Instant Noodle Intake and Dietary Patterns Are Associated with Distinct Cardiometabolic Risk Factors in Korea

Hyun Joon Shin,5,10 Eunyoung Cho,8,1  Hae-Jeung Lee,11 Teresa T. Fung,5,12 Eric Rimm,5,6,8 Bernard Rosner,7,8 JoAnn E. Manson,6,8,9 Kevin Wheelan,10 and Frank B. Hu5,6,8*

Departments of 5Nutrition, 6Epidemiology, and 7Biostatistics, Harvard School of Public Health, Boston, MA; 8Channing Division of Network Medicine and 9Division of Preventive Medicine, Department of Medicine, Brigham and Women’s Hospital/Harvard Medical School, Boston, MA; 10Division of Cardiology, Department of Medicine, Baylor University Medical Center and Baylor Jack and Jane Hamilton Heart and Vascular Hospital, Dallas, TX; 11Department of Food and Nutrition, Eulji University, Gyeonggi-do, Korea; and 12Department of Nutrition, Simmons College, Boston, MA

Abstract
The consumption of instant noodles is relatively high in Asian populations. It is unclear whether a higher intake of instant noodles is associated with cardiometabolic risk independent of overall dietary patterns. We therefore investigated the association using the Korean National Health and Nutrition Examination Survey IV 2007–2009, a nationally representative cross-sectional survey of the Korean population with a clustered, multistage, stratified, and rolling sampling design. A total of 10,711 adults (54.5% women) 19–64 y of age were analyzed, with adjustment for sampling design complexity. Diet was assessed by using a 63-item food-frequency questionnaire. We identified 2 major dietary patterns with the use of principal components analysis: the “traditional dietary pattern” (TP), rich in rice, fish, vegetables, fruit, and potatoes, and the “meat and fast-food pattern” (MP), with less rice intake but rich in meat, soda, fried food, and fast food including instant noodles. The highest MP quintile was associated with increased prevalence of abdominal obesity (OR: 1.41; 95% CI: 1.05, 1.90), LDL cholesterol ≥130 mg/dL (1.3 g/L) (OR: 1.57, 95% CI 1.26, 1.95), decreased prevalence of low HDL cholesterol (OR: 0.65; 95% CI: 0.53, 0.80), and high triglycerides ≥150 mg/dL (1.5 g/L); OR: 0.73; 95% CI: 0.57, 0.93). The highest quintile for the TP was associated with decreased prevalence of elevated blood pressure (OR: 0.73; 95% CI: 0.59, 0.90) and marginally lower trends for abdominal obesity (OR: 0.76; 95% CI: 0.58, 0.98; Ptrend = 0.06), but neither of the dietary patterns was associated with prevalence of metabolic syndrome. The consumption of instant noodles ≥2 times/wk was associated with a higher prevalence of metabolic syndrome (OR: 1.68; 95% CI: 1.10, 2.55) in women but not in men (OR: 0.93; 95% CI: 0.58, 1.49; Pinteraction = 0.04). The 2 major dietary patterns were associated with distinct cardiometabolic risk factors. The consumption of instant noodles was associated with increased prevalence of metabolic syndrome in women, independent of major dietary patterns. J. Nutr. 144: 1247–1255, 2014.

Introduction
The prevalence of cardiometabolic risk factors is rapidly increasing in South Korea. The prevalence of overweight in the adult population increased from 26% in 1998 to 32% in 2007 (1) and that of metabolic syndrome in the adult population increased from 25% to 31% in the same time period (2). Such changes can lead not only to increased cardiovascular disease mortality and total mortality (3) but also eventually to increased health care costs (4).

One of the main driving forces for increased cardiometabolic risk factors could be unhealthy dietary choices, including increased consumption of fast food (5,6). The consumption of instant noodles is relatively high among Asian populations and especially among South Koreans (7), who consumed 3.4 billion packages of instant noodles in 2010, which makes South Koreans the highest consumers per capita of instant noodles in the world (7). Lee et al. (8) reported an increased prevalence of cardiometabolic risk factors associated with a dietary pattern high in intake of instant noodles, hamburgers, and pizza in a population of Korean men. However, the association between instant noodle intake and metabolic syndrome independent of dietary patterns has not been investigated. Therefore, the aim of
Participants and Methods

Participants and exclusion criteria. The KNHANES was designed to gather information on health status, attitudes, and behaviors associated with health, diet, and nutrition among South Koreans through 3 surveys including a health interview, a health examination, and a nutrition survey. Dietary intake information was collected by using a 63-item FFQ. The KNHANES IV included all seasons to reduce seasonal bias on diet. A nationally representative cross-sectional survey of the Korean population with a clustered, multistage, stratified, and rolling sampling design was conducted to represent the noninstitutionalized civilian South Korean population (6,9). We collected data from 2007 (n = 4594), 2008 (n = 9744), and 2009 (n = 10,533) KNHANES data sets (KNHANES IV) on a total of 24,871 participants (10). Among them, 20,899 participants completed the health interview, health examination, and nutrition survey. Candidates were excluded if their age was <19 y (n = 5678) or ≥65 y (n = 3667), which left 11,554 individuals. We then sequentially excluded the following individuals: 110 participants who were pregnant; 97 participants with extreme energy intake (≤500 or >6000 kcal/d); 470 participants with a history of stroke, angina, myocardial infarction, or cancer; and 166 participants with ≥1 missing responses to the FFQ. A final sample of 10,711 participants (1810 from 2007, 4212 from 2008, and 4689 from 2009) formed our study population (Supplemental Fig. 1). Specific sampling weight with consideration of sampling probability in a health interview, a health examination, and a nutrition survey was used. In addition, survey nonresponse and poststratification were taken into account. KNHANES is a publicly available database, and the Baylor Research Institute Institutional Review Board approved our exemption from review.

Dietary assessment. Dietary intake information was collected by FFQ (frequency only with no portion-size question) and independent 1-d 24-h recall. The FFQ consists of 63 food and beverage items reflecting the most frequently consumed foods and other nutrients among South Koreans; it has been widely used for many diet-disease studies in Korea, supporting the validity of the FFQ (11). In addition, a modified version of the FFQ from the KNHANES study was validated by using 3-d diet records (12). Participants were asked to choose from 10 possible frequency responses, ranging from “almost never” to “3 times a day” for each food. Food and beverage intakes from the FFQ were categorized into 38 food groups (Supplemental Table 1). The median intake frequency was normalized by using a Z score to generate dietary pattern scores separately in males and females. In secondary analysis the median intake frequency of each food group was divided by total energy intake (nutrient density method (11)) as assessed by 24-h dietary recall and normalized using a Z-score to generate energy-adjusted dietary patterns to decrease variation from differences in body size or physical activity and to decrease measurement error (11,13–15) (Supplemental Table 2). Intakes of total energy, proteins, fats, carbohydrates, and sodium were calculated from the 24-h dietary recall data.

Measurement of cardiometabolic risk factors. Trained researchers measured waist circumference from the iliac crest to the lower rib cage borders at end-expiration to the nearest 0.1 cm and measured body weight with the GL-6000-20 electronic scale (Cass Korea) to the nearest 0.1 kg and height with the Seca 223 stadiometer (Seca GmbH) to the nearest 0.1 cm (2). After the participant rested for >10 min in a sitting position, we measured blood pressure 3 times with a mercury sphygmomanometer (Baumanometer); using the latter 2 blood pressures, mean systolic and diastolic blood pressures were obtained. Fasting (≥8 h) serum glucose, total cholesterol, TGs, and HDL cholesterol were measured by using enzymatic methods with an automatic analyzer (ADVIA 1650; Siemens (in 2007); Hitachi Automatic Analyzer 7600; Hitachi (in 2008 and 2009)) in central, certified laboratories (6). LDL cholesterol was calculated by using the Friedewald formula: LDL (mg/dL) = total cholesterol (mg/dL) − [HDL (mg/dL) + TGs (mg/dL)/5] for participants with TG concentrations <400 mg/dL (4 g/L) (16). Details of laboratory standardization methods are described elsewhere (2,6).

Definition of cardiometabolic risk factors. By using International Diabetes Federation criteria (17), metabolic syndrome was defined as abdominal obesity (waist circumference ≥90 cm in men and ≥80 cm in women) plus any 2 of the following components: 1) elevated blood pressure (systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥85 mm Hg or antihypertensive medication use), 2) low HDL cholesterol [fasting HDL cholesterol <40 mg/dL (0.4 g/L) in men and <50 mg/dL (0.5 g/L) in women], 3) hyperglycemia [fasting glucose ≥100 mg/dL (1 g/L) or antiobesity prescription use (insulin or oral agents) or physician-diagnosed diabetes], and 4) hypertriglyceridemia [fasting TGs ≥150 mg/dL (1.5 g/L)]. In addition, high LDL cholesterol was defined as fasting LDL cholesterol ≥130 mg/dL (1.3 g/L).

Statistical analysis. Dietary patterns were generated by using principal components analysis from the predefined food groups according to gender (Supplemental Table 1). Analysis was stratified by gender to explore dietary differences in men and women. We determined the number of factors to retain by scree plot, eigenvalues >2.0, and interpretability to extract 2 major dietary patterns (18), which explained 22.4% and 23.6% of total variance in men and women, respectively. The orthogonal rotation procedure (varimax) yielded dietary patterns uncorrelated with each other, increasing interpretability. Foods with factor-loading values ≥0.3 were considered to have important contributions to the specific pattern (19,20). Instant noodle intake was divided into 5 categories (<1 time/mo, 1 time/mo, 2–3 times/mo, 1 time/wk, and ≥2 times/wk) according to frequency distribution. PROC SURVEYREG and PROC SURVEYLOGISTIC (SAS Institute) were used to estimate age-standardized mean and prevalence of demographic factors and nutrient profiles in each dietary pattern and instant noodle categories (Table 1), taking into account the clustering sampling design of the survey.

We used PROC SURVEYLOGISTIC analysis to assess the associations between dietary pattern, instant noodle intake, and endpoints (primary: metabolic syndrome; secondary: each component of metabolic syndrome and LDL cholesterol). Adjusted potential confounding factors included age (y, continuous), gender, education (college or higher, high school, middle school, elementary school), household income (quartiles), alcohol consumption (servings/wk, continuous), smoking (current smoker: ≥1 pack/d; current smoker: <1 pack/d; past smoker; non-smoker), physical activity (metabolic task equivalent-hours/wk, continuous), survey year (2007, 2008, or 2009), energy intake (kcal, continuous), BMI (kg/m², continuous), sodium intake (mg, continuous), estrogen use (yes or no, in women), menopause (yes or no, in women), and dietary pattern quintiles. Linear trends across dietary pattern quintiles or instant noodle intake categories were tested by using the median intake frequency within each exposure category in PROC SURVEYLOGISTIC analysis. The significance of interaction terms to test effect modification by gender was determined by using the Wald test. All analyses were performed by using SAS 9.3 software (SAS Institute), with the type I error rate fixed at 0.05 (2-tailed).

Results

Identification of dietary patterns in each gender

We identified 2 major dietary patterns: the “traditional dietary pattern” (TP), rich in grain, legumes, potatoes, fish, mushrooms, seaweed, fruit, and vegetables, and the “meat and fast-food pattern” (MP), with less rice and cereal but rich in meat, soda, fried food, instant noodles, bread, cookies, fish paste, ice cream, hamburgers, and pizza (Supplemental Table 1). Similar dietary

14 Abbreviations used: KNHANES, Korean National Health and Nutrition Examination Survey; MP, meat and fast food pattern; TP, traditional dietary pattern.
patterns were identified in men and women. Those with the highest quintiles of the MP also had a higher frequency of instant noodle intake (a mean of 2 times/wk in men and 1.2 times/wk in women) compared with the highest quintiles of the TP (a mean of 1.1 times/wk in men and 0.7 times/wk in women) (Table 1).

### Baseline characteristics

Differences were small in protein and fat intake between participants in the highest quintile of the MP and participants in the highest quintile of the TP. In addition, the mean sodium intake was very high across all categories (age-standardized mean sodium intake: 6.0 g in men, 4.2 g in women). Participants who frequently consumed instant noodles (≥2 times/wk) and those in the highest quintile of the MP were more likely to be current smokers, drink more alcohol, be less physically active, and have low carbohydrate intake in both genders (Table 1). Interestingly, although participants in the highest quintile of the MP had a higher education/income level than participants in the lowest quintile, frequent consumers of instant noodles had lower educational/income levels than did infrequent instant noodle consumers.

Those in the highest quintile of the TP were older, were physically more active, had attained a higher educational/income level, were less likely to be current smokers, and had a diet that consisted of more protein, fat, and sodium than participants in the lowest quintile in both genders.

### Major dietary patterns and metabolic syndrome

The highest MP quintile was not associated with metabolic syndrome (OR: 1.05; 95% CI: 0.78, 1.41) (Table 2, model 2). There was a significant interaction between gender and this pattern (P-interaction <0.0001) in relation to metabolic syndrome. MP quintiles as a group (quintiles 2–5) had marginally increased odds for metabolic syndrome (OR: 1.33; 95% CI: 0.99, 1.78; P = 0.06) compared with the lowest MP quintile (quintile 1) in men but not in women. The highest TP quintile was not associated with metabolic syndrome (OR: 1.02; 95% CI: 0.80, 1.30) (Table 2, model 2).

### Major dietary patterns and other cardiometabolic risk factors

The highest MP quintile was associated with higher prevalence of abdominal obesity (OR: 1.41; 95% CI: 1.05, 1.90) and LDL cholesterol ≥130 mg/dL (1.3 g/L) (OR: 1.57; 95% CI: 1.26, 1.95) compared with the lowest quintile (Table 3). Interestingly, there was a lower prevalence of low HDL cholesterol (OR: 0.65; 95% CI: 0.53, 0.80) and TGs ≥150 mg/dL (1.5 g/L) (OR: 0.73; 95% CI: 0.57, 0.93) in the highest MP quintile. Further

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**Table 1** Demographic and nutrient profiles according to instant noodle intake and dietary pattern in adults (KNHANES)¹

<table>
<thead>
<tr>
<th>Men, n</th>
<th>&lt;1 time/mo</th>
<th>2-3 times/mo</th>
<th>≥2 times/wk</th>
<th>Women, n</th>
<th>&lt;1 time/mo</th>
<th>2-3 times/mo</th>
<th>≥2 times/wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>46.6 ± 0.7</td>
<td>41.9 ± 0.5</td>
<td>34.1 ± 0.4</td>
<td>1674</td>
<td>48.1 ± 0.4</td>
<td>41.9 ± 0.4</td>
<td>32.1 ± 0.5</td>
</tr>
<tr>
<td>Energy intake, kcal/d</td>
<td>2.19 ± 0.06</td>
<td>2.27 ± 0.04</td>
<td>2.35 ± 0.03</td>
<td>1.60 ± 0.02</td>
<td>1.65 ± 0.02</td>
<td>1.65 ± 0.03</td>
<td>1.96 ± 0.09</td>
</tr>
<tr>
<td>Sodium, g/d</td>
<td>5.53 ± 0.21</td>
<td>6.09 ± 0.15</td>
<td>6.19 ± 0.13</td>
<td>5.36 ± 0.48</td>
<td>5.73 ± 0.48</td>
<td>6.01 ± 0.48</td>
<td>6.01 ± 0.48</td>
</tr>
<tr>
<td>BML, kg/m²</td>
<td>24.0 ± 0.2</td>
<td>24.3 ± 0.2</td>
<td>24.2 ± 0.1</td>
<td>22.7 ± 0.2</td>
<td>23.0 ± 0.2</td>
<td>23.7 ± 0.2</td>
<td>22.9 ± 0.2</td>
</tr>
<tr>
<td>Physical activity, MET-h/wk</td>
<td>38 ± 28</td>
<td>41 ± 31</td>
<td>35 ± 33</td>
<td>24 ± 19</td>
<td>20 ± 18</td>
<td>18 ± 17</td>
<td>17 ± 16</td>
</tr>
<tr>
<td>Alcohol, servings/wk</td>
<td>4.1 ± 5.1</td>
<td>4.1 ± 5.2</td>
<td>4.1 ± 5.3</td>
<td>1.5 ± 1.1</td>
<td>1.5 ± 1.1</td>
<td>1.5 ± 1.1</td>
<td>1.5 ± 1.1</td>
</tr>
<tr>
<td>High education, %</td>
<td>83 ± 0.6</td>
<td>86 ± 0.8</td>
<td>80 ± 0.8</td>
<td>18.2 ± 1.2</td>
<td>21.7 ± 1.2</td>
<td>28.3 ± 1.2</td>
<td>26.4 ± 1.2</td>
</tr>
<tr>
<td>Currently smoking, %</td>
<td>41 ± 0.9</td>
<td>41 ± 0.8</td>
<td>41 ± 0.9</td>
<td>37 ± 0.8</td>
<td>37 ± 0.9</td>
<td>27 ± 0.8</td>
<td>26 ± 0.8</td>
</tr>
<tr>
<td>Protein, % of total energy</td>
<td>15 ± 0.4</td>
<td>15 ± 0.4</td>
<td>15 ± 0.4</td>
<td>17 ± 0.4</td>
<td>18 ± 0.4</td>
<td>19 ± 0.4</td>
<td>18 ± 0.4</td>
</tr>
<tr>
<td>Fat, % of total energy</td>
<td>65 ± 3.6</td>
<td>63 ± 3.8</td>
<td>62 ± 4.0</td>
<td>69 ± 3.6</td>
<td>63 ± 3.8</td>
<td>62 ± 4.0</td>
<td>63 ± 3.6</td>
</tr>
</tbody>
</table>

¹ KNHANES, Korean National Health and Nutrition Examination Survey; MET-h, metabolic equivalent task-hours; Q, quintile.

² Values are means ± SEMs.

³ Values are age-standardized means ± SEMs.

⁴ Data source: 24-h recall.

⁵ Values are medians.

⁶ High school education or higher.

⁷ Values are age-standardized prevalences.
Traditional dietary pattern was fixed at 0.05 (2-tailed). In models 2 and 3, ORs were separately reported for men and women. KNHANES, Korean National Health and Nutrition Examination Survey.

Smoking, alcohol, total energy intake, survey year, physical activity, and dietary pattern quintiles; model 3 adjusted for BMI in addition to covariates in model 2. Type I error rate was not change the positive relation between instant noodle intake and metabolic syndrome in women (OR: 1.83; 95% CI: 1.14, 2.92; P-trend = 0.004) among 5315 men (675 metabolic syndrome cases), although there was no association between instant noodle consumption ≥2 times/wk and metabolic syndrome (OR: 0.97; 95% CI: 0.57, 1.64; P-trend = 0.66) among 3459 men (489 metabolic syndrome cases in men; P-interaction (gender × instant noodle intake) = 0.02).

Subgroup analysis. The linear positive trend between metabolic syndrome and instant noodle consumption ≥2 times/wk persisted in women (but not in men) who were leaner [BMI less than the median; OR: 5.22; 95% CI: 1.62, 16.78; P-trend = 0.01, P-interaction (gender × instant noodle intake) = 0.02], younger [age <40 y; OR: 2.81; 95% CI: 0.95, 8.29; P-trend = 0.03], and metabolic syndrome and abdominal obesity in women.

Sensitivity analysis. Another dietary pattern was constructed without instant noodles to decrease multicollinearity between instant noodles and the MP. Analysis adjusting for this pattern did not change associations between instant noodle intake and metabolic syndrome and abdominal obesity in women.

We performed the same analysis by using an energy-adjusted dietary pattern (Supplemental Table 2) and energy-adjusted instant noodle intake; overall associations between dietary patterns, instant noodle intake, and cardiometabolic risk factors remained unchanged.

The exclusion of participants taking blood pressure-lowering or lipid-lowering medications or who had a history of diabetes mellitus did not change the overall associations between dietary patterns and cardiometabolic risk factors.

### Instant noodles and cardiometabolic risk factors

The consumption of instant noodles ≥2 times/wk was associated with a higher prevalence of metabolic syndrome in women (OR: 1.83; 95% CI: 1.14, 2.92; P-trend = 0.004) among 5315 women (675 metabolic syndrome cases), although there was no association between instant noodle consumption ≥2 times/wk and metabolic syndrome (OR: 0.97; 95% CI: 0.57, 1.64; P-trend = 0.66) among 3459 men (489 metabolic syndrome cases in men; P-interaction (gender × instant noodle intake) = 0.02).

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### Subgroup analysis

The linear positive trend between metabolic syndrome and instant noodle consumption ≥2 times/wk persisted in women (but not in men) who were leaner [BMI less than the median; OR: 5.22; 95% CI: 1.62, 16.78; P-trend = 0.01, P-interaction (gender × instant noodle intake) = 0.02], younger [age <40 y; OR: 2.81; 95% CI: 0.95, 8.29; P-trend = 0.03], and metabolic syndrome and abdominal obesity in women.
TABLE 3  ORs (95% CIs) of cardiometabolic risk factors according to meat and fast food pattern quintiles in adults (KNHANES)\(^1\)

<table>
<thead>
<tr>
<th>Abdominal obesity (%)</th>
<th>Men</th>
<th>1 (0.87, 1.05)</th>
<th>1.06 (0.88, 1.28)</th>
<th>1.31 (1.01, 1.69)</th>
<th>1.46 (1.03, 2.07)</th>
<th>0.02</th>
<th>1.16 (0.90, 1.47)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>0.06 (0.13, 1.17)</td>
<td>0.92 (0.79, 1.06)</td>
<td>0.87 (0.67, 1.13)</td>
<td>0.83 (0.63, 1.10)</td>
<td>0.71</td>
<td>0.89 (0.71, 1.12)</td>
</tr>
</tbody>
</table>

Elevated blood pressure (%)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>1 (0.73, 1.04)</th>
<th>1.12 (0.92, 1.35)</th>
<th>1.29 (1.08, 1.54)</th>
<th>1.36 (1.10, 1.65)</th>
<th>0.0001</th>
<th>1.21 (1.11, 1.32)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>1.10 (0.79, 1.53)</td>
<td>1.23 (0.81, 1.87)</td>
<td>1.31 (0.96, 1.76)</td>
<td>1.45 (1.04, 2.02)</td>
<td>0.01</td>
<td>1.20 (0.94, 1.53)</td>
</tr>
</tbody>
</table>

High LDL cholesterol (%)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>1.08 (0.72, 1.07)</th>
<th>0.89 (0.62, 1.20)</th>
<th>0.81 (0.65, 1.00)</th>
<th>0.73 (0.57, 0.93)</th>
<th>0.01</th>
<th>0.86 (0.80, 0.97)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>0.86 (0.70, 1.04)</td>
<td>0.95 (0.78, 1.15)</td>
<td>0.76 (0.61, 0.94)</td>
<td>0.67 (0.53, 0.88)</td>
<td>0.01</td>
<td>0.87 (0.77, 0.95)</td>
</tr>
</tbody>
</table>

Low HDL cholesterol (%)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>1.00 (0.75, 1.29)</th>
<th>0.80 (0.67, 1.08)</th>
<th>0.71 (0.53, 0.97)</th>
<th>0.64 (0.48, 0.81)</th>
<th>0.01</th>
<th>0.84 (0.74, 0.96)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>1.04 (0.73, 1.45)</td>
<td>1.06 (0.81, 1.38)</td>
<td>0.82 (0.60, 1.13)</td>
<td>0.73 (0.50, 1.07)</td>
<td>0.11</td>
<td>0.88 (0.76, 1.03)</td>
</tr>
</tbody>
</table>

Hypertriglyceridemia (%)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>0.88 (0.62, 0.97)</th>
<th>0.77 (0.53, 1.06)</th>
<th>0.85 (0.53, 0.98)</th>
<th>0.82 (0.56, 1.08)</th>
<th>0.01</th>
<th>0.86 (0.78, 0.99)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>0.88 (0.63, 1.25)</td>
<td>0.83 (0.59, 1.25)</td>
<td>0.71 (0.41, 1.09)</td>
<td>0.67 (0.42, 1.06)</td>
<td>0.05</td>
<td>0.82 (0.75, 0.90)</td>
</tr>
</tbody>
</table>

Elevated blood pressure (OR): 1.59 (1.17, 2.16); P = 0.003 in women but was not associated with metabolic syndrome or hyperglycemia in men [OR for metabolic syndrome: 1.28; 95% CI: 0.87, 1.88; P = 0.22; OR for hyperglycemia: 1.16; 95% CI: 0.87, 1.54; P = 0.30; P-interaction (gender × instant noodle intake) in metabolic syndrome = 0.72].

Discussion

In this nationally representative study, the TP was associated with a low prevalence of abdominal obesity and elevated blood pressure, whereas the MP was associated with a high prevalence of abdominal obesity and high LDL cholesterol but a decreased prevalence of low HDL cholesterol and hypertriglyceridemia. The TP, rich in fruit, vegetables, and fish, was inversely associated with abdominal obesity and elevated blood pressure, which is in agreement with previous studies (21–23).

It is interesting to see that there was a simultaneous increase in both healthy metabolic components (HDL cholesterol increase, TG decrease) and some unhealthy metabolic components (abdominal obesity, LDL cholesterol increase) with the MP. The direct association with increased HDL cholesterol and a decrease in TGs with the MP might be mediated by a reduced intake of carbohydrates (24,25), such as polished rice (26), and an increased intake of fat (27) among those in the highest quintile of the MP; there were similar findings in a Japanese population (28). Red meat (18,29–31), processed meat (18,20), smoking, alcohol, total energy intake, survey year, physical activity, BMI, and traditional dietary pattern quintile; model 2 adjusted for instant noodle intake in addition to covariates in model 1. Type I error rate was fixed at 0.05 (2-tailed). In model 2, ORs were separately reported for men and women. KNHANES, Korean National Health and Nutrition Examination Survey.

1 In all analyses, PROC SURVEYLOGISTIC (SAS Institute) was used. Model 1 adjusted for age, gender, household income, education, smoking, alcohol, total energy intake, survey year, physical activity, BMI, and traditional dietary pattern quintile; model 2 adjusted for instant noodle consumption assessed from a 24-h dietary recall. Men and women. KNHANES, Korean National Health and Nutrition Examination Survey.

2 OR per 1-quintile increase in dietary pattern score.
It has been reported that South Koreans consume instant noodles 1.12 times/wk on average, making this food one of the main sources of total energy intake [58.4 kcal/(person·d), 3.2% of daily calories, second only to rice], carbohydrate calories [33.2 kcal/(person·d), 2.9% of daily carbohydrate intake, again second only to rice], fat calories [20.7 kcal/(person·d), 6% of daily fat intake, third after pork and soybean oil], and sodium [221.4 mg/(person·d), fifth ranking] (1). However, the possible health risks of instant noodles have been controversial (39). Although a previous report suggested that dietary patterns containing instant noodles might increase cardiometabolic risk factors, other fast foods with well-known health risk factors were blamed due to lack of supporting evidence with regard to instant noodles (8,40). We found that the consumption of instant noodles was associated with an increased prevalence of metabolic syndrome and marginally associated with abdominal obesity, independent of the major dietary patterns, in women. Our findings suggest that instant noodle consumption alone might confer a higher cardiometabolic risk independent of overall dietary patterns. The combined effect of high energy density (381–464 kcal/100 g) (41), high glycemic loads with refined carbohydrates, high saturated fat content (66.2–87.2 kcal/100 g) (42), and high sodium (1.7–2.5 g/serving) (43) may contribute to an increased risk of metabolic syndrome and abdominal obesity. Even though measurements of the glycemic index of instant noodles varied among studies (44–51), the overall glycemic load of instant noodles is high, given their high carbohydrate content (35,38–43).
In our study, the association between instant noodles and metabolic syndrome differed significantly between genders, and there was no effect modification of this association by age, BMI, or physical activity. Biologic differences between men and women such as sex hormones and metabolism (52, 53), gender-specific cutoff values in abdominal obesity (54) and metabolic syndrome components (17), different food group compositions between men and women in their dietary patterns, and social desirability and differences in the accuracy of food reporting (52) and in distribution of confounding factors across dietary patterns in each gender (52) might contribute to gender differences. Bisphenol A, which is frequently found in styrofoam containers (widely used for packaging instant noodles), is a selective modulator of estrogen receptors that can accelerate adipogenesis; gender-specific associations between bisphenol A and obesity were reported (55–57). The positive association between instant noodles and obesity were independent of major confounders including sex hormones and metabolism; gender-specific analysis, because portion size contributes a relatively small amount of information on variation in intake (59–61).

In conclusion, the TP was associated with a lower prevalence of abdominal obesity and marginally lower trends for elevated blood pressure, whereas the MP was associated with abdominal obesity, high LDL cholesterol, and decreased prevalence of low HDL cholesterol and hypertriglyceridemia. Independent of major dietary patterns, instant noodle consumption was associated with increased prevalence of metabolic syndrome in women.

Acknowledgments
H.J.S. and F.B.H. designed the research; H.J.S. conducted the research, performed statistical analysis, and had primary responsibility for the final content; H.-J.L. provided the database; and H.J.S., E.C., H.-J.L., T.T.F., E.R., B.R., J.E.M., K.W., and F.B.H. wrote the manuscript. All authors read and approved the final manuscript.

References

In all analyses, PROC SURVEYLOGISTIC (SAS Institute) was used. Covariates adjusted included age, household income, education, smoking, alcohol, total energy intake, survey year, physical activity, BMI, traditional dietary pattern quintile, and meat and fast-food pattern quintile. Type I error rate was fixed at 0.05 (2-tailed). KNHANES, Korean National Health and Nutrition Examination Survey.

<table>
<thead>
<tr>
<th>Instant noodle intake frequency</th>
<th>OR/time/wk</th>
<th>P-trend</th>
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<tbody>
<tr>
<td><strong>Metabolic syndrome (%)</strong></td>
<td></td>
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<tr>
<td>Men 1 0.93 (0.58, 1.47) 1.11 (0.73, 1.68) 1.19 (0.79, 1.78) 0.93 (0.58, 1.49) 0.98 (0.82, 1.17) 0.81</td>
<td></td>
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<tr>
<td>Women 1.11 (0.82, 1.50) 1.20 (0.85, 1.69) 1.44 (1.02, 2.04) 1.68 (1.10, 2.55) 1.26 (1.06, 1.50) &lt;0.01</td>
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<tr>
<td><strong>Abdominal obesity (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men 1 0.98 (0.58, 1.64) 1.15 (0.72, 1.84) 1.02 (0.66, 1.60) 0.99 (0.63, 1.55) 0.99 (0.83, 1.19) 0.94</td>
<td></td>
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<tr>
<td>Women 1.28 (0.96, 1.69) 1.21 (0.89, 1.65) 1.37 (0.95, 1.97) 1.48 (0.99, 2.21) 1.17 (0.99, 1.39) 0.06</td>
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<tr>
<td><strong>Hyperglycemia (%)</strong></td>
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<tr>
<td>Men 1 1.21 (0.85, 1.73) 1.18 (0.84, 1.66) 1.05 (0.75, 1.48) 1.16 (0.82, 1.64) 1.03 (0.91, 1.17) 0.67</td>
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<tr>
<td>Women 1.98 (0.76, 1.27) 1.02 (0.79, 1.32) 1.05 (0.78, 1.40) 1.01 (0.69, 1.48) 1.01 (0.87, 1.18) 0.86</td>
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<tr>
<td><strong>Hypertriglyceridemia (%)</strong></td>
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<tr>
<td>Men 1 1.09 (0.80, 1.49) 1.22 (0.90, 1.66) 1.32 (0.99, 1.76) 1.24 (0.91, 1.70) 1.06 (0.94, 1.19) 0.35</td>
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<tr>
<td>Women 1.05 (0.64, 1.12) 0.95 (0.72, 1.26) 1.22 (0.92, 1.63) 1.26 (0.86, 1.86) 1.15 (0.98, 1.34) 0.10</td>
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<tr>
<td><strong>Low HDL cholesterol (%)</strong></td>
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<tr>
<td>Men 1 0.93 (0.68, 1.28) 0.93 (0.68, 1.26) 0.92 (0.69, 1.23) 0.79 (0.57, 1.10) 0.91 (0.81, 1.04) 0.13</td>
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<tr>
<td>Women 1.11 (0.80, 1.38) 1.16 (0.92, 1.45) 1.30 (1.05, 1.62) 1.15 (0.97, 1.54) 1.06 (0.94, 1.10) 0.36</td>
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<tr>
<td><strong>Elevated blood pressure (%)</strong></td>
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<tr>
<td>Men 1 1.06 (0.77, 1.44) 1.02 (0.76, 1.38) 1.04 (0.79, 1.37) 1.10 (0.80, 1.51) 1.04 (0.92, 1.17) 0.57</td>
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</tr>
<tr>
<td>Women 1.02 (0.76, 1.35) 0.95 (0.71, 1.26) 0.93 (0.71, 1.24) 0.91 (0.61, 1.37) 0.95 (0.81, 1.13) 0.58</td>
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<tr>
<td><strong>High LDL cholesterol (%)</strong></td>
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<td></td>
</tr>
<tr>
<td>Men 1 1.18 (0.86, 1.61) 1.05 (0.76, 1.45) 1.66 (1.22, 2.26) 1.23 (0.89, 1.70) 1.04 (0.93, 1.17) 0.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women 1.05 (0.82, 1.33) 0.92 (0.72, 1.17) 0.89 (0.68, 1.17) 0.90 (0.63, 1.28) 0.94 (0.81, 1.09) 0.40</td>
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</tbody>
</table>

1 In all analyses, PROC SURVEYLOGISTIC (SAS Institute) was used. Covariates adjusted included age, household income, education, smoking, alcohol, total energy intake, survey year, physical activity, BMI, traditional dietary pattern quintile, and meat and fast-food pattern quintile. Type I error rate was fixed at 0.05 (2-tailed). KNHANES, Korean National Health and Nutrition Examination Survey.

2 OR per 1 time/wk increase in instant noodle intake.


