ORIGINAL ARTICLE

Practical Cut Off Values to Determine Body Mass Index

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SUMMARY

We tried to understand whether there are significant cut off values simply determining body mass index (BMI). The study was performed in Internal Medicine Polyclinics on consecutive check up patients aged between 15 and 70 years to see possible consequences of excess weight on health and to avoid debility induced weight loss in elders. Insulin using diabetics and patients with devastating illnesses were excluded to avoid their possible effects on weight. Cases were subdivided into three groups according to their body weights as under 65, between 65 and 85, and above 85kg groups and prevalences of underweight, normal weight, overweight, and obesity were determined. Sensitivity, specificity, and positive and negative predictive values of body weights to determine BMI were calculated. The study included 954 cases (566 females). Sensitivity of 65kg as a cut off value to detect normal weight was 61.0%, specificity 94.3%, positive predictive value 82.9%, and negative predictive value was 97.6%. Similarly, sensitivity, specificity, and positive and negative predictive values of 65 and 85kg to detect overweight cases were 71.5%, 63.3%, 56.2%, and 77.1% respectively. So both values were statistically significant to detect normal weight, overweight and obese individuals (p=0.000 for both). Although BMI is probably a more valuable parameter to show weight status, the cut off values of 65 and 85kg, as an easier way, have significant places, too.

KEY WORDS:
Body mass index, Normal weight, Overweight, Obesity

INTRODUCTION

In recent years, excess weight is becoming a major health problem all over the world, particularly in developed countries. For example, 30% of adults in the United States can be classified as obese [1]. Obesity is a disorder characterized by increased mass of adipose tissue that results from a systemic imbalance between food intake and energy expenditure, and it is associated with increased levels of inflammatory markers[2] and many systemic disorders including hypertension (HT), type 2 diabetes mellitus (DM), dyslipidemia, coronary heart disease (CHD), and increased mortality rate [3,4]. Additionally, obesity is highly correlated with dietary intake of increased calories and fat, both of which have been linked to several types of cancer [5]. For instance, a recent study of 900,000 persons found that obese patients more likely die from a number of cancers including breast, colon, and prostate [6]. Although many studies have shown that excess weight is associated with numerous medical complications and increased all-cause mortality [3-6], there are not simple cut off values to determine body mass index (BMI) of individuals and many individuals need a medical help to determine their weight status. Here we tried to understand whether or not there are some statistically significant cut off values simply determining the BMI of individuals.

MATERIALS AND METHODS

The study was performed in the Internal Medicine Polyclinics of the Dumlupinar and Mustafa Kemal Universities between August 2005 and July 2007. We took consecutive patients aged between 15 and 70 years to be able to see the possible consequences of excess weight on health and to avoid debility induced weight loss in elders. All cases were evaluated by the same internist and their medical histories including already used medications were learnt, and a routine check up procedure including fasting plasma glucose (FPG), low density lipoprotein cholesterol (LDL-C), triglyceride (TG), and high density lipoprotein cholesterol (HDL-C) was performed. Insulin using diabetics and patients with devastating illnesses including malignancies, acute or chronic renal failure, chronic liver diseases, hyper- or hypothyroidism, and heart failure were excluded to avoid their possible effects on weight. Weight in kilograms is divided by height in meters squared, and obesity is defined as a BMI of 30 or greater, overweight as 25–29.9, normal weight as 18.5-24.9, and underweight as a BMI of lower than 18.5kg/m(2) [7]. Office blood pressure (OBP) was checked after a 5-minute of rest in seated position with the mercury sphygmomanometer on three visits, and no smoking was permitted during the previous 2-hour. A 10-day twice daily measurement of blood pressure at home (HBP) was obtained in all cases, even in normotensives in the office due to the risk of masked HT after a 10-minute education about proper BP measurement techniques[8]. The education included recommendation of upper arm while discouraging wrist and finger devices, using a standard adult cuff with bladder sizes of 12 x 26cm for arm circumferences up to 33cm in length and a large adult cuff with bladder sizes of 12 x 40cm for arm circumferences up to 50cm in length, and taking a rest at least for a period of 5-minute in the seated position before measurement. Eventually, HT is defined as a BP of 135/85 mmHg or greater on mean HBP values[8,9]. Cases with an overnight FPG level of 126 mg/dL or higher on two occasions or already taking antidiabetic medications were defined as diabetics. An oral glucose tolerance test with 75-gram glucose

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was performed in cases with a FPG level between 110 and 126 mg/dL, and diagnosis of cases with a 2-hour plasma glucose level of 200 mg/dL or greater is DM. Additionally patients with dyslipidemia were detected, and we used the National Cholesterol Education Program Expert Panel's recommendations for defining dyslipidemic subgroups [7]. Dyslipidemia is diagnosed with a LDL-C value of 160 or greater and/or a TG value of 200 or greater and/or a HDL-C value of <40 mg/dL and/or already usage of medication for dyslipidemia [7]. Eventually, all of the cases were subdivided into three groups according to their body weights as under 65kg, between 65 and 85, and above 85kg groups and prevalences of underweight, normal weight, overweight, and obesity were determined in them. Sensitivity, specificity, and positive and negative predictive values of the body weights to determine BMI of individuals correctly were calculated. Sensitivity and specificity are defined as true positive/ true positive + false negative, and true negative/ true negative + false positive, respectively. Positive and negative predictive values are defined as true positive/ true positive + false positive and true negative/ true negative + false negative, respectively. Additionally, prevalences of the DM, HT, and dyslipidemia were detected in each group, and results were compared in between. Pearson Chi-Square and student t tests were used as the statistical analysis methods, and p-values lower than 0.05 was accepted as significant.

RESULTS

The study included 954 cases (566 females and 388 males) totally. There were 217 cases under 65, 482 cases between 65 and 85, and 255 cases over 85kg, and characteristics of the groups were summarized in Table I. On the other hand, there were 16 cases with underweight, 279 with normal weight, 379 with overweight, and 280 cases with obesity. Due to the very low prevalence of underweight cases here and previously detected lower prevalences of HT and white coat hypertension like disorders in underweight group even than normal weight cases by us [10], we included the 16 underweight cases into the normal weight cases here. So sensitivity of 65kg as a cut off value to detect the normal weight cases was 61.0%, specificity 94.3%, positive predictive value 82.9%, and negative predictive value was 97.6%. Similarly, sensitivity, specificity, and positive and negative predictive values of 65 and 85kg to detect the overweight cases were 71.5%, 63.3%, 56.2%, and 77.1% respectively. So both of the values are statistically significant to detect normal weight, overweight and obese individuals (p=0.000 for both). Additionally, when we compared the under 65, between 65 and 85, and above 85kg cases according to the prevalences of DM, HT, and dyslipidemia, there were highly significant differences between the groups (p<0.05 for all) (Table II).

DISCUSSION

An extensive literature has documented numerous complications of excess weight [3-6]. Even we detected in a previous study [11] compairing sustained normotensive cases with hypertensives that prevalence of obesity was significantly higher in the HT group (55.1% vs 20.3%, p<0.001), and 55.1% of cases with HT had obesity against 26.6% of cases with normotension (p<0.001) in the other study [12]. But calculation of limits for overweight and obesity for every individual may be difficult and some practical cut off values are required. Although the BMI is probably a more valuable parameter to show the weight status of individuals, as shown here the cut off values of 65 and 85kg, to detect normal weight, overweight, and obese cases, have significant

Table I: Characteristic features of the study cases

Weight range (kg)	Number of cases (n=954)	Mean age (year)	Female ratio	Prevalence of underweight	Prevalence of normal weight	Prevalence of overweight	Prevalence of obesity
40-49	20	29.7	90%	40%	60%		
50-54	45	30.8	97%	8.8%	88.8%	2.2%	
55-59	72	34.4	75%	5.5%	79.1%	15.2%	
60-64	80	40.5	57%		68.7%	27.5%	3.7%
65-69	129	42.9	68%		37.9%	55.8%	6.2%
70-74	133	46.9	54%		26.3%	61.6%	12.0%
75-79	110	48.2	55%		20.9%	47.2%	31.8%
80-84	110	45.6	41%		6.3%	59.0%	34.5%
85-89	90	47.8	46%		1.1%	40.0%	58.8%
90-94	55	46.3	50%			36.3%	63.6%
95-99	45	42.0	60%			26.6%	73.3%
100-110	43	49.0	44%			11.6%	88.3%
110-120	17	47.1	76%			5.8%	94.1%
120-130	5	51.4	100%				100%

Table II: Comparison of the cases according to body weight and systemic disorders

Body weight (kg)	Number of cases	Female ratio	Prevalence of diabetes mellitus	Prevalence of hypertension	Prevalence of dyslipidemia
Lower than 65	217	74.6%	2.7%	5.0%	15.2%
T-test value			14.73	6.25	9.27
			***	***	***
Between 65 and 85	482	55.6%	13.6%	11.2%	30.4%
T-test value			1.67	5.39	2.77
			†	***	**
Equal to or greater than 85	255	52.5%	17.2%	21.9%	38.4%

*p<0.05 **p<0.01 ***p<0.001 †Nonsignificant (p>0.05)

places, too. For example, there were only three cases of obesity (1.0%) under 65kg and one case of normal weight (0.3%) above 85kg groups in the study. More importantly, it is a very easy way for every person without any requirement of medical help and we did not account sex and height of individuals in the study. Similarly, authors in the Adult Treatment Panel III reported[7] that although some people classified as overweight actually have a larger muscular mass, most of them have excess body fat, and both the overweight and obesity do not only predispose to CHD, stroke, and numerous other conditions, they also have a high burden of other risk factors for CHD including dyslipidemia, type 2 DM and HT. Similarly, the differences between the normal weight and overweight groups according to the increasing prevalences of DM, HT, and dyslipidemia were highly significant in the study ($p<0.05$ for all). Additionally, when we compared the underweight, normal weight, and overweight cases with a mean age of 24 years, there was a significantly decreased prevalence of sustained normotension against a significantly increased prevalence of white coat hypertension in another study, although the very low mean age of them, as a probable indicator of effect of body mass on blood pressure [10]. So the larger muscular mass of the males, except athletes like extreme cases with pure muscular mass, probably does not protect themselves from the harmful effects of excess weight. As a similar result to ours, increasing weight showed a significant increase in prevalence of HT in a linear relationship in another study [13]. So lower the weight, higher the health.

When we came to the children and teenagers, it was already shown by us with the previous reports [9, 10] that excess weight is becoming a great health problem even in early decades. For example, the prevalences of white coat hypertension, as an indicator of something going bad for health [11], were 33.3% and 46.6% even in the second and third decades of life, respectively. Additionally, when we compared the underweight, normal weight, and overweight cases with a mean age of 24 years, there was a significantly decreased prevalence of sustained normotension against a significantly increased prevalence of white coat hypertension in another study [10], although the very low mean age of them, as a probable indicator of effect of body mass on blood pressure. Similarly, the proportion of obese school boys aged between 6 and 14 years was 24.5% in Saudi Arabia in 2005 [14]. Additionally, it was found in another study 15 performed on 2,478 children aged between 12 and 14 years in Turkey that 14.1% (350) had prehypertension, 5.4% (147) had HT, and 1.6% (40) had malign HT, and there was a statistically significant relationship between HT prevalence and BMI equal to or greater than 85th percentile. So excess weight initiates to effect health in early ages, and probably terminates with HT, type 2 DM, CHD, stroke, and a higher all-cause mortality [11].

As a conclusion, due to the already known numerous complications of excess weight, weight control has become one of the key points of health for today but calculation of limits for overweight and obesity for every individual may be little difficult. On the other hand, the reliabilities of 65 and 85kg in determining weight status of the individuals are significant and every individual knows his or her body weight approximately or can measure easily with a simple effort without a medical need. So although the BMI is probably a more valuable parameter to show weight status of individuals, the cut off values of 65 and 85kg, as a much more easier way, have significant places, too.

REFERENCES

1. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. JAMA 2006; 295: 1549-55.
2. Saito I, Yonemasu K, Inami F. Association of body mass index, body fat, and weight gain with inflammation markers among rural residents in Japan. Circ J 2003; 67: 323-29.
3. Kuchta KF. Pathophysiologic changes of obesity. Anesthesiol Clin North America 2005; 23: 421-29.
4. Jee SH, Sull JW, Park J, Lee SY, Ohrr H, Guallar E, *et al.* Body-mass index and mortality in Korean men and women. N Engl J Med 2006; 355: 779-87.
5. Satia-Abouta J, Patterson RE, Schiller RN, Kristal AR. Energy from fat is associated with obesity in U.S. men: results from the Prostate Cancer Prevention Trial. Prev Med 2002; 34: 493-501.
6. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 2003; 348: 1625-38.
7. 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) final report. Circulation 2002; 17:106: 3143-21.
8. O'Brien E, Asmar R, Beilin L, Imai Y, Mallion JM, Mancia G, *et al.* European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. J Hypertens 2003; 21: 821-48.
9. Helvaci MR, Seyhanli M. What a high prevalence of white coat hypertension in society! Intern Med 2006; 45: 671-74.
10. Helvaci MR, Kaya H, Yalcin A, Kuvandik G. Prevalence of white coat hypertension in underweight and overweight subjects. Int Heart J 2007; 48: 605-13.
11. Helvaci MR, Kaya H, Seyhanli M, Cosar E. White Coat Hypertension Is Associated with a Greater All-cause Mortality. J Health Sci 2007; 53: 156-60.
12. Helvaci MR, Ozcura F, Kaya H, Yalcin A. Funduscopic examination has limited benefit for management of hypertension. Int Heart J 2007; 48: 187-94.
13. Al-Nozha MM, Abdullah M, Arafah MR, Khalil MZ, Khan NB, Al-Mazrou YY, *et al.* Hypertension in Saudi Arabia. Saudi Med J 2007; 28: 77-84.
14. Al-Hazzaa HM. Prevalence and trends in obesity among school boys in Central Saudi Arabia between 1988 and 2005. Saudi Med J 2007; 28: 1569-74.
15. Akis N, Pala K, Irgil E, Utku AM, Bingol S. Prevalence and risk factors of hypertension among school children aged 12-14 years in Bursa, Turkey. Saudi Med J 2007; 28: 1263-68.