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Body mass index and factors associated with overweight and obesity: a cross-sectional study of adult subjects living in a small city of Western Sicily (Italy)

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ABSTRACT

BACKGROUND: although the epidemiological features of overweight and obesity have been well described, especially for very populous urban areas, less evidences are available for small urban areas. The aim of the present work was to assess BMI and factors associated with overweight and obesity in a representative sample of general population of a small city of Western Sicily (Italy).
METHODS: four hundred and eleven randomly selected adult subjects from general population living in a small Sicilian city with 7 144 inhabitants were interviewed by a standardized questionnaire investigating life-styles, eating habits, anthropometric measurements (weight, height and BMI) and socio-economic deprivation.
RESULTS: the standardized prevalence of overweight and obesity were 43.8% and 18.3%, respectively. The multivariate analysis has indicated an increased risk of BMI≥25 in subjects 40-59 years old (OR=2.3; 95% CI=1.2-4.4) in comparison with 18-39 years old, in males (OR=2.8; 95% CI=1.6-4.7) in comparison with females, and in participants who had a higher socio-economic deprivation (OR=1.3; 95% CI=1.1-1.7).
CONCLUSIONS: in small urban areas some demographic factors and socio-economic deprivation can be considered important risk factors for increased BMI also after controlling for the most common confounding factors.

Key words: Obesity, Overweight, BMI, Socio-economic deprivation

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INTRODUCTION

The prevalence of overweight and obesity has increased rapidly over the last decades especially in developed countries (1-3). In the last years, the World Health Organization (WHO) estimates that globally approximately 1.5 billion adults (age>20 years) were overweight and more than 500 million adults were obese (4), and the International Obesity Task Force has indicated

that the prevalence of obesity has increased on the "Old Continent" (5). In the same period, the Multiscope Survey conducted by the Italian National Institute of Statistics (ISTAT) observed a high proportion of obese adults in Italy (9.8%), including Sicily (11.3%) (6).

Obesity is generally associated to a significantly higher risk of arterial hypertension, diabetes mellitus, hepatic steatosis, hyperdyslipidemia and renal failure, and it is a major contributor leading to an increase in the prevalence of chronic diseases and cancers (7-10). For these reasons, the WHO considers the epidemic a worldwide problem which requires public health interventions (11) that act on different factors associated with overweight and obesity as well as technological changes that have lowered food prices, shifted dietary choices to energy dense food, made work more sedentary (12). Also environmental attributes such as lack of nearby recreational facilities and poor side walk quality have been linked to the obesity epidemic (13). Economic, political, and socio-cultural efforts are required for changing these behavioural and environmental factors, not only from a national point of view but also as a first intervention line that involves local public health authorities of small towns and cities with high prevalence of overweight and obesity. As a consequence, assessing and characterizing BMI status of general population in relation to dietary pattern, lifestyle and socio-demographic factors can be considered a prioritary preventive measure in order to plan public health interventions on a local as well as national basis. Following these considerations, the aim of the present study was to assess BMI and investigate factors associated with obesity and overweight in a representative sample of the general population of a small city of Western Sicily (Italy).

METHODS

Study design

The study was carried out between May 2009 and July 2010 in Calatafimi-Segesta, a city located in Western Sicily (Italy) and accounting for 7 144 inhabitants (14). Calatafimi-Segesta has an overall surface area of about 154 km² (15), and it is situated at an altitude of 338 m above sea level. The economy of Calatafimi-Segesta is primarily agricultural, the most important crops being citrus, grain, grapes and olives (16).

A random sample of 802 subjects (about 10% of the total population) was selected, after stratification by sex and age, from the National Health System Patients Roster for Calatafimi-Segesta that covers more than 90% of resident inhabitants managed by 6 local general practitioners and 1 family pediatrician who were involved in the study. Selected individuals were asked to participate and, those who did not meet the exclusion criteria were enrolled directly by their own medical practitioners. Exclusion criteria from the study included: severe cognitive dysfunction (N=38), death before recruitment (N=11), residence different than Calatafimi-Segesta (N=62), institutionalization (N=0), urinary incontinence (N=10) and impossibility to be reached by general practitioners' recruitment for at least three months (N=38). Subjects less than 18 years old (N=74) were enrolled but their data have been not included in the analysis. After giving an informed consent, participants were called to set the date for the interview and, on voluntary basis, the blood withdrawal.

Each interview has been conducted face-to-face by well trained medical personnel in a mean time of 20 minutes. Specimens of venous blood were collected in Vacutainer TM tubes and within 6 h after collection they have been analyzed. For each blood sample, serum total cholesterol (TC) and triacylglycerol (TG) were determined. Interviews and phlebotomies were performed in sanitary locations provided by health local unit (Azienda Sanitaria Provinciale) of Trapani. According to the Italian regulations, ethical approval was required to and obtained by the Institutional Review Board of the AOUP "P. Giaccone" of Palermo, Italy.

Questionnaire

A structured questionnaire was developed in order to systematically collect population based data.

A large majority of items of the questionnaire were derived from that used for the 2001-2002 National Health and Nutrition Examination Survey (NHANES) (17) and the "Progressi delle Aziende Sanitarie per la Salute in Italia" study (PASSI) (18). The questionnaire was first pilot tested on 20 subjects for evaluating its reliability and validity.

Overall, the questionnaire was organized in 4 different sections as detailed below.
• *Section 1:* anagraphic and socio-demographic data included age (categorized as "18 to 39 years old", "40 to 59 years old", "60 to 79 years old", "80 or more years old"), gender, marital status (categorized as "married/free

union", "widow/er", "single", "divorced"), occupation (categorized as "unemployed/ housewife", "employed", "different sectors", "retired"), education (categorized as "no title", "primary", "secondary and tertiary degrees"), living arrangement (categorized as "alone", "co-habitation"), house size (using the 10th percentile as the cutoff, house size has been categorized as "≤60 m²" and ">60 m²") and house ownership (categorized as "yes" and "no").

- *Section 2:* anthropometric measurements included weight (in kg), height (in cm) and body mass index (BMI) (19). Body weight has been measured in light underwear without shoes to the nearest 0.1 Kg, using a mechanical scale. Height measurements were carried out, without shoes, to the nearest 0.1 cm, using a non extensible tape.

- *Section 3:* lifestyle habits and exposure to risk factors afforded.

  a) physical activities: participants were asked to report the frequency that they spent participating in physical activities of moderate (such as walking or cycling) and vigorous intensity (such as competitive sports, running and aerobics). Physical activity has been coded as "Yes, regular activity" for participants performing moderate intensity physical activity for at least 30 min per day with a frequency of at least 4 days per week or vigorous intensity physical activity for at least 20 min per session with a frequency of at least 3 days per week otherwise the variable was coded as "No"(18).

  b) smoking habits: active smoking status was categorized as "never", "passive smoker", "former smoker" and "current smoker". Subjects who did not actively smoke were considered passive smokers if they stated an exposure to at least 1 cigarette per day at work or at home per at least one year.

- *Section 4:* eating habits and dietary intake were assessed by asking how often per week participants consumed six different food groups (fishes, meats, milk, fruits, raw and cooked vegetables) during the last year. For each food group, four answers were available ("never", "1 to 3 times for week", "4 to 6 times for week", "every day").

Typical weekly alcohol consumption was also recorded as self-reported estimate. To obtain a measure of units of consumed alcohol, participants were asked to state their alcohol intake over the past week by indicating the number of drinks they had consumed in each of three categories: beer (including lager or cider), wine (including sherry, martini and fortified wine), and spirits (e.g. whisky, gin, etc.). One unit of alcohol was defined as equivalent to half a pint of beer, one glass of wine or a single measure of spirits (20).

Deprivation score

By using answers of participants, a social-economic deprivation score was created. Deprivation was defined by the number of positive responses to the following six criteria: educational level (primary school/no education=2; secondary school=1; tertiary school=0), job (unemployed for at least 3 months in the previous 5 years=1, employed=0), household (living alone=1; living with other persons=0), house size (≤60 mq=1; >60 mq=0), and home-ownership (not being a home-owner=1; being a home-owner=0) (21, 22). The scale of deprivation ranged from 0 (minimum score of deprivation) to 6 (maximum score of deprivation).

Statistical analysis

The questionnaire responses were entered in a database created within EpiInfo 3.5.1 software. Absolute and relative frequencies were calculated for qualitative variables, while quantitative variables were summarized as mean ± standard deviation. BMI was categorized as overweight (BMI≥25 and <30 kg/m²) and obesity (BMI≥30 kg/ m²). Crude prevalence of overweight and obesity was standardized by sex and age in the over-17 Italian general population according to the 2001 census. Categorical variables were analyzed using Chi-square test (Mantel-Haenszel), Fisher's exact test or Chi-square test for trend. Odds ratios (OR) and 95% confidence intervals (CI) were computed using unconditional logistic regression. Mean ± standard deviation data were compared with the Student t-test or one-way ANOVA test. Correlation between serum concentration of triacylglycerol, total cholesterol and BMI were evaluated by performing a linear regression analysis. Variables found to have a statistically significant association (p-value<0.05) with having a BMI≥25 in the univariate analysis were included in a multivariate logistic-regression model to check for independent

associations. All data were analyzed using the R statistical software package (23).

RESULTS

Of the initial sample (N=802), 159 (19.8%) subjects did not meet inclusion criteria of the study, 158 (19.7%) refused to participate and 74 (9.2%) were not included in the analysis because <18 years old. The final sample study accounted for 411 subjects. Sex and age did not differ significantly between enrolled and non-enrolled subjects older than 17 years (p=0.49 and p=0.21, respectively).

The socio-demographic and occupational characteristics of the study sample, stratified by overweight and obesity, are summarized in Table 1. After standardization for age and sex, the overall prevalence of overweight and obesity were 43.8% and 18.3%, respectively.

As reported in Table 2, a higher risk of overweight and obesity has been found in males (OR=3.17; 95% CI=2.07-4.89), 40 to 59 and 60 to 79 years old (OR=3.10; 95% CI=1.80-5.31 and OR=3.02; 95% CI= 1.77-5.14, respectively), married/free union participants (OR=2.74; 95% CI=1.67-4.49), former smokers (OR=2.01; 95% CI=1.03-3.86), subjects drinking 14 units of alcohol or more per week (OR=3.89;

TABLE 1

SOCIO-DEMOGRAPHIC AND OCCUPATIONAL CHARACTERISTICS OF THE 411 STUDY PARTICIPANTS AFTER STRATIFICATION BY OVERWEIGHT AND OBESITY		
	TOTAL N (% BY COLUMN)	OVERWEIGHT SUBJECTS (25≤BMI<30) N (% BY ROW)	OBESE SUBJECTS (BMI≥30) N (% BY ROW)
ALL	411 (100)	183 (44.5)	75 (18.2)
GENDER			
- Males	190 (46.2)	104 (54.7)	42 (22.1)
- Females	221 (53.8)	79 (35.7)	33 (14.9)
AGE GROUPS, YEARS			
- 18 to 39	101 (24.6)	34 (33.7)	11 (10.9)
- 40 to 59	136 (33.1)	65 (47.8)	32 (23.5)
- 60 to 79	144 (35)	73 (50.7)	29 (20.1)
- 80 or more	30 (7.3)	11 (36.7)	3 (10)
EDUCATION			
- No education	26 (6.3)	12 (46.2)	5 (19.2)
- Primary	252 (61.3)	121 (48)	50 (19.8)
- Secondary	83 (20.2)	34 (41)	11 (13.3)
- Tertiary	50 (12.2)	16 (32)	9 (18)
CIVIL STATUS			
- Married/ free union	285 (69.3)	138 (48.4)	60 (21.1)
- Widow/er	38 (9.3)	11 (28.9)	8 (21.1)
- Single	86 (20.9)	32 (37.2)	7 (8.1)
- Divorced	2 (0.5)	2 (100)	0 (0)
KIND OF HOUSEHOLD			
- Alone	30 (7.3)	13 (43.3)	5 (16.7)
- Co-habitation	381 (92.7)	170 (44.6)	70 (19.2)
OCCUPATION			
- Unemployed/housewife	122 (29.7)	47 (38.5)	23 (18.9)
- Employed, different sectors	198 (48.2)	90 (45.4)	36 (18.2)
- Retired	91 (22.1)	46 (50.5)	16 (17.6)
HOUSE SIZE			
- ≤60 mq	39 (9.5)	17 (43.6)	7 (18)
- > 60 mq	372 (91.5)	156 (41.9)	64 (17.2)
HOME-OWNERSHIP			
- Yes	367 (89.3)	158 (43.1)	68 (18.5)
- No	44 (10.7)	22 (50)	7 (15.9)

95% CI=1.09-13.79) and those with a high deprivation score (p<0.01). Performing a regular physical activity has been associated with a reduced risk of overweight and obesity (OR=0.50; 95% CI=0.28-0.90). Otherwise, education, kind of household, occupation, house size, home ownership, consumption, TV or PC, and consumption of some foods (e.g. fish, meat, milk or derivates, raw vegetables, cooked vegetables and fruit) were not significantly associated with a BMI≥25.

In Table 3, the logistic regression analysis shows an increased risk of BMI ≥25 in subjects 40-59 years old (OR=2.3; 95% CI=1.2-4.4) in comparison with 18-39 years old, in males (OR=2.8; 95% CI= 1.6-4.7) in comparison with females and in participants who had a higher socio-economic deprivation score (OR=1.3; 95% CI= 1.1-1.7).

Finally, 380 (92.5%) out of 411 interviewed subjects were willing to provide a blood sample. Average levels of TC were 195 ± 44 mg/dL (191 ± 41 mg/dL in males and 198 ± 46 mg/dL in females) whereas average levels of TG were 119 ± 69 mg/dL (136 ± 79 mg/dL in males and 103 ± 55 mg/dL in females). BMI was positively correlated with serum concentration of triacylglycerol (β-coefficient= 4.7; p<0.01) and total cholesterol (β-coefficient=1.1; p=0.03).

DISCUSSION

In European Countries, the epidemiological features of BMI increasing have been well described especially for very populous urban areas (24) but less evidences are available for small urban areas. In such contexts, the economy improvement of the last decades has induced industrialization and modernization. As a result, people do less manual labor with the assistance of mechanized equipment and their lifestyles are more sedentary than previously. Less physically demanding jobs and plentiful availability of food are deemed to be the major determinants of the "obesity epidemic".

Moreover, in agricultural areas different patterns of exposure to risk factors may play an adjunctive role in growing the burden of this public health concern whose prevalence is often misunderstood. The present study aimed to assess prevalence of increased BMI and factors influencing BMI among residents of a small agricultural city of Western Sicily.

BMI was chosen as anthropometric indicator of individual and collective general body-weight status because it is commonly used in clinical practice and epidemiology, and it has been largely correlated with health and longevity (25, 26).

In our study population, about 18% of participants were found to be obese and more than 40% were overweight, exceeding that reported in 2005 among subjects ≥18 years old living in Italy (9.8% obese and 34.2% overweight) and in Sicily (11.3% obese and 37.6% overweight) (6). This finding may be partially explained by considering that, in hill agricultural cities such as Calatafimi-Segesta, a sedentary life is encouraged by a poor side walk quality and a reduced number of recreational facilities or sport structures. These factors are usually indipendently associated with low physical activity and with obesity (27, 28). According to other studies carried out in developed countries, also a decreased accessibility of utilitarian destinations, such as shops, schools, and leisure amenities have been linked to physical inactivity (29). In our study as well as in others, BMI was associated with age (6, 30, 31) and male sex (18). Higher percentages of overweight and obesity among middle aged adults have been related to a fall in basal metabolic rate and reduced physical activity (32). Then, in older adults, the aging process involves physiological and nutritional changes that have been associated with a reduction of about one kilogram and 0.5-1.5 cm per decade (33, 34). Consistent with this last observation, a general BMI lowering was reported in residents in Calatafimi-Segesta older than 79 years.

A high prevalence of overweight and obesity was also found in former smokers. Quite recent results from the Czech MONICA study confirm that stopping of smoking leads in most of the individuals to weight gain (35). A review of the smoking and body weight literature found that estimates of weight gain associated with smoking cessation range from 0.2 to 8.2 kg depending on the sample, study design, and follow-up period (36). The mechanism of this association includes increased energy intake, decreased resting metabolic rate, increased lipoprotein lipase activity and decreased physical activity (37). However, in the multivariate analysis former smoking habits lost their association with increased BMI, suggesting that this association may be confused by other risk factors or that a larger population sample size may be required for a more accurate analysis.

According to several studies (38, 39), low levels of physical activity have been strongly linked

TABLE 2

SOCIO-DEMOGRAPHIC, OCCUPATIONAL AND LIFESTYLE CHARACTERISTICS OF THE 411 STUDY PARTICIPANTS SIGNIFICANTLY ASSOCIATED WITH OVERWEIGHT AND OBESITY

	SUBJECTS WITH BMI≥25		P-VALUE
	N (% by row)	OR (95% CI)	
GENDER			
- Females	113/222 (50.9)	1	
- Males	145/189 (76.7)	3.17 (2.07-4.89)	<0.001[a]
AGE GROUPS, YEARS			
- 18 to 39	45/101 (44.6)	1	
- 40 to 59	97/136 (71.3)	3.10 (1.80-5.31)	
- 60 to 79	102/144 (70.8)	3.02 (1.77-5.14)	0.03[b]
- 80 or more	14/30 (46.7)	1.09 (0.48-2.47)	
CIVIL STATUS			
- Single	39/86 (45.3)	1	
- Married/free union	198/285 (69.5)	2.74 (1.67-4.49)	<0.001[a]
- Widow/er	19/38 (50.0)	1.21 (0.56-2.59)	0.6[a]
- Divorced	2/2 (100)	NC	NC
SMOKING HABITS			
- Non smokers	48/79 (60.8)	1	
- Passive smokers	70/129 (54.3)	0.77 (0.43-1.35)	0.36[a]
- Former smokers	68/90 (75.6)	2.01 (1.03-3.86)	0.04[a]
- Current smokers	72/113 (63.7)	1.13 (0.63-2.05)	0.68[a]
PHYSICAL ACTIVITY			
- No	233/359 (64.9)	1	
- Yes, regular activity	25/52 (48.1)	0.50 (0.28-0.90)	0.02[a]
ALCOHOL CONSUMPTION, UNITS PER WEEK			
- No	88/145 (60.7)	1	
- Yes, 0.1 to 14	152/245 (62.0)	1.06 (0.69-1.61)	0.79[a]
- Yes, 14 or more	18/21 (85.7)	3.89 (1.09-13.79)	0.04[a]
DEPRIVATION SCORE			
- 0	8/13 (61.6)	1	
- 1	25/57 (43.9)	0.49 (0.14-1.68)	
- 2	111/173 (64.2)	1.12 (0.35-3.57)	
- 3	81/125 (64.8)	1.15 (0.35-3.73)	<0.01[b]
- 4	28/38 (73.7)	1.75 (0.46-6.62)	
- 5	5/5 (100.0)	NC	
- 6	0/0 (0.0)	NC	

[a] Chi-square

[b] Chi-square for trend

NC: not calculable

TABLE 3

MULTIVARIATE ANALYSIS ON FACTORS ASSOCIATED WITH AN INCREASED BMI (≥25)		
	ADJUSTED OR (95%CI)	P-VALUE
GENDER		
- Females	1	
- Males	2.8 (1.6-4.7)	<0.01
AGE GROUPS, YEARS		
- 18 to 39	1	
- 40 to 59	2.3 (1.2-4.4)	0.01
- 60 to 79	1.9 (0.9-3.7)	0.07
- 80 or more	0.8 (0.3-2.2)	0.66
CIVIL STATUS		
- Single	1	
- Married/free union	1.9 (1-3.4)	0.05
- Widow/er	1.4 (0.5–3.7)	0.55
- Divorced	NC	0.98
SMOKING HABITS		
- Non smokers	1	
- Passive smokers	0.8 (0.4-1.6)	0.58
- Former smokers	1.2 (0.6–2.6)	0.60
- Current smokers	1.0 (0.5–1.9)	0.91
PHYSICAL ACTIVITY		
- No	1	
- Yes, regularly	0.6 (0.3–1.2)	0.17
ALCOHOL CONSUMPTION, UNITS PER DAY		
- No	1	
- Yes, 0.1 to 14	0.9 (0.6–1.5)	0.75
- Yes, 14 or more	3.8 (0.9–16.5)	0.07
DEPRIVATION SCORE	1.3 (1.1–1.7)	0.03

NC: not calculable

to an increased risk of weight gain. In our study, a very low percentage of subjects (12.6%) stated to do a regular physical activity but the role of this behaviour in BMI decreasing lost its significance in the multivariate analysis probably due to its association with male sex and younger age.

With the exception of alchol consumption, dietary habits did not significantly influenced body weight status. However, foods rich in animal proteins such as fish and meat seem to have a protective, but not statistically significant, role in BMI control.

In developed countries it was confirmed more times that low socio-economic status is associated with high BMI. Similar data have been found in Italy (18) as well as in the present study. Unhopefully,

our index did not allow a comparison with other indexes since these last had included different variables. The multivariate analysis showed that the socioeconomic deprivation score can be a risk factor for increased BMI also after adjusting for age and sex. This finding should suggest to the Public Health Autorities the use of indicators like this in order to easily identify target groups for educational programmes.

Finally, a major limitation of the present study is the possible frailty of BMI as indicator of body weight status. BMI is a proxy measure of obesity/overweight and using it instead of measure of body composition (eg. percentage body fat) may result in miss-classification that under-estimates or over-estimates associations with risk factors. In contrast with this possible limitation, in our investigations BMI has been associated with well-known health risk factors such as serum total cholesterol.

Concluding, our findings confirm that increased BMI is a complex and multi-factorial phenomenon that can involve demographic, social and life-style habits. The present study documents a high prevalence of overweight and obesity among residents in a small urban city of Western Sicily suggesting the need that local Health Autorities implement BMI-assessment programs for managing the burden of obesity. A policy paying particular attention the most socio-economic deprived groups should be locally promoted in order to reduce the health damaging effects of weight gain.

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