Assessment of Diet Quality and Health-Related Quality of Life in Young Adults According to Household Food Security Status and Income Level

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Abstract

Background

Food insecurity is still a concern not only in low- and middle-income countries but also in high-income countries and it is reported to have a relationship with health outcome such as chronic diseases. This study was conducted to compare diet quality and health-related quality of life in young adults according to their household income and food security.

Methods

Our population-based sample included 10,224 young adults aged 19–34 y participating in the Korea National Health and Nutrition Examination Survey (KNHANES) 2008–2018. The participants were classified into four groups according to household income and food security: food security & higher-income, food insecurity & higher-income, food security & low-income, and food insecurity & low-income. General characteristics, daily diet, and nutritional quality were compared among the four groups.

Results

The percentage of participants consuming daily diet with protein, vitamin A, B1, B2, niacin, vitamin C, calcium, phosphorus, and iron less than Estimated Average Requirement increased in the food insecurity & low-income group. In case of most commonly consumed food, ramen and sprite were highly placed in the food insecurity & low-income group while apple and beef ranked relatively high in the food security & higher-income group. Multiple logistic regression analysis showed that odds ratio (OR) (95% confidence interval, CI) of Euro Quality of Life five Dimensions (EQ5D) in the food insecurity & low-income group were 1.55 (1.05–2.29) and 1.33 (1.07–1.64) for mobility and anxiety/depression respectively, compared to the food security & higher-income group after adjusting confounding factors.

Conclusions

Household food insecurity and low-income had relationships with poor diet quality and poor health-related quality of life in young adults, in particular, mobility and anxiety/depression.

Background

Household food insecurity refers to a state where a household lacks the availability of and access to sufficient food due to economic difficulty or other insufficient resources [1, 2]. Food insecurity is still a concern not only in low- and middle-income countries but also in high-income countries [3–5], and it is reported to have a relationship with socio-economic characteristics [6], asthma [7], health-related quality of life (HRQoL) [8], body composition [9], underweight and poverty of older adults [10], obesity [11], sleep complaints [12], and cardiovascular disease [13].

Food insecurity prevalence varies depending on various factors including age, ethnicity and region. Food insecurity prevalence of adults aged 19–64 y in Korea was 8.2% (11.3% for people aged 1 or older) [14] and in the US, it was 27.23% for adults aged 18–34 y and 11.78% for the elderly aged 65 y or older, showing a higher level in adults than the elderly [15]. In the Mexican population-based survey, mild insecurity, moderate insecurity, and severe insecurity were found to be 41%, 20%, and 12%, respectively [16]. Food insecurity is presented as one of risk factors of mental health including depression and anxiety [17]. According to a report of WHO, depression was the single largest contributor to global disability in 2015 (7.5%), and anxiety disorders took the 6th place (3.4%). The number of people who suffer from depression worldwide was 322 mil-lion (4.4%), of which south-east Asia region had the highest number as 27% (85.67 mil-lion). The number of people who suffer from anxiety disorders worldwide was 264 million (3.6%), of which south-east Asia region also had the highest number as 23% (60.05 million) [18]. Euro Quality of Life five Dimensions (EQ5D) is an index which was devised to measure health-related quality of life including anxiety/depression, mobility, self-care, usual activities, and pain/discomfort [19], and it is reported to have a relationship with diet quality [20–23], food insecurity [8, 24], and chronic diseases [25] and also is presented as a predictor of mortality in the older adults [26].

In the Korean population, several studies have been performed on the prevalence of food insecurity [27] and associations between food insecurity and dietary intake [14, 28–31], childhood obesity [32], asthma [7], and risk factors with older adults [33]. However, there has been little research conducted on young adults compared to other ages and the relationship between food insecurity and health-related quality of life in young adults.

Therefore, this study aimed to assess the dietary quality and health-related quality of life in vulnerable young adults group using KNHANES data. To select the vulnerable group, participants were classified into groups according to household income and food security. And then dietary intake status of young adults was compared, and a relationship between household income & food security and the decline of the health-related quality of life was analyzed using EQ5D.

Materials And Methods

Data Source and Study Population

This study was based on data from the Korea National Health and Nutrition Survey (KNHANES), a cross-sectional, nationally representative survey conducted by the Korea Disease Control and Prevention Agency (http://knhanes.kdca.go.kr). This study was approved by the Institutional Review Board of the Korea

Centers for Disease Control and Prevention (2008-04EXP-01-C, 2009-01CON-03-2C, 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). KNHANES is a legal survey conducted based on the Koreans National Health Promotion Act and is designed to assess the health-related behaviors, chronic diseases prevalence status, and food nutritional state of Korean people. As KNHANES corresponds to research projects conducted by nation for public welfare according to Article 2-1 of the Bioethics and Safety Act and Article 2-2-1 of Enforcement Regulations of the same Act, it was conducted in 2015 – 2017 with IRB review exemption. The survey target was 11,250 adults aged 19 – 34 y who participated in the health survey and the dietary intake survey of KNHANES IV-2 to KNHANES VII-3. The exclusion criteria were as follows: persons who had no food security data (n=30), persons who had no health-related quality of life (EQ5D) data (n=359), pregnant women (n=337), persons with a history of cancer (n=43), persons who had no information on household income (n=76), and persons whose daily energy intake was less than 250 kcal or 5000 kcal or higher (n=181). As a result, a total of 10,224 people were included in the analysis.

General Characteristics

Age, sex, body mass index (BMI), marital status, women's birth experience, residential area, monthly household income, household composition type, occupation, education level, smoking status, alcohol consumption, and subjective health state of participants were analyzed. For monthly household income, monthly income was analyzed using gross household income variable of KNHANES and annual income was analyzed after converting it into monthly income by dividing by 12.

Household Food Security and Household Income

Household food security was investigated by a question on household dietary life status. The survey participants selected one from four response options to the question "Which of the following best describes your household dietary life status for the past one year? The participants who responded "Our family could have many different types of foods as much as we wanted" were classified as the food security group and the participants who responded "Our family could have sufficient amount of food but could not eat various kinds" or "Our family went short of food from time to time due to financial difficulty" or "Our family often went short of food due to financial difficulty" were classified as the food insecurity group. As for household income, using household income quartiles, participants in low and low-middle categories were classified as the low income group and participants in middle-high and high categories were classified as the high income group. The sensitivity and specificity of a single food insufficiency questionnaire with the food security status by 18-item questionnaire were reported as 56.8% and 92.3%, respectively [34].

Euro Quality of Life five Dimensions (EQ5D)

EQ5D was developed by Euro Quality of Life Group and is an index to assess health-related quality of life with five dimensions [35]. It consists of mobility, self-care, usual activity, pain/discomfort, and anxiety/depression and three response options were used (not at all, some problems, many problems). EQ5D was investigated with the approval of EuroQol Group (www.euroqol.org), and validity and reliability were assessed in the Korean population-based survey [35]. In this study, the participants who responded their daily life was hindered or they felt uncomfortable with daily life in mobility, self-care, usual activity, and pain/discomfort areas or the participants who responded they had an anxiety or depression in anxiety/depression area were classified as the any problem group and the subjects who responded they had no discomfort at all in those areas as the no problem group.

Food intake assessment

The food intakes of the participants were estimated by the 24-h dietary recall method. In the study, the food items were categorized into 18 food groups including cereal and cereal products, potatoes and starch products, sugar and sugar products, beans and bean products, nuts and seeds products, vegetables, mushrooms, fruits, meat and meat products, eggs and egg products, fish and shellfish, seaweeds, milk and dairy products, oil and fat, beverages, seasoning, processed foods, others.

Furthermore, we estimated most commonly consumed foods of participants. Among the foods taken by participants, in case the same food ingredients were used even though cooking and processing methods were different, the case was classified as one kind of food. Twenty major most commonly consumed foods were selected by food lists with high intake amount.

Nutrient intake assessment

Daily intake of carbohydrates, protein, and fat in participants and energy composition were calculated. Intake of vitamins and minerals (calcium, phosphorus, iron, sodium, potassium, thiamin, riboflavin, niacin, vitamin C, and vitamin A) was assessed. Calcium and vitamin A are especially nutrients that are prone to lack among Koreans [36, 37]. Therefore, we evaluated nutrient intake status including these nutrients. In addition, to assess the quality of dietary intake, we investigated the intake status compared to 2020 Dietary Reference Intakes for Koreans [38]. The percentages of participants who took less than Estimated Average Requirement (EAR) by nutrients were calculated.

Statistical Analysis

SAS 9.4 software (SAS Institute, Cary, NC, USA) was used for statistical process of all data. As for KNHANES, SURVEY procedure was used with stratified, multistage sampling design, and significance was set to $\alpha < 0.05$ for the test. In this study, participants were classified into four study groups based on household food security and in-come: Food security & higher-income, food insecurity & higher-income, food security & low-income, and food insecurity & low-income groups. And general characteristics, eating habits, food and nutrient intake, and most commonly consumed foods were compared between four groups and a relationship with health-related quality of life was analyzed. General characteristics and eating habit related matters of young adults according to the food security and household income groups were compared and intake of foods and nutrients was estimated.

For categorical variables, the ratio (weighted %) considering frequency and weight was calculated by conducting chi-square test through SURVEY FREQ procedure and for continuous variables, weighted mean and standard error were calculated using SURVEY MEANS procedure and significance by groups was tested by conducting analysis of co-variance (ANCOVA) using SURVEY REG procedure. Post hoc analysis was performed using Tukey's test and age and sex were adjusted. SURVEY LOGISTIC analysis was performed to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for health-related quality of life in young adults according to food security and household income. We conducted analyses adjusted for age, sex, BMI, marital status, residential area, occupation, education level, smoking status, and alcohol consumption.

Results

General characteristics of young adults according to household income and food security

In the result of comparing demographic characteristics according to household in-come and food security, all variables except for sex had significant difference ($p < 0.05$). In the food security & higher-income group, age, monthly household income, the percentage of married persons, university graduates or higher, and administrators/specialists were higher than other groups. On the contrary, the food insecurity & low-income group showed higher percentage of high school graduates and current smokers than other groups and the percentage of poor and that of very poor were high in case of subjective health state (Table 1).

Table 1
Demographic characteristics of participants according to income level and food security.

Variables	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	P-value[1)]
Age (years)	27.2 ± 0.1[a]	27.1 ± 0.1[a]	26.4 ± 0.2[b]	26.0 ± 0.1[b]	< 0.0001
Sex					
Male	1512 (51.6)	1251 (53.1)	569 (52.7)	846 (53.3)	0.6134
Female	2259 (48.4)	1790 (46.9)	811 (47.3)	1186 (46.7)	
BMI (kg/m^2)	23.0 ± 0.1	22.9 ± 0.1	23.3 ± 0.1	23.3 ± 0.1	0.0387
Marital experience					
Married	1497 (34.0)	1103 (29.3)	544 (32.3)	718 (28.5)	0.0009
Single	2271 (66.0)	1938 (70.7)	832 (67.7)	1313 (71.5)	
Maternal childbirth experience					
Yes	552 (54.7)	394 (46.2)	263 (65.7)	322 (55.8)	< 0.0001
No	419 (45.3)	358 (53.8)	120 (34.3)	205 (44.2)	
Residential area					
Urban	3367 (90.6)	2723 (90.9)	1180 (87.5)	1779 (89.4)	0.0390
Rural	404 (9.4)	318 (9.1)	200 (12.5)	253 (10.6)	
Household structure					
one person	239 (7.8)	133 (5.2)	166 (14.1)	153 (9.3)	< 0.0001
Husband and wife	320 (8.7)	178 (5.5)	20 (1.5)	31 (1.5)	
One generation, others	97 (3.1)	109 (4.5)	94 (8.2)	112 (7.0)	
Husband and wife with children	2357 (60.1)	1874 (58.7)	746 (51.1)	1032 (47.9)	
Single parent with children	259 (7.5)	349 (12.6)	148 (11.4)	373 (18.5)	
Two generations, others	124 (3.2)	119 (4.0)	64 (4.6)	95 (4.7)	
≥ Three generations	375 (9.6)	278 (9.5)	142 (9.1)	236 (11.0)	
Occupation					
Administrators & specialists	911 (24.0)	684 (22.1)	193 (14.6)	260 (12.6)	< 0.0001
Clerks	633 (16.6)	514 (16.1)	153 (10.5)	184 (8.6)	
Service workers & marketers	436 (12.2)	395 (13.3)	191 (15.0)	309 (16.8)	
Engineers, technicians & assemblers	259 (8.1)	233 (9.1)	104 (7.1)	162 (9.0)	
Manual labors	110 (3.3)	121 (5.0)	68 (5.3)	123 (6.3)	
Unemployed (housewife, students)	1409 (35.9)	1084 (34.4)	663 (47.6)	982 (46.8)	
Household income (won/month)	559.7 ± 7.5[a]	492.9 ± 6.2[b]	183.3 ± 3.9[c]	174.7 ± 2.6[c]	< 0.0001
Educational level					
< High school graduate	42 (1.0)	32 (1.2)	33 (2.4)	100 (4.5)	< 0.0001
High school graduate	1470 (41.6)	1326 (46.2)	758 (57.2)	1193 (61.4)	
≥ College graduate	2258 (57.3)	1682 (52.5)	588 (40.5)	737 (34.1)	
Smoking status					
Current smokers	758 (24.0)	705 (28.4)	334 (27.2)	519 (29.7)	0.0003
Nonsmokers or Ex-smokers	3008 (76.0)	2333 (71.6)	1045 (72.8)	1512 (70.3)	

Values are n(weighted %) or mean ± SE. [1] Significant differences among the study groups were analyzed by $\chi 2$ test.

[abc] Different superscripts were significantly different among study groups by Tukey's test (α = 0.05).

Variables	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	P-value[1)]
Alcohol consumption					
≥ 4 drink/week	108 (3.2)	78 (3.0)	52 (3.8)	73 (4.3)	< 0.0001
2–3 drink/week	636 (18.1)	460 (16.2)	229 (17.0)	263 (13.3)	
2–4 drink/month	1228 (34.3)	1031 (35.7)	456 (34.8))	653 (34.1)	
1 drink/month	537 (14.0)	427 (14.0)	190 (14.2)	278 (14.0)	
< 1 drink/month	798 (20.0)	652 (20.5)	254 (17.8)	409 (18.8)	
Never	455 (10.6)	384 (10.4)	196 (12.4)	352 (15.6)	
Subjective health status					
Very good	236 (6.7)	177 (6.5)	79 (5.8)	111 (6.0)	0.0004
Good	1479 (38.7)	1055 (34.7)	478 (34.8)	667 (32.7)	
Average	1662 (44.4)	1393 (45.5)	650 (47.0)	946 (46.6)	
Poor	376 (9.7)	395 (12.5)	160 (11.6)	291 (13.9)	
Very poor	18 (0.5)	21 (0.8)	13 (0.8)	17 (0.8)	

Values are n(weighted %) or mean ± SE. [1] Significant differences among the study groups were analyzed by $\chi 2$ test.

[abc] Different superscripts were significantly different among study groups by Tukey's test ($\alpha = 0.05$).

Eating habit of young adults according to household income and food security

Eating habits of young adults according to household income and food security were presented in Table 2. Young adults of the food insecurity & low-income group showed higher percentage of skipping breakfast, lunch and dinner than other groups ($p < 0.05$). Young adults of the food security & higher-income group ate out more frequently than other groups and the percentage of dietary supplement user was significantly high ($p < 0.05$).

Table 2
Dietary habit and behavior of subjects according to income level and food security.

Variables	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	P-value[1)]
Skipping breakfast					
Yes	1446 (40.6)	1267 (44.3)	584 (44.0)	860 (44.4)	0.0400
No	2325 (59.4)	1774 (55.7)	796 (56.0)	1172 (55.6)	
Skipping lunch					
Yes	360 (10.2)	297 (9.9)	152 (11.4)	253 (13.1)	0.0100
No	3411 (89.8)	2744 (90.1)	1228 (88.6)	1779 (86.9)	
Skipping dinner					
Yes	216 (5.5)	242 (7.9)	97 (6.9)	169 (8.1)	0.0010
No	3555 (94.5)	2799 (92.1)	1283 (93.1)	1862 (91.9)	
Frequency of eating-out					
Everyday	1480 (43.8)	1129 (40.7)	423 (35.0)	624 (33.6)	< 0.0001
5–6 /week	940 (22.8)	837 (25.0)	334 (23.2)	487 (23.2)	
3–4/week	604 (14.9)	483 (14.6)	239 (15.9)	331 (15.9)	
1–2/week	524 (13.0)	430 (14.3)	248 (16.9)	368 (17.3)	
1–3/month	207 (5.2)	149 (5.0)	121 (7.6)	179 (8.1)	
Rarely	15 (0.4)	13 (0.4)	15 (1.3)	42 (2.0)	
Dietary supplement use[2)]					
Yes	1214 (39.9)	844 (37.1)	378 (33.9)	452 (29.6)	< 0.0001
No	1716 (60.1)	1375 (62.9)	681 (66.1)	1036 (70.4)	

Values are n (weighted %). [1] Significant difference among the study groups were analyzed by χ2 test. [2] Study subjects with dietary supplement used for longer than two weeks during the previous year.

Intake amount of foods and nutrients in young adults according to household income and food security

Intake amount by food group in young adults according to household income and food security was presented in Table 3. Total food intake of the food security & high-er-income group was 1,646.8 g, which was higher than food security & low-income and food insecurity & low-income groups, but not food insecurity & higher-income ($p < 0.05$). In the food insecurity & low-income group, intakes of vegetables and beverages were higher than food security & higher-income group. For fruits, fish/shellfish, and seasoning, the intake of food security & higher-income group was higher compared to food security & low-income and food insecurity & low-income groups but not the food insecurity & higher-income group. Intake of cereal & cereal products and nuts & seeds products in the food insecurity & low-income group was 295.7 g and 5.3 g, respectively, which were significantly higher than those in the food security & low-income group. Intake of nuts & seeds in the food insecurity & low-income group was significantly higher than that in the food security & low-income group as the former group took in acorn jelly of 1.98 g and acorn powder of 0.01 g, respectively. However, intake of nuts & seeds including almond, macadamia and walnut showed no significant difference between groups. (data not shown).

Table 3
Daily food intake of subjects according to income level and food security.

Food group (g)	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	p-value[1)]
Cereal and cereal products	287.5 ± 3.0[ab]	293.6 ± 3.4[a]	273.9 ± 4.5[b]	295.7 ± 4.3[a]	0.0022
Potatoes and starch products	32.4 ± 1.5[ab]	31.9 ± 1.7[ab]	38.4 ± 2.8[a]	27.0 ± 1.9[b]	0.0103
Sugar and sugar products	11.5 ± 0.4	11.7 ± 0.4	10.0 ± 0.6	10.4 ± 0.5	0.0194
Beans and bean products	35.8 ± 1.6	33.3 ± 1.8	31.5 ± 2.5	30.5 ± 2.7	0.3167
Nuts and seeds products	4.3 ± 0.3[a]	4.6 ± 0.5[a]	2.7 ± 0.3[b]	5.3 ± 1.1[a]	0.0014
Vegetables	278.9 ± 3.9[a]	270.7 ± 4.2[ab]	263.5 ± 6.5[ab]	251.4 ± 5.0[b]	0.0091
Mushrooms	6.0 ± 0.3	6.7 ± 0.7	5.2 ± 0.4	5.3 ± 0.4	0.2231
Fruits	160.9 ± 5.3[a]	150.5 ± 5.4[ab]	126.2 ± 6.8[bc]	115.0 ± 5.3[c]	< 0.0001
Meat and meat products	145.0 ± 3.4	140.9 ± 3.8	138.4 ± 5.1	133.0 ± 4.7	0.0958
Eggs and egg products	31.4 ± 0.9	33.0 ± 1.0	31.4 ± 1.5	31.7 ± 1.3	0.6840
Fish and shellfish	74.9 ± 2.1[a]	68.9 ± 2.7[ab]	62.1 ± 2.8[b]	60.2 ± 3.3[b]	0.0015
Seaweeds	12.6 ± 1.1	12.4 ± 1.5	8.9 ± 1.1	12.0 ± 2.0	0.1395
Milk and dairy products	110.0 ± 3.4	115.6 ± 4.3	104.1 ± 5.6	110.9 ± 5.3	0.2891
Oil and fat	10.2 ± 0.2	10.1 ± 0.2	9.7 ± 0.4	9.7 ± 0.3	0.3973
Beverages	389.2 ± 10.5[a]	375.6 ± 11.4[ab]	386.2 ± 17.6[ab]	341.8 ± 13.1[b]	0.0224
Seasoning	42.7 ± 0.9[a]	39.7 ± 1.0[ab]	37.8 ± 1.2[b]	37.7 ± 1.1[b]	0.0010
Processed foods	13.2 ± 1.2	9.7 ± 1.0	11.4 ± 1.6	10.0 ± 1.4	0.0842
Other	0.4 ± 0.1	0.3 ± 0.1	0.5 ± 0.2	0.2 ± 0.1	0.3525
Total food intake	1646.8 ± 15.7[a]	1609.2 ± 17.2[ab]	1541.9 ± 26.5[bc]	1487.8 ± 20.8[c]	< 0.0001

Values are mean ± SE. [1] Significant difference among study groups was analyzed by ANCOVA including age and sex as covariates. [abc] Different superscripts were significantly different among study groups by Tukey's test (α = 0.05).

In the food security & higher-income group, intake of energy, fat, calcium, phos-phorus, iron, potassium, riboflavin, and vitamin C was higher compared to food insecu-rity & low-income group (Table 4). Also, Energy from carbohydrate was lower but energy from fat was higher in the food security & higher-income group than the food insecurity & low-income group.

Table 4
Daily energy and nutrient intake of subjects according to income level and food security.

Variables	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	p-value[1)]
Energy (kcal)	2136.9 ± 16.6[a]	2143.1 ± 19.8[a]	2049.6 ± 28.4[bc]	2066.1 ± 23.1[b]	0.0030
Carbohydrate (g)	302.4 ± 2.4[ab]	306.3 ± 2.7[a]	292.0 ± 3.8[b]	297.7 ± 3.3[ab]	0.0322
Protein (g)	79.3 ± 0.8	79.7 ± 0.9	76.3 ± 1.3	75.9 ± 1.2	0.0222
Fat (g)	57.1 ± 0.7[a]	55.9 ± 0.8[ab]	53.5 ± 1.2[b]	53.4 ± 0.9[b]	0.0005
Calcium (mg)	506.7 ± 5.5[a]	513.1 ± 6.8[a]	479.2 ± 9.9[ab]	471.5 ± 7.7[b]	0.0005
Phosphorus (mg)	1158.8 ± 9.4[a]	1171.7 ± 11.7[a]	1113.5 ± 16.9[ab]	1098.4 ± 13.7[b]	0.0005
Iron (mg)	14.3 ± 0.2[a]	14.4 ± 0.2[a]	13.2 ± 0.3[b]	12.9 ± 0.3[b]	< 0.0001
Sodium (mg)	4396.9 ± 53.7[a]	4413.7 ± 62.1[a]	4090.0 ± 79.0[b]	4230.5 ± 68.4[ab]	0.0188
Potassium (mg)	2893.2 ± 25.5[a]	2884.2 ± 30.1[ab]	2733.6 ± 42.1[bc]	2665.1 ± 35.9[c]	< 0.0001
Thiamin (mg)	1.6 ± 0.0	1.6 ± 0.0	1.5 ± 0.0	1.6 ± 0.0	0.0517
Riboflavin (mg)	1.5 ± 0.0[a]	1.5 ± 0.0[a]	1.4 ± 0.0[b]	1.4 ± 0.0[b]	0.0007
Niacin (mg)	16.9 ± 0.2	17.3 ± 0.2	16.4 ± 0.3	16.2 ± 0.3	0.0579
Vitamin C (mg)	86.8 ± 1.8[a]	86.3 ± 2.1[a]	80.8 ± 2.5[ab]	76.4 ± 2.2[b]	0.0067
Vitamin A (μgRE)	737.7 ± 16.9	767.2 ± 23.5	716.7 ± 37.6	676.4 ± 20.5	0.0826
Energy from carbohydrate (%)	61.7 ± 0.2[b]	62.4 ± 0.2[ab]	62.5 ± 0.4[ab]	62.9 ± 0.3[a]	0.0003
Energy from protein (%)	14.9 ± 0.1	14.8 ± 0.1	14.9 ± 0.1	14.6 ± 0.1	0.1450
Energy from fat (%)	23.4 ± 0.2[a]	22.8 ± 0.2[ab]	22.6 ± 0.3[b]	22.5 ± 0.2[b]	0.0006

Values are mean ± SE. [1] Significant difference among study groups was analyzed by ANCOVA including age and sex as covariates. [abc] Different superscripts were significantly different among study groups by Tukey's test (α = 0.05).

Percentage of participants who took less than Estimated Average Requirement (EAR) for young adults according to household income and food security

Percentages of young adults who took less than daily estimated average requirement (EAR) by nutrients were compared and the results were presented in Table 5. Food insecurity & low-income group had higher percentage of young adults who took less than estimated average requirement (EAR) for protein, vitamin A, riboflavin, niacin, vitamin C, calcium, and iron than all other groups ($p < 0.05$). Food insecurity & low-income group had higher percentage of young adults who took less than EAR for vitamin A than other groups. For phosphorus, the percentage of subjects who took less than EAR in the low-income groups higher compared to those in the high-income groups. In case of vitamin A, vitamin C, and calcium, more than 50% of young adults in the food insecurity & low-income group took the amount less than EAR a 53.6%, 65.9% and 74.4%, respectively.

Table 5
Percentage of subjects consuming nutrients less than Estimated Average Requirement (EAR) from daily diet according to income level and food security.

Nutrients	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	p-value[1)]
		%			
Carbohydrate	2.1	2.3	2.8	2.6	0.4477
Protein	18.2	20.2	23.2	25.2	< 0.0001
Vitamin A	47.6	46.8	51.8	53.6	< 0.0001
Thiamin	24.4	26.3	29.7	27.9	0.0035
Riboflavin	36.3	38.1	42.4	43.8	< 0.0001
Niacin	30.3	30.6	34.7	36.2	< 0.0001
Vitamin C	59.6	60.9	62.1	65.9	0.0009
Calcium	71.3	70.2	73.7	74.4	0.0172
Phosphorus	10.1	10.7	13.1	13.1	0.0034
Iron	33.9	34.0	38.7	39.8	< 0.0001

[1] Significant differences among the study groups were analyzed by χ2 test.

Most commonly consumed food of young adults according to household income and food security

Table 6 shows the result of calculating commercial foods based on intake amount of foods. Food insecurity & low-income group took rice, milk, and beer in order of highest amount while the other groups took rice, beer, and milk in order of highest amount. In the food insecurity & low-income group, ramen took the 11th place, which was relatively higher rank than other groups, and beef and fruit were not included within the 15th place. On the contrary, in the food security & higher-income group and the food insecurity & higher-income group, apples took 11th place respectively and beef took 13th and 14th places, respectively. Another point of interest in that sprite was ranked 12th in the food insecurity & low-income group and 14th in the food security & low-income group, and 18th in the food insecurity & higher-income group but not even on the food security & higher-income group.

Table 6
The most consumed food items of subjects according to income level and food security.

Rank	Food security & Higher-income (n = 3,771)				Food insecurity & Higher-income (n = 3,041)				Food security & Low-income (n = 1,380)				Food insecurity & Lo (n = 2,032)	
	Food	Intake (g)	Intake (%)	CP (%)	Food	Intake (g)	Intake (%)	CP (%)	Food	Intake (g)	Intake (%)	CP (%)	Food	Intake (g)
1	Rice	137.23	8.46	8.46	Rice	145.73	9.20	9.20	Rice	143.34	9.39	9.39	Rice	149.10
2	Beer	95.85	5.91	14.36	Beer	85.87	5.42	14.62	Beer	100.73	6.60	15.99	Milk	78.97
3	Milk	76.66	4.72	19.09	Milk	81.07	5.12	19.73	Milk	67.60	4.43	20.42	Beer	76.93
4	Kimchi	61.52	3.79	22.88	Kimchi	63.99	4.04	23.77	Kimchi	62.06	4.07	24.49	Kimchi	66.81
5	Pork	55.06	3.39	26.27	Pork	54.08	3.41	27.18	Pork	58.95	3.86	28.35	Cola	54.80
6	Cola	48.60	2.99	29.27	Cola	48.31	3.05	30.23	Cola	56.43	3.70	32.05	Pork	53.29
7	Soju	38.38	2.37	31.63	Soju	40.80	2.58	32.81	Chicken	43.16	2.83	34.88	Chicken	40.54
8	Chicken	37.62	2.32	33.95	Chicken	39.66	2.50	35.31	Soju	37.39	2.45	37.33	Soju	40.31
9	Egg	31.77	1.96	35.91	Egg	33.15	2.09	37.40	Egg	31.69	2.08	39.41	Egg	32.23
10	Onion	31.53	1.94	37.85	Onion	30.69	1.94	39.34	Onion	31.50	2.06	41.47	Onion	28.61
11	Apple	28.02	1.73	39.58	Apple	26.90	1.70	41.04	Potato	29.66	1.94	43.41	Ramen	25.80
12	Green tea[1)]	25.95	1.60	41.17	Fruit drink	23.51	1.48	42.52	Green tea[1)]	25.35	1.66	45.07	Sprite	25.18
13	Beef	25.05	1.54	42.72	Potato	23.39	1.48	44.00	Apple	22.76	1.49	46.57	Bread	21.13
14	Fruit drink	24.65	1.52	44.24	Beef	23.19	1.46	45.46	Sprite	21.90	1.44	48.00	Potato	19.26
15	Bread	24.18	1.49	45.73	Ramen	20.77	1.31	46.77	Fruit drink	20.54	1.35	49.35	Chili	19.25
16	Potato	23.52	1.45	47.18	Bread	20.76	1.31	48.08	Bread	20.06	1.31	50.66	Fruit drink	19.16
17	Mandarin	21.04	1.30	48.47	Chili	20.60	1.30	49.38	Mandarin	19.96	1.31	51.97	Mandarin	18.42
18	Beef bone soup	20.70	1.28	49.75	Sprite	19.78	1.25	50.63	Cucumber	19.69	1.29	53.26	Green tea[1)]	18.36
19	Chili	20.40	1.26	51.00	Mandarin	19.37	1.22	51.85	Beef	18.77	1.23	54.49	Apple	18.28
20	Tofu	19.89	1.23	52.23	Green tea[1)]	19.10	1.21	53.06	Chili	18.51	1.21	55.70	Beef	17.44

CP, Cumulative percent. [1] Green tea infusion.

Relationship between household income and food security and health-related quality of life

Table 7 shows OR and 95% CI for the index of health-related quality of life in young adults according to household income and food security. Food insecurity & low-income group showed any problem of mobility 1.55 times higher than that of the food security & higher-income group [OR (95% CI) = 1.55 (1.05–2.29)], and of anxiety/depression 1.33 times higher than that of the food security & higher-income group [OR (95% CI) = 1.33 (1.07–1.64)]. However, there was no significant relationship in self-care, usual activity, and pain/discomfort.

Table 7
ORs and 95% CIs of EQ-5Ds according to income level and food security.

Variables	Food security & Higher-income (n = 3,771)	Food insecurity & Higher-income (n = 3,041)	Food security & Low-income (n = 1,380)	Food insecurity & Low-income (n = 2,032)	p-value
Mobility					
Any problem, n (%)[1)]	80 (2.0)	76 (2.4)	33 (2.3)	74 (3.7)	0.0020[2)]
Age- and sex-adjusted	Ref	1.24 (0.86–1.79)	1.19 (0.75–1.91)	1.98 (1.39–2.83)	
Multiple adjusted[3)]	Ref	1.22 (0.84–1.76)	1.04 (0.64–1.68)	1.55 (1.05–2.29)	
Self-care					
Any problem, n (%)	16 (0.5)	11 (0.3)	3 (0.2)	15 (0.7)	0.0677
Age- and sex-adjusted	Ref	0.64 (0.28–1.46)	0.32 (0.08–1.34)	1.49 (0.68–3.28)	
Multiple adjusted	Ref	0.68 (0.29–1.58)	0.21 (0.04–1.18)	1.11 (0.50–2.49)	
Usual activity					
Any problem, n (%)	64 (1.9)	62 (1.9)	28 (1.8)	52 (2.8)	0.1512
Age- and sex-adjusted	Ref	1.01 (0.68–1.48)	1.00 (0.58–1.66)	1.51 (1.00-2.30)	
Multiple adjusted	Ref	1.00 (0.67–1.48)	0.85 (0.50–1.45)	1.25 (0.81–1.94)	
Pain/discomfort					
Any problem, n (%)	496 (13.2)	437 (13.7)	191 (13.6)	301 (14.3)	0.7708
Age- and sex-adjusted	Ref	1.05 (0.90–1.22)	1.05 (0.86–1.28)	1.12 (0.94–1.34)	
Multiple adjusted	Ref	1.04 (0.90–1.22)	0.97 (0.79–1.19)	1.01 (0.84–1.22)	
Anxiety/depression					
Any problem, n (%)	283 (7.5)	254 (7.8)	114 (7.8)	236 (10.6)	0.0010
Age- and sex-adjusted	Ref	1.06 (0.87–1.29)	1.05 (0.81–1.35)	1.46 (1.19–1.79)	
Multiple adjusted	Ref	1.05 (0.86–1.28)	0.99 (0.76–1.27)	1.33 (1.07–1.64)	

OR, Odds ratio; CI, confidence interval; EQ-5D, Euro Quality of Life five Dimension. [1] Proportions are given as n (%) reporting any problems. [2] Significant differences among the study groups were analyzed by $\chi 2$ test. [3] The multiple models were adjusted for age, sex, BMI, marital status, residential area, occupation, education level, smoking status, and alcohol consumption.

Discussion

This study was a cross-sectional study conducted to assess the dietary quality of young adults aged 19–34 y in vulnerable group in food-related life and investigate the relationship with the decline of health-related quality of life using KNHANES data from 2008 to 2018. We confirmed that the food insecurity & low-income group had lower foods and nutrients such as fruits, vegetables, fish and shellfish, protein, some vitamins and minerals compared to the food security & higher-income group. In the commonly consumed food, ramen and sprite ranked relatively high in the food insecurity & low-income group while apple and beef ranked high in the food security & higher-income group. In addition, we found that subjects in the food security & low-income group had 55% and 33% higher risk of mobility problem and anxiety/depression respectively.

In this study, total food intake, energy intake, and diet quality were lower in the food insecurity & low-income group than in the food security & higher-income group. Intake of cereal and cereal products was high and intake of vegetables, fruits, fish and shellfish was significantly low in the food insecurity & low-income group. Previous studies have also reported the relationship between food insecurity and intake of low fruit and vegetable [11, 39]. In the Canadian Community Health Survey [4], household food insecurity was negatively associated with intakes of protein, all vitamins and minerals. Whereas, higher energy density and higher proportion of energy obtained from carbohydrates were positively associated with household food insecurity. Purchasing nutritious and costly food may limit for financial reason [40]. Food insecurity seems to be associated with low accessibility to fresh foods such as vegetables and fruits [41–43]. In this study, income level, residential area and household composition type were different according to food security status. In particular, the food insecurity groups showed high percentage of single parents & unmarried children. Such socioeconomic characteristics of the household are considered to be associated with the difference in lifestyle including dietary intake. These results were in line with the previous studies. The previous studies [6, 44–46] showed that there were more younger persons, women and single parents with children in the food insecurity household group than in the food security household group and the former group did not own a house and earned low income. Furthermore, the lower income, socio-economic status, and education level, the higher dietary energy density and the lower diet quality [47, 48]. Such diet quality difference was reported to be caused by higher intake of added sugar, sodium, and saturated fat, and lower intake of fruit and vegetables. In the present study, the food insecurity & low-income group had higher intake of ramen and sprite compared to other groups. Some previous studies [49–51] suggested that food insecurity would be associated with poorer dietary quality. Nutrient-

dense foods, including fruits and vegetables, are often more expensive and less available in low-income group compared to processed foods. Processed foods are relatively inexpensive and accessible.

In this study, the percentage of participants who took less than estimated average requirement (EAR) of KDRI [38] was calculated to assess diet quality of the subjects. As a result, the food insecurity & low-income group has higher percentage of participants who took less than EAR than other groups in nutrients intake except for carbohydrate. In case of vitamin A, vitamin C, and calcium, the percentage of participants who took less than EAR was more than 50%. In particular, calcium was the micronutrient participants took the most insufficiently and 74.4% of young adults in the food insecurity & low-income group took less than EAR ($p < 0.0172$). Unlike this, US adults did not show significant difference in calcium intake according to food security status [50]. Calcium intake in our study was 471.5–406.7 mg while calcium intake in US women aged 20–70 y between 1999 and 2000 was 756 mg [51], showing that calcium intake of the participants of this study was overall lower than US women and particularly, the participants of the food insecurity & low-income group showed even lower calcium intake. In a systematic review study, most countries in Asia have daily dietary calcium intake less than 500 mg [52]. In addition, this study reported that the calcium intake among Korean adults differed according to income, but Brazil was similar. In our study, although milk ranked second and third in the most consumed foods, consumption of milk and dairy products, which are major sources of calcium, seems to be lower than that of Western countries.

As in previous studies [8, 24], this study confirmed that there was a relationship between food insecurity and worse health-related quality of life. In particular, mobility problem and anxiety/depression prevalence of vulnerable group in dietary life, which was the food insecurity & low-income group, was significantly increased in this study. Many studies have reported the relationship between food insecurity and mental health [3, 53, 54]. Meta-analysis for food insecurity and mental health was performed using 19 studies from ten different countries and the results showed that food insecurity increased risk of depression among adults by 44% [OR (95% CI) = 1.44 (1.30–1.58)] and stress by 34% [OR (95% CI) = 1.34 (1.24–1.44)] [17].

This study has some limitations. As KNHANES is a cross-sectional study, we could not confirm the causal relationship between EQ-5Ds and income and food-security. Furthermore, since we used a single 24-hour dietary recall data, which may not be sufficient to estimate the usual dietary intake. Also, there is a limit to absolutely evaluate the lack of nutrients intake using EAR. Therefore, the results of this study had to be interpreted as a relative evaluation of groups classified by food security status and income level. Also, food security was determined using a single question asking household food insufficiency, which may not be sufficient to measure the food security status. Using a single item for measuring food security status could underestimate the prevalence of food insecurity as its low sensitivity [55]. A validation study conducted in Korea assessed the sensitivity and specificity of KNHANES's a single item question with the developed food security measures based on the US household food security survey module [34]. The sensitivity and specificity of the food insufficiency question were 56.8% and 92.3%, respectively. This is consistent with the previous studies [55–57]. On the other hand, Urke et al. [58] reported that a single question for measuring food security could be a useful tool in a large-scale investigation in terms of rapid assessment. Nevertheless, This study has an advantage in that it was a large population-based study and the first study that analyzed the relationship between household income and food security and health-related quality of life (EQ5D) in Korean young adults.

Conclusions

Income level and food insecurity status in Korean young adults had a relationship with dietary intake status and health-related quality of life, and in particular, mobility and anxiety/depression. Therefore, there is a need to take measures for supporting nutrients for such vulnerable group in dietary life and improving their accessibility to healthy and fresh food. Also, the present study could be used as basic data for the development of government support policies to mitigate gap and inequality in young adults' dietary life and health.

Abbreviations

KNHANES
Korea National Health and Nutrition Examination Survey; EQ5D:Euro Quality of Life five Dimensions; HRQoL:Health-related Quality of Life; BMI:Body Mass Index, EAR:Estimated Average Requirement

Declarations

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Availability of data and materials

The KNHANES data is available on the website (http://knhanes.kdca.go.kr).

Ethics approval and consent to participate

All participants signed a written informed consent form and the protocols for KNHANES were approved by the Institutional review board of the Korean Centers for Disease Control and Prevention (KCDC).

Competing interests

The authors declare no conflict of interest.

Consent for publication

Not applicable

Authors' contributions

E.-k. K. took primary responsibility for writing the manuscript. E.-k. K. and Y.-S. K. performed the statistical analyses and methodology. S.-N. K. and J.-Y. L. reviewed the manuscript. Y.H. P. designed the project and contributed critically to the interpretation of the results. All authors have read and agreed to the published version of the manuscript.

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