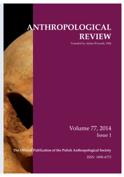
Anthropological Review • Vol. 77 (2), 205–218 (2014)

DE G

DE GRUYTER
OPEN

Anthropological Review
Available online at: www.degruyter.com
Journal homepage: www.ptantropologiczne.pl



Relationship of social and lifestyle factors with central fat distribution expressed by the aggregate fat distribution index

Agnieszka Suder[1], *Andrzej Sokołowski*[2]

[1]Department of Anatomy, University School of Physical Education, al. Jana Pawła II 78, 31-571 Cracow, Poland
[2]Department of Statistics, Cracow University of Economics, Rakowicka 27, 31-510 Cracow, Poland

Abstract: Abdominal obesity is caused by several factors and the explanation of the level of its variability also depends on anthropometric indexes applied for its assessment. The aim was to determine the degree of explanation of the abdominal adiposity variation, presented by the aggregate fat distribution index (AFDI), through the socio-economic status and lifestyle. Subjects and methods: A cross-sectional population-based study was conducted on a sample of 259 healthy working males aged 20–30 from the city of Cracow, Poland. A full model was created using a stepwise backward regression with the social and lifestyle data as independent variables and the AFDI as a dependent variable. The AFDI was created by unitarization applied to selected characteristics of fat distribution which were transformed into [0,1] interval (without measurement unit) and then added and averaged to form a composite index. The highest autonomous influence on AFDI is ascribed to age (b=0.2456 p=0.000), level of motor fitness (b=–0.2392 p=0.000), leisure time physical activity (b=–0.1353 p=0.000) and being born in a rural area (b=0.1300 p=0.000). The variables explain 17% (R^2=0.1667) of the variation of the central fat distribution. Variation of the abdominal adiposity was explained with the use of AFDI at the level close to the commonly applied indexes.

Key words: determinants of abdominal obesity, aggregate fat distribution index, motor fitness, leisure time physical activity, waist circumference

Introduction

Determinants of abdominal obesity consist of several factors and the explanation of the level of its variability also depends on anthropometric indexes applied for its evaluation. The most commonly applied anthropometric features and indexes used in population studies to evaluate

Original Article: Received February 6, 2014; Accepted for publication June 18, 2014
DOI: 10.2478/anre-2014-0016

body fat distribution are: waist-hip ratio (WHR), waist circumference (WC), waist-thigh ratio (WTR), conicity index (CI), or, recently, waist-height ratio (WHtR) (Lobstein et al. 2004). Variation of the central type of adipose tissue distribution in men was accounted for in 22.6% by factors such as age, educational level, alcohol consumption, smoking habits, giving up smoking, leisure time physical activity and the year of examination (Lahti-Koski et al. 2000). It was shown by Marti et al. (1991) that age, leisure time of physical activity, resting heart rate, and alcohol consumption explained 17.5% of the variation of WHR in Finnish men. Molarius et al. (1999) obtained WC variation explained in 83% in the studies of 19 cohorts conducted under the WHO MONICA project, but the main variable was BMI explaining WC variation in 77%. In the previous study (Suder 2008), it was shown that WHR variation of young Cracow men was explained in 19% by factors such as age, the level of motor fitness, upper-middle class, undertaking physical activity in leisure time, and a village as birthplace. Slightly different set of factors i.e.: age, city as a place of residence until the age of 14, smoking less than 20 cigarettes per day, family obesity residence and level of motor fitness explained in 20% the variation of the sum of the three trunk skinfold thicknesses in the males. Their waist circumference was explained only in 8% by age, the level of motor fitness, and family obesity resemblance. Variability of each of the indexes was explained at different level by various sets of factors. The present work suggests applying anthropometric indexes commonly accepted for evaluation of adipose tissue distribution type in one, aggregate measure which allows more profound analyses of mutual influences of social and lifestyle variables onto adipose tissue distribution. Therefore, the aim of the study was to determine the degree of explanation of the central adiposity variation, measured by the aggregate fat distribution index (AFDI), through the socio-economic status and lifestyle.

Methods

Subjects

The analysis was performed on anthropometric measurements, results of motor fitness tests and social data of 259 young, working males aged 20–30 (mean: 27.04; SD: 2.67) from Cracow, Poland. The men, all of them employees of the Sendzimir Metallurgical Plant in Cracow and various companies located on its premises, were measured during periodical medical check-ups in 2001–2003 as a part of a research project concerning physical condition of the Cracow adult population (Gołąb et al. 2004).

The study was conducted according to the ethical principles for medical research stated in the Helsinki Declaration (see Human Experimentation. Code of Ethics of the World Medical Association 1964).

Anthropometry

Body height, body weight, waist (WC), hip and thigh circumference were used for the purpose of this study. The measurements were taken according to standard procedures (Weiner and Lourie 1969) and the course of anthropometry was described in details in Suder (2008). Several fat distribution indexes were derived from the anthropometric measurements:

waist-hip ratio (WHR) was calculated as waist circumference (cm) divided by hip circumference (cm), waist-thigh ratio (WTR) was calculated as waist circumference (cm) divided by thigh circumference (cm). Conicity index (CI) is equal to waist circumference (m) divided by 0.109 × the square root of weight (kg)/height (m).

Social and lifestyle factors

A precise description of social and lifestyle factors was presented in Suder (2008, 2009). Briefly, a 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 is presented in parentheses). Birth place: 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.

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 sports done in the past as well as the regularity and number of hours in a week spent on physical activity. Based on the replies given, 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 practice, 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) × 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 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

At the first stage of the analysis, the correlation coefficients between indexes of body fat distribution was estimated and a cluster analysis was performed in order to check the groups homogeneity. Next, the Wright's path analysis was applied to determine the effect of social variables and lifestyle elements on fat distribution (Wright 1960) which enabled to determine the influence of particular standardized variables (e.g. socio-economic status, physical activity, motor fitness, smoking habits, dietary habits) on the variations of the dependent variable (body fat distribution). Path coefficients (b), which are standardized regression coefficients, determine the influence of particular independent variables on the dependent variable, adjusted for other variables included in the analysis. Path coefficients thus enable the assessment of independent share of particular autonomous independent variables in the variability of the dependent variable. The basis for determining path coefficients is the correlation matrix of the whole set of variables which constitutes a list of variables of direct influence layer. Correlation coefficient is the measure of the strength of the relations between the attributes; in order to additionally determine the direction of this relation, the relations between the variables in this study were expressed using gamma correlation coefficients. Models of standardized multiple regression were estimated by calculating variables with stepwise backward regression which also allowed testing independent inter-correlated variables. Consecutively, the variable with the highest $P>\alpha$ was eliminated and, following each elimination, the model was subjected to new assessment. Elimination of variables was carried out until all structural parameters left in the model were statistically significant.

An attempt was made to analyze the effect of selected lifestyle and socio-economic status elements on the coefficient defining the distribution in a more complex manner. In order to do this, the aggregate fat distribution index (AFDI) was constructed using a standardization procedure called unitarization, where the value of a variable or its distance from one of variable limits was divided by its range according to the formula (see for example Kukuła 2000):

$$x^*ij = (x_{ij} - \min\{x_{ij}\}) / (\max\{x_{ij}\} - \min\{x_{ij}\})$$

x_{ij} – j variable value for object i,
x^*_{ij} – normalized value.

This procedure deprives the variables of the titre, unifies their order of magnitudes and leads to a constant, unitary variability range of standardized attributes. Attributes and ratios of adipose tissue of highest correlation coefficients were subjected to standardization, i.e. WC, WHR, WTR and CI. The aggregate index is the arithmetic average of normalized variables transformed into the [0.100] interval. Unification and aggregation methods are commonly applied, e.g. within the calculation methodology of Human Development Index (Jahan 2002).

Results

A description of the examined males according to the average level of somatic features, body fat distribution and body fatness have been presented elsewhere (Suder 2008, 2009). The majority of young males from the studied sample had normal BMI values (mean: 24.72; SD:3.6). Overweight characterized over one-third of the studied group and the obesity rate amounted to 8.11% (Suder 2009). Increased waist-hip ratio (WHR≥0.94; Lemieux et al., 1996) concerned 12.73% of the studied subjects and 3.86% of males had WHR≥1.0 with the mean value equal to 0.87. At the same time, because of increased waist circumference (WC≥94 cm; Lean et al., 1995), over 20% of the studied males qualified into the increased and high cardiovascular disease risk group. Abdominal obesity, recognized based on waist circumference, occurred in the studied group twice more often than obesity defined with waist-hip ratio (Suder 2008).

Table 1 presents high values of correlation coefficients between commonly used indexes of adipose tissue distribution. When applying AFDI, the correlation coefficients for all the indexes amount to more than 0.90. The cluster analysis for the four most correlated indexes divided the collection of data concerning the examined males into four homogeneous groups (Table 2). Each subgroup features minimal variability and the homogeneity of the groups was also retained. Group IV is a group of high risk of complications resulting from abdominal type of body fatness.

Gamma correlation coefficients of the analyzed factors and AFDI (mean:41.25; SD:8.18; min:26.54; max:75.12) were presented in Table 3. Only statistically significant correlations were taken into consideration in further analysis. Path coefficients (b), calculated by standardized multiple regression, made it possible to assess the effect of an autonomous influence of particular social factors and lifestyle elements on AFDI (Table 4). The comparison of the influence of these factors was conducted through the assessment of the value of path coefficients expressed in percentage. The percentage, which determines the share of particular factors, was calculated by dividing the value of path coefficient of a particular variable by the sum of the remaining

Table 1. Correlation coefficients between indexes of body fat distribution

Indexes	WHR	WTR	CI	WC	AFDI
WHR	1.00	0.79*	0.87*	0.80*	0.91*
WTR	x	1.00	0.82*	0.70*	0.91*
CI	x	x	1.00	0.81*	0.93*
WC	x	x	x	1.00	0.91*
AFDI	x	x	x	x	1.00

WHR – waist-hip ratio; WTR – waist-tight ratio; CI – conicity index; WC – waist circumference; AFDI – aggregate fat distribution index
*significant at the level of $\alpha=0.001$

Table 2. Groups of males of homogenous body fat distribution selected on cluster analysis results

Group	n=259	%	WHR	WTR	CI	WC
I	76	29	0.80	1.40	1.11	76.8
II	95	37	0.86	1.52	1.18	83.3
III	72	28	0.92	1.62	1.24	93.2
IV	16	6	1.00	1.79	1.34	106.1

WHR – waist-hip ratio; WTR – waist-tight ratio; CI – conicity index; WC – waist circumference

Table 3. Gamma correlation coefficients between the aggregate fat distribution index (AFDI) and the selected elements of socio-economic status and lifestyle

Variables		Gamma coefficients
Age		0.171[c]
Birthplace	Village	0.335[c]
	City	–0.126[a]
Place of residence until the age of 14	Village	0.158[a]
	City	–0.103
Social class	Peasant	0.232[b]
	Upper–middle class	–0.216[a]
Educational level	Ground or basic vocational	0.137[a]
	High (Incomplete university or university)	–0.136
Mental work		–0.172[b]
Socio-economic status	Low	0.125
	High	–0.205[b]
Smoking fewer than 20 cigarettes per day		–0.152[a]
Smoking more than 20 cigarettes per day		0.185[a]
Ex-smokers		0.139
Dietary habits	Proper	0.038
	Unsatisfactory	0.004
Family obesity resemblance		0.212[b]
Physical activity in the past		–0.180[b]
Leisure time physical activity		–0.214[c]
Level of motor fitness		–0.173[c]

Statistically significant at the level of $\alpha=0.05^a$, $\alpha=0.01^b$, $\alpha=0.001^c$

path coefficients for a given combination (Table 4). Lower accumulation of adipose tissue in the abdominal area was observed with the increase of level of motor fitness and engaging in leisure time physical activity, the fact reflected by the negative values of path coefficients. On the other hand, higher values of AFDI indicating the more central obesity type are related to being born in a rural area and older age.

Table 4. The values of path coefficients (b) and relative influence of the elements of socio-economic status and lifestyle on the aggregate fat distribution index

Variables	b	%
Age	0.2456	32.7
Level of motor fitness	–0.2392	31.9
Leisure time physical activity	–0.1353	18.1
Being born in a rural area	0.1300	17.3
R^2	0.1677	100

Path analysis enables the identification of both direct and indirect influences of the analysed factors on the body fat distribution (Table 5). Direct influence of the level of motor fitness was expressed by the absolute value of the standardized elementary regression coefficient (path coefficient): b=0.2392. 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 leisure time physical activity factor was expressed by the product of path coeffi-

Table 5. Evaluation of direct and indirect influences of the analyzed factors on the aggregate fat distribution index (AFDI) differentiation

Types of influences on AFDI	Product[1]	Influence size	Influence percentage %
1. Direct influence of level of motor fitness		0.2392	81.7
Indirect influence by leisure time of physical activity	0.1353 × 0.30	0.0406	13.9
Indirect influence by age	0.2456 × 0.01	0.0025	0.9
Indirect influence by being born in a rural area	0.1300 × 0.08	0.0104	3.5
Total	r=	0.2927	100
2. Direct influence of age		0.2456	97.5
Indirect influence by level of motor fitness	0.2392 × 0.01	0.0024	0.9
Indirect influence by leisure time of physical activity	0.1353 × 0.02	0.0027	1.1
Indirect influence by being born in a rural area	0.1300 × 0.01	0.0013	0.5
Total	r=	0.2520	100
3. Direct influence of leisure time of physical activity		0.1353	60.1
Indirect influence by age	0.2456 × 0.02	0.0049	2.2
Indirect influence by being born in a rural area	0.1300 × 0.01	0.0130	5.8
Indirect influence by level of motor fitness	0.2392 × 0.30	0.0718	31.9
Total	r=	0.2250	100
4. Direct influence of being born in a rural area		0.1300	26.4
Indirect influence by age	0.2456 × 0.03	0.0074	1.5
Indirect influence by leisure time of physical activity	0.1353 × 0.10	0.0353	7.2
Indirect influence by level of motor fitness	0.2392 × 0.08	0.3192	64.9
Total	r=	0.4919	100

[1] absolute value of the product of standardized regression coefficient and correlation coefficient along the path joining the analyzed variables

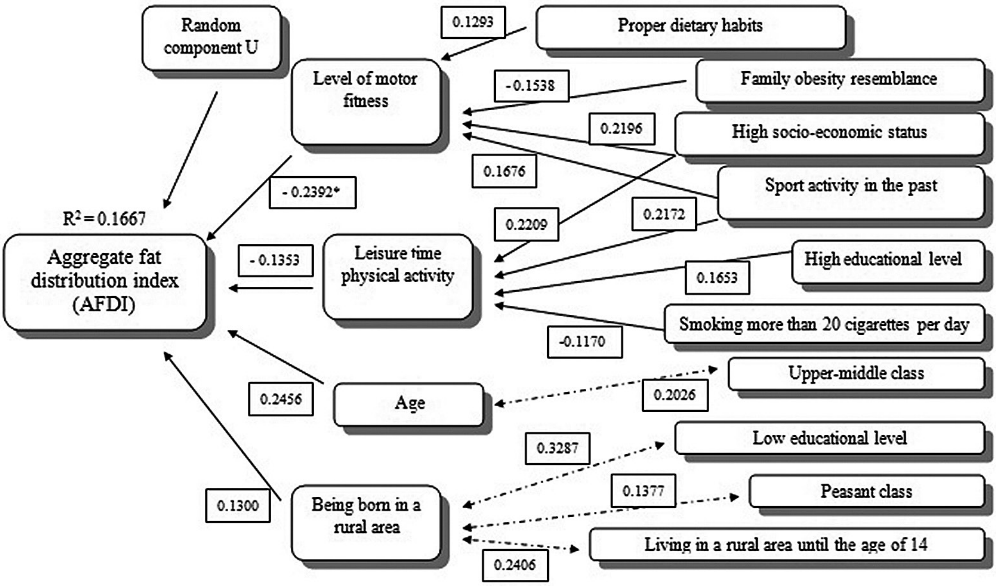


Fig. 1. The model of influence of the socio-economic status and lifestyle elements on body fat distribution, described by the aggregate fat distribution index (AFDI)
*regression coefficients β from multiple regression model

cient absolute value |0.1353| and correlation coefficient absolute value |0.1353| *0.30|=|0.0406| (Table 5). The analysed influence of the variables on AFDI mainly took place autonomously and directly.

During further analyses, the subsequent, second layer of interactions of the analysed variables was also tested. Figure 1 presents a simplified model of the examined variables influences on AFDI. High socio-economic status, sport activity in the past and proper dietary habits are connected with an increase of the level of motor fitness in young men which subsequently decreases the values of AFDI index, i.e. accumulation of adipose tissue in abdominal region. Whereas, a contrary influence is achieved by family obesity resemblance as it is connected with a lower level of motor fitness. Undertaking leisure time physical activity is also linked with a high socio-economic status, high educational level and sport activity undertaken in the past. Smoking more than 20 cigarettes per day negatively influences leisure time physical activity in the examined men. The fact of being born in a rural area was correlated in one group with low educational level, the peasant class and living in a rural area until the age of 14, whereas age with the upper-middle class.

Discussion

Three elements, i.e. a high correlation coefficient between the ratios (Table 1), the homogeneity of the groups in respect to adipose tissue distribution ratios (Table 2) and the fact that each ratio was explained by a slightly different set of variables (Suder 2008) caused the analysis of direct and indirect influences of selected lifestyle and socio-economic status elements on fat distribution to be performed in a complex manner, using aggregate fat distribution index (AFDI). Assessment of the explanation level of body fat distribution variance in a complex way, i.e. with the use of AFDI conducted in the study, shows that factors like age, level of motor fitness, leisure time physical activity and birthplace in a village explain 17% of the central body fat distribution variability in young men. Lower accumulation of adipose tissue in the abdominal area was observed with the increase of the level of motor fitness and engaging in leisure time physical activity, the fact reflected by the negative values of path coefficients. On the other hand, higher values of AFDI indicating the more central obesity type are related to birthplace in a village and older age. The obtained level of adipose tissue variability is close to the level of variability explanation obtained with the use of commonly applied indexes (WHR being the most frequent of them) (Lahti-Koski et al. 2000b; Marti et al. 1991; Ramos de Marins et al. 2001), but it appears to take into consideration benefits and drawbacks of each of the indexes used. Waist-hip ratio is a simple widely accessible method to recognize the android type of obesity (Hartz et al. 1983). It is considered to be a good index to estimate visceral amount of adipose tissue (Seidell et al. 1987, 1988). Increased WHR is highly correlated with prevalence of cardiovascular system diseases, diabetes II type, cerebral strokes and it is connected with insulin resistance, increased level of triglycerides and blood pressure (Lapidus et al. 1984; Larsson et al. 1984). The obtained values of WHR index are not easy to be interpreted, though. After all, the measure of waist circumference comprises both internal body parts with visceral fat and subcutaneous, abdominal adipose tissue. Whereas, the hip circumference is affected by the amount of subcutaneous fat, muscles mass and massiveness of the skeleton (Molarius and Seidell 1998). Therefore, increased values of WHR index may result from both an increased amount of abdominal fat (higher waist circumference) and from weakened, lowered muscle mass of gluteal muscles (lowered hip circumference) (Seidell et al. 1989). Waist-thigh ratio (WTR) is created according to similar assumptions as for WHR; however, the influence of the skeleton massiveness on WTR value is decreased. Thigh circumference, particularly in men, can better reflect muscle mass than hip circumference, whereas in women increased circumference of both thigh and hips is significantly correlated with the amount of subcutaneous adipose tissue (Snijder et al. 2003). Conicity index (CI) constructed by Valdez et al. in the 1990s is another index of adipose tissue distribution considering waist circumference as a circumference of a theoretical cylinder created on the basis of body height and weight of the examined person assuming constant body density (Valdez et al. 1993). It was demonstrated that it is as much correlated with the risk of cardiovascular diseases as WHR (Mueller et al. 1996; Valdez et al. 1993). A simple measurement of waist circumference itself is believed to be a reliable index of abdominal fatness (Després et al. 1991; Lean et al. 1995, 1998; Pouliot et al. 1994; Reinehr and Wunsch 2010). Janssen et al. (2002) in the conducted analysis of the Third National Health and Nutrition Examination Survey results showed that increased waist circumference better estimates global cardiovascular risks dependant on overweight and obesity, than the risk determined only according to a BMI category. The risk of prevalence of some metabolic coexisting diseases in men was found to be higher within the same BMI category in a group of individuals with higher waist circumference than in those with lower one. (Janssen et al. 2002). Waist circumference is highly correlated with visceral fat amount (Rankinen et al. 1999; Lee et al. 2008; Jansen et al. 2005; Lemieux et al. 1996;), and weakly with body height (Han et al. 1997a, 1997b). Molarius et al. (1999) emphasize that waist circumference indicates accumulation of adipose tissue in abdominal region, but it is also dependant, at a higher degree than WHR, on general body fatness.

A review of the influence of particular demographic, socio-economic and lifestyle factors on body fat distribution in the examined men was presented in a former study (Suder 2008). The subsequent, second layer of the analysed variables interactions seems to be quite interesting. High socio-economic status, sport activity in the past and proper dietary habits are connected with an increase of the level of motor fitness in young men which subsequently decreases the values of AFDI index, i.e. accumulation of adipose tissue in abdominal region. Whereas, a contrary influence is achieved by family obesity resemblance as it is connected with lower level of motor fitness. Undertaking leisure time physical activity is also linked with high socio-economic status, high educational level and sport activity in the past. Smoking more than 20 cigarettes per day negatively influences leisure time physical activity in the examined men. The fact of being born in a rural area was correlated in one group with low educational level, the peasant class and living in a rural area until the age of 14, whereas age with the upper-middle class.

In summary, distribution of adipose tissue can be modified be elements of lifestyle: smoking too many cigarettes, prevalence of obesity in the family, lack of sport activity in the past, no physical activity during leisure time and low level of motor fitness. In young males the elements are connected with abdominal type of obesity, therefore engaging in healthy activities can contribute to improving fat distribution in the body. Age, with its relatively low range of variability, turned out to be the strongest determinant of both central fat distribution and general fatness. It implies a fast increase of risk connected with fatness and its central distribution in the body if no counteracting factors are introduced. The influence of socio-economic status described, among others, by the level of education and social background, on adipose tissue distribution is an indirect influence expressed by e.g. the level of motor fitness or undertaking physical activity during leisure time. The two factors are variables which particularly strongly determine the type of adipose tissue distribution i.e. low level of motor fitness and no leisure time physical activity lead to the central type of body fatness.

So many aspects and problems connected with obesity make the issue particularly interesting, and obesity, especially abdominal one, is currently one of the investigative areas most frequently examined by researchers and scientists. The application of generally accepted anthropometric indexes in one aggregate measure suggested in the present work allowed a more profound analysis of mutual influences of social and lifestyle variables on adipose tissue distribution.

Acknowledgments

The author wishes to acknowledge all participants of the study and the whole research team for their collaboration in data collection.

This work was supported by grant 160/KA/2003 (University School of Physical Education, Cracow).

Authors' contributions

ASu conceived and designed the paper, was principle project investigator, wrote the first and final version of manuscript; ASo performed statistical analyses and interpreted results, drafted was co-author of the first version of manuscript.

Conflict of interest

The Authors declare that there is no conflict of interests regarding the publication of this article.

Corresponding author

Agnieszka Suder, Department of Anatomy, University School of Physical Education, al. Jana Pawła II 78, 31-571 Cracow, Poland
e-mail address:
agnieszka.suder@poczta.fm

References

Ashwell M, Cole TJ, Dixon AK. 1985. Obesity: new insight into the anthropometric classification of fat distribution shown by computed tomography. Br Med J 290:1692–94.

Després JP, Prud'homme D, Pouliot MC, Tremblay A, Bouchard C. 1991. Estimation of deep abdominal adipose-tissue accumulation from simple anthropometric measurements in men. Am J Clin Nutr 54:471–77.

Eurofit. Handbook for Eurofit tests of physical fitness. 1993. Council of Europe. Strasbourg.

Gołąb S, Chrzanowska M, Sobiecki J, Żarów R, Woronkowicz A, Brudecki J, 2004. Level of somatic and motor development in healthy men from Cracow. Cracow: AWF, Studia i Monografie 30.

Gacek M, Chrzanowska M, Matusik S. 2004. Wybrane zachowania żywieniowe mężczyzn w wieku 40–50 lat aktywnych zawodowo. In: E Bartnikowska et al., editors. Fizjologiczne uwarunkowania postępowania dietetycznego. Warszawa: Wydawnictwo SGGW. 497–502.

Han TS, McNeill G, Seidell JC, Lean MEJ. 1997a. Predicting intra-abdominal fatness from anthropometric measures: the influence of stature. Int J Obes Relat Metab Disord 21 :587–93.

Han TS, Seidell JC, Currall JEP, Morrison CE, Deurenberg P, Lean MEJ. 1997b. The influences of height and age on waist circumference as an index of adiposity in adults. Int J Obes Relat Metab Disord 21:83–89.

Hartz AJ, Rupley DCjr, Kalkhoff RD, Rimm AA. 1983. Relationship of obesity to diabetes: influence of obesity level and body fat distribution. Prev Med 12:351–57.

Human Experimentation. 1964. Code of Ethics of the World Medical Association. Br Med J 2:177.

Jahan S. 2002. Evolution of the Human Development Index in Readings in Human Development. In: S Fukuda-Parr and AK Shiva-Kumar, editors. Oxford University Press.

Janssen I, Katzmarzyk PT, Ross R. 2002. Body mass index, waist circumference and health risk. Evidence in support of current National Institutes of Health Guidelines. Arch Intern Med 162:2074–79.

Krotkiewski M, Björntop P, Sjöström L, Smith U. 1983. Impact of obesity on metabolism in men and women. J Cin Invest 72:1150–62.

Kukuła K. 2000. Metoda unitaryzacji zerowanej. Warszawa: PWN.

Lahti-Koski M, Pietinen P, Mannisto S, Vartiainen E. 2000. Trends in waist-to-hip ratio and its determinants in adults in Finland from 1987 to 1997. Am J Clin Nutr 6:1436–44.

Lapidus L, Bengtsson C, Larsson B, Pennert K, Rybo E, Sjöström L. 1984. Distribution of adipose tissue and risk of cardiovascular disease and death: a 12 year follow up of participants in the population study of women in Gothenburg, Sweden. BMJ 289:1257–61.

Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Björntorp P, Tibblin G. 1984. Abdominal adipose tissue distribution, obesity and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. BMJ 288:1401–04.

Lean ME, Han TS, Morrison CE. 1995. Waist circumference as a measure for indicating need for weight management. BMJ 311:158–61.

Lean ME, Han TS, Seidell JC. 1998. Impairment of health and quality of life in people with large waist circumference. Lancet 351:853–56.

Lemieux S, Prud`home D, Bouchard C, Tremblay A, Després JP. 1996. A single threshold value of waist girth identifies normal-weight and overweight subjects with excess visceral adipose tissue. Am J Clin Nutr 64:685–93.

Lobstein T, Baur L, Uauy R. 2004. Obesity in children and young people: a crisis in public health. Obes Rev 5(S1):4–85.

Marti B, Tuomilehto J, Salomaa V, Kartovaara K, Korhonen HJ, Pietinen P, 1991. Body fat distribution in the Finnish population: environmental determinants and predictive power for cardiovascular risk factor levels. J Epidemiol Commun Health 45:131–37.

Molarius A, Seidell JC, Sans S, Tuomilehto J, Kuulasmaa K. 1999. Waist and hip circumferences, and waist-hip ratio in 19 populations the WHO MONICA Project. Int. J Obes Relat Metab Disord 23:116–25.

Molarius A, Seidell JC. 1998. Selection of anthropometric indicators for classification of abdominal fatness – a critical review. Int J Obes Relat Metab Disord 22:719–27.

Mueller WH, Meinninger JC, Liehr P, Chan W, Chandler PS. 1996. Conicity: A new index of body fat distribution – what does it tell us? Am J Hum Biol 8:489–96.

Pouliot MC, Després JP, Lemieux S, Moorjani S, Bouchard C, Tremblay A, Nadeau A, Lupien PJ. 1994. Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. Am J Cardiol 73:460–68.

Ramos de Marins VM, Varnier Almeida RMR, Pereira RA, Barros MBA. 2001. Factors associated with overweight and central body fat in the city of Rio de Janeiro: results of a two stage random sampling survey. Public Health 115:236–42.

Rankinen T, Kim SY, Pérusse L, Després JP, Bouchard C. 1999. The prediction of abdominal visceral fat level from body composition and anthropometry: ROC analysis. Int J Obes Relat Metab Disord 23:801–09.

Seidell JC, Björntorp P, Sjöström L, Sannerstedt R, Krotkiewski M, Kvist H. 1989. Regional distribution of muscle and fat mass in men – new insight into the risk of abdominal obesity using computed tomography. Int J Obes Relat Metab Disord 13:289–03.

Seidell JC, Oosterlee A, Deurenberg P, Hautvast JG, Ruijs JH. 1988. Abdominal fat depots measured with computed tomography: effects of degree of obesity, sex and age. Eur J Clin Nutr 42:805–15.

Seidell JC, Oosterlee A, Thijssen MA, Burema J, Deurenberg P, Hautvast JG, Ruij JH. 1987. Assessment of intra-abdominal and subcutaneous abdominal fat: Relation between anthropometry and computed tomography. Am J Clin Nutr 45:7–13.

Snijder MB, Dekker JD, Visser M, Bouter LM, Stehouwer CDA, Kostense PJ, Yudkin JS, Heine RJ, Nijpels G, Seidell JC. 2003. Associations of hip and thigh circumferences independent of waist circumference with the incidence of type 2 diabetes: the Hoorn Study. Am J Clin Nutr 77:1192–97.

Suder A. 2008. Socioeconomic and lifestyle determinants of body fat distribution in young working males from Cracow, Poland. Am J Hum Biol 20:100–09.

Suder A. 2009. Body fatness and its social and lifestyle determinants in young working males from Cracow, Poland. J Biosoc Sci 41:139–54.

Valdez R, Seidell JC, Ahn YI, Weiss KM. 1993. A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A cross-population study. Int J Obes Relat Metab Disord 17:77–82.

Wright S. 1960. Path coefficients and path regression: Alternative or complementary concepts. Biometrics 16:189–202.

Weiner JS Lourie JA. 1969. Human Biology, A Guide to Field Methods. IBP Handbook No. 9. Oxford: Blackwell.