                                    | 591 (25.9) | 3,190 (24.9) |                  |
| Q2                                                    | 581 (25.4) | 3,199 (24.9) |                  |
| Q3                                                    | 548 (24.0) | 3,232 (25.1) |                  |
| Q4                                                    | 564 (24.7) | 3,216 (25.1) |                  |
| <b>Percentage of energy from carbohydrate</b>         |            |              | 0.703            |
| Q1                                                    | 567 (24.8) | 3,214 (25.1) |                  |
| Q2                                                    | 587 (25.7) | 3,196 (24.9) |                  |
| Q3                                                    | 578 (25.3) | 3,202 (24.9) |                  |
| Q4                                                    | 552 (24.2) | 3,228 (25.1) |                  |
| <b>Percentage of energy from fat</b>                  |            |              | 0.259            |
| Q1                                                    | 545 (23.9) | 3,236 (25.2) |                  |
| Q2                                                    | 600 (26.3) | 3,180 (24.8) |                  |

|                      |            |              |       |
|----------------------|------------|--------------|-------|
| Q3                   | 584 (25.6) | 3,196 (24.9) |       |
| Q4                   | 555 (24.2) | 3,225 (25.1) |       |
| <b>Energy intake</b> |            |              | 0.153 |
| Q1                   | 587 (25.7) | 3,194 (24.9) |       |
| Q2                   | 555 (24.3) | 3,225 (25.1) |       |
| Q3                   | 603 (26.4) | 3,177 (24.7) |       |
| Q4                   | 539 (23.6) | 3,241 (25.3) |       |

Data are presented as N (%).

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Table 4. Association Between Shift Work and Component-Based Dietary Quality Using the Korean Healthy Eating Index (KHEI; Outcome: Healthy Diet), Stratified by Sex.

| KHEI Component                                 | Male                    |                 | Female                  |                  |
|------------------------------------------------|-------------------------|-----------------|-------------------------|------------------|
|                                                | OR (95% CI)             | P-value         | OR (95% CI)             | P-value          |
| Total score                                    | 0.96 (0.81-1.15)        | 0.710           | 0.86 (0.72-1.03)        | 0.104            |
| Have breakfast                                 | 0.85 (0.72-1.01)        | 0.080           | <b>0.64 (0.52-0.78)</b> | <b>&lt;0.001</b> |
| Mixed grains intake                            | 1.02 (0.87-1.20)        | 0.764           | 1.04 (0.86-1.25)        | 0.664            |
| Total fruits intake                            | <b>0.80 (0.66-0.97)</b> | <b>&lt;0.05</b> | 0.99 (0.84-1.17)        | 0.975            |
| Fresh fruits intake                            | 0.92 (0.76-1.10)        | 0.371           | <b>0.79 (0.66-0.94)</b> | <b>&lt;0.05</b>  |
| Total vegetables                               | 0.90 (0.77-1.05)        | 0.182           | 0.86 (0.70-1.05)        | 0.161            |
| Vegetables intake excluding kimchi and pickles | 1.02 (0.87-1.11)        | 0.465           | 1.00 (0.89-1.07)        | 0.378            |
| Meat, fish, eggs and beans intake              | 0.88 (0.75-1.03)        | 0.131           | <b>0.84 (0.67-0.98)</b> | <b>&lt;0.05</b>  |
| Milk and milk products intake                  | 0.95 (0.81-1.12)        | 0.592           | 0.94 (0.75-1.12)        | 0.498            |
| % Energy from saturated fatty acid             | 0.97 (0.83-1.15)        | 0.795           | 0.86 (0.71-1.04)        | 0.127            |
| Sodium intake                                  | <b>1.23 (1.03-1.48)</b> | <b>&lt;0.05</b> | <b>1.17 (1.00-1.36)</b> | <b>&lt;0.05</b>  |
| % Energy from sweets and beverages             | 1.01 (0.86-1.17)        | 0.896           | 0.97 (0.81-1.18)        | 0.826            |
| % Energy from carbohydrate                     | 0.98 (0.84-1.15)        | 0.886           | 1.00 (0.83-1.19)        | 0.989            |
| % Energy from fat                              | 1.08 (0.92-1.28)        | 0.332           | 1.08 (0.92-1.28)        | 0.332            |
| Energy intake                                  | 0.90 (0.77-1.06)        | 0.234           | 0.86 (0.72-1.04)        | 0.129            |

KHEI, Korean Healthy Eating Index; OR, odds ratio; CI, confidence interval; Adjusted for age, sex, income level, education level, marital status, occupation classification, working hours, residential area and body mass index (BMI).

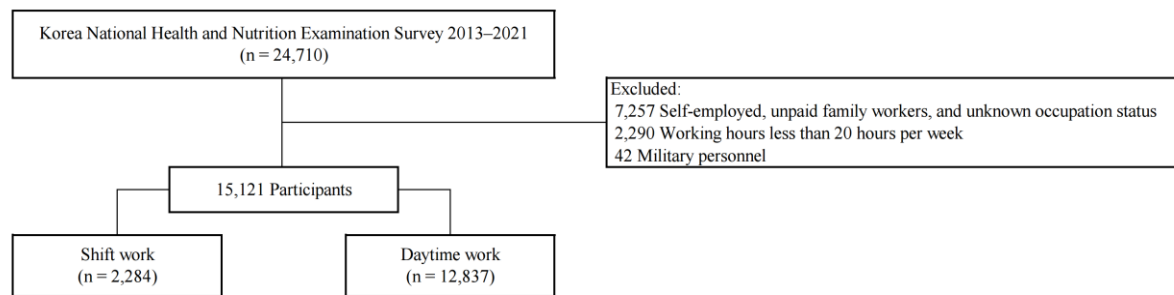


Fig. 1. Flowchart of the study participants.

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