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Prevalence in the eligibility for weight loss treatment in a Mediterranean population

Helmut Schröder*, Roberto Elosua, Juan Vila, Helena Martí, Maria-Isabel Covas and Jaume Marrugat

Lipids and Cardiovascular Epidemiology Research Unit, Institut Municipal d'Investigació Mèdica, IMIM-Hospital de Mar Barcelona, Biomedical Research Park – Parc de Recerca Biomèdica de Barcelona – PRBBS, Spain

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The aim of the present study was to analyse the prevalence and time trends of the subjects in a Mediterranean population meeting the criteria for weight loss treatment according to the National Institutes of Health (US) treatment algorithm proposed by the National Heart, Lung and Blood Institute's Obesity Education Initiative Expert Panel. A random sample of the 25–74 year old population (*n* 4908) of Gerona, Spain, was examined in 1994–1995 and 1999–2000 in two independent population-based cross-sectional surveys. Cardiovascular risk factors, lifestyle measures and anthropometric variables were analysed. The prevalence of subjects meeting the criteria for weight loss treatment according to the National Institutes of Health algorithm significantly increased from 46·4 to 52·9 % in men and from 35·1 to 40·4 % in women from 1995 to 2000. Stratifying this analysis for age groups revealed a significant increase among women aged 25 to 39 years and the older age group (60 to 74 years) of both genders. This increase was mainly observed in men and women with primary school education. The high prevalence of subjects meeting the criteria for weight loss treatment and the increasing secular trend is an important issue for health policy. This trend is more pronounced in older age groups and among the population with a basic educational level.

Weight gain: Obesity: Algorithm: Waist

One of the most important health issues in the 21st century is the continuous increase in body weight. Excess body weight is associated with several adverse health outcomes[1–5] and with an increased mortality risk[6–9]. Therefore, it is of importance to identify subjects that would benefit from weight loss treatment. Furthermore, monitoring secular changes of the need for weight loss treatment is necessary for the development of adequate strategies for weight control.

The Obesity Education Initiative Expert Panel of the National Heart, Lung and Blood Institute, one of the US National Institutes of Health (NIH), proposed a treatment algorithm that was published by NIH with the aim to give health care professionals a guide to assess and treat obesity[10,11]. This treatment algorithm, based on BMI, waist circumferences (WC) and CVD risk factors, should help health practitioners to identify individuals in need of weight loss. The Spanish Society of Endocrinology and Nutrition adopted this algorithm for use in the Spanish population[12]. Indeed, early identification of individuals at high risk of morbidity and mortality related to excessive weight is important for health policy. However, to the best of our knowledge there are no data on the prevalence and secular trends of individuals in need of weight loss based on this treatment algorithm. Hence, the aim of the present study was to identify changes in the proportion of the population from a representative Mediterranean region eligible for weight loss treatment according to the NIH algorithm for men and women aged 25 to 74 years.

Subjects and methods

Study population

Data of two independent and representative population-based surveys conducted in 1995 and 2000 in Girona (Spain) were used for this analysis. Recruitment procedures have been described in detail elsewhere[13]. From 6925 randomly selected and eligible subjects between 25 and 74 years of age, 4908 (2383 men and 2525 women) agreed to participate. Total participation rate reached 71 %. A two-stage sampling method was used in 1995 and 2000: thirty-three and seventeen towns, respectively, were randomly selected in the first stage. Half of the towns were urban (>10 000 inhabitants) and half were rural (500–10 000 inhabitants). In both studies, the second sampling stage consisted of randomly recruiting the same number of female and male participants, stratifying by 10-year age groups from the closest census. All participants were duly informed and consented to participate in the study. The protocol was approved by the local Ethics Committee.

Abbreviations: NIH, National Institutes of Health; WC, waist circumference.

* **Corresponding author:** Dr Helmut Schröder, fax (34) 933 160796, email hschroeder@imim.es

Anthropometric measurements

A precision scale of easy calibration was used for weight measurement. Readings were rounded to 200 g. Individuals wore underwear. Height was measured in the standing position and measurements rounded to 5 mm. BMI was determined as weight divided by height squared (kg/m^2). BMI categories (normal weight, overweight and obesity) were calculated according to the WHO classification[14]. WC was measured at midway between the lowest rib margin and iliac crest, with the subject standing. Measurements were taken with a tape measure in cm and rounded to 5 mm. Abdominal obesity was defined as WC > 88 cm in women and > 102 cm in men[15].

Measurements of blood pressures and lipid profile

Two blood pressure determinations were taken by trained personnel using a periodically calibrated Hg sphygmomanometer with strict standard procedures. Measurements were performed in the sitting position after a 5-min rest. Two measurements were taken, at least 20 min apart, and the lower value was recorded for the study. The mean of two measurements was used for analysis.

Blood samples were obtained after a 14-h fast. Serum was immediately frozen at −120°C in liquid N for transportation and stored at −80°C for final conservation. Total cholesterol, TAG and HDL-cholesterol were analysed by standardized enzymatic methods (Roche Diagnostic, Basel, Switzerland) adapted to a Cobas Mira Plus autoanalyzer (Hoffmann-La Roche, Basel, Switzerland).

National Institutes of Health algorithm

The NIH algorithm was calculated as follows: BMI ≥ 30 or ((BMI 25–29·9 or WC > 88 cm (women), > 102 cm (men)) and two or more CVD risk factors). Participants were assigned a CVD risk status based on the presence of two or more risk factors. These included age, ≥45 years in men and ≥55 years in women, current smoking, HDL-cholesterol ≤35 mg/dl, LDL-cholesterol >160 mg/dl, hypertension (systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or on hypertension drug treatment), glycaemia >125 mg/dl or history of diabetes.

Educational level and lifestyle variables

Leisure-time physical activity was measured by the Minnesota leisure-time physical activity questionnaire. This questionnaire has been previously validated for Spanish men and women[16,17].

Information on smoking habits of the participants was obtained by a structured standard interview. Participants were categorized as non-smokers or current smokers (at least one cigarette per d on average during the past year).

Maximum level of education attained was elicited and recorded as primary school, secondary school and university for purposes of analysis.

Statistical analysis

Data are presented descriptively for each gender with means or proportions. Student *t* test was used in the univariate analysis.

Adjusted OR were calculated to investigate the association of the need for weight loss treatment, according to the NIH treatment algorithm, with age and educational level. Cohort analysis was added to the model to examine if there were secular changes in the prevalence of recommended weight loss treatment according to age and educational level (PROC LOGISTIC procedure, version 8.0; SAS Institute Inc., Cary, NC, USA).

Results

Table 1 shows the general characteristics of the participants. BMI significantly increased from 1995 to 2000 in both genders. The same trend was observed for WC in men (Table 1). The crude prevalence of men and women meeting the criteria for weight loss treatment according to the NIH treatment algorithm was highest for the oldest male and female age group in 1995 and 2000 (Table 2). The adjusted relative risk of need for weight loss treatment significantly increased with older age in both genders and in both surveys

Table 1. General characteristics, BMI, waist circumference of men and women aged 25–74 years in 1995 and 2000†

Results are expressed as mean (standard deviation or 95 % confidence interval)

	1995 (*n* 836)	2000 (*n* 1547)	*P*
Men			
Age (years)	51·3 (13·5)	50·3 (13·6)	0·077
LTPA (MET·min/wk)	2458 (2420)	2474 (2612)	0·882
BMI (kg/m^2)*	26·3 (26·0–26·5)	27·3 (27·1–27·5)	<0·001
Waist circumference (cm)*	93·1 (92·4–93·9)	94·1 (93·5–94·7)	0·046
	1995 (*n* 910)	2000 (*n* 1615)	*P*
Women			
Age (years)	51·0 (13·5)	49·9 (13·5)	0·069
LTPA* (MET min/week)	1465 (1979)	1530 (1477)	0·353
BMI (kg/m^2)*	25·6 (25·3–25·8)	26·4 (26·2–26·7)	<0·001
Waist circumference (cm)*	82·5 (81·8–83·3)	82·5 (81·8–83·3)	0·964

LTPA, Leisure-time physical activity; MET, standard metabolic equivalent.
* Age standardized. Standard World Population[28].
† For details of subjects and procedures, see Subjects and methods.

British Journal of Nutrition

Table 2. Proportion (%) and 95 % CI of the male and female population meeting the criteria for weight loss treatment* according to age group and educational level§

	1995		2000	
	%	95 % CI	%	95 % CI
Men				
25–74 years†	46·4	43·0, 49·7‡	52·9	50·4, 55·4
25–39 years	25·6	19·6, 31·6	29·7	25·0, 34·3
40–59 years	60·8	55·6, 66·0	67·2	63·7, 70·8
60–74 years	68·4	63·0, 73·9 ‡	83·4	79·2, 86·9
University	51·9	38·5, 65·2	46·6	39·0, 54·3
Secondary school	38·3	30·6, 46·0	46·3	40·8, 51·9
Primary school	58·5	54·6, 62·5 ‡	70·0	67·2, 72·9
Women				
25–74 years†	35·1	32·4, 37·8‡	40·4	38·2, 42·7
25–39 years	9·9	25·0, 34·3 ‡	19·0	15·2, 22·8
40–59 years	46·7	43·7, 50·8	49·1	45·4, 52·8
60–74 years	77·0	79·2, 86·9	82·4	78·9, 86·0
University	18·5	8·2, 28·9	20·5	14·8, 26·1
Secondary school	19·6	13·6, 25·7	30·2	25·5, 34·9
Primary school	56·1	52·4, 60·0 ‡	64·3	61·3, 67·3

* According to National Institutes of Health treatment algorithm: BMI ≥30 or ((BMI 25–29·9 or waist circumference >88 cm (women), >102 cm (men)) and two or more CVD risk factors). Risk factors: age (≥45 years in men and ≥55 years in women); current smoking; HDL-cholesterol ≤35 mg/dl; LDL-cholesterol >160 mg/dl. Hypertension: systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or on hypertension drug treatment. History of diabetes or glycaemia >125 mg/dl.
† Age standardized. Standard World Population[28].
‡ Significantly different ($P<0·05$) between 1995 and 2000.
§ For details of subjects and procedures, see Subjects and methods.

(Table 3). More men and women with only a basic educational level (primary school) would benefit from weight loss treatment as compared with higher educational levels (Table 2). We observed an increasing linear trend across lower educational levels in the need for weight loss treatment in both men and women (Table 3), with the exception of men in 1995. Multiple logistical regression analysis revealed an increased need for weight loss treatment in men and women from 1995 to 2000 (Table 4). Stratifying this analysis for age groups revealed a significant increase among women aged 25 to 39 years and in both genders aged 60 to 74 years (Table 4). More men and women with a primary school education would benefit from weight loss treatment in 2000 than in 1995. A similar trend was observed for women with secondary school education (Table 4).

Discussion

Our data indicate that about half of the present population is recommended to lose weight. Most importantly, the need for weight loss treatment increased markedly from 1995 to 2000 in both genders. This trend was more pronounced in older age groups and among the population with only a basic educational level.

Excessive weight is strongly associated with several adverse health outcomes, such as CVD[18]. Identifying individuals with excessive weight who are at increased risk of obesity-related morbidity and mortality is of importance for the development of promising treatment strategies. Based on National Heart, Lung, and Blood Institute (NHLBI) recommendations, the US NIH proposed an algorithm to identify individuals with excessive weight who would greatly benefit from weight loss treatment[10,11]. In a large longitudinal study, Mason and colleagues have shown that the risk of all-cause mortality significantly increased in men meeting these criteria for weight loss treatment compared with normal weight men[19]. Mason and Katzmarzyk[20] also found that 24 % of Canadians would be eligible for weight loss treatment, according to these

Table 3. OR and 95 % CI of the need for weight loss treatment* according to age group and educational level§

	1995		2000	
	OR	95 % CI	OR	95 % CI
Men				
25–39 years (reference)†	1		1	
40–59 years	4·62	3·02, 7·08	4·28	3·22, 5·69
60–74 years	5·48	3·43, 8·76	10·13	7·09, 14·46
P for linear trend		<0·001		<0·001
University (reference)‡	1		1	
Secondary school	0·66	0·31, 1·41	0·94	0·62, 1·43
Primary school	0·99	0·50, 1·95	1·56	1·07, 2·27
P for linear trend		0·423		0·001
Women				
25–39 years (reference)†	1		1	
40–59 years	5·99	3·54, 10·12	3·27	2·42, 4·41
60–74 years	18·16	10·22, 32·26	12·52	8·63, 18·19
P for linear trend		<0·001		<0·001
University (reference)‡	1		1	
Secondary school	1·11	0·39, 3·13	1·72	1·11, 2·67
Primary school	3·19	1·23, 8·30	3·61	2·41, 5·39
P for linear trend		<0·001		<0·001

* According to National Institutes of Health treatment algorithm: BMI ≥30 or ((BMI 25–29·9 or waist circumference >88 cm (women), >102 cm (men)) and two or more CVD risk factors). Risk factors: age (≥45 years in men and ≥55 years in women); current smoking; HDL-cholesterol ≤35 mg/dl; LDL-cholesterol >160 mg/dl. Hypertension: systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or on hypertension drug treatment. History of diabetes or glycaemia >125 mg/dl.
† Adjusted for educational level and leisure-time physical activity.
‡ Adjusted for age and leisure-time physical activity.
§ For details of subjects and procedures, see Subjects and methods.

Table 4. OR and 95 % CI of secular trends of the recommendation for weight loss treatment* of men and women||

	Men		Women	
	OR	95 % CI	OR	95 % CI
Age group/year of survey†				
25–74 years/1995	1		1	
25–74 years/2000	1·22	1·11, 1·34§	1·23	1·12, 1·35§
25–39 years/1995	1		1	
25–39 years/2000	1·27	0·84, 1·92	2·43	1·42, 4·16§
40–59 years/1995	1		1	
40–59 years/2000	1·21	0·90, 1·63	1·30	0·99, 1·71
60–74 years/1995	1		1	
60–74 years/2000	2·56	1·75, 3·74§	1·58	1·06, 2·35§
Educational level/ year of survey‡				
University/1995	1		1	
University/2000	0·92	0·44, 1·91	1·34	0·50, 3·61
Secondary school/1995	1		1	
Secondary school/2000	1·27	0·81, 1·99	2·05	1·22, 3·43§
Primary school/1995	1		1	
Primary school/2000	1·68	1·32, 2·14§	1·43	1·13, 1·81§

* According to National Institutes of Health treatment algorithm: BMI ≥30 or ((BMI 25–29·9 or waist circumference >88 cm (women), >102 cm (men)) and two or more CVD risk factors). Risk factors: age (≥45 years in men and ≥55 years in women); current smoking; HDL-cholesterol ≤35 mg/dl; LDL-cholesterol >160 mg/dl. Hypertension: systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or on hypertension drug treatment. History of diabetes or glycaemia >125 mg/dl.
† Adjusted for educational status and leisure-time physical activity.
‡ Adjusted for age and leisure-time physical activity.
§ Significantly different ($P<0·05$) between 1995 and 2000.
|| For details of subjects and procedures, see Subjects and methods.

criteria. In 1995, about 40 % of the present study population would have been identified for weight loss treatment; by 2000 there was a significant increase in this prevalence in men and women. Indeed, the magnitude and time trend of the prevalence of men and women meeting the NIH weight loss treatment criteria is a serious problem in the present population and should be an alarming signal for public health policy.

Evidence indicates that low education is associated with greater weight gain over time in young and middle adulthood[21–23]. Hence, it was not surprising to observe a significant increase in the prevalence of subjects meeting the NIH criteria for weight loss treatment among men and women with a basic educational level between 1995 and 2000 in the present population.

The NIH treatment algorithm included WC, an indirect measure of abdominal obesity. It has been shown that abdominal obesity, clinically defined by WC > 88 cm in women and >102 cm in men, is an independent risk factor for CHD, hypertension, increased oxidized LDL-cholesterol, and type 2 diabetes[24–27]. However, these WC cut-offs were developed as an alternative to BMI measures and are strongly correlated with a BMI of 30 or more[15]. Therefore, the question has been raised if the inclusion of these WC cut-offs in the NIH treatment algorithm is useful in increasing the rate of identification of subjects who meet weight loss treatment criteria.

In the present population, excluding the WC cut-offs of >88 cm in women and >102 cm in men would have excluded only 0·3 % of men and 1·0 % of women from those identified for weight loss treatment by the NIH treatment algorithm. In contrast, an additional 3·2 % and 4·2 % of men and women, respectively, would be considered at elevated risk according to the NIH algorithm using WC cut-offs of >80 cm in women and >94 cm in men; these levels are strongly correlated with a BMI of 25 or more[20]. All of these subjects were normal weight (BMI 18·5–24·9) with elevated WC and two or more CVD risk factors. In view of the increasing evidence of adverse health effects of elevated WC, independent of BMI, it might be reasonable to incorporate these WC cut-offs into the NIH treatment algorithm. This would help to identify considerably more subjects who would benefit from weight loss treatment.

It should be noted that the loss of about 30 % of participants can be considered a certain limitation of the present study.

In conclusion, in 1995 about 40 % of the present population would be identified for weight loss treatment according to the NIH obesity treatment algorithm. This prevalence significantly increased 5 years later, by 6·5 % in men and 5·3 % in women. These results should be a strong indicator of the need to reinforce public policy and patient education efforts to develop weight loss strategies in the present Mediterranean population.

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References

1. Nanchahal K, Morris JN, Sullivan LM & Wilson PW (2005) Coronary heart disease risk in men and the epidemic of overweight and obesity. *Int J Obes (Lond)* **29**, 317–323.
2. Rahmouni K, Correia ML, Haynes WG & Mark AL (2005) Obesity-associated hypertension: new insights into mechanisms. *Hypertension* **45**, 9–14.
3. Ascaso JF, Romero P, Real JT, Lorente RI, Martinez-Valls J & Carmena R (2003) Abdominal obesity, insulin resistance, and metabolic syndrome in a southern European population. *Eur J Intern Med* **14**, 101–106.
4. Krauss RM, Winston M, Fletcher BJ & Grundy SM (1998) Obesity: impact on cardiovascular disease. *Circulation* **98**, 1472–1476.
5. Klein S (2001) Outcome success in obesity. *Obes Res* **9**, Suppl. 4, 354S–358S.
6. Thomas F, Bean K, Pannier B, Oppert JM, Guize L & Benetos A (2005) Cardiovascular mortality in overweight subjects. The key role of associated risk factors. *Hypertension* **46**, 654–659.
7. Flegal KM, Graubard BI, Williamson DF & Gail MH (2005) Excess deaths associated with underweight, overweight, and obesity. *JAMA* **293**, 1861–1867.
8. Seidell JC, Verschuren WM, van Leer EM & Kromhout D (1996) Overweight, underweight, and mortality. A prospective study of 48,287 men and women. *Arch Intern Med* **156**, 958–963.
9. Calle EE, Rodriguez C, Walker-Thurmond K & Thun MJ (2003) Overweight, obesity, and mortality from cancer in a

prospectively studied cohort of U.S. adults. *N Engl J Med* **348**, 1625–1638.
10. National Institutes of Health (1998) Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. The evidence report. *Obes Res* **6**, Suppl. 2, 51S–209S.
11. Expert Panel (1998) Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Arch Intern Med* **158**, 1855–1867.
12. Arrizabalaga JJ, Masmiquel L, Vidal J, *et al.* (2004) Overweight and obesity in adults: recommendations and treatment algorithms. *Med Clin (Barc)* **122**, 104–110.
13. Masia R, Pena A, Marrugat J, Sala J, Vila J, Pavesi M, Covas M, Aubo C & Elosua R (1998) High prevalence of cardiovascular risk factors in Gerona, Spain, a province with low myocardial infarction incidence. *J Epidemiol Community Health* **52**, 707–715.
14. Kuczmarski RJ & Flegal KM (2000) Criteria for definition of overweight in transition: background and recommendations for the United States. *Am J Clin Nutr* **72**, 1074–1081.
15. Lean ME, Han TS & Morrison CE (1995) Waist circumference as a measure for indicating need for weight management. *BMJ* **311**, 158–161.
16. Elosua R, Marrugat J, Molina L, Pons S & Pujol E (1994) Validation of the Minnesota Leisure Time Physical Activity Questionnaire in Spanish men. The MARATHOM Investigators. *Am J Epidemiol* **139**, 1197–1209.
17. Elosua R, Garcia M, Aguilar A, Molina L, Covas MI & Marrugat J (2000) Validation of the Minnesota Leisure Time Physical Activity Questionnaire In Spanish Women. Investigators of the MARATDON Group. *Med Sci Sports Exerc* **32**, 1431–1437.
18. Grundy SM (2004) Obesity, metabolic syndrome, and cardiovascular disease. *J Clin Endocrinol Metab* **89**, 2595–2600.
19. Mason C, Katzmarzyk PT & Blair SN (2005) Eligibility for obesity treatment and risk of mortality in men. *Obes Res* **13**, 1803–1809.
20. Mason C & Katzmarzyk PT (2005) Application of obesity treatment algorithms to Canadian adults. *Eur J Clin Nutr* **59**, 797–800.
21. James PT (2004) Obesity: the worldwide epidemic. *Clin Dermatol* **22**, 276–280.
22. Lahmann PH, Lissner L, Gullberg B & Berglund G (2000) Sociodemographic factors associated with long-term weight gain, current body fatness and central adiposity in Swedish women. *Int J Obes Relat Metab Disord* **24**, 685–694.
23. Everson SA, Maty SC, Lynch JW & Kaplan GA (2002) Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *J Psychosom Res* **53**, 891–895.
24. Rexrode KM, Carey VJ, Hennekens CH, Walters EE, Colditz GA, Stampfer MJ, Willett WC & Manson JE (1998) Abdominal adiposity and coronary heart disease in women. *JAMA* **280**, 1843–1848.
25. Lofgren I, Herron K, Zern T, West K, Patalay M, Shachter NS, Koo SI & Fernandez ML (2004) Waist circumference is a better predictor than body mass index of coronary heart disease risk in overweight premenopausal women. *J Nutr* **134**, 1071–1076.
26. Weinbrenner T, Schroder H, Escurriol V, Fito M, Elosua R, Vila J, Marrugat J & Covas MI (2006) Circulating oxidized LDL is associated with increased waist circumference independent of body mass index in men and women. *Am J Clin Nutr* **83**, 30–35.
27. Wang Y, Rimm EB, Stampfer MJ, Willett WC & Hu FB (2005) Comparison of abdominal adiposity and overall obesity in predicting risk of type 2 diabetes among men. *Am J Clin Nutr* **81**, 555–563.
28. United Nations (1991) *World Population Prospects 1990*. New York: United Nations.

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