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


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 (OR: 1.41; 95% CI: 1.05, 1.90), LDL cholesterol (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

1 H.J.S. received funding from The Baylor Heart and Vascular Institute Cardiovascular Research Review Committee for this study. The Baylor Heart and Vascular Institute had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.
3 Supplemental Figure 1 and Supplemental Tables 1–3 are available from “Online Supporting Material” link in the online posting of the article and from the same link in the online table of contents at http://jn.nutrition.org.
4 The abstract was presented as a poster at the Experimental Biology 2013 meeting 24 April 2013, Boston, MA and the fellows abstract competition at the American College of Cardiology, Texas chapter meeting (18 May 2013, San Antonio, TX).
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this study was to investigate the association between dietary patterns, instant noodle consumption, and cardiometabolic risk factors by using the Korean National Health and Nutrition Examination Survey (KNHANES) cross-sectional survey.

**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. 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 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.

**Dietary assessment.** Dietary intake information was collected by FFQ (frequency only with a portion-size question) and individual 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 normalized using a Z-score to generate energy-adjusted dietary patterns, instant noodle consumption, and cardiometabolic risk factors.** 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 (quarters), 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 (Table 1). Similar dietary

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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 younger, 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
Traditional dietary intake, estrogen use, menopause, or waist circumference also did not change the overall associations between instant noodle intake and cardiometabolic risk factors. 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. 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 strengthened the positive association between instant noodle consumption and metabolic syndrome and abdominal obesity in women.

### Table 2

**ORs (95% CIs) of metabolic syndrome according to dietary pattern quintiles in adults (KNHANES)**

<table>
<thead>
<tr>
<th>Dietary pattern score quintile</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>OR/quintile $^2$</th>
<th>P-trend</th>
<th>Quintiles 2–5 vs. quintile 1 $^3$</th>
<th>$^p$</th>
<th>P-interaction $^4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total adults, n</td>
<td>1996</td>
<td>2008</td>
<td>2021</td>
<td>2031</td>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Median $^5$</strong></td>
<td>-1.1</td>
<td>-0.6</td>
<td>-0.1</td>
<td>0.4</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 1</td>
<td>1.00 (0.82, 1.22)</td>
<td>1.18 (0.96, 1.46)</td>
<td>0.97 (0.77, 1.24)</td>
<td>1.03 (0.78, 1.36)</td>
<td>1.01 (0.91, 1.13)</td>
<td>0.84</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td>1.04 (0.84, 1.29)</td>
<td>1.27 (1.02, 1.57)</td>
<td>1.01 (0.79, 1.29)</td>
<td>1.05 (0.78, 1.41)</td>
<td>1.01 (0.94, 1.14)</td>
<td>0.81</td>
<td>0.30</td>
<td></td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>Men</td>
<td>1.35 (0.95, 1.90)</td>
<td>1.41 (1.01, 1.97)</td>
<td>1.22 (0.83, 1.78)</td>
<td>1.27 (0.83, 1.96)</td>
<td>1.05 (0.89, 1.24)</td>
<td>0.57</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.83 (0.65, 1.08)</td>
<td>1.17 (0.89, 1.55)</td>
<td>0.85 (0.61, 1.19)</td>
<td>0.92 (0.62, 1.37)</td>
<td>0.97 (0.83, 1.14)</td>
<td>0.72</td>
<td>0.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 3</td>
<td>1.08 (0.84, 1.40)</td>
<td>1.25 (0.96, 1.62)</td>
<td>1.06 (0.80, 1.42)</td>
<td>0.88 (0.62, 1.25)</td>
<td>0.95 (0.83, 1.08)</td>
<td>0.44</td>
<td>0.30</td>
<td></td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>Men</td>
<td>1.68 (1.10, 2.55)</td>
<td>1.72 (1.12, 2.63)</td>
<td>1.60 (1.01, 2.54)</td>
<td>0.96 (0.56, 1.65)</td>
<td>0.94 (0.77, 1.14)</td>
<td>0.52</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.77 (0.57, 1.03)</td>
<td>1.00 (0.72, 1.38)</td>
<td>0.78 (0.51, 1.12)</td>
<td>0.88 (0.56, 1.40)</td>
<td>0.95 (0.78, 1.15)</td>
<td>0.58</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In all analyses, PROC SURVEYLOGISTIC (SAS Institute) was used. Model 1 adjusted for age and gender; model 2 adjusted for age, gender, household income, education, 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 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.

$^2$ OR per 1-quintile increase in dietary pattern score.

$^3$ Interaction between gender and median dietary pattern scores in models 2 and 3.

$^4$ To test threshold effect, quintiles 2–5 were compared with quintile 1 in models 2 and 3.

$^5$ Median dietary pattern scores in each dietary pattern quintile.
P-interaction (gender × instant noodle intake) = 0.02], and more active [physical activity more than or equal to the median; OR: 1.88; 95% CI: 1.00, 3.56; P-trend = 0.04, P-interaction (gender × instant noodle intake) = 0.01]. In addition, there was no significant effect modification in the association between instant noodle intake and metabolic syndrome by physical activity level, BMI, or age in either gender (Supplemental Table 3).

**Instant noodle consumption assessed from a 24-h dietary recall.** Compared with instant noodle nonconsumption, instant noodle consumption assessed from a 24-h dietary recall was associated with a higher prevalence of metabolic syndrome (OR: 1.34; 95% CI: 1.01, 1.76; P = 0.04) and hyperglycemia (OR: 1.30; 95% CI: 1.04, 1.61; P = 0.02) among the overall population, marginally increasing trends for metabolic syndrome (OR: 1.41; 95% CI: 0.96, 2.07; P = 0.08) and a higher prevalence of hyperglycemia (OR: 1.59; 95% CI: 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; OR = 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), fried food and soda/snacks (32–34), and dietary patterns containing these foods are known to increase cardiometabolic risk factors. Some unhealthy dietary components (abdominal obesity, LDL cholesterol increase) with the MP were not associated with metabolic syndrome or hyperglycemia in men [OR for metabolic syndrome: 1.28; 95% CI: 0.87, 1.88; OR = 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].

**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>Meat and fast-food pattern score quintile (median)</th>
<th>1 (−1.1)</th>
<th>2 (−0.6)</th>
<th>3 (−0.2)</th>
<th>4 (0.4)</th>
<th>5 (1.3)</th>
<th>P-trend</th>
<th>OR/quintile²</th>
</tr>
</thead>
</table>

- **Abdominal obesity (%)**
  - Model 1: 1.11 (0.86, 1.43) 1.31 (1.01, 1.69) 1.46 (1.11, 1.92) 1.41 (1.05, 1.90) 0.02 1.16 (1.03, 1.31)
  - Model 2: 1.06 (0.82, 1.38) 1.24 (0.95, 1.61) 1.36 (1.03, 1.81) 1.31 (0.95, 1.80) 0.06 1.13 (0.99, 1.28)

- **Elevated blood pressure (%)**
  - Model 1: 0.95 (0.80, 1.14) 0.94 (0.77, 1.13) 0.97 (0.79, 1.19) 0.89 (0.71, 1.11) 0.46 0.97 (0.88, 1.06)

- **Hypertriglyceridemia (%)**
  - Model 1: 0.88 (0.72, 1.07) 0.99 (0.82, 1.20) 0.81 (0.65, 1.00) 0.73 (0.57, 0.93) <0.0001 1.21 (1.11, 1.32)

- **Low HDL cholesterol (%)**
  - Model 1: 0.81 (0.68, 0.96) 0.87 (0.73, 1.05) 0.73 (0.60, 0.88) 0.65 (0.53, 0.80) 0.0001 0.85 (0.78, 0.92)

- **Hyperglycemia (%)**
  - Model 1: 0.88 (0.73, 1.07) 1.04 (0.84, 1.29) 1.10 (0.86, 1.41) 0.90 (0.69, 1.16) 0.76 0.98 (0.89, 1.09)

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 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.

² OR per 1-quintile increase in dietary pattern score.
risk factors (18,20,35). Our results regarding the MP are in some ways consistent with previous reports (18,20,29–34) of increased cardiometabolic risk factors such as abdominal obesity and high LDL cholesterol. Similar associations between crude and energy-adjusted dietary patterns and cardiometabolic risk factors suggest that these associations might not be driven by total energy intake. Although the Western dietary pattern (20,36) is known to increase the risk of type 2 diabetes, there was no association between the MP and hyperglycemia in our study. This null association between the MP and hyperglycemia might be explained by a reduced intake of carbohydrates, especially from polished white rice in the MP. As shown in previous reports, a high intake of refined carbohydrates such as white rice (37,38) is known to increase the risk of type 2 diabetes, therefore nullifying the possible association between the MP and hyperglycemia in our study.

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 in 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 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 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.

### TABLE 4 ORs (95% CIs) of cardiometabolic risk factors according to traditional pattern quintiles in adults (KNHANES)\(^1\)

<table>
<thead>
<tr>
<th>Abdominal obesity (%)</th>
<th>Model 1</th>
<th>1.00 (0.84, 1.17)</th>
<th>1.03 (0.88, 1.22)</th>
<th>1.03 (0.88, 1.22)</th>
<th>1.03 (0.88, 1.22)</th>
<th>1.00 (0.84, 1.17)</th>
<th>P-trend</th>
<th>OR/quintile(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 2</td>
<td>1</td>
<td>1.00 (0.85, 1.18)</td>
<td>1.04 (0.90, 1.20)</td>
<td>1.04 (0.90, 1.20)</td>
<td>1.04 (0.90, 1.20)</td>
<td>1.00 (0.85, 1.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>1</td>
<td>0.99 (0.85, 1.15)</td>
<td>1.02 (0.88, 1.19)</td>
<td>1.02 (0.88, 1.19)</td>
<td>1.02 (0.88, 1.19)</td>
<td>0.99 (0.85, 1.15)</td>
<td>0.06</td>
<td>0.99 (0.85, 1.15)</td>
</tr>
<tr>
<td>Women</td>
<td>1</td>
<td>1.00 (0.85, 1.16)</td>
<td>1.03 (0.89, 1.20)</td>
<td>1.03 (0.89, 1.20)</td>
<td>1.03 (0.89, 1.20)</td>
<td>1.00 (0.85, 1.16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)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 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 in men and women. KNHANES, Korean National Health and Nutrition Examination Survey.

\(^2\)OR per 1-quintile increase in dietary pattern score.
TABLE 5  ORs (95% CIs) of cardiometabolic risk factors according to instant noodle intake in adults (KNHANES)1

<table>
<thead>
<tr>
<th>Instant noodle intake frequency</th>
<th>&lt;1 time/mo</th>
<th>1 time/mo</th>
<th>2–3 times/mo</th>
<th>1 time/wk</th>
<th>≥2 times/wk</th>
<th>OR/time/wk2</th>
<th>P-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic syndrome (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men 1</td>
<td>1</td>
<td>0.93</td>
<td>1.11</td>
<td>1.11</td>
<td>1.19</td>
<td>0.93</td>
<td>0.98</td>
</tr>
<tr>
<td>Women 1</td>
<td>1.11</td>
<td>1.11</td>
<td>1.23</td>
<td>1.44</td>
<td>1.68</td>
<td>1.68</td>
<td>1.26</td>
</tr>
<tr>
<td>Abdominal obesity (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men 1</td>
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<td>1.15</td>
<td>1.02</td>
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<tr>
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<td>1.05</td>
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<td>1.03</td>
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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 timewk increase in instant noodle intake.

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 metabolic syndrome seen in younger, more active, and leaner women suggests that the hazards of instant noodles might not be overcome by the beneficial health effects of increased physical activity, weight loss, and young age.

Our study had several limitations. First, we cannot infer a causal relation given our cross-sectional study design. People diagnosed with hypertension, hyperlipidemia, or diabetes mellitus might reduce their consumption of unhealthy foods, leading to reverse causation bias (30). However, the stronger association between instant noodle consumption ≥2 times/wk and metabolic syndrome among women after excluding participants taking blood pressure-lowering and lipid-lowering medications or who had a history of diabetes mellitus might indicate the robustness of that association. Second, dietary pattern construction by principal components analysis may be limited by subjectivity in the proper number of extracted factors and food-grouping methods (58). Third, our FFQ was limited by the lack of portion size, but previous reports showed that a frequency-only FFQ might be sufficient for diet-disease relation 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


