

## Still life with less: North Korean young adult defectors in South Korea show continued poor nutrition and physique

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### Abstract

North Korean defectors who settle in South Korea have experienced severe food shortage and transition of food environment which could affect their health status. However, little is known about their anthropometric measurements and dietary intake after settlement in South Korea. The purpose of this study is to compare anthropometric measurements and dietary intake between North Korean young adults who defected to South Korea and those of South Koreans. We hypothesized that North Korean young adults' physiques and dietary intake would be poorer than that of South Koreans. We compared anthropometric measurements and dietary intake from 3-day food records in a cross-sectional study of 103 North Korean young adult defectors, aged 12 to 24 and 309 South Korean subjects. North Korean subjects were significantly shorter (4.9 to 10.8 cm) and lighter (6.0 to 12.5 kg) than the control group. Body mass index were significantly different between North and South Korean groups only in men. North Korean young adult defectors had lower mean daily intakes of energy and most nutrients and food groups compared to the control group, while North Korean subjects had higher nutrient density diet than that of South Koreans. The proportion of subjects who had dietary intakes of nutrients of less than the Estimated Average Requirement was higher in North Korean subjects than in controls except for in the cases of vitamin A and vitamin C. In conclusion, we recommend providing nutrition support programs for North Korean young adult defectors to secure adequate nutrient intake.

**Key Words:** North Korean, under-nutrition, growth retardation

### Introduction

Since the 1990s, North Korea has suffered from chronic severe food shortages because of natural disasters and economic hardships. Many starving North Koreans have escaped from their homeland and roamed around in China and other neighboring countries for food before re-settlement in South Korea. As of January 2009, over 15,000 North Korean defectors including young adult defectors have settled in South Korea [1].

Food deprivation gave rise to prevalent malnutrition in North Korea. A previous study reported that North Korean defectors aged 4 to 19 in China were shorter in stature between 70-90% of the South Korean reference value, indicating serious malnutrition [2]. In 2002, the United Nations Children's Fund (UNICEF) and World Food Programme (WFP) surveyed anthropometric measurements of children aged below 7 and mothers of children aged below 2. Among the children, 20.2% were underweight (weight for age < -2Z), 39.2% had experienced stunting (height for age < -2Z) and 8.1% were wasting (weight

for height < -2Z). Among mothers of children aged under 2, 32.0% were malnourished and 33.6% presented with anemia [3]. As these reports were conducted in limited populations that investigators were able to access, it is conceivable that other North Koreans might be experiencing more severe problems. Also, health problems observed in North Korean children and mothers have been described as being more severe than in their South Korean counterparts [4].

Due to severe food shortages during periods of growth, North Korean young adults have experienced growth retardation and have become physically adapted to under-nutrition. In addition, North Korean defectors in South Korea had to undergo a drastic change in transition from chronic food shortage to abundant food environment, which can create a harmful synergy [5]. In fact, maternal under-nutrition during gestation has been linked to early onset and cumulative incidence of coronary artery disease [6]. Further, low birth weight, rapid weight gain in early life with low birth weight and postnatal retardation are predictors for weight gain and high blood pressure during early teenage years

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[7,8]. In addition, short stature during adulthood is associated with stroke [9] and coronary heart disease [10]. What is more, malnutrition in early childhood has also been shown to have negative effects on mental development [11].

Risk factors contributing to nutrition related non-communicable diseases (NR-NCDs) affect adults; it can also contribute to disease pathogenesis in childhood, adolescence, or even fetal period [12]. The risk factors of NR-NCDs accumulate throughout life; therefore, it is important to prevent transmission of risk factors to later life at an early stage [12,13].

Taking these pieces of evidences into consideration, we expect that North Korean young adult defectors who have risk factors of NR-NCDs and other diseases during adolescence will have higher risk of suffering from these conditions later in life. Also, if those who suffered from growth retardation become obese, they could suffer from negative health consequences while their adaptation to living in South Korea. Therefore, it is necessary to improve dietary intake of North Korean young adult defectors to prevent health problems later in life, which would contribute to their successful settlement in South Korea. However, there has been no study about dietary intake of North Korean defectors in South Korea. The purpose of this study is to assess dietary intake of North Korean young adult defectors and to compare it with that of their South Korean counterparts. We hypothesized that North Korean young adults' physiques and dietary intake would be poorer than that of South Koreans. Assessing growth and dietary intake of North Korean young adults will allow us to develop a plan that caters to their specific health needs.

## Subjects and Methods

### *Subjects*

Study population included 141 North Korean young adult defectors aged 12 to 24 who had settled in South Korea and attended one of two alternative schools for North Korean settlers during January 2007 to July 2008. Excluding subjects who did not complete anthropometric measurements and diet records, 103 subjects were included in the final analysis. All subjects signed a written informed consent form which was previously approved by the Institutional Review Board at the Graduate School of Public Health, Seoul National University. The control group comprised 309 South Korean young adults randomly selected from the 2005 Korea National Health and Nutrition Examination Survey matched by age and sex.

### *Instruments*

We collected information on general characteristics such as age, sex, monthly household income, number of household family members, economic status in North Korea, and duration of escape and settlement using a questionnaire.

### *Anthropometric measurements*

We measured height (cm), weight (kg) and body mass index (BMI;  $\text{kg}/\text{m}^2$ ) (Inbody 4.0, Biospace Co. Ltd., Seoul, Korea). Subjects aged under 20 were classified by BMI percentiles as underweight (< 5th percentile), normal (5-85th percentile) or overweight ( $\geq$  85th percentile) [14]. For subjects aged over 20, obesity status was defined using BMI (underweight: < 18.5  $\text{kg}/\text{m}^2$ ; normal: 18.5-25.0  $\text{kg}/\text{m}^2$ ; overweight:  $\geq$  25.0  $\text{kg}/\text{m}^2$ ).

### *Dietary assessment*

Dietary intake was obtained by collecting self-administered food records over three consecutive days including two weekdays and one weekend day. Participants were instructed on how to write the food records by nutrition experts, who reviewed the records. Measurement aids such as food pictures and rulers were provided to help estimate the amount of food and beverage consumed. We calculated daily intake of nutrients from the three day food records using the seventh edition of Food Composition Table of Korea [15] and DS-24 program (Human Nutrition Lab, Seoul National University & AI/DB Lab, Sookmyung Women's University, 1996). Nutrient density was calculated as the quantity of nutrient per 1,000kcal and was used to evaluate the nutrient intake of subjects with adjustment for energy intake. To assess nutrient intake status, subjects were divided into three groups according to nutrient intake levels: "insufficiency", less than Estimated Average Requirement (EAR); "optimum", EAR~125% Recommended Intake (RI); "excess", over 125% RI. All foods reported by subjects were categorized into 17 food groups: cereals, potatoes & starches, sugars, legumes & their products, nuts & seeds, vegetables, mushrooms, fruits, meat & meat products, eggs, fish & shellfish, seaweed, milk & milk products, plant oil, animal fat, beverages & alcohol, and seasonings.

### *Statistical analysis*

Growth velocity and anthropometric measurements were differed with respect to the age and sex of subjects. Therefore, for analysis of anthropometry data, subjects were categorized according to age (< 20,  $\geq$  20) and sex. Differences between North Korean young adult defectors and South Korean young adults were tested for statistical significance using the chi-square test and Fisher's exact test for categorical variables and Student's t tests for continuous variables. The significance level for all tests was set at  $P < 0.05$ . All statistical tests were performed using the SAS version 9.1 (SAS Institute Inc, Cary, NC).

## Results

North Korean young adult defectors took an average of 2.8  $\pm$  2.8 years to escape from North Korea and enter South Korea,

**Table 1.** General characteristics of North Korean young adult defectors and South Korean young adults

Variables	North Korean	South Korean	P <sup>1)</sup>
Sex (n = 409)			
Men	50 (48.5)	150 (48.5)	1.000
Women	53 (51.5)	159 (51.5)	
Age group (n = 409)			
20 >	54 (52.4)	162 (52.4)	1.000
20 ≤	49 (47.6)	147 (47.6)	
Monthly household income (n = 383) <sup>2)***</sup>			
1,000 thousand won ≥	52 (68.4)	35 (11.4)	< 0.001
1,000-2,000 thousand won	18 (23.7)	78 (25.4)	
2,000 thousand won ≤	6 (7.9)	194 (63.2)	
Number of household family members (n = 391) <sup>***</sup>			
0	18 (22.0)	10 (3.2)	< 0.001
1	27 (32.9)	34 (11.0)	
2	21 (25.6)	81 (26.2)	
3 ≤	16 (19.5)	184 (59.6)	
Economic status in North Korea (n = 97)			
High	5 (5.2)		
Middle	65 (67.0)		
Low	27 (27.8)		
Duration of escape (years) (n = 83)	2.8 ± 2.8		
Duration of settlement (years) (n = 87)	2.4 ± 1.9		

Values are number (percentage) of subjects or means ± SD of each variable.

<sup>1)</sup>χ<sup>2</sup>-test

<sup>2)</sup>The current exchange rate is 1,150 won: 1 US dollar

\* P < 0.05, \*\* P < 0.01, \*\*\* P < 0.001

and average settlement period in South Korea was 2.4 ± 1.9 years. North Korean young adults were poorer ( $P < 0.001$ ) and had fewer household family members ( $P < 0.001$ ) than their South Korean counterparts (Table 1).

Table 2 summarizes anthropometric measurements for the subjects. Irrespective of age or sex, North Korean young adult defectors were shorter, lighter and thinner than South Korean young adults in both men and women. When stratified by age and sex, North Korean young adult defectors were 4.9 cm (men aged under 20) to 10.8 cm (men aged over 20) shorter and 6.0 kg (women aged under 20) to 12.4 kg (men aged over 20) lighter than South Koreans. BMI was significantly different between the two groups in men only. However, obesity prevalence was not significantly different between North and South Koreans.

Daily food group consumption was lower among North Korean defectors compared to that of South Korean young adults except for the consumption of mushrooms and fruits. Mean daily consumption of cereals ( $P < 0.001$ ), legumes and their products ( $P = 0.012$ ), nuts and seeds ( $P = 0.005$ ), meats ( $P < 0.001$ ), plant oil ( $P < 0.001$ ) and beverage and alcohols ( $P < 0.001$ ) were significantly lower in North Korean subjects than in South Koreans. North Korean defectors had significantly lower consumption than South Korean young adults for total plant food ( $P = 0.001$ ), total animal food ( $P = 0.001$ ) and total food ( $P < 0.001$ ) (Table 3).

North Korean young adult defectors had significantly lower intakes of energy ( $P < 0.001$ ), protein ( $P < 0.001$ ), fat ( $P < 0.001$ ), sugar ( $P < 0.001$ ), phosphorus ( $P < 0.001$ ), potassium ( $P < 0.001$ ), sodium ( $P < 0.001$ ), vitamin B<sub>1</sub> ( $P < 0.001$ ), vitamin

**Table 2.** Comparison of anthropometric measurements between North Korean defectors and South Korean young adults by age and gender

Variable	Men			Women		
	North Korean	South Korean	P	North Korean	South Korean	P
Aged under 20						
Height (cm) <sup>***</sup>	166.0 ± 9.0	170.9 ± 9.3	0.044	153.4 ± 5.5	161.7 ± 5.0	< 0.001
Weight (kg) <sup>***</sup>	57.8 ± 8.9	66.7 ± 14.7	0.002	50.3 ± 6.4	56.3 ± 7.7	< 0.001
BMI (kg/m <sup>2</sup> )	20.9 ± 2.3	22.6 ± 3.9	0.021	21.4 ± 2.4	21.5 ± 2.8	0.749
Obesity status(%)						
Underweight	10.0	6.7	0.186	5.9	2.0	0.421
Normal	85.0	71.7		88.2	88.2	
Overweight	5.0	21.7		5.9	9.8	
Aged over 20						
Height (cm) <sup>***</sup>	163.4 ± 6.4	174.2 ± 6.6	< 0.001	153.5 ± 5.0	160.6 ± 5.5	< 0.001
Weight (kg) <sup>***</sup>	58.0 ± 6.6	70.4 ± 11.9	< 0.001	49.2 ± 4.5	56.6 ± 10.0	< 0.001
BMI (kg/m <sup>2</sup> )	21.7 ± 2.4	23.2 ± 3.5	0.013	20.9 ± 2.1	21.9 ± 3.7	0.145
Obesity status (%)						
Underweight	3.3	4.4	0.083	10.5	10.5	0.891
Normal	90.0	71.1		84.2	77.2	
Overweight	6.7	24.4		5.3	12.3	

Values are means ± SD.

Student's t-test or Fisher's exact test

BMI: Body Mass Index

Underweight : < 5 percentile (aged under 20); BMI < 18.5 kg/m<sup>2</sup> (aged over 20)

Normal : 5-85 percentile (aged under 20); BMI 18.5-25.0 kg/m<sup>2</sup> (aged over 20)

Overweight : ≥ 85 percentile (aged under 20); BMI ≥ 25.0 kg/m<sup>2</sup> (aged over 20)

\* P < 0.05, \*\* P < 0.01, \*\*\* P < 0.001

**Table 3.** Comparison of daily food group consumption between North Korean defectors and South Korean young adults

Food group (g)	North Korean	South Korean	<i>P</i> <sup>1)</sup>
Cereals***	232.2 ± 80.3	330.0 ± 163.8	< 0.001
Potatoes and starches	18.7 ± 30.9	23.5 ± 55.0	0.269
Sugars	7.2 ± 8.1	7.3 ± 12.3	0.861
Legumes and their products*	25.9 ± 35.5	40.1 ± 78.2	0.012
Nuts and seeds**	1.2 ± 3.5	2.6 ± 5.7	0.005
Vegetables	263.2 ± 530.5	277.5 ± 177.7	0.789
Mushrooms	4.2 ± 8.0	2.9 ± 8.8	0.195
Fruits	112.5 ± 130.8	87.1 ± 184.2	0.128
Meats***	65.6 ± 67.7	114.9 ± 136.5	< 0.001
Eggs	30.4 ± 30.3	36.2 ± 52.5	0.169
Fish and shellfish	42.5 ± 38.2	53.7 ± 79.5	0.056
Seaweeds	4.1 ± 6.5	6.4 ± 23.7	0.121
Milk and milk products	114.7 ± 100.1	115.7 ± 174.5	0.941
Plant oil***	7.9 ± 5.5	11.3 ± 12.4	< 0.001
Animal fat	0.1 ± 0.7	0.3 ± 1.7	0.220
Beverages and alcohols***	54.7 ± 121.4	185.1 ± 403.3	< 0.001
Seasonings	33.7 ± 19.3	36.2 ± 39.9	0.412
Total plant food**	739.6 ± 586.2	969.9 ± 570.0	0.001
Total animal food**	253.2 ± 139.8	320.9 ± 245.6	0.001
Total food***	992.8 ± 617.4	1290.7 ± 676.6	< 0.001
Percentage of plant food	73.9 ± 11.2	75.4 ± 14.4	0.251
Percentage of animal food	26.1 ± 11.2	24.6 ± 14.4	0.251

Values are means ± SD for each food group.

<sup>1)</sup> Student's *t*-test

\* *P* < 0.05, \*\* *P* < 0.01, \*\*\* *P* < 0.001

**Table 5.** Comparison of nutrient intake status between North Korean defectors and South Korean young adults

Nutrient	North Korean	South Korean	<i>P</i> <sup>1)</sup>	
Protein***	Less than EAR <sup>2)</sup>	20 (19.4)	42 (13.6)	< 0.001
	EAR~125% RI <sup>3)</sup>	49 (47.6)	80 (25.9)	
	Over 125% RI	34 (33.0)	187 (60.5)	
Vitamin A	Less than EAR	44 (42.7)	135 (43.7)	0.130
	EAR~125% RI	41 (39.8)	95 (30.7)	
	Over 125% RI	18 (17.5)	79 (25.6)	
Vitamin C*	Less than EAR	56 (54.4)	176 (57.0)	0.013
	EAR~125% RI	33 (32.0)	61 (19.7)	
	Over 125% RI	14 (13.6)	72 (23.3)	
Vitamin B <sub>1</sub> ***	Less than EAR	60 (58.3)	91 (29.5)	< 0.001
	EAR~125% RI	34 (33.0)	92 (29.8)	
	Over 125% RI	9 (8.7)	126 (40.8)	
Vitamin B <sub>2</sub> ***	Less than EAR	81 (78.6)	150 (48.5)	< 0.001
	EAR~125% RI	17 (16.5)	92 (29.8)	
	Over 125% RI	5 (4.9)	67 (21.7)	
Niacin***	Less than EAR	51 (49.5)	91 (29.5)	< 0.001
	EAR~125% RI	40 (38.8)	121 (39.2)	
	Over 125% RI	12 (11.7)	97 (31.4)	
Calcium*	Less than EAR	89 (86.4)	226 (73.1)	0.019
	EAR~125% RI	9 (8.7)	61 (19.7)	
	Over 125% RI	5 (4.9)	22 (7.1)	
Phosphorus***	Less than EAR	26 (25.2)	41 (13.3)	< 0.001
	EAR~125% RI	48 (46.6)	106 (34.3)	
	Over 125% RI	29 (28.2)	162 (52.4)	
Iron**	Less than EAR	72 (69.9)	157 (50.8)	0.003
	EAR~125% RI	19 (18.5)	82 (26.5)	
	Over 125% RI	12 (11.7)	70 (22.7)	

Values are number (percentage) of subjects.

<sup>1)</sup>  $\chi^2$ -test

<sup>2)</sup> EAR: Estimated Average Requirements

<sup>3)</sup> RI: Recommended Intake

\* *P* < 0.05, \*\* *P* < 0.01, \*\*\* *P* < 0.001

**Table 4.** Comparison of daily nutrient intake and nutrient density between North Korean defectors and South Korean young adults

Nutrient	Daily nutrient intake			Nutrient density (per 1,000 kcal)		
	North Korean	South Korean	<i>P</i> <sup>1)</sup>	North Korean	South Korean	<i>P</i> <sup>1)</sup>
Energy (kcal)	1516.2 ± 482.1	2143.1 ± 904.6***	< 0.001			
Protein (g)	59.8 ± 30.1	78.8 ± 40.2***	< 0.001	38.3 ± 8.3	36.6 ± 10.4	0.084
Fat (g)	41.2 ± 19.5	58.4 ± 37.1***	< 0.001	26.8 ± 7.5	26.4 ± 9.4	0.655
Sugar (g)	220.8 ± 67.3	306.6 ± 127.7***	< 0.001	147.8 ± 20.5	147.4 ± 29.1	0.891
Calcium (mg)	475.5 ± 494.3	502.9 ± 298.4	0.596	297.9 ± 156.0	241.9 ± 124.3**	0.001
Phosphorus (mg)	891.5 ± 426.1	1215.4 ± 547.0***	< 0.001	575.3 ± 115.0	571.7 ± 137.1	0.797
Iron (mg)	11.6 ± 15.3	12.3 ± 7.7	0.649	7.4 ± 9.4	5.8 ± 3.2	0.093
Potassium (mg)	2076.5 ± 1284.7	2667.9 ± 1290.1***	< 0.001	1339.4 ± 368.3	1272.5 ± 409.0	0.142
Vitamin A (R.E.)	752.0 ± 938.1	732.7 ± 645.9	0.846	462.0 ± 317.5	358.6 ± 431.1*	0.010
Sodium (mg)	3760.7 ± 1332.8	5181.9 ± 3084.0***	< 0.001	2538.6 ± 716.9	2436.9 ± 1062.0	0.275
Vitamin B <sub>1</sub> (mg)	1.0 ± 0.6	1.5 ± 0.9***	< 0.001	0.6 ± 0.2	0.7 ± 0.3	0.089
Vitamin B <sub>2</sub> (mg)	1.0 ± 0.8	1.3 ± 0.7**	0.003	0.7 ± 0.2	0.6 ± 0.2*	0.033
Niacin (mg)	13.0 ± 7.0	16.8 ± 10.2***	< 0.001	8.4 ± 2.5	7.8 ± 2.9	0.058
Vitamin C (mg)	89.3 ± 115.7	94.6 ± 87.5	0.668	57.6 ± 44.3	45.5 ± 38.8**	0.009
Retinol (μg)	105.6 ± 78.7	109.8 ± 111.3	0.677	69.1 ± 44.7	49.5 ± 43.8***	< 0.001
Carotene (μg)	3831.5 ± 5603.8	3441.0 ± 3596.6	0.508	2309.3 ± 1996.3	1711.7 ± 2574.8*	0.016
Fiber (g)	6.6 ± 7.7	6.4 ± 4.2	0.777	4.1 ± 2.7	3.0 ± 1.6***	< 0.001

Values are means ± SD for each nutrient.

<sup>1)</sup> Student's *t*-test

\* *P* < 0.05, \*\* *P* < 0.01, \*\*\* *P* < 0.001

B<sub>2</sub> ( $P=0.003$ ) and niacin ( $P<0.001$ ) compared to South Korean young adults. However, North Korean subjects showed higher mean nutrient densities than South Korean subjects, for calcium ( $P=0.001$ ), vitamin A ( $P=0.010$ ), vitamin B<sub>2</sub> ( $P=0.033$ ), retinol ( $P<0.001$ ), carotene ( $P=0.016$ ) and fiber ( $P<0.001$ ) (Table 4).

Among North Korean young adults, the proportion of subjects whose dietary intake was less than EAR was significantly higher in protein ( $P<0.001$ ), vitamin B<sub>1</sub> ( $P<0.001$ ), vitamin B<sub>2</sub> ( $P<0.001$ ), niacin ( $P<0.001$ ), calcium ( $P=0.019$ ), phosphorus ( $P<0.001$ ) and iron ( $P=0.003$ ) than for South Korean young adults. The proportion of North Korean defectors with vitamin A and vitamin C intake less than EAR was less than that of South Koreans; however, both North and South Korean young adults had poor dietary intake for these nutrients (Table 5).

## Discussion

We performed an age and sex matched comparison of anthropometric measurements and dietary intake of North Korean young adult defectors living in South Korea with those of their South Korean counterparts. North Korean defectors were found to have smaller body frames and lower intake of nutrients than South Koreans.

These results are similar to those of other researchers who have assessed anthropometric measurement for young adults in North Korea [3,4] or North Korean defectors in China [2,16]. Kim [17] also reported that the weight and height of North Koreans aged 9-19 who attended Hanawon, the government-run resettlement support center for North Korean defectors, were lower than that of similarly-aged South Koreans. Moreover, about one third of the North Korean subjects suffered from growth stunting or were severely underweight. Previous research had reported that North Korean young adults were shorter than older generations [18]. Growth retardation of North Korean young adults is likely due to severe food shortages in North Korea during 1990s, as well as food and water shortages during the period of escape in China [19]. Pak [5] reported that height stunting was more severe than weight stunting among North Korean children in South Korea, especially among North Korean girls. This implies the possibility that North Korean girls may become overweight later in life. Although the obesity prevalence was low in our data, North Korean young adult defectors exhibited risk factors linked to obesity in later life such as malnutrition in earlier life and growth retardation. Therefore, it is necessary to monitor their weight change closely.

Several previous studies reported that North Koreans were suffered from food shortage not only in North Korea [3], but also during period of defection in third countries such as China [2]. In this study, intake of nutrients and food groups among North Korean subjects was lower than that of South Korean young adults. North Korean subjects' dietary intake was still poor

during their period of resettlement in South Korea. Such chronic malnutrition status has adversely affected their growth. If North Korean young adult defectors continue to suffer from inadequate nutrient intake, they are likely to experience adverse health outcomes. One third of North Korean subjects had vitamin A, vitamin C, vitamin B<sub>1</sub>, niacin and iron intakes below EAR. In particular, over 70% of them had vitamin B<sub>2</sub> and calcium intakes below EAR. Refugee populations frequently are subjected to micronutrient deficiency [20]. Long term poor eating could impair physical and neurological functions [21-23]. In addition, the US National Intelligence Council [24] has estimated that 17 to 29 percent of North Korean young people of military age would have cognitive disabilities because of malnourishment during childhood. Poor health status of North Korean defectors would eventually degrade their quality of life, interrupt successful settlement in South Korea, and increase social and economic burden of supporting ill North Korean defectors. On the other hand, North Korean subjects in this study showed higher nutrient density diet than South Korean subjects. It indicates that North Korean young adults' composition of diet is not poorer than that of South Koreans. Daily food consumption of North Korean subjects was about three quarters of South Korean subjects. Therefore, increasing amount of intake would be helpful to improve North Korean subjects' nutrient intake.

The North Korean subjects in this study lived with fewer family members. It is likely that most of them do not have care givers, including meal providers. Also, monthly household income of North Korean subjects was lower. The lack of ability to prepare meals or deal with economic hardship would inevitably affect dietary intake. According to staff at the study sites, many North Korean defector students skip meals because they do not know how to cook or do not have enough money. Nutrition education about how to cook and how to choose proper foods would be helpful for improving North Korean young adult defectors' diet.

In this study, subjects who attended alternative schools for North Korean defectors were provided with breakfast [usually kimbab (seaweed-covered rice with vegetables) and milk] and lunch at school. This practice could explain why they had higher intakes of calcium (abundant in milk products), vitamin A and carotene (abundant in carrot, an ingredient of kimbab) compared to South Korean counterparts. This implies that meal services could improve nutrient intakes of North Korean young adult defectors.

There were no significant differences in subjects' anthropometric measurements and dietary intake by age at escape from North Korea and at entrance to South Korea (data not shown). Since the sample size was small, further study with larger samples would be necessary.

This study had several limitations. First, subjects attended alternative schools; therefore, the subjects in this study may not be a representative sample of all North Korean young adult defectors in South Korea. We did not include regular school students and non-students who do not participate in the school

system. However, among the North Korean young adult defectors attending regular school, only 57.9% were in middle school and 10.9% were in high school. Also, approximately 12.8% of North Korean young adult defectors drop out of regular school [25]. Most North Korean young adult defectors who settle in South Korea are not part the regular school support system and may not have other forms of support. Those left outside of public or private aid-networks would suffer from more severe health problems and lack of proper diet. Second, it was not possible to gather information about subjects' health status and dietary intake while they were in North Korea and intermediate countries before entering South Korea. As a result, it was not feasible to assess the transition of stature and diet from North Korea to South Korea.

This is the first study that evaluates dietary intake of North Korean young adult defectors. To provide more effective care for vulnerable North Korean young adult defectors, further studies on growth, diet change and comparative studies on differences between North and South Korean life are necessary. Dietary approach would be useful in promoting healthy living for defectors assisting adaptation to their new environment.

In summary, North Korean young adult defectors exhibited smaller body frames and a higher prevalence of under-nutrition than their South Korean counterparts. We recommend providing nutrition support programs such as meal services or financial aid for North Korean young adult defectors to secure adequate nutrient intake.

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