Average Dietary Energy Intake does not Increase as BMI Increased in the National Health and Nutrition Examination Survey Data of Korea

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Abstract : Although the idea that obese people consume higher calorie diets is widely accepted, many dietary surveys have shown that obese people do NOT consume larger amounts of energy. We had an opportunity to study the relationship between calorie intake and obesity in Korea from the data contained in the '98 National Health and Nutrition Examination Survey of Korea. The survey was executed nationwide for two months - from Nov. 1 to Dec.30 in 1998. The survey included 10,876 (aged >10 years) subjects of whom 9,771 underwent health examinations. Surveyors visited each household and checked health status, measured anthropometry and blood pressures, collected blood and urine samples, and interviewed from the health questionnaires. Well-trained dietitians evaluated the food consumption of 11,525 subjects over the age of 1 year with the 24-hour recall method. The number of subjects from whom a complete health examination and food consumption information was obtained was 8,004. Subjects were classified by BMI (< 20, 20-22, 22-24, 24-26, 26-28, 28≤) and into newly diagnosed patients with DM (FBS ≥126 mg/dl), hypertension (SBP ≥ 140 mmHg or DBP ≥90 mmHg) and hyperlipidemia (Total cholesterol ≥ 220 mg/dl or TG ≥200 mg/dl). Our main results were as following: 1) their average energy intake was 2,029.6 ± 908.5 kcal and BMI is 22.6 ± 3.4 kg/m^2; 2) a comparison of nutrient intakes by BMI level did not show a significant difference of energy intake even though BMI increased (BMI, < 20: 1,999kcal ~ 28≤: 2,028 kcal); and 3) Even in newly diagnosed patients with diabetes, hypertension or hyperlipidemia, their energy consumption was not significantly increased as BMI increased (from BMI 20). There are several possible explanations for these results: 1) Reduced physical activity caused the weight of obese people to increase even with the same energy intake; 2) people underreported their energy consumption; or, people intentionally reduced their energy consumption due to self-image regarding their obesity. We might also hypothesize that there is a metabolic problem conceiving obese people, because calorie intake was not higher in obese people than in non-obese people in Korea. Further research is necessary for re-evaluating these current conclusions.

Key Words : BMI, calorie intake, '98 National Health and Nutrition Examination Survey

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I. Introduction

Obesity is defined as excessive storage of energy in the form of fat, and it is clearly associated with hypertension, hypercholesterolaemia, non-insulin-dependent diabetes mellitus, some cancers, and other medical problems (Despres, 2001; WHO, 1997). BMI is also one of the independent risk factors of mortality (Haapanen-Niemi, Miilunpalo, Pasanen, Vuori, Oja , Malmberg, 2000; Lew, Garfinkel, 1979; WHO, 1997). To define and grade obesity, body mass index (BMI) is popularly used. A person with a BMI between 20-24.9 is considered normal. In the overweight grade, a person with a BMI above 25 to 30 is considered as pre-obesity and one with a BMI above 30 is obese class I (moderate) (WHO, 1997). In the US, the prevalence of obesity, defined as even BMI $\geq$ 30, was around 20% in the early 1990s; and, for ten years, the prevalence was expected to increase (WHO, 1997). Among 84 countries covering 79.5% of the adult population worldwide, 8.2% of the population was BMI $\geq$ 30; and, in developed countries, obesity prevalence BMI $\geq$30 was 20.4% (WHO, 2001).

The etiology of obesity has not been accurately constructed, but one obvious fact about obesity is the balance problem of energy intake and expenditure. The idea that obese people eat more than they expend is generally accepted. A lot of studies have provided the results that obese subjects consume more than normal or lean subjects (Kim, Wee, 2001; Mokhtar, Elati, Chabir, Bour, Elkari, Schlossman, Caballero, Aguenaou, 2001; Waxman, Stunkard, 1980).

However, some studies have reported that the energy intake of overweight or obese people is not greater than expected (Garaulet, Martinez, Victoria, Perez-Llamas, Ortega, Zamora, 2000; Guillaume, Lapidus, Lambert, 1998; Kim, Moon, 2001; Miller, Lindeman, Wallace, Niederpruem, 1990; Ortega, Requejo, Andres, Lopez-Sobaler, Redondo, Gonzalez-Fernandez, 1995; Romieu, Willett, Stampfer, Colditz, Sampson, Rosner, Hennekens, Speize, 1988). Several studies of obesity in Korea have also shown the opposite results of what is a normally accepted idea (Kim, Park, Byoun, 2000; Lee, Sung, Sung, Choi, Lee, Cho, 2000; Yim, Yoon, Kim, Kim, Kim, Choi, 1993). Most of the research has interpreted this phenomenon as "under-reporting of energy intake" (Garaulet and colleagues, 2000; Lee and colleagues, 2000; Romieu and colleagues, 1988; Yim and colleagues 1993).

In 1998, the health examination survey was added to the national nutrition survey for further analysis of relationships between diet and health. With the National Health and Nutrition Examination Survey data, we authors examined the energy intake level by BMI level from the nationwide study done in Korea.

II. Subjects and Methods

1. Data source

The National Health and Nutrition Examination Survey of Korea was executed nationwide for two months from Nov. 1 to Dec.30 in 1998. The survey sample was selected from 200 sample clusters based on the national census in 1995. From 200 sample clusters, 13,523 households were recruited and whole household members participated in the survey. A total of 39,060 subjects joined this national survey. All subjects were administered health questionnaires which included inquiries regarding exercise level and alcohol consumption.

2. Health examination

Among the total number of households, a quarter of them were included in the health examination and dietary survey. From the full number of 10,876 target subjects (aged >10 years), 9,771 took health examinations. Cancer patients who had undergone chemical therapy within the past 4 weeks, hemophiliacs, and patients with cognitive disorders were excluded. Well-trained nurses measured blood pressure and anthropometry including height, weight, abdomen circumference, and hip circumference. Clinical pathologists collected blood and urine samples. Blood pressure was measured using a Baumanometer® (W.A. Baum Co. Inc. Copiague, NY, USA). Blood contents including total cholesterol, HDL-cholesterol, fasting blood sugar, SGOT, SGPT, BUN, creatinine, HBA1c, type-B hepatitis antigen, antibody, and CBC and urinary protein secretion were assessed.

3. Dietary data

Dietary data was obtained by a 24-hour recall method for 11,525 subjects over the age of 1 year. Well-trained dietitians interviewed subjects conceiving food consumption with a measuring cup or 2-dimensional food models. They also checked the household tableware and leftovers of food ingredients. Nutrient intake was calculated based on the 5th edition of food composition tables (1996) and the database of processed food/fast food.

4. Classification of subjects

The number of subjects with a complete health examination and food consumption information was 8,004. Subjects were classified into 6 BMI groups (<20, 20-22, 22-24, 24-26, 26-28, 28≤). Subjects who were not diagnosed before and with fasting blood sugar (FBS) ≥126 mg/dl were categorized as newly diagnosed diabetic patients. Also, newly diagnosed hypertensive patients were subjects who had "SBP ≥ 140 mmHg or DBP ≥ 90 mmHg"; they had never been diagnosed with hypertension before. Newly diagnosed hyperlipidemic patients were subjects with "Total cholesterol ≥ 220 mg/dl or Triacylglyceride ≥ 200 mg/dl"; they had never been diagnosed with hyperlipidemia before.

5. Data analysis

Results are expressed as mean ± SD (standard deviation). Statistical comparison of means among groups was tested by general linear model (GLM) and age and sex were adjusted. All the analyses were conducted using SAS ver. 8.01 (SAS Institute Inc. 2001).

III. Results

The mean age of the studying participants was

39.6 ±18.4 (mean ±SD) years (range 10 to 94 years). The mean age (40.5 ±18.7) of the females was slightly, but significantly higher than that (38.5 ±18.0) of the males. Anthropometric data tested in this study were significantly higher in males than those in females. The average energy intake of all of the participants was 2029.6 ± 908.5 kcal and BMI is 22.6 ± 3.4 kg/m^2. BMI and energy intake were also significantly different between males and females ($p< 0.001$ for both BMI and energy intake) (Table 1).

Table 2 shows the change of macronutrient intakes by BMI level. The BMI group did not significantly change energy intakes as BMI increased even though other nutrient intakes were slightly different. The energy intake of men increased as BMI increased, but in the BMI 26-28 group and over 28 group, the energy intake dropped slightly. In women, the energy intake was not significantly changed. The range of average energy intakes by the BMI group was only 71 kcal (1,999 to 2,070 kcal) in total subjects.

The protein and carbohydrate consumption of subjects with BMI < 20 was lower and the other groups consumed similar amounts of protein and carbohydrate. Men showed similar trends, but women did not change their protein and carbohydrate consumption as BMI changed. The proportion of calories from protein was not significantly different among BMI groups in men, women, and total subjects. Proportion of calories from carbohydrate was slightly increased in the BMI 28 group and then fell down. Women had a similar change, but men showed a declination trend as BMI increased. However, after adjustment by sex and age, differences between the proportion of calories from carbohydrate by BMI level disappeared. Fat consumption was decreased by a BMI increase; and, at the above BMI 28 group, it slightly increased in total subjects and women, but fat was consumed a similar level in every BMI group of men. The proportion of calories from fat showed the same trend as fat consumption. They decreased as BMI increased and slightly increased at the above BMI 28 group. Differences between fat consumption and the proportion of calories from fat by BMI level also disappeared after adjustment by sex and age.

Questions regarding frequency of exercise and alcohol consumption during the previous month

<Table 1> Characteristics of subjects

Nutrients \ BMI	Men (n=3657)	Women (n=4347)	All (n=8004)
Age (year) ***	38.5 ± 18.0	40.5 ± 18.7	39.6 ± 18.4
Height (cm) ***	167.4 ± 8.45	155.9 ± 6.76	161.1 ± 9.51
Weight (cm) ***	63.7 ± 10.0	55.4 ± 9.3	59.0 ± 11.3
W/H ratio ***	0.87 ± 0.07	0.83 ± 0.08	0.85 ± 0.08
BMI (kg/m^2) ***	22.5 ± 3.31	22.8 ± 3.52	22.6 ± 3.43
Energy intake (kcal) ***	2293.9 ± 983.4	1807.4 ± 773.5	2029.6 ±908.5

*** : $p < 0.001$

<Table 2> Comparison of nutrient intakes by BMI level

(n=8004)

Nutrients	BMI	20	20-22	22-24	24-26	26-28	28-
Energy (kcal)	Total	*n=1831*	*n=1758*	*n=1777*	*n=1390*	*n=737*	*n=511*
	(n=8004)	1999±905.3	2012±956.6	2049±890.9	2070±892.1	2005±869.1	2028±909.9
	Men	*n=870*	*n=786*	*n=841*	*n=642*	*n=326*	*n=192*
	(n=3657)	2203±927.7[c 1)]	2268±1112[bc]	2283±959.1[abc]	2414±943.0[a]	2328±923.3[abc]	2401±963.8[ab]
	Women	*n=961*	*n=972*	*n=936*	*n=748*	*n=411*	*n=319*
	(n=4347)	1813±843.2	1822±753.0	1838±766.5	1775±726.7	1749±729.4	1803±797.2
Protein (g)	Total	71.7±44.0	76.2±66.3	78.1±58.8	78.9±51.0	75.7±53.3	78.7±54.7
	Men	78.6±43.9	85.5±71.5	87.9±64.3	92.5±49.9	90.8±61.8	94.8±61.0
	Women	65.5±43.2	68.7±60.9	69.2±51.7	67.1±48.9	63.7±41.8	68.9±48.0
% calories from protein	Total	14.5±8.7	15.0±11.3	15.2±9.0	15.1±7.8	14.9±6.6	15.1±6.3
	Men	14.5±7.9	14.9± 6.9	15.5±10.1	15.3±5.9	15.6±7.1	15.4±6.0
	Women	14.5±9.4	15.1±13.9	14.9±7.8	15.0±9.2	14.4±6.2	15.0±6.4
Carbohydrate (g)	Total	328.2±146.0	333.7±139.6	340.6±141.0	344.9±145.4	340.3±139.4	337.4±142.4
	Men	358.1±146.3[b]	362.9±148.0[ab]	368.7±148.6[ab]	384.0±152.1[a]	374.6±147.5[ab]	379.6±148.2[ab]
	Women	301.2±141.1	310.0±127.6	315.3±129.0	311.3±130.4	313.1±126.3	312.1±132.7
% calories from carbohydrate	Total	67.1±11.6	67.7±11.9	68.1±11.8	68.4±12.5	69.8±11.8	68.4±12.0
	Men	66.4±11.7	65.9±12.2	66.2±12.3	65.0±12.9	65.9±12.4	64.5±13.3
	Women	67.8±11.4	69.1±11.5	69.7±11.1	71.3±11.4	72.8±10.4	70.7±10.5
Fat (g)	Total	43.0±34.9	40.4±43.1	39.7±34.8	38.3±31.0	34.6±29.6	37.7±32.8
	Men	47.1±36.9	46.4±55.0	45.3±39.4	46.7±33.8	43.1±33.5	48.9±38.4
	Women	39.3±32.6	35.6±29.5	34.6±29.1	31.1±26.3	27.9±24.1	31.1±26.7
% calories from fat	Total	18.2±9.4	16.6±9.0	16.3±9.2	15.7±8.7	14.5±7.9	15.5±8.3
	Men	18.0±9.3	16.8±8.8	16.7±9.2	16.7±8.3	16.0±8.1	17.6±8.6
	Women	18.3±9.4	16.5±9.1	16.0±9.1	14.8±8.9	13.4±7.5	14.3±7.8

1) Different alphabets mean the average nutrient intake was significantly different by GLM after sex and age adjustment ($p<0.05$).

were asked in the health questionnaire section. The questions regarding exercise were answered with responses which of 7 levels of activity from "never" to "every day". Because the exercise questionnaire created difficulties for conversion into quantitative exercise levels, we scored them to calculate the correlation coefficients. The Spearman's correlation coefficient between BMI and exercise levels showed an inverse but very weak correlation ($r=-0.041$, $p < 0.004$). The energy intakes of subjects increased as the exercise level increased to the moderate exercise level but then fell down at the group exercising 3 times a week. Average energy intakes were significantly increased as BMI increased in drinkers but decreased as BMI increased in non-drinkers (data were not shown).

Newly diagnosed diabetic patients showed

<Table 3> Comparison of macronutrients intake by BMI level in diabetic patients

Nutrients \ BMI	- 20	20-22	22-24	24-26	26-28	28 -
Energy						
n=521	*75*	*78*	*121*	*101*	*82*	*64*
Newly DM	1745±612[b]	1854±619[ab]	1969±803[ab]	2100±851[a]	1971±785[ab]	2046±845[a]
n=7224	*1718*	*1638*	*1599*	*1229*	*617*	*423*
Normal	2013±916	2038±974	2066±901	2085±902	2020±891	2035±927
Protein						
Newly DM	59.4±32.3	71.4±64.6	70.8±39.1	85.0±60.3	69.1±36.0	80.5±49.5
Normal	72.3±44.4	76.6±65.6	78.9±60.4	79.0±50.6	76.7±55.8	78.47±56.2
Carbohydrate						
Newly DM	297.5±105.9	325.4±105.0	336.6±141.7	343.1±133.0	337.6±121.1	344.9±133.7
Normal	329.9±148.5[b]	335.3±141.5[ab]	343.0±141.4[ab]	347.0±147.5[a]	341.0±143.4[ab]	338.1±145.6[ab]
Fat						
Newly DM	32.0±25.9[ab]	27.6±21.0[b]	31.7±27.0[ab]	38.1±31.9[a]	33.0±29.6[ab]	36.0±27.2[ab]
Normal	43.6±34.8	41.5±44.2	40.5±35.3	38.9±31.2	35.3±30.0	38.1±33.8

1) Different alphabets mean the average nutrient intake was significantly different by GLM after sex and age adjustment ($p<0.05$)

<Table 4> Comparison of macronutrients intake by BMI level in hypertensive patients

Nutrients \ BMI	- 20	20-22	22-24	24-26	26-28	28 -
Energy						
n=1327	*168*	*209*	*305*	*290*	*201*	*154*
Newly HT[1)]	1754±865[c 2)]	1890±757[bc]	1976±919[ab]	2116±879[a]	2022±891[ab]	2117±784[a]
n=6173	*1635*	*1486*	*1362*	*963*	*443*	*284*
Normal	2033±908	2050±983	2084±888	2085±894	2024±874	2048±997
Protein						
Newly HT	61.4 ±43.9	70.8 ±49.1	73.9±51.8	81.3±51.5	77.4±49.9	82.9±46.9
Normal	73.1 ±44.0	77.3 ±67.7	80.2 ±61.0	78.5 ±48.5	75.0 ±44.0	79.4 ±60.5
Carbohydrate						
Newly HT	304.9±149.2[c]	321.8±129.2[bc]	336.8±158.4[ab]	354.8±148.5[a]	346.6±143.6[ab]	349.8±130.6[ab]
Normal	331.8±146.5	336.5±140.6	342.8±137.0	345.5±146.1	338.6±138.3	339.0±152.2
Fat						
Newly HT	29.0 ±29.5[c]	31.3 ±27.7[bc]	32.3 ±29.0[bc]	36.9 ±30.8[ab]	32.6 ±27.9[bc]	40.0 ±28.2[a]
Normal	44.8 ±35.2	42.3 ±45.2	42.6 ±36.3	40.1 ±30.6	37.3 ±31.5	38.8 ±36.8

1) HT: Hypertension patients

2) Different alphabets mean the average nutrient intake was significantly different by GLM after sex and age adjustment ($p<0.05$).

similar energy intakes as BMI increased except in the BMI $<$ 20 group. But normal subjects showed similar energy intakes at all BMI levels. Protein and carbohydrate intakes were increased a little bit in newly diagnosed patients from BMI 20; however, after adjustment of sex and age, there was no significant difference. In the normal subjects similar trends were shown in macronutrients except in carbohydrate intake. The BMI $<$ 20 group consumed lower carbohydrate in normal subjects. The fat intakes of subjects decreased as BMI increased to BMI 26. In newly diagnosed diabetic patients, the average fat intake by BMI level was significantly different (Table 3).

Newly diagnosed hypertensive patients (Table 4) also showed the same inclination in energy intakes. Energy intakes were increased as BMI increased in newly diagnosed patients and were statistically the same by BMI level as normal subjects. Protein, fat, and carbohydrate intakes were increased as BMI increased in hypertensive patients; but, in normal subjects, fat intake showed a negative relation to BMI. But, after adjusting by sex and age, there was no significant difference.

Hyperlipidemic patients showed very similar energy, protein, fat, and carbohydrate intake levels in newly diagnosed patients and normal subjects except the carbohydrate intake of newly diagnosed patients (Table 5). They consumed more carbohydrate as BMI increased.

<Table 5> Comparison of macronutrients intake by BMI level in hyperlipidemic patients

Nutrients \ BMI	- 20	20-22	22-24	24-26	26-28	28 -
Energy						
n=1711	*172*	*265*	*402*	*402*	*264*	*206*
Newly HL[1)]	1839±1033	1998±1287	2047±991	2113±945	2040±904	2048±976
n=6263	*1658*	*1492*	*1370*	*977*	*465*	*301*
Normal	2015±890	2025±886	2051±861	2054±873	1978±845	2023±865
Protein						
Newly HL	68.6±49.4	77.2±105.1	79.0±65.3	82.3±57.6	75.9±61.8	82.0±63.4
Normal	72..0±43.4	76.0±56.8	77.8±56.6	77.5±48.1	74.7±46.7	76.7±48.0
Carbohydrate						
Newly HL	304.7±181.1[c][2)]	325.1±131.0[bc]	346.8±149.7[ab]	356.9±148.4[a]	346.2±137.8[ab]	337.6±153.3[ab]
Normal	338.9±142.1	335.2±141.1	338.9±138.7	339.9±144.3	336.1±140.1	338.9±134.9
Fat						
Newly HL	34.9±32.8	38.8±72.4	37.0±37.7	36.6±31.3	33.2±32.4	38.5±34.3
Normal	43.9±35.0	40.7±35.6	40.5±33.8	39.1±30.9	35.3±27.6	37.5±31.8

1) HL: Hyperlipidemic patients

2) Different alphabets mean the average nutrient intake was significantly different by GLM after sex and age adjustment ($p<0.05$).

IV. Discussion

Obesity has been thought to be caused by high energy intake and less energy expenditure (Garrow, 1988; Jequier, Tappy, 1999). Many studies have reported that the high fat intake or high proportion of energy from fat is associated with obesity (Alfieri, Pomerleau, Grace, 1997; Bray, Popkin, 1998; Guillaume and colleagues 1998; Mohktar and colleagues, 2001; Nguyen, Larson, Johnson, Goran, 1996; Ortega and colleagues, 1995; Romieu and colleagues, 1988). In industrial countries, calorie intake from fat is 40% or more of the total energy intake and obesity prevalence is very high (Jequier, Tappy, 1999; WHO, 2001). Although it appears that obese subjects consume high fat diets, Jequier has commented that fat is not a major cause for the development of obesity (WHO, 2001). In this study, subjects who had higher BMI showed lower fat intake and a lower proportion of energy from fat. Rather than fat intake, alcohol consumption was related to obesity.

WHO (2001) provided the criteria of obesity as BMI above 30, and the prevalence in western countries is over 20%. In this study, only 2.22% (178 subjects from 8,004) were considered obese with WHO criteria. And overweight or obese subjects did not show a higher energy intake than normal subjects.

There might be several possible explanations for our results. First, reduced physical activity may increase the weight of obese people even at the same energy intake. Kuboonchoo (2001) has suggested that the increase in obesity is the result of reduced physical activity, and other studies have reported the obese tend to be less physically active (Miller and colleagues, 1990; Garaulet and colleagues, 2000; Romieu and colleagues, 1988; Waxman, Stunkard, 1980). This relationship sufficiently explains the weak inverse relation between body size and caloric intake that has been observed in most epidemiologic studies (Willett, 1998). The same energy intake but a different BMI might be accepted as the same energy intake but with less movement. In this study, it is hard to say if there is a correlation between BMI and exercise. But exercising subjects (1-5 times a week) had higher energy consumption than subjects with no exercise or every day exercise. More investigation is needed about exercise, BMI, and energy intake.

A second possible explanation is under-reporting. Siedell (1998) has commented that reported fat or energy intake was usually lower than expected or measured energy expenditure and errors are related to the degree of obesity. Several studies have reported the confirmed underreporting of energy intake in obese subjects (Lichtman, Pisarska, Berman, Pestone, Dowling, Offenbacher, Weisel, Heshka, Mattews, Heymsfield, 1992; Zhang, Temme, Sasaki, Kesteloot, 2000). And some reports have argued that the prevalence of underreporting and the degree of underreporting of energy intake were increased with increasing BMI (Gnardellis, Boulou, Tricholpoulou, 1998; Zhang and colleagues, 2000). In general, those who consumed considerably less than the average intake of energy are more likely to over-report their intakes, while those who eat considerably more than the average intake of energy tend to underreport. This it is called "flat-slope syndrome" (Gersovitz, Madden, Smiciklas-Wright, 1978;

Madden, 1980). Fatter subjects might answer that their intakes were lower than is true at the 24 hr recall survey. Many studies have blamed this weak or inverse correlation between energy intake and BMI to underreporting. However, our data was not from a small group study. As Romieu and colleagues (1988) have commented, it is hard to believe that all the people answered with an amount lower than their real diet. We could not find any supporting evidence for the underreporting in our data, although lack of evidence is not enough to disrepute.

The other explanation is the intentional reducing of energy consumption by self-image of obesity. Less obese people intentionally reduce the amount of calories in their diet because they thought they were obese. Decreasing fat intake by BMI increasing might be a reflection of nutrition knowledge.

When considering the change of dietary patterns after subjects became aware of their diseases, we compared the energy intake after excluding the pre-diagnosed patients. A significant difference in energy and other macronutrient intakes showed at the BMI < 20 group. In BMI 20 and over, nutrient intakes by BMI level were similar. In newly diagnosed hypertensive patients, subjects with BMI 22 had significantly lower energy intakes. Their energy intakes were also lower than normal subjects. This seems to present us with the peculiar fact that there are hypertensive patients with low BMI and low energy intake in Korea.

High energy intake was not sufficient to explain obesity. Furthermore, it is difficult to explain why all the groups with different BMI should take same amount of calories. We believe there are some biological constraints which make body energy balance constant, and increased weight is balanced out by reduced activities. In support of this view, Guillaume and colleagues (1998) suggested that the positive energy balance causing obesity is due mainly to a low energy output. However, it is also possible that a condition which causes less energy production, such as lowered mitochondrial function, as suggested by Lee (2001), causes obesity. This view is supported by Saltzman and Roberts (1995), who summarized in their review that in individuals who are genetically susceptible to weight gain, reduced energy expenditure for resting metabolism and/or physical activity appears to occur in response to underlying metabolic mechanisms that create a drive for surplus energy. We cannot extract evidence supporting hypothesis of Saltzman and Roberts' hypothesis from this study, and further research will be needed to reevaluate.

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