

## Effects of Nutritional Education and Physical Exercise Program on Nutritional and Health Status of Obese Children in Busan Metropolitan City

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### Abstract

The objective of this study was to investigate the effects of a nutritional education and physical exercise program on obese children (47 boys and 36 girls). The nutritional education and physical exercise program was provided for 6 weeks and dietary habits, nutrient intake and hematological profiles were measured before and after the program. The BMI (body mass index, kg/m<sup>2</sup>) in male children was significantly reduced to 24.58 ± 2.81 from 25.89 ± 3.27 (p < 0.01) and it was significantly reduced to 24.29 ± 3.51 from 25.21 ± 3.59 in female children after the completion of nutritional education and exercise program. Body fat in male children was remarkably reduced to 32.69 ± 7.74% after education from 37.38 ± 9.21% (p < 0.001). After the program total cholesterol concentration in male children was reduced to 176.48 ± 29.10 mg/dL from 196.03 ± 29.10 mg/dL, whereas there was no significant difference in females before and after the nutritional education and exercise program. The grasping power of male children (p < 0.05) and backmuscle strength of male (p < 0.05) and female children (p < 0.001) were significantly increased after the exercise program. The nutrient intakes that were different before and after the nutrition education were calories (p < 0.05) and carbohydrate (p < 0.05) in male children, and a significant increase in intake of vitamin A (p < 0.05) was found in female children. There was a significant difference in meal time regularity before and after program. The findings of this study showed that there was a significant decrease in both body fat and weight, in addition to normalization of hematological profiles after the completion of nutrition education and physical exercise programs.

**Key words:** obese children, nutritional education, physical exercise, hematological profile

### INTRODUCTION

The rising prevalence of obesity in both adults and children is generally attributed to not only bad eating habits resulting from a better standard of living, but also physical inactivity (1). Although obesity occurs at all ages, obese children are more likely to become obese adults because there is a significant increase in the size and number of fat cells during early childhood (2).

In addition, obesity in early childhood negatively affects children's physical and mental development, as well as the formation of character, so that it can interfere with their social development (3). Moreover, childhood obesity can lead to a variety of adult-diseases including diabetes, fatty liver, high blood pressure and heart disease that result in serious health threatening morbidity. It is required, therefore, to better understand and prevent obesity (4,5).

In particular, obesity in children is one of the most

devastating problems because obese children are more likely to become obese adults and reducing weight is more difficult in adults who have been obese since childhood than in these who become obese during adulthood (6).

Obese children tend to show a higher potential for developing obesity, with respect to their eating habits, eating behaviors, living habits and eating frequency. Many studies have shown that these obesity related habits can be changed through nutrition education programs. The obesity rate in children (elementary school students) was 18.3% in 2005 compared to 12.1% in 1998 (7). The prevalence of obesity in children has risen by more than two fold between 1961 to 2001 in America (8). In addition to the rising prevalence, another problem with childhood obesity is that proper education is not provided for children to reduce their weight, even after being diagnosed as overweight or obese. It is important to provide proper nutrition education for children before reaching

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the age of puberty (9).

By comparatively analysing differences between before and after providing education programs related to eating habits, nutrient intakes, blood values and living habits in elementary school students who were diagnosed as obese, this study was performed to evaluate the effects of nutrition education programs on the improvement of childhood obesity and to emphasize the need for continuous management of obesity in children.

## METHODS

### Subjects

This study was carried out in 47 boys and 36 girls in grades 4 through 6 grades diagnosed as obese. The obesity index (%) was calculated with the formula below  $[(\text{Present weight} - \text{standard weight}) / \text{standard weight}] \times 100$ . Standard body weight is the 50th percentile value of same age, sex and height according to the 1998 Korean growth standard. Children with an obesity index value equal to or greater than 20 were classified as obese (Korean Society of Pediatrics, 1999).

### Anthropometric measures

Height and weight of the subjects were measured with automatic instrument (Fanocs model: Fa-95) and body mass index (BMI) was calculated as weight (kg)/height (m)<sup>2</sup>. The triceps skinfold and subscapular skinfold were measured using a Caliper (Lange, Cambridge Scientific Industry, HB 859-122). Grasping power and backmuscle strength were measured by a hand dynamometer (TKK, Japan) and back muscle strength dynamometer (TKK, Japan).

### Measurement of hematological profile

Serum was separated in a centrifugal separator and stored at -70°C. Total cholesterol, HDL (high density lipoprotein)-cholesterol and blood glucose were analyzed by an automatic blood analyzer (747, Hitachi, Japan). LDL (low density lipoprotein)-cholesterol was calculated according Friedwald method (10).

### Daily nutrient intake and food frequency

Nutrient intakes were measured with a 24 h hour recall method before and after the nutritional education and

exercise program. Calculated nutrients were compared with DRI (2005, Korean nutrition society, 7th ed.). Food frequency was divided into 5 different levels as follows: Score: No=1, 1~2 times/week=2, 3~4 times/week=3, 5~6 times/week=4, always=5

### Nutritional education and physical exercise program

Nutritional education and physical exercise programs were provided during the six-week period. The nutrition education program's content explained the disadvantages of obesity, needs for diet therapy, and a balanced diet. The physical exercise program was designed to provide swimming (6.0 kcal/kg/hour consumption) and exercise sessions (5.5 kcal/kg/hour consumption) on alternate days for a period of six weeks (1 hour/day).

### Statistical analysis

All data collected were statistically analyzed, using SPSS PC+ package. For each variable, the values of average and standard deviation were calculated. The physical characteristic, hematological indices, nutritional intake, food frequency and features of body strength were compared using Student's t-test, and dietary habits were compared by  $\chi^2$ -test before and after nutritional education and exercise program.

## RESULTS AND DISCUSSIONS

### Anthropometric measures of the subjects

Table 1 shows the anthropometric measures of the subjects. The initial height and weight of male children were  $145.04 \pm 8.82$  cm and  $54.32 \pm 9.60$  kg, those of female children were  $144.32 \pm 9.61$  cm and  $52.92 \pm 8.18$  kg, respectively. There was a significant increase in the height of both male and female students after the completion of the education program ( $p < 0.01$ ), and their weight reduced after the completion of the program ( $p < 0.05$ ). The BMI ( $\text{kg}/\text{m}^2$ ) of male children was significantly reduced to  $24.58 \pm 2.81$  from  $25.89 \pm 3.27$  ( $p < 0.01$ ) and it was significantly reduced to  $24.29 \pm 3.51$  from  $25.21 \pm 3.59$  ( $p < 0.05$ ) in female children. Body fat (%) in male children was remarkably reduced to  $32.69 \pm 7.74\%$  after education from  $37.38 \pm 9.21\%$  before education ( $p < 0.001$ ) and there was significant de-

**Table 1.** Anthropometric measures of the subjects before and after nutritional education and physical exercise program

| Variables                                    | Male              |                        | Female            |                        |
|--|-------------------|------------------------|-------------------|------------------------|
|  | Before            | After                  | Before            | After                  |
| Height (cm)                                  | $145.04 \pm 8.82$ | $146.54 \pm 8.85^{**}$ | $144.32 \pm 9.61$ | $145.79 \pm 9.64^{**}$ |
| Body wt. (kg)                                | $54.32 \pm 9.60$  | $53.50 \pm 8.47^*$     | $52.92 \pm 8.18$  | $51.84 \pm 11.08^*$    |
| BMI ( $\text{kg}/\text{m}^2$ ) <sup>1)</sup> | $25.89 \pm 3.27$  | $24.58 \pm 2.81^{**}$  | $25.21 \pm 3.59$  | $24.29 \pm 3.51^*$     |
| Body fat (%)                                 | $37.83 \pm 9.21$  | $32.69 \pm 7.74^{***}$ | $38.10 \pm 9.08$  | $33.22 \pm 8.58^{***}$ |

Mean  $\pm$  SD. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . <sup>1)</sup>BMI ( $\text{kg}/\text{m}^2$ ): Body Mass Index.

crease ( $p < 0.001$ ) in female children, also. A study carried out with elementary school students by Lee (11) showed that BMI in male and female students was 25.8 and 25.1, respectively. A study performed by Shin et al. (9) with obese students in the fourth, fifth and six grades reported a reduction to 24.9 from 25.5 after the nutrition education program.

Table 2 show the hematological index of subjects. The total cholesterol concentration in male children was reduced to  $176.48 \pm 29.10$  mg/dL after education from  $192.03 \pm 36.20$  mg/dL before education, but there was no significant difference in females before and after the program. The triglyceride level was reduced to  $167.95 \pm 76.39$  mg/dL from  $172.13 \pm 133.29$  mg/dL before education, but the difference was not significant. The level of HDL-cholesterol in female children increased significantly compared to before education ( $p < 0.05$ ), and there was a significant decrease in male children's LDL-cholesterol level after education ( $p < 0.05$ ). It was found, therefore, that their blood values were improved after the completion of the nutrition education program. Several studies (12-14) have reported that the total cholesterol level and LDL-cholesterol concentration of obese children were higher than those of normal chil-

dren, while their HDL-cholesterol concentration was lower than those of normal children. The hemoglobin concentration and blood glucose level showed no significant difference before and after the program (Table 2).

#### Daily nutrient intake, food frequency of the subjects

The nutrient intakes of the subject are shown in Table 3. The total energy intake of the male children was 1780.19 kcal {93.7% of EER (Estimated Energy Requirements)} and protein intake was 61.06 g {174.6% of RI (recommended intake)}. This show that obese children's energy intake found in this study was lower than 2002 kcal which is the mean calorie intake in obese children reported by Choi and Seo (15). It has been shown that the calcium intake of male children was 65.0% of RI and iron intake was 107.8% of RI. The nutrients were different before and after the nutrition education were calories ( $p < 0.05$ ) and carbohydrates ( $p < 0.05$ ) in male children, and a significantly increased intake of vitamin A ( $p < 0.05$ ) was found in female children. The study carried out by Shin et al. (7) also reported that there was 18% decrease in adolescent's calorie intake after nutritional education as compared to their intake before the education. In the study of Kim and Kim (16), it was also reported that there was a reduc-

**Table 2.** Hematologic profiles of the subjects before and after the nutritional education and physical exercise program

| Variables                   | Male                |                      | Female             |                    |
|-----------------------------|---------------------|----------------------|--------------------|--------------------|
|                             | Before              | After                | Before             | After              |
| Total cholesterol (mg/dL)   | $192.03 \pm 34.20$  | $176.48 \pm 29.10^*$ | $192.04 \pm 36.70$ | $182.18 \pm 34.12$ |
| Triglyceride (mg/dL)        | $172.13 \pm 133.29$ | $167.95 \pm 76.39$   | $184.13 \pm 84.11$ | $166.86 \pm 57.13$ |
| HDL-C (mg/dL) <sup>1)</sup> | $49.05 \pm 7.96$    | $51.83 \pm 9.34$     | $48.13 \pm 7.16$   | $53.13 \pm 4.57^*$ |
| LDL-C (mg/dL) <sup>2)</sup> | $117.32 \pm 31.52$  | $97.06 \pm 27.11^*$  | $111.45 \pm 30.13$ | $109.06 \pm 15.62$ |
| Hemoglobin (g/dL)           | $13.42 \pm 0.80$    | $13.63 \pm 0.78$     | $13.54 \pm 0.58$   | $13.76 \pm 0.89$   |
| Blood glucose (mg/dL)       | $101.07 \pm 14.99$  | $97.92 \pm 12.41$    | $103.49 \pm 17.46$ | $105.19 \pm 18.76$ |

Mean  $\pm$  SD. \* $p < 0.05$ . <sup>1)</sup>High density lipoprotein-cholesterol. <sup>2)</sup>Low density lipoprotein-cholesterol.

**Table 3.** Daily nutrient intake of the subjects before and after the nutritional education and physical exercise program

| Nutrient                    | Male                        |                               | Female                       |                               |
|-----------------------------|-----------------------------|-------------------------------|------------------------------|-------------------------------|
|                             | Before                      | After                         | Before                       | After                         |
| Protein (g)                 | $61.06 \pm 16.85$ (174.2)   | $62.21 \pm 15.12$ (177.1)     | $59.20 \pm 17.42$ (169.1)    | $58.52 \pm 15.62$ (165.7)     |
| Fat (g)                     | $49.32 \pm 9.76$            | $47.42 \pm 8.79$              | $48.26 \pm 7.58$             | $43.39 \pm 8.72$              |
| Carbohydrate (g)            | $271.43 \pm 52.99$          | $251.24 \pm 31.88^*$          | $264.43 \pm 39.55$           | $268.52 \pm 31.90$            |
| Fe (mg)                     | $12.94 \pm 5.13$ (107.8)    | $11.75 \pm 5.08$ (97.9)       | $12.84 \pm 5.55$ (107.0)     | $10.82 \pm 4.88$ (90.2)       |
| P (mg)                      | $776.16 \pm 176.53$ (77.6)  | $758.42 \pm 159.13$ (75.8)    | $742.16 \pm 119.42$ (82.4)   | $699.24 \pm 122.53$ (77.6)    |
| Ca (mg)                     | $520.23 \pm 101.52$ (65.0)  | $576.15 \pm 99.76$ (72.0)     | $526.30 \pm 106.15$ (65.8)   | $539.25 \pm 93.55$ (67.4)     |
| Vitamin A (R.E.)            | $760.13 \pm 402.13$ (138.1) | $749.75 \pm 206.32$ (136.2)   | $719.06 \pm 315.15$ (143.8)  | $755.20 \pm 185.88^*$ (151.2) |
| Vitamin B <sub>1</sub> (mg) | $0.98 \pm 0.31$ (110.0)     | $0.86 \pm 0.19$ (95.5)        | $0.79 \pm 0.36$ (98.7)       | $0.66 \pm 0.17$ (82.5)        |
| Vitamin B <sub>2</sub> (mg) | $1.13 \pm 0.42$ (102.7)     | $1.09 \pm 0.76$ (99.1)        | $1.01 \pm 0.26$ (112.2)      | $1.18 \pm 0.68$ (131.1)       |
| Niacin (mg)                 | $12.97 \pm 5.10$ (108.0)    | $12.16 \pm 4.83$ (101.3)      | $12.19 \pm 4.19$ (121.9)     | $11.29 \pm 4.77$ (112.9)      |
| Vitamin C (mg)              | $72.10 \pm 22.41$ (103.0)   | $65.13 \pm 16.85$ (92.9)      | $71.12 \pm 20.15$ (101.6)    | $65.11 \pm 16.99$ (93.0)      |
| Total Energy (kcal)         | $1780.19 \pm 252.91$ (93.7) | $1626.50 \pm 219.28^*$ (88.2) | $1729.25 \pm 324.18$ (101.7) | $1694.04 \pm 311.40$ (99.6)   |

Mean  $\pm$  SD. \* $p < 0.05$ .

Percentages of mean nutrient intakes compared with Dietary Reference Intakes for Koreans.

Compared with EER (Estimated Energy Requirements) for energy, RI (Recommended Intake) for other nutrient.

tion of 30% in caloric intake after nutritional education.

As shown in Table 4, the average scores of the respondents' habit for eating Kimchi ( $4.76 \pm 1.02$ ), fried food ( $4.20 \pm 1.09$ ), fruit ( $3.72 \pm 1.11$ ), milk and dairy product ( $3.57 \pm 1.19$ ), vegetable ( $3.48 \pm 1.08$ ) were more than 3 to 4 times a week, while intakes of bean ( $2.38 \pm 1.05$ ), seaweed ( $2.22 \pm 1.03$ ) and chicken ( $1.98 \pm 0.94$ ) were low. The food that showed a difference in frequency before and after program was fruit which was increased to  $4.20 \pm 1.02$  after nutritional education from  $3.72 \pm 1.11$  before nutritional education ( $p < 0.05$ ).

#### Features of body strength of the subjects

Table 5 shows body strength and anthropometric measurements of the subjects before and after nutritional education and the physical exercise program. The average waist and hip circumferences of the male children were  $82.55 \pm 10.61$  cm and  $89.63 \pm 7.71$  cm and there were no significant differences after the program. The triceps skinfold of male children was significantly reduced to  $24.71 \pm 5.42$  mm from  $27.79 \pm 5.97$  mm ( $p < 0.05$ ) and the subscapular skinfold was significantly reduced to  $20.63 \pm 8.03$  mm from  $26.69 \pm 9.88$  mm ( $p < 0.01$ ). Grasping power and backmuscle strength of male children were significantly increased after the pro-

gram ( $p < 0.05$ ), also. The triceps skinfold ( $p < 0.05$ ) and subscapular skinfold ( $p < 0.05$ ) were decreased and the backmuscle strength had increased after the program in female children. In the studies carried out by Ko and Lee (17) with obese children, it was also found that both fat loss and back strength were significantly increased by nutrition education and aerobic exercise.

#### Dietary habits of the subjects

Table 6 shows the dietary habits of the subjects. Forty two subjects (50.6%), the majority of the subjects in this study, had three meals a day and 30 students (36.1%) had two meals a day. It was shown that 25 subjects skipped their breakfast (30.1%); 15 skipped their dinner (18.1%); and 6 skipped their lunch (7.2%). The first reason for skipping meal of the subject was that there was 'no appetite' (30.1%) followed by there is 'no time for eating' for 18 students (21.7%) and 'oversleeping' for 15 students (18.1%), respectively; after the program the first reason for skipping meals was 'no appetite' (20.5%) followed by there is 'no time for eating' and 'to loose weight' for 16 students (19.3%) and 14 students (16.8%), respectively. In terms of the regularity of their meal time, 37 students (44.6%) said that it is 'generally regular', 29 students (34.9%) 'generally irregular', 14 students 'irregular (16.9%)' and 3 students (4.1%) 'regular'. When the frequency of dining out was surveyed, 'more than 1 time a day' was reported by 1.2%, '1~3 times a week' for 8.4%; 'once a week' for 35.0%; 'once every 2~3 weeks' for 30.1%; 'once a month' for 25.3%, respectively. There was a significant difference in regularity of meal times ( $p < 0.05$ ) before and after the program. It was found in the study carried out by Shin et al. (7) that 27.8% of obese children skipped breakfast. Also, the study by Kim et al. (18) 42.1% of mildly obese skipped breakfast, 43.3% with moderate obesity and 33% of severely obese. These findings indicated that meal skipping percentages varied depending on the rates of obesity. In this study, it was found there were affirmative responses to 'eating speed is fast' by 34.9% and 28.9% before and after the education, respectively. It

**Table 4.** Comparison of food frequency before and after nutritional education and physical exercise program

| Food                   | Before          | After             |
|------------------------|-----------------|-------------------|
| Kimchi                 | $4.76 \pm 1.02$ | $4.72 \pm 1.01$   |
| Fried food             | $4.20 \pm 1.09$ | $3.80 \pm 0.78$   |
| Fruit                  | $3.72 \pm 1.11$ | $4.20 \pm 1.02^*$ |
| Milk and dairy product | $3.57 \pm 1.19$ | $3.66 \pm 0.84$   |
| Vegetable              | $3.48 \pm 1.08$ | $3.81 \pm 0.97$   |
| Eggs                   | $2.94 \pm 0.54$ | $2.72 \pm 0.79$   |
| Meat                   | $2.79 \pm 0.72$ | $2.90 \pm 0.88$   |
| Fish                   | $2.78 \pm 0.57$ | $2.83 \pm 0.76$   |
| Bean                   | $2.38 \pm 1.05$ | $2.79 \pm 0.76$   |
| Seaweed                | $2.22 \pm 1.03$ | $2.85 \pm 0.85$   |
| Chicken                | $1.98 \pm 0.94$ | $1.85 \pm 0.72$   |

Mean  $\pm$  SD. \* $p < 0.05$ .

Score: no=1, 1~2 times/week=2, 3~4 times/week=3, 5~6 times/week=4, always=5.

**Table 5.** Anthropometric and body strength measurements of the subjects before and after the nutritional education and physical exercise program

| Variables                 | Male              |                       | Female            |                     |
|---------------------------|-------------------|-----------------------|-------------------|---------------------|
|                           | Before            | After                 | Before            | After               |
| Waist circumference (cm)  | $82.55 \pm 10.61$ | $81.36 \pm 10.82$     | $74.66 \pm 9.76$  | $72.99 \pm 7.55$    |
| Hip circumference (cm)    | $89.63 \pm 7.71$  | $88.06 \pm 7.61$      | $83.30 \pm 3.28$  | $82.13 \pm 4.16$    |
| Triceps skinfold (mm)     | $27.79 \pm 5.97$  | $24.71 \pm 5.42^*$    | $26.80 \pm 5.49$  | $23.19 \pm 5.85^*$  |
| Subscapular skinfold (mm) | $26.69 \pm 9.88$  | $20.63 \pm 8.03^{**}$ | $22.75 \pm 8.95$  | $19.08 \pm 7.42^*$  |
| Grasping power (kg)       | $20.81 \pm 4.45$  | $22.19 \pm 5.09^*$    | $19.19 \pm 5.11$  | $20.75 \pm 4.75$    |
| Backmuscle strength (kg)  | $54.74 \pm 13.96$ | $60.84 \pm 17.86^*$   | $49.83 \pm 12.19$ | $53.38 \pm 16.85^*$ |

Mean  $\pm$  SD. \* $p < 0.05$ , \*\* $p < 0.01$ .

**Table 6.** Dietary habit of subjects before and after the nutritional and physical exercise program

| Variables                     |                         | Before    | After     | N (%)  | $\chi^2$ -test |
|-------------------------------|-------------------------|-----------|-----------|--------|----------------|
| Meal frequency per day        | 1 time                  | 6 (7.2)   | 7 (8.4)   | 3.354  |                |
|                               | 2 times                 | 30 (36.1) | 37 (44.6) |        |                |
|                               | 3 times                 | 42 (50.6) | 36 (43.4) |        |                |
|                               | 4 times                 | 5 (6.0)   | 3 (3.6)   |        |                |
| Skipping meals                | Breakfast               | 25 (30.1) | 21 (25.3) | 4.622  |                |
|                               | Lunch                   | 6 (7.2)   | 2 (2.4)   |        |                |
|                               | Dinner                  | 15 (18.1) | 13 (15.7) |        |                |
|                               | Non                     | 37 (44.6) | 47 (56.6) |        |                |
| The reason for skipping meals | Oversleeping            | 15 (18.1) | 13 (15.7) | 4.313  |                |
|                               | No appetite             | 25 (30.1) | 17 (20.5) |        |                |
|                               | Difficulty to digestion | 6 (7.2)   | 4 (4.8)   |        |                |
|                               | Eating snack            | 5 (6.0)   | 6 (7.2)   |        |                |
|                               | To loose weight         | 10 (12.0) | 14 (16.8) |        |                |
|                               | To spare money          | 1 (1.2)   | 5 (6.0)   |        |                |
|                               | No time for eating      | 18 (21.7) | 16 (19.3) |        |                |
| Just habit                    | 3 (3.6)                 | 8 (9.6)   |           |        |                |
| Meal time                     | Regular                 | 3 (5.4)   | 8 (10.0)  | 9.321* |                |
|                               | Generally regular       | 37 (44.6) | 45 (54.2) |        |                |
|                               | Generally irregular     | 29 (34.9) | 19 (22.9) |        |                |
|                               | Irregular               | 14 (16.9) | 11 (13.3) |        |                |
| Eating speed                  | Fast (< 15 min)         | 29 (34.9) | 24 (28.9) | 5.012  |                |
|                               | Normal (15 ~ 25)        | 50 (60.2) | 52 (62.7) |        |                |
|                               | Slow (> 25 min)         | 4 (4.8)   | 7 (8.4)   |        |                |
| Frequency of dining out       | more than 1 time a day  | 1 (1.2)   | 2 (2.4)   | 3.127  |                |
|                               | 1 ~ 3 times a week      | 7 (8.4)   | 7 (8.4)   |        |                |
|                               | Once a week             | 29 (35.0) | 33 (39.7) |        |                |
|                               | Once 2 ~ 3 week         | 25 (30.1) | 23 (27.7) |        |                |
|                               | Once a month            | 21 (25.3) | 18 (21.7) |        |                |

\* p &lt; 0.05.

was found that the 'fast eating speed' was reported by 34.5% in the study by Her et al. (19) with obese children, and 17% in Lim and Nam's study (20).

The findings of this study showed that there was a significant decrease in both body fat and weight, in addition to normalization of blood values after the completion of nutrition education and exercise programs. Because it has been reported that it is more important than short-term weight loss to maintain a good weight after weight loss (21,22), it is necessary to continue managing and monitoring the children who participated in the future.

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