Body adiposity index and all-cause and cardiovascular disease mortality in men

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Abstract

Objective—To evaluate the association of body adiposity index (BAI) with all-cause and cardiovascular disease (CVD) mortality risk.

Design and Methods—The current analysis comprised 19 756 adult men who enrolled in the Aerobics Centre Longitudinal Study and completed a baseline examination during 1988-2002. All-cause and CVD mortality was registered till December 31, 2003.

Results—During an average follow-up of 8.3 years (163 844 man-years), 353 deaths occurred (101 CVD deaths). Age- and examination year-adjusted hazard ratios (HRs) and 95% confidence intervals (95% CIs) for all-cause mortality risk were higher for men with high values of BMI (HR = 1.63, 95% CI = 1.19–2.23), waist circumference (1.55, 1.22-1.96) and percentage of body fat (%BF) (1.36, 1.04-1.31), but not for men with high values of BAI (1.28, 0.98-1.66). The HRs for CVD mortality risks were higher for men with high values in all adiposity measures (HRs ranged from 1.73 to 2.06). Most of these associations, however, became nonsignificant after adjusting for multiple confounders including cardiorespiratory fitness.

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Conflicts of interest statement
The authors declared no conflict of interest.

Conclusion—BAI is not a better predictor of all-cause and CVD mortality risk than BMI, waist circumference or %BF.

Keywords

Adiposity; body mass index; mortality; adults

INTRODUCTION

The prevalence of obesity among adults has reached epidemic levels worldwide.(1, 2) It is well known that overweight and obesity are major risk factors which can lead to further morbidity and mortality.(3-5)

Body mass index (BMI) and waist circumference are strong predictors of obesity-related morbidity and mortality.(6-8) Despite their limitations, both are commonly used as adiposity measures in large epidemiological studies where the use of more accurate methods such as dual-energy X-ray absorptiometry (DXA), hydrostatic weighing, bioelectrical impedance or even skinfold thickness are limited due to its complexity and/or cost.(9, 10)

Recently, Bergman et al.(11) proposed the body adiposity index (BAI) as a new method intended to substitute BMI as an estimate of percentage body fat (%BF) without requiring a measure of body weight. Several validation studies have analyzed the correlation between BAI and %BF estimated by accurate gold standard methods such as DXA,(11-17) magnetic resonance imaging,(18) bioelectrical impedance,(19, 20) and computed tomography.(13) Moreover, other studies have examined the associations between BAI and traditional and novel cardiovascular disease (CVD) risk factors.(13, 16-18, 20-23)

To our knowledge, the association between BAI and mortality has not been investigated. Such a study is needed to determine the potential use of BAI as a mortality risk predictor in large epidemiological studies. Therefore, the purpose of this study was to evaluate the association of BAI with all-cause and CVD mortality risk. In addition, we analyzed the cross-sectional associations between BAI and traditional CVD risk factors in a sample of men participating in the Aerobics Center Longitudinal Study (ACLS).

METHODS AND PROCEDURES

Subjects

Data for this report were from the ACLS, a prospective epidemiological study of individuals who received extensive preventive medical examinations at the Cooper Clinic in Dallas, Texas. Details of the study design and the characteristics of the cohort have been reported previously.(24) Study participants were referred by their employers or physicians or were self-referred. They were mainly Caucasian, relatively well-educated, and from middle to upper socioeconomic strata. After receiving complete information about the aims and methods of the study, all participants gave written informed consent for the examinations and follow-up. The study protocol was reviewed and approved annually by the Cooper Institute's Institutional Review Board.

For the present analysis we included all men who received at least 1 medical examination between 1977 and 2002, and with valid data for hip circumference. For men attending more than one examination we used the first examination (baseline). Among 23 126 men aged ≥ 20 years at baseline, we excluded 299 with a history of myocardial infarction or stroke; 1 265 reporting cancer; 28 with BMI <18.5 kg/m^2; and 631 not reaching 85% of their age-predicted maximal hart rate (220 minus age in years) on a maximal treadmill exercise test. In addition, 1 147 men with less than one year of mortality follow up were excluded to minimize potential bias due to serious underlying illness on mortality. The final sample comprised 19 756 men for analyses of all-cause and CVD mortality.

Clinical Examination

The clinical examination procedures are described in detail elsewhere.(24, 25) Briefly, weight, height, waist and hip circumferences were measured with standard clinical scale, stadiometer and plastic tape according to ACLS standard procedures. BMI was computed as weight in kilograms divided by height in meters squared (kg/m^2), and BAI was calculated according to Bergman et al.'s equation ((hip circumference in cm/height in meters$^{1.5}$)-18). (11) %BF was assessed using hydrostatic weighing, the sum of seven skinfold measures, or both methods, following standardized protocols.(26) Detailed description of our hydrodensitometry procedures have been published elsewhere.(27) Men were classified according to adiposity categories using standard clinical definitions for BMI (18.5 to 24.9 as normal weight; 25 to 29.9 as overweight; ≥ 30 as obese) and waist circumference (≥ 102 cm as central obese).(28) Since there is not a specific agreement about obesity cut-off points for BAI and %BF, specific tertiles from this population were used.

Resting blood pressure was measured in the seated position by trained technicians using auscultatory methods with mercury sphygmomanometer and was recorded as the first and fifth Korotkoff sounds after ≥ 5 minutes of sitting quietly. Two readings separated by 2 minutes were averaged. If the first 2 readings differed by >5 mmHg, additional readings were obtained and averaged. Hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or a history of physician diagnosis. Electrocardiogram (ECG) was measured at rest and with exercise, and abnormal ECG responses included rhythm and conduction disturbances and ischemic ST-T wave abnormalities. Serum samples were analyzed for glucose and total cholesterol using standardized automated bioassays at the Cooper Clinic Laboratory. Diabetes mellitus was defined as fasting plasma glucose concentration of ≥ 126 mg/dL, a history of physician diagnosis, or insulin use. Hypercholesterolemia was defined as total cholesterol of ≥ 240 mg/dL or a history of physician diagnosis.

Physical activity habits, cigarette smoking habit, alcohol intake, and parental history of CVD were assessed by self-report on a medical history questionnaire. Physically inactive was defined as reporting no leisure-time physical activity in the 3 months before the examination. Smoking status was classified as current smoker or non-current smoker. Heavy alcohol consumption was established as >14 units/week. One unit of alcohol intake was defined as a bottle or can of beer [355 mL (12 oz)], a glass of wine [148 mL (5 oz)], or 44 mL (1.5 oz) of hard liquor. Parental history of CVD was defined as the occurrence of heart

attacks, coronary disease, angioplasty, or stroke before the age of 50 years in either father or mother. Cardiorespiratory fitness (CRF) was quantified as the total time of a symptom-limited maximal treadmill exercise test, using a modified Balke protocol.(29, 30) Total treadmill endurance time (in minutes) on this protocol correlates highly with measured maximal oxygen uptake in men (r=0.92).(31) To standardize exercise performance, we estimated maximal metabolic equivalents (METs; 1 MET = 3.5 mL O_2 uptake per kilogram per minute) from the final treadmill speed and grade.(32)

Vital status

All participants were followed for mortality from the baseline examination to the date of death or to December, 31, 2003. Deaths were identified from the National Center for Health Statistics National Death Index and official death certificates from the departments of vital records of the various states. The underlying cause of death was determined by a nosologist according to the International Classification of Diseases, Ninth Edition, with CVD defined as codes 390 to 449.9 before 1999 and Tenth Edition, with CVD defined as codes I00 to I78 during 1999 to 2003. The National Death Index has been shown to be an accurate method of ascertaining deaths in observational studies, with high sensitivity (96%) and specificity (100%).(33)

Statistical analysis

Descriptive analyses summarized baseline characteristics of the participants based on vital status and BAI tertiles. Differences between groups were tested using analysis of the variance (ANOVA) for continuous variables and chi square tests for categorical variables. Partial correlations between body adiposity measures were calculated after controlling for age and examination year. We also examined the association of body adiposity measures with CVD risk factors using linear regression, controlling for age and examination year. Cox proportional hazards regression analysis (timescale: years) was used to estimate mortality rates (deaths per 10 000 man-years of follow-up), hazard ratios (HRs), and associated 95% confidence intervals (95% CIs) for all-cause and CVD mortality, according to adiposity exposure categories from BAI, BMI, waist circumference, and %BF. The lowest adiposity category was used as the reference category. To allow comparisons between adiposity measures, the results were also presented as standardized HRs by transforming each variable to have a mean of zero and a SD of 1. In multivariable analyses, model 1 accounted for age and examination year. Model 2 included physical activity, smoking habit, alcohol intake, abnormal ECG, hypercholesterolemia, diabetes, hypertension and parental history of CVD as additional confounders. Model 3 additionally adjusted for CRF. The proportional hazards assumption was examined by comparing the cumulative hazard plots grouped on exposure; no appreciable violations were noted. All the analyses were performed using PASW statistical package version 18.0 (SPSS Inc, Chicago, IL), considering P<0.05 as being statistically significant.

RESULTS

During an average follow-up of 8.3 years and 163 844 man-years of observation, 353 deaths occurred (101 due to CVD). The characteristics of the study population by vital status and

BAI tertiles are shown in Table 1. Decedents presented significantly higher values at baseline for age, %BF, total cholesterol, fasting blood glucose, systolic blood pressure, as well as higher prevalence of abnormal ECG and hypertension. On the other hand, decedents had significantly lower values for CRF. All values and prevalence rates showed significant differences among BAI tertiles, except for the prevalence of heavy drinkers.

Partial correlations examining the association among body adiposity measurements after controlling for age and examination year are shown in Table 2. Although all body adiposity measurements were positively correlated (P 0.001), %BF was more strongly correlated with waist circumference (r=0.77) and BMI (r=0.72) than BAI (r=0.65).

According to Table 3, all body adiposity measures were significantly associated with CVD risk factors (all P<0.001). Except for systolic blood pressure, correlations between BAI and CVD risk factors were slightly weaker than for BMI, waist circumference and %BF. Among all the risk factors, CRF showed the strongest association with all adiposity measurements.

Table 4 shows death rates and HRs for all-cause mortality according to 3 different sets of confounders (model 1, model 2 and model 3). In model 1, all-cause mortality risk was higher for BMI-based obese men (HR = 1.63, 95% CI = 1.19 2.23), central obese men (1.55, 1.22-1.96) and those in the upper tertile of %BF (1.36, 1.04-1.31). All adiposity measures showed significantly higher hazard ratios per 1 SD increase. After additional adjustments (model 2 and model 3), the association between adiposity status and risk of all-cause mortality became not significant, except for the central obese participants in model 2 (1.31, 1.02-1.68).

Table 5 shows death rates and HRs for CVD mortality. In model 1, CVD mortality risk was higher for men in the highest category of all adiposity measurements (HRs ranged from 1.73 to 2.06). After additional adjustments (model 2 and model 3), the association between adiposity status and risk of CVD mortality became not significant.

To further evaluate the possible bias due to subclinical disease at baseline, all the analyses were repeated excluding participants with resting or exercise abnormal ECG, and also excluding deaths that occurred during the first 3 years of follow-up. The results did not substantially change (data not shown).

DISCUSSION

The results of the present report suggest that, among men enrolled in the ACLS between 1977 and 2002, BAI is not a better predictor for all-cause and CVD mortality risk than other body adiposity measures such as BMI, waist circumference or %BF. Furthermore, associations between BAI and traditional CVD risk factors (e.g. cholesterol, glucose, blood pressure and CRF) are slightly weaker than for BMI, waist circumference or %BF.

The BAI has recently been proposed by Bergman et al.(11) to provide valid direct estimates of %BF. The mean intra-individual difference between BAI and %BF in our study was 3.5%, 2.7% and 1.9% in lower, middle and upper BAI tertiles, respectively. Moreover, %BF showed a relatively higher correlation with BMI (r=0.72) and waist circumference (r=0.77)

than BAI (0.65). Similar results have been found in some BAI validation studies when correlation analyses were sex-stratified, indicating that calculation of BAI would result in less accurate estimates of %BF.(12, 17-19)

Previous studies have showed a strong association of CVD risk factors with traditional body adiposity measures,(4, 6, 34, 35) but the association with BAI seemed to be weaker.(13, 17, 18, 20-23) In fact, only one study performed in 13 women aged 33.6±11.5 years with familial partial lipodystrophy, found BAI to be more strongly correlated with leptin than BMI (r=0.57 and r=0.02, respectively).(15) Our results are consistent with previous findings reporting significant associations between all adiposity measures and CVD risk factors (e.g. cholesterol, glucose, blood pressure, and CRF), and showing slightly weaker associations with BAI. Therefore, BAI seems not to provide a meaningful alternative to traditional adiposity measurements as a CVD risk indicator.

The association of obesity with all-cause and CVD mortality is well established.(7, 8, 36, 37) In our best knowledge, no previous studies have analyzed the ability of BAI to predict all-cause and CVD mortality. According to our results, BAI is not a good predictor of mortality risk. Indeed, only men in the upper BAI tertile showed statistically higher CVD mortality risk after adjusting for age and examination year. However, men in the highest adiposity categories for BMI, waist circumference, and %BF presented statistically higher risks of all-cause and CVD mortality after adjusting for age and examination year. The lack of accuracy of BAI estimating %BF, and the fact that it does not reflect fat distribution, which is known to have a large influence on mortality risk in men (android obesity), could partially explain these differences between mortality and the analyzed body adiposity measurements.

Several studies provide evidence that CRF substantially modifies the association of adiposity measures with mortality,(38) but no previous study using BAI included CRF in their analysis. We analyzed 3 different sets of confounders, and in the fully adjusted model including CRF all the associations between obesity and mortality became not significant.

The results of the present analysis should be interpreted with caution due to several limitations. First, since our study only included Caucasian, well-educated men from middle-to-upper socioeconomic strata, the results may not be extended to other populations. However, the homogeneity of the sample enhances internal validity of our findings because it reduces the likelihood of confounding by these characteristics. Second, %BF was estimated from skinfold measures or hydrostatic weighing, each of which has methodological limitations.(39) Third, as we only compared baseline data for exposures, we do not know whether changes in any of these variables occurred during follow-up and how that might have influenced the results. However, we recently published a report on changes in weight, %BF, and CRF with all-cause and CVD mortality.(40) When each of these exposures were adjust for all other exposures, only changes in CRF were associated with mortality. Fourth, the small number of deaths during the follow-up period restricted the statistical power of the analyses. Finally, we could not take into account dietary factors due to lack of adequate dietary information. Despite of these limitations, the main strengths of this study included the large, well-characterized cohort of men, the prospective design of the

study, the use of two different mortality outcomes, the extensive follow-up period, and the extensive baseline examination that reduced the possible bias of subclinical disease.

In conclusion, the findings of the present analysis add information about the newly proposed BAI, suggesting that BAI is not a better predictor of all-cause and CVD mortality risk in men than traditional adiposity measures. Also, our results show that the association of BAI with CVD risk factors is relatively weaker than for BMI, waist circumference, and %BF. Further epidemiological studies examining the utility of BAI in other populations and women are still needed for a better understanding of the validity of this new index.

Acknowledgments

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What is already known about this subject

Traditional body adiposity measures, such as BMI or waist circumference, are strong predictors of obesity-related morbidity and mortality.

Body adiposity index (BAI) has been recently proposed as a new method intended to estimate percentage of body fat without requiring a measure of body weight.

What this study adds

This study analyze the potential use of BAI as a mortality risk predictor, showing that BAI was not a better predictor for all-cause and CVD mortality risk than traditional body adiposity measures in a sample of adult men enrolled in the ACLS.

Associations between BAI and traditional CVD risk factors were slightly weaker than for traditional body adiposity measures.

Table 1

Baseline characteristics of participants by vital status and body adiposity index (BAI) tertiles.

Characteristic	Vital status			BAI (tertiles)			
	Survivors (n=19403)	Decedents (n=353)	P value[a]	Lower (n=6554)	Middle (n=6590)	Upper (n=6612)	P value[a]
Age (years)	46.5 (9.5)	57.4 (12.1)	<0.001	45.2 (9.7)	47.2 (9.6)	47.6 (9.5)	<0.001
Body mass index (kg/m^2)	27.0 (3.9)	26.8 (4.0)	0.241	24.1 (2.0)	26.4 (2.2)	30.5 (4.0)	<0.001
Waist circumference (cm)	94.5 (10.8)	95.6 (11.2)	0.057	87.6 (7.3)	93.3 (7.7)	102.6 (11.0)	<0.001
BAI (%)	24.8 (3.5)	25.1 (3.4)	0.151	21.5 (1.4)	24.4 (0.7)	28.5 (3.0)	<0.001
%BF	22.1 (6.1)	22.9 (5.9)	0.025	18.0 (5.0)	21.7 (4.6)	26.6 (5.2)	<0.001
Treadmill time (min)	18.5 (4.8)	15.9 (5.7)	<0.001	21.0 (4.5)	18.7 (4.3)	15.6 (4.2)	<0.001
Maximal metabolic equivalents	11.9 (2.4)	10.7 (2.7)	<0.001	13.2 (2.4)	12.0 (2.1)	10.6 (2.0)	<0.001
Total cholesterol (mg/dL)	204.8 (38.9)	212.2 (44.5)	<0.001	196.5 (37.2)	206.2 (38.3)	212.0 (40.1)	<0.001
Fasting blood glucose (mg/dL)	100.3 (17.4)	104.9 (26.2)	<0.001	97.9 (15.0)	99.7 (15.5)	103.6 (21.0)	<0.001
Blood pressure (mmHg)							
Systolic	122.6 (13.4)	127.3 (15.9)	<0.001	120.1 (12.8)	122.3 (13.0)	125.5 (13.8)	<0.001
Diastolic	82.2 (9.5)	82.7 (10.5)	0.329	79.9 (9.0)	82.1 (9.1)	84.7 (9.6)	<0.001
Physically inactive, No (%)[b]	4554 (23.5)	93 (26.3)	0.207	1162 (17.7)	1448 (22.0)	2037 (30.8)	<0.001
Current smokers, No (%)	2672 (13.8)	48 (13.6)	0.925	818 (12.5)	892 (13.5)	1010 (15.3)	<0.001
Heavy drinkers, No (%)[c]	2075 (10.7)	43 (12.2)	0.371	685 (10.5)	731 (11.1)	702 (10.6)	0.467
Baseline medical conditions, No (%)							
Abnormal ECG[d]	1710 (8.8)	104 (29.5)	<0.001	496 (7.6)	621 (9.4)	697 (10.5)	<0.001
Hypercholesterolemia[e]	5862 (30.2)	111 (31.4)	0.167	1502 (22.9)	2047 (31.1)	2424 (36.7)	<0.001
Diabetes mellitus[f]	1070 (5.5)	22 (6.2)	0.559	237 (3.6)	296 (4.5)	559 (8.5)	<0.001
Hypertension[g]	6222 (32.1)	159 (45.0)	<0.001	1473 (22.5)	2038 (30.9)	2870 (43.4)	<0.001
Parental history of CVD, No (%)	4393 (22.6)	87 (24.6)	0.373	1322 (20.2)	1523 (23.1)	1635 (24.7)	<0.001

Values are means (standard deviations) or numbers (percentage). %BF indicates percentage of body fat; CVD indicates cardiovascular disease.

[a] Analysis of the variance (ANOVA) for continuous variables and chi-square tests for categorical variables.

[b] Defined as reporting no physical activity during leisure time in the 3 months before the examination.

[c] Defined as >14 units/week.

[d] Abnormal resting or exercise electrocardiogram.

[e] Defined as total cholesterol 240 mg/dL or previous physician diagnosed hypercholesterolemia.

[f] Defined as fasting blood glucose 126 mg/dL, previous physician diagnosed diabetes or use of insulin.

[g] Defined as resting blood pressure 140/90 mmHg or previous physician diagnosed hypertension.

Table 2

Partial correlations examining the association between body adiposity measurements after controlling for age and examination year.

	BAI	BMI	Waist	%BF
BAI	-			
BMI	0.818	-		
Waist	0.680	0.889	-	
%BF	0.646	0.724	0.765	-

BAI indicates body adiposity index; BMI indicates body mass index; waist indicates waist circumference; %BF indicates percentage of total body fat

All correlations were statistically significant at P   0.001

Table 3

Standardized regression coefficients examining the association of body adiposity index (BAI), body mass index (BMI), waist circumference and percentage of body fat with cardiovascular disease risk factors.

Dependent variable	Body Adiposity Index (BAI)				Body Mass Index (BMI)			
	R^2	β	r	R^2 change	R^2	β	r	R^2 change
Total cholesterol	0.044	0.157	0.155	0.024	0.046	0.163	0.144	0.026
Fasting blood glucose	0.043	0.155	0.166	0.024	0.063	0.212	0.208	0.044
Systolic blood pressure	0.076	0.167	0.192	0.027	0.101	0.232	0.244	0.052
Diastolic blood pressure	0.069	0.207	0.226	0.042	0.105	0.284	0.299	0.078
Cardiorespiratory fitness[a]	0.342	−0.459	−0.498	0.206	0.382	−0.503	−0.523	0.246
	Waist Circumference				Percentage of body fat			
Total cholesterol	0.048	0.168	0.174	0.028	0.055	0.193	0.188	0.034
Fasting blood glucose	0.066	0.219	0.233	0.047	0.045	0.166	0.185	0.025
Systolic blood pressure	0.092	0.210	0.237	0.043	0.071	0.155	0.203	0.022
Diastolic blood pressure	0.102	0.277	0.292	0.175	0.080	0.239	0.264	0.053
Cardiorespiratory fitness[a]	0.419	−0.538	−0.579	0.283	0.460	−0.592	−0.579	0.324

All analyses adjusted for age and baseline examination year. β indicates multiple regression coefficients; r indicates partial correlations; R^2 and R^2 change indicate coefficients of determination

All the associations were significant at P   0.001

[a]Maximal metabolic equivalents, METs.

Table 4

Mortality rates and hazard ratios for all-cause mortality.

	Deaths (n)	Man-years	Mortality rate [a]	Hazard ratio (95% CI)		
				Model 1[b]	Model 2[c]	Model 3[d]
BAI						
Low	104 (6554)	57370	19.5	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Middle	125 (6590)	55521	20.4	1.05 (0.81 – 1.36)	0.99 (0.76 – 1.28)	0.89 (0.68 – 1.16)
Upper	124 (6612)	50953	25.0	1.28 (0.98 – 1.66)	1.12 (0.86 – 1.46)	0.88 (0.66 – 1.17)
Per 1 SD increase				1.15 (1.04 – 1.29)	1.09 (0.97 – 1.22)	0.97 (0.86 – 1.09)
BMI						
18.5 - 24.9 kg/m^2	139 (6458)	59921	19.1	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
25.0 - 29.9 kg/m^2	154 (9702)	78143	20.2	1.06 (0.84 – 1.34)	0.97 (0.76 – 1.22)	0.82 (0.65 – 1.05)
30.0 kg/m^2	60 (3596)	25780	31.2	1.63 (1.19 – 2.23)	1.28 (0.93 – 1.78)	0.90 (0.63 – 1.29)
Per 1 SD increase				1.28 (1.14 – 1.42)	1.17 (1.04 – 1.32)	1.02 (0.90 – 1.17)
Waist circumference						
< 102 cm	257 (15352)	129175	19.3	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
102 cm	96 (4404)	34669	29.9	1.55 (1.22 – 1.96)	1.31 (1.02 – 1.68)	1.05 (0.81 – 1.36)
Per 1 SD increase				1.20 (1.08 – 1.34)	1.10 (0.98 – 1.24)	0.94 (0.82 – 1.07)
%BF						
Low	103 (6439)	59042	18.8	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Middle	121 (6462)	52821	22.1	1.18 (0.91 – 1.53)	1.10 (0.85 – 1.44)	0.92 (0.70 – 1.21)
Upper	129 (6502)	49074	25.5	1.36 (1.04 – 1.76)	1.18 (0.90 – 1.55)	0.83 (0.62 – 1.12)
Per 1 SD increase				1.18 (1.05 – 1.31)	1.10 (0.98 – 1.23)	0.92 (0.81 – 1.06)

BAI indicates body adiposity index; BMI indicates body mass index; SD indicates standard deviation; %BF indicates percentage body fat.

[a] Per 10 000 man-years, adjusted for age and examination year.

[b] Adjusted for age and examination year.

[c] Adjusted for model 1 plus physical activity (active or inactive), smoking (current smoker or not), alcohol intake (> 14 units/week or not), abnormal electrocardiogram, hypercholesterolemia, hypertension and diabetes (present or not for each), and parental history of CVD.

[d] Adjusted for model 2 plus cardiorespiratory fitness (treadmill test duration in minutes).

Table 5

Mortality rates and hazard ratios for cardiovascular disease (CVD) mortality.

	Deaths (n)	Man-years	Mortality rate [a]	Hazard ratio (95% CI)		
				Model 1[b]	Model 2[c]	Model 3[d]
BAI						
Low	23 (6473)	56716	4.5	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Middle	40 (6505)	54812	6.5	1.44 (0.86 – 2.41)	1.32 (0.79 – 2.22)	1.17 (0.69 – 1.96)
Upper	38 (6526)	50262	7.9	1.73 (1.03 – 2.91)	1.40 (0.82 – 2.38)	1.02 (0.59 – 1.78)
Per 1 SD increase				1.20 (0.99 – 1.47)	1.08 (0.88 – 1.34)	0.92 (0.73 – 1.15)
BMI						
18.5 - 24.9 kg/m^2	34 (6353)	59045	4.5	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
25.0 - 29.9 kg/m^2	50 (9598)	77294	6.6	1.48 (0.95 – 2.30)	1.28 (0.81 – 2.00)	1.04 (0.65 – 1.64)
30.0 kg/m^2	17 (3553)	25452	9.2	2.06 (1.13 – 3.77)	1.42 (0.76 – 2.67)	0.89 (0.46 – 1.75)
Per 1 SD increase				1.49 (1.22 – 1.81)	1.29 (1.05 – 1.59)	1.08 (0.85 – 1.36)
Waist circumference						
< 102 cm	69 (15164)	127605	5.2	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
102 cm	32 (4340)	34185	10.1	1.94 (1.27 – 2.97)	1.50 (0.96 – 2.33)	1.10 (0.69 – 1.76)
Per 1 SD increase				1.42 (1.16 – 1.73)	1.25 (1.01 – 1.54)	1.02 (0.80 – 1.29)
%BF						
Low	26 (6439)	59051	4.9	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Middle	31 (6462)	52869	5.7	1.18 (0.70 – 1.99)	1.04 (0.61 – 1.76)	0.82 (0.48 – 1.41)
Upper	44 (6502)	49047	8.5	1.75 (1.07 – 2.85)	1.46 (0.88 – 2.42)	0.91 (0.52 – 1.60)
Per 1 SD increase				1.24 (1.002 – 1.52)	1.12 (0.90 – 1.39)	0.87 (0.68 – 1.12)

BAI indicates body adiposity index; BMI indicates body mass index; SD indicates standard deviation; %BF indicates percentage body fat.

[a] Per 10 000 man-years, adjusted for age and examination year.

[b] Adjusted for age and examination year.

[c] Adjusted for model 1 plus physical activity (active or inactive), smoking (current smoker or not), alcohol intake (> 14 units/week or not), abnormal electrocardiogram, hypercholesterolemia, hypertension and diabetes (present or not for each), and parental history of CVD.

[d] Adjusted for model 2 plus cardiorespiratory fitness (treadmill test duration in minutes).