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Research Article

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Assessment of dietary quality and nutrient intake of obese children in Changwon area

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ABSTRACT

Purpose: In this study, we assessed the intake of nutrients and food groups and analyzed the nutrition quotient of obese children in South Korea. The hypothesis was that dietary quality and nutrient intake are related to the body mass index (BMI) of obese children.
Methods: The participants included 48 children (20 boys and 28 girls). Based on the guidelines for the age-for-body mass index provided by the Korean National Growth Charts for children and adolescents, the participants were divided into 3 groups: overweight, BMI ≥ 85th percentile; obese, BMI ≥ 95th percentile; severely obese, BMI ≥ 99th percentile.
Results: The energy distribution showed that the carbohydrate ratio was significantly higher in the overweight group ($p < 0.01$), whereas the fat ratio was significantly higher in the obese and severely obese groups ($p < 0.05$). Thus, in the overweight and obese groups, the percent body fat was negatively associated with the carbohydrate ratio ($p < 0.05$) but was positively associated with the fat ratio ($p < 0.05$). The Dietary Reference Intakes (DRI) data revealed that the intake levels of protein, vitamin B_1, vitamin B_{12}, and sodium were higher in all groups. Intakes of fiber, calcium, potassium, and magnesium were insufficient in all groups, and the DRI percent for protein was significantly higher in the obese and severely obese groups than in the overweight group. No significant differences were obtained in food group patterns or Nutrition Quotient (NQ) scores among the 3 groups. According to the evaluation results by food record and NQ, a significant difference was obtained in the dietary quality of obese children.
Conclusion: We conclude that a higher intake of fat enhances weight gain. Based on the study results, we propose that the guidelines should consider the energy distribution of carbohydrate and fat intake to prevent and control obesity among Korean children.

Keywords: pediatric obesity; eating habits; diet records; child nutrition sciences; nutrition surveys

INTRODUCTION

According to the World Health Organization (WHO), childhood obesity is one of the most serious health issues, and its prevalence has been rapidly increasing since 1980 due to changes in eating habits [1]. By 2025, 260 million of the world's 5–17 years old children and adolescents will be overweight, of which more than 90 million will become obese [2].

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Conflict of Interest
There are no financial or other issues that might lead to conflict of interest.

In Korea, the prevalence of obesity among Korean children increased from 10.3% in 2010 to 13.6% in 2019, and the prevalence of obesity among Korean adolescent has more than increased 1.5 times, from 10.1% in 2010 to 18.9% in 2019 [3].

Childhood obesity negatively affects the quality of life of children by causing cardiovascular complications such as dyslipidemia, hypertension, and diabetes, as well as contributing to eating disorders, such as self-esteem degradation, emotional anxiety, and depression [4,5]. In addition, childhood obesity causes economic issues. It was reported that health care expenses of obese adults were 36% higher than those of non-obese adults [6]. The possibility of childhood obesity becoming adulthood obesity is as high as 80%. The more excessive body weight in childhood, the more likely that obesity and cardiovascular complications will continue into adulthood [7].

Childhood obesity is caused by genetic factors, environment, and diet-related individual lifestyle [8]. Diet is an important factor related to obesity and the risk of metabolic disorders [9]. Children develop eating habits that continue until adulthood [10]; therefore, it is an important time to acquire healthy eating habits [11]. Poor eating habits, such as picky eating, fasting, and overeating, lead to health problems [12]. In the case of obese children, dietary problems such as irregular meals, skipping breakfast, and inappropriate snacks have been reported, and they have poor eating behaviors such as eating too fast and overeating [13].

The Nutrition Quotient (NQ) has been developed to assess the nutritional status of children and adolescents [14]. The NQ is an assessment tool that provides an inclusive viewpoint of the children's quality of meals and dietary habits [15]. Obese children and adolescents have low NQ scores [16,17]. Korean obese children consume approximately 1.2 times more energy than their estimated energy requirements (EER). Protein intake is approximately 2.5 times higher than the recommended nutrient intake (RNI), and phosphorus, iron, vitamin A, vitamin B_1, and niacin are significantly higher than the RNI, while calcium is about 60% lower than the RNI [18]. Severely obese children have not only an increased risk of morbidity but also an increased association with various dietary problems, including higher consumption of fast-food and foods that are high in energy dense and saturated fats [19].

Therefore, it is very important to assess the nutrient and food intake status in children for the prevention and management of obesity in children. We hypothesized that the nutrient and food intake status is related to the body mass index of obese children. This study investigated the nutritional intake and food group intake status of obese children in Korea and evaluated the nutritional quotient.

METHODS

Participants

Participants enrolled directly, through parents, or through legal caregivers. The study was conducted from September 2019 to March 2020 at the Changwon Fatima Hospital and Gyeongsang National University Changwon Hospital, Changwon, South Korea. The target participants were children aged 7 to 11 years with body mass index (BMI) ≥ 85th percentile according to age-for-BMI provided by the Korean National Growth Charts for children and adolescents. A BMI above the 85th percentile and below the 95th percentile for the same age and sex indicates overweight. Obesity is classified as a BMI above the 95th percentile, while

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severe obesity is classified as a BMI above the 99th percentile for children and adolescents of the same age and sex.

Recruitment was achieved through online and offline media (poster, blog, and social network service). Potential participants were phone-screened, and eligibility was determined at a screening visit. Participants with heart, renal, and liver disease, depression, eating disorders, or other chronic diseases were excluded from this study. Moreover, participants with a history of surgery relevant to this study within the last 6 months, and those who were participating in weight management programs were excluded from this study. The study was conducted in accordance with the principles of the 1964 Declaration of Helsinki and approved by the Institutional Review Boards of the Changwon Fatima Hospital and Gyeongsang National University Changwon Hospital. Informed consent was obtained from all participants (GNUCH 2019-07-016-002, CFH-2019-11). This study process followed is illustrated in **Fig. 1**.

Anthropometrics measurement

Anthropometrics were measured using bioelectrical impedance analysis (InBody 720 Body Composition Analyzer; Bio Space Co., Seoul, Korea). The participants were dressed lightly without footwear before measurement. Height and weight were measured, and BMI was calculated. Waist and hip circumferences were measured while the participants were standing with their arms open wide. All anthropometrics were measured twice, and the results were averaged and recorded with an accuracy to 2 decimals.

Dietary intake assessment

Nutrition intake and food group intake were assessed using a 3-day food record (2 weekdays and 1 weekend). Participants were required to provide the food record for a total of 4 weeks. Researchers have explained the amount of food, food ingredients, and cooking method records using food models, measuring cups, and spoons to the participants and caregivers. Food and nutrient intake of the participants was analyzed using the Computer Aided Nutritional Analysis Program (web version 5.0, 2016; Korean Nutrition Society, Seoul, Korea).

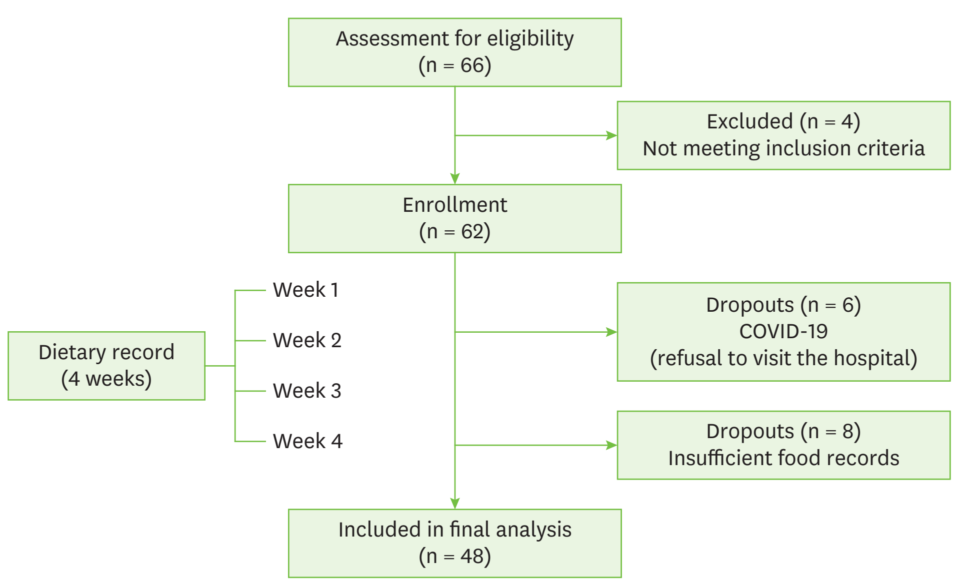

Fig. 1. Flow diagram of the participants.
COVID-19, coronavirus disease 2019.

Food group patterns

Food group patterns were expressed as grain, meat, vegetables, fruit, dairy, and oil (GMVFDO). It was expressed as 1 if consumed more than the minimal amount and 0 if consumed less than the minimal amount. The minimal amount was 15 g for solid foods such as rice, flour, and cheese, 30 g for liquid foods such as milk and yogurt, 30 g for meat and vegetables, 30 g for solid foods such as lean meat, apples, and spinach, and 60 g for soy milk and orange juice [20].

NQ

The NQ questionnaire was distributed to the participants and caregivers. Five items in the "Balance" components measured the frequency of eating multi-grain rice, milk, beans and bean products, and eggs. The "Diversity" components measured the number and distribution of vegetable side dishes consumed in one meal. The "Moderation" components measured four items on the frequency of eating processed meat, fast-food (ramyeon, instant noodles), sweet foods (chocolate, cake, donut), and processed beverages. The "Practice" components gathered whether the child cleaned their hands before meals, exercised, and checked nutrition labeling. The "Environment" components assessed frequency of breakfast consumption, movement during the meals, and screen time (TV, smart phone, computer).

Statistical analyses

Statistical evaluation was performed using statistical packages (SPSS ver. 25; IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean and standard deviation values, and categorical variables are presented as percentages. Differences between the groups were analyzed using the one-way analysis of variance for dietary intake of participants and NQ score. Participant characteristics and food group patterns were analyzed using the χ^2 test.

RESULTS

Anthropometrics measurement

Table 1 lists the anthropometric characteristics of the participants. The distribution of age and sex in overweight, obese, and severely obese participants was not significantly different. The average weight, BMI, waist circumference, waist hip ratio, and total body water in the overweight and obese groups were significantly lower than those in the severely obese group ($p < 0.01$). The average height percentile, weight percentile, body fat mass, and percent body fat in the overweight group were significantly lower than those in the obese and severely obese groups ($p < 0.01$). In the weight percentile and BMI percentile, the severely obese group was the highest, followed by the obese and overweight groups.

Daily nutrient intake of the participant

Table 2 indicates the amount of energy and macronutrients intake of the participants. In the analysis of nutrient intake, the intake of all macronutrients was not significantly different among the overweight, obese, and severely obese groups, but intake of cholesterol was significantly lower in the overweight group than in the obese and severely obese groups ($p < 0.05$). Carbohydrate ratio was significantly higher in the overweight group than in the obese and severely obese groups ($p < 0.01$). However, fat and protein ratio were significantly higher in the obese and severely obese groups than in the overweight group ($p < 0.05$).

Table 1. Anthropometric data of participants

Variables	Overweight (n = 10)	Obese (n = 18)	Severely obese (n = 20)	p-value
Age (yrs)	9.90 ± 1.10	9.28 ± 0.75	9.00 ± 1.17	0.084
Boys	4 (40.0)	8 (44.4)	8 (40.0)	0.955
Girls	6 (60.0)	10 (55.6)	12 (60.0)	(χ^2 value: 0.091)
Height (cm)	143.43 ± 6.31	143.69 ± 6.32	146.69 ± 8.90	0.378
Weight (kg)	45.59 ± 5.70[a]	48.71 ± 5.14[a]	59.37 ± 10.26[b]	0.000
BMI (kg/m^2)	22.15 ± 1.01[a]	23.57 ± 0.81[a]	26.98 ± 2.74[b]	0.000
Height percentile	64.21 ± 25.07[a]	79.11 ± 18.62[b]	88.73 ± 11.41[b]	0.003
Weight percentile	86.74 ± 7.91[a]	96.06 ± 3.56[b]	99.48 ± 0.56[c]	0.000
BMI percentile	90.99 ± 3.35[a]	97.28 ± 1.24[b]	99.72 ± 0.33[c]	0.000
Waist circumference (cm)	73.45 ± 4.38[a]	76.14 ± 4.52[a]	82.55 ± 8.15[b]	0.001
Hip circumference (cm)	83.40 ± 3.37	86.77 ± 3.35	91.85 ± 7.93	0.001
Waist hip ratio	0.88 ± 0.04[a]	0.88 ± 0.05[a]	0.90 ± 0.07[b]	0.456
Total body water	21.98 ± 3.22[a]	20.22 ± 4.22[a]	25.38 ± 4.11[b]	0.001
Body fat mass	14.92 ± 3.98[a]	21.30 ± 3.12[b]	24.01 ± 6.54[b]	0.000
Skeletal muscle mass	15.88 ± 2.74	14.29 ± 3.45	17.38 ± 4.78	0.066
Percent body fat	32.90 ± 7.65[a]	44.19 ± 7.81[b]	40.55 ± 5.39[b]	0.001

Values are expressed as mean ± SD or number (%). The p-values were analyzed by one way analysis of variance.
BMI, body mass index.
[a-c]Different letters are significantly different between BMI groups by Duncan's multiple range test.

Table 2. Daily macronutrient intake of the participants

Variables	Overweight (n = 10)	Obese (n = 18)	Severely obese (n = 20)	p-value
Energy (kcal)	1,752.87 ± 327.20	1,854.96 ± 260.52	1,826.51 ± 2,293.75	0.669
Carbohydrate (g)	250.83 ± 49.87	239.02 ± 32.18	242.50 ± 35.48	0.729
Protein (g)	65.02 ± 12.00	73.84 ± 10.03	72.73 ± 13.94	0.170
Fat (g)	52.61 ± 12.60	64.45 ± 14.89	60.35 ± 13.82	0.112
Cholesterol (mg)	314.36 ± 71.17[a]	414.85 ± 82.72 [b]	413.69 ± 117.15[b]	0.021
Energy distribution				
% Carbohydrate	57.25 ± 3.99[a]	51.72 ± 3.98[b]	53.37 ± 4.11[b]	0.005
% Protein	14.87 ± 0.95	15.94 ± 0.76	15.92 ± 1.70	0.076
% Fat	27.02 ± 3.79 [a]	31.06 ± 3.74[b]	29.51 ± 2.88[ab]	0.016

Values are expressed as mean ± SD. The p-values were analyzed by one way analysis of variance.
[a,b]Different letters are significantly different between body mass index groups by Duncan's multiple range test.

Table 3 indicates the percentage of Dietary Reference Intake (DRI) for Korean children and adolescents. The mean DRI percent for protein was significantly higher in the obese and severely obese groups than in the overweight group. The DRI percent for fiber, vitamin A, calcium, magnesium, and potassium was approximately below 70% of the DRI, and magnesium was the lowest nutrient in the DRI percentage. The DRI percent of protein, thiamin, riboflavin, and sodium was above 150% of the DRI, and cobalamin was the highest nutrient in the DRI percentage.

Correlations coefficients between macronutrients and anthropometric measurements

The correlations between carbohydrate and fat ratio and body fat percent are shown in **Figs. 2** and **3**. Percent body fat was negatively associated with carbohydrate ratio in the overweight groups ($r = −0.709$, $p = 0.022$) and obese groups ($r = −0.472$, $p = 0.048$). But fat ratio was positively associated with body fat percent in the overweight ($r = 0.673$, $p = 0.033$) and obese groups ($r = 0.492$, $p = 0.038$). In the severely obese group, there was no significant correlation between carbohydrate and fat intake and body fat percentage.

Food group pattern and intake

Table 4 shows the food group pattern and intake of the participants. Overall, the GMVFDO 111111 pattern, which consumed all six food groups, was the most common in all groups.

Table 3. Intake ratio to DRI for the participants

Variables	Overweight (n = 10)	Obese (n = 18)	Severely obese (n = 20)	p-value
EER	92.86 ± 13.49	100.55 ± 15.66	103.26 ± 15.09	0.210
Protein	137.89 ± 20.22[a]	161.58 ± 26.24[b]	161.58 ± 26.24[b]	0.008
Fiber	72.73 ± 10.80	69.29 ± 14.58	70.97 ± 15.27	0.824
Vitamin A	73.35 ± 21.33	68.64 ± 18.36	79.66 ± 25.38	0.315
Vitamin D	111.55 ± 43.64	95.58 ± 35.23	91.62 ± 58.53	0.556
Thiamin	181.22 ± 46.61	198.35 ± 47.99	185.67 ± 43.15	0.472
Riboflavin	137.60 ± 24.26	150.08 ± 32.36	157.103 ± 34.11	0.323
Niacin	107.50 ± 24.05	117.24 ± 22.42	114.19 ± 25.27	0.592
Vitamin C	156.36 ± 99.84	116.76 ± 52.37	126.56 ± 90.90	0.503
Folic acid	128.97 ± 23.36	131.51 ± 32.83	149.33 ± 51.63	0.294
Cobalamin	464.63 ± 122.20	528.94 ± 180.14	535.08 ± 197.36	0.350
Calcium	64.05 ± 18.69	63.44 ± 13.65	58.88 ± 10.52	0.611
Phosphorus	81.96 ± 14.72[a]	101.26 ± 36.40[ab]	118.27 ± 42.73[b]	0.041
Potassium	64.52 ± 12.15	63.73 ± 11.96	66.90 ± 10.14	0.673
Sodium	214.45 ± 39.06	236.53 ± 44.49	227.20 ± 44.69	0.441
Magnesium	39.95 ± 9.88	42.34 ± 13.66	44.90 ± 15.67	0.133
Iron	128.83 ± 19.29	124.27 ± 27.14	134.65 ± 24.14	0.388
Zinc	114.75 ± 24.20	125.95 ± 27.26	143.10 ± 36.13	0.051

Values are expressed as mean ± SD. The p-values were analyzed by one way analysis of variance.
DRI, Dietary Reference Intakes; EER, estimated energy requirements.
[a,b]Different letters are significantly different between body mass index groups by Duncan's multiple range test.

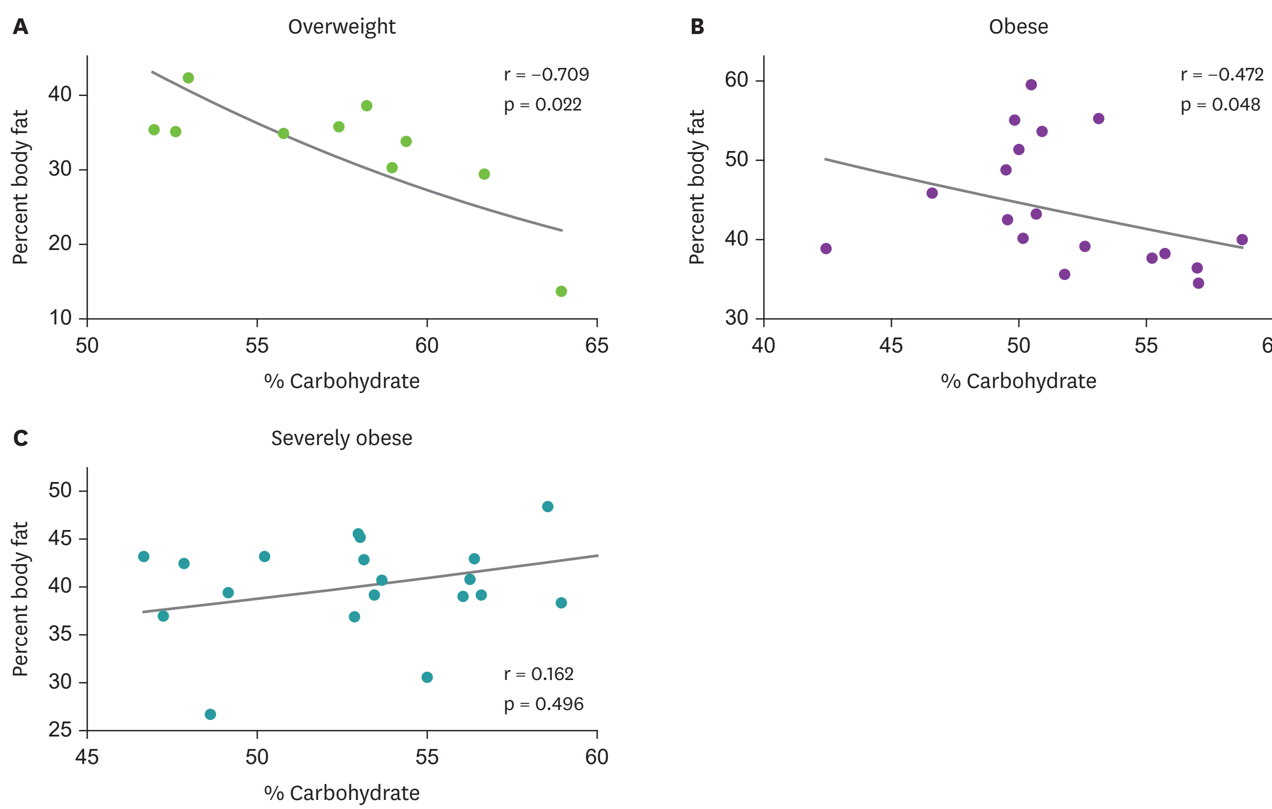

Fig. 2. Correlations coefficients between carbohydrate ratio and percent body fat in (A) overweight, (B) obese, and (C) severely obese.
Correlations between carbohydrate intake ratio and percent body fat were determined using the Spearman's correlation coefficients. The level of significance was set at $p < 0.05$. Percent body fat was negatively associated with fat intake ratio in overweight and obese groups.

The proportion of the GMVFDO 111101 pattern, which excludes dairy, was 10.0% in the overweight group. The proportion of the GMVFDO 111011 pattern, which excludes fruit, was highest in the obese group (22.2%), followed by the severely obese group with 14.6%, and the

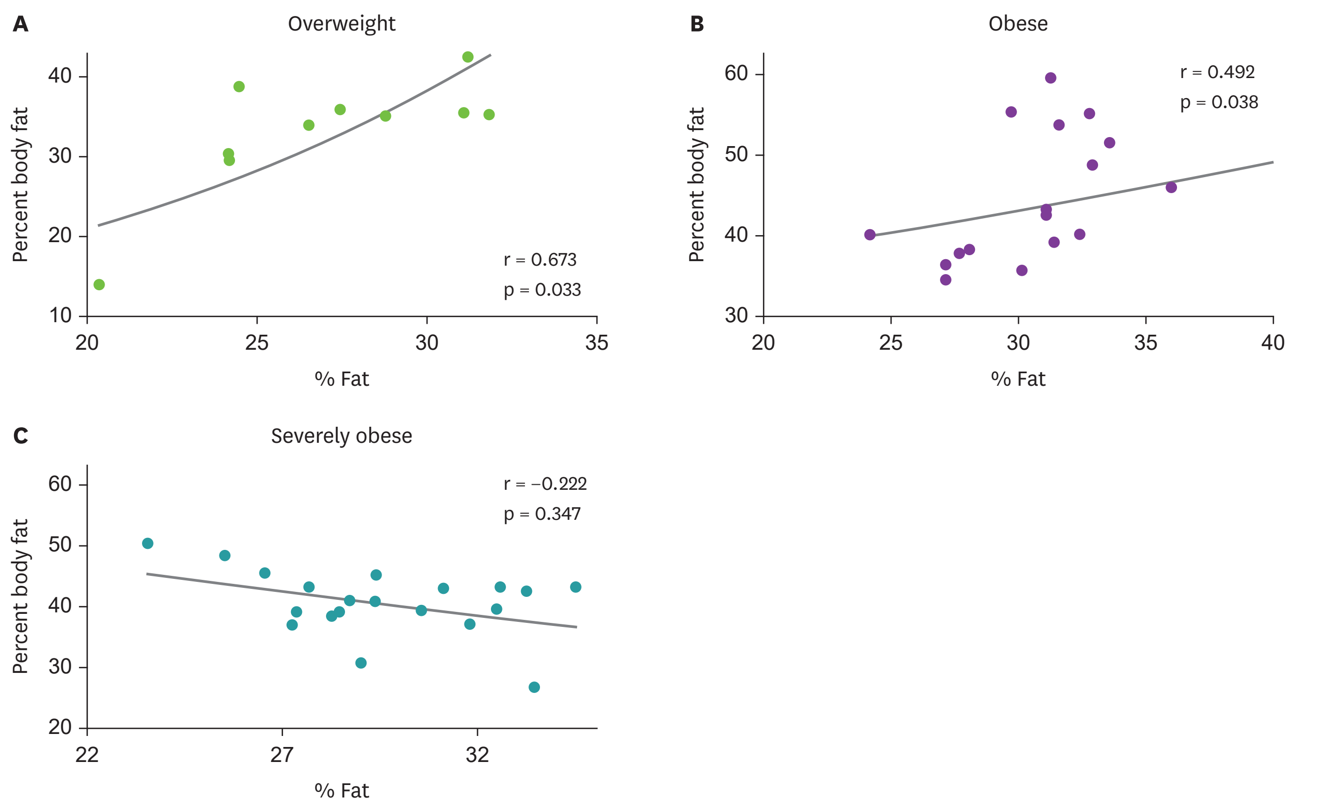

Fig. 3. Correlations coefficients between fat ratio and percent body fat in (A) overweight, (B) obese, and (C) severely obese.
Correlations between fat intake ratio and percent body fat were determined using the Spearman's correlation coefficients. The level of significance was set at $p < 0.05$. Percent body fat was positively associated with fat intake ratio in overweight and obese groups.

Table 4. The food group pattern and intake of the participants

Variables	Overweight (n = 10)	Obese (n = 18)	Severely obese (n = 20)	p-value
GMVFDO[1)] 111111	9 (90.0)	14 (77.8)	17 (85.0)	0.191 (χ^2 value: 6.108)
GMVFDO 111011	-	4 (22.2)	3 (15.0)	
GMVFDO 111101	1 (10.0)	-	-	
Grains (g)	268.07 ± 68.02	271.52 ± 41.82	278.37 ± 58.38	0.874
Meats (g)	94.41 ± 34.01	128.87 ± 48.73	118.97 ± 45.85	0.184
Vegetables (g)	196.03 ± 41.45	166.01 ± 40.77	167.295 ± 53.68	0.251
Fruits (g)	115.16 ± 99.15	89.37 ± 61.31	114.34 ± 80.22	0.560
Milk & dairy (g)	146.01 ± 103.28	131.66 ± 52.34	125.21 ± 52.90	0.738
Oils & fat (g)	10.91 ± 2.25	13.04 ± 2.66	12.31 ± 3.83	0.266
Sugars & sweeteners (g)	10.34 ± 3.79[a]	7.55 ± 3.03[ab]	6.37 ± 3.42[b]	0.019

Values are expressed as number of participants (%) or mean ± SD. Significance of food group pattern as determined by χ^2 test. The p-values were analyzed by one way analysis of variance.
[1)]GMVFDO, grains, meats, vegetables, fruits, dairy, fat, and oils food group (1: food groups present; 0: food groups absent); GMVFDO 111111 denotes that all food groups (grains, meats, vegetables, fruits, dairy, fat, and oils) were consumed.

overweight group had none. There were no significant differences in the proportions of food group patterns among the three groups.

The intake of all food groups was not significantly different among the overweight, obese, and severely obese groups. The intake of vegetables, fruits, and dairy tended to be higher in the overweight group than in the obese and severely obese groups. The intake of meats tended to be higher in the obese and severely obese groups than in the overweight group.

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Table 5. Comparison of NQ scores of the participants

Variables	Overweight (n = 10)	Obese (n = 18)	Severely obese (n = 20)	p-value
NQ score	61.42 ± 9.24	62.93 ± 8.24	62.64 ± 11.19	0.923
Balance	66.59 ± 9.54	61.41 ± 9.30	61.91 ± 10.63	0.382
Diversity	49.09 ± 13.20	52.45 ± 17.11	55.21 ± 24.09	0.725
Moderation	53.92 ± 12.17	58.73 ± 10.56	55.70 ± 16.51	0.637
Regularity	80.98 ± 16.24	82.48 ± 26.26	85.22 ± 20.16	0.870
Practice	59.00 ± 20.16	63.35 ± 13.22	61.31 ± 20.71	0.827

Values are expressed as mean ± SD. The p-values were analyzed by one way analysis of variance.
NQ, Nutrition Quotient.

NQ

Table 5 shows the NQ scores of the participants. The analysis showed that the average scores of the overweight and severely obese groups were 61.42, 62.93, and 62.64, respectively. Regarding the total NQ scores, the obese group showed the highest score, followed by the overweight and severely obese groups. No significant differences were found in any of the components. The NQ scores for obese children in this study showed the lowest scores for diversity and moderation components and the highest scores for regularity components.

DISCUSSION

The aim of this study was to assess the eating habits and daily nutrient and food group intake in overweight, obese, and severely obese children. The results of this study show several nutritional problems among overweight, obese, and severely obese children that lower the quality of their eating habits and influence the further excess of body fat. This study shows the difference in the fat and carbohydrate ratio of energy distribution in overweight and obese children. These findings support the main hypothesis of the study.

Kim and Kim's study [21] showed 51.3 g of fat intake in obese child groups with metabolic syndrome and 54.4 g of fat intake in healthy obese child groups in Korea. Choi et al.'s study [18] analyzed nutrient intake in children and adolescents with severe obesity and showed 104.82 g fat intakes for boys and 83.99 g for girls. Compared to the 60.57 g fat intake of the obese group in this study, the fat ratio in energy distribution was higher than that in other studies, and it was assumed that obese children with higher BMI tended to have a higher fat rate in energy distribution. Previous studies have reported a positive correlation between high intake of fat and body fat in children [22]. In this study, there was a highly significant correlation between carbohydrate and fat intake ratio and body fat. But carbohydrate and fat intake ratio did not appear to increase the risk for body fat in severe obese children. This indicates that the lifestyle and eating habits such as physical activity, eating out, and night eating were found to be associated with an increase in severe obesity. These results suggest that not only dietary intake also eating habit and lifestyle should be considered when designing nutrition education or intervention programs targeting severe obese children.

Dietary intervention that changed the type or amount of carbohydrate intake have been shown to be beneficial for weight management [23]. A low-carbohydrate diet that restricted carbohydrate intake to no more than 60 g/day, reportedly improved weight status in younger children [24]. Recently, Jefferson reported that a low-carbohydrate and high-protein diet decreased weight by controlling appetite-controlled ghrelin and peptide YY hormones in obese children [25]. Shelley and colleagues showed conflicting results: a reduced 500-kcal diet consisting of 55-60% carbohydrates, 10–15% protein, and less than 30% fat was more effective in weight management than a strict carbohydrate-restricted diet in obese children [26]. There are no reports of childhood obesity and carbohydrate and fat intake in Korea; therefore, intervention studies on the ratio of carbohydrates and fat intake for childhood obesity prevention and management are necessary.

Furthermore, insufficient intake of fiber, calcium, magnesium, and potassium was observed in overweight and obese children, suggesting the need to include more vegetables, fruits, milk, and dairy products in meals. In addition, overweight and obese children in this study had an excessive intake of cobalamin and sodium. High sodium intake influences the occurrence of hypertension, which itself is a complication of obesity; therefore, appropriate mineral and vitamin intake education is needed for obese children.

Analysis of the intake of food groups according to BMI showed that the sugar and sweeteners were significantly higher in the overweight group (10.34 g) and significantly lower in the obese (7.55 g) and severely obese groups (6.37 g). Sugar and sweeteners come from a variety of sources, such as beverages, ice cream, and snacks [27]. The increasing intake of sugar and sweeteners might have a positive association with the prevalence of childhood obesity and decayed teeth [28]. Sugar and sweeteners in children and adolescents in Korea exceed 10% of the total calories, and sugar and sweeteners through beverages are high [29]. Several studies have found a positive correlation between sugar and sweeteners, long-term weight increase, and obesity [30,31]. However, Gibson reported that energy consumption through non-alcoholic beverages was not correlated with BMI, so the association between sugar and sweeteners and obesity showed no consistent result in children and adolescents [32]. This study showed that sugar and sweeteners did not affect obesity, but increased amounts in children significantly lowered nutrition density and intake of micronutrients such as iron, zinc, and niacin [33,34]. Therefore, it is necessary to focus on training related to eating behavior included appropriate sugar intake for obese children.

Analysis using the NQ score to compare the difference in dietary behaviors by BMI displayed no statistical significance for all contents. The total NQ scores of the participants in this study were 61.42 (overweight), 62.93 (obese), and 62.64 (severely obese); these were considerably lower than the scores for normal weight children 66.2 in Daegu [35], 68.3 in elementary school students of Seoul [36], and 66.8 of the children in Gwangju [37]. In Boo's study, which analyzed NQ according to weight status, there was no significant difference between underweight, normal weight, obesity, and NQ scores [38]. This is consistent with the results of this study. In the NQ components, the participants of this study showed the lowest score for moderation and diversity, although normal-weight children showed a lower score for balance than did obese children [35,38]. In the study by Bae and Kang [17], the NQ score of children with normal weight aged 9–11 years old was 66.3 and that of obese children was 62.2. In the NQ component, the score of the Moderation component was significantly lower in obese children (60.3) than in normal-weight children (74.3). It showed the lowest score among the five component factors, showing a similar pattern to the NQ results of this study participants.

As a result of analyzing the correlation between weight and NQ in the study by Bae and Kang [17], there was a significant negative correlation between body weight and NQ score, and a negative correlation with body weight, diversity, and moderation. Therefore, this study suggests that dietary habits education related to moderation and diversity, such as avoiding unhealthy sweet foods, reducing the frequency of fast food, ramyeon, and eating various vegetable side dishes should be treated as important factor for Korean obese children.

It has been reported that the modification of eating habits in children becomes more difficult with increasing age [39]. Obesity treatment through dietary changes is more successful in preschool children than in adolescents [40]. This is presumably because the younger the child, the greater the role of parents in eating habits. The age of the study participants was 9.8 years old, which is the period when eating habits begin to become stabilized; therefore, it is essential to evaluate and correct eating habits for obesity management.

This study has some limitations. First, the self-reported food records may not have accurately reflected the dietary intakes of participants with obesity. Second, the number of participants was small and regionally limited to the Changwon area; therefore, it would be difficult to generalize the results. Third, we could not compare the differences between normal-weight children. Despite these limitations, this study is significant in that it compares the dietary quality and nutrient intake of obese children by food record and NQ. This study also found a significant difference in the carbohydrate and fat intake ratio of children according to BMI. The findings of this study will be useful as foundational data for nutrition education programs of Korean obese children more effectively.

SUMMARY

The study examined the dietary quality and nutrients intake was associated with the risk of children obesity. A total of 48 obese children in Changwon area, were investigated for dietary intake and body measurements for 4 weeks. There was no significant difference in dietary quality according to BMI of the studied obese children, but there was a difference in the energy distribution of carbohydrate and fat ratio. The dietary intake of obese children was rich in protein, sodium, and vitamin B_{12}, and poor in fiber, calcium, potassium, and magnesium. These results suggest that the carbohydrate and fat intake ratio is an important regulator of a child's body fat, and that interventions aimed at preventing obesity in children should also focus on energy distribution. In addition, the positive association between fat intake and body fat is an important consideration for both child obesity management and nutritional guidelines. Further large-scale, prospective studies should be conducted to investigate the effects of energy distribution on prevention and treatment in obese children.

REFERENCES

1. World Health Organization (WHO). World Health statistics 2016: monitoring health for the SDGs, sustainable development goals. Geneva: WHO; 2016 [cited 2016 May 19]. Available from: https://www.who.int/publications/i/item/9789241565264.
CROSSREF
2. Lobstein T, Jackson-Leach R. Planning for the worst: estimates of obesity and comorbidities in school-age children in 2025. Pediatr Obes 2016; 11(5): 321-325.
PUBMED | CROSSREF
3. Ministry of Health and Welfare, Korea Centers for Disease Control and Prevention. Korea Health Statistics 2019: Korea National Health and Nutrition Examination Survey (KNHANES VIII-1). Cheongju: Korea Centers for Disease Control and Prevention; 2019.
4. Cho IS, Ryu HS. The effect of community based participatory obesity management program in obese school children. J Korean Appl Sci Technol 2017; 34: 737-745.
CROSSREF
5. Kim HS, Park J, Ma Y, Ham OK. Factors influencing health-related quality of life of overweight and obese children in South Korea. J Sch Nurs 2013; 29(5): 361-369.
PUBMED | CROSSREF

https://doi.org/10.4163/jnh.2022.55.6.630

6. Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. Pediatrics 2002; 109(5): E81-E1.
PUBMED | CROSSREF
7. Vander Wal JS, Mitchell ER. Psychological complications of pediatric obesity. Pediatr Clin North Am 2011; 58(6): 1393-401.
CROSSREF
8. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. Gastroenterology 2007; 132(6): 2087-2102.
PUBMED | CROSSREF
9. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012; 70(1): 3-21.
PUBMED | CROSSREF
10. Agostoni C, Baselli L, Mazzoni MB. Early nutrition patterns and diseases of adulthood: a plausible link? Eur J Intern Med 2013; 24(1): 5-10.
PUBMED | CROSSREF
11. Choi ES, Shin NR, Jung EI, Park HR, Lee HM, Song KH. A study on nutrition knowledge and dietary behavior of elementary school children in Seoul. Nutr Res Pract 2008; 2(4): 308-316.
PUBMED | CROSSREF
12. Gortmaker SL, Swinburn BA, Levy D, Carter R, Mabry PL, Finegood DT, et al. Changing the future of obesity: science, policy, and action. Lancet 2011; 378(9793): 838-847.
PUBMED | CROSSREF
13. Jeong NY, Kim KW. Nutrition knowledge and eating behaviors of elementary school children in Seoul. Korean J Community Nutr 2009; 14: 55-66.
14. Kang MH, Lee JS, Kim HY, Kwon S, Choi YS, Chung HR, et al. Selecting items of a food behavior checklist for the development of Nutrition Quotient (NQ) for children. Korean Journal of Nutrition 2012; 45(4): 372-389.
CROSSREF
15. Huang YC, Kim HY. Assessment of dietary behavior of Chinese children using Nutrition Quotient for children. J Nutr Health 2014; 47(5): 342-350.
CROSSREF
16. Yoo JS, Choi YS. Evaluation of items for the food behavior checklist and Nutrition Quotient score on children in rural areas of Gyeongbuk. J Nutr Health 2013; 46(5): 427-439.
CROSSREF
17. Bae JM, Kang MH. Age difference in association between obesity and Nutrition Quotient scores of preschoolers and school children. J Nutr Health 2016; 49(6): 447-458.
CROSSREF
18. Choi SN, Kim HJ, Chung NY. Nutrient intakes, nutritional knowledge, food habits, and lifestyle behaviors of obese children. J Korean Diet Assoc 2011; 17: 349-363.
CROSSREF
19. Johns DJ, Lindroos AK, Jebb SA, Sjöström L, Carlsson LM, Ambrosini GL. Dietary patterns, cardiometabolic risk factors, and the incidence of cardiovascular disease in severe obesity. Obesity (Silver Spring) 2015; 23(5): 1063-1070.
PUBMED | CROSSREF
20. Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the first national health and nutrition examination survey epidemiologic follow-up study. Am J Clin Nutr 1993; 57(3): 434-440.
PUBMED | CROSSREF
21. Kim JH, Kim EK. The relationship among insulin resistance, blood profiles and nutrient intake in overweight or obese children and adolescents. Korean J Community Nutr 2012; 17(5): 530-542.
CROSSREF
22. Alexy U, Sichert-Hellert W, Kersting M, Schultze-Pawlitschko V. Pattern of long-term fat intake and BMI during childhood and adolescence--results of the DONALD Study. Int J Obes 2004; 28(10): 1203-1209.
PUBMED | CROSSREF
23. Bilsborough SA, Crowe TC. Low-carbohydrate diets: what are the potential short- and long-term health implications? Asia Pac J Clin Nutr 2003; 12(4): 396-404.
PUBMED
24. Dunlap BS, Bailes JR Jr, James R. Unlimited energy, restricted carbohydrate diet improves lipid parameters in obese children. Metab Syndr Relat Disord 2008; 6(1): 32-36.
PUBMED | CROSSREF

25. Jefferson ME, Nicklas BJ, Chmelo EA, Crotts CI, Shaltout HA, Diz DI, et al. Effects of resistance training with and without caloric restriction on arterial stiffness in overweight and obese older adults. Am J Hypertens 2016; 29(4): 494-500.
PUBMED | CROSSREF
26. Kirk S, Brehm B, Saelens BE, Woo JG, Kissel E, D'Alessio D, et al. Role of carbohydrate modification in weight management among obese children: a randomized clinical trial. J Pediatr 2012; 161(2): 320-327.e1.
PUBMED | CROSSREF
27. Han Y, Kwon SO, Lee SA. Distribution and exposure prevalence of carbohydrate-based food intake among obese Korean adults based on the health examinees (HEXA) study. Korean J Community Nutr 2017; 22(2): 159-170.
CROSSREF
28. Chan TF, Lin WT, Huang HL, Lee CY, Wu PW, Chiu YW, et al. Consumption of sugar-sweetened beverages is associated with components of the metabolic syndrome in adolescents. Nutrients 2014; 6(5): 2088-2103.
PUBMED | CROSSREF
29. Ha K, Chung S, Lee HS, Kim CI, Joung H, Paik HY, et al. Association of dietary sugars and sugar-sweetened beverage intake with obesity in Korean children and adolescents. Nutrients 2016; 8(1): 31.
PUBMED | CROSSREF
30. Anderson PM, Butcher KE. Childhood obesity: trends and potential causes. Future Child 2006; 16(1): 19-45.
PUBMED | CROSSREF
31. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr 2006; 84(2): 274-288.
PUBMED | CROSSREF
32. Gibson S, Neate D. Sugar intake, soft drink consumption and body weight among British children: further analysis of National Diet and Nutrition Survey data with adjustment for under-reporting and physical activity. Int J Food Sci Nutr 2007; 58(6): 445-460.
PUBMED | CROSSREF
33. Ko YS, Kim EM, Lee HS. A study of dietary intake of total sugars by elementary students in Jeju Province. J Nutr Health 2015; 48(1): 81-93.
CROSSREF
34. Rennie KL, Livingstone MB. Associations between dietary added sugar intake and micronutrient intake: a systematic review. Br J Nutr 2007; 97(5): 832-841.
PUBMED | CROSSREF
35. Lee SJ, Kim Y. Evaluation of the diet and nutritional states of elementary and middle school students in the Daegu area by using Nutrition Quotient for children. J Nutr Health 2013; 46(5): 440-446.
CROSSREF
36. Lim JY, Kim JH, Min SH, Lee MH, Lee MJ. Evaluation of dietary behavior among elementary school students in Seoul area using Nutrition Quotient for children. Korean J Food Cookery Sci 2016; 32(1): 84-95.
CROSSREF
37. Jo H, Kim KY, Yun JM. Evaluation of the nutritional status of high-grade elementary school students in Gwangju using Nutrition Quotient. J Korean Soc Food Cult 2020; 35(4): 371-381.
CROSSREF
38. Boo MN, Cho SK, Park K. Evaluation of dietary behavior and nutritional status of elementary school students in Jeju using Nutrition Quotient. J Nutr Health 2015; 48(4): 335-343.
CROSSREF
39. Kim WK, Kang MH, Kim SH. Survey on nutritional status and dietary behaviors of middle school students in Korea using the Nutrient Quotient (NQ) of children for dietary education. J Korean Soc Food Sci Nutr 2019; 48(4): 456-468.
CROSSREF
40. Fernández San Juan PM. Dietary habits and nutritional status of school aged children in Spain. Nutr Hosp 2006; 21(3): 374-378.
PUBMED