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Body Mass Index and Body Fat Distribution and New-Onset Atrial Fibrillation. Sub study of The European Prospective Investigation Into Cancer and Nutrition in Norfolk (EPIC-Norfolk) Study

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Abstract

Background—Obesity is a recognized risk factor for new-onset atrial fibrillation (AF). The association between body fat distribution, measured by body mass index (BMI) and waist-hip ratio (WHR), its changes, and new-onset AF are conflicting.

Methods—Participants of the European Prospective Investigation into Cancer and Nutrition in Norfolk cohort study were included, with exclusion of prevalent AF, rheumatic heart disease and cancer. AF was confirmed by the *International Classification of Disease-10* hospital discharge code I48. Adjusted sex-specific Cox proportional hazards models quantified the AF risk per 1 standard deviation increase and for quintiles of adiposity indices.

Results—In total 10,885 men and 12,857 women were followed 19 years median, yielding 451,098 person years. New-onset AF was diagnosed in 1,408 (12.9%) men and 1,102 (8.6%) women. Multivariable analyses showed that BMI predicted new-onset AF in all, while WHR only in men. New-onset AF risk gradually increased across the range of adiposity indices, for men for BMI, HR: 1.59 (CI 1.32–1.91, *p* for trend < 0.001), for women, HR: 1.52 (CI 1.23–1.88, *p* for trend < 0.001). Further, for men for WHR, HR: 1.31 (CI 1.09–1.57, *p* for trend = 0.01), whereas

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women, HR: 1.12 (CI 0.90-1.41, *p* for trend 0.17). The change in BMI and WHR was similar in participants with or without new-onset AF.

Conclusions—An increased body mass, as measured by BMI, is associated with an increased risk of developing new-onset AF. A more abdominal fat distribution, as measured by WHR, is associated with an increased risk of developing new-onset AF in men, but not in women.

Keywords

abdominal fat; body mass index; visceral fat; waist-hip ratio; atrial arrhythmia

Introduction

Obesity has been associated with an increased risk of new-onset atrial fibrillation (AF)¹⁻⁵. As obesity enhances the risk of CVD, it indirectly contributes to the risk of AF^{1, 6}. However, obesity may also have a direct causal effect on atrial remodeling, fibrosis and inflammation, creating an essential arrhythmogenic substrate for AF. In sheep, progressive obesity was associated with changes in atrial size, expression of profibrotic mediators and importantly with new-onset AF^{7, 8}. On the other hand, weight reduction combined with intensive risk factor management reduced cardiac remodeling assessed by transthoracic echography and AF symptom burden^{9, 10}.

Obesity is usually quantified by calculation of the body mass index (BMI), as it provides an indexed weight measure. A more specific measurement for body fat distribution is the waist-hip ratio (WHR): the ratio between waist and hip circumferences. WHR can be used to discriminate an abdominal fat distribution from a peripheral, subcutaneous fat distribution. It is well established that an abdominal fat distribution is more strongly associated with CVD¹¹. However, data concerning WHR and the risk of new-onset AF is conflicting¹². Further, data on change in BMI or WHR over time in relation to AF is scarce.

We hypothesized that not only obesity, defined by BMI, but also a more abdominal fat distribution, described by WHR, increases the risk of developing new-onset AF. This risk may be different for men and women. Furthermore, we hypothesized that changes in BMI and WHR, as assessed during follow-up, will alter the risk of developing new-onset AF. We tested these hypotheses among participants of the European Prospective Investigation into Cancer and Nutrition (EPIC) in Norfolk prospective population study.

Methods

The European Prospective Investigation Into Cancer and Nutrition in Norfolk (EPIC-Norfolk) is a prospective population study of men and women aged 45 to 79. The detailed description of the study design and data collection was published previously¹³. In brief, the study was conducted in Norfolk, United Kingdom, and recruited patients from general practice registers between 1993-1997. The study was approved by the Norfolk Health District Ethical Committee, and participants signed an informed consent. Participants underwent a health check at time of inclusion and were invited back for a follow-up health check three years after inclusion.

Case Ascertainment

For the current analysis, all participants with a history of AF were excluded. Case ascertainment of prevalent AF was based on a (reported) prescription of vitamin K antagonists or digitalis, as previously described¹⁴. Incident AF was defined as *International Classification of Disease* (ICD)-10 hospital discharge code I48, including both AF and atrial flutter. Participants with prevalent cancer or rheumatic heart disease were excluded. Vital status was obtained for the whole cohort, and the participants were flagged for death certifications at the Office of National Statistics.

Anthropometric measurements

Trained research nurses obtained anthropometric measurements at the first and second health check. Participants were measured in light clothing without shoes using a standard protocol¹⁵. Height was measured to the nearest millimeter using a free-standing stadiometer. Weight was measured to the nearest 0.2 kg using digital scales (Salter, United Kingdom). Body mass index (BMI) was calculated as weight divided by the squared height (kg/m^2). A BMI of $<19 \text{ kg/m}^2$ indicates underweight, a BMI of $19\text{--}24.9 \text{ kg/m}^2$ a healthy weight, a BMI of $25\text{--}29.9 \text{ kg/m}^2$ overweight and a BMI of $\geq 30 \text{ kg/m}^2$ obesity.¹⁶ Body circumferences were measured with a D loop non-stretch fiberglass tape to the nearest millimeter at end of expiration. Waist circumference was defined as the minimum circumference at the natural waistline between the lower rib margin and the iliac crest. Hip circumference was defined as the maximum circumference between iliac crest and the crotch. Waist-hip ratio (WHR) was calculated as hip circumference/waist circumference. Abdominal obesity was defined in accordance with the World Health Organization definition as a WHR of 0.90 for men and 0.85 for women¹⁷.

Statistical analysis

Baseline characteristics of study participants with and without new-onset AF were compared. Unpaired sample T-test was used to compare normally distributed continuous variables, expressed as means $\pm$ standard deviations (SD). Mann-Whitney U test was used for not normally distributed continuous variables, expressed as median with interquartile range [IQR]. Categorical variables were expressed as frequencies with percentages and compared by the Pearson χ^2 test.

Event rates of new-onset AF per person year were calculated. The included cohort was divided into quintiles of BMI and WHR using the bottom fifth as reference group. The AF event rates were calculated per 1,000 person years using corresponding follow-up durations. Tukey honest significant difference test was used to compare event rates per quintile of the adiposity index. Kaplan-Meier estimates were used to compute cumulative incidence of AF and a log-rank test was used for between-group comparisons.

Sex-specific Cox proportional hazards models were used to quantify the risk of new-onset AF. Observations were censored at the date of first episode of AF, death or March, 31st 2015. The multivariable models were adjusted for clinically significant parameters: age, social class, previous myocardial infarction, prevalent diabetes mellitus, thyroid disease, systolic blood pressure and total cholesterol. Hazard ratios (HR) and 95% confidence

intervals (CI) were calculated for quintiles of adiposity indices. The p-value for trend was calculated. The models were assessed for interaction based on sex.

Changes in body composition were calculated by the delta of the anthropometric measurements obtained at the first and second health check. A measurement was categorized as stable, if the change between the first and second health check was less than 1 SD. In case of an increase of 1SD or more a participant was categorized as increased and vice versa for 1 SD decrease.

Next, the delta change in body composition was categorized in quartiles per anthropometric measurement: weight per 2.5 kg increase or decrease, therefore the forth category represented patients with a delta change of 7.5 kg or over; waist per 5 cm increase or decrease; BMI per 1 unit increase or decrease; WHR per 0.05 increase or decrease. The risk of new-onset AF was assessed using multivariable models, adjusted as described above with in addition covariates concerning incidence ischemic heart disease systolic and diastolic heart failure during follow-up. Observations were censored at the date of first episode of AF, death or March, 31st 2015, independent of change in anthropometric measurements.

Data analysis was performed by means of IBM SPSS Statistics for Windows, version 24 (IBM Corp., Armonk, New York, United States of America) and R version 3.3.2.. A two-sided p-value of <0.05 was considered to be significant. The current analysis was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.¹⁸

Results

From the EPIC Norfolk cohort, consisting of 25 639 participants, we excluded 1,897 participants because of prevalent AF, cancer or rheumatic heart disease, resulting in an inclusion of 23 742 participants (10 885 men and 12 857 women). During a median follow-up of 19 years (451 098 person years), 2,510 participants developed new-onset AF; 1,408 (12.9%) men and 1,102 (8.6%) women developed new-onset AF.

Participants with versus without new-onset AF were more often male (56.1% vs. 44.6%, $p<0.001$), and older (64.9 ± 7.8 vs. 58.2 ± 9.2 years, $p<0.001$). They also had a higher BMI (27.3 ± 4.1 vs. 26.2 ± 3.9 kg/m², $p<0.001$) and WHR (0.89 ± 0.09 vs. 0.85 ± 0.09 , $p<0.001$). Other cardiovascular factors were also more prevalent in participants with new-onset AF (Supplementary table 1).

New-onset AF

A sex-specific difference in body fat distribution was found in the new-onset AF group. BMI was 27.1 ± 3.4 kg/m² in men and 27.4 ± 4.7 kg/m² in women, $p<0.001$. WHR was 0.94 ± 0.06 in men and 0.81 ± 0.06 in women, $p<0.001$. This was driven by an absolute higher waist circumference in men compared to women (98.1 ± 10.0 cm vs 85.9 ± 11.4 cm, $p<0.001$) (Supplementary table 2). This resulted in a difference in the distribution of absolute number of cases with new-onset AF between men and women after stratification based on the cut-off values defined by the World Health Organization for obesity (Figure 1). The majority of men

and women with new-onset AF had a high BMI, whereas for WHR this was only the case in men.

When the cohort was subdivided based on the cut-off values of BMI and WHR, indicating overweight, the cumulated AF event rate was significantly higher in men and women with a BMI or WHR above the cut-off values (Supplemental figure 1). The incidence of new-onset AF increased across the range of body composition indices in men and women (Figure 2). Strikingly, the majority of the men had a WHR above the cut-off value for obesity, while only the highest quintile of the women had a WHR above the cut-off value. This difference was not seen for BMI. In men, the event rates of new-onset AF by increasing BMI quintiles were up to 9.5 per 1,000 person years. For WHR quintiles, the equivalent AF event rates were up to 9.8 per 1,000 person years. In women, the event rates of new-onset AF by increasing BMI quintiles were up to 6.8 per 1,000 person years. For WHR quintiles, the equivalent AF event rates were up to 6.8 per 1,000 person years. The cumulative hazard rose significantly among the sex specific quintiles of BMI and WHR, log rank $p < 0.001$ for all models (Figure 3).

The new-onset AF risk gradually increased across the quintiles of body composition indices in both men and women and remained after adjusting for covariates (Table 1A and B, Figure 4). Men in the highest BMI quintile had a 59% higher new-onset AF risk compared to the lowest, HR: 1.59 (95% CI 1.32-1.91, p for trend < 0.001). For women, the risk of new-onset AF was 52% higher for the highest BMI quintile in comparison to the lowest, HR: 1.52 (95% CI 1.23-1.88, p for trend < 0.001). Furthermore, men in the highest WHR quintile had a 31% higher new-onset AF risk compared to the lowest, HR: 1.31 (95% CI 1.09-1.57, p for trend: 0.01). However, no significant increase in new-onset AF risk was seen for the highest WHR quintile compared to the lowest, HR: 1.12 (95% CI 0.90-1.41, p for trend: 0.17). No interaction was found for sex (p : 0.93).

Addition of WHR to the model for BMI per quintile yielded a HR for men 1.54 (95% CI 1.26-1.89, p for trend < 0.001) in the highest quintile of BMI, comparable to the model without WHR. In women however, the addition of WHR increased the risk of new-onset AF to a HR of 1.55 (95% CI 1.25-1.93, p for trend < 0.001) for the highest quintile of BMI.

Changes in body composition and new-onset AF

Fourteen-thousand and ten participants had a second health check and met the inclusion criteria. Participants who completed the second health check differed statistically significantly, but not clinically relevant, from the 9,732 participants who only attended the first health check on all baseline characteristics. (Supplementary table 3). Of the participants with a change in body composition the majority increased to a more unfavorable body composition. The percentages of men and women with a changed BMI or WHR did not differ when adjusted for onset of AF (Supplementary table 4 and 5).

In men, an increased BMI was not associated with an increased new-onset AF risk, HR highest quartile (> 3 BMI units increase): 1.41 (95% CI 0.93 – 2.13, p for trend: 0.20), but it was associated with a significantly increased AF risk in women, HR highest quartile (> 3 BMI units increase): 1.58 (95% CI 1.09 – 2.28, p for trend: 0.01). Further, an increased

WHR was not associated with an increased risk of new-onset both in men, HR highest quartile (>0.05 WHR unit increase): 3.99 (95% CI 0.98 - 16.14, *p for trend*: 0.27) and in women, HR highest quartile (>0.05 WHR unit increase): 1.90 (95% CI 0.60 - 5.98, *p for trend*: 0.38).

Also, a decreased BMI was not associated with a decreased new-onset AF risk in men, HR highest quartile (>3 BMI units decrease): 3.58 (95% CI 0.89 - 14.46, *p for trend*: 0.59) and in women, HR highest quartile (>3 BMI units decrease): 0.66 (95% CI 0.38 - 1.13, *p for trend*: 0.85). A decreased WHR was not associated with a decreased new-onset AF risk, in men, HR highest quartile (>0.05 WHR unit decrease): 0.96 (95% CI 0.24 - 3.88, *p for trend*: 0.55) and in women, HR highest quartile (>0.05 WHR unit decrease): 1.69 (95% CI 0.42 - 6.83, *p for trend*: 0.85).

Discussion

In this very large, prospective population study of middle-aged men and women, we found that body composition increases the risk developing of new-onset AF. That is: BMI increases the risk of AF in men and women. Increased WHR significantly increases the risk of new-onset AF in men, but not in women. These findings were supported by absence of interaction of sex for the indexed measurements WHR and BMI. This discrepancy is explained by the absolute mean waist circumference, which is notably larger in men than in women, yielding a higher WHR in men. Importantly, BMI was similar in both men and women. Further, the absolute number of men above the cut-off value of WHR for obesity was considerably higher than of women. Body fat in men was thus mainly distributed abdominally. This may reflect that a greater abdominal fat distribution, mainly consisting of visceral fat, is more unfavorable for the risk of AF compared to a more peripheral fat distribution, thus more subcutaneous fat. Further, in women an increased risk of developing new-onset AF was found when WHR was added to the multivariable model for BMI. This can be interpreted as an increased risk of developing new-onset AF in women with a high BMI is dependent of the body fat distribution. Thus women with a high BMI and WHR, so probably more abdominal fat, have an increased AF risk compared to women with a high BMI and lower WHR, probably meaning more subcutaneous fat. In men, addition of WHR to the model for BMI yielded a comparable risk of developing new-onset AF. Lastly, our data show that a healthy body weight is associated with a lower incidence of new-onset AF.

These outcomes are partly in line with previous prospective cohort studies¹². One unit BMI increment has been described to independently increase the risk of new-onset AF of 3-8%^{4, 19, 20}. However, WHR was found to significantly increase the risk of new-onset of AF, mainly driven by the cohort of Frost et al.²¹. The current analysis of the EPIC cohort contradicts this, as it shows an increased risk in men, but rejects WHR as risk stratification in women. In comparison, the participants from both cohorts were comparable based on body composition measurements. However, the EPIC cohort was followed six years longer and relatively more participants experienced new-onset AF. The latter was not consequently based on the longer follow-up duration, as events occurred evenly during follow-up.

Our results show an association in women between an increased BMI and an increased risk of new-onset AF, but this was not seen in men. Nor was a decrease in BMI associated with a decreased risk in both sexes. Even though anthropometric measurement changes were relatively small in most patients and the time window between last measurement and censor date relatively long. Anthropometric measurements may change more drastically over a longer duration, which would have gone undetected with a baseline and 3-year follow-up measurement. Subsequently, this should be considered when interpreting our findings. Of note, the LEGACY study, including patients with AF and a BMI ≥ 27 kg/m², found that 45.5% of patients, who lost $\geq 10\%$ body weight, remained free of arrhythmia without antiarrhythmic drugs or ablation during follow-up, compared to 13.4% in patients, who lost $<3\%$ or gained weight²². Moreover, the ARREST-AF cohort study found that long-term freedom of AF after ablation was improved by weight management²³. This underlines the role of regulating and sustaining a normal body weight on AF vulnerability.

Obesity induces atrial remodeling, an eminent process in AF pathophysiology.⁷ Atrial remodeling can be caused by metabolic dysfunction, a low-grade inflammatory status and atrial pressure overload, ascribed to a range of local and systemic metabolically active secretions of visceral fat.^{6, 24, 25} Importantly, atrial remodeling is also caused by comorbidities, such as hypertension and metabolic dysfunction²⁴. The current analyses corrected for these comorbidities.

Limitations

Firstly, case certainty was based on medication prescription specific for AF treatment, which has been validated before to be a good assessment of AF prevalence¹⁴. Importantly we included patients using anticoagulants or digitalis reducing the chance to wrongly include or exclude patients. However of note, with this method we may have included patients needing anticoagulants for other reasons, on the other hand excluded patients with AF without a prescription. Further, this may have led to exclusion of patients suffering from asymptomatic AF. ICD-10 hospital discharge codes were used to confirm AF incidence, which is an accepted method, but limited by accurate registration of diagnosis and comorbidities. This may have underestimated the event rate of new-onset AF, concurrently that of important comorbidities. However, our results show a similar incidence as described in literature¹.

Secondly, as a whole the entire EPIC Norfolk population was slightly overweight. As the obesity epidemic has only increased in the last decades, it can be expected that a consecutive generation may be more intensively exposed to risk factors to develop obesity and consequently its negative comorbidities²⁶.

Thirdly, the current analysis is only able to confirm an association between body fat distribution and AF. Adjustments for many covariates known to elevate the risk for new-onset AF were made to assess the influence of body fat distribution. However, it cannot be ruled out that the increased risk of new-onset AF is indirectly based on the influence of mechanistic influence of obesity itself or on the concomitant risk profile, including CVD. Of note, animal studies have suggested a direct casual relation between obesity and new-onset AF^{7, 25}. Therefore, future studies should assess the causal role of visceral fat in AF pathophysiology in humans.

Conclusion

An increased body mass, described by BMI, is, in a dose dependent manner, associated with an increased risk of developing new-onset AF. A more abdominal fat distribution, described by WHR, is associated with an increased risk of developing new-onset AF in men, but not in women. Our results point at more abdominal, likely mainly visceral, fat being associated with the risk of new-onset AF. Thus, future studies should assess the independent and causal role of visceral fat in AF pathophysiology and targets to alter the risk of new-onset AF.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Absolute number of men and women with new-onset atrial fibrillation by the sex-specific WHO cut-off values for overweight. Cut-off values: BMI >25 kg/m² and WHR > 0.90 (men) or 0.85 (women) indicating obesity.

Figure 2.

Sex-specific event rates of new-onset atrial fibrillation per 1,000 person years by quintiles (Q) of adiposity indices and the sex-specific WHO cut-off values for overweight. Statistical significance was tested between quintiles around the WHO cut-off values for BMI and WHR indicating overweight.

Figure 3.

Sex-specific cumulative hazard ratios of new-onset atrial fibrillation by quintiles (Q) of adiposity indices.

Figure 4.

Sex-specific hazard ratios of new-onset atrial fibrillation among 9,454 men (1,406 cases) and 12,834 women (1,100 cases) by quintiles of adiposity indices, adjusted for age, diabetes mellitus, systolic blood pressure, thyroid disease and total cholesterol. CI: confidence interval.

Table 1A

Unadjusted and adjusted hazard ratio for new-onset atrial fibrillation among 9,454 men (1,406 cases) per quintile of body composition. Models were adjusted for age, diabetes mellitus, systolic blood pressure thyroid disease and total cholesterol. Person-years calculated with corresponding follow-up duration. HR: hazard ratio, CI: confidence interval. Event rate was calculated as the rate of incident AF per 1000 person-years.

	MEN					
	Weight (kg)					
	Q1	Q2	Q3	Q4	Q5	p-trend
	42.8-71.1	71.1-76.8	76.8-82.2	82.2-89.2	89.2-154	
Number	2,174	2,141	2,190	2,191	2,176	
AF events	220	257	254	317	358	
Event rate	5.6	6.4	7.2	7.9	9.1	
Person years	39 610	38 731	39 617	39 153	38 450	
Model 1, unadjusted	1.00	1.20	1.16	1.47	1.69	<0.001
	(ref)	(1.00-1.44)	(0.97-1.39)	(1.24-1.75)	(1.43-2.00)	
Model 2, adjusted	1.00	1.24	1.25	1.58	1.90	<0.001
	(ref)	(1.03-1.49)	(1.03-1.50)	(1.32-1.89)	(1.59-2.25)	
BMI (kg/m ²)						
	Q1	Q2	Q3	Q4	Q5	p-trend
	16.1-23.9	23.9-25.5	25.5-27.0	27.0-29.0	29.0-47.7	
Number	2,171	2,173	2,172	2,172	2,172	
AF events	207	238	289	313	359	
Event rate	5.2	6.0	7.4	8.1	9.4	
Person years	39 621	39 483	38 987	38 835	38 379	
Model 1, unadjusted	1.00	1.16	1.43	1.55	1.81	<0.001
	(ref)	(0.96-1.39)	(1.19-1.71)	(1.30-1.85)	(1.52-2.15)	
Model 2, adjusted	1.00	1.10	1.31	1.41	1.58	<0.001
	(ref)	(0.91-1.34)	(1.09-1.58)	(1.17-1.69)	(1.32-1.89)	
Waist (cm)						
	Q1	Q2	Q3	Q4	Q5	p-trend
	61.0-88.0	88.0-93.0	93.0-97.5	97.5-103.0	103.0-180.0	

MEN										
Number	2,149	2,111	2,231	2,222	2,154					
AF events	195	229	259	328	393					
Event rate	5.2	6.2	7.0	8.0	9.5					
Person years	39 413	38 336	40 403	39 752	37 566					
Model 1, unadjusted	1.00 (ref)	1.21	1.30	1.69	2.15					<0.001
	(ref)	(1.00-1.47)	(1.08-1.56)	(1.41-2.01)	(1.81-2.56)					
Model 2, adjusted	1.00 (ref)	1.13	1.09	1.33	1.56					<0.001
	(ref)	(0.92-1.37)	(0.90-1.32)	(1.10-1.60)	(1.30-1.87)					
WHR										
	Q1	Q2	Q3	Q4	Q5					p-trend
	0.58-0.88	0.88-0.92	0.92-0.94	0.94-0.98	0.98-1.74					
Number	2,171	2,172	2,172	2,172	2,171					
AF events	204	261	274	290	374					
Event rate	5.1	6.6	7.0	7.5	9.8					
Person years	39 664	39 400	39 118	38 944	38 188					
Model 1, unadjusted	1.00	1.29	1.37	1.46	1.93					<0.001
	(ref)	(1.08-1.55)	(1.14-1.64)	(1.22-1.74)	(1.63-2.29)					
Model 2, adjusted	1.00	1.15	1.12	1.15	1.30					<0.001
	(ref)	(0.95-1.39)	(0.93-1.35)	(0.95-1.38)	(1.08-1.55)					

Table 1B

Unadjusted and adjusted hazard ratio for new-onset atrial fibrillation 12 834 women (1,100 cases) per quintile of body composition. Models were adjusted for age, diabetes mellitus, systolic blood pressure thyroid disease and total cholesterol. Person-years calculated with corresponding follow-up duration. HR: hazard ratio, CI: confidence interval. Event rate was calculated as the rate of incident AF per 1000 person-years.

WOMEN						
Weight (kg)						
	Q1	Q2	Q3	Q4	Q5	p-trend
	36.0-58.4	58.4-63.6	63.6-68.8	68.8-76.4	76.4-139.2	
Number	2,536	2,646	2,531	2,587	2,54	
AF events	164	185	201	254	295	
Event rate	3.4	3.8	4.5	5.4	6.4	
Person years	46,865	48,845	46,545	47,316	46,152	
Model 1, unadjusted	1.00	1.08	1.24	1.54	1.84	<0.001
(ref)		(0.88-1.34)	(1.01-1.52)	(1.27-1.88)	(1.52-2.23)	
Model 2, adjusted	1.00	1.10	1.24	1.45	1.90	<0.001
(ref)		(0.88-1.37)	(1.00-1.54)	(1.18-1.78)	(1.55-2.33)	
BMI (kg/m ²)						
	Q1	Q2	Q3	Q4	Q5	p-trend
	15.2-22.7	22.7-24.6	24.6-26.5	26.5-29.3	29.3-52.7	
Number	2,566	2,567	2,566	2,566	2,567	
AF events	148	159	220	262	310	
Event rate	3.1	3.4	4.7	5.6	6.7	
Person years	47,445	47,490	47,163	46,906	46,591	
Model 1, unadjusted	1.00	1.07	1.49	1.80	2.14	<0.001
(ref)		(0.86-1.34)	(1.21-1.84)	(1.47-2.20)	(1.76-2.61)	
Model 2, adjusted	1.00	0.93	1.17	1.23	1.54	<0.001
(ref)		(0.73-1.17)	(0.94-1.45)	(0.99-1.52)	(1.25-1.89)	
Waist (cm)						

WOMEN

	Q1 56.0-73.0	Q2 73.0-78.0	Q3 78.0-83.2	Q4 83.2-90.4	Q5 90.4-141.3	p-trend
Number	2,551	2,706	2,458	2,560	2,571	
AF events	109	170	224	260	338	
Event rate	2.6	3.7	4.7	5.8	6.8	
Person years	47,423	50,061	45,153	46,746	46,432	
Model 1, unadjusted	1.00	1.48	2.17	2.44	3.21	<0.001
	(ref)	(1.17-1.88)	(1.72-2.72)	(1.95-3.05)	(2.59-3.98)	
Model 2, adjusted	1.00	1.17	1.48	1.41	1.76	<0.001
	(ref)	(0.91-1.51)	(1.16-1.88)	(1.11-1.79)	(1.39-2.22)	

WHR

	Q1 0.60-0.74	Q2 0.74-0.77	Q3 0.77-0.80	Q4 0.80-0.84	Q5 0.84-1.87	p-trend
Number	2,566	2,571	2,563	2,567	2,567	
Person years	47,548	47,486	47,236	46,771	46,565	
AF events	130	175	207	271	317	
Event rate	2.7	3.7	4.4	5.8	6.8	
Model 1, unadjusted	1.00	1.35	1.61	2.13	2.51	<0.001
	(ref)	(1.07-1.70)	(1.29-2.00)	(1.73-2.63)	(2.04-3.07)	
Model 2, adjusted	1.00	1.03	0.99	1.13	1.14	0.13
	(ref)	(0.81-1.30)	(0.80-1.26)	(0.91-1.42)	(0.91-1.42)	