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BODY FATNESS AND ITS SOCIAL AND LIFESTYLE DETERMINANTS IN YOUNG WORKING MALES FROM CRACOW, POLAND

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Summary. The aim of this study was to determine the degree to which general body fatness variation, presented by body mass index (BMI), the sum of the three skinfold thicknesses (TST) (triceps, subscapular, abdominal) and percentage of body fat (%FAT), can be explained by socioeconomic status (SES) and lifestyle. The cross-sectional, population-based survey was of 259 healthy working males aged 20–30 from the city of Cracow, Poland. Objective anthropometric measurements, bioelectrical impedance analysis, the results of motor fitness tests and social and lifestyle data from a questionnaire were analysed. The independent variables were: age, socioeconomic status (birthplace, place of residence until the age of 14, social class, educational level and the type of work done) and lifestyle elements (smoking habits, dietary habits, family obesity resemblance, sport activity in the past, leisure time physical activity and level of motor fitness). Three separate full models were created using stepwise straightforward regression with BMI, TST and %FAT as dependent variables. The highest autonomous influence on BMI and %FAT was ascribed to age and family obesity resemblance, whereas variation in TST was explained by level of motor fitness, age, city as a place of residence until the age of 14 and family obesity resemblance. Although the analysed variables explained only from 8% (BMI) to 13% (TST) of body fatness variation, indicating at the same time that most variations are explained by other variables, the impact of lifestyle family-shared factors on body fatness seems to be significant.

Introduction

Obesity is the condition in which excess body fat has accumulated to the degree that heath and function are negatively affected (Ulijaszek & Lofink, 2006). For the last decade the percentage of obese people has increased by 10–40% in most European countries (Rössner, 2002). It is a matter of concern that figures show an increase of obesity and overweight prevalence in younger and younger males (Flegal *et al.*, 1998; Lahti-Koski *et al.*, 2000; Bielicki *et al.*, 2000; Visscher *et al.*, 2002). Studies of conscript soldiers in Poland (Bielicki *et al.*, 2000, 2003; Kozieł *et al.*, 2006) have presented a continuous growth of the fraction of 19-year-old obese and overweight males from 5·3% in 1965 to 14·3% in 2001. Pol-MONICA researches conducted in Warsaw and Cracow in the years 1983/84–1992/93 also showed the highest increase of BMI in the group of younger males (Dennis *et al.*, 2000).

A number of biological, demographic, socio-cultural and behavioural factors are associated with overweight and obesity (Seidell & Flegal, 1997; Lahti-Koski *et al.*, 2000, 2002; van Lenthe *et al.*, 2000; Aranceta *et al.*, 2001; Ramos de Marins *et al.*, 2001; Paeratakul *et al.*, 2002; Visscher *et al.*, 2002; Ball *et al.*, 2003; Huot *et al.*, 2004; Novak *et al.*, 2006; Ulijaszek & Lofink, 2006), but their determinants in a particular population are often different. The economic, social and political transition in Poland over the past 20 years has provided important changes in lifestyle, and a conscious choice of leisure time activities, eating habits, smoking and active relation to one's own health or ways of stress management. According to Kozieł *et al.* (2006), the increase in BMI, especially between 1995 and 2001, in Polish conscripts corresponds with significant improvements in economic and living conditions associated with the later stages of the socio-political transformation of the 1990s.

The objective of this study was to determine the degree of explanation of body fatness variation through socioeconomic status and lifestyle variables in young healthy males from a city population of Cracow, Poland.

Subjects and Methods

Subjects

The data in this cross-sectional study comprised objective anthropometric measurements, results of motor fitness tests and social and lifestyle indices of 259 young, working males aged 20–30 (27·04 ± 2·67) employed by the Sendzimir Metallurgical Plant in Cracow and some other companies located on its premises. The employees included in the study participated in anthropological measurements and motor fitness tests voluntarily, following previous medical qualification. They were measured during periodical medical check-ups between 2001 and 2003 as a part of a research project concerning physical condition of the Cracow adult population, described in detail elsewhere (Gołąb *et al.*, 2004). Such medical tests are compulsory for all workers and they are usually performed every two years. The examination is intended to check the employee's health condition and capability to perform work on a given position, and thus both white- and blue-collar workers are examined (constituting, respectively, 29 and 71% of the studied group). Over 21% of males had university or incomplete university level education. Twenty-three per cent of the studied males possessed secondary comprehensive or technical education, while the majority (56%) were poorly educated (ground or basic vocational education) (Suder, 2008). These proportions well reflect the structure of education of young people in Polish urban populations (GUS, 2003). The majority of young males from the studied sample had normal BMI values (24·72 ± 3·6). Overweight ($25 \leq BMI < 30$) characterized over one-third of the studied group and obesity frequency ($BMI \geq 30$) amounted to 8·11% (Suder, 2006a).

The protocol was conducted according to the scientific studies ethic principles stated in the Helsinki Declaration. A detailed description of the examined males according to socioeconomic status, selected lifestyle elements, average level of somatic features and body fat distribution indices and central type of body fat distribution prevalence has been presented elsewhere (Suder, 2006a, 2006b, 2008).

Anthropometry

The anthropometric measurements conducted in this study included: body height (basis–vertex, measured without shoes, in standing position to the nearest 0·1 cm, using a stadiometer) and body weight (BW, measured to the nearest 0·1 kg, using a clinical balance scale). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Skinfold thicknesses (triceps, subscapular, abdominal) were measured with Holtain skinfold callipers from Sieber-Hegner Machines S.A. with 10g/mm^2 pressure force. The sum of the three skinfold thicknesses (triceps, subscapular, abdominal) (TST) was used as the indicator of subcutaneous body fatness. Fat mass (FM), percentage of body fat (%FAT) and fat-free mass (FFM) were estimated with bioelectrical impedance analysis (BIA), using a Body Composition Analyzer TBF 300 (Tanita Corp., Tokyo, Japan). The Tanita system measures the voltage drop from foot to foot when small alternating current is applied through contact with two metal foot plates. It resembles a set of bathroom scales on which the subject stands barefoot and the machine displays weight and the percentage body fat. The BIA test was carried out in the morning (fasting) after the subjects had emptied their bladders, according to procedures provided by the manufacturer.

The anthropometric measurements were taken according to standard procedures (Weiner & Lourie, 1969) by a trained team consisting of the same investigators throughout the whole course of the study.

Questionnaire studies

Qualified interviewers collected data from all the participants of the study using a questionnaire prepared at the Faculty of Anthropology at the Academy of Physical Education in Cracow, previously verified in former studies (Gołąb *et al.*, 2004). The questionnaire covered social and lifestyle factors.

Social factors. In the present study, socioeconomic status (SES) was determined from the sum of scores obtained for each category of every single variable, and then three SES degrees were defined based on percentile distribution: low (<25th percentile), medium (25th–75th percentile) and high (>75th percentile). The criterion that was worked out on the basis of the data included many attributes and determined the SES of young males, including the total effect of five variables. The following five variables of SES are correlated, but not completely interchangeable (the score given for a particular answer has been presented in parentheses). Birthplace: village (1), small town up to 10,000 inhabitants (2), medium-size town up to 100,000 (3), a city over 100,000 inhabitants (4); place of residence until the age of 14: village (1), small town up to 10,000 inhabitants (2), medium-size town up to 100,000 (3), a city over 100,000 inhabitants (4); social class: working class (1), peasant (2), upper-middle (3); educational level: ground or basic vocational (1), secondary comprehensive or technical (2), incomplete university or university (3); the type of work done: manual (1), mental (2). The relations between given SES variables and body fatness were also analysed.

Lifestyle factors. The following lifestyle factors were considered:

Smoking habits. The studied males were categorized into groups of smokers and non-smokers on the basis of their questionnaire responses. Smokers were further divided into those smoking fewer and more than 20 cigarettes a day. From among non-smokers, ex-smokers (i.e. those who had given up the habit at least six months before the study) were differentiated.

Dietary habits. A questionnaire prepared at the Faculty of Hygiene and Health Promotion at the Academy of Physical Education in Cracow (Gacek *et al.*, 2004) was applied to evaluate the subjects' dietary habits. The questions assessed their dietary habits as well as usual eating patterns and tested: number of meals consumed during a day, regularity of meals, highest caloric value of meals, the time of the last meal eaten on a day, conscious control over the time of the last meal, eating between meals, morbidly increased appetite attacks, eating fast food, frequency of eating fish, fruit, vegetables and sweets. The replies that were consistent with healthy eating rules got higher scores. Following that, all scores were summed up and, based on quartiles, three groups of subjects with dietary habits were identified, namely: unsatisfactory dietary habits: individuals with dietary habits inconsistent with healthy eating rules (>25th percentile), satisfactory dietary habits (25th–75th percentiles), right dietary habits (>75th percentiles).

Family obesity resemblance. Respondents' information on obese relatives in their families made it possible to divide them into two groups: those who originated from obese families and those whose families were non-obese. The closest family members, i.e. parents and siblings, were taken into consideration. It was assumed that obesity in a family is, apart from genetic conditioning, the effect of the lifestyle adopted by a given family. Thus family obesity resemblance was seen as an element resulting from the lifestyle of the family and, at the same time, of the studied subject.

Physical activity in the past. Subjects were asked about sport discipline done in the past as well as the regularity and number of hours in a week spent on physical activity. Based on given replies two groups were identified: those who used to do sports in the past (on a regular basis, at least 2 hours per week) and those who did not.

Leisure time physical activity (LTPA). Subjects were asked about current sport discipline, as well as the regularity and number of hours spent on physical activity. Those who spent at least 2 hours a week on physical activity were considered physically active, allowing the division of all subjects into two categories: those engaged in physical activity in their leisure time and those abstaining from physical activity.

Fitness tests. Motor fitness tests included five of the European Fitness Tests (Council of Europe, 1993), namely: general balance: flamingo balance test, i.e. balancing on one leg as on a beam of set dimensions; speed of limb movement: plate tapping, i.e. rapid tapping of two plates alternately with the preferred hand; flexibility: sit and reach, i.e. reaching forward as far as possible from a seated position; explosive strength: standing broad jump, i.e. distance jumping from a standing start; and static strength: hand grip, a calibrated hand dynamometer with adjustable grip. The analyses were carried out based on relative strength: the relation of dominant hand strength (kg) to body mass (kg). The results of the motor fitness tests for each of the five groups were standardized using a T-scale in accordance with the formula: (individual result–total median)/total standard deviation) $\times 10 +/- 50$. Then, the results of particular trials on the T-scale were summed (mean=250) and, on this basis, subjects were divided into two groups of more (results above the mean) and less (results below the mean) fit. Motor fitness is an objective physical activity indicator whose level indicates degree of physical fitness (Drabik, 1995) and, indirectly, overall health condition. Thus, in the present study motor fitness was assumed one of the independent variables which, contrary to the questionnaire studies of physical activity, allowed more objective evaluation of interrelations between fitness and physical activity and body fatness. The level of motor fitness analysed in this study is thus to be considered as an indicator of health and the effect of the adopted lifestyle, defining body activity more objectively than physical activity level declared by the subjects.

Statistical analysis

Data analyses were carried out in three steps. During the first stage of working out the data, the basic statistic characteristics of somatic features of young males included in the study were assessed. Due to skewed distribution of most somatic attributes that were analysed, demonstrated with the Shapiro-Wilk's test (non-included data), measurements were transformed into a logarithmic scale.

In the next phase, in order to determine the effect of social variables and lifestyle elements on body fatness, Wright's path analysis was applied (Wright, 1960), which enabled the determination of the influence of particular standardized variables in explaining variations of dependent variables. In the present study, age and elements related to SES and lifestyle of the examined males were included as independent variables, and the attributes and ratios which determined body fatness as dependent variables. All independent variables were categorized into '0' and '1', with '0' corresponding to the reference category. Path coefficients (β), which are standardized elementary regression coefficients, determined the influence of particular independent variables on a dependent variable, following the elimination of other variables included in the analysis (Ryguła, 2003). Path coefficients thus enabled assessment of an independent share of particular autonomous independent variables in the variability of a dependent variable. Models of standardized multiple regression were estimated by calculating an interpretative variable with stepwise straightforward regression, which also allowed the testing of independent inter-correlated variables. Consecutively, variables of $p > a$ were eliminated and, following each elimination, the model was subjected to new assessment. Elimination of variables was carried out as long as all structural parameters of the regression model maintained statistical significance (Ryguła, 2003). Three separate full models were created using stepwise straightforward regression with BMI, TST and %FAT as dependent variables.

Table 1. The basic statistical characteristics of somatic features of the study sample

Characteristics	Mean	SD	Min.	Max.	Median
Age	27·04	2·67	19·65	30·47	27·61
Body height (cm)	177·36	6·14	161·40	194·00	177·20
Body weight (kg)	77·98	12·99	50·00	154·60	76·00
BMI (kg/m^2)	24·72	3·60	16·80	43·30	24·30
Skinfold thickness					
Triceps (mm)	9·45	4·31	2·80	28·50	8·90
Subscapular (mm)	15·42	7·42	2·30	44·00	13·20
Abdominal (mm)	17·86	9·08	3·40	48·00	16·40
TST (mm)	42·73	18·73	11·80	104·20	39·00
FM (kg)	13·77	6·81	2·30	57·10	12·20
%FAT	16·87	5·55	4·00	36·90	16·40
FFM (kg)	64·22	7·06	46·30	97·50	63·00

BMI, body mass index; TST, sum of the three skinfold thicknesses; FM, fat mass; %FAT, percentage of body fat; FFM, fat-free mass.

The path analysis method made it possible to trace both direct and indirect influences on body fatness of the analysed factors, and these were presented in the final stage of data analysis. Due to the relatively low percentage of variability explanation of indexes describing body fatness, the sum of the three skinfold thicknesses (TST) was selected to analyse direct and indirect influences, as the feature was explained by the applied variables at the highest degree.

Measurement data were statistically evaluated using STATISTICA PL. 6 and Microsoft Excel 7·0. Significance of differences was determined at the level of $p<0{\cdot}05$, $p<0{\cdot}01$ and $p<0{\cdot}001$.

Results

Table 1 presents basic statistical characteristics of somatic features of the subjects. The β path coefficients, calculated based on standardized partial regression, made it possible to assess the effect of autonomous influence of particular social factors and lifestyle elements on BMI, TST and %FAT (Table 2). The comparison of the influence of these factors was conducted through the assessment of the value of path coefficients expressed as a percentage. The percentage that determined the share of particular factors was calculated by dividing the value of the path coefficient of a particular variable by the sum of the remaining path coefficients for a given combination (Table 2). Path analysis demonstrated that of all socioeconomic- and lifestyle-related factors, age and family obesity resemblance had the greatest relative influence on BMI and %FAT. Variation in TST was explained by level of motor fitness, age, city as a place of residence until the age of 14 and family obesity resemblance. The direction of interrelation between the analysed features was defined by path coefficient mark. Age, city as a place of residence until the age of 14 and family obesity resemblance were

Table 2. The values of β path coefficients and relative influence of the elements of socioeconomic status and lifestyle on the indices of body fatness

Variables	β	%
	Body mass index (BMI)	
Age	0·2040	55·2
Family obesity resemblance	0·1655	44·8
R^2	0·079	100
	Sum of three skinfold thicknesses (TST)	
Level of motor fitness	− 0·2175	30·5
Age	0·1731	24·3
Place of residence until the age of 14 – city	0·1700	23·8
Family obesity resemblance	0·1523	21·4
R^2	0·1298	100
	Percentage of body fat (%FAT)	
Age	0·2789	60·5
Family obesity resemblance	0·1818	39·5
R^2	0·1244	100

connected with greater fatness. On the other hand, an increasing level of motor fitness was related to lower values of TST. The analysed variables explained only from 8% (BMI), 12% (%FAT) to 13% (TST) of body fatness variability in young males from Cracow. The remaining SES variables (birthplace, social class, educational level and the type of work done) and lifestyle elements (smoking habits, dietary habits, sport activity in the past and leisure time physical activity) were the variables that were in this study excluded from the final model due to lack of statistical significance.

Path analysis enabled both direct and indirect influences on fatness of the analysed factors to be followed. Due to the relatively low percentage of variability explanation of indexes describing body fatness, TST was selected to analyse direct and indirect influences as the feature was explained by the applied variables at the highest degree (Table 3).

Direct influence of level of motor fitness was expressed by the absolute value of the standardized elementary regression coefficient (path coefficient): $\beta = -0{\cdot}2175$. Indirect influences were expressed by the absolute value of the product of right-standardized elementary regression coefficient and correlation coefficient along the path joining the analysed variables, i.e. indirect influence of level of motor fitness through the family obesity resemblance factor was expressed by the product of path coefficient absolute value /0·1523/ and correlation coefficient absolute value /0·11/= /0·0167/ (Table 3). The analysed variables' influence on subcutaneous fatness was mainly realized autonomously and directly. The impact of level of motor fitness on TST amounted to 90%, so most influences were realized directly. The contribution of age in the explanation of TST variation by level of motor fitness turned out to be relatively low (1·6%). Connections between age and city as a place of residence until the age of 14 factors and TST showed that at about 85% they autonomously and

Table 3. Evaluation of direct and indirect influences of the analysed factors on the sum of the three skinfold thicknesses (TST) differentiation

Types of influences on TST	Product[a]	Influence size	Influence percentage
1. Direct influence of level of motor fitness		/0·2175/	88·9
Indirect influence by age	/0·1731/×/0·02/	/0·0034/	1·6
Indirect influence by place of residence until the age of 14 – city	/0·1700/×/0·04/	/0·0068/	2·7
Indirect influence by family obesity resemblance	/0·1523/×/0·11/	/0·0167/	6·8
Total	$r=$	/0·2444/	100
2. Direct influence of age		/0·1731/	85·1
Indirect influence by level of motor fitness	/0·2175/×/0·02/	/0·0043/	2·1
Indirect influence by place of residence until the age of 14 – city	/0·1700/×/0·01/	/0·0017/	0·8
Indirect influence by family obesity resemblance	/0·1523/×/0·16/	/0·0243/	12·0
Total	$r=$	/0·2034/	100
3. Direct influence of place of residence until the age of 14 – city		/0·1700/	84·9
Indirect influence by age	/0·1731/×/0·01/	/0·0017/	0·9
Indirect influence by level of motor fitness	/0·2175/×/0·04/	/0·0087/	4·3
Indirect influence by family obesity resemblance	/0·1523/×/0·13/	/0·0198/	9·9
Total	$r=$	/0·2002/	100
4. Direct influence of family obesity resemblance		/0·1523/	67·4
Indirect influence by age	/0·1731/×/0·16/	/0·0277/	12·2
Indirect influence by place of residence until the age of 14 – city	/0·1700/×/0·13/	/0·0221/	9·8
Indirect influence by level of motor fitness	/0·2175/×/0·11/	/0·0239/	10·6
Total	$r=$	/0·2260/	100

[a]Absolute value of the product of standardized elementary regression coefficient and correlation coefficient along the path joining the analysed variables.

directly differentiated subcutaneous fatness with some participation of the remaining variables. The autonomous participation of family obesity resemblance in the explanation of TST variation reached 67% and was accompanied by a relatively high contribution of indirect influences of age (12%).

Discussion

The model of multiple regression used in the study demonstrated that of all demographic, socioeconomic and lifestyle factors, age and family obesity resemblance had the greatest relative influence on BMI and %FAT. On the other hand, variation in the sum of the three skinfold thicknesses was explained by level of motor fitness, as the result of a certain lifestyle, age, city as a place of residence until the age of 14 and family obesity resemblance.

An increase in the value of indexes describing age-affected body fatness is well described in the literature (Shimokata *et al.*, 1989; Flegal *et al.*, 1998; Lahti-Koski *et al.*, 2000; Bielicki *et al.*, 2001; Rosmond, 2004; Pardo Silva *et al.*, 2006). The older the examined persons, the higher their mean values of BMI and the more frequent the prevalence of obesity and overweight in both males and females – reaching a peak in the 55- to 60-years-old subgroup, when the amount of fat-free tissue begins to decrease and the proportion of adipose tissue continuously increases (Flegal *et al.*, 1998; Lahti-Koski *et al.*, 2000; Rosmond, 2004). With increase in calendar age, energy demand reduces as a result of a decrease in basic metabolism. While age was characterized by a relatively low range variation in this study, it turned out to be one of the strongest determinants of body fatness in the young males from Cracow. It means a fast increase in fatness-related hazards if no countermeasures are undertaken.

Due to the fact that the studied subjects defined the degree of relation to obese individuals in their families (only closest family members, i.e. parents and siblings were taken into consideration) it can be stated that the family obesity resemblance factor was a variable that possessed a genetic component. On the other hand, it is commonly recognized that obesity in a family is also an effect of the lifestyle adopted by this family, thus family obesity resemblance was treated as one of the elements defining the lifestyle of the studied subjects. Parental obesity may influence tracking of the offspring's own obesity, which is much stronger if both parents are obese (Lake *et al.*, 1997). Because parents transmit genes and largely define the environmental conditions to which their children are exposed, families may be enhancing their children's susceptibility to obesity (Provencher *et al.*, 2005). Lobstein *et al.* (2004) reviewed recent work looking at how lifestyle factors might contribute to the parent–child relationship, and suggested that obesogenic and non-obesogenic family clusters can be identified based on parents' diet and activity patterns. For example, results from the study by Provencher *et al.* (2005) showed that eating behavioural traits are characterized by significant family resemblance, particularly for susceptibility to hunger. The study of Burke *et al.* (2001) confirmed that health behaviours and BMI aggregate within families and showed an association between health behaviours in parents (especially alcohol intake, physical activity and eating patterns) and the BMI of offspring. Family obesity resemblance is a factor that, as proved by regression equations, directly and autonomously influences the level of fatness in young males, explaining about 40% of BMI and %FAT variability and more than 20% of TST variability. A similar analysis was conducted by Chrzanowska *et al.* (2006), examining the influence of social and lifestyle variables on fatness in adult males (aged 40–50) from the same population and reaching explanation of 27% of BMI variability by the family obesity resemblance factor. Some data have shown that parental obesity becomes less important with increasing age of the child, and is a more important predictor of offspring obesity earlier in childhood (Whitaker *et al.*, 1997). The analysis of direct and indirect influence done in this study presented relatively high co-participation of the remaining factors, mainly age and level of motor fitness, in the explanation of TST variation by family obesity resemblance factor. The examined men were mostly bachelors, still living with their parents, so besides genetic influences, the impact of shared lifestyles seemed to be very significant. The family obesity resemblance variable was consequently and significantly connected with high values of all analysed body fatness indexes in the males, possibly due to the accumulation of genetic and shared lifestyle factors.

Motor fitness elements that were tested in the study are, together with morphological, muscular, motor, cardiorespiratory and metabolic factors, the components of so-called health-related fitness (Bouchard & Shephard, 1994). As compared with cardiorespiratory fitness, only a few studies have examined the associations between different components of muscular and motor fitness and health. Muscular and motor fitness is associated with better physical functioning and quality of life among older individuals (Warburton *et al.*, 2001), higher mobility and work abilities in middle-aged men and women (Suni *et al.*, 1998; Pohjonen, 2001), and negative association with excess body fat, especially in the abdominal region in men (Fogelholm *et al.*, 2006). The adopted manner of examining motor fitness in this work, when compared with the questionnaire studies of physical activity, allowed more objective assessment of interrelations between fitness and physical activity and body fatness. Physical fitness is a function of both physical activity and non-modifiable factors such as genetic ones (Perusse *et al.*, 2003). Studies have indicated that high physical fitness scores, especially high levels of cardiorespiratory fitness, are associated with increased levels of physical activity (Warburton *et al.*, 2001; Huang & Malina, 2002). According to Drabik (1995), physical activity is an important element of a healthy lifestyle, but mainly when the activity can improve or keep a certain level of fitness as long as possible. The level of motor fitness turned out to be the strongest determinant of body fatness described by the sum of the three skinfold thicknesses in young men from Cracow. These negative connections between the level of motor fitness and skinfold thicknesses have also been demonstrated in more detailed studies in the literature (Welon *et al.,* 1988). Beunen *et al.* (1983) and Malina *et al.* (1995) claim that individual elements of physical fitness are negatively correlated with obesity expressed by the sum of four skinfold thicknesses in children and adolescents examined within the frames of the Leuven Growth Study. Also, in the Amsterdam Growth and Health Study (Minck *et al.*, 2000), both among young females and males, the analysis results of regression of certain motor fitness attempts showed negative correlation with body fatness measured by the sum of four skinfold thicknesses. Significantly negative connections with fatness were noticed in males examined in the Amsterdam Growth and Health Study in the attempts of running speed, standing high jump, leg-lift speed and maximal oxygen uptake (Minck *et al.*, 2000).

It should be emphasized that the contribution of age to the explanation of TST variation in Cracow males by level of motor fitness turned out to be low (1·6%). The factor connected with fitness seemed to autonomously influence body fatness described by skinfold thicknesses in young males. An analysis of another, second layer of influences showed (data not included) that the variable level of motor fitness was affected positively and statistically significantly by the variable leisure time physical activity. It can be explained – as claimed by Minck *et al.* (2000) – by a sort of training influence of physical activity on motor fitness level.

The level of motor fitness was not included in the model explaining body fatness variability described by BMI. Despite many limitations, BMI is the most frequently used measure for population-based work. This measure is not independent of stature and body proportion, may misclassify people with highly developed muscles (it takes high values at strongly mesomorphic physique), the range of its norms is the same for both women and men in all age categories and it is more informative in women than in men, as well as in older persons (Gallagher *et al.*, 1996; Kopelman, 2000; Ulijaszek & Lofink, 2006). Muscle mass increases considerably during male adolescence and continues to increase up to the mid-20s (Malina & Bouchard, 1991). Therefore, BMI index seems to be an indicator of fat-free mass (muscle) in these young men, especially as most of the examined males (more than 70%) were blue-collar workers, which may contribute to their more mesomorphic body build. However, Lahti-Koski *et al.* (2002) claim that a high level of physical activity at work is connected in males with lower values of relative body mass index. The results of studies by Gutíerrez-Fisac *et al.* (2002) do not confirm such relations, and they show at the same time an unimportant tendency to increase mean values of BMI and the percentage of obese persons along with an increase of physical activity at work. Dependencies between BMI, the sum of skinfold thicknesses and %FAT were analysed based on χ^2 statistics (data not included). Out of 21 men qualified as obese on the basis of their BMI, 81% should be considered obese based on the %FAT in the body when accepting the level of the 90th centile as the obesity border line. On the other hand, based on the sum of the three skinfold thicknesses, also accepting the level of the 90th centile as the obesity border line, only 57% of the examined qualified as obese. Calculated correlation coefficients of Spearman's ranks amounted at 0·94 for BMI and %FAT and 0·80 for BMI and the sum of the three skinfold thicknesses. Therefore, mentioned limitations of BMI are confirmed in the analysed material.

City as a place of residence until the age of 14 was one of the variables significantly connected with increased subcutaneous fatness in the examined males. Research data referring to the place of residence showed that mean values of BMI index in males and females inhabiting rural areas were higher than in city dwellers (Reeder *et al.*, 1997; Huot *et al.*, 2004). On the other hand, the relations present the opposite direction in e.g. Spain (Aranceta *et al.*, 2001) or in the Palestinian West Bank population (Abdul-Rahim *et al.*, 2003). A WHO report stated that sudden urbanization increases the frequency of obesity prevalence in developing countries, while in developed countries the frequency is higher in rural areas (Lobstein *et al.*, 2004).

The analysed variables explained only from 8 to 13% of body fatness variation, indicating at the same time that most variations are explained by other variables not included in the study. Among the factors influencing body fatness, Seidell & Flegal (1997) also describe demographic ones (sex, ethnic origin); biological (genetic background and menopause effect); socio-cultural (education, marital status, number of children); and also behavioural factors, such as dietary habits, alcohol intake, smoking habits and physical activity. Besides the most frequently presented factors, other variables also influence obesity prevalence, for example unemployment, shift work, long-term psychosocial and socioeconomic stress, low or excessive birth mass, smoking when pregnant and television watching (Rosmond & Björntorp, 2000; Lobstein *et al.*, 2004; Laitinen *et al.*, 2004; Rosmond, 2004).

A similar study, which would analyse the influence of socioeconomic and lifestyle factors on obesity level measured by the sum of the three skinfold thickness – an index with variability explained by the factors at highest level – has not been found. BMI variability in males from Cracow was explained only at 8% by age and family obesity resemblance. Ball *et al.* (2003) obtained 13% of variability explanation of body fatness described by BMI, and the explaining variables were demographic and socioeconomic factors like age, living conditions, family status and lifestyle elements: low-fat diet, alcohol consumption and smoking. Physical activity level was, in the research of Ball *et al.* (2003), the variable that was excluded from the final model due to lack of statistical significance. In studies of adult inhabitants of Rio de Janeiro (Ramos de Marins *et al.*, 2001) it was indicated that BMI variability was explained by age, education level and smoking habits. Marti *et al.* (1991) gained 9·4% of BMI variability explanation in males by age, education level and leisure time physical activity.

A similar analysis on the same material conducted with reference to adipose tissue distribution indexes showed relatively high (WHR = 19%) percentage of explanation of fat distribution variability by lifestyle and socioeconomic elements (Suder, 2008). The type of adipose tissue distribution seems then to be more dependent on adopted lifestyle and socioeconomic status variables in the examined males than their total fatness, and the features and indexes describing adipose tissue distribution appear more sensitive identifiers of lifestyle than indexes and features describing total body fatness.

Overall, it should be emphasized that the cross-sectional design of this study does not allow causal conclusions to be drawn. However, due to the fact that the obtained results were based on a significant number of observations, they can be, with a certain degree of approximation, treated as referring to a typical young city population, particularly as the percentage distribution of education reflects the structure of education of young city dwellers (GUS, 2003). Strengths of this study are the use of direct anthropometric measurements, several comprehensive, empirically derived social and lifestyle elements and also applying many indicators describing body fatness. The results may contribute to completing the information on obesity determinants in the world literature concerning the inhabitants of Eastern Europe.

In conclusion, age and family obesity resemblance had the greatest relative influence on BMI and %FAT, whereas variation in the sum of the three skinfold thicknesses was explained by level of motor fitness, age, city as a place of residence until the age of 14 and family obesity resemblance. Although the analysed variables explained only some of the body fatness variation in young working males, indicating at the same time that most variations are explained by other variables not included in the study, the impact of lifestyle family-shared factors on body fatness, apart from genetic influences, seems to be significant.

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