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ORIGINAL ARTICLE

Prevalence of obesity – baseline assessment in the prospective cohort 'PONS' study

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Abstract

Objective: The aim of the study was to evaluate the prevalence of overweight and obesity in the population of Świętokrzyskie Province in Poland.

Methods: Body mass index (BMI), waist to hip ratio (WHR) and waist circumference (WC) in the Polish-Norwegian Study (PONS) was measured in 2,567 females and 1,287 males. Anthropometric measurements included fat mass, height, weight, waist and hip circumference. BMI and WHR were calculated.

Results: Data showed that 52% of males and 42% of females were overweight (25.0≤BMI<30.0 kg/m^2), and the prevalence of obesity (BMI≥30.0 kg/m^2) was 35% in both genders. The average BMI was higher in males (28.5 kg/m^2) than in females (28.2 kg/m^2). Analysis of WC showed that 36% of males and 45% of females had abdominal obesity, whereas measurements of WHR showed abdominal obesity in 64% of males and 79% of females. Generally, the prevalence of obesity was higher in the older age group (55-64 years) and in rural inhabitants. The prevalence of overweight increased with educational level, but the prevalence of obesity decreased with level of education in both males and females.

Conclusions: Almost 80% of the PONS population were either overweight or obese; therefore, the PONS population is at increased risk of developing obesity-related diseases.

Keywords

BMI, WHR, overweight, obesity, prospective study, cohort study, Poland, PONS

INTRODUCTION

Obesity is a growing public health problem worldwide. Its prevalence is increasing in both developed and developing countries [1-4]. It has been suggested that obesity has increased to epidemic proportions in Europe, especially in the central, eastern and southern regions [5].

Overweight is a consequence of imbalance between calorie consumption and energy expenditure which manifests with an increase of adipose tissue and raises the risk of many chronic diseases and health problems, such as non-insulin-dependent diabetes mellitus, coronary heart disease, hypertension, certain cancers (breast cancer in postmenopausal females, endometrial cancer, colon cancer, kidney cancer) among others [6-10]. Obesity is also one of 7 leading risk factors which have influence on a healthy life, expressed in disability-adjusted life years (DALYs) [11]. It is well documented in large epidemiological studies that overweight and obesity are risk factors of all-cause mortality [12-16]. A recent publication of Prospective Studies Collaboration, which included analysis of 57 prospective studies, found BMI less than 22.5 kg/m^2 and more than 25.0 kg/m^2 as a strong predictor of overall mortality in males and females [17].

According to data from a WOBASZ study conducted on a representative sample of the Polish population aged 20-74 years, 40% of males and 28% of females were overweight, whereas obesity concerned 21% and 22%, respectively [18]. Jarosz and Rychlik found that the prevalence of overweight and obesity in Poland is rising, especially in males, and was comparable with most European countries. They found that excessive body weight (BMI≥25.0) was observed in approximately 60% of males and 50% of females. Similarly to other studies, obesity tended to increase with age [19]. In 2002 in Poland, the prevalence of overweight was found in 39% of males and 24% of females aged 20-64, while

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the prevalence of obesity was observed in 18% and 11%, respectively [20].

Data on overweight and obesity in Poland are limited. Hence, the aim of this study was to describe the variability of BMI, WHR, and WC in a sample of the Polish adult population, and to determine relationships between BMI and factors such as gender, age, place of residence and level of education.

MATERIALS AND METHODS

This study presents preliminary analysis of data collected in the first group of participants of the Polish-Norwegian Study (PONS) of chronic diseases in the Świętokrzyskie Province of Poland. The PONS study was a large, open-ended prospective study with very broad research aims. One of these aims was to extensively survey the study population with respect to important factors related to health and wellbeing, and establish solid knowledge about major causes of premature morbidity and mortality.

Sample and data collection. Recruitment units were established in urban and rural areas of Świętokrzyskie Province. The results presented in this article are based on data from the first group of 3,854 participants (2,567 females and 1,287 males aged between 45-64 years) recruited between September 2010 and April 2011. All participants were examined in accordance with the PONS project protocol. The questionnaire data were collected at a systematic interview and the responses entered on an electronic form. After completion of the interview, data were sent directly to a data server for processing and further management.

Measurement. Anthropometric measurements included height, weight, waist and hip circumference. During weight measurement, the percentage of fat mass was additionally evaluated using bioelectrical bioimpedance. Subjects were examined after removal of clothes and shoes. Weight was measured using electronic scales (TANITA), model BC-554. Hip and waist circumference were measured using a non-stretch measuring tape within an accuracy of 1/10 cm. Waist circumference was measured in the section midway between the lower edge of the ribs and the iliac crest, and hip circumference at the widest point of the buttocks.

BMI was calculated as weight (kg) divided by height (m) squared. Subjects were classified into 4 BMI categories according to the WHO guidelines as being underweight (BMI<18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2), and obese (BMI≥30.0 kg/m^2). In the presented study, analysis included only overweight and obesity.

WHR was calculated as waist circumference (cm) divided by hip circumference (cm). Females with WHR≥0.8 and males with WHR≥0.94 were acknowledged as having abdominal obesity. Cut-off points to categorize subjects with abdominal obesity were waist circumference in females at 88 cm and in males 102 cm, according to the Third Report of the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP III) [21].

Statistical analysis. Mean and standard deviation were calculated to summarize continuous variables. For all analyses, the criterion for statistical significance was set at p=0.05. Statistical analyses were made using computer programme STATISTICA v. 9.1 PL StatSoft Inc., USA, and IBM SPSS Statistics v. 19.0, SPSS Inc. (an IBM Co.), USA.

Ethics. The study was approved by the Ethics Committee of the Cancer Centre and Institute of Oncology in Warsaw, Poland.

RESULTS

Table 1 shows the average BMI, WHR and WC in males and females. The average BMI was significantly higher in males (28.5 kg/m^2) compared to females (28.2 kg/m^2). Males were additionally characterized by higher average WC and WHR. Analysis of WC showed that 36% of males and 45% of females had abdominal obesity, whereas analysis of WHR showed abdominal obesity in 64% of males and 79% of females (Fig. 1). 90% of males had a fat mass greater than 20%, and 85% of females were characterized by a fat mass higher than 30%. Data showed in males a strong positive correlation between BMI and fat mass (r=0.79, p<0.01), between WC and fat mass (r=0.75, p<0.001), and between WHR and fat mass (r=0.52, p<0.001). In females, correlation was strong between BMI and fat mass (r=0.55, p<0.001), and between WC and fat mass (r=0.52, p<0.001). However, the correlation between WHR and fat mass was weak (r=0.29, p<0.001).

Table 1. Average BMI, WHR and WC in males and females

Variables	Gender	N	Average	Min.	Max.	SD	p-value
BMI	Males	1,287	28.5	18	45	3.8	<0.01
	Females	2,567	28.2	18	63	5.0	
WC	Males	1,288	99.6	68	138	10.2	<0.01
	Females	2,570	88.3	38	144	11.7	
WHR	Males	1,287	0.96	0.70	1.22	0.07	<0.01
	Females	2,568	0.84	0.37	1.18	0.07	

Abbreviations:
SD – standard deviation
BMI – body mass index
WC – waist circumference
WHR – waist to hip ratio

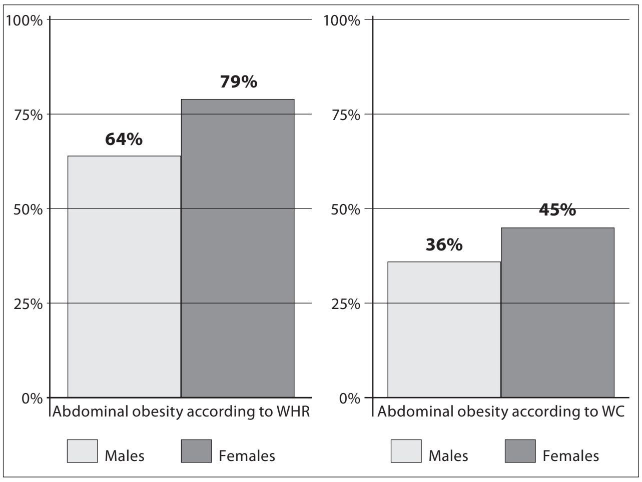

Figure 1. Prevalence of central adiposity in males and females

Tab. 2. Overweight and obesity in men and women by age, residence and education

Variables		Normal weight (BMI<25.0)		Overweight (25.0≤BMI<30.0)		Obesity (BMI≥30.0)	
		Males	Females	Males	Females	Males	Females
Age groups	45-54, n=1582	16%	31%	52%	42%	32%	26%
	55-64, n=2272	11%	19%	52%	42%	37%	40%
Residence	Rural, n=1179	11%	18%	49%	41%	39%	41%
	Urban, n=2675	14%	27%	53%	42%	33%	31%
Education	Primary, n=230	9%	8%	38%	35%	53%	57%
	Vocational, n=686	11%	17%	50%	40%	39%	43%
	Secondary, n=1704	14%	23%	50%	41%	36%	36%
	Higher, n=1234	14%	33%	58%	44%	28%	23%

Table 2 shows the prevalence of overweight and obesity in males and females, according to selected socio-demographic factors. Males were characterized by a higher prevalence of overweight (52%) compared to females (42%). Male gender compared to female gender was positively associated with overweight (OR=1.53, 95% CI 1.31-1.72, p<0.001). The prevalence of obesity was similar for both genders, and averaged about 35%.

The prevalence of overweight was similar in the age groups, both for males (52%) and females (42%). Analysis showed a significantly higher prevalence of obesity in the older age group of females – 42% in females aged 55-64 years vs. 26% in females aged 45-54 years, but no such association was found in males.

There were no differences in the prevalence of overweight between rural and urban inhabitants, both in males (49% vs. 53%) and in females (41% vs. 42%). However, the prevalence of obesity was significantly higher in rural compared to the urban area in both males (39% vs. 33%) and females (41% vs. 31%), respectively (Tab. 2). Urban compared to rural residence was negatively associated with obesity. In males, the OR averaged 0.76 (95% CI 0.60-0.97, p=0.02). In females, the association was more prominent (OR=0.66, 95% CI 0.55-0.78, p<0.001) (Tab. 3).

Table 3. Association between overweight, obesity and socio-demographic factors

Gender		Variables	OR	95% CI	p-value
Males	Overweight	Age 55-64	1.00	0.80 – 1.25	0.522
		Urban residence	1.16	0.92 – 1.47	0.120
		Higher education	1.26	0.99 – 1.60	0.034
	Obesity	Age 55-64	1.21	0.95 – 1.53	0.065
		Urban residence	0.76	0.60 – 0.97	0.017
		Lower education	0.67	0.52 – 0.86	0.001
Females	Overweight	Age 55-64	0.98	0.83 – 1.15	0.409
		Rural residence	1.04	0.88 – 1.24	0.332
		Lower education	1.18	0.97 – 1.44	0.049
	Obesity	Age 55-64	1.82	1.53 – 2.16	<0.001
		Urban residence	0.66	0.55 – 0.78	<0.001
		Lower education	0.48	0.40 – 0.59	<0.001

Abbreviations:
OR – odds ratio
CI – confidence interval

The prevalence of overweight increased and the prevalence of obesity decreased with educational level. The prevalence of overweight ranged between 38% (primary education) and 58% (higher education) in males, and between 35% and 44% in females, respectively (Tab. 2). The prevalence of obesity was similar in males and females, between approx. 25% in subjects with the lowest education and approx. 55% in those with the highest education. Analysis showed negative association between obesity and lower level of education (primary and vocational), compared to higher level of education (secondary and higher) in males (OR=0.67, 95% CI 0.52-0.86, p=0.01) and in females (OR=0.48, 95% CI 0.40-0.59, p<0.001) (Tab. 3).

In both males and females, BMI was correlated with WHR and WC. The correlation coefficients were higher between BMI and WC (r=0.86 in males, r=0.87 in females, p<0.001) than between BMI and WHR (r=0.55 in males, r=0.46 in females, p<0.001). Both, large WC and high WHR were positively associated with obesity.

The relationship between BMI and abdominal obesity is presented in Table 4. Among participants with obesity, 89% of males and 93% of females had central adiposity defined by WHR. According to ATP III criteria for waist circumference, there were 98% of males and 100% of females with abdominal obesity among those with BMI≥30 kg/m^2. Interestingly, 27% of males and 54% of females with normal weight (BMI<25.0 kg/m^2) had abdominal obesity according to WHR, whereas analysis of WC showed central adiposity in 7% of males and 23% of females.

Table 4. Prevalence of excessive weight (BMI≥25.0) and obesity (BMI≥30.0) in relation to WC and WHR

Gender	BMI	WHR<0.8/0.94	WHR≥0.8/0.94	WC<88/102	WC≥88/102
Males	BMI<30	48.7%	51.3%	47.0%	53.0%
	BMI≥30	10.9%	89.1%	1.6%	98.4%
	BMI<25	73.4%	26.6%	93.5%	6.5%
	BMI≥25	29.8%	70.2%	21.7%	78.3%
Females	BMI<30	29.0%	71.0%	41.0%	59.0%
	BMI≥30	7.0%	93,0%	0.1%	99.9%
	BMI<25	45.8%	54.2%	76.7%	23.3%
	BMI≥25	13.8%	86.2%	11.3%	88.7%

Abbreviations:
BMI - body mass index
WC - waist circumference
WHR - waist to hip ratio

DISCUSSION

In the presented study it was found that 80% of subjects had excessive weight (BMI≥25.0 kg/m^2). Analysis of BMI, WC, WHR, and some socio-demographic factors showed considerable variations within the cohort. Mean BMI was higher in males compared to females; however, the prevalence of central adiposity described on the basis of WC and WHR was higher in females. Generally, the prevalence of overweight was higher in males compared to females, and obesity was the same. When considering age groups, significant differences were found only in the prevalence of obesity between the younger and older age groups in females. In the PONS study, place of residence had no influence on the prevalence of overweight; however, obesity was significantly higher in both rural males and rural females. Obesity was negatively associated with a lower level of education, and positively associated with a higher level of education.

Data from the PONS study are consistent with results from other European studies. In the European Prospective Investigation into Cancer and Nutrition (EPIC) study [22], conducted in 25 centres in 9 European countries in subjects aged 50-64, overweight based on measured weight and height in males ranged between 47% in Sweden and 55% in Spain, and obesity ranged between 10% in Sweden and 35% in Spain. In females, overweight varied between 20% in France and 44% in Spain, and obesity between 5% in France and 41% in Spain. In the EPIC-Norfolk study conducted on 9,933 males and 11,856 females aged 39-79, mean BMI was 26.4 kg/m^2 in males and 26.1 kg/m^2 in females [23]. Mean WC was higher in males (95.4 cm) compared to females (81.2 cm). This, however, was lower than in the PONS study. Mean WHR in males in the EPIC-Norfolk study (0.93) was similar to mean WHR in the PONS study (0.96) in males, but in females was slightly lower (0.79 vs. 0.84). Data from the Health Survey for England (HSE) and English Longitudinal Study of Aging Wave 1 (ELSA W1), studies conducted in the United Kingdom on a national population sample of 1,030 females and 888 males aged 55-74 years, showed similar mean BMI in males and females (27.6 kg/m^2). However, WC and WHR were higher in males (99.5 cm, 0.95, respectively) than in females (86.9 cm, 0.82, respectively) [24].

In a Polish study conducted in 2000 on a sample of 4,153 subjects, mean BMI was lower in males and females compared to the results of the PONS study [25]. Additionally, mean BMI in females aged 40+ (27.3 kg/m^2) was higher than in males (26.9 kg/m^2). Mean WC in males aged 40+ was lower than in the PONS study, and averaged 94.4 cm, but in females it was the same (88.3 cm). Mean WHR averaged 0.93 in males and 0.83 in females, and was comparable between these 2 studies. The NATPOL PLUS study [26] conducted in 2002 on a representative sample of the Polish population showed overweight in 39% of males and 29% of females. Obesity was found in 16% of males and 19% of females. Furthermore, results from the previous NATPOL study conducted in 1997 and the NATPOL PLUS study in 2002 indicated that there were no substantial differences in the prevalence of overweight and obesity in males and females in Poland in the 5-year time period.

Analyses in the presented study were restricted to participants aged 45-64 years, and the high prevalence of overweight and obesity observed can be partly explained because obesity rises with age at the population level, in both males and females, it increases at least up to the age of 50-60. Surprisingly, in the PONS study the prevalence of obesity was similar in males and females. However, generally, females have a higher prevalence of obesity than males, especially in older age [27]. Lawlor and Chaturvedi [28] have suggested that in developing countries, from cultural point of view, females with obesity are perceived as an indication of wealth, which could be associated with the higher prevalence of obesity.

Low et al. [29] reported that a higher prevalence of obesity is characteristic for urban areas in developing countries. This is associated with the change of lifestyle from rural to urban, together with a decreased level of physical activity and increased high-energy diet. In the PONS study, however, the results were the opposite.

In large populations, BMI and the percentage of body fat have a good correlation, and it is one of the reasons that BMI is used to classify people in terms of excess body fat. This is consistent with the results of the PONS study. BMI is also an excellent measure of adiposity in young and middle-aged adults, but is less useful in older age groups because elderly people lose their fat free mass and gain fat mass along with having the same BMI [30]. Therefore, for the elderly, complementary measurements may be more appropriate. Changes in waist circumference reflect adipose rather than muscle tissue, and may be a better indicator of overall adiposity than weight alone or BMI [31].

In the PONS study, in both in males and females, there was a good correlation between WC and percentage of body fat. However, WHR did not correlate with percentage of fat mass or WC. Thus, waist circumference seems to be the best measurement as it strongly correlates with abdominal fat and can be easily measured and interpreted.

In the PONS study, central adiposity was higher in females than in males. This is surprisingly because this type of obesity is more typical for males. In females, the excess body fat is usually distributed mainly peripherally in the thighs, buttocks and breasts, while in males there is a relative excess of body fat stored in the abdominal cavity.

Presented results concern sample of population living in one of 16 regions of Poland and thus their interpretation cannot be used to make conclusions for general Polish population. However, the study had also strengths. Weight and height were measured using standard protocol. Therefore, there is no bias of underestimation of weight and overestimation of height, what usually happens when data are reported.

The presented results concern only preliminary analysis and a baseline assessment of the PONS study. Multi-factoral analyses of correlation with diet, physical activity, smoking status and selected diseases (for example hypertension, CVD, diabetes, etc.) is planned to determine the causes of overweight and obesity in the PONS population.

Limitations. The obtained results come from a preliminary cross-sectional analysis from an on-going cohort study in Poland. More females than males, and more participants aged 55-64 years than 45-54 years, have been recruited to the study to-date. It is not unreasonable to assume that during the initial phase of the study a skewed distribution of the population has been recruited.

CONCLUSIONS

Population in Świętokrzyskie Province of Poland may be experiencing significant burden of obesity-related diseases. Regarding the high prevalence of overweight and obesity, there is urgent need for intervention activities in this area.

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