Original Article

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Association of Infant Feeding Characteristics With Dietary Patterns and Obesity in Korean Childhood

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Objectives: Young children's feeding characteristics can play an important role in eating habits and health during later childhood. This study was conducted to examine the associations of feeding characteristics with dietary patterns and obesity in children.

Methods: This study utilized data from the Korea National Health and Nutrition Examination Survey conducted between 2013 and 2017. In total, 802 toddlers were included, with information on their demographic characteristics, feeding practices and duration, and 24-hour recall obtained from their parents. Feeding characteristics were categorized into feeding type, duration of total breastfeeding, duration of total formula feeding, duration of exclusive breastfeeding, and age when starting formula feeding. Dietary patterns were identified based on factor loadings for the food groups for 3 major factors, with "vegetables & traditional," "fish & carbohydrates," and "sweet & fat" patterns. Overweight/obesity was defined as ≥85th percentile in body mass index based on the 2017 Korean National Growth charts for children and adolescents. Multiple regression analysis was conducted to examine associations between feeding characteristics and dietary patterns. The association between dietary patterns and obesity was analyzed using multivariable logistic regression analysis.

Results: The early introduction of formula feeding was inversely associated with the "vegetables & traditional" pattern (β=-0.18; 95% confidence interval [CI], -0.34 to -0.02). A higher "vegetables & traditional" intake was associated with a lower risk of obesity (odds ratio, 0.48; 95% CI, 0.24 to 0.95).

Conclusions: Feeding characteristics are associated with dietary patterns in later childhood, and dietary patterns were shown to have a potential protective association against obesity.

Key words: Feeding, Diets, Obesity, Children

INTRODUCTION

Obesity continues to be a major health issue worldwide, particularly the growing prevalence of childhood obesity. Since 1980, overweight and obesity rates have more than doubled, and in 2014, roughly 41 million children under the age of 5 years were overweight or obese [1,2]. The Korea National Health and Nutrition Examination Survey (KNHANES) in 2001 and 2017 revealed that the prevalence of obesity among individuals aged 2 years to 18 years increased from 8.6% in 2001 to 9.8% in 2017 [3]. Obesity in infants and children is likely to result in adolescent obesity [4,5]. Therefore, interventions must be implemented to prevent childhood obesity.

Various factors contribute to childhood obesity, such as diet, physical activity, and home/family factors, which play a role in the progression of obesity into adolescence and adulthood

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[6-9]. Feeding factors, including breastfeeding, infant formula feeding, and the introduction of solid foods, significantly impact infancy and later obesity [10]. Other reported predictors of rapid growth encompass early childhood feeding characteristics, such as supplementing or substituting breastfeeding with formula feeding and the early introduction of solids [11]. The World Health Organization recommends that infants be exclusively breastfed for the first 6 months of life, partially breastfed for up to 2 years or beyond, and introduced to formula feeding or solid foods only during the second half of the first year. Longitudinal studies have demonstrated that breastfeeding provides protection against rapid growth and childhood obesity [12]. Conversely, infant formula feeding may increase the risk of overweight and obesity [13].

Previous studies have indicated that certain early feeding characteristics may be linked to a greater variety of food consumption in later childhood [14-16]. Some evidence suggests that infants weaned between 4 months and 6 months of age tend to have higher intakes of fruits and vegetables in later childhood than those weaned at a later time [15]. Furthermore, consuming a wider variety of foods during the first 2 years of life has been positively correlated with the variety of fruits consumed at ages 6 years, 7 years, and 8 years [14]. A previous study [16] by our research group demonstrated that feeding characteristics substantially influenced healthy eating habits in childhood. Numerous studies have identified a connection between feeding characteristics and dietary intake, with a focus on healthy dietary patterns for the duration of infant breastfeeding [17,18]. Adult offspring who were breastfed for 6 months or less exhibited lower adherence to the so-called "prudent pattern," which is associated with healthy eating habits [17]. Additionally, exclusive breastfeeding for less than 1 month, as well as introducing complementary feeding before 4 months, resulted in eating habits characterized by a high intake of snacks and treats and a lower intake of fruits and vegetables [18].

Previous studies have examined feeding characteristics and eating habits, and the evidence from these studies suggests a connection between various epidemiological characteristics and eating habits. As a result, it is crucial to investigate feeding characteristics and eating habits more thoroughly. Specifically, only a few studies have evaluated the relationship between feeding characteristics and dietary patterns in children. Dietary patterns can be valuable in understanding their association with an individual's overall eating habits. Numerous studies will be required to determine the relationship between feeding characteristics and dietary patterns. Furthermore, dietary factors may impact growth outcomes in children. A Korean study reported a connection between a healthy eating pattern and a lower risk of being overweight in preschool children [19]. Additionally, the Avon Longitudinal Study of Parents and Children found that an energy-dense, high-fat diet was associated with adiposity in school children [20]. Although dietary intake is a critical determinant of a person's weight, few studies have clarified this relationship. More research is needed to better comprehend the association between dietary patterns and the risk of obesity in later childhood.

Based on these findings, this study investigated how feeding characteristics of young children impact the development of dietary patterns, which in turn may be reflected in eating habits during later childhood and potentially serve as a risk factor for obesity.

METHODS

Study Design and Participants

The KNHANES is a cross-sectional study conducted periodically to monitor the association between risk factors, including health and nutritional status, and major chronic diseases in a representative sample of the Korean population aged 1 year and older. In short, the KNHANES was designed to enroll nationally representative samples using a complex, multistage, stratified, and clustered sampling design based on the Korean National Census Registry. Detailed information on the KNHANES can be found elsewhere [21]. In the present study, we utilized data from the KNHANES, which included 958 participants aged 2 years and 3 years in 2013-2017. From the original 958 participants recruited at 2 years and 3 years of age, we excluded those with a birth weight less than 2.5 kg (n=104), along with those with data missing from the feeding questionnaire (n=6), total energy intake (n=2), and survey weights (n=44), leading to 802 eligible participants included in the final analysis [22]. The participants' demographic characteristics, including age, sex, birth weight, and childcare type, were collected through a survey of their parents. Childcare type was categorized into "child care center" and "home." Parental data were obtained using the parent's identification, along with their age, body mass index (BMI), and monthly household income. BMI was calculated by dividing weight by the square of height (kg/m^2). Monthly household income was categorized into less than 4 million Korean won and 4 million Korean won or more.

Feeding Characteristics

Feeding data for 10 items were obtained from a questionnaire completed by the participants' parents. The reported items, such as breast and formula feeding, were categorized by response (yes or no), duration (in months), and age of first introduction (in months). Feeding types were divided into 3 categories: "exclusive breastfeeding," "partial breast and formula feeding," and "exclusive formula feeding". Exclusive breastfeeding was defined as respondents who reported that they "never had formula fed" and "had breastfed." Partial breast and formula feeding was defined as respondents who reported that they "had breastfed" and "had formula fed" [16,22]. The duration of total breast or formula feeding was calculated from the sum of the feeding durations reported as having breastfed or having formula fed. The duration of exclusive breastfeeding was obtained from the feeding type and classified as exclusive breastfeeding [16,22,23]. Exclusive breastfeeding is defined by the World Health Organization as having no food or drink, except breast milk, for the first 6 months of life [24,25]. Therefore, the duration of total feeding was classified into the following 4 categories based on available references: 0 months, 1-6 months, 7-11 months, or more than 12 months [16,22]. The duration of exclusive feeding was categorized as less than 12 months or more than 12 months, and the age of starting feeding was categorized as 0 months, after 4 months, or before 4 months, again according to references [16,22].

Dietary Assessment

A survey of the participants' dietary intake was conducted using the 24-hour recall method. The parents provided accurate reports of their children's daily intake by recording details of food consumption, including the type and portion size, on the day prior to the survey. The total energy, macronutrients, vitamins, minerals, and fatty acids were calculated based on this daily consumption data.

The KNHANES categorized food items into 18 food groups based on 24-hour recall data, which included grains, potatoes, sugars, legumes, nuts and seeds, vegetables, mushrooms, fruits, meats, eggs, fish, seaweed, dairy products, fats, beverages, seasonings, processed foods, and other foods. In this study, the individual foods consumed by the participants within these 18 food groups were reclassified into 21 food groups. These 21 food groups were determined using the literature provided by the KNHANES. Two food groups, coffee and alcohol, were excluded from the 23 food groups mentioned in the KNHANES literature, as they are not typically consumed by children [26].

The factors were identified through principal component analysis rotating by an orthogonal transformation to the varimax method. The interpreted eigenvalue represented the rotated factors that explained the sum of the total variance by food groups. The 3 most meaningful factors were determined based on an eigenvalue >1.3. Factor analysis was conducted with these 3 factors, and the results were analyzed based on the derived dietary patterns as the correlation of the factors and food groups with loadings of at least ± 0.20 [27]. The dietary pattern was identified based on factor loadings according to the food groups for 3 factors, which explained 23.1% of the total variance in food intake (10.4, 6.6, and 6.1%, respectively). The first pattern, named the "vegetables & traditional" pattern, had high loadings of vegetables, oils, mushrooms, meat and meat products, grains, kimchi, potatoes, seasonings, legumes, white rice, and flours & bread and a low loading of cereals & snacks. The second pattern, named the "fish & carbohydrates" pattern, had high loadings of fish & shellfish, seaweeds, white rice, noodles and dumplings, and seasonings. The third pattern, named the "sweet & fat" pattern, had high loadings of white rice, beverages, sweets, cereals and snacks, meat and meat products, kimchi, and fruits and a low loading of milk and dairy products and flours and bread (Table 1) [28].

Definition of Overweight/Obesity

Anthropometric data, including height, weight, BMI, and other parameters, were collected from all study participants. Height was measured using a stadiometer (Seca 225; Seca, Hamburg, Germany), and weight was measured with a scale (GL-6000-20; G-tech International Co. Ltd., Uijeongbu, Korea), both recorded to 1 decimal place. BMI was calculated by dividing weight by the square of height (kg/m^2) [29]. Overweight/obesity status was determined based on BMI, which was categorized into underweight (<5th percentile), normal weight (≥ 5th, <85th percentile) and overweight/obesity (≥ 85th percentile) by the 2017 Korean Centers for Disease Control and Prevention Growth charts [30] (Supplemental Material 1).

Statistical Analysis

All statistical analyses were conducted using PROC SURVEY in SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) to account for the complex sampling design and appropriate sampling weights. In the complex sampling design data, multistage, stratified, clustered values were used along with survey weights.

Table 1. Food group rotated factor loadings[1] for major dietary patterns[2]

Food items	Food groups	Vegetables & traditional	Fish & carbohydrates	Sweet & fat
White rice	White rice	0.214	0.322	0.383
Glutinous rice, black rice, brown rice, barley, foxtail millet, millet, sorghum	Grains	0.411	-0.194	0.044
Rice cakes, noodles, dumplings, ramyun	Noodles and dumplings	-0.048	0.217	-0.151
Wheat flours, bread, cake	Flours and bread	0.133	-0.115	-0.263
Cereals, snacks, cookies, biscuits	Cereals and snacks	-0.209	0.144	0.313
Potatoes, sweet potatoes	Potatoes	0.301	0.068	-0.077
Sugar, starch syrup, honey, candy, jelly, jam	Sweets	0.007	-0.164	0.356
Tofu, black bean, red bean, kidney bean, soybean, green bean, soy milk	Legumes	0.233	-0.087	0.166
Sesame, chestnuts, almonds, perilla seeds, walnuts, peanuts	Nuts and seeds	0.194	0.155	-0.077
Garlic, green onion, tomato juice, carrots, pumpkin, radishes, peppers, cucumbers, ginger, bean sprouts, cabbage	Vegetables	0.627	0.160	0.098
Kimchi, pickled vegetables	Kimchi	0.309	-0.113	0.315
Mushrooms	Mushrooms	0.542	0.085	-0.232
Apples, tangerines, bananas, pears, watermelon, strawberries, oranges, grapes, persimmons	Fruits	0.154	0.104	0.324
Pork, beef, poultry, ham, sausages	Meat and meat products	0.429	-0.172	0.250
Eggs	Eggs	-0.013	0.199	0.145
Anchovies, fish paste, squid, canned tuna, mussels, shrimp, mackerel	Fish and shellfish	0.174	0.782	0.038
Sea mustard, dried laver, brown seaweed	Seaweeds	0.076	0.728	0.083
Milk, yogurt, cheese, ice cream	Milk and dairy products	-0.020	0.043	-0.579
Oils, butter, margarine	Oils	0.560	0.185	-0.052
Sweetened beverages, barley tea, carbonated beverages	Beverages	-0.076	0.016	0.358
Salt, soy sauce, pepper powder, pepper, red pepper paste, soybean paste, tomato ketchup, vinegar	Seasonings	0.278	0.215	0.003
Eigenvalue		2.19	1.37	1.28
Explained variance (%)		10.4	6.6	6.1
Cumulative variance (%)		10.6	17.0	23.1

[1]Factor loadings ≥0.20.
[2]Values are correlation coefficients between each food variable and the dietary pattern, derived from factor analysis.

These survey weights were divided by the number of combined data from 2013 to 2017 [31]. The chi-square test was employed to compare the proportions of categorical variables between feeding types. The mean levels of continuous variables between the feeding types were estimated using a generalized linear regression model. Multiple regression analysis was utilized to investigate a linear/non-linear relationship between feeding characteristics and dietary patterns. Additionally, multivariable logistic regression analysis was performed to compare the prevalence of overweight/obesity with dietary patterns. Dietary pattern levels were divided into quartiles, using the lowest quartile (Q1) as the reference. The risk of overweight/obesity was presented as the odds ratio (OR) and 95% confidence interval (CI). Multivariable linear and logistic regression analyses were conducted after adjusting for age, sex, birth weight, total energy, type of care, and parent's household income. A *p*-value of less than 0.05 was considered to indicate statistical significance.

Ethics Statement

The Institutional Review Board of the Korea Centers for Disease Control and Prevention approved the study (IRB No. 2013-07CON-03-4C in 2013-2015; 2013-12EXP-03-5C in 2013-2015; 2018-01-03-P-A in 2013-2018), and all participants provided written informed consent.

RESULTS

General Characteristics Based on Feeding Type

Table 2 displays the participants' feeding types as means or numbers and percentages, categorized into exclusive breast-

Table 2. General characteristics by feeding type[1]

Characteristics	Total (n=802)	Exclusive breastfeeding (n=211)	Breast and formula feeding (n=515)	Exclusive formula feeding (n=76)	*p*-value
Child's characteristics					
Sex					
Male	427 (53.5)	99 (46.8)	289 (56.2)	39 (53.3)	0.10
Female	375 (46.5)	112 (53.2)	226 (43.8)	37 (46.7)	
Type of care					
Child care center	686 (85.5)	172 (81.0)	452 (87.9)	62 (81.6)	0.08
Home	109 (14.5)	39 (19.0)	57 (12.1)	13 (18.4)	
Age (mo)	35.8±0.3	36.6±0.5	35.6±0.3	35.3±0.9	0.27
Birth weight (kg)	3.3±0.0	3.3±0.0	3.3±0.0	3.2±0.1	0.28
Body mass index (kg/m^2)	15.9±0.1	15.8±0.1	15.8±0.0	16.2±0.2	0.09
Normal	669 (84.0)	183 (86.6)	427 (84.0)	59 (76.3)	0.19
Overweight	133 (16.0)	28 (13.4)	88 (16.0)	17 (23.7)	
Total energy (kcal/day)	1236.0±16.0	1262.2±34.6	1224.6±19.3	1243.9±59.1	0.63
Father's characteristics					
Monthly household income (Korean won)					
<4 000 000	263 (49.8)	75 (52.5)	164 (47.7)	24 (58.9)	0.37
≥4 000 000	272 (50.2)	73 (47.5)	180 (52.3)	19 (41.1)	
Age (y)	36.7±0.2	37.1±0.4	36.5±0.3	37.2±0.8	0.28
Body mass index (kg/m^2)	25.3±0.2	25.3±0.4	25.4±0.2	24.3±0.5	0.13
Mother's characteristics					
Monthly household income (Korean won)					
<4 000 000	318 (51.4)	89 (54.6)	197 (48.9)	32 (61.7)	0.19
≥4 000 000	316 (48.6)	80 (45.4)	213 (51.1)	23 (38.3)	
Age (y)	34.1±0.2	34.2±0.3	34.0±0.2	33.6±0.7	0.66
Body mass index (kg/m^2)	22.8±0.2	22.8±0.4	22.6±0.2	24.3±1.1	0.29

Values are presented as the weighted mean±standard error or the weighted number (%).
[1]A generalized linear regression model and the chi-square test were used to assess the significance of the difference in the participant distribution for continuous and categorical variables.

feeding, partial breast and formula feeding, and exclusive formula feeding. A borderline significant difference in feeding type was observed among the participants in the child's characteristics; however, those with exclusive formula feeding were more likely to report a higher BMI than the other groups (p=0.09). Moreover, a borderline significant difference was observed in participants with partial breast and formula feeding, who were more likely to be cared for at a center than the other groups (p=0.08). In terms of the parents' characteristics, no significant differences were observed in the variables.

Association of Feeding Characteristics With Overweight/Obesity and Dietary Pattern

The OR of feeding characteristics for overweight/obesity was examined using logistic regression (Table 3). No significant difference was observed in feeding characteristics between overweight and obesity. The linear and non-linear relationships between feeding characteristics and dietary patterns were analyzed with respect to feeding factors (Table 4). The early introduction of formula feeding for 4 months was inversely associated with the "vegetables & traditional" pattern (β=-0.18; 95% CI, -0.34 to -0.02). A borderline significance in the "vegetables & traditional" pattern was observed; compared to exclusively breastfed children, those exclusively formula-fed had an inverse association with the "vegetables & traditional" pattern (β=-0.24; 95% CI, -0.49 to 0.01). Similarly, compared to non-breastfed children, a longer duration of total breastfeeding (12 months) was positively associated with the "vegetables & traditional" pattern (β=0.21; 95% CI, -0.03 to 0.45). In comparison to exclusively breastfed children, those who re-

Table 3. Association of feeding characteristics with overweight/obesity[1]

Variables	No. of cases/participants (n=133/802)	Model 1	*p* for trend	Model 2	*p* for trend
Feeding type			0.23		0.18
Exclusive breastfeeding	28/211	1.00 (reference)		1.00 (reference)	
Breast and formula feeding	88/515	1.22 (0.72, 2.07)		1.24 (0.72, 2.11)	
Exclusive formula feeding	17/76	1.96 (0.90, 4.26)		2.08 (0.95, 4.60)	
Duration of total breastfeeding (mo)			0.20		0.17
0	17/76	1.00 (reference)		1.00 (reference)	
1-6	39/234	0.54 (0.27, 1.08)		0.52 (0.25, 1.07)	
7-11	37/193	0.65 (0.32, 1.31)		0.62 (0.30, 1.27)	
≥12	40/299	0.48 (0.24, 0.98)		0.45 (0.22, 0.94)	
Duration of total formula feeding (mo)			0.35		0.39
0	28/211	1.00 (reference)		1.00 (reference)	
1-6	14/85	1.30 (0.59, 2.87)		1.33 (0.60, 2.93)	
7-11	23/104	1.80 (0.93, 3.52)		1.78 (0.91, 3.49)	
≥12	68/402	1.18 (0.68, 2.06)		1.22 (0.69, 2.13)	
Duration of exclusive breastfeeding (mo)			0.40		0.35
≤12	13/76	1.00 (reference)		1.00 (reference)	
≥12	15/135	0.66 (0.25, 1.75)		0.61 (0.22, 1.72)	
Age when starting formula feeding (mo)			0.27		0.23
0	28/211	1.00 (reference)		1.00 (reference)	
≤4	92/480	1.42 (0.83, 2.43)		1.45 (0.85, 2.50)	
>4	13/111	0.93 (0.44, 1.98)		0.93 (0.43, 2.03)	

Values are presented as odds ratio (95% confidence interval).
[1]Model 1: adjusted for age and sex; Model 2: model 1 with additional adjustment for birth weight (kg), total energy (kcal/day), type of care (care center or home), and parent's monthly household income (<4 000 000 or ≥4 000 000 Korean won).

ceived partial breast and formula feeding had an inverse association with the "sweet & fat" pattern (β=-0.21; 95% CI, -0.38 to -0.04). Moreover, compared to non-breastfed children, a longer duration of total breastfeeding (7-11 months) was inversely associated with the "sweet & fat" pattern (β=-0.30; 95% CI, -0.61 to 0.00). The introduction of formula feeding after 4 months was also inversely associated with the "sweet & fat" pattern (β=-0.30; 95% CI, -0.53 to -0.08). No significant difference was observed in the "fish & carbohydrates" pattern.

Association of Dietary Patterns With Overweight/Obesity

The OR of the highest quartiles of the dietary pattern for overweight/obesity was compared with the lowest quartiles (Table 5). After adjusting for general variables and feeding type, a higher intake of the "vegetables & traditional" pattern was associated with a lower risk of overweight/obesity (OR, 0.48; 95% CI, 0.24 to 0.95). A significant difference in moderate to high intake among participants in the "sweet & fat" pattern was observed. After adjusting for general variables, a higher intake of the "sweet & fat" pattern was associated with a higher risk of overweight/obesity (OR, 1.94, 95% CI, 1.10 to 3.42). When adjusted for feeding type, there was a significant difference in the moderate to high quartiles for overweight/obesity (OR, 1.99; 95% CI, 1.11 to 3.58). No significant difference was observed between overweight/obesity in the "fish & carbohydrates" pattern.

DISCUSSION

We discovered that feeding characteristics were significantly linked to dietary patterns in children, and these patterns were also associated with obesity. However, we observed no significant difference in feeding characteristics between overweight and obese children. Numerous theories have been proposed to explain how breastfeeding may protect children from obesity. Current guidelines recommend continuing exclusive breastfeeding for more than 6 months to promote child health [2,12].

Table 4. Association of feeding characteristics with dietary patterns[1]

Variables	Vegetables & traditional	*p*-value	Fish & carbohydrates	*p*-value	Sweet & fat	*p*-value
Feeding type						
Exclusive breastfeeding	Reference		Reference		Reference	
Breast and formula feeding	-0.13 (-0.30, 0.03)	0.10	-0.05 (-0.25, 0.15)	0.60	-0.21 (-0.38, -0.04)	0.01
Exclusive formula feeding	-0.24 (-0.49, 0.01)	0.06	-0.14 (-0.41, 0.14)	0.34	0.01 (-0.29, 0.30)	0.95
Duration of total breastfeeding (mo)						
0	Reference		Reference		Reference	
0-6	0.09 (-0.16, 0.33)	0.49	0.03 (-0.22, 0.28)	0.83	-0.10 (-0.38, 0.19)	0.50
7-11	0.15 (-0.11, 0.40)	0.25	0.10 (-0.16, 0.35)	0.44	-0.30 (-0.61, 0.00)	0.05
≥12	0.21 (-0.03, 0.45)	0.09	0.18 (-0.08, 0.43)	0.18	-0.18 (-0.47, 0.11)	0.22
Duration of total formula feeding (mo)						
0	Reference		Reference		Reference	
0-6	0.05 (-0.24, 0.35)	0.72	0.00 (-0.40, 0.40)	0.99	-0.14 (-0.43, 0.14)	0.32
7-11	0.01 (-0.20, 0.21)	0.96	-0.06 (-0.39, 0.26)	0.69	-0.08 (-0.34, 0.19)	0.58
≥12	-0.05 (-0.22, 0.12)	0.57	-0.18 (-0.40, 0.04)	0.10	-0.18 (-0.37, 0.01)	0.07
Duration of exclusive breastfeeding (mo)						
≤12	Reference		Reference		Reference	
≥12	0.06 (-0.28, 0.39)	0.74	-0.19 (-0.57, 0.18)	0.31	-0.01 (-0.29, 0.26)	0.93
Age at the start of formula feeding (mo)						
0	Reference		Reference		Reference	
≤4	-0.18 (-0.34, -0.02)	0.03	-0.04 (-0.24, 0.16)	0.70	-0.15 (-0.32, 0.02)	0.09
>4	-0.03 (-0.25, 0.18)	0.77	-0.08 (-0.35, 0.19)	0.56	-0.30 (-0.53, -0.08)	0.01

Values are presented as beta coefficient (95% confidence interval).
[1]Adjusted for age (months), sex (male or female), birth weight (kg), total energy (kcal/day), type of care (care center or home), and parent's monthly household income (<4 000 000 or ≥4 000 000 Korean won).

Table 5. Association of dietary patterns with overweight/obesity[1]

Variables	Score quartile				
	1 (lowest)	2 (moderate)	3 (moderate to high)	4 (highest)	*p* for trend
Vegetables & traditional					
No. of cases/participants	38/198	34/209	38/200	23/195	
Model 1	1.00 (reference)	0.73 (0.42, 1.28)	0.98 (0.55, 1.71)	0.56 (0.29, 1.07)	0.23
Model 2	1.00 (reference)	0.69 (0.39, 1.22)	0.91 (0.49, 1.68)	0.48 (0.24, 0.95)	0.10
Fish & carbohydrates					
No. of cases/participants	36/203	37/200	35/201	25/198	
Model 1	1.00 (reference)	1.03 (0.59, 1.78)	0.95 (0.53, 1.69)	0.57 (0.31, 1.03)	0.23
Model 2	1.00 (reference)	1.11 (0.62, 1.97)	0.99 (0.55, 1.78)	0.58 (0.32, 1.05)	0.22
Sweet & fat					
No. of cases/participants	32/197	31/199	37/201	33/205	
Model 1	1.00 (reference)	1.15 (0.62, 2.13)	1.94 (1.10, 3.42)	1.15 (0.64, 2.07)	0.10
Model 2	1.00 (reference)	1.10 (0.57, 2.11)	1.99 (1.11, 3.58)	1.09 (0.58, 2.05)	0.07

Values are presented as odds ratio (95% confidence interval).
[1]Model 1: adjusted for age and sex; Model 2: model 1 with additional adjustment for birth weight (kg), total energy (kcal/day), type of care (care center or home), feeding type (exclusive breastfeeding, breast and formula feeding, or exclusive formula feeding), and parent's monthly household income (<4 000 000 or ≥4 000 000 Korean won).

In contrast, infant formula feeding may increase the risk of overweight and obesity [10,13,32]. Nevertheless, some studies have not reported a significant association, leaving the relationship between breastfeeding and obesity a topic of ongo-

ing debate.

Numerous studies have found a correlation between longer breastfeeding duration and reduced consumption of processed foods, a preference for natural sources of animal protein, and greater adherence to healthy dietary patterns in children aged 2 years to 8 years old [17,33]. Our results demonstrated that the early introduction of formula feeding was negatively associated with the "vegetables & traditional" pattern. Moreover, introducing formula feeding after 4 months was inversely related to the "sweet & fat" pattern. Borderline significant differences were found in the "vegetables & traditional" pattern based on breastfeeding in this study. The "vegetables & traditional" pattern was identified as having a high loading of vegetables. In our previous study [16], evidence also revealed a strong association between longer breastfeeding duration and higher vegetable consumption. This mechanism is linked to exposure to a greater variety of flavors early in life through breastfeeding [34]. In contrast, formula products consist of a constant, unchanging flavor profile that does not vary over time [35]. Prolonged exposure to breastfeeding may enhance the acceptance of new foods and help manage food neophobia throughout infancy and adolescence.

These results suggest that the "vegetables & traditional" pattern was related to obesity. A recent review also emphasized that healthy dietary factors, such as plant foods and a well-balanced diet, have an inverse association with childhood obesity [36]. Furthermore, in the present study, a higher "sweet & fat" pattern was significantly associated with an increased risk of obesity in medium intakes. It was determined that the "sweet & fat" pattern had a high loading of beverages and sweets. Additionally, when evaluating nutrient contents according to dietary patterns, the highest scores of the "vegetables & traditional" and "fish & carbohydrates" patterns were more strongly associated with fat, vitamin B2, vitamin A, retinol, and calcium compared to the lowest scores of these patterns. Conversely, the highest score of the "sweet & fat" pattern had a weaker association with fat, vitamin B2, vitamin A, retinol, and calcium compared to the lowest scores of this pattern (Supplemental Material 2). The "vegetables & traditional" pattern included healthy nutrients, while the "sweet & fat" pattern contained unhealthy nutrients. These results indicate that an association exists between the dietary patterns and nutrient intake of young children, and they also reflect an assessment of dietary patterns among children. Although this study has demonstrated that the "vegetables & traditional" pattern plays a larger role in obesity, more research is needed to evaluate the growth outcomes in children according to the dietary factors of the "sweet & fat" pattern.

Regarding strengths, this research utilized a large national database, which enabled adjustments to be made for numerous covariates. It was also possible to account for parental epidemiological factors that influenced feeding characteristics. However, this study had several limitations. Due to the cross-sectional data analysis, the causality of associations could not be inferred. Moreover, it should be noted that the association between feeding characteristics and a child's eating habits is not fully explained by maternal dietary choices alone.

In conclusion, important factors such as feeding characteristics are associated with dietary patterns in later life, and these dietary patterns were found to demonstrate an association with obesity. This may suggest a relationship with obesity based on the dietary pattern, independent of feeding characteristics. Overall, these findings may contribute to the development of a strategy to promote healthy infant feeding characteristics in early infancy and encourage healthy eating habits in childhood.

SUPPLEMENTAL MATERIALS

Supplemental materials are available at https://doi.org/10.3961/jpmph.22.504.

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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AUTHOR CONTRIBUTIONS

Both authors contributed equally to conceiving the study, analyzing the data, and writing this paper.

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