Some Determinants of Body Weight, Subcutaneous Fat, and Fat Distribution in 25–64 Year Old Swiss Urban Men and Woman

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There is a consensus about the fact that obesity is associated with an increased risk of cardiovascular disease at middle-age. Moreover, recent epidemiologic studies [1], [2] suggest that the distribution of adipose tissue, a concept whose significance was already pointed out several decades ago [3], is related to the risk of coronary heart disease independently of the total amount of body fat. Obesity is defined as an excess accumulation of body fat, and a subject is considered obese when the fat tissue represents a fraction of his total body mass exceeding a certain percent, such as 25% in men and 30% in women [4]. However, direct estimation of body fat content is cumbersome and relatively expensive. The most frequently used indirect estimates are the body mass index (BMI), defined as the ratio of weight to the square of height, and skinfold thickness measured at different sites of the body, which is an indicator of subcutaneous fat deposits. Percent body fat can be estimated from sums of skinfolds by means of several validated formulas [5]. Correlation coefficients of the BMI with skinfold thicknesses or hydrostatic estimation of body fat content (which is often considered to represent the «gold standard») are usually around 0.7 [6], [7]. The thickness ratio of subscapular skinfold to triceps skinfold (also called centrality index) and other ratios of centrally located to peripherally located skinfold thicknesses have been proposed as indicators of adipose tissue distribution. Among these, the waist to hip girth ratio has become particularly popular in recent research. Fat distribution indices are in general moderately correlated with percent body fat [8], [9].
Several behavioral and socioeconomic factors (mainly dietary habits, physical activity, smoking and education) can be influential on the whole cardiovascular risk factor profile and on obesity in particular. In fact, their precise effect on obesity is not yet completely clear. For example, while earlier observations suggested that smokers were leaner than non-smokers [10], individuals smoking more than 20 cigarettes daily have recently been found to be fatter than moderate smokers and even than non-smokers [11]. This could be explained by a modifying effect of other related factors, eg poor dietary habits, alcohol consumption and little exercise. Such a clustering of negative health habits has been increasingly found in recent studies [12], [13].
Although it seems plausible that excessive caloric intake can be one of the causes of obesity, many published studies have failed to find a relationship – or even found a weak inverse relationship – between BMI and energy intake [14], [15], [16]. Another reason for the absence of an unequivocal linear relationship between energy intake and body fat mass is that some individuals do have a lower rate of energy expenditure, which predisposes to weight-gain and development of obesity [17]. Moreover, it has been shown that physical activity and endurance capacity are negatively correlated with indicators of body fat amount and body fat distribution [16], [18].
In the present cross-sectional study, population-based data from the French speaking part of Switzerland, were analysed, addressing the following questions:
- How are relative weight, subcutaneous fat and fat distribution related to age and gender, and what is the interrelationship of these anthropometric characteristics?
- To what extent are relative weight, subcutaneous fat and fat distribution dependent on health habits and socioeconomic factors?

Subjects and Methods

The population under study consisted of a subgroup of 246 subjects (116 males and 130 females) aged 25–64 years and predominantly from the city of Lausanne, investigated in 1984/85 in course of the Swiss participation in the WHO MONICA project [19]. Information on sampling and data collection, as well as a participation analysis, have already been published [20], [21], [22].
Weight and height were measured in light clothing, to the nearest 200 gr and the nearest cm respectively. The thickness of four skinfolds – biceps (parallel to the arm axis, halfway between acromion and olecranon, while the arm was hanging vertically), triceps (at the same level), subscapular (at the inferior angle of the scapula, 45 degrees with respect to the vertical, in the sense of the contour of the skin) and suprailiac (above the iliac crest, in the mid-axillary line, in the sense of the skin contour) – were measured on the right side of the body

by two observers using a Lange caliper. Each measurement was repeated three times and the mean value of the three readings was entered into analysis. Finally, each subject answered a questionnaire about lifestyle and sociodemographic characteristics [23].
Smoking history was assessed by standard questions [23]; each individual was then classified into one of six categories, with 1 = never smoked, 2 = ex-smoker, 3 = irregular smoker, 4 = current smoker of 1–14 cigarettes a day, 5 = current smoker of 15–24 cigarettes a day, and 6 = current smoker of more than 24 cigarettes a day. Information on diet was collected with two types of questions: items pertaining to dietary habits, and a structured, qualitative 24-hour dietary recall. An additive index of dietary behavior was computed in an attempt to characterize diet more comprehensively. Five questions concerning habits with a total of 17 items, as well as 29 food items and 20 different types of beverages from the 24-hour dietary recall were taken into account. Allocation of points for the score was based on current recommendations of a healthy diet, i.e. considering the intake of saturated and polyunsaturated fatty acids, complex carbohydrates, fiber, alcohol, sodium, sugar, and foods/beverages relatively low in calories. Definitely «healthy» habits or consumption of «healthy» food items were given +1 point, while unequivocally «unhealthy» habits or food items were given −1 point. The theoretical range of this index of dietary behavior was from −11 to +14, with the positive direction indicating healthier habits. Observed index values ranged from −3 to +13, and they were approximately normally distributed in both sexes. Alcohol consumption was assessed by asking whether the subject had drunk wine, beer and/or liquors the day before, and counting the number of affirmative answers reported, from 0 to 3. Information on coffee consumption was recorded by asking whether the subject had drunk coffee the day before or not. A three-level index of leisure-time physical activity (LTPA) was computed as follows: Subjects reporting «predominantly sedentary leisure-time activities, such as watching TV or reading» and engaging «never» or «rarely» in sports were termed «sedentary», while subjects reporting «regular physical training» and exercising at least twice a week were termed accordingly, which corresponded to the highest activity level. All other subjects, reporting for example «some leisure-time physical activity such as frequently walking, cycling or gardening» or exercise «once a week» were termed «moderate leisure-time exercise». The educational level was assessed as the number of years of full-time education. Marital status was expressed by a dummy variable, dichotomizing individuals currently married or living with a partner vs all others.

Statistical analyses were carried out in three steps: descriptive, bivariate and multivariate. Overall, the two sexes were treated separately. Due to the modest sample size, stratification by age (25–44 and 45–64) was only performed in some analyses. A standard statistical software package (SPSS-X) was used.

Results

Table 1 shows descriptive statistics of men and women under study. A clear differentiation in fat distribution was observed between sexes. Although the total amount of subcutaneous fat was found to be similar in both sexes, in men it was mainly located on the trunk, while in women it tended to be uniformly deposited. Subscapular skinfold thickness, however, was not related to gender.

Tab. 1. Descriptive statistics of study group

	Men (n = 116)		Women (n = 130)		
	Mean	SD	Mean	SD	t-value[a]
Age (years)	42.71	10.67	42.62	10.58	0.06
BMI (kg/m^2)	25.39	3.27	23.47	3.91	4.19***
Suscapular (mm)	18.18	7.32	17.83	9.28	0.33
Suprailiac (mm)	30.17	15.52	23.32	13.55	3.61***
Biceps (mm)	6.98	4.49	10.32	6.22	−4.83***
Triceps (mm)	13.91	8.02	21.08	7.40	−7.21***
Sum of skinfolds (mm)	69.40	31.43	71.73	32.92	−0.56
Trunk/arm[b]	2.53	0.84	1.30	0.42	13.97***
Subscapular/triceps	1.50	0.62	0.85	0.31	10.21***

[a] t-values correspond to difference of means between men and women.
[b] Trunk = subscapular + suprailiac, arm = biceps + triceps.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

As shown in Figure 1, the amount of subcutaneous fat tended to increase in the third and fourth decade in males until it levelled-off after age 45, while the BMI kept slowly increasing throughout the whole middle-age range from 25 to 64. In women, the increase of both skinfold thickness and BMI was constant and almost linear. On the other hand, the two skinfold ratios were practically independent of age in both sexes.

Bivariate analyses

Table 2 presents correlation coefficients of relative weight with skinfolds and skinfold ratios, adjusted for age. All skinfold thicknesses were highly correlated with BMI, while the skinfold ratios were independent

Tab. 2. Age-adjusted correlation coefficients of body mass index with skinfolds and skinfold ratios

	BMI	
	Men	Women
Subscapular	0.70***	0.82***
Suprailliac	0.63***	0.75***
Biceps	0.61***	0.70***
Triceps	0.60***	0.67***
Sum of skinfolds	0.71***	0.84***
Trunk/arm	0.00	0.40***
Subscapular/triceps	−0.04	0.41***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

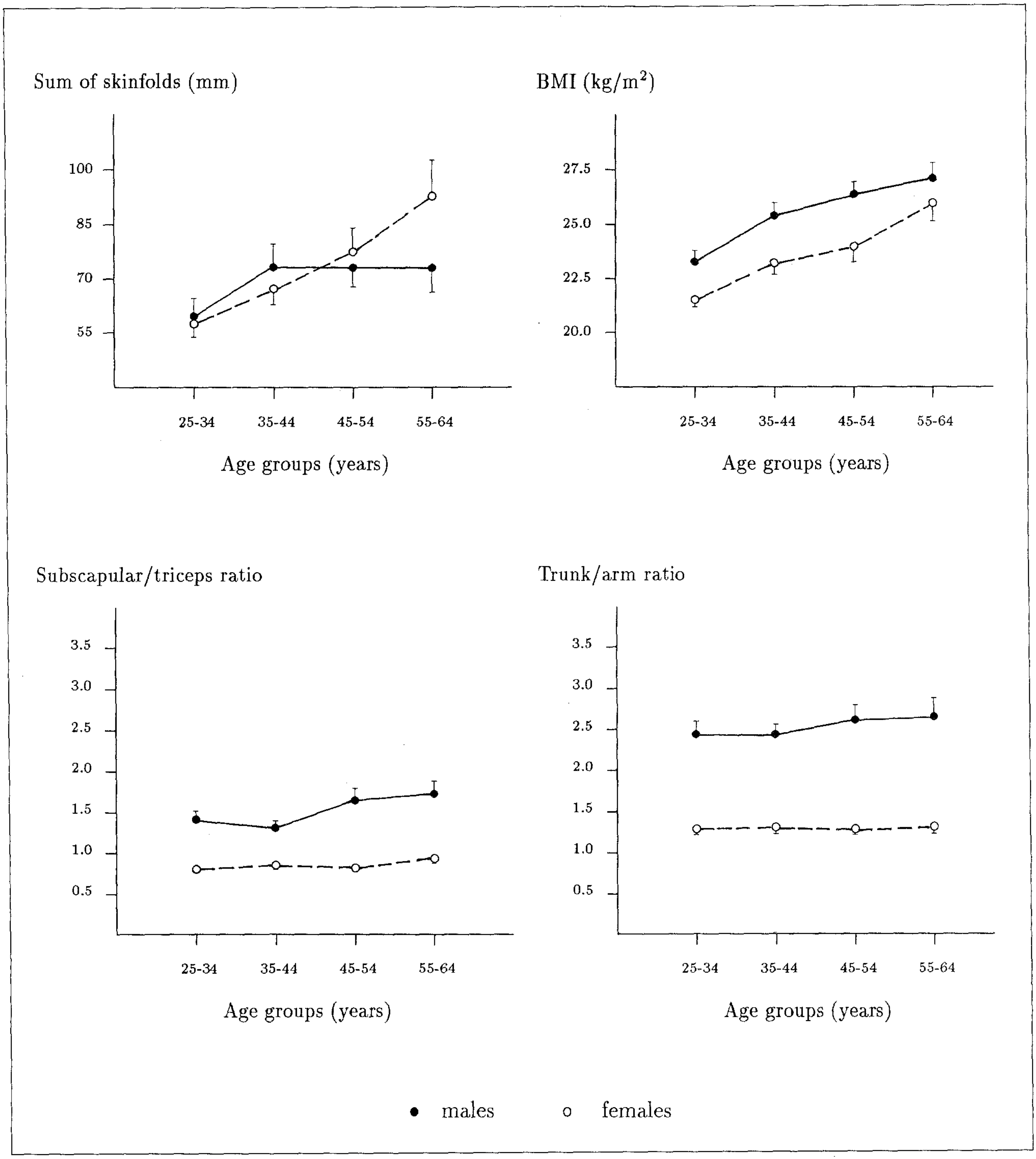

Fig. 1. Variation of sum of skinfolds, body mass index, subscapular to triceps ratio and trunk to arm ratio with respect to age and gender (means and standard errors of the respective variables in each ten-year age group have been represented; the number of individuals in the four 10-year age groups was 33, 33, 29, and 21 in men, and 34, 34, 42, and 20 in women, respectively)

of BMI in men and significantly and positively correlated with BMI in women. Hence, assessment of upper body fat distribution can provide additional information independently of relative weight, particularly in the male population.

Table 3 shows behavioral and sociodemographic correlates of fatness indicators. Frequency of smoking appeared to be associated with increased body fat amount in men, but with leanness in women. To examine whether differences in relative weight and subcutaneous fat were related to the current status of smoking versus nonsmoking or, instead, to the variation in the number of daily cigarettes among smokers, analysis of variance was performed, comparing means of all fatness indicators in five groups of subjects (Table 4). Interestingly, heavy smokers (20 cigarettes/

Tab. 3. Pearson correlation coefficients of fatness indicators with environmental factors

	BMI	Subsc.	Supra.	Bic.	Tric.	Sum	T/A	S/T
Men								
Smoking[a]	0.09	0.02	0.10	0.10	0.09	0.09	−0.10	−0.12
LTPA[b]	−0.13	−0.18*	−0.20*	−0.03	−0.08	−0.16*	−0.12	−0.06
Diet[c]	−0.25**	−0.19*	−0.14	−0.05	−0.05	−0.13	−0.18*	−0.08
Alcohol[d]	0.33***	0.21*	0.16*	0.17*	0.17*	0.19*	0.00	−0.01
Coffee[e]	−0.01	−0.04	0.06	−0.05	−0.01	0.01	0.09	−0.01
Education[f]	−0.18*	−0.20*	−0.06	0.00	0.03	−0.07	−0.17*	−0.18*
Marital st.[g]	−0.12	−0.09	−0.06	−0.09	−0.09	−0.08	0.01	−0.06
Age	0.42***	0.33***	0.10	0.16*	0.08	0.17*	0.08	0.19*
Women								
Smoking	−0.16*	−0.19*	−0.13	−0.12	−0.22**	−0.18*	−0.05	−0.04
LTPA	−0.09	−0.05	−0.09	−0.04	−0.05	−0.04	−0.10	−0.03
Diet	−0.03	0.09	0.02	−0.07	0.05	0.02	0.08	0.03
Alcohol	−0.06	−0.04	0.10	0.00	0.02	0.05	0.06	−0.00
Coffee	0.06	0.06	0.12	0.19*	0.14	0.15	−0.07	−0.06
Education	−0.29***	−0.27**	−0.21*	−0.22**	−0.23**	−0.24**	−0.03	−0.09
Marital st.	−0.08	0.01	−0.05	−0.02	−0.09	−0.03	0.07	0.14
Age	0.35***	0.32***	0.26**	0.28**	0.32***	0.34***	−0.03	0.07

[a] Six-point scale from 1 =having never smoked to 6 = current smoker of more than 24 cigarettes a day.
[b] Leisure-time physical activity, three-point scale from 1 = sedentary to 3 = vigorous exercise.
[c] Additive index of dietary behavior, three-point scale from 1 = unhealthy habits to 3 = very healthy habits.
[d] Four-point scale from 0 = having not drunk any alcohol the day before to 3 = having drunk wine, beer and liquor.
[e] Two-point scale, 0 = having not drunk coffee the day before, 1 = having drunk coffee.
[f] Four-point scale from 1 = up to 9 years of education to 4 = more than 17 years of education.
[g] Two-point scale, 0 = currently married or living with a prtner, 1 = living alone.
T/A = trunk/arm, S/T = subscapular/triceps.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Tab. 4. Analysis of variance of fatness indicators (means) by groups of smoking frequency

	n	BMI (kg/m²)	Subsc. (mm)	Supra. (mm)	Bic. (mm)	Tric. (mm)	Sum (mm)	T/A	S/T
Men									
Never smoked	23	24.66	16.5	27.9	6.2	12.9	63.7	2.70	1.58
Ex-smokers	33	25.71	19.6	31.4	7.5	14.4	72.8	2.46	1.47
Occasional	15	25.52	18.5	28.9	6.3	13.6	67.2	2.66	1.53
1–19 cig./day	17	24.06	15.1	23.8	5.8	10.5	55.1	2.58	1.72
> 19 cig./day	28	26.34	19.5	35.2	8.3	16.6	80.2	2.37	1.31
Women									
Never smoked	48	24.19	20.2	26.3	11.2	22.5	78.8	1.38	0.90
Ex-smokers	25	23.68	17.6	23.1	11.1	22.8	74.7	1.17	0.76
Occasional	13	22.38	16.0	19.6	8.3	18.8	61.6	1.34	0.86
1–19 cig./day	13	23.81	19.0	24.8	12.2	22.2	78.2	1.32	0.89
> 19 cig./day	28	22.55	14.9	20.7	8.6	17.9	61.2	1.30	0.86

T/A = trunk/arm, S/T = subscapular/triceps.

day or more) were consistently the fattest males and the leanest females. Although this observation was independent of age in men, among women it was partially due to a younger age of the smokers (data not shown).

A consistently inverse but only pnrtially significant relationship was observed between leisure-time physical activity and fatness indicators both in the male and female populations (Table 3). The relatively strongest associations were those with truncal fat in men, especially in younger subjects. Healthy dietary habits were also consistently and partially significantly associated with lower values of relative weight, skinfold thickness and central to peripheral skinfold ratios in men – more markedly in the older – but apparently not in women.

A significant direct association of alcohol consumption with BMI and all skinfolds was observed in men. On the other side, in women, those having drunk coffee the day before tended to have thicker subcutaneous fat deposits, as confirmed by analysis of variance (not shown). In women, education was also clearly and inversely correlated with fatness indicators, even after age adjustment. Being married or living with a partner appeared to be associated with a moderate increase in relative weight and in subcutaneous fat among men.

It shall be noted that due to the great number of comparisons made, some of the associations significant at the $p < 0.05$ level may be chance findings and the importance of single correlations should thus not be overstated.

Multivariate analyses

The independent impact of each one of the environmental variables on relative weight and subcutaneous fat was evaluated by multiple linear regression with forced stepwise entry. First, behavioral variables were entered into the model (smoking, leisure-time physical activity, dietary habits, alcohol and coffee consumption); secondly, years of education and marital status were included, and finally age. Table 5 presents the cumulative percents of explained variance of each fatness indicator. Overall, R^2 values were low, indicating a very modest explanatory power of the regression models. Nevertheless, the findings suggest that, in men, subcutaneous fat deposits – especially upper arm fat – depend less on environmental factors than BMI. In women, all percents of variance in skinfolds explained were similar, and they were higher than the corresponding proportions in men, after all environmental factors had been entered. The percents of explained variance of fat distribution, however, were considerably lower in women than in men. Age appeared to be a relatively strong independent determinant of relative weight in both sexes, and of subscapular skinfold in men.

Standardized regression coefficients are shown in Table 6, in order to specify which environmental factors had most independent influence on anthropometric characteristics. Generally, coefficients were low, indicating only moderate predictive power. The main predictors of BMI in men were age and, clearly weaker, alcohol consumption, while in women it was age, years of education (inversely) and coffee consumption. The contribution of age was also significant for the subscapular skinfold in men (for which it was, indeed, the only single strong predictor). Among men, marital status tended to have an independent influence

Tab. 5. Cumulative percents of explained variance of fatness indicators in a multiple linear regression model with environmental factors and age as predictor variables

	Cumulated R^2 (%)							
	BMI	Subsc.	Supra.	Bic.	Tric.	Sum	T/A	S/T
Men								
Behavioral[a]	12.7	5.6	7.6	2.3	2.3	5.2	7.7	4.7
Sociodemographic[b]	15.3	9.2	9.5	3.7	4.4	7.6	9.5	7.1
Age	29.7***	18.6*	9.9	5.1	4.6	9.2	9.7	9.2
Women								
Behavioral	3.6	4.0	9.3	8.1	12.5	9.3	2.8	2.5
Sociodemographic	11.5	10.2	13.6	11.5	15.8	14.6	3.7	4.3
Age	23.3*	14.1	14.9	15.4	18.8	17.9	4.4	4.3

[a] Behavioral variables: smoking, LTPA, dietary habits, alcohol and coffee consumption.
[b] Sociodemographic variables; years of education, marital status.
T/A = trunk/arm, S/T = subscapular/triceps.
Significance of final R^2 value: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Tab. 6. Standardized regression coefficients of fatness indicators with environmental factors and age as predictor variables

	BMI	Subsc.	Supra.	Bic.	Tric.	Sum	T/A	S/T
Men								
Smoking	0.11	0.07	0.15	0.12	0.09	0.13	−0.10	−0.14
LTPA	−0.02	−0.07	−0.16	0.02	0.00	−0.09	−0.17	−0.11
Diet	−0.08	−0.09	−0.07	0.01	0.00	−0.05	−0.17	−0.06
Alcohol	0.20	0.08	0.06	0.07	0.10	0.09	−0.04	−0.02
Coffee	0.11	0.04	0.12	0.04	0.07	0.09	0.05	−0.02
Education	−0.01	−0.01	0.04	0.07	0.09	0.05	−0.12	−0.09
Marital st.	−0.04	−0.11	−0.13	−0.10	−0.13	−0.14	−0.01	−0.04
Age	0.42***	0.34**	0.07	0.13	0.05	0.14	0.04	0.16
Women								
Smoking	0.03	−0.06	−0.13	−0.02	−0.13	−0.10	−0.12	0.00
LTPA	−0.00	0.01	−0.03	0.05	0.03	0.01	−0.03	−0.02
Diet	0.11	0.15	0.13	0.08	0.15	0.15	0.03	0.01
Alcohol	−0.04	−0.00	0.11	0.12	0.11	0.09	0.04	−0.02
Coffee	0.19	0.10	0.22	0.24*	0.26*	0.22	−0.12	−0.15
Education	−0.20	−0.21	−0.18	−0.15	−0.13	−0.19	−0.09	−0.10
Marital st.	−0.04	0.04	−0.03	0.00	−0.05	−0.01	0.08	0.12
Age	0.37**	0.22	0.13	0.22	0.19	0.20	−0.09	−0.00

T/A = trunk/arm, S/T = subscapular/triceps.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

on subcutaneous fat, with married men having thicker skinfolds. Further, the relative importance of smoking and exercise (inversely) in predicting suprailiac skinfold thickness in males was confirmed. In the female population, age was strongly predictive of relative weight; in addition, an effect of coffee consumption and of years of education on all fatness indicators was observed. As observed in bivariate analyses, the contribution of smoking to subcutaneous fat had a different sign in men and women.

Discussion

This study suggests that, in middle-aged urban men, relative weight and truncal fat depend somewhat more on health habits and sociodemographic factors than depends upper arm fat. In women, the influence of environmental variables on both skinfold thicknesses and relative weight was similar, and it was slightly greater than in men in absolute terms. Our data also confirmed the close statistical association between relative weight and subcutaneous fat observed in many studies. However, this does not imply that these anthropometric measures are interchangeable, since their respective associations with other variables such as behavioral traits or biological risk factors need not be equivalent. Indeed, some authors have suggested that skinfold thicknesses might be a preferable estimate of obesity [7], [24], [25].

The amount of body fat commonly increases with age. The pattern of age-related increases observed in our sample agrees with findings from the United States [26]. In women, skinfold thickness steadily increased until the sixties, while in men a peak was observed at about age 40 to 45. In contrast, relative weight tended to increase in the whole age range 25–64 in both sexes. This suggests that, in the male population, fat deposits after middle-age could be internal rather than subcutaneous [27].

Gender differences in fat distribution are well established. It has been proposed [28] that values of the central to peripheral skinfold ratios higher than 1 are typical of android obesity, while those lower than 1 are specifically gynoid. Although the skinfold ratios used in the present analysis are primarily indicators of upper body subcutaneous fat distribution, several studies [8], [9], [29], have found that they were positively related to relative weight and total amount of subcutaneous fat. We could confirm this trend in the female group, but in men only low correlations with BMI and sum of skinfolds were found. In fact, evaluation of associations between ratios and close correlates of their components seems to be a problem of mathematical rather than biological nature [30].

Age had a significant independent influence on relative weight in both sexes and on the subscapular skinfold in men, but its independent effect on the other skinfolds and on fat distribution was much weaker. Age added less than 2% in men and 4% in women to explained variance of skinfold thickness when entered after environmental variables. Therefore, the effect of age on subcutaneous fat could be partially mediated by changes in behavior, as for example dietary habits or a decrease in physical activity [31].

Our data agree with a possibly U-shaped association between smoking and body fat in men [11]; this could be due to a clustering of heavy smoking with other unhealthy habits, as described in Finnish men [12]. In women, heavy smokers were found to be leaner. However, the association was weakened after age-adjustment, which might be explained by a younger average age of heavily smoking females. In contrast to data from NHANES II [11], male ex-smokers were consistently fatter than those who never smoked in the present study.

We found a consistent but rather weak inverse association between leisure-time physical activity and fatness indicators, predominantly for centrally located fat in men, which agrees with observations from Finnish middle-aged males [32]. Although energy intake or energy expenditure were not measured, our data also suggest that healthy dietary habits are associated with lower values of BMI and of truncal fat in men. Surprisingly, no association of dietary habits with anthropometric characteristics could be observed in women. Another factor to be considered in the association between obesity and energy intake is the composition of the diet. Several studies suggest that ingested fat, mainly saturated fat, is responsible for obesity, independently of the total energy intake [14]. Coffee consumption was found to be positively (though weakly) related to all skinfolds in women, which might be due in part to other habits – as eating sweets – possibly associated with coffee drinking. Other studies have also pointed out a relationship between BMI and high coffee ingestion [33]. Finally, our study confirmed that education is a consistent determinant of anthropometric characteristics, especially in women [32], [34].

Plainly, in the present analysis the predictive power of environmental variables for anthropometric characteristics was disappointingly modest in absolute terms. When evaluating this apparently small size of effect of behavioral variables on body composition and fat distribution, several important methodological shortcomings of our investigation must be considered. Firstly, the statistical power of the study was limited by the relatively small sample size; in a dition, the sample may only be representative for urban populations. Secondly, potentially important determinants of body fat and its distribution, such as genetic of metabolic factors [35], [36], [37], [38] were not included in the study. Thirdly, the accuracy in the assessment of dietary habits was limited by the lack of quantitative data, such as approximate daily caloric intake or amount of ingested alcohol. Similarly, information on smoking, habitual exercise and education attainment was only based on self-reported questionnaire data which may be distorted by a «social desirability bias». Plainly, any such misclassification will tend to attenuate the «true», underlying biological associations. Finally, even though the independent impact of environmental factors on body fat was estimated by multivariate procedures, the interrelationship between the predictor variables forces us to interpret the results with caution. In summary, this cross-sectional analysis of middle-aged urban men and women revealed varying, partially significant associations of relative weight, skinfold thicknesses and fat distribution with age and environmental factors such as diet, smoking, exercise, education, and marital status. Gender emerged as an important modifying factor of several environment-body fat-associations. Even though relative weight, subcutaneous fat and fat distribution may correlate intra-individually, these three fatness indicators are not equivalent and interchangeable anthropometric measures. A question that merits further study is to what extent different anthropometric characteristics may mediate relations between individual health habits or the sociodemographic background and biological risk factors for coronary heart disease, such as hypertension and hypercholesterolemia.

Summary

Data from a predominantly urban sample of 116 men and 130 women aged 25–64 years and collected in 1984/85 as a part of the Swiss WHO MONICA project, were analysed cross-sectionally to study the interrelationship between relative weight, subcutaneous fat and fat distribution, as well as the dependence of these anthropometric characteristics on behavioral and sociodemographic factors. Skinfold thicknesses were found to increase with age almost linearly in women, while in men they increased only before age 40 to 45. Subcutaneous fat was, but fat distribution was not, highly correlated with relative weight in both sexes. Alcohol consumption, healthy dietary habits (inversely), and exercise (inversely) were all significantly related to subcutaneous fat in men, while the relatively strongest predictors of female skinfold thicknesses were smoking (inversely), coffee consumption, and education (inversely). In multivariate analysis, environmental factors explained up to 10% of skinfold variance in male subjects and between 10 and 15% in females. Fat distribution was more influenced by environmental factors in men (about 8% of explained variance) than in women (about 4%). In men, truncal fat depended more on lifestyle that did upper arm fat, with smoking (directly) and exercise (inversely) being relatively most predictive of abdominal fat. We conclude that, although relative weight, subcutaneous fat, and fat distribution correlate intra-individually, they are not equivalent and interchangeable anthropometric characteristics. This is reflected by the varying associations of the three fatness indicators with age and environmental factors such as smoking, diet, exercise, and education. Gender seems to be an important modifying factor of environment-body fat-associations. Thus, epidemiological studies investigating the health hazards of obesity should probably include estimates both of body fat and its distribution, as well as measures of their potential environmental determinants.

Résumé

Quelques facteurs déterminant le poids, la graisse sous-cutanée et la distribution de la graisse corporelle chez des hommes et femmes suisses agés de 25 à 64 ans

Un échantillon représentatif d'une population urbaine suisse, consistant de 116 hommes et 130 femmes âgés de 25–64 ans, faisant partie de la première enquête realisée en 1984/85 dans le cadre du projet MONICA de l'O.M.S., a été utilisé dans une étude transversale dont le but principal était d'analiser les intercorrélations entre le poids rélatif, la graisse sous-cutanée et la distribution de cette graisse, ainsi que d'étudier la dépendance de ces mesures anthropométriques par rapport à l'âge, le sexe et les habitudes de vie. Nous avons observé que les plis cutanés augmentaient régulièrement avec l'âge chez les femmes, tandis que chez les hommes ils augmentaient seulement jusqu'aux environs de quarante ans. La graisse souscutanée était fortement associée avec le poids rélatif chez les deux sexes. Chez les hommes, la consommation d'alcohol, les habitudes alimentaires saines (inversément) et l'activité physique étaient les mieux associés avec la graisse sous-cutanée. Chez les femmes, les associations les plus fortes de la graisse sous-cutanée ont été observées avec le tabagisme (inversément), la consommation de café et les années d'excolarisation. Les habitudes de vie expliquaient environ 10% de la variance chez les hommes et entre le 10 et le 15% chez les femmes. La distribution de la graisse était mieux associée avec les habitudes de vie chez les hommes (près de 8% de la variance expliquée) que chez les femmes (près de 4%). Chez les hommes, la graisse du tronc était mieux associée avec les habitudes de vie (spécialement avec le tabagisme et l'activité physique) qu'avec la graisse périphérique. En conclusion, malgré les intercorrélations significatives observées entre le poids rélatif, la graisse sous-cutanée et la distribution de cette graisse, ces variables ne sont pas nécessairement équivalentes et interchangeables. On peut confirmer cela en observant les différentes associations de ces trois indicateurs avec l'âge et des habitudes de vie comme le tabagisme, l'activité physique, les habitudes alimentaires, les années de scolarisation et l'était civil. Le sexe apparaît être un important facteur modifiant des associations entre les facteurs de vie et la graisse du corps. En conséquence, dans de futures études épidémiologiques consacrées à l'obesité, il serait intéressant d'y inclure des mesures de la graisse aussi bien que de sa distribution, et des habitudes de vie qui peuvent les modifier.

Zusammenfassung

Einflussfaktoren auf Körpergewicht, Subkutanfett und Fettgewebsverteilung von 25–64jährigen städtischen Schweizer Männern und Frauen

Im Rahmen des Schweizer WHO MONICA-Projekts 1984/85 bei 116 männlichen und 130 weiblichen, überwiegend städtischen Personen im Alter von 25–64 Jahren erhobene Daten wurden im Querschnitt analysiert, um Beziehungen zwischen Körpergewicht, Subkutanfett und Fettgewebsverteilung sowie deren Abhängigkeit von Lebensstil und soziodemographischen Faktoren zu beschreiben. Bei den Frauen nahmen Hautfaltendicken mit dem Alter nahezu linear zu, während bei den Männern nur bis zum 40. bis 45. Lebensjahr eine entsprechende Dickenzunahme festzustellen war. Subkutanfett und relatives Körpergewicht waren bei beiden Geschlechtern hoch interkorreliert, während die Fettgewebsverteilung bei den Männern keinen und bei den Frauen einen vergleichsweise schwachen Zusammenhang mit dem relativen Körpergewicht aufwies. Bei den Männern waren Alkoholkonsum, gesunde Ernährung (inverse Beziehung) und körperliche Freizeitaktivität (inverse Beziehung) signifikant mit der Subkutanfettmasse verbunden, während bei den Frauen Rauchen (inverse Beziehung), Kaffeekonsum und Bildung (inverse Beziehung) die relativ stärksten Prädiktoren der Hautfaltendicken waren. Verhaltensabhängige Variablen erklärten multivariat bei den Männern bis zu 10%, bei den Frauen 10–15% der Varianz der Hautfaltendicken. Die gleichen Verhaltensfaktoren erklärten bei den Männern 8%, bei den Frauen lediglich 4% der Varianz der Körperfettverteilung. Bei den Männern hing das Subkutanfett am Stamm mehr von Lebensstilfaktoren ab als dasjenige des Oberarms, wobei Rauchen (direkte Beziehung) und körperliche Freizeitaktivität (inverse Beziehung) die relativ stärksten Korrelate des Abdominalfetts waren. Die Studie zeigt, dass relatives Körpergewicht, Subkutanfett und Fettgewebsverteilung keine austauschbar-gleichwertigen anthropometrischen Messgrössen sind, selbst wenn sie untereinander korreliert sind. Die drei genannten Körperfettparameter wiesen unterschiedliche Beziehungen zu Faktoren wie Alter, Rauchen, Ernährung, physische Aktivität und Bildung auf, wobei das Geschlecht ein relevanter, die Lebensstil-Körperfett-Assoziation modifizierender Faktor zu sein schien. Es wäre deshalb wohl nützlich, wenn zukünftige epidemiologische Studien über den

Risikofaktor Adipositas jeweils auch Körperfettmasse, Fettgewebsverteilung und deren verhaltensabhängige Determinanten erfassen würden.

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