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Prevalence of metabolic syndrome and its related factors among North Korean refugees in South Korea: a cross-sectional study

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ABSTRACT

Objectives: To determine the prevalence of metabolic syndrome (MetS) and its related factors among North Korean refugees (NKR) in South Korea.

Design: Cross-sectional study conducted using a questionnaire and anthropometric and biochemical data on NKR in South Korea.

Setting: Seoul, South Korea.

Participants: A sample of NKR who voluntarily underwent medical examinations in Anam Hospital of Korea University, Seoul, South Korea (N=708, consisting of 161 males and 547 females). To compare the prevalence of MetS, 1416 age- and gender-matched individuals from the South Korean population (SKP, at a ratio of 1:2 to NKR) were randomly selected from the fifth Korean National Health and Nutrition Examination Survey.

Main outcome measures: The prevalence of MetS and its related factors among NKR in South Korea and comparison with its prevalence among the general SKP.

Results: The prevalence of MetS among male and female NKR in South Korea was 19.7% and 17.2%, respectively. Although obesity is more prevalent in South than in North Korea, we found no difference in the prevalence of MetS between the female NKR and SKP groups (17.2% vs 16.6%, respectively; p=0.830). As regards the males, the small sample size of the NKR group yielded insufficient evidence of any difference in MetS prevalence between the NKR and SKP groups (19.7% vs 26.2%, respectively; p=0.134). We found that excess weight gain (≥5%) in South Korea was significantly associated with MetS among NKR.

Conclusions: The prevalence of MetS among NKR did not differ from that in the SKP group despite the lower prevalence of obesity in NKR than in the general SKP. The fact that excess weight gain in South Korea was associated with the risk of MetS suggests that public health policy makers should focus on preventing excess weight gain in NKR during resettlement in South Korea.

Strengths and limitations of this study

- Our study is the first to investigate the prevalence of metabolic syndrome (MetS) and its related factors among North Korean refugees (NKR) living in South Korea.
- A key strength of this study is that we compared the prevalence of MetS in NKR to that of the general South Korean population who had the same ethnic and cultural background.
- It may not be possible to generalise the findings to all NKR in South Korea; however, the general demographics of the NKR in this study did not differ from those of a representative sample of NKR living in South Korea.

abdominal obesity, hypertriglyceridaemia, low levels of high-density lipoprotein cholesterol (HDL-C), elevated serum levels of fasting glucose and elevated blood pressure. These factors tend to cluster together, suggesting a common aetiology, and place individuals at increased risk for diabetes mellitus and cardiovascular disease (CVD).[1 2] Recently, the prevalence of MetS has increased substantially in many developing Asian countries with the improved economic environment and the resulting sedentary lifestyles and changes in diet.[3 4]

Immigrants who migrate from poorer to richer countries are often at particularly high risk for CVD.[5 6] Research has also shown that individuals who migrate to Western countries characterised by greater industrialisation and economic growth than their home countries are more prone than the local population to chronic diseases, such as diabetes mellitus and CVD, resulting from changes in lifestyle, physical activity, dietary habits and nutrition.[5–8]

For most of the past 5000 years, Korea has been a homogeneous nation with a shared ethnic background. However, in 1950, the

INTRODUCTION

Metabolic syndrome (MetS) is defined as a constellation of risk factors, including

Korean war resulted in the formation of two Koreas and since the 1980s, the economic gap between the two countries has gradually widened. South Korea is now one of the world's most developed nations, while North Koreans lived in absolute poverty and famine because of natural disasters and the economic failures of communism.[9] Many starving North Koreans have left their homeland in search of food and most have eventually resettled in South Korea.[10 11] The number of North Korean refugees (NKR) living in South Korea has grown rapidly over the past 10 years, and reached 28 000 in October 2015.[12] Previous research on NKR has focused mainly on mental health problems associated with exposure to trauma.[13 14] However, no previous study has explored the prevalence of non-communicable diseases among NKR in South Korea, such as MetS or diabetes mellitus, which are major public health concerns in South Korea. Data on non-communicable diseases among North Korean people are also scarce. A WHO survey reported that North Koreans had a very low prevalence of obesity, which was only one tenth of that among South Koreans (3.7% prevalence among male NKR, 4.2% among female NKR).[15 16]

As the number of NKR in South Korea grows, they will become a target group for Korean healthcare services. The prevalence of MetS needs to be assessed so that the findings can serve as a basis for the development of health-promotion programmes tailored to NKR. Furthermore, unlike other immigrant studies, Korea has been an ethnically homogeneous nation for centuries, and North and South Korea have been separated for only six decades. Therefore, comparison of the two Korean populations represents a unique opportunity to investigate environmental effects on human health.

The purpose of the study, as the first part of the NOrth Korean Refugee health iN South Korea (NORNS) study, was to determine the prevalence of MetS and its related factors among NKR in South Korea and compare the prevalence with that in the general South Korean population (SKP).[17]

METHODS

Study population

We used data from the NORNS study with the aim of determining the current health status of NKR in South Korea and investigating health changes occurring during the period of adaptation to westernised South Korean society. Consequently, the study was composed of two phases: phase 1 was a cross-sectional survey of NKR including a health questionnaire and medical examination, while phase 2 was an identical follow-up survey performed 42 months after phase 1. Phase 1 began in October 2008 and remains ongoing at the Anam Hospital of Korea University located in north-eastern Seoul, South Korea. We used phase 1 data to determine the prevalence of MetS and its related factors among NKR in South Korea. We recruited participants

with the help of a Hana Center, a representative welfare centre which advertised our survey on the internet and contacted participating NKR by telephone on a monthly basis. Eligible individuals (≥30 years of age, resident in Seoul, a history of immigration as a refugee from North Korea) voluntarily participated in the study. A total of 708 participants (161 males, 547 females) were enrolled from October 2008 to December 2013. We arranged for all participants to be interviewed by doctors from North Korea to improve the quality and completeness of questionnaire data. The detailed protocol and methods have been previously reported.[17]

Questionnaire

The NORNS questionnaire was composed of 42 health-related questions derived from existing questionnaires targeting NKR and questions used in the Korea National Health and Nutrition Examination Survey (KNHANES).[18] The questionnaire explored the following six domains: (1) demographic characteristics and migration history, (2) disease history, (3) mental health status, (4) health-related lifestyle factors, (5) female reproductive health, and (6) sociocultural adaptation. We use two socioeconomic indicators: educational attainment in North Korea and current family income in South Korea. To evaluate health-related lifestyle factors, we assessed smoking status, alcohol consumption and exercise status in the original questionnaire. Regular exercise was defined as exercising for >60 min/week. The duration of residence in transit countries and South Korea was measured in years and classified as <1, 1–5 and ≥5 years for variables. We further classified all participants into two groups based on the percentage change in their body weight in South Korea (<5% increase and ≥5% increase) to examine differences in the risk of MetS by the degree of body weight change. We used medication histories to estimate the prevalence of treated diabetes mellitus and hypertension.

Anthropometric and biochemical measurements

Blood pressure, waist circumference, height and body weight were measured according to standard procedures and were reported in detail previously.[17] Blood pressure measurements were the means of two separate measurements of systolic and diastolic blood pressure taken at an interval of 5 min. Blood samples were obtained after 8 hours of fasting to determine blood chemistry parameters. Serum total cholesterol, triglycerides and HDL-C were determined by enzymatic methods using a chemistry analyser (TBA 200-FR; Toshiba, Tokyo, Japan). Plasma glucose was measured using the glucose oxidase-peroxidase method.

Definition of MetS and obesity

The prevalence of each metabolic component was determined using the definition of the National Cholesterol Education Program Adult Treatment Panel III.[19] Participants with more than three of the following five

components were classified as having MetS: (1) abdominal obesity: waist circumference more than 90 cm in males and 85 cm in females; (2) elevated blood pressure: systolic blood pressure higher than 130 mm Hg and/or diastolic blood pressure higher than 85 mm Hg, or receiving treatment for hypertension; (3) elevated serum fasting glucose: glucose concentrations greater than 100 mg/dL or receiving treatment for diabetes; (4) hypertriglyceridaemia: fasting plasma triglycerides higher than 150 mg/dL; and (5) low HDL-C: HDL-C lower than 40 mg/dL for males and 50 mg/dL for females. We defined obesity as body mass index (BMI) ≥25 kg/m^2.

Selection of SKP as a comparison group

We selected the SKP group from all subjects registered on the database of the fifth KNHANES (2010–2012), a representative nationwide health survey of South Koreans, for comparison with our NKR sample. A total of 1416 subjects, who were age- and gender-matched to the NKR at a ratio of 1:2, were sampled randomly to ensure comparability between the two groups. Items assessed for the NKR group and obtained using the health questionnaire and the medical check-up were also analysed for the SKP group.

Statistical analysis

All analyses were performed using the Stata software package (V.11.0; Stata, College Station, Texas, USA). Random sampling for the SKP group was performed using the syntax 'sample', which draws random samples from a dataset. Comparison of the prevalence of MetS between the NKR and SKP groups was performed with the χ^2 test and logistic regression model while adjusting covariates. To investigate factors related to MetS among NKR, multiple logistic regression with various models was used.

Ethics

Approval of the study was obtained from the Institutional Review Board of Korea University Medical Center (approval number: Ed08023), and all participants provided written informed consent.

RESULTS

General characteristics of the NKR and SKP groups by gender

The general characteristics of the NKR and SKP groups are listed in table 1. Among the 708 NKR, 161 (23%) were males and 547 (77%) were females. Most NKR were in their 30s and 40s. Compared with the SKP group, a lower proportion of both male and female NKR had an educational level of college or above. Also, more than half of the NKR had a monthly family income below 1 000 000 Korean won (KRW), indicating that they had a low socioeconomic status in South Korea. The males in the two groups did not differ with

regard to smoking status or alcohol use, but both male groups were small in size. In terms of physical activity, the proportion of male NKR who exercised regularly was higher than that of the male SKP group. Smaller proportions of female NKR were current smokers and alcohol drinkers than in the female SKP group. Female NKR exercised more than the female SKP group. In terms of migration, the duration of residence in South Korea did not differ between male and female NKR. However, females had stayed twice as long as males in transit countries (4.1±3.6 years vs 2.1±2.6 years, respectively). In terms of weight change, one third of subjects had gained 5% or more of their body weight since immigrating to South Korea.

Comparison of the prevalence of MetS between the two groups

Table 2 compares the prevalence of MetS between the two groups. The prevalence of MetS did not differ between the female NKR and SKP groups (17.2% vs 16.6%, respectively; p=0.757), although female NKR had a lower prevalence of obesity than the female SKP group (19.4% vs 26.6%, respectively; p=0.002). As for the prevalence of MetS in male groups, our data showed insufficient evidence of a difference because of the small sample size (19.7% of male NKR vs 26.2% of males in the SKP group; p=0.134). After further adjusting for smoking status, alcohol consumption, exercise level, income and education, the prevalence of MetS did not differ between the respective genders of the two groups.

Individual metabolic component findings differed between the NKR and SKP groups by gender (table 2). In males, abdominal obesity, hypertriglyceridaemia and low HDL-C were more prevalent in the SKP group, while elevated blood pressure was more prevalent in the NKR group. For females, there was no group difference in the prevalence of abdominal obesity between the NKR and SKP groups (22.5% vs 20.4%, respectively; p=0.323), but in terms of obesity, the NKR group exhibited a lower prevalence than the SKP group (19.4% vs 26.6%; p=0.002). In females, the prevalence of elevated blood pressure, elevated fasting glucose and hypertriglyceridaemia did not differ between the two groups. Unlike the male groups, female NKR exhibited a higher prevalence of a low HDL-C level than the female SKP group.

MetS-related factors among NKR in South Korea

Multivariate logistic regression analyses of the factors related to MetS in NKR and relevant ORs are shown in table 3. Model 1 included the control variables of gender, age and duration of residence in South Korea and transit countries. Model 2 consisted Model 1 together with health-related lifestyle factors, such as smoking status, alcohol consumption and exercise. Model 3 consisted of Model 2 together with education and income. Model 4 was the full model and consisted of Model 3 together with weight gain. According to Model 4, older age was associated with MetS. NKR who

Table 1 Characteristics of NKR and the SKP group

	Male					Female				
	NKR (n=161)		SKP (n=322)			NKR (n=547)		SKP (n=1094)		
	N	Per cent	N	Per cent	p Value	N	Per cent	N	Per cent	p Value
Age (years)										
Mean (SD)	46.9	(12.1)	46.9	(12.1)		44.1	(11.0)	44.1	(11.0)	
30–39	50	31.1	100	31.1		231	42.2	462	42.2	
40–49	58	36.0	116	36.0		167	30.5	334	30.5	
50–59	23	14.3	46	14.3		78	14.3	156	14.3	
60+	30	18.6	60	18.6		71	13.0	142	13.0	
Education*					<0.001					<0.001
Primary school or below	3	2.0	28	14.9		11	2.2	145	22.3	
Middle/high school	68	46.3	19	10.1		276	53.9	92	14.2	
College or above	76	51.7	141	75.0		225	44.0	413	63.5	
Family income* (10⁴ KRW/month)					<0.001					<0.001
<100	56	51.4	20	6.3		225	61.6	89	8.3	
≥100	53	48.6	300	82.3		140	38.4	990	91.8	
Alcohol consumption*					0.189					0.003
Current drinker	127	87.0	238	82.1		256	61.5	722	69.7	
Non-drinker	19	13.0	52	17.9		160	38.5	314	30.3	
Smoker*					0.086					0.003
Current	62	44.6	98	34.0		6	1.4	47	4.6	
Ex and non-smoker	77	55.4	175	64.1		423	98.6	969	95.4	
Regular exercise*					0.031					0.02
Yes	42	35.3	68	24.2		98	24.0	190	18.5	
No	77	64.7	213	75.8		311	76.0	837	81.5	
Length of stay in South Korea (years)*										
Mean (SD)	3.6 (3.3)					3.2 (2.5)				
<1	42	26.6				169	31.8			
1–5	68	43.0				229	43.1			
≥5	48	30.4				134	25.2			
Length of stay in transit countries (years)*										
Mean (SD)	2.1 (2.6)					4.1 (3.6)				
<1	90	57.3				169	32.1			
1–5	42	26.8				160	30.4			
≥5	25	15.9				198	37.6			
Weight gain (%)*										
Mean (SD)	1.77 (6.71)					1.03 (4.88)				
<5%	93	68.4				336	69.7			
≥5%	43	31.6				146	30.3			

*Variables do not add up to total numbers because of missing data.
KRW, Korean won; NKR, North Korean refugees; SKP, South Korean population.

Table 2 Comparison of the prevalence of MetS between the two groups and the adjusted OR of MetS

	Male				Female			
	NKR (n=161)	SKP (n=322)	p Value	AOR	NKR (n=547)	SKP (n=1094)	p Value	AOR
Obesity (%)	23.4	37.3	0.003		19.4	26.6	0.002	
MetS (%)	19.7	26.2	0.134	0.96 (0.40 to 2.30)	17.2	16.6	0.757	0.68 (0.39 to 1.18)
Abdominal obesity (%)	13.7	22.9	0.021		22.5	20.4	0.323	
Elevated blood pressure (%)	52.6	41.3	0.023		28.3	25.3	0.200	
Elevated fasting glucose (%)	32.5	31.2	0.783		22.0	20.0	0.350	
Hypertriglyceridaemia (%)	28.5	42.3	0.004		17.7	19.6	0.378	
Low HDL-C (%)	19.9	30.0	0.022		42.7	31.9	<0.001	

AOR (adjusted OR): controlled for education, income, alcohol consumption, smoking and exercise (the SKP is reference).
HDL-C, high density lipoprotein cholesterol; MetS, metabolic syndrome; NKR, North Korean refugees; SKP, South Korean population.

Table 3 Results of logistic regression on MetS among NKR in South Korea

	Model 1 (n=646)	Model 2 (n=376)	Model 3 (n=269)	Model 4 (n=258)
Sex (female)				
Male	1.02 (0.62 to 1.70)	1.08 (0.49 to 2.38)	0.75 (0.28 to 2.05)	0.60 (0.21 to 1.71)
Age (30–49)				
≥50	4.70 (3.06 to 7.24)	4.60 (2.53 to 8.31)	5.52 (2.60 to 11.70)	6.98 (3.08 to 15.82)
Stay in South Korea (<1 year)				
1–5	0.98 (0.58 to 1.65)	0.75 (0.37 to 1.54)	0.74 (0.28 to 1.95)	0.72 (0.27 to 1.98)
≥5	1.29 (0.72 to 2.28)	1.27 (0.59 to 2.74)	1.56 (0.57 to 4.31)	1.50 (0.53 to 4.30)
Stay in transit countries (<1 year)				
1–5	0.84 (0.49 to 1.43)	0.83 (0.41 to 1.67)	0.71 (0.30 to 1.66)	0.69 (0.29 to 1.63)
≥5	0.86 (0.51 to 1.45)	0.74 (0.37 to 1.48)	0.74 (0.32 to 1.73)	0.67 (0.27 to 1.62)
Alcohol consumption (no)				
Current drinker		0.76 (0.41 to 1.41)	0.75 (0.35 to 1.57)	0.84 (0.38 to 1.86)
Smoking (no)				
Current smoker		1.27 (0.48 to 3.34)	1.96 (0.59 to 6.56)	2.00 (0.59 to 6.80)
Regular exercise (yes)				
No		0.63 (0.35 to 1.14)	0.60 (0.29 to 1.23)	0.62 (0.29 to 1.31)
Income (<10^6 KRW)				
≥10^6 KRW			1.24 (0.59 to 2.62)	1.31 (0.60 to 2.86)
Education (≥college)				
<College			0.78 (0.39 to 1.54)	0.87 (0.43 to 1.77)
Weight gain (<5%)				
≥5%				2.66 (1.25 to 5.67)

Model 1: controlled for sex, age, stay in South Korea and transit countries.
Model 2: Model 1+controlled for alcohol consumption, smoking and exercise.
Model 3: Model 2+controlled for income and education.
Model 4: Model 3+controlled for weight gain.
KRW, Korean won; MetS, metabolic syndrome; NKR, North Korean refugees.

experienced excess weight gain (≥5%) were 2.66-fold more likely to have MetS than those who experienced <5% weight gain (95% CI 1.25 to 5.67; p<0.05). However, the risk of MetS among NKR did not rise as the duration of residence in South Korea and transit countries increased. Health-related lifestyle factors such as alcohol consumption, smoking status, lower level of exercise and socioeconomic factors did not increase the risk of MetS among NKR.

DISCUSSION

This is the first study to investigate the prevalence of MetS and its related factors among NKR in South Korea. As compared with the general SKP, the prevalence of MetS among female NKR did not differ from that among South Korean females despite their lower prevalence of obesity. NKR males also had a lower prevalence of obesity, but we could not conclude that the male groups differed in terms of MetS prevalence because the NKR group was small in size. In terms of MetS-related factors, excess weight gain (≥5%) since immigration to South Korea was associated with the risk of MetS in NKR.

The two Korean groups had different patterns of health-related lifestyle factors and NKR had a lower level of education and income than South Korean subjects. As health-related lifestyle factors and low socioeconomic status could have an effect on MetS, we investigated the

risk of MetS after controlling for these factors and found that there was no difference in the prevalence of MetS between the two Korean groups.

A gender difference between the NKR and SKP groups was apparent regarding obesity. Male NKR had a lower prevalence of obesity and abdominal obesity than the male SKP group. Female NKR also had a lower prevalence of obesity than the female SKP group, but there was no difference in abdominal obesity between the two groups. Important information concerning the relationship between abdominal obesity and CVD has emerged over the last few decades, and highlights the importance of abdominal obesity as being a more important determinant of CVD risk than BMI alone.[20 21] Individuals of Asian origin in particular were more prone to visceral obesity and CVD at a low BMI compared to Caucasian subjects.[21] Female NKR had similar abdominal obesity compared to the female SKP group, indicating that the CVD risk in females is not lower than that of the female SKP group despite lower BMI.

Notably, male NKR had a lower prevalence of obesity but a higher prevalence of elevated blood pressure than the male SKP group. Female NKR did not differ from the female SKP group in terms of the prevalence of elevated blood pressure, but had higher average systolic blood pressure than the female SKP group (116.9 mm Hg vs 112.8 mm Hg; p<0.001, data not shown). Although obesity is an important determinant

of blood pressure, the trends for blood pressure and obesity were divergent between the two Korean groups. The fact that treatment for hypertension is more common in South Korea could partly explain these data. Another explanation may be differences in salt consumption between the two Korean populations.[22] In addition, undernourishment of NKR in early life may explain their higher blood pressure compared to that of South Koreans.[23 24]

The higher prevalence of hypertriglyceridaemia in the male SKP group than in male NKR may be associated with the higher prevalence of obesity.[25] Furthermore, the lower HDL-C level of the male SKP group may be related to a lower level of physical activity and an increased prevalence of hypertriglyceridaemia.[26 27] The reason for the higher prevalence of a low HDL-C level among female NKR compared to the SKP group is not clear. Further research on gender differences in HDL-C levels between the two Korean populations is needed.

Regarding factors associated with MetS among NKR, older subjects (>50 years of age) were at higher risk of MetS than younger NKR. Age is the most important risk factor for MetS.[28] More than two-thirds of our participants were in their 30s and 40s (physical strength is required to leave North Korea). Thus, the prevalence of MetS in NKR could increase in the future as the NKR age. We found no significant association between the duration of residence in South Korea and the risk of MetS; some earlier studies found significant positive correlations between duration of residence in a host country and obesity.[29 30] One previous study of US immigrant subgroups found that the number of years of residence in the host country was associated with a higher BMI, but this was the case after only 10 years.[29] Another study found that longer-term Hispanic immigrants (≥15 years) in the USA had a nearly fourfold higher risk of obesity than recent immigrants (<5 years).[30] The differences between our findings and those of previous studies may be attributable to the fact that our participants resettled relatively recently in South Korea (average of 3 years previously). The phase 2 study will yield more definitive information.

NKR who experienced excess weight gain (≥5%) since immigrating to South Korea had a higher risk of MetS. This indicated that excess weight gain over a short period of time may have a significant effect on health. Previous studies revealed a strong relationship between weight gain and MetS in the general population.[31 32] Weight gain is of special concern in immigrants who have moved to richer countries and consume high-calorie diets and engage in less physical activity than in their country of origin. Weight gain is a by-product of adaptation to the host country.[33] We did not conduct a dietary assessment or explore changes in dietary patterns among NKR. Further study is needed to determine changes in dietary patterns and their association with weight gain.

This study had several limitations. First, it did not employ scientific sampling methods. Random sampling in NKR was practically impossible since the total numbers of participants were low and NKR tend to avoid disclosing their identities. There might be a selection bias in that the NKR participants may have been those who were more concerned about their health. In order to evaluate how the demographic characteristics of our NKR sample deviated from those of the total NKR population, a large-scale national survey of adult NKR aged 20 and above conducted by the South Korean government was used as reference.[34] The general demographics of our NKR sample did not differ from those of the survey in terms of gender ratio, age distribution, time of entry to South Korea, length of stay in transit countries, or region of origin (see online supplementary table S1). Second, the KNHANES data were self-reported, but we employed a doctor from North Korea to conduct one-on-one interviews to verify the NKR data. Third, a cross-sectional study cannot reveal the causes of findings. Fourth, the NKR sample size may be too small to yield valid evidence of differences between male NKR and the male SKP group. Fifth, the NKR blood pressure results were the means of two separate measurements taken at one visit. This might partially explain the higher blood pressure of NKR. Despite these limitations, we believe our work provides meaningful information on the metabolic health of NKR. Currently, not only are psychological problems among NKR in South Korea substantial, but also the potential metabolic disease burdens. However, in the near future, the prevalence of obesity and MetS among NKR may reach or overtake that of the SKP. As weight gain during adaptation to South Korean society is a potential risk factor for MetS, public health initiatives to prevent rapid weight gain among NKR are needed. Considering the substantial burdens of CVD and diabetes mellitus in South Korea, efforts should be made to decrease the prevalence of obesity and MetS in NKR in order to reduce morbidity and mortality due to these diseases.

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