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Running headline: Changes in adiposity in older Chinese

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What is already known on this subject?

That obesity is an increasing problem in China or anywhere is hardly novel, but longitudinal studies tracking changes in individuals are scarce.

What this study adds?

1. In this large longitudinal study, waist circumference increased in 77% of women and 69% of men. Among these participants, the mean annual increase was 2.01 cm and 1.70 cm respectively. These very sharp rises were 2-3 times that reported by previous studies in China and elsewhere.
2. About one in five participants with obesity at baseline became non-obese, suggesting the evolution of the obesity epidemic is not one-sided and the trends of increase and reduction need to be monitored and analyzed separately.

Abstract

Objective

To examine the changes in body mass index (BMI) and waist circumference (WC) in Guangzhou, South China, which is probably experiencing the most rapid economic transition in history.

Methods

17,786 Chinese aged 50+ years were recruited from 2003-2008 and followed-up until 2012. BMI and WC were measured at two time points.

Results

During the mean follow-up of 3.6 years (median=3, interquartile=1), age-adjusted mean BMI increased only slightly. By contrast annually mean WC increased sharply by 0.94cm (95% confidence interval 0.93-0.94) in men and 1.29cm (1.28-1.29) in women. In 77% of women and 69% of men WC increased and among them, the mean annual increase was 2.01cm and 1.70cm respectively. Among healthy never smoking participants, the incidence of central obesity was 29.0% (36.4% in women and 14.2% in men). The incidence of general obesity was 1.9% and was similarly low in both men and women (2.1% versus 1.8%). Conversely 20.3% of generally obese individuals became non-obese and 12.8% centrally obese individuals returned to normal.

Conclusion

Central obesity has risen sharply in this cohort. Such increases may have been greatly underestimated previously and should form the basis of an even stronger warning for regions undergoing economic transitions in China and elsewhere.

(200 words)

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Keywords: general obesity, central obesity, adiposity, adults, China

Introduction

During the recent decades, China has consistently been the most rapidly growing economy in the world.(1) The accompanying lifestyle changes have transformed the disease profile of the country, including increasing obesity. Observed changes in obesity have mainly come from serial population-based surveys,(2, 3, 4, 5) but interpretation of these studies is problematic because different individuals are studied and dynamic changes in individuals cannot be captured. In other words, mean population values at different time points could hide important changes in individuals. We identified two longitudinal studies with small number of older participants in China showing small annual increases in waist circumference during the period 1992-2008.(6, 7)

In this study, we report more recent changes in body mass index (BMI) and waist circumference (WC) in a large cohort in Guangzhou, the capital city of Guangdong. Within China, Guangdong has led the unprecedented economic growth.(8) As such our results could be informative for the rest of China and other rapidly developing economies.

Methods

Setting and participants

Guangzhou Biobank Cohort Study (GBCS) is a three-way collaboration among the Guangzhou No. 12 Hospital and the Universities of Birmingham and Hong Kong. Details of the setting and subject recruitment have been described elsewhere.(9) Briefly, recruitment of participants was from "The Guangzhou Health and Happiness Association for the Respectable Elders" (GHHARE), a community social and welfare organization. GHHARE is unofficially aligned with the municipal government. Membership is open to Guangzhou permanent residents aged 50 years or above for a nominal fee of 4 CNY (≈50 US cents) per month. The GHHARE has a city-wide network with more than 150 branches throughout Guangzhou. It has more than 100,000 older Guangzhou permanent residents. All participants of the GBCS were randomly selected from the membership list of the GHHARE. They were permanent Guangzhou residents, ambulatory and not receiving treatment for dialysis for renal failure, or radiotherapy/chemotherapy for cancer.(9) Most of the selected GHHARE members were keen to join the GBCS study because they received a free health examination. Thus the response rate was more than 95%. Within sex and age group, the participants had fairly similar levels of chronic diseases such as diabetes and hypertension to nationally representative samples of urban Chinese.(9) From September 2003 to January 2008, 30,430 Guangzhou permanent residents aged 50 years or above were recruited in three phases (phase 1 2003-4, phase 2 2005-6, and phase 3 2006-8) and attended a half-day detailed assessment session which included a structured interview and a physical examination. All assessments in these three phases were the same unless otherwise stated. All GBCS participants were invited to return from March 2008 to December 2012 for a follow-up examination. The methods and some results based on the follow-up data have been published elsewhere.(10, 11) The GBCS received approval from the Medical Ethics Committee of the Guangzhou Medical Association, and all participants gave written informed consent.

Adiposity measures

Several anthropometric measurements were taken both at baseline and at follow-up using the same methods. Weight, standing height, and WC were measured in the morning before breakfast, with light indoor clothing and no shoes, by trained technicians according to standard protocols. Weight was measured to the nearest 0.1 kg on a platform scale at the first two phases of baseline (2003-2006) recruitment (RGZ-120-RT, WuXi Weighing Apparatus factory)(9) and a self-zeroing electronic scale (BF-350, Tanita Corporation, Tokyo, Japan) thereafter. The intraclass correlation coefficient (ICC) for reliability test of these two instruments was 0.998, suggesting high reliability. Height was measured to the nearest 0.1 cm with a wall-mounted metal tape. WC was measured with a non-stretch tape, to the nearest 0.1 cm, horizontally around the narrowest part of the torso, between the lowest rib and the iliac crest.

BMI was calculated as weight divided by height squared (kg/m^2). Given the differences in the body build between Caucasians and Asians, we applied Chinese-specific cut-offs as per the World Health

Organization, with underweight defined as BMI 18.5 kg/m^2 or below, normal weight as BMI 18.6-24.9 kg/m^2, overweight as BMI 25.0- <27.5 kg/m^2 and obesity as BMI ≥27.5 kg/m^2.(12) We defined central obesity as waist circumference ≥90 cm in men and ≥80 cm in women.(13)

Other measurements

From the baseline questionnaire we derived information on the highest educational level (primary or below, middle school, college or above), occupation (manual including agricultural, factory and sales, non-manual including administration, professional or military, and others including housewife, unemployed or others), personal income (<10,000, 10,000-14,999, ≥15,000 CNY/year; US$1=7CNY), marital status, employment status, alcohol use and smoking status (never, former, current), level of physical activity (inactive, minimally active, and active) based on the short version of the International Physical Activity Questionnaire (IPAQ) validated in a Chinese population(14) and health status (good, poor). Poor health status was defined as any of the following: 1) regular use of medication for chronic diseases, such as diabetes, hypercholesterolemia or vascular diseases, or 2) any hospital admission during the follow-up period, or 3) self-reported cardiovascular disease history, or 4) self-reported cancer history. As information on medication for hypercholesterolemia or vascular diseases was not asked during the follow up interview, poor health status was defined by using the available data as above. Relatively healthy participants were defined as never smokers without poor health status at both baseline and follow up.

Statistical analysis

We included those who attended both baseline and follow-up sessions and had information on BMI and WC in both visits. The distribution of socio-demographic, lifestyle, and adiposity at baseline between the included participants (n = 17,786) and non-respondents at follow-up (n = 12,325) was compared by Cohen's effect size (w), where w <0.3 indicates a small difference.(15) Changes were presented by sample mean BMI and WC, and by proportions in BMI categories and central obesity. We also assessed the individual annual changes in BMI and WC separately in never smoking participants with good health status at both baseline and follow-up, because underlying illness and smoking(16) might lead to weight loss and might mask the different patterns of changes in BMI/WC. Most of the underweight people were likely to be unhealthy even though they might not have symptoms, and a very low BMI is a predictor of mortality.(17) Hence, we also excluded them in further analysis. Age and sex-adjusted annual changes was assessed using generalized linear models. Incidence of newly developed obesity in individuals without obesity at baseline, and incidence of return to non-obesity in individuals with obesity at baseline during the follow-up period were obtained by logistic regression. Sensitivity analysis assessing adiposity changes in participants who performed both baseline and follow-up examinations in the same season was conducted.(18) Results were reported as percentage and 95% confidence interval (CI). All analyses were conducted in Stata 13 (Stata, College Station, TX, USA).

Results

As of 31 December 2012, vital status was determined for 30,028 (98.7%) with 1,812 deaths identified, of which 1,453 occurred before the follow-up examination started, giving 28,575 available for follow-up of whom 18,106 (63.4%, 13,179 women and 4,927 men) returned and had follow-up examination. Of the 18,106 respondents, 17,786 (98.2%) who had available BMI and WC data were included. They were followed-up for a mean duration of 3.6 years (median=3, interquartile =1). At baseline these 4,821 men and 12,965 women had a mean age of 63.6 (SD 6.5) and 60.3 years (SD 6.7), respectively. Table 1 shows the demographic characteristics of the study sample.

Table 2 shows that the prevalence of underweight was low (about 4-5% in men and in women). After adjusting for age and sex, mean BMI increased only slightly from 23.7 to 23.8 kg/m^2, with a mean annual change of 0.028 kg/m^2 per year. Adjusted for age, the increase was greater in women than men. In terms of relative change, during the follow-up, BMI increased by 0.30% (0.38% for men and 0.29% for women) while WC increased by 4.53% (3.68% for men and 5.28% for women) in all participants.

Further exclusion of healthy participants who were underweight at baseline did not change the results substantially.

The age-adjusted WC changed from 81.6 cm to 84.6 cm in men and from 77.7 cm to 81.8 cm in women during the follow-up period, which corresponds to an age and sex-adjusted annual change in WC of 1.29 cm/year in men and 0.94 cm/year in women (Table 2). Furthermore, WC increased in 77% of women and 69% of men. Among them, the mean annual increase was 2.01 cm (95% CI 2.012-2.015) and 1.70 cm (95% CI 1.702-1.705) respectively (Not shown in Table 2). Additional sensitivity analyzing of the WC change in participants measured in the same season, for example, warm (May-October) or cold (November-April) at baseline and follow-up showed very similar results (women 2.02 cm (95% CI 2.02-2.02) and men 1.68 cm (95% 1.68-1.69)). Overall, the prevalence of central obesity increased from 18.7% to 29.4% (~11 percentage points; relative increase 57%) in men and from 38.7% to 58.2% (~20 percentage points; relative increase 50%) in women (all p values for the differences between baseline and follow up proportions were <0.001). The female to male prevalence ratios were about 2 at both time points (Table 2).

Table 3 shows that, in the overall sample including participants who had poor health status and ever-smoking habit, the incidence of obesity defined by BMI was 1.9% and by WC was 25.0%. The incidence of obesity by both BMI and WC was 25.3% (Table 3). As poor health and smoking can influence weight we assessed changes in never smokers with good health, to obtain an unbiased observation of individual weight/WC changes (n = 6,040 participants). Among them, the incidence of obesity defined by BMI was 1.8% (1.4%-2.3%) for women and 2.1% (1.3%-3.2%) for men. After adjusting for age and sex, the incidence of obesity defined by BMI was 1.9% (95% CI 1.5%-2.3%), while adjusted incidence by WC was 29.0% (27.6%-30.4%). The incidence in women (36.4% (34.9%-38.0%) was more than double that in men (14.2% (12.1%-16.6%)). Using both BMI and WC together for defining obesity did not increase the incidence of obesity substantially compared to WC only-defined obesity (29.3% (27.9%-30.7%)). The results were similar after further excluding those who were underweight at baseline (Supplementary Table 1).

Table 4 shows that among never smoking healthy participants with obesity defined by BMI or WC at baseline, 20.3% (21.0% men and 17.3% women) became non-obese, and 12.8% (17.0% men and 9.3% women) returned to normal WC. The incidence of return to non-obesity defined by BMI and WC tended to increase with older age. After including those with poor health and ever-smoking habit, the incidence of return to non-obesity in individuals with obesity at baseline defined by BMI slightly increased (22.5%), while the return defined by WC was almost the same (12.2%, Table 4). The results were similar after further excluding those who were underweight at baseline (Supplementary Table 2). Overall, 45.6% had stable and persistent normal WC, 22.7% developed central obesity, 3.1% returned to normal WC and 28.6% had persistent central obesity (Supplementary table 3).

Supplementary Table 4 shows that, compared with non-respondents, GBCS participants who returned for follow-up were younger, had higher educational attainment or were married compared with those excluded, although the differences, as suggested by the Cohen's w, were small (0.280, 0.197 and 0.137, respectively). There were no material differences in other lifestyle variables and co-morbidity. The prevalence of general and central obesity at baseline in the respondents were very similar to those in the non-respondents, being about 2 percentage points lower in the latter (Supplementary Table 4).

Discussion

In this large cohort of older Chinese individuals, we found a striking increase in mean WC during the follow-up, while mean BMI increased only slightly. Approximately three quarters of the participants gained in WC, and among them the mean annual increase was about 2 cm. Conversely, about one in five participants with obesity at baseline became non-obese (17.3% women and 21.0% men).

The annual change of WC was substantially higher in this study than those from previous repeated cross-sectional studies(5, 19) or longitudinal studies(6, 7) in China. It was unlikely due to the cut-off points used because most of the studies used the same definitions for central and general obesity for Chinese people.(4, 5, 6, 20) Results from the China Health and Nutrition Survey showed an annual WC change of 0.4 cm in women and 0.3 cm in men from 2004 to 2009 in people aged 60+ years.(2, 19) Similar results were observed in another repeated cross-sectional study from 2002 to 2010 in Guangdong, in which annual WC change was 0.4 cm in women and 0.5 cm in men in similar age groups as our sample.(5) A small longitudinal study of 654 participants in Beijing aged 55-64years found that WC increased by 0.56 cm in women and 0.33 cm in men annually from 1992 to 2002.(7) Another longitudinal study in 10 provinces included approximately 2,500 participants aged 55-74 years. It reported that the annual incidence of central obesity was 2-4% from 1998 to 2008.(6) The changes in WC we found was more than double that of the previous studies in China, although it could reflect the difference in the time period under study. Moreover, in about 75% of our sample, WC had increased during the follow up period. Among these participants, the annual changes in WC was almost 3-fold that of the previous studies.(2, 5, 19) These results suggest that previous studies in China have hugely underestimated the increase in adiposity.

There is evidence from other countries that increases in BMI have plateaued while WC is still increasing.(21, 22) Moreover, age-related remodeling commonly leads to weight loss with concomitant gains in WC,(23, 24) and menopausal changes can increase central adiposity.(25) The striking change we observed could also be due to the “mismatch” between a poor childhood environment and a relatively affluent adulthood conditions.(26) As our participants are the first generation to experience this marked socio-economic development, they might be especially prone to central adiposity when exposed to this obesogenic environment.(27) Earlier studies of our cohort and others have shown that poor childhood environment was associated with adiposity more specifically in women (27, 28). The association was more pronounced for central rather than general obesity,(26, 27) operating probably via epigenetic mechanisms.(28) Given the strong association between obesity and the risk of many non-communicable diseases (NCDs),(29) such increases could explain at least partly the sharp rise in incidence of conditions such as diabetes in China (30)and could continue to fuel the relentless escalation of NCD incidence.

In our study, incidence of obesity defined by WC and defined by BMI or WC was similar, which was consistent with results from a recent study by Tanamas *et al*(31), probably because those who were obese by BMI tended to also have high WC but not vice versa. Thus analyzing obesity defined by WC would capture the majority of those with general obesity. We also found that 20% of the generally obese and 13% of the centrally obese at baseline became non-obese. We have excluded those with poor self-rated health at baseline or follow-up and those who smoked at baseline. One reason for the return to non-obesity in baseline obese individuals observed in our study was positive intentional lifestyle changes, which would be encouraging given most of the previous studies in China(4, 5, 19, 32) and elsewhere(33, 34, 35, 36, 37) consistently focused on the increasing prevalence of obesity. Other possible explanations include sarcopenia and unreported ill health.(24) Our results suggested that adiposity change is not unidirectional. Hence, the trends of increase and reduction need to be monitored and analyzed separately.

The strengths of the present study included a large sample size and the longitudinal nature of the analysis. The latter allowed us to assess the individual dynamic changes in BMI and WC. This contrasts with data from serial cross-sectional studies, in which the upward and downward changes could nullify each other. We were able to take into account important factors such as baseline and follow-up health and smoking status. This would not be possible in serial cross-sectional surveys. The study has a few limitations. First, our sample may not be fully representative of the entire older population in Southern China. However, mean BMI and WC in our population were remarkably similar to a recent population-based survey in Guangdong China in 2002-2010.(5) In this province wide study, among people aged 50+ years, the prevalence of general obesity was 9.3%-13.8%, while the prevalence of general obesity in our study was 11.8%.(5) Similarly, among similar age groups, the

Guangdong study showed a prevalence of central obesity of 13.2%-20.1% in men and 35.1%-47.5% in women,(5) while in our study the prevalence was 18.7% in men and 38.7% in women. Moreover, within our sample, the participants had fairly similar levels of chronic diseases such as diabetes and hypertension to nationally representative samples of urban Chinese,(9) suggesting the differences, if any, are unlikely to be substantial. Second, approximately 40% of our participants did not return for the follow-up visit, although vital status was determined in over 99%. As respondents tended to be healthier and were survivors, non-responder bias was possible although is common to all large population-based cohorts. Since the baseline characteristics including BMI status and central obesity between respondents and non-respondents were quite similar (Supplementary Table 4), the impact of the missing data was likely to have been small. Third, body weight at baseline was measured using different instruments. However, this would not be a major concern as a high ICC (0.998) was found for these two instruments. Fourth, the definition of poor health was based on the presence, rather than severity/frequency, of the underlying illness. Finally, our study was short and limited to measurement at two time points.

In conclusion, in this large longitudinal cohort study in a rapidly developing region of China, central obesity has risen very sharply. Such increases may have been greatly underestimated previously and should form the basis of an even stronger warning for regions undergoing economic transitions in China and elsewhere.

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conflicts of interest. The sponsors had no involvement in the study design, in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication. The authors have no competing interests.

Contribution statement

LX, THL, CQJ, WSZ, TZ, YLJ, KBL, CMS, PA, GNT and KKC have substantial contributions to conception and design, acquisition of funding, data and interpretation of data; LX and THL analyzed the data, LX, THL and KKC drafted the article, THL, GNT and KKC revised it critically for important intellectual content, and all authors contributed to final approval of the paper.

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Table 1 Baseline characteristics of 4,821 men and 12,965 women recruited from 2003-2008 and followed up until end 2012

Baseline characteristics	Women	Men
Number	12,965	4,821
Age, years, %		
50-59	54.6	31.7
60-69	35.3	49.9
70+	10.1	18.4
Education, %		
Primary	43.5	27.2
Middle school	50.4	55.7
College or above	6.2	17.1
Occupation, %		
Manual	64.9	47.5
Non-manual	19.5	38.2
Others	15.6	14.3
Personal income, CNY/year, %		
<10,000	35.8	21.5
10,000-14,999	46.4	39.1
≥15,000	13.4	33.9
Don't know	4.4	5.6
Marital status, %		
Married	79.7	94.6
Separated / divorced	1.5	0.7
Widowed	18.1	4.4
Never married	0.6	0.2
Employment status, %		
Retired	97.3	89.4
Current employed	2.7	10.6
Physical activity, %		
Inactive	8.1	8.6
Minimally active	38.5	42.7
Active	53.4	48.7
Smoking history, %		
Never	97.3	41.9
Former	1.3	27.5
Current	1.4	30.7
Poor health status at baseline, %		
No	73.9	72.9
Yes	26.1	27.1
Poor health status at follow up, %		
No	68.1	66.0
Yes	31.9	34.0
Hypertension[†]**, %**	38.1	43.2
Diabetes[‡]**, %**	11.5	11.6
Cardiovascular disease, %	4.3	5.6
Body mass index category, kg/m^2, mean (SD)	23.8 (3.3)	23.6 (3.2)
Waist circumference, cm, mean (SD)	77.3 (8.5)	81.7 (8.9)

[†] Blood pressure ≥140/90 mmHg or receiving treatment for hypertension

[‡] Fasting plasma glucose ≥7.0 mmol/L or a previous diagnosis of type 2 diabetes

Table 2 Comparison of adiposity measures of 17,786 participants recruited from 2003-2008 and followed up until end 2012

	Baseline		Follow-up		Adjusted changes per year (95% CI) ‡	Cohen's effect size
	Number	Mean (95% CI) / %	Number	Mean (95% CI) / %		
Body mass index (kg/m^2)						
All†‡	17,786	23.7 (23.7-23.8)	17,786	23.8 (23.7-23.8)	0.028 (0.027-0.028)	0.02
All without underweight at baseline †‡	17,057	24.1 (24.0-24.1)	17,057	24.1 (24.1-24.1)	0.023 (0.023-0.024)	
Underweight	729	4.2	829	4.8		
Normal	11,074	62.9	10,712	60.9		
Overweight	3,769	21.1	3,822	21.7		
Obese	2,214	11.8	2,423	12.7		
Men‡	4,821	23.6 (23.5-23.7)	4,821	23.7 (23.6-23.8)	0.019 (0.018-0.019)	0.02
Men without underweight at baseline‡	4,602	23.9 (23.9-23.9)	4,602	23.9 (23.9-23.9)	0.013 (0.012-0.014)	
Underweight	219	4.5	240	5.0		
Normal	3,101	64.3	3,002	62.3		
Overweight	1,000	20.7	1,067	22.1		
Obese	501	10.4	512	10.6		
Women‡	12,965	23.8 (23.8-23.9)	12,965	23.9 (23.8-24.0)	0.031 (0.031-0.031)	0.02
Women without underweight at baseline‡	12,455	24.1 (24.1-24.1)	12,455	24.2 (24.2-24.2)	0.027 (0.026-0.027)	
Underweight	510	3.9	589	4.5		
Normal	7,973	61.5	7,710	59.5		
Overweight	2,769	21.4	2,755	21.3		
Obese	1,713	13.2	1,911	14.7		
Waist circumference (cm)						
All†‡	17,786	79.5 (79.4-79.7)	17,786	83.1 (83.0-83.2)	1.22 (1.22-1.22)	0.44
All without underweight at baseline †‡	17,057	79.1 (79.1-79.2)	17,057	83.0 (83.0-83.0)	1.21 (1.21-1.22)	
<90	11,873	71.3	8,824	56.2		
≥90	5,913	28.7	8,962	43.8		
Men‡	4,821	81.6 (81.3-81.8)	4,821	84.6 (84.3-84.9)	0.94 (0.93-0.94)	0.33
Men without underweight at baseline‡	4,602	82.4 (82.4-82.5)	4,602	85.3 (85.3-85.4)	0.90 (0.89-0.90)	
<90	3,922	81.3	3,405	70.6		
≥90	899	18.7	1,416	29.4		
Women‡	12,965	77.7 (77.5-77.8)	12,965	81.8 (81.6-81.9)	1.29 (1.28-1.29)	0.49
Women without underweight at baseline‡	12,455	77.9 (77.9-77.9)	12,455	82.1 (82.1-82.1)	1.33 (1.33-1.34)	

<80	7,951	61.3	5,419	41.8
≥80	5,014	38.7	7,546	58.2

†: P value from paired t-test between baseline and follow-up all <0.001.

‡: Analyses in men and women together were age and sex adjusted and analyses by each sex were age adjusted.

Cohen's effect size: Effects size based on Cohen's w: 0.1 for small; 0.3 for medium; 0.5 for large.

Table 3 Incidence of obesity defined by BMI and/or WC in participants without central or general obesity at baseline

	Incidence of obesity defined by BMI (95% CI) †, ‡	Incidence of obesity defined by WC (95% CI) †, ‡	Incidence of obesity defined by BMI or WC (95% CI) †, ‡
		Total participants (n=11,656)	
Sex			
Men	1.8 (1.4-2.3)	15.8 (14.7-17.0)	16.2 (15.0-17.4)
Women	1.9 (1.6-2.3)	37.6 (36.5-38.7)	37.8 (36.7-39.0)
Total	1.9 (1.6-2.1)	25.0 (24.1-25.9)	25.3 (24.4-26.2)
Age, years			
50-59	1.8 (1.1-3.0)	34.0 (30.6-37.6)	34.3 (30.9-37.9)
60-69	1.9 (1.4-2.6)	30.4 (28.5-32.4)	30.7 (28.8-32.6)
70+	6.2 (0.7-37.4)	32.1 (22.5-43.6)	32.8 (23.0-44.3)
		Relatively healthy participants[a] (n=6,040)	
Sex			
Men	2.1 (1.3-3.2)	14.2 (12.1-16.6)	14.7 (12.6-17.1)
Women	1.8 (1.4-2.3)	36.4 (34.9-38.0)	36.7 (35.2-38.2)
Total	1.9 (1.5-2.3)	29.0 (27.6-30.4)	29.3 (27.9-30.7)
Age, years			
50-59	1.9 (1.1-3.5)	34.4 (30.0-39.2)	35.1 (30.7-40.0)
60-69	2.1 (1.4-3.1)	28.8 (26.1-31.8)	29.0 (26.2-31.9)
70+	0.4 (0.02-7.4)	28.6 (16.3-45.3)	29.0 (16.6-45.7)

[a]: Relatively healthy participants were defined as never smokers without poor health status at both baseline and follow up

†: Incidence presented as percentage over a 3.6-year period

‡: Analyses by each age group were sex adjusted and analyses by each sex were age adjusted. All other analyses were age and sex adjusted.

Table 4 Percentage of return to non-obesity in total participants and healthy participants who had obesity at baseline [a]

	Return to non-obesity defined by BMI % (95% CI) †, ‡	Return to non-obesity defined by WC % (95% CI) †, ‡
Total participants	**N=2,214**	**N=5,913**
Sex		
Men	23.8 (20.2-28.0)	15.9 (13.5-18.6)
Women	20.0 (18.1-22.0)	9.1 (8.3-9.9)
Total	22.5 (20.5-24.6)	12.2 (11.1-13.3)
Age, years		
50-59	21.1 (15.0-28.9)	11.5 (8.4-15.7)
60-69	22.5 (19.0-26.3)	11.3 (9.7-13.2)
70+	30.3 (11.4-59.7)	16.3 (7.6-31.5)
Relatively healthy participants[a]	**N=1,029**	**N=2,857**
Sex		
Men	21.0 (14.4-29.5)	17.0 (12.2-23.1)
Women	17.3 (14.8-20.1)	9.3 (8.2-10.5)
Total	20.3 (16.9-24.1)	12.8 (10.8-15.1)
Age, years		
50-59	16.9 (9.5-28.2)	12.5 (8.0-19.1)
60-69	19.6 (14.8-25.6)	11.4 (8.9-14.4)
70+	43.3 (4.1-93.2)	23.5 (6.6-57.3)

[a]: Relatively healthy participants were participants who were never smokers and without poor health status at both baseline and follow up

†: Return to non-obesity was presented as percentage of participants returned from obese to non-obese over a 3.6-year period

‡: Analyses by each age group were sex adjusted and analyses by each sex were age adjusted. All other analyses were age and sex adjusted.