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# Dietary patterns are associated with sexual maturation in Korean children

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The purpose of this study was to investigate the association between dietary patterns and sexual maturation among Korean children. A cross-sectional study was conducted in 422 boys and 365 girls aged 9–12 years living in Seoul, Korea. Three-day food records were obtained, and pubertal stages were determined with a questionnaire using Tanner stages. Body fat was measured by bioelectrical impedance analysis, and bone mass content at the right calcaneus was measured by portable dual-emission X-ray absorptiometry. Exploratory factor analysis with a Varimax rotation was applied to identify dietary patterns using twenty-four food groups. Four distinct dietary patterns – 'rice and Kimchi', 'shellfish and processed meat', 'pizza and drinks' and 'milk and cereal' – were obtained. Twenty-six per cent (24 % stage 2, 2 % stage 3) of boys had genital development, and 79 % (63 % stage 2, 16 % stage 3) of girls showed breast development. In boys, genital development was weakly positively associated with 'shellfish and processed meat' dietary factor scores (odds ratio 1·65, CI 0·95, 2·89, *P* for trend 0·07) after adjusting for confounders. In girls, breast development was significantly positively associated with the factor score of 'shellfish and processed meat' (odds ratio 1·88, CI 1·08, 3·26, *P* for trend 0·05). These results suggest that dietary patterns were related to body composition and sexual maturation among the Korean children. Further investigations are needed to identify components of the foods consumed in high amounts in these patterns and how they are related to sexual maturation.

**Sexual maturation: Dietary patterns: Children**

The body size, shape and composition of children rapidly change in puberty, and nutrient intake, a major determinant of growth, is of great importance during that time (Rogol *et al.* 2002). Recent studies, including some from Korea, have reported that the average age of entering puberty is younger today than it was in the past, but differences between ethnic groups have been reported (Garn *et al.* 1986; Gerver *et al.* 1994; Park & Kim, 1994; Herman-Giddens *et al.* 1997; Fredriks *et al.* 2000). Children with early sexual maturation may be at greater risk for diseases such as breast cancer, CVD, endometritic cancer, pancreatic cancer and osteoporosis in later life (Kelsey & Bernstein, 1996; Petridou *et al.* 1996; Morrison *et al.* 1999; Wang, 2002).

Many researchers have investigated the possible reasons for early sexual maturation in children, including improved health and nutritional status, BMI and percentage body fat, and other factors such as socio-economic status, environment and physical activity (Meyer *et al.* 1990; Maclure *et al.* 1991. Malina *et al.* 1994; Koprowski *et al.* 1999; Kaplowitz *et al.* 2001; Koo *et al.* 2002).

In previous research on sexual maturation and pubertal age, the most consistent findings were the negative association of height, weight, BMI and percentage body fat with age at menarche in girls (Guo *et al.* 1998; Koprowski *et al.* 1999; Kaplowitz *et al.* 2001), and the negative association of BMI and percentage body fat with the onset of puberty in boys (Wang, 2002). Several studies have reported that single nutrients or foods influence sexual maturation, but results have been inconsistent regarding the specific nutrient levels among girls at onset of menarche (Meyer *et al.* 1990; Moisan *et al.* 1990; Maclure *et al.* 1991; Merzenich *et al.* 1993). For example, Britton *et al.* (2004) found that higher polyunsaturated fat consumption was positively associated with breast development and that vitamin C level was inversely related to pubic hair development. Other studies have reported that higher polyunsaturated fat (Maclure *et al.* 1991) and lower vitamin C consumption (Petridou *et al.* 1996) delayed menarche. Besides those nutrients, higher intakes of fibre, vitamin A, Fe and thiamine have been associated with a later age at menarche (Hughes & Jones 1985; Moisan *et al.* 1990; Koo *et al.* 2002). Furthermore, higher intakes of seeds and nuts were shown to have an inverse association with breast development (Li *et al.* 2004).

Earlier studies have focused mainly on the effects of single nutrients or foods with sexual maturation (Hill *et al.* 1980; Moisan *et al.* 1990; Merzenich *et al.* 1993; Koo *et al.* 2002). Foods and nutrients are, however, consumed in combination, and the combined effects can be observed only when the entire eating pattern is considered (Newby *et al.* 2003). No studies have yet examined the relationship between dietary

**Abbreviations:** BMC, bone mineral content; OR, odds ratio.

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pattern and sexual maturation. Therefore, the purpose of this study was to explore the association between dietary patterns and sexual maturation among Korean children in the early stages of puberty.

## Subjects and methods

### *Subjects*

The survey was conducted with 816 Korean students, aged 9–12 years old, who were attending the fourth and fifth grades of two elementary schools in Seoul, South Korea in May 2003. Data from 787 individuals (96·4 %) who successfully completed all components of the survey were used for analysis.

### *Data collection*

Data collection included a 3-d food record, anthropometric measurements and a questionnaire to assess sexual maturation based on the Tanner stages. The questionnaire included socio-economic information on the parents, such as their level of education, subjective economic status (high, middle, low) and job status.

During the first visit to the school, the trained project staff provided detailed instructions to the children on how to keep the 3-d (two weekdays and one weekend day) food records and how to select their Tanner stages on the questionnaire. We also sent a letter asking parents to assist their children with completing the dietary record and included instructions for the parents. We collected school lunch recipes and checked the amount of leftovers. School teachers helped the children to keep their diet records during class at school. The completed 3-d food records and the questionnaire were collected at the second visit and reviewed by trained Korean dietitians. Incomplete or unclear food records were discussed with children using three-dimensional food models, cups and spoons.

At the second visit, anthropometric measurements including height, weight, body fat and bone mass were measured. Body fat mass, weight and height were measured by bioelectrical impedance analysis using the Inbody3.0 (Biospace Co. Ltd, Seoul, Korea), and bone mineral content (BMC) at the right calcaneus was measured by PIXI (Peripheral Instantaneous X-Ray Imager; Lunar Radiation Corp. Madison, WI, USA).

### *Dietary pattern assessment*

Food items from the 3-d food records of each subject were aggregated into groups. Prior to the factor analysis, the food items were initially categorized into twenty-seven food groups, which were comparable to the food groups of the Korean Nutrition Society's Food Composition Database (Korean Nutrition Society, 2000). In a second step, three food groups were deleted, as their average amount of intake was less than 20 g/d. Thus, a total of twenty-four food groups were used for the dietary pattern analysis. The list of food groupings used in the dietary pattern analysis is shown in Table 1. We used the average amount of each of the twenty-four food groups consumed during the 3 d. Average amounts were used because: (1) serving sizes are not commonly used in Korean dietary surveys; (2) the highest percentage of energy typically comes from the grain group; (3) the percentages of energy from the vegetable group are very low. The factors were rotated by orthogonal transformation (Varimax rotation function in SAS 8.1; SAS Institute Inc., Cary, NC, USA) to achieve a simpler structure with greater interpretability. In determining the number of factors to retain, we used the eigenvalue $>1{\cdot}0$ criterion in the first step. This criterion is most widely used in factor analysis and is based on the fact that each factor retained should explain more variance than that of a single original variable in the dataset. This procedure created twelve independent factors in the present study, which was considered too large for further analysis. Thus, in the second step, we used the Scree plot and an eigenvalue of $>1{\cdot}25$. Four patterns remained and were used for this study.

### *Statistical analysis*

Data were analysed using the Statistical Analysis System (SAS version 8.1, SAS Institute). We conducted exploratory factor analysis to identify major dietary patterns, and calculated the factor scores of each pattern for each individual. We tested the differences in body composition and nutrient intake between genders using the General Linear Model procedure after adjusting for age. The correlation between dietary patterns and body composition and nutrient intakes were calculated by partial Pearson correlation, including age as a covariate. The association between dietary patterns and sexual maturation was assessed using multiple logistic regression analysis by the factor score of the four dietary patterns.

## Results

Although the ages of the boys and girls were similar, a higher percentage of girls indicated sexual maturation. Only 26 % of the boys stated genital development, whereas 79 % of girls stated breast development (Table 2). Mean BMI and BMC were significantly higher in boys than in girls after adjusting for age ($P<0{\cdot}001$).

The four identified dietary patterns accounted for 29·2 % of the total variation (Fig. 1). Factor loading is shown in Table 3. The first dietary pattern was termed 'rice and Kimchi'. In this group, green and yellow vegetables, garlic, white rice, meats, beans, bean products and vegetables showed the highest positive loading. The second dietary pattern showed a high loading for shellfish and processed meat; we called this group 'shellfish and processed meat.' The third dietary pattern was termed 'pizza and drinks'. In this group, carbonated drinks, pizza and hamburger, fruit and fruit juice, cookies and cakes showed the highest positive loading. The fourth dietary pattern was termed 'milk and cereal' and showed the highest positive loading for milk and yoghurt, cereal (breakfast cereal), other grains and fish.

The correlations between the dietary factor scores and body composition and nutrient intakes are presented in Table 4 after adjusting for age and energy intake. The 'shellfish and processed meat' dietary factor score was significantly positively associated with BMI and bone mineral density in boys ($P<0{\cdot}05$), but not in girls. After adjusting for age and energy intake, the 'pizza and drinks' dietary factor score was significantly positively associated with the percentage body fat and bone mineral density ($P<0{\cdot}05$), and the 'milk

**Table 1.** Food groupings used in the dietary pattern analysis
(Mean values and standard deviations)

| Food or food groups (g/d) | Mean | SD | Food items |
|---|---|---|---|
| White rice | 329·4 | 105·9 | Rice |
| Other grains | 42·8 | 35·9 | Barley, brown rice, black rice, rice cakes, foxtail millet |
| Cereals | 40·5 | 21·5 | Cereals |
| Bread | 51·8 | 43·0 | Wheat flour, wheat products |
| Noodles | 190·4 | 105·6 | Noodles, spaghetti, udong, Chinese noodle, wheat noodle |
| Ramyon | 101·9 | 39·2 | Ramyon (a Korean instant noodle) |
| Meat | 64·1 | 41·2 | Pork, beef, grilled beef with vegetable |
| Processed meat | 44·2 | 21·4 | Pork cutlet, bacon, sausage, meat ball, ham |
| Fish | 44·4 | 30·9 | Hair tail, tuna, pacific cod, anchovy, Alaska pollock, Spanish mackerel |
| Shellfish | 44·2 | 26·9 | Crab, oyster, whip-arm octopus, solen, warty sea squirt, little neck clam, common squid, clam, hard-shelled mussel |
| Poultry | 119·7 | 96·4 | Chicken, chicken breaded and fried, duck meat |
| Eggs | 39·3 | 26·2 | Egg, quails egg, ducks egg |
| Green and yellow vegetables | 32·6 | 20·3 | Green pepper, lettuce, spinach, chicory greens, sweet pepper |
| Other vegetables and mushrooms | 39·9 | 22·4 | Sweet potato stalk, bracken, oyster mushroom, Korean cabbage, radish |
| Potatoes | 31·4 | 39·1 | Potatoes, potato salad, potato chips |
| Garlic and onion | 24·7 | 12·9 | Garlic, garlic – young stem, Welsh onion, onion |
| Kimchi | 63·9 | 33·3 | Korean cabbage, Yimu kimchi (leafy radish), small radish, cucumber |
| Pizza and hamburgers | 158·4 | 82·1 | Pizza, hamburger, hotdog |
| Cookies and cakes | 70·7 | 44·5 | Snack, biscuit, cookies, cracker, cake |
| Fruit and fruit juice | 233·7 | 168·8 | Fruits, fruit juice |
| Milk and yoghurt | 288·5 | 128·0 | Milk, cheese, yoghurt |
| Sweets and ice cream | 158·7 | 152·6 | Gum, starch syrup, candy, sugar, jelly, ice cream, sherbet |
| Carbonated drink | 48·9 | 47·6 | Tea, carbonated drink, coffee, soda |
| Beans and bean products | 41·0 | 38·7 | Kidney beans, black soyabean, green peas, soyabean curd, soyabean curd soft, soyabean curd fried, soyabean milk |

For details of procedures, see p. 818.

**Table 2.** Characteristics of subjects by gender
(Mean values and standard deviations)

| | Boys (*n* 422) | | Girls (*n* 365) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Body composition | | | | |
| Age (years) | 10·22 | 0·58 | 10·23 | 0·57 |
| BMI (kg/m$^2$)*** | 19·38 | 3·19 | 18·03 | 2·81 |
| Body fat (%) | 23·56 | 7·37 | 22·78 | 7·0 |
| BMD (g/cm$^2$) | 0·43 | 0·08 | 0·43 | 0·06 |
| BMC (g)*** | 1·61 | 0·39 | 1·47 | 0·29 |
| Nutrient intake | | | | |
| Energy (KJ)*** | 7588 | 1808 | 6876 | 1474 |
| Protein (g)*** | 69·6 | 14·2 | 62·9 | 10·6 |
| Fat (g)*** | 54·7 | 12·8 | 49·2 | 10·6 |
| Carbohydrate (g)*** | 258 | 45·1 | 236 | 33·6 |
| Ca (mg)*** | 577 | 171 | 534 | 133 |
| Fe (mg)*** | 9·7 | 2·4 | 8·9 | 1·7 |
| Vitamin A (RE)* | 597 | 155 | 573 | 104 |
| Niacin (mg)*** | 14·9 | 3·9 | 13·4 | 2·3 |
| Vitamin C (mg) | 63·3 | 24·7 | 61·2 | 23·3 |
| Zn (mg)*** | 8·4 | 1·6 | 7·6 | 1·5 |
| Fibre (g)** | 4·9 | 4·8 | 4·2 | 1·3 |
| Tanner stage | Genital | Pubic hair | Breast | Pubic hair |
| | *N* (%) | *N* (%) | *N* (%) | *N* (%) |
| Stage 1 | 307 (73) | 380 (90) | 76 (21) | 306 (84) |
| Stage 2 | 103 (24) | 32 (7·6) | 229 (63) | 49 (13) |
| Stage 3 or above | 7 (2) | 5 (1·2) | 58 (16) | 8 (2) |

BMC, bone mineral content; BMD, bone mineral density; RE, retinol equivalent.
Mean values were significantly different between genders by ANCOVA including age as a covariate. *$P<0·05$, **$P<0·01$, ***$P<0·001$.
For details of subjects and procedures, see p. 818.

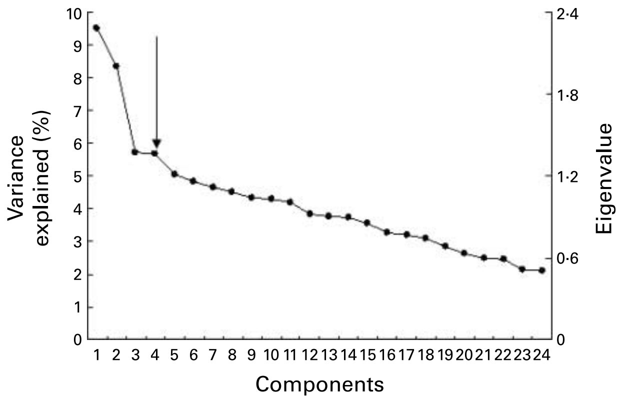


**Fig. 1.** Scree plot showing percentage of variance and eigenvalue explained by each component. ↓, indicates the cut-off point for dietary patterns. For details of subjects and procedures, see p. 818.

and cereal' dietary factor score was significantly negatively associated with BMI and percentage body fat ($P<0·01$) in girls, but not in boys. The 'rice and Kimchi' and 'milk and cereal' patterns were associated with most nutrient intakes, whereas the 'shellfish and processed meat' pattern was only associated with energy and niacin intake in girls and with energy, protein, fat, carbohydrate and niacin intake in boys.

The odds ratios (OR) and the 95 % CI of the stages of puberty of dietary pattern and body composition, genital stage 2 in boys and breast stage 2 and 3 in girls, are shown in Table 5. In boys, genital development was significantly negatively associated with percentage body fat (OR 0·96, CI 0·93, 0·99) and weakly positively associated with the factor score of 'shellfish and processed meat' (OR 1·65, CI 0·95, 2·89, *P* for trend 0·07). In girls, breast development was significantly positively associated with percentage body fat (OR 1·05, CI 1·02, 1·09), BMC (OR 6·06, CI 2·64, 13·9) and with the factor score of 'shellfish and processed meat' (OR 1·88, CI 1·08, 3·26, *P* for trend 0·05).

## Discussion

Using factor analysis, four distinct dietary patterns – 'rice and Kimchi,' 'shellfish and processed meat', 'pizza and drinks' and 'milk and cereal' – were identified from the 3-d dietary records obtained from 787 Korean children aged 9–12 years living in Seoul, Korea.

The four dietary patterns explained 29·2 % of the total variation, which compares favourably with results previously reported. North & Emmett (2000) identified four components from food-frequency data that explained 23·5 % of the dietary variation in 3-year-old children. The four components identified by Whichelow & Prevost (1996) using 1-week frequency dietary data from 18–81-year-old Americans accounted for 27·5 % of the total variance, and the three components identified by Beaudry *et al.* (1998), obtained from the 24-h dietary recall data, accounted for 21·5 % of the variance.

Several studies have reported that dietary pattern is associated with body composition in adults and the elderly. Maskarinec *et al.* (2001) reported that a high consumption of meat ('meat' pattern) was positively correlated with BMI and that 'vegetables', 'beans' and 'cold foods' were negatively related with BMI in Hawaiian women. Tucker *et al.* (2002) reported that a high intake of 'fruits, vegetables and cereals', along with Mg and K, was associated with greater bone mineral density in older subjects of the Framingham Heart Study, aged 69–93 years. Among Hispanic elderly, the identified 'milk pattern' group had a significantly lower BMI (Lin *et al.* 2003).

The present study found that dietary patterns were associated with body composition in children. The boys with a higher score for the 'shellfish and processed meat' pattern (which is a more Westernized diet) had significantly higher BMI and body fat percentages after adjusting for age. On the other hand, girls with a higher score for the 'milk and cereal' pattern had significantly lower BMI and body fat percentages after adjusting for age, which is comparable to the study among Hispanic older adults, mentioned earlier. There

**Table 3.** Factor loading matrix for Korean children's diets*

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | % variance explained |
|---|---|---|---|---|---|
| Green and yellow vegetables | 0·58 | | | | 36·4 |
| Garlic | 0·56 | | | | 43·8 |
| Kimchi | 0·56 | | | | 35·7 |
| White rice | 0·54 | | | | 49·3 |
| Meat | 0·39 | | | | 18·3 |
| Beans and bean products | 0·37 | | | | 15·5 |
| Vegetables | 0·36 | | | 0·33 | 27·0 |
| Shellfish | | 0·75 | | | 57·5 |
| Processed meat | | 0·73 | | | 54·0 |
| Bread | | 0·47 | | | 24·8 |
| Carbonated drinks | | | 0·68 | | 51·1 |
| Pizza and hamburgers | | | 0·63 | | 44·9 |
| Fruit and fruit juice | | | 0·41 | | 21·3 |
| Cookie and cakes | | | 0·32 | | 13·6 |
| Milk and yoghurt | | | | 0·61 | 44·1 |
| Cereals | | | | 0·52 | 32·3 |
| Other grains | | | | 0·49 | 34·2 |
| Fish | | | | 0·48 | 33·2 |
| Eigenvalue | 2·28 | 2·00 | 1·37 | 1·36 | |
| Percentage of variability | 9·51 | 8·35 | 5·7 | 5·67 | Σ 29·23 |
| Factor name | Rice and Kimchi | Shellfish and processed meat | Pizza and drinks | Milk and cereals | |

* For simplicity, absolute factor loading values $<0·30$ were not listed in the table.

**Table 4.** Partial correlation coefficients between dietary factor score and body composition and nutrient intake

| Dietary patterns | Rice and Kimchi | Shellfish and processed meat | Pizza and drinks | Milk and cereal |
|---|---|---|---|---|
| | | Boys (*n* 422) | | |
| Body composition | Partial Pearson correlation including age as a covariate | | | |
| BMI (kg/m$^2$) | 0·03 | 0·134* | 0·044 | −.0010 |
| Body fat (%) | −0·006 | 0·108* | −0·011 | −0·010 |
| BMD (g/cm$^2$) | −0·020 | 0·088 | 0·002 | 0·046 |
| | Partial Pearson correlation including age and energy as covariates | | | |
| BMI (kg/m$^2$) | −0·012 | 0·108* | 0·004 | −0·026 |
| Body fat (%) | −0·036 | 0·094 | −0·038 | −0·023 |
| BMD (g/cm$^2$) | −0·014 | 0·096* | 0·004 | 0·039 |
| Energy and nutrients | Partial Pearson correlation including age as covariate | | | |
| Energy (KJ) | 0·383*** | 0·321*** | 0·416*** | 0·276*** |
| Fat (g) | −0·192*** | −0·121** | −0·026 | 0·194*** |
| Ca (mg) | 0·002 | 0·094* | −0·242*** | 0·351*** |
| Fe (mg) | 0·385*** | −0·029 | −0·024 | 0·209*** |
| Vitamin A (RE) | 0·250*** | −0·065 | 0·001 | 0·128** |
| Niacin (mg) | 0·337*** | −0·166*** | −0·070 | 0·306*** |
| Vitamin C (mg) | 0·262*** | −0·039 | 0·093 | 0·175*** |
| Zn (mg) | 0·225*** | −0·085 | −0·079 | 0·178*** |
| Fibre (g) | 0·244*** | 0·003 | −0·172*** | 0·125*** |
| | | Girls (*n* 365) | | |
| Body composition | Partial Pearson correlation including age as a covariate | | | |
| BMI (kg/m$^2$) | −0·084 | 0·046 | 0·061 | −0·166** |
| Body fat (%) | 0·029 | −0·026 | 0·067 | −0·182*** |
| BMD (g/cm$^2$) | −0·030 | −0·018 | 0·097 | −0·060 |
| | Partial Pearson correlation including age and energy as covariates | | | |
| BMI (kg/m$^2$) | −0·011 | 0·070 | 0·095 | −0·156** |
| Body fat (%) | 0·062 | 0·004 | 0·112* | −0·165** |
| BMD (g/cm$^2$) | −0·031 | −0·014 | 0·117* | −0·057 |
| Energy and nutrients | Partial Pearson correlation including age as a covariate | | | |
| Energy (KJ) | 0·367*** | 0·333*** | 0·416*** | 0·276*** |
| Fat (g) | −0·283*** | 0·002 | 0·089 | 0·194*** |
| Ca (mg) | 0·028 | 0·015 | −0·297*** | 0·351*** |
| Fe (mg) | 0·344*** | −0·008 | −0·020 | 0·209*** |
| Vitamin A (RE) | 0·134*** | 0·050 | 0·087 | 0·128** |
| Niacin (mg) | 0·209*** | −0·196*** | −0·120* | 0·306*** |
| Vitamin C (mg) | 0·275*** | −0·009 | −0·021 | 0·175*** |
| Zn (mg) | 0·151*** | −0·121* | −0·068 | 0·178*** |
| Fibre (g) | 0·062 | 0·082 | −0·114*** | 0·125** |

BMD, bone mineral density; RE, retinol equivalent.
*$P<0·05$, **$P<0·01$, ***$P<0·001$.
For details of subjects and procedures, see p. 818.

is limited information about the association between dietary patterns and body composition in children, so we were only able to compare our results with reports from the elderly. Our findings contribute to the limited body of evidence available for this target group.

We also examined the association between dietary pattern and sexual maturation, which was the purpose of the present study. To our knowledge, this is the first study that has examined the association between dietary patterns and sexual maturation in children. A causal relationship between dietary pattern and sexual maturation could not be determined because of the cross-sectional design of this study. However, a significant association between dietary pattern and sexual maturation remained after adjusting for age, percentage body fat and BMC. Although socio-economic status assessed using parental education, subjective economic status and employment status is known as a factor influencing pubertal maturation, we did not enter socio-economic status into the model as a confounder, because socio-economic status was not significantly different between the Tanner stages in both girls and boys in our study (data not shown).

In our results, the ‘shellfish and processed meat’ pattern was positively associated with sexual development in both boys and girl, after adjusting for confounders. The ‘milk and cereal’ pattern tended to be negatively associated with sexual development in girls after adjusting for confounders, but the association was weak and was not dose-dependent. Although it is not known whether diet influences sexual maturation in puberty, it is possible to speculate that dietary patterns affect body composition (e.g. body fat and BMI) and result in an early onset of pubertal maturation in children. Some longitudinal studies have suggested that early-maturing girls are more likely to be heavier and taller, and have a higher percentage of body fat and a greater BMI, than late-maturing girls of the same age (Guo *et al.* 1998; Kaplowitz *et al.* 2001; Rogol *et al.* 2002). Wang (2002) reported that early-maturing boys were less likely to be obese (OR 0·4, CI 0·2, 0·8), whereas early-maturing girls were twice as likely to be obese. In this study, sexual maturation was negatively associated with the percentage of body fat in boys and was positively associated with the percentage of body fat in girls, which is consistent with the results of previous studies.

**Table 5.** Adjusted odds ratios (OR) for sexual maturation for categories of dietary factor score – multiple logistic regression models*

(Mean values and standard deviations)

| | Factor score | | OR (95 % CI) | |
|---|---|---|---|---|
| | Mean | SD | Boys | Girls |
| Rice and Kimchi | | | | |
| T1 (low) | −1·02 | 0·44 | 1·00 | 1·00 |
| T2 | 0·00 | 0·20 | 1·04 (0·60, 1·83) | 0·98 (0·57, 1·69) |
| T3 (high) | 1·31 | 0·75 | 1·20 (0·70, 2·67) | 0·85 (0·50, 1·46) |
| *P* for trend | | | 0·39 | 0·45 |
| Shellfish and processed meat | | | | |
| T1 (low) | −1·07 | 0·33 | 1·00 | 1·00 |
| T2 | −0·04 | 0·32 | 1·11 (0·63, 1·961) | 1·29 (0·75, 2·22) |
| T3 (high) | 1·14 | 0·61 | 1·65 (0·95, 2·89) | 1·88 (1·08, 3·26) |
| *P* for trend | | | 0·07 | 0·05 |
| Pizza and drinks | | | | |
| T1 (low) | −1·00 | 0·35 | 1·00 | 1·00 |
| T2 | −0·20 | 0·22 | 1·14(0·65, 2·01) | 0·82 (0·48, 1·41) |
| T3 (high) | 1·24 | 0·88 | 1·30(0·75, 2·26) | 0·90 (0·52, 1·53) |
| *P* for trend | | | 0·22 | 0·91 |
| Milk and cereal | | | | |
| T1 (low) | −1·05 | 0·53 | 1·00 | 1·00 |
| T2 | −0·03 | 0·24 | 0·99 (0·56, 1·75) | 0·44 (0·25, 0·78) |
| T3 (high) | 1·2 | 0·77 | 1·07 (0·62, 1·86) | 0·61 (0·35, 1·06) |
| *P* for trend | | | 0·84 | 0·07 |
| Age (years) | | | 1·10 (0·72, 1·68) | 2·34 (1·54, 3·56) |
| Body fat (%) | | | 0·96 (0·93, 0·99) | 1·05 (1·02, 1·09) |
| Bone mineral content (g) | | | 1·71 (0·92, 3·21) | 6·06 (2·64, 13·89) |
| Model $\chi^2$ | | | 13·96 $P=0·234$ | 79·38 $P<0·0001$ |

* The test P for trend was calculated with mean values in each category as a continuous variable and adjusted for age, percentage fat and bone mineral content. The effect variables contain four dietary factor scores (categorical), age (continuous), body fat (continuous) and bone mineral content (continuous).

In the present study, the dietary factor score of the ‘shellfish and processed meat’ pattern was not associated with body composition in girls but was significantly positively associated with sexual maturation. Since fish consumption is high and the early onset of puberty is increasing in Korea, we can presume that contaminants such as dioxin/polychlorinated biphenyls and organochlorine, consumed with foods in this pattern, are possible factors contributing to the earlier onset of puberty (Blanck *et al.* 2000; Yoshida *et al*. 2000; Smith & Gangolli, 2002).

The present study had several limitations, and the results should be interpreted with caution. First, cross-sectional data were used, and as a result causal association cannot be proven. Second, although the pictures of the Tanner stages were carefully explained to the children, sexual maturation was assessed by self-reporting. As the reliability and validity of the self-reported measures remains questionable, more accurate assessments of pubertal onset will be needed for future studies.

In brief, our study identified four dietary patterns derived from food-consumption data, and some dietary patterns were related to body composition and sexual maturation among Korean children. Our results support the idea that the dietary pattern during puberty may affect physical development and sexual maturation. Further investigation is needed to identify the components of the foods, including natural components and additives, which are consumed in high amounts within the identified patterns, and how they relate to sexual maturation.

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