Original article

Can the duration of obesity, diet, and physical activity be determinants in metabolic healthy obesity?

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Abstract *Objective:* A subgroup is defined as metabolic healthy obese, resistant to the development of complications caused by obesity. This study aims to evaluate the difference between obese subgroups in terms of diet, physical activity, and time spent obese. *Methods:* 401 individuals between the ages of 18-65 with a body mass index greater than 30 kg/m^2 participated in the study. A questionnaire form was applied in which the general characteristics of the individuals were questioned, anthropometric measurements were made, and biochemical blood parameters were taken. Food consumption and physical activity records were taken. According to the metabolic syndrome diagnostic criteria, ATP III, individuals are classified as metabolically healthy or metabolically unhealthy. *Results:* At the end of the study, 60% of women (n=147) and 69% of men (n=109) were found to be metabolically unhealthy obese ($p<0.05$). It was observed that the amount of energy, total fat, saturated fat, and carbohydrates taken with the daily diet are higher in those with unhealthy obesity than in the healthy obese ($p<0.05$). The risk of metabolic unhealthy obesity was found to be 2.2 times higher in individuals with a body mass index over 30 kg/m^2 for more than 10 years. After the age of 52, the risk of being obese with metabolic unhealthy is 2.5 times higher. *Conclusion:* It is thought that lifestyle may be a distinguishing factor in the group of obesity resistant to metabolic risk factors. Clarification of the possible effects of nutrition in metabolically healthy obese will be important in the treatment of obesity.

Key words: Diet, Physicial Activity, Healthy obesity, Obese subgoups, Unhealthy obesity

Introduction

Obesity, defined as excessive fat accumulation in the body, is a major public health problem responsible for the development of many chronic diseases, especially diabetes and cardiovascular diseases in the modern world (1). Its incidence is increasing rapidly in our country and in the world. The prevalence of obesity has increased approximately three times in the last 40 years worldwide. The World Health Organization reported that 39% of the 18-year-old and older group are overweight and 13% are obese (2). According to the 2017 data of the Turkey Nutrition and Health Survey conducted in our country, 36.6% of individuals aged 19 and over are overweight, 30.0% are obese, and 4.1% are morbidly obese (3).

While the metabolic basis of chronic diseases caused by obesity continues to be investigated, it was observed that the presence of complications caused by obesity differs among obese individuals. About 20 years ago, a new phenomenon called "Metabolic Healthy Obesity" was described (4). Although obese individuals, defined as metabolically healthy, have high fat mass and BMI ≥ 30 kg/m^2, high insulin sensitivity, low organ fattening, low triglyceride level, low inflammation, high HDL-C and high adiponectin concentration, and normal blood pressure are observed (5). Due to the lack of precise criteria for defining metabolic healthy obesity, the prevalence of this phenotype is determined as 10%-45% in studies. Ethnicity, age, and gender are shown as the cause of metabolic healthy obesity (6). NHANES data from 1994 to 2004 show that 31.7% (or 19.5 million people) of obese 20-year-old adults were metabolically healthy obese (7,8). At the end of the study conducted by scanning the national health insurance database in Korea, it was found that 39.3% of men and 55.2% of women had metabolic healthy obesity (9).

Nutrition and exercise are modifiable risk factors that affect human health. In the development of insulin resistance, the basis of metabolic unhealthy obesity, and in the medical nutrition therapy used in the treatment of the disease, the amount and variety of the energy taken with the daily diet from carbohydrates and fats have an important place (10). Also, considering the effects of nutrition and exercise on the formation of chronic diseases, independent of excess body weight, it is considered that nutrition and exercise are important determinants of the healthy obesity phenotype, but their effects have not been determined definitively (11).

This study aims to evaluate the difference between obese subgroups in terms of diet, physical activity, and time spent obese based on gender.

Materials and methods

Participants

People from the province of Istanbul who visited the Acbadem Atakent Hospital Diet Polyclinic between December 2017 and November 2021 participated in this cross-sectional study. The sample of the study consisted of volunteers between the ages of 18 and 65, with a body mass index of 30 kg/m^2 and above. Individuals who are not in the determined age and BMI range, pregnant, or lactating women were not included in the study.

According to the power analysis, the sample of the study was determined as 356 people in order to achieve 80% power at the level of $\propto = 0.05$, taking into account the possible losses, more people were included and it was completed with a total of 401 volunteers, 147 women and 109 men.

Permission for the study was obtained from Acıbadem Mehmet Ali Aydınlar University Medical Research Evaluation Board with the decision number 2021-24/13. Additionally, participants signed a formal consent form confirming their willingness to take part in the study. Metabolic healthy obesity was defined using the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATPIII) criteria (12). Accordingly, Metabolic unhealthy obesity is defined as the presence of at least two of the criteria of diabetes mellitus, impaired glucose tolerance or insulin resistance, abdominal obesity (BMI>30 kg/m^2 or waist circumference over 94 cm for men and 80 cm for women), dyslipidaemia (fasting triglyceride level above 150 mg/dl or low HDL cholesterol level (40 mg/dL in men, below 50 mg/dL in women), and hypertension (systolic ≥ 130 mmHg, diastolic ≥ 85 mmHg or being hypertensive).

Procedure

The levels of FBG, total cholesterol, HDL and LDL cholesterol, and triglycerides were assessed in biochemical blood samples taken from people following a 12-hour fast. After at least five minutes of rest, systolic and diastolic blood pressure were monitored while the subject was sitting, and the mean value was calculated by taking two readings for each person.

Anthropometric measurements consist of body weight, body mass index, and waist circumference. The height of the individuals was measured with a stadiometre. When the person was standing with the abdomen in a typical relaxed position, the midpoint between the lowest rib bone and the cristailiac was measured. The circumference passing through the midway was measured with a non-stretchable tape measure, assuring parallelism to the ground. On a computerized balance, the subject's weight was recorded (Seca, 727).

The amount of food and drink consumed by individuals with their diets was determined by taking a 24-hour retrospective food consumption record form, two days on weekdays and one day on weekends, a total of 3 days. In order to determine the amount of food consumed, the sources of Food Photo Catalogue: Measures and Quantities and Standard Food Tariffs were used (13). The data obtained from the food consumption record were analysed with the BEBIS 7.2 program (14).

The International Physical Activity Questionnaire (IPAQ), which was translated into Turkish and validated, was used to determine the physical activity levels of individuals (15).

Statistical evaluation

The statistical analysis was done using NCSS (Number Cruncher Statistical System) software. While analyzing the study data, descriptive statistical methods (mean, standard deviation, median, frequency, percentage, minimum, and maximum) were used. The Shapiro-Wilk test and visual analyses were used to determine if the quantitative data adhered to the normal distribution. The Mann-Whitney U test was used to compare two groups of quantitative variables with non-normal distributions, and the Student t-test was used to compare two groups of quantitative variables with normally distributed distributions. Comparing qualitative data was done using the Pearson chi-square test. To define the cut-off value for the parameters, diagnostic screening tests (sensitivity, specificity, PKD, and NKD) and ROC analysis were utilized. The threshold for statistical significance was set at p< 0.05.

Results

Of the 245 women and 156 men who participated in the study, 64% were metabolically unhealthy and 36% were metabolically healthy. It was discovered that the subjects with metabolically unhealthy obesity were statistically older than those with healthy obesity. The difference between the groups was statistically significant (p=0.001; p<0.01). Statistical analysis revealed that the BMI values of people with unhealthy obesity were statistically substantially higher than those with healthy obesity (p=0.003; p<0.01). The time period for individuals with unhealthy obesity to have a BMI greater than 30 was found to be statistically significantly higher than those with healthy obesity (p=0.001; p<0.01). Waist circumferences of individuals with unhealthy obesity were found to be statistically significantly higher than individuals with healthy obesity (p=0.023; p<0.05) (Table 1).

Table 1. Evaluation of Descriptive Characteristics by Obesity Type.

		Obesity Type			
		Unhealthy (n=256)	**Healthy (n=145)**	**Total (n=401)**	***p***
Age	*Mean±SD*	47,07±12,2	41,19±13,19	44,94±12,87	***a0,001*****
	Median (Min-Max)	50 (19-65)	43 (18-65)	47 (18-65)	
Gender	**Female**	147 (60,0)	98 (40,0)	245 (61,1)	***b0,045****
	Male	109 (69,9)	47 (30,1)	156 (38,9)	
Height (cm)	*Mean±SD*	166,84±9,3	167,05±8,86	166,92±9,13	***c0,830***
	Median (Min-Max)	166 (145-195)	166 (150-194)	166 (145-195)	
Body Weight (kg)	*Mean±SD*	94,71±14,73	92,81±15,44	94,02±15	***a0,063***
	Median (Min-Max)	93 (70-191)	90 (70-179,9)	91 (70-191)	
BMI (kg/m²)	*Mean±SD*	34,05±4,17	33,34±4,54	33,79±4,32	***a0,003*****
	Median (Min-Max)	33 (30-56,8)	32 (30-65)	32,7 (30-65)	
Time to BMI>30 (years)	*Mean±SD*	12,97±8,53	10,55±7,58	12,09±8,27	***a0,001*****
	Median (Min-Max)	10 (1-61)	9 (1-46)	10 (1-61)	
Waist Circumference (cm)	*Mean±SD*	107,42±13,31	104,34±12,22	106,3±13	***c0,023****
	Median (Min-Max)	106,5 (82-167)	104 (76-137)	105 (76-167)	

[a]Mann Whitney U Test
[b]Pearson Chi-Square Test
[c]Student-t Test
*p<0.05
**p<0.01

Fasting blood glucose, LDL-Cholesterol, triglyceride values, and systolic and diastolic blood pressure values of individuals with unhealthy obesity were found to be statistically significantly higher than those with healthy obesity (p=0.001; p<0.01). The HDL-cholesterol value of the subjects with unhealthy obesity was found to be statistically significantly lower than the subjects with healthy obesity (p=0.001; p<0.01). (Table 2)

The number of weekly meals out in the cases with unhealthy obesity was found to be statistically significantly higher than the cases with healthy obesity (p=0.001; p<0.01).

There is no statistically significant difference between the daily intakes of polyunsaturated fat, omega-3 fatty acids, and protein for individuals according to their level of obesity (p>0.05). The amount of energy, carbohydrate, and saturated fat consumed daily in the cases with unhealthy obesity were found to be statistically significantly higher than the cases with healthy obesity, and the amount of fibre was found to be lower (p=0.001; p<0.01). The daily intake of mono-saturated fat in patients with unhealthy obesity was found to be statistically significantly higher than in patients with healthy obesity (p=0.011; p<0.05).

The distribution of sitting time, average MET, and activity levels of individuals according to obesity type do not show a statistically significant difference (p>0.05) (Table 3).

The cut-off point for age was determined as 52 and above according to obesity type. For the 52 cut-off values of age, the sensitivity was 44.14%, the specificity was 76.55%, the positive predictive value was 76.90%, and the negative predictive value was 43.70%. In the ROC curve obtained, the area under it was 63% and the standard error was 2.9%.

A statistically significant relationship was found between the type of obesity and the cut-off value of 52 for age (p=0.001; p<0.01). We can say that the risk of being unhealthy obese in 52 years old and over cases is 2,580 times higher. The ODDS ratio for age is 2,580 (95% CI: 1.634-4.073). According to the obesity type, the cut-off point for the duration of BMI>30

Table 2. Evaluation of Laboratory Results by Obesity Type.

		Obesity			
		Unhealthy (n=256)	**Healthy (n=145)**	**Total (n=401)**	***p***
FBG	*Mean±SD*	121,33±44,61	96,78±17,96	112,45±39,04	***a0,001***
	Median (Min-Max)	111 (11-388)	95 (70-240)	101 (11-388)	
HDL_Cholesterol	*Mean±SD*	45,33±12,32	54,31±12,91	48,58±13,25	***a0,001***
	Median (Min-Max)	44 (21-120)	53 (30-86)	47 (21-120)	
LDL_Cholesterol	*Mean±SD*	144,26±40,64	125,28±35,44	137,4±39,86	***c0.001***
	Median (Min-Max)	146 (33-272)	121 (47-239)	137 (33-272)	
Total Cholesterol	*Mean±SD*	355,28±186,39	354,77±196,18	355,1±189,74	***c0.979***
	Median (Min-Max)	325,1 (42-942,1)	326,5 (14,6-909,8)	325,2 (14,6-942,1)	
Triglyceride	*Mean±SD*	207,55±95,11	123,54±53,42	177,3±91,84	***a0,001***
	Median (Min-Max)	181 (48-792)	116,5 (42-400)	158 (42-792)	
Systolic Blood Pressure	*Mean±SD*	126,41±19,91	113,82±28,72	121,86±24,21	***a0,001***
	Median (Min-Max)	130 (13-180)	120 (11-150)	120 (11-180)	
Diastolic Blood Pressure	*Mean±SD*	80,54±15,06	73,11±20,56	77,85±17,59	***a0,001***
	Median (Min-Max)	80 (6-150)	80 (6-120)	80 (6-150)	

[a]Mann Whitney U Test
[c]Student-t Test
**p<0.01

Table 3. Evaluation of Daily Nutrients and Physical Activity Levels by Obesity Type.

		Obesity			
		Unhealthy (n=256)	**Healthy (n=145)**	**Total (n=401)**	***p***
Number of Meals Out per Week	*Mean±SD*	2,92±2,3	2,11±1,96	2,62±2,21	***a0,001*****
	Median (Min-Max)	2 (0-10)	2 (0-14)	2 (0-14)	
Energy (kcal)	*Mean ±Sd*	1950,39±672,12	1680,35±558,93	1852,75±646,01	***c0.001*****
	Median (Min-Max)	1883.5 (631,7-5039,5)	1611.6 (490,9-4011,8)	1783.4 (490,9-5039,5)	
Protein (g)	*Mean ±SD*	78,69±26,38	81,26±73,67	79,62±48,98	***a0.107***
	Median (Min-Max)	76 (21,7-177,2)	70,1 (17,1-874,2)	73,6 (17,1-874,2)	
Fat (g)	*Mean±SD*	88,17±37,94	80,23±38,15	85,3±38,16	***a0.011****
	Median (Min-Max)	80,8 (13,9-280,2)	75,1 (16,4-283,7)	79 (13,9-283,7)	
Carbohydrates (g)	*Mean ±SD*	207,97±91,17	164,09±72,71	192,11±87,45	***c0.001*****
	Median (Min-Max)	194,6 (34,4-619,4)	155,2 (18,8-376,2)	180,6 (18,8-619,4)	
Fibre(g)	*Mean ±SD*	20,33±7,68	24,37±10,19	22,91±9,55	***c0.001*****
	Median (Min-Max)	19,5 (5,4-49,5)	22,6 (2,9-63,8)	21,4 (2,9-63,8)	
SFA (g)	*Mean ±SD*	33,81±13,64	32,98±50,62	33,51±32,27	***a0,001*****
	Median (Min-Max)	33,4 (4,5-100,4)	28,4 (8,7-623,4)	31,4 (4,5-623,4)	
MUFA (g)	*Mean ±SD*	30,76±13,34	27,69±12,24	29,65±13,02	***a0.011****
	Median (Min-Max)	28,3 (4,7-109,8)	26,4 (5,2-97,8)	27,7 (4,7-109,8)	
PUFA (g)	*Mean ±SD*	15,43±10,89	13,88±10,17	14,87±10,64	***a0.127***
	Median (Min-Max)	12,3 (3-70,6)	12 (1,7-85,5)	12,2 (1,7-85,5)	
Omega 3 (g)	*Mean ±SD*	2,4±3,07	2,42±3,39	2,4±3,18	***a0.471***
	Median (Min-Max)	1,6 (0,3-31,7)	1,6 (0,3-30,6)	1,6 (0,3-31,7)	
Sitting Time	*Mean ±SD*	10,86±13,21	8,85±2,86	10,13±10,73	***a0.220***
	Median (Min-Max)	9 (2-136)	9 (1-18)	9 (1-136)	
Activity Level	**Inactive**	97 (63,0)	57 (37,0)	154 (38,4)	***b0,912***
	Minimal Active	133 (63,9)	75 (36,1)	208 (51,9)	
	Very Active	26 (66,7)	13 (33,3)	39 (9,7)	

[a]Mann Whitney U Test
[b]Pearson Chi-Square Test
[c]Student-t Test
**p<0.01

was determined as 10 years and above. For the 10-year cut-off value of the BMI value higher than 30, the sensitivity was 67.46%, the specificity was 51.75%, the positive predictive value was 71.10%, and the negative predictive value was 47.40%. In the ROC curve obtained, the area under it was 60.7% and the standard error was 3%.

A statistically significant relationship was found between the type of obesity and the 10-year cut-off value of the BMI value higher than 30 (p=0.001; p<0.01). In unhealthy obese cases, we can say that the risk of having a BMI higher than 30 to be 10 years or more is 2,223 times higher. The ODDS ratio is 2.223 (95% CI: 1.460-3.386) for a BMI greater than 30 to be 10 years. (Table 4)

Table 4. Diagnostic Screening Tests and ROC Curve Results for Age and Time to Overweight by Obesity Type.

	Diagnostic Scan					ROC Curve		
	Cut off	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Area	95% Confidence Interval	*p*
Age	*≥52 years*	44.14	76.55	76.90	43.70	**0.630**	0,574-0,687	***0,001****
BMI>30 Time	*≥10 years*	67.46	51.75	71.10	47.40	**0.607**	0,548-0,665	***0,001****

**p<0.01

Discussion

While trying to define the mechanism of the relationship between obesity and other metabolic diseases, the concept of metabolic healthy obesity, which is a new phenotype of obesity, has emerged in recent years. It has not been clearly understood that individuals with metabolic healthy obesity have a healthy profile despite having excess body fat and a universal definition of this concept has not been made. Therefore, different criteria are used in studies (1). In this study, the presence of metabolic syndrome was defined as metabolic healthy obesity according to ATP III criteria, while the absence of metabolic syndrome was defined as metabolically healthy obesity (16).

Of the 245 women and 156 men who participated in the study, 64% were metabolically unhealthy and 36% were metabolically healthy. Studies to determine the prevalence of metabolic healthy obesity show that this rate varies between 6% and 45%. It is due to the difference in criteria used to define metabolic healthy obesity (1,7).

Metabolic healthy obesity is more common in women than in men, and its incidence decreases with age (17). In this study, the rate of unhealthy obesity in men was found to be significantly higher than in women ($p=0.045$; $p<0.05$). Also, the cut-off point for age was defined as 52 and above according to the obesity phenotype. The risk of unhealthy obesity after age 52 was 2,580 (95% CI: 1.634-4.073).

The area of fat accumulation is defined as a more important factor in obesity-related metabolic abnormalities rather than total body fat. Visceral adiposity is a good indicator of impaired adipose tissue function. Compared with the unhealthy obese, it was defined that the metabolic healthy obesity phenotype has low visceral adiposity (18). At the end of this study, it was determined that the waist circumference of the unhealthy obese was statistically significantly higher than that of the healthy obese ($p=0.023$; $p<0.05$).

Nutritional habits are at the forefront of the factors that affect cardiometabolic morbidity and mortality regardless of body weight. It is considered that healthy eating habits are an important determinant in determining metabolic healthy and unhealthy obesity (19). In recent years, the changing demographic and socioeconomic characteristics of societies have led to an increase in the habit of eating outside the home. It is shown as an important risk factor for inadequate and unbalanced nutrition problems and obesity. In a study, it was determined that the prevalence of obesity is high among individuals who eat out more than 5-7 meals a week (20). In this study, the number of weekly meals out for individuals with unhealthy obesity was found to be statistically significantly higher than those with healthy obesity ($p=0.001$; $p<0.01$). In the PREDIMED study, which is a large randomized controlled study conducted in Europe, the Mediterranean Type diet model applied without energy restriction and the administration of a low-fat control diet for 5 years were compared. It was observed that the Mediterranean Type diet model reduces the risk of Type-2 Diabetes by 20-40% and the risk of cardiovascular disease by 30% (21). In a study conducted in the USA, it was observed that half of cardio-metabolic deaths were caused by high sodium, high sugar-sweetened beverage consumption, and red meat consumption, and low consumption of oilseeds, omega-3 fatty acids, vegetables, and fruits (22). In this study, it was determined that the total energy, total fat (g), saturated fat (g), and carbohydrate amount (g) that the metabolically unhealthy obese received with their daily diet were significantly higher than the metabolic healthy obese ($p<0.05$). In the PURE study, which evaluated 7-year retrospective data of 135,335 adults from 18 countries in 2017, it was found that there was a significant relationship between diet and high carbohydrate intake and cardiovascular deaths. The factor that causes this result is especially focused on the high amount of added sugar in the diet (23). In this study, it was seen that the daily total fibre intake was lower than the metabolically healthy obese individuals while the daily total carbohydrate intake of the metabolically unhealthy group was found to be higher. Increasing adipose tissue contributes to the development of chronic diseases by causing low-level chronic inflammation. While dietary polyphenols and antioxidant vitamins are beneficial in controlling obesity-related inflammation, some nutrients, on the contrary, show pro-inflammatory properties. One of them is saturated fatty acids. Excessive dietary intake of saturated fatty acids leads to increased inflammation (24). In this study, the daily saturated fat intake of the metabolically unhealthy obese was found to be statistically significantly higher than the individuals with healthy obesity ($p=0.001$; $p<0.01$).

Increasing physical activity level and maintaining cardiorespiratory fitness are effective in reducing the risk of chronic diseases such as obesity-related Type-2 DM. While the results of studies examining physical activity and time spent sedentary among obesity phenotypes are inconsistent, it was found that there is a significant correlation between increased physical activity level and cardiorespiratory fitness and metabolic healthy obesity phenotype (25). In the study of Jennings et al. (2008) and Yu, Yau, Ho, and Woo (2013), it was observed that MS obese individuals were more active than MSO obese individuals, but these differences were not statistically significant (26,27). In this study, although the sitting times of the metabolically unhealthy obese were longer than the metabolically healthy obese, no statistically significant difference was observed in the sitting time and physical activity distribution of individuals according to obesity type ($p>0.05$).

In studies evaluating whether the metabolic healthy obesity phenotype is a continuous condition, it was concluded that this condition does not continue for a long time. In an observation study in which 55 metabolically healthy obese individuals were followed for 10 years, two-thirds of the individuals were found to have metabolic syndrome at the end of 10 years (28). In the Pizarra study, in which 1051 participants were followed up retrospectively, it was observed that there was a significant decrease in the number of metabolically healthy obese after 11 years (29). A similar conclusion was reached at the end of this study. A statistically significant correlation was found between the type of obesity and the 10-year cut-off value of the time the BMI value was higher than 30 kg/m^2 ($p=0.001$, $p<0.01$). In case the BMI value is higher than 30 kg/m^2 over 10 years, the risk of being unhealthy obese is 2.22 times higher (95% CI: 1.460-3,386).

At the end of this study, it was observed that the incidence of metabolic healthy obesity decreased with age. Metabolic healthy obesity is more common in women. As the duration of being overweight increases, the rate of metabolic unhealthy obesity increases. When metabolically unhealthy obese individuals are compared with metabolically healthy obese individuals, it was observed that the amount of total fat, saturated fat, and carbohydrate they take with their daily diet is higher, but the amount of fibre they take with their daily diet is lower than the metabolically healthy obese. While the daily sitting times of the metabolically unhealthy obese were longer than the metabolically healthy obese, the difference between the groups was not significant.

It is the most comprehensive study conducted in our country that examines the nutritional status and physical activity level of different obesity phenotypes.

The frequency of metabolic healthy obesity phenotype in our country is unknown. Epidemiological studies with large samples are needed. It is required to better understand the lifestyle strategies that cause metabolic healthy obesity in order to reduce obesity and its complications. Good eating habits, increased exercise level, and controlled weight loss have positive effects on both types of obesity. Considering sub-phenotypes and developing new treatment strategies can be very important and supportive in order to obtain the best results in the recommendations for the treatment of obesity.

Limitation

Although the food recording method is a frequently preferred method in nutrition studies, it is an obstacle to the definition of the relationships in studies that try to explain the relationship between chronic diseases and nutrition, due to the constant variation in individual food consumption.

Considering the advantages and disadvantages of the food recording method in determining food consumption, it is thought that the predicted limitations of the methods and the errors that may arise can be avoided by using more than one method together in determining the food consumption.

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Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study

References

1. Muñoz-Garach A, Cornejo-Pareja I, & Tinahones F. J. Does metabolically healthy obesity exist? Nutrients 2016; 8(6): 320.
2. World Health Organization. (2021). "Obesity and Overweight".http://www.who.int/en/news-room/factsheets/detail /obesity-and-overweight. Accessed 2022.
3. Sağlık Bakanlığı. Türkiye Beslenme ve Sağlık Araştırması (TBSA) 2017. 2019. Accessed : https://hsgm.saglik.gov.tr/depo/birimler/saglikli-beslenme-hareketli-hayat-db/Yayinlar/kitaplar/TBSA_RAPOR_KITAP_20.08.pdf .
4. Sims EA. Are there persons who are obese, but metabolically healthy? Metabolism-Clinical and Experimental 2001; 50(12): 1499-1504.
5. Blüher M. The distinction of metabolically 'healthy'from 'unhealthy'obese individuals. Current Opinion in Lipidology 2010;21(1): 38-43.
6. Roberson L, Aneni E, Maziak W, et al. Beyond BMI: The "Metabolically healthy obese" phenotype & its association with clinical/subclinical cardiovascular disease and all-cause mortality—A systematic review. BMC Public Health 2014; 14(1): 1–12.
7. Wildman RP, Munter P, Reynolds K, et al. The obese without cardiometabolic risk factor clustering and the normal weight with cardiometabolic risk factor clustering: prevalance and correlates of 2 phenotypes among US population (NHANES 1999-2004). Archives of İnternal Medicine 2008; 168(15), 1617-1624.
8. Jana V, Marja N, Sandra NS, et al. The prevalence of metabolic syndrome and metabolically healthy obesity in Europe: a collaborative analysis of ten large cohort studies. BMC Endocrine Disorders 2014;14(1): 1-13.
9. Seo Y, Lee S, Ahn JS, et al. Association of metabolically healthy obesity and future depression: using national health insurance system data in Korea from 2009–2017. International Journal of Environmental Research and Public Health 2021; 18(1): 63.
10. Hoyas I, Leon-Sanz M. Nutritional challenges in metabolic syndrome. Journal of Clinical Medicine 2019; 8(9): 1301.
11. Slagter SN, Corpelejin E, Van Der Klauw MM, et al. Dietary patterns and physical activity in the metabolically (un) healthy obese: the Dutch Lifelines cohort study. Nutrition Journal 2018;17(1): 1-14.
12. Expert Panel on Detection, Evaluation, et al. Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Jama 2001;285(19):2486–2497.
13. Rakicioglu N, Acar Tek N, Ayaz A, et al. Yemek ve besin fotoğraf kataloğu. (3. Baskı). Hatiboğlu Yayınevi. 2012;3:1-131.
14. Sistemleri, B.B., Ebispro for Windows. Stuttgart, Germany, 2004.
15. Saglam M, Arikan H, Savici S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. Perceptual and Motor Skills 2010; 111(1): 278-284.
16. Ramachandran A, Snehalatha C, Satyavani K, et al. Metabolic syndrome in urban Asian Indian adults—a population study using modified ATP III criteria. Diabetes Research and Clinical Practice 2003; 60(3): 199-204
17. Van JV, Nuotio M, Slagter S, et al. The prevalence of metabolic syndrome and metabolically healthy obesity in Europe: A collaborative analysis of ten large cohort studies. BMC Endocrine Disorders 2014; 14 (1): 9–22.

18. Iacobini C, Pugliese G, Fantauzzi CB, et al. Metabolically healthy versus metabolically unhealthy obesity. Metabolism 2019; 92: 51-60.
19. Stefan N, Häring HU and Matthias BS. Metabolically healthy obesity: the low-hanging fruit in obesity treatment?. The Lancet Diabetes & Endocrinology 2018; 6(3): 249-258.
20. Kim D, Ahn BI. Eating out and consumers' health: evidence on obesity and balanced nutrition intakes. International Journal of Environmental Research and Public Health 2020; 17(2): 586.
21. Magkos F. Metabolically healthy obesity: what's in a name?. The American Journal of Clinical Nutrition 2019;110 (3): 533-539.
22. Micha R, Peñalvo JL, Cudhea F, Imamura F, Rehm CD, Mozaffarian D. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. Jama 2017; 317(9):12–24.
23. Dehghan M, Mente A, Zhang X, et al. Associations of fats and carbohydrate intake with cardiovascular disease and mortality in 18 countries from five continents (PURE): a prospective cohort study. The Lancet 2017; 390 (10107): 2050–2062.
24. Teng KT, Chang CY, Chang LF, Nesaretnam K, Modulation of obesity-induced inflammation by dietary fats:mechanisms and clinical evidence. Nutrition Journal 2014; 13(1): 12.
25. Blüher M. Metabolically healthy obesity. Endocrine Reviews 2020; 41(3): bnaa004.
26. Jennings CL, Lambert EV, Collins M, et al. Determinants of insulin-resistant phenotypes in normal-weight and obese Black African women. Obesity 2008; 16(7): 1602-1609.
27. Yu R, Yau F, Ho SC, et al. Associations of cardiorespiratory fitness, physical activity, and obesity with metabolic syndrome in Hong Kong Chinese midlife women. BMC Public Health 2013;13(1): 1-10.
28. Hwang YC, Hayashi T, Fujimoto WY, et al. Visceral abdominal fat accumulation predicts the conversion of metabolically healthy obese subjects to an unhealthy phenotype. International Journal of Obesity 2015; 39(9): 1365-1370.
29. Soriguer F, Gutierrez-Repiso C, Rubio-Martin E, et al. Metabolically healthy but obese, a matter of time? Findings from the prospective Pizarra study. The Journal of Clinical Endocrinology & Metabolism 2013; 98(6): 2318-2325.

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