



Nutritional status and dietary behavior of North Korean adolescent refugees based on Nutrition Quotient for Korean adolescents: a preliminary study

Young Goh^{1),2)*}, Seong-Woo Choi^{3)*}, So-Yeong Kim⁴⁾, Jeong-Hwa Choi^{5)†}

¹⁾Researcher, Department of Food Science and Nutrition, Keimyung University, Daegu, Korea

²⁾Dietitian, Department of Nutrition, Keimyung University Dongsan Hospital, Daegu, Korea

³⁾Professor, Department of Preventive Medicine, Chosun University Medical School, Gwangju, Korea

⁴⁾Researcher, Department of Preventive Medicine, Chosun University Medical School, Gwangju, Korea

⁵⁾Assistant professor, Department of Food Science and Nutrition, Keimyung University, Daegu, Korea

†Corresponding author

Jeong-Hwa Choi
Department of Food Science and Nutrition, Keimyung University,
1095 Dalgubeol-daero, Dalseo-gu,
Daegu 42601, Korea

*These two authors equally contributed to this work.

Tel: +82-53-580-5913
Fax: +82-53-580-6268
E-mail: jhchoi@kmu.ac.kr

Received: November 30, 2022
Revised: January 2, 2023
Accepted: January 9, 2023

ABSTRACT

Objectives: This study aimed to investigate the nutritional status and dietary behavior of adolescents from North Korean refugee (NKR) families residing in South Korea (SK), who are known to be at a higher risk of malnutrition due to their lower socioeconomic status and facing other psychological challenges.

Methods: A total of 178 adolescents (91 males and 87 females) from NKR families were included in the analysis, and their demographic details such as age, birthplace, parental nationality, and duration of their settlement in SK were collected through questionnaires. Anthropometric measurements were also taken to determine their growth and nutritional status according to the 2017 Korean National Growth Charts for children and adolescents. The study used the Nutrition Quotient for Korean Adolescents (NQ-A) questionnaire to assess the dietary behavior of the participants.

Results: Approximately 11.8% and 10.1% of participants were identified with malnutrition and obesity, respectively. The total mean score for the NQ-A was 50.1. The mean scores for the individual factors of balance, diversity, moderation, environment, and practice were 49.2, 44.7, 43.8, 51.2, and 61.5, respectively. Approximately 47.2% of participants had a low NQ-A grade. However, there was no significant difference in the NQ-A scores according to their nutritional status or duration of time in SK.

Conclusions: Adolescents from NKR families exhibited both malnutrition and obesity. However, their dietary behavior, as assessed using the NQ-A, did not vary with their nutritional status. The unique challenges and related dietary behavior of North Korean adolescent refugees should be taken into consideration, when developing targeted strategies for nutritional education and health management programs.

KEY WORDS children and adolescents, malnutrition, North Korean refugee, NQ-A, obesity

Introduction

The number of North Korean refugees (NKR) in South Korea (SK) increased dramatically from an average of 8.5 per year in the early 1990s to over 1,000 per year in the 2000s [1]. Initially, the defections were driven by financial constraints and food shortages in North Korea (NK) [2], and recently, NKRs have been migrating to SK with their families, resulting in an increase in the number of adolescent refugees [3]. As of June 2021, a total of 33,788 NKRs have entered SK, with 3,591 of them being between the ages of 10 and 19. However, this data may not reflect the actual number of NKRs in SK, as it does not account for those born in other countries [4].

Adolescents from NKR families in SK have been impacted by the drastic differences in the lifestyles of the two countries after defection, including changes in dietary habits that could affect their physical development in addition to academics and other factors [5]. Studies have shown that children and adolescents who have fled NK and entered Hanawon, a resettlement center in SK, are 19% shorter and weigh 15% lower than South Korean children and adolescents of the same age [6]. This has led to North Korean adolescents being more concerned about their height, compared to those from SK [7, 8]. North Korean adolescents are also at a higher risk of chronic diseases due to nutritional deficiencies seen in early childhood [9]. Adolescence is an important stage of growth and development. It is therefore crucial that adolescents have a balanced diet and healthy eating habits to provide them with adequate nutrition for healthy growth [10]. However, adolescents in general, including those from NKR families, often have irregular eating habits, miss breakfast, and consume high-calorie, low-nutrient foods, which can lead to nutritional imbalances. NKR adolescents are also likely to be less involved in regular physical activities due to academic pressures [11]. Given the history of poverty and starvation that the NKR youths have experienced, it is important to provide them with adequate nutritional support and to find ways to improve their diet and eating behavior.

Research on the nutritional status or dietary habits of adolescents from migrant families has been poorly reported, particularly from developed countries. Eating behavior varies greatly between ethnic groups, families, and individuals, and has a significant impact on an individual's health. Several studies regarding the nutritional status of NKRs have been conducted, but most of them have focused on assessing their nutritional status [4, 12]. Thus, studies that analyze their eating behavior using an objective instrument are lacking.

This study aimed to examine the nutritional status and eating behavior of adolescents from NKR families settled in SK. The study applied the Nutrition Quotient for Korean Adolescents (NQ-A) to investigate and evaluate their eating habits in terms of their nutritional status. The results of this study could provide a better understanding of the nutrition and eating behavior of North Korean adolescent refugees which would help in the design of health and nutrition education programs for them in the future.

Methods

Ethics statement

The study was approved by the Institutional Review Board of Chosun University (IRB No. 2-1041055-AB-N-01-2017-0025). Written consent was obtained from the subjects prior to the commencement of the study. Participants were told that all data collected in this study would be used exclusively for this project and that they were free to withdraw at any time.

1. Study population

This study focused on adolescents between the ages of 13 and 18 years who were born in NKR families and are currently living in SK. An adolescent is classified as a North Korean adolescent refugee if one of his/her parents, is an NKR. The participants were recruited through the local Hana centers, alternative schools, and non-government nonprofit organizations. A

total of 178 adolescents (91 males and 87 females) from NKR families were interviewed using structured questionnaires between September 2017 and December 2019.

2. General characteristics

The study collected data on sex, date and country of birth, duration of residence in SK, and the nationality of the birth mother and father of the participants. The age of the adolescents was calculated based on the date of data collection and the birth date. Information about their current school grade was not collected and was therefore not included in the study. Height and weight were measured using an InKids ultrasonic extensometer (InLab S50, InBody Co., Ltd., Seoul, Korea) and a digital scale (CAS HE-58, CAS, Yangju, Korea) with increments of 0.1 cm and 0.1 kg, respectively.

3. Determination of nutritional status

The study assessed the growth and nutritional status of adolescents based on the ‘2017 Childhood and Adolescent Growth Chart’ published by the Korea Disease Control and Prevention Agency and the Korean Pediatric Society [13]. The standard score (z-score) of height for age, weight for age, weight for height, and body mass index (BMI) for age values were calculated using the Korean physical development measurement survey data for children and adolescents between the ages of 13 and 18.

The nutritional status of the participants was determined using the following criteria, based on an earlier study [12]: if the height for age z-score (HAZ) was < -2 standard deviations (SD) the participant was classified as stunted; if the weight for age z-score (WAZ) was $< -2SD$ the participant was classified as underweight; if the weight for height z-score (WHZ) was $< -2SD$ the participant was classified as wasted, and finally, if the participant met any of the above criteria, then he/she was classified as malnourished [14]. For the obesity classification, if the WAZ or WHZ was $\geq +2SD$ the participant was classified as obese. Furthermore, if the BMI for age z-score (BMIZ) was $\geq 2SD$ the participant was considered obese finally, based on an earlier study [12].

4. Evaluation of dietary behavior using NQ-A

The study evaluated the eating behavior of adolescents using the NQ-A, developed by the Korean Nutrition Society. The NQ-A is designed for adolescents between the ages of 13 and 18 (mainly middle and high school students) and is used to evaluate their nutritional status and eating behavior. The NQ-A questionnaire is divided into five detailed factors: balance, diversity, moderation, environment, and practice. It comprises 19 items, including 4 questions on balance, 6 questions on moderation, 3 questions on diversity, 3 questions on practice, and 3 questions on the environment. A total of 178 participants responded to the survey, and the scores for each evaluation item were calculated, multiplied by weights, and summed up to arrive at the total score. The total score was then classified into three categories or grades, namely ‘high’ (63.1-100), ‘medium’ (49.0-63.0), and ‘low’ (0-48.9) grade [11].

5. Statistical analysis

The general characteristics of the study participants were presented using mean, standard deviation, frequency, and percentage. One-way analysis of variance, Chi-square, and/or Fisher's exact test were used to analyze the data. General linear models were employed to compare the NQ-A scores to evaluate the differential nutritional status of the subjects. Model I was crude and model II was adjusted for sex and age. Fisher's exact test was used to compare the distribution of the grades of NQ-A, according to the nutritional status. The data were analyzed using the SPSS version 27.0 (SPSS Inc., IBM Corp., Armonk, NY, USA), and all results were considered statistically significant at $P < 0.05$.

Results

1. General characteristics of the survey participants

Table 1 shows the general characteristics and nutritional status of the survey participants. A total of 178 adolescents (91 boys and 87 girls) aged 15.6 ± 1.7 years old participated in this study. The nutritional status was determined by evaluating the HAZ, WAZ, WHZ, and BMIZ of the participants. Among the participants, 139 were considered normal (78.1%), 21 were malnourished (11.8%), and 18 were obese (10.1%).

An analysis of the social characteristics of the adolescents revealed that 63.5%, 29.8%, and 5.1% of them were born in China, NK, and SK, respectively. The majority of the birth mothers (96.1%) were North Korean, while the birth fathers were Chinese

Table 1. General characteristics of participants by nutritional status

| Variables | All participants (n = 178, 100.0%) | Normal (n = 139, 78.1%) | Malnutrition (n = 21, 11.8%) | Obesity (n = 18, 10.1%) | P-value |
|---------------------------------|---------------------------------------|----------------------------|---------------------------------|----------------------------|---------|
| Age (years) | 15.6 ± 1.7 | 15.5 ± 1.8 | 16.0 ± 1.6 | 16.1 ± 1.5 | 0.220 |
| Height (cm) | 163.5 ± 9.7 | 164.4 ± 8.3 | 155.9 ± 15.0 | 165.5 ± 9.3 | 0.001 |
| Weight (kg) | 59.0 ± 12.9 | 58.2 ± 10.1 | 47.0 ± 11.4 | 79.7 ± 10.2 | < 0.001 |
| BMI (kg/m ²) | 22.0 ± 3.8 | 21.5 ± 2.7 | 19.3 ± 4.1 | 29.1 ± 2.7 | < 0.001 |
| Sex | | | | | 0.315 |
| Male | 91 (51.1) | 68 (48.9) | 14 (66.7) | 9 (50.0) | |
| Female | 87 (48.9) | 71 (51.1) | 7 (33.3) | 9 (50.0) | |
| Country of birth | | | | | 0.933 |
| South Korea | 9 (5.1) | 8 (5.8) | 0 (0.0) | 1 (5.6) | |
| North Korea | 53 (29.8) | 41 (29.9) | 6 (30.0) | 6 (33.3) | |
| China | 113 (63.5) | 88 (64.2) | 14 (70.0) | 11 (61.1) | |
| No answer | 3 (1.7) | | | | |
| Age at settlement | | | | | 0.474 |
| < age 9 | 38 (21.3) | 31 (26.7) | 3 (14.3) | 4 (26.7) | |
| ≥ age 9 | 114 (64.0) | 85 (73.3) | 18 (85.7) | 11 (73.3) | |
| No answer | 26 (14.6) | | | | |
| Duration of settlement | | | | | 0.940 |
| < 5 years | 91 (51.1) | 69 (58.0) | 13 (61.9) | 9 (60.0) | |
| ≥ 5 years | 64 (36.0) | 50 (42.0) | 8 (38.1) | 6 (40.0) | |
| No answer | 23 (12.9) | | | | |
| Nationality of the birth mother | | | | | 0.628 |
| South Korea/China | 4 (2.3) | 3 (2.2) | 1 (5.0) | 0 (0.0) | |
| North Korea | 171 (96.1) | 134 (97.8) | 19 (95.0) | 18 (100.0) | |
| No answer | 3 (1.7) | | | | |
| Nationality of the birth father | | | | | 0.773 |
| South Korea | 10 (5.6) | 8 (5.8) | 2 (10.5) | 0 (0.0) | |
| North Korea | 53 (29.8) | 42 (30.7) | 6 (31.6) | 5 (27.8) | |
| China | 110 (61.8) | 86 (62.8) | 11 (57.9) | 13 (72.2) | |
| Other | 1 (0.6) | 1 (0.7) | 0 (0.0) | 0 (0.0) | |
| No answer | 4 (2.2) | | | | |

n (%) or Mean ± SD.

P-values for age and anthropometric data are from the analysis of variance, or else, chi-squared or Fisher's exact tests.

'No answer', zero, and other responses were excluded from the analyses due to rarity.

Nutritional status was defined as follows: for malnutrition; height for age z-score or weight for age z-score or weight for height z-score < -2SD, for obesity; BMI for age z-score ≥ +2SD.

BMI: body mass index, n: number of participants

(61.8%), North Korean (29.8%), and South Korean (5.6%). Earlier studies have reported that malnutrition tends to decrease in children who have lived in SK for more than 5 years [4]. Therefore, the participants were divided into two groups based on the duration of their residence in SK (more or less than 5 years) to analyze the distribution of malnutrition. Results showed that 51.1% of the surveyed individuals had lived in SK for less than 5 years. Adolescence is a period of accelerated growth, and the surrounding environment during this phase can influence growth [15]. In line with this, study participants were also classified into 2 groups according to their age when they settled in SK, namely up to 9 years of age or older than 9 years. Results showed that about 64.0% of the study participants settled in SK after the age of 9. However, the social characteristics such as the duration of residence and settlement in SK, the nationality of the parents, and the country of birth, were not found to have a significant association with the nutritional status of these participants.

2. Evaluation of nutritional status and nutritional index of survey participants

The overall mean NQ-A score of the adolescents was 50.1 (Table 2). The scores for each component were as follows: 49.2 for balance, 44.7 for diversity, 43.8 for moderation, 51.2 for environment, and 61.5 for practice.

The nutritional status of the participants was classified according to the HAZ, WAZ, and WHZ scores of each. No significant difference in the NQ-A scores between these groups was evident. However, when the nutritional status was classified by WHZ, the balance scores of the obese and malnourished groups tended to be lower than that of the normal group (Tables 2-4).

The NQ-A scores for the three different nutritional groups defined taking into account all HAZ, WAZ, and WHZ scores, are presented in Table 5. For adolescents with malnutrition, the overall mean score was 51.1, which was not significantly different from those for other groups. However, their scores for balance (53.9) and moderation (48.6) were higher than those for normal

Table 2. NQ-A scores of the participants according to nutrition status as defined by the HAZ score

| Variables | All participants (n = 178, 100%) | Normal (n = 168, 94.4%) | Malnutrition (n = 10, 5.6%) | P-value ¹⁾ | P-value ²⁾ |
|-------------|-------------------------------------|----------------------------|--------------------------------|-----------------------|-----------------------|
| NQ-A | 50.1 ± 11.5 | 50.1 ± 11.5 | 49.9 ± 12.8 | 0.963 | 0.845 |
| Balance | 49.2 ± 19.8 | 49.2 ± 20.0 | 48.9 ± 17.2 | 0.953 | 0.838 |
| Diversity | 44.7 ± 17.5 | 44.6 ± 17.6 | 46.3 ± 16.9 | 0.778 | 0.699 |
| Moderation | 43.8 ± 17.3 | 43.6 ± 17.2 | 47.1 ± 19.2 | 0.529 | 0.615 |
| Environment | 51.2 ± 22.0 | 51.3 ± 22.1 | 50.1 ± 21.2 | 0.871 | 0.595 |
| Practice | 61.5 ± 20.5 | 61.7 ± 20.8 | 57.3 ± 16.0 | 0.502 | 0.583 |

Mean ± SD.

Nutritional status was defined as follows: malnutrition; HAZ < -2SD.

1) P-values were from crude models.

2) P-values were from generalized linear models with covariates including sex and age.

HAZ: height-for z-score, NQ-A: Nutrition Quotient for Korean Adolescents, n: number of participants

Table 3. NQ-A scores of the participants according to nutrition status as defined by the WAZ scores

| Variables | All participants (n = 178, 100%) | Normal (n = 156, 87.6%) | Malnutrition (n = 10, 5.6%) | Obesity (n = 12, 6.7%) | P-value ¹⁾ | P-value ²⁾ |
|-------------|-------------------------------------|----------------------------|--------------------------------|---------------------------|-----------------------|-----------------------|
| NQ-A | 50.1 ± 11.5 | 50.3 ± 11.5 | 49.9 ± 12.8 | 47.0 ± 10.8 | 0.627 | 0.513 |
| Balance | 49.2 ± 19.8 | 49.7 ± 20.0 | 48.9 ± 17.2 | 43.0 ± 23.4 | 0.522 | 0.439 |
| Diversity | 44.7 ± 17.5 | 44.2 ± 17.6 | 46.3 ± 16.9 | 50.9 ± 17.2 | 0.430 | 0.355 |
| Moderation | 43.8 ± 17.3 | 44.1 ± 17.0 | 47.1 ± 19.2 | 36.4 ± 18.3 | 0.273 | 0.245 |
| Environment | 51.2 ± 22.0 | 51.7 ± 21.9 | 50.1 ± 21.2 | 46.5 ± 25.3 | 0.728 | 0.460 |
| Practice | 61.5 ± 20.5 | 62.0 ± 21.1 | 57.3 ± 16.0 | 58.2 ± 15.9 | 0.663 | 0.707 |

Mean ± SD.

Nutritional status was defined as follows: malnutrition; WAZ < -2SD, obesity; WAZ ≥ +2SD.

1) P-values were from crude models.

2) P-values were from generalized linear models with covariates including sex and age.

n: number of participants, NQ-A: Nutrition Quotient for Korean Adolescents, WAZ: weight-for-age z-score

Table 4. NQ-A scores of the participants according to nutrition status as defined by the WHZ score

| Variables | All participants (n = 178, 100%) | Normal (n = 145, 81.5%) | Malnutrition (n = 6, 3.4%) | Obesity (n = 27, 15.2%) | P-value ¹⁾ | P-value ²⁾ |
|-------------|-------------------------------------|----------------------------|-------------------------------|----------------------------|-----------------------|-----------------------|
| NQ-A | 50.1 ± 11.5 | 50.8 ± 11.6 | 44.7 ± 11.9 | 47.4 ± 10.5 | 0.187 | 0.176 |
| Balance | 49.2 ± 19.8 | 50.7 ± 19.8 | 36.0 ± 9.0 | 44.1 ± 20.1 | 0.068 | 0.058 |
| Diversity | 44.7 ± 17.5 | 44.6 ± 17.7 | 39.3 ± 19.6 | 46.5 ± 16.3 | 0.652 | 0.745 |
| Moderation | 43.8 ± 17.3 | 44.1 ± 18.0 | 47.1 ± 15.7 | 41.1 ± 13.1 | 0.638 | 0.717 |
| Environment | 51.2 ± 22.0 | 52.3 ± 21.7 | 48.2 ± 25.7 | 46.2 ± 22.9 | 0.396 | 0.396 |
| Practice | 61.5 ± 20.5 | 62.3 ± 21.1 | 52.9 ± 13.7 | 59.2 ± 18.1 | 0.447 | 0.501 |

Mean ± SD.

Nutritional status was defined as follows: malnutrition; WHZ < -2SD, obesity; WHZ ≥ +2SD.

1) P-values were from crude models.

2) P-values were from generalized linear models with covariates including sex and age.

n: number of participants, NQ-A: Nutrition Quotient for Korean Adolescents, WHZ: weight-for-height z-score

Table 5. NQ-A scores of the participants according to nutrition status, considering the HAZ, WAZ, WHZ and BMIZ scores

| Variables | All participants (n = 178, 100%) | Normal (n = 139, 78.1%) | Malnutrition (n = 21, 11.8%) | Obesity (n = 18, 10.1%) | P-value ¹⁾ | P-value ²⁾ |
|-------------|-------------------------------------|----------------------------|---------------------------------|----------------------------|-----------------------|-----------------------|
| NQ-A | 50.1 ± 11.5 | 50.4 ± 11.8 | 51.1 ± 10.4 | 46.6 ± 10.3 | 0.392 | 0.565 |
| Balance | 49.2 ± 19.8 | 49.5 ± 19.9 | 53.9 ± 14.8 | 42.0 ± 22.7 | 0.166 | 0.107 |
| Diversity | 44.7 ± 17.5 | 44.6 ± 18.2 | 43.4 ± 15.8 | 47.7 ± 14.2 | 0.723 | 0.100 |
| Moderation | 43.8 ± 17.3 | 43.3 ± 17.9 | 48.6 ± 16.2 | 42.1 ± 12.7 | 0.389 | 0.670 |
| Environment | 51.2 ± 22.0 | 51.9 ± 22.4 | 49.9 ± 17.1 | 47.3 ± 24.6 | 0.677 | 0.867 |
| Practice | 61.5 ± 20.5 | 62.7 ± 20.9 | 59.8 ± 19.8 | 54.0 ± 17.2 | 0.218 | 0.611 |

Mean ± SD.

Nutritional status was defined as follows: malnutrition; HAZ or WAZ or WHZ < -2SD, obesity; BMIZ ≥ +2SD.

1) P-values were from crude models.

2) P-values were from generalized linear models with covariates including sex and age.

BMI: body mass index, BMIZ: BMI for age z-score, HAZ: height for age z-score, n: number of participants, NQ-A: Nutrition Quotient for Korean Adolescents, WAZ: weight for age z-score, WHZ: weight for height z-score

Table 6. NQ-A grades according to the nutritional status of the participants

| Variables | NQ-A grade (score) | | | P-value |
|-----------------------|------------------------------------|---------------------------------------|---------------------------------|---------|
| | High (63.1 - 100) n = 23, 12.9% | Medium (49.0 - 63.0) n = 71, 39.9% | Low (0 - 48.9) n = 84, 47.2% | |
| Normal (n = 139) | 20 (14.4) | 53 (38.1) | 66 (47.5) | 0.326 |
| Malnutrition (n = 21) | 2 (9.5) | 12 (57.1) | 7 (33.3) | |
| Obesity (n = 18) | 1 (5.5) | 6 (33.3) | 11 (61.1) | |

n (%). P-values for data are from Fisher's exact tests.

Nutritional status was defined as follows: for malnutrition; height for age z-score or weight for age z-score or weight for height z-score < -2SD, for obesity; BMI for age z-score ≥ +2SD.

Grade criterion high grade: NQ-A score 63.1-100, medium grade: NQ-A score 49.0-63.0, low grade: NQ-A score 0-48.9.

n: number of participants, NQ-A: Nutrition Quotient for Korean Adolescents

participants, while their scores for diversity (43.4), environment (49.9), and practice (59.8) tended to be lower. For obese individuals, the overall average score of NQ-A was 46.6, and the average score for diversity was 47.7, which was higher than those of normal participants, but the scores for the remaining factors were lower. Finally, these NQ-A scores and the scores for each component showed no significant difference between the normal, malnourished, and obese groups.

Table 6 shows the distribution of NQ-A grades according to the total NQ-A score of the North Korean adolescent refugees. Overall, 23 (12.9%), 71(39. 9%), and 84 (47.2%) participants were in the high, medium, and low-grade groups, respectively. Additionally, among the normal subjects, 20 (14.4%), 53 (38.1%), and 66 (47.5%) were also in the high, medium, and lower groups, respectively. Twelve of the subjects with malnutrition were in the medium grade (57.1%), and most of the obese

individuals were in the low grade (11, 61.1%). However, the distribution of nutritional status was not associated with the NQ-A grades.

Discussion

This study assessed the nutritional status of 178 adolescents from NKR families who grew up in SK and examined the association between their dietary behavior and nutritional status using the NQ-A.

Ascertaining appropriate eating behavior and maintaining proper nutrition during adolescence is crucial, as it can greatly influence physical and emotional development, academic performance, and lifetime health [10]. According to the 2017-2019 Korea National Health and Nutrition Examination Survey, the proportion of underweight Korean adolescents with a standard score < -2SD in WAZ was 4.2% in 2017, 4.7% in 2018, and 3.5% in 2019 [16]. The prevalence of malnutrition among North Korean adolescent refugees observed in this study was about three times (11.8%). On the other hand, the obesity rate of the study participants was 10.1%, which is not greatly different from the obesity rate of 15.7% among adolescents in Korea in 2019 [16]. This may suggest that NKR adolescents are experiencing the issue of the 'double burden' of malnutrition wherein both undernutrition and obesity coexist [12].

The relatively high rates of malnutrition and obesity among adolescent refugees seem to be related to the socioeconomic problems faced by the NKR families. The Ministry of Unification, SK reported that the monthly household income of NKRs has improved but is still lower than that of the general South Korean population [3]. The lower socioeconomic status of NKRs is associated with poor meal quality and/or starvation. Leading to a higher prevalence of the double burden of undernutrition and obesity [17]. Kim et al. [5] also reported that NKRs experience physical and mental stress due to differences in their eating pattern compared to their place of birth. NKRs need to adapt to unfamiliar ingredients, recipes, and condiments which are integral to South Korean culture. Studies have shown that refugee adolescents have low adherence to new types of vegetables such as broccoli and celery, dairy products, and sauces (e.g. mayonnaise), which they had not consumed till their shift to SK [18]. These socioeconomic and dietary differences faced by the adolescent refugees in addition to other general problems commonly associated with adolescents, such as poor eating behavior - missing breakfast, lower intake of natural foods, and increase in the intake of instant foods, may influence the nutritional status of these youth. These factors could explain the poor nutritional status and associated health issues among them.

Previous studies have reported that the malnutrition rate of NKRs improves by 0.7% - 3.4% after 5 years of resettlement in SK [4]. In addition, growth may vary depending on the living environment and the food intake levels of adolescents [15]. In line with this, analyses were performed to examine whether the age and period of resettlement of the NKR youths affect their nutritional status. However, the results suggested that the period of resettlement and the puberty period spent in SK were not significantly associated with nutritional status. This may be due to the differences between the participants of this study and those in earlier studies. Unlike earlier studies conducted with children under 12, this study was conducted on adolescents. The onset of puberty in an individual and the rate of growth varies by a differential degree. Additionally, malnutrition in the early stages of life may not be compensated for by later environmental changes and improved nutrition [19]. These factors may be associated with the lack of significant changes in the nutritional status based on the timing and duration of settlement in SK of these study participants.

In this study, the total NQ-A scores and individual factor scores of the adolescents with three different types of nutritional status were compared, but there was no significant difference between the normal, malnourished and obese groups. In an earlier study on a nationwide scale, the overall average NQ-A score was 56.0, and for each factor, the scores were as follows: 58.6 for balance, 55.6 for diversity, 48.1 for moderation, 70.6 for the environment, and 52.1 for practice [11]. Inconsistencies have been reported from many earlier studies that examined the distribution of nutritional status and NQ/NQ-A/NQ-preschoolers scores [20-22]. In this study, the overall NQ-A scores of the participants tended to be low, and hence there was no significant difference

in the scores between the groups. The participants of this study also had lower scores for overall average, balance, diversity, moderation, and environment of eating behavior, but higher scores for practice, compared to South Korean adolescents. A large difference in scores was evident in the area of environment between the SK and NKR groups. The practice factor includes items such as checking nutrition fact labeling, washing hands before meals, and frequency of exercise. The environment factor includes items such as intake frequency of breakfast, not moving around while eating, and screen time [11]. As described above, although an earlier study had shown that the malnutrition rate for NKR who have lived in SK for more than 5 years improved, the rate was still higher than that in South Koreans [4]. The lower socioeconomic status of NKR and their children in SK may lead to health disparities. However, the relatively higher score for practice for NKR adolescents may play a positive role in improving their nutritional status in the future. Eating behaviors are known to be influenced by the home environment for younger children. However, school and social-environmental factors, such as nutritional knowledge and the preferences of friends have a greater effect with time [23]. Also, parents' eating behavior, which determines the dietary pattern for the entire family, remains important with respect to the acceptance of new foods for children from outside SK [22]. Considering the differences in the environmental factor scores seen in this study, to improve the nutritional status of adolescents in NKR families, it is important to implement educational programs that encourage or strengthen parental participation, taking into account the socioeconomic environment of NKR.

The nutritional status of the study subjects was classified into three groups - high, middle, and low grades, using NQ-A scores and most of the NKR in this study were in the low to middle group requiring continuous monitoring [11]. Adolescents in SK who belong to the low grade have shown significantly lower values for vitamin C, potassium, and zinc intake, but higher values for fat, compared to the recommended level, than those in the high group [11]. Additionally, according to the 2020 Korea Youth Risk Behavior Survey data, increased intake of high-calorie and high-fat foods with high lipid content, but reduced vitamin C, folic acid, and potassium intake from fruits and vegetables and lower physical activity have been reported [11, 24]. Given this, although dietary consumption data was not investigated in the present study, NKR youth may also have poor nutritional intake. Such inappropriate dietary intake should be considered while formulating the nutrition and dietary behavior education of adolescents from NKR families [11].

This study has some limitations. First, due to the limited sample size, analysis of the nutritional status and dietary behavior by gender was not performed. Additionally, the study subjects were not representative of all NKR adolescents in SK because they were not randomly recruited. Also, the study did not survey food and nutrient consumption. The economic status of the family or the educational qualifications of parents that may affect the growth and nutritional status of adolescents were not considered in the analyses. Last, NQ-A is a dietary evaluation tool for South Korean adolescents, and its use in evaluating the eating habits of NKR youth with different food and cultural backgrounds may not be appropriate. However, the results of this study provide preliminary data for a better understanding of the eating behavior and nutritional status of NKR adolescents in SK.

Conclusion

NKR adolescents showed a higher prevalence of malnutrition, compared to SK adolescents. However, no significant differences in dietary behavior between nutritional groups were evident as evaluated by the NQ-A scores. Given the socioeconomic challenges for NKR families and the importance of nutrition for adolescents, it is necessary to develop and implement appropriate nutrition education programs to improve the nutritional status and dietary behaviors of NKR adolescents.

ORCID

Young Goh: <https://orcid.org/0000-0002-0103-9826>

Seong-Woo Choi: <https://orcid.org/0000-0002-6150-3934>

So Yeong Kim: <https://orcid.org/0000-0002-2132-9580>

Jeong-Hwa Choi: <https://orcid.org/0000-0003-4730-6544>

Conflict of interest

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

Funding

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (No. NRF-2017R1D1A3B03031660).

Data availability

Datasets for this study are available from the corresponding author on reasonable request.

References

1. Joo JW, Kim B, Chung J. North Korean refugees' media use and social capital. *Korean J Journal Commun Stud* 2019; 63(4): 45-82.
2. Food and Agriculture Organization of the United Nations. FAO/WFP crop and food supply assessment mission to democratic people's Republic of Korea [internet]. 1997 [updated 1997 Dec 10; cited 2022 Jan 9]. Available from: <https://reliefweb.int/report/democratic-peoples-republic-korea/faowfp-crop-and-food-supply-assessment-mission-democratic>.
3. Ministry of Unification. 2021 Working-level manual on support for settlement of North Korean refugees. 1st revision. Seoul: Ministry of Unification; 2021. p. 8-13.
4. Choi SW. Growth and nutritional status of children in North Korean refugee families. *J Korean Soc Matern Child Health* 2020; 24(2): 96-101.
5. Kim KB, Choi MJ, Kwon YD, Noh JW. Affecting changes of meal habit into stress and depression among North Korea juvenile. *North Korean Stud Rev* 2014; 18(2): 311-333.
6. Lee IS, Park HR, Kim YS, Park HJ. Physical and psychological health status of North Korean Refugee children. *Child Health Nurs Res* 2011; 17(4): 256-263.
7. Kim YY. An evaluation of the health status of children from North Korea. *Nurs Sci* 2005; 17: 55-63.
8. Park SY. The biological standard of living in the two Koreas. *Econ Hum Biol* 2004; 2(3): 511-521.
9. Chang NS, Kang EY, Lee JM, Lee MK. Anthropometric measurements and dietary patterns of North Korean migrant children in China. *Korean J Nutr* 2000; 33(3): 324-331.
10. Bae YJ. Evaluation of nutrient intake and food variety by age in Korean adolescents: Based on 2010-2012 Korean National Health and Nutrition Examination Survey. *J Nutr Health* 2015; 48(3): 236-247.
11. Kim HY, Lee JS, Hwang JY, Kwon SH, Chung HR, Kwak TK et al. Development of NQ-A, Nutrition Quotient for Korean Adolescents, to assess dietary quality and food behavior. *J Nutr Health* 2017; 50(2): 142-157.
12. Kim SY, Choi SW. Double burden of malnutrition and obesity in children and adolescents from North Korean refugee families. *PLoS One* 2020; 15(11): e0241963.
13. Kim JH, Yun S, Hwang SS, Shim JO, Chae HW, Lee YJ et al. The 2017 Korean National Growth Charts for children and adolescents: Development, improvement, and prospects. *Korean J Pediatr* 2018; 61(5): 135-149.
14. World Health Organization. Physical status: the use and interpretation of anthropometry. 1st revision. Geneva: World Health Organization; 1995.
15. Norris SA, Frongillo EA, Black MM, Dong Y, Fall C, Lampl M et al. Nutrition in adolescent growth and development. *Lancet* 2022; 399(10320): 172-184.
16. Korea Health Promotion Institute. Statistical data on obesity for national health promotion (2016-2020). 1st revision. Seoul: Korea Health Promotion Institute; 2021. p. 27.
17. Ogden CL, Carroll MD, Fakhouri TH, Hales CM, Fryar CD, Li X et al. Prevalence of obesity among youths by household income and education level of head of household - United States 2011-2014. *Morb Mortal Wkly Rep* 2018; 67(6): 186-189.

18. Lee JE, Um MH, Kye SH. Qualitative study on dietary experience in South Korea for North Korean Refugee adolescents. *J Korean Soc Food Cult* 2021; 36(1): 56-65.
19. Ulijaszek SJ. The international growth standard for children and adolescents project: Environmental influences on preadolescent and adolescent growth in weight and height. *Food Nutr Bull* 2006; 27(4): S279-S294.
20. Kim JH, Jung YH. Evaluation of food behavior and nutritional status of preschool children in Nowon-gu of Seoul by using Nutrition Quotient (NQ). *Korean J Community Nutr* 2014; 19(1): 1-11.
21. Kim JM, Song HJ, Ahn YJ. Relationships between obesity and dietary habits of preschool children and their parents in Dongducheon based on the Nutrition Quotient (NQ). *Korean J Community Nutr* 2018; 23(3): 216-225.
22. Lee HJ, Kim JH, Song SJ. Assessment of dietary behaviors among preschoolers in Daejeon: Using Nutrition Quotient for preschoolers (NQ-P). *J Nutr Health* 2019; 52(2): 194-205.
23. Yperman AM, Vermeersch JA. Factors associated with children's food habits. *J Nutr Educ* 1979; 11(2): 72-76.
24. Lee SJ, Ryu HK. Dietary lifestyle status of adolescents: Analysis of large-scale survey data in Korea. *J Korean Soc Food Sci Nutr* 2021; 50(1): 95-111.