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Depressive Symptoms and Change in Abdominal Obesity in the Elderly: positive or negative association?

Samuel YS WONG, M.D.[1], **Jason C LEUNG, M.Sc.**[2], **Ping C LEUNG, D.S.Sc.**[2], and **Jean WOO, M.D.**[3]

[1] School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong S.A.R

[2] Jockey Club Centre for Osteoporosis Care and Control, The Chinese University of Hong Kong, Hong Kong S.A.R

[3] Division of Geriatrics, Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Hong Kong S.A.R

Abstract

Objectives—Recent evidence suggests depression could result in abdominal obesity in the elderly. Few longitudinal studies are available and none has been conducted outside of the US.

Methods—To examine the relationship between depressive symptoms and abdominal obesity, data from 3998 community dwelling Chinese elderly men and women aged 65 years and above with 4-year follow up were analyzed. Depression was defined by a Geriatric Depression Scale score of 8 or higher. At baseline and after 4 years, overall obesity measures included body mass index, percentage of body fat and general adiposity or body fat index (BFI) (expressed by total body fat mass measured by DEXA in kilograms divided by the square of stature in metres). Abdominal obesity measures included waist circumference, waist hip ratio and relative truncal fat (ratio of truncal fat mass to total fat mass measured by DEXA).

Results—After adjustment for socio-demographics, lifestyle and medical factors, the presence of clinically relevant depressive symptoms at baseline was associated with significant decrease in waist circumference at follow up after adjusting for socio-demographic factors, baseline obesity, lifestyle and medical factors ($\beta=-1.801$, $t=-2.93$, $df=1564$, $p=0.0034$) although this relationship disappeared in older aged women in further age stratified analysis.

Conclusions—This study shows that depressive symptoms may result in a decrease in abdominal obesity, suggesting that more research is needed to further explore this relationship. Similar studies conducted in different cultural groups may help to explain these conflicting findings.

Keywords

Depression; elderly; body mass index

OBJECTIVES

Obesity and major depression are two major public health problems.[1–3] With respect to the high prevalence of the two conditions, both obesity and depression have been shown to be

Address for correspondence and request of reprint: Dr. Samuel YS Wong, 4/F, School of Public Health, Prince of Wales Hospital, Shatin, N.T. Hong Kong S.A.R. Tel: 852-2252-8774, Fax: 852-2606-3500, yeungshanwong@cuhk.edu.hk.

associated with a number of chronic conditions that included cardiovascular disease, metabolic disorders and cancers.[4–11] Recent clinical and epidemiological evidence suggests a significant relationship between depression and obesity.[12–15] In particular, several studies have identified the relationship between abdominal obesity and depression.[15–20] Studies to further establish the mechanisms responsible for the relationship are important from two perspectives. First, it has been established that depression is associated with a number of chronic diseases including cardiovascular and metabolic diseases and research that examines the association between depression and obesity can shed light on potential mechanisms that account for the associations between depression and these chronic conditions. Second, interventions that treat obesity may be effective for reducing co-morbidity associated with depression and chronic conditions.

Although studies have established the link between the two conditions, most of the studies up to date were cross-sectional [21–23] and the direction of causality between depression and obesity was unknown. Recent longitudinal studies have documented the association between obesity and incident depression. Almeida et al[24] examined the association between obesity and incident depression over a 10-year period in a community cohort of elderly men and showed that men with a body mass index over 30 had a 31% increase in the risk of depression when compared to men that were not obese. Other studies[25–27] have also demonstrated increased risk of incident depression in obese individuals. It has been suggested that hypothalamic pituitary dysregulation,[28–29] decrease in physical activity, changes in eating habits associated with depression such as binging or overeating[30] and the use of antidepressants[12] could all potentially increase the risk of having metabolic dysregulation resulting in obesity.

On the other hand, other studies[31–33] have demonstrated the relationship between the presence of depression and weight loss over time. Recently, a large prospective study conducted in the US by Vogelzangs and colleagues showed that the presence of depressive symptoms at baseline was associated with an increase in abdominal obesity independent of overall obesity and other socio-demographic and lifestyle factors over a period of 5 years.[34] However, this study is one of the few studies that showed that depression may “cause” older people to develop obesity and more research is needed to address the directionality of the association between depression and obesity.

The present study aims to investigate the association between depressive symptoms and changes in abdominal obesity longitudinally over a 4 year period in a large sample of community dwelling elderly Chinese men and women. We hypothesize that similar to findings reported by Vogelzangs et al, depressive symptoms at baseline will predict an increase in abdominal obesity over time and this association would be specific to abdominal obesity.[34]

METHODS

Study Sample

The methodology of this study was described previously.[11] Mr and Ms Os are two large prospective studies conducted in Hong Kong, China initially to investigate risk factors associated with osteoporosis and fractures in Chinese elderly. Since inception, these two studies have been expanded to cover other areas that are of interests to health of the elderly. In brief, two thousand Chinese men and two thousand Chinese women who were 65 years and older were recruited for this study. Exclusion criteria for this study included: those who were unable to walk without the assistance of another person; those who had had a bilateral hip replacement because that would have affected the bone mineral density measurement and those who were not competent to give informed consent. To avoid under-sampling of

the oldest old, stratified sampling was adopted in order to have around 33% of subjects in each of the following age groups: 65–69, 70–74, ≥75 years. Recruitment notices were placed in housing estates and community centers for the elderly and subjects were invited to the research center for interviews and physical examination. Subjects were interviewed between August 2001 and February 2003 at baseline using a standardized, structured questionnaire. All interviewers in this study received training prior to interviews with regular monitoring and assurance activities. After that, the subjects were invited for a second visit after 2 years and at the end of four years with questions that measure clinically relevant depressive symptoms, medical history and new hospitalizations including usage or change of medications repeated. At the end of the four year, in addition to clinically relevant depressive symptoms and medical history, data on weight and height and bone mineral density together with body composition was also collected. Informed consent was obtained from all subjects. The study was approved by the ethics committee of the Faculty of Medicine, the Chinese University of Hong Kong. In the current study, 3998 participants were available at baseline and 3152 participants were available at the end of four year (retention rate = 79%).

For those who were lost to follow up, they were older (74.7 vs. 71.9 years old; t=13.0, df=1197, p<0.0001), less physically active (PASE score = 82.3 vs. 93.8; t=−7.2, df=1416, p<0.0001); more likely to smoke cigarettes (9.3% vs. 6.2%; χ^2=10.1, df=1, p=0.0015); more likely to have stroke (5.9% vs. 4.0%; χ^2=6.0, df=1, p<0.0141) and depression as defined by CES-D (12.7% vs. 8.4%; χ^2=14.2, df=1, p=0.0002).

Clinically Relevant Depressive Symptoms

Questions on having clinically relevant depressive symptoms were asked both at baseline, at 2 years and at then end of four years. The presence of having clinically relevant depressive symptoms were defined by face-to-face interviews, using a validated 15-item Chinese version of the Geriatric Depression Scale (GDS), with the presence of clinically relevant depressive symptoms defined as a cut-off of 8 or more.[16] The use of the short form was found to be a useful measure and screening tool for geriatric depression due to the elderly tendency to fatigue with long questionnaire and using this cut-off, the scale has high reliability (reliability coefficient of 0.90) and validity for screening those with depression with a sensitivity of 96.3% and specificity of 87.5 % specific in Hong Kong elderly.[16] For simplicity, clinically relevant depressive symptoms and depression were used interchangeably in this manuscript. For sensitivity analyses, depressed persons were further categorized into persons who were only depressed at baseline (single depression) and those who also had depression for at least 1 follow up assessment (either at 2 year or at 4 year) which was defined as persistent depression.

Obesity

All obesity measures were collected at baseline visit and at the end of four years. Body weight was measured by asking participants to stand upright without shoes and look straight ahead with their standing heights measured by the Holtain Harpenden stadiometer (Holtain Ltd, Crosswell, UK). Body weight was measured with the participants wearing a light gown by the Physician Balance Beam Scale (Health-O-Meter, Inc., Alsip, IL). Waist circumferences (the narrowest circumference around the trunk between the rib cage and the pelvis) and hip circumferences (the maximum circumference around the buttock posteriorly and the pubis symphysis anteriorly) were measured with a flexible measuring tape and also with the participants wearing a light gown.

Total body muscle mass, total body fat mass and truncal fat mass were measured by DEXA using a Hologic QDR 2000 densitometer (Hologic, Waltham, WA; Hologic Delphi, software

11.2). For the measurement of the truncal fat, a line of delineation was drawn between the head of the humerus and the glenoid fossa of the scapula to separate the upper limb from the trunk, and the leg consisted of the parts of the body between the inferior border of the ischial tuberosity to the most distal tip of the toes. The maximum coefficient of variation for fat mass and muscle mass is 1.47% and 0.84%, respectively. Calibration with a Hologic body composition step phantom was performed at least three times a week.

All body composition measurements were corrected to body built in the same way as the calculation of body mass index. General adiposity or body fat index (BFI) was expressed by total body fat mass in kilograms divided by the square of stature in metres. Relative truncal fat (RTF)[35–36] was used to indicate central adiposity, which was the ratio between truncal fat mass to that of total fat mass. In addition, waist hip ratio and waist circumference were calculated and measured respectively as outcomes of abdominal obesity.

Baseline Characteristics

Socio-demographic information that included age, address, place of origin, education levels and occupation was also obtained. Information on subjects' medical history was obtained based on self-reports of medical conditions. Subjects were asked to bring in all medications for identification. Lifestyle characteristics that were of relevance to obesity and depression were also recorded that included smoking status and amount (former smoker: at least 100 cigarettes smoked in a lifetime, current smoker, and those who never smoke), alcohol consumption (daily frequency of intake of alcohol and other beverages in portion sizes), dietary intake and physical activity. Physical activity was measured by the validated Physical Activity Scale for the Elderly Questionnaire (PASE).[37] It measured the level of physical activity in individuals aged 65 years and older. The instrument is a self report/ interview-based measure designed to capture and assess occupational, household, and leisure activities typically performed by older adults. This was adapted in Hong Kong Chinese by adding activity items which were popular in the local culture. Dietary intake was assessed by a modified version of the Block food frequency questionnaire, based on data obtained in the Hong Kong Adult dietary survey in 1995. Two hundred and eighty five dietary items were included in the questionnaire. Mean nutrient quantitation per day was calculated using food tables derived from McCance and Widdowson[38] and the Chinese Medical Sciences Institute[39]. Cognitive impairment was measured by the validated Chinese version of the mini-mental status exam (CMMSE).[40] The CMMSE is a validated Chinese version of Folstein's Mini-Mental Status Examination (MMSE).[41] CMMSE scores ranged from 0 to 30; a lower CMMSE score reflects more dementia-related cognitive impairment. An individual with an MMSE score of 23 or less is identified as cognitively impaired.[42] The presence of chronic conditions was measured by self report of common chronic conditions that included cardiovascular diseases including congestive heart failure, myocardial infarction and angina; stroke, hypertension, diabetes mellitus; chronic obstructive pulmonary diseases, cancer, osteoarthritis, osteoporosis, gastrointestinal diseases, prostate disease, thyroid disease, Parkinson disease and kidney disease. In addition, all medications that are taken regularly in the 2 weeks prior to the visit were recorded and participants brought all their medications to the visit site for verification including antidepressants.

Statistical Analysis

Participant characteristics were compared between depressed and non-depressed participants using χ^2 statistics for dichotomous and categorical variables and independent t tests for continuous variables. To investigate the association between depressive symptoms and abdominal obesity, the analyses were conducted to examine 1) if having depression at baseline is associated with central obesity at follow up; 2) if persistent depression (at baseline and after 4 years) is associated with central obesity at follow up; 3) if central

obesity at baseline is associated with depression at follow up; and 4) if persistent central obesity (at baseline and after 4 years) is associated with depression at follow up. Linear regression analyses were conducted at first adjusting for covariates that have been shown to be related to central obesity and depression that included baseline obesity measure, age and education. Second, as overall obesity may confound the relationship between baseline depressive symptoms and abdominal obesity, the same analyses were further adjusted for baseline overall BMI. Finally, since lifestyle factors, chronic medical conditions, the presence of cancer and general health status might partially explained the relationship between depression and abdominal obesity, cigarette smoking, alcohol consumption, weight adjusted energy intake, physical activity, diabetes, cardiovascular disease, cancer, number of chronic conditions, number of prescription medications, cognitive impairment and the use of antidepressants were further adjusted in the analyses. Since total energy intake could be affected by their weight, total energy intake was adjusted for weight by using residual method in separate sexes.[43] By regressing total energy intake on weight, residual term of each subject was added to the total energy intake with mean weight.

As it has been shown that there were sex differences in the relationships between depression and abdominal obesity[44] and fat distribution differs between males and females, separate analyses with respect to sex were conducted. Moreover, analyses stratified by age (every 5 years of change) were also conducted to explore possible effects of age on the outcomes.

RESULTS

Baseline Characteristics

Basic socio-demographic information of the sample was reported previously.[45] The mean age of the participants was 72.5 (5.2) and 50% were women. Depression was present in 9.3% of participants and the mean (SD) BMI was 23.7 (3.3). When the socio-demographic characteristics of our sample were compared to the socio-demographic characteristics of the Hong Kong population, we found that our sample had a higher proportion of persons who were married (70.7% vs. 46.1%; χ^2=978.5, df=2, p<0.0001); higher proportion of our sample participants with secondary or higher education (28.4% vs. 14.8%; χ^2=854.9, df=2, p<0.0001). Moreover, participants in our sample were more likely to have hypertension (42.7% vs. 34.7%; χ^2=112.3, df=1, p<0.0001) and chronic lung diseases (8.3% vs. 7.2%; χ^2=7.6, df=1, p=0.0059).

Table 1a showed the sample characteristics for male participants who had clinically relevant depressive symptoms at baseline with these characteristics being compared with male participants who did not have clinically relevant depressive symptoms at baseline. A large proportion of men with clinically relevant depressive symptoms at baseline had lower education. Moreover, they were, more likely to be current smoker, and were more likely to have cardiovascular disease. They also tended to have larger number of chronic diseases and used larger number of prescription medications when compared to those without clinically relevant depressive symptoms at baseline. In addition, they were also more likely to be cognitively impaired when compared to those without clinically relevant depressive symptoms. With respect to obesity measures, depressed men had significantly lower relative truncal fat and had lower percentage abdominal fat when compared to those of the non depressed men.

Table 1b showed the sample characteristics among female participants with and without clinically relevant depressive symptoms at baseline. Women with clinically relevant depressive symptoms were more likely to be older, having a larger proportion of participants with lower education. Moreover, they had lower PASE score and had lower weight adjusted energy intake when compared to women who were not clinically depressed. In addition, they

were more likely to suffer from diabetes mellitus and cardiovascular diseases when compared to women who were not clinically depressed. In addition, they suffered from a higher number of chronic conditions, used higher number of prescription medications and were more likely to be cognitively impaired. With respect to obesity measures, women with clinically relevant depressive symptoms had higher waist circumference, higher waist hip ratio and lower abdominal percentage fat.

Table 2a and 2b showed the sample characteristics among male and female participants among those with waist hip ratio above or below the median of overall waist hip ratio respectively, those with waist hip ratios that were equal to or above the median waist hip ratio were more likely to have lower education; more likely to have chronic conditions that included diabetes mellitus, cardiovascular diseases, and number of chronic conditions and number of prescribed medications. Among women, those with waist hip ratios that were equal to or above the overall median waist hip ratio were more likely to be older, to have lower education, lower PASE score when compared to those with below median waist hip ratio. Moreover, they were also more likely to have chronic conditions that included diabetes mellitus, cardiovascular diseases and the number of chronic conditions and number of prescribed medications. They were also more likely to have clinically relevant depressive symptoms and were more likely to have cognitive impairment when compared to those with below median waist hip ratios.

Baseline Depressive Symptoms and 4-year Change in Abdominal Obesity

The results of adjusted regression analysis for male and female participants using change in central obesity as outcome measure were shown in Table 3a and 3b respectively. Among men, no significant association was seen between baseline depressive symptoms and measures of central obesity at the end of 4 years for both baseline and persistent depressive symptoms. On the other hand in women, the presence of clinically relevant depressive symptoms at baseline was associated with significant decrease in waist circumference at follow up after adjusting for baseline obesity, age, education, cigarette smoking, alcohol drinking, cognitive impairment, weight adjusted energy intake and the presence of chronic conditions including cardiovascular diseases, cancer and the taking of prescription medications ($\beta=-1.801$, $t=-2.93$, $df=1564$, $p=0.0034$). There were also no significant association (not shown) between baseline depressive symptoms and follow up overall obesity measured by BMI or percentage body fat in both men and women.

To further explore the relationship between baseline depressive symptoms and measures of central obesity at follow up with respect to age, analyses were also conducted separately in 3 different age strata (65–69 years of age, 70–75 years of age and more than 75 years of age) in both males and females. Among men, baseline depressive symptoms were not significantly associated with abdominal obesity at follow up for all age strata. On the other hand, among women, baseline depressive symptoms were statistically significantly associated with decrease in BMI and decrease in waist circumference in women aged 65 to 69 years. Baseline depressive symptoms were only marginally significantly associated with decrease in waist circumference ($\beta=-1.7483$; $t=-1.74$, $df=524$, $p=0.0829$) and waist hip ratio ($\beta=-0.0153$; $t=-1.77$, $df=524$, $p=0.0768$) for females aged 70–74 years and there was no significant association between baseline depressive symptoms and waist circumference at follow up among women aged 75 or above.

To study the possible association between baseline or persistent central obesity (independent variable) and follow up depressive symptoms (dependent variable) in men and women respectively, separate analyses were conducted in each gender. No statistically significant association was found between baseline or persistent central obesity and the presence of clinically relevant depressive symptoms at follow up in both men and women, although a

trend for a significant association between persistent above median waist hip ratio was observed in both men and women (table 4a and 4b) after adjustment was made for baseline obesity, age, education, cigarette smoking, alcohol drinking, cognitive impairment, weight adjusted energy intake and the presence of chronic conditions including cardiovascular diseases, cancer and the taking of prescription medications.

CONCLUSIONS

This study examined whether depressive symptoms could predict change in abdominal obesity over time in a large community based cohort of older Chinese men and women. Although we initially hypothesized that depressive symptoms could predict a larger increase in abdominal obesity over time than non depressed participants as reported by a recent large study in elderly Caucasians and Black men aged 70–79 years of age,[34] our findings showed that depressive symptoms at baseline were associated with a decrease in abdominal obesity over time when compared to findings in non-depressed participants. This association is independent of other covariates that included socio-demographic factors, overall obesity, lifestyle factors, cognitive impairment and chronic diseases and the use of medications including antidepressants. Moreover, this relationship seems to be sex specific and dependent on age. In this study, we could only find significant relationship in female participants and the relationship disappears in women who were aged 75 years or older. To our knowledge, this is the first study to prospectively examine the association between depressive symptoms and abdominal obesity measures in Chinese conducted in Asia. Our findings are in contrast to findings from Vogelzangs et al[34] where a significant positive association was found between the presence of depressive symptoms and an increase in abdominal obesity measures over time. Moreover, we also failed to find a temporal relationship between baseline obesity measures and the presence of clinically relevant depressive symptoms at follow up which has been reported in other recent studies. [24–27,46] Findings from our study do not support the association between baseline depressive symptoms and increase in abdominal obesity measures over time. In fact, our findings suggest that depressive symptoms at baseline may decrease abdominal obesity measures over time. Results from cross-sectional studies that examined the association between depression and abdominal obesity were inconsistent with some studies reported positive association,[12–13, 47–48] some studies reported negative or no association[49–53] and some studies reported a U shaped [21,54] association. Our findings were consistent with other studies that found a relationship between baseline depressive symptoms and loss of central obesity at follow up.[31–32]

Depression has been shown to be related to weight loss or both weight gain and weight loss. [31–32,54] A cross-sectional study conducted by Wit et al[54] suggested that the association between depression and BMI may be a nonlinear (U-shaped) association with depression associated with both underweight and obesity. In a prospective study, Haukkala et al[31] also demonstrated that higher depression scores at baseline predicted both weight gain and weight loss at follow-up. Similarly, a recent prospective study conducted by Forman-Hoffman et al[32] also showed that baseline depressive symptoms were associated with both weight loss and weight gain in women and weight loss in men aged 53–63 over a period of two years. In contrast to their findings, we did not find any weight gain in women who showed clinically relevant depressive symptoms at baseline and we did not find any significant association between baseline depressive symptoms and weight gain or loss at follow up in men.

In Chinese elderly, weight loss is common and is associated with increase in mortality and morbidity[55] and mild weight gain is protective against disease and is associated with better health maintenance.[56] As a result, the significant association between the presence of

depressive symptoms and weight loss over time in our study may have impact on mortality in these elderly.

Differences in ethnicity have been shown to confound or mediate the relationship between depression and abdominal obesity. For example, Vogelzang et al[34] demonstrated a significant relationship between depression and abdominal obesity in white men and women but not black women and the authors were unable to explain the reasons for the lack of relationship between depression and abdominal obesity in Black women Similar to our findings, Black depressed women experienced a significant decrease in abdominal obesity when compared to non depressed Black women. Findings from our current Asian sample thus add further research data on the relationship between depression and obesity in a large Chinese population and suggest that the relationship between depression and obesity is a complex one which requires further studies in various ethnic groups.

Limitations

Our study has several limitations. First, we have recruited a volunteer sample, where they may not be representative of the general population. Second, our diagnosis of clinically relevant depressive symptoms was based on a screening instrument for depression in elderly and no physician administered criterion-based psychiatric diagnoses of depression were used in this study. However, GDS is a commonly used geriatric depression screening in Hong Kong with established validity and reliability in the Hong Kong geriatric population. Third, we have a loss of follow up of 21% and we showed that those who were lost to follow up were less healthy when compared to those who were followed and there was a larger proportion of depressed males when compared to non-depressed males who were lost to follow up (33.7% vs. 20.6% respectively). This could have affected the findings on the association between depression and abdominal obesity although no such association was seen in the female sample.

The strength of our study is the large community based sample size and the use of the same instruments and physical examinations over 4 years which provides reliable measurements of key variables in this study.

Our prospective design suggests that depressive symptoms may be associated with decrease in abdominal obesity over time independent of overall obesity. Our results could mean that the relationships between depressive symptoms and abdominal obesity may be a simple one relating to decrease in food intake although conflicting results from other cohort studies and those of our study suggest more complicated mechanisms at work. Our results also suggest that ethnicity may be an important factor to consider in this relationship and further studies that are conducted in different ethnic groups are needed to further delineate the mechanisms responsible for this association.

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Table 1a

Characteristics of male participants at baseline with respect to depressive symptom status

Variable	Mean (SD)/Freq (%)		Mean diff/OR	t-test (df)/Wald (df)	P value[a]
	GDS<8 (n=1830)	GDS≥8 (n=169)			
Sociodemographic variables					
Age	72.34 (4.96)	72.94 (5.41)	0.60	−1.48 (1997)	0.1377
Education primary or below	1085 (59.3%)	121 (71.6%)	1.73	9.60 (1)	0.0019
Lifestyle variables					
Current smoker	205 (11.2%)	33 (19.5%)	1.92	9.92 (1)	0.0016
Current alcohol use	440 (24.0%)	31 (18.3%)	0.71	2.76 (1)	0.0965
PASE score	97.96 (50.56)	90.28 (46.84)	−7.68	1.90 (1997)	0.0575
Weight adj. energy intake (kcal/d)	2,101.60 (582.88)	2,075.90 (609.29)	−25.75	0.55 (1995)	0.5852
Somatic comorbidities					
Diabetes	266 (14.5%)	27 (16.0%)	1.12	0.26 (1)	0.6125
MI/angina/CHF	314 (17.2%)	52 (30.8%)	2.15	18.44 (1)	<.0001
Cancer	75 (4.1%)	12 (7.1%)	1.79	3.26 (1)	0.0709
No. of chronic diseases	1.92 (1.53)	2.49 (1.63)	0.57	−4.63 (1997)	<.0001
No. of prescription medications	1.12 (1.35)	1.36 (1.51)	0.24	−1.99 (194)	0.0482
Cognitive variable					
Demented (MMSE<24)	196 (10.7%)	30 (17.8%)	1.80	7.46 (1)	0.0063
Obesity variables					
Overall obesity					
BMI	23.47 (3.09)	23.18 (3.47)	−0.30	1.07 (194)	0.2852
Body fat index (BFI)	5.76 (1.70)	5.61 (1.90)	−0.14	0.95 (194)	0.3410
Percentage of body fat	24.42 (4.89)	23.95 (5.53)	−0.47	1.07 (193)	0.2851
Abdominal obesity					
Waist circumference (cm)	87.27 (8.93)	87.02 (10.37)	−0.25	0.31 (192)	0.7607
Relative truncal fat (RTF)	0.56 (0.06)	0.54 (0.06)	−0.02	4.02 (1997)	<.0001
Waist hip ratio	0.923 (0.065)	0.926 (0.069)	0.002	−0.43 (1997)	0.6650
Abdominal % fat	28.00 (6.86)	26.77 (7.58)	−1.23	2.22 (1997)	0.0268
Overall and abdominal obesity					

Variable	Mean (SD)/Freq (%)		Mean diff/OR	t-test (df)/Wald (df)	P value[a]
	4				
	GDS<8 (n=1830)	GDS≥8 (n=169)			
BMI ≥ 25 and waist hip ratio>0.95	309 (16.9%)	32 (18.9%)	1.15	0.46 (1)	0.4982

[a]Based on chi square test for dichotomous and categorical variables and on independent t test for continuous variables.

Table 1b

Characteristics of female participants at baseline with respect to depressive symptom status

Variable	Mean (SD)/Freq (%)		Mean diff/OR	t-test (df)/Wald (df)	P value[a]
	GDS<8 (n=1796)	GDS≥8 (n=203)			
Sociodemographic variables					
Age	72.43 (5.30)	73.84 (5.72)	1.41	−3.57 (1997)	0.0004
Education primary or below	1473 (82.0%)	182 (89.7%)	1.90	7.25 (1)	0.0071
Lifestyle variables					
Current smoker	31 (1.7%)	6 (3.0%)	1.73	1.48 (1)	0.2236
Current alcohol use	45 (2.5%)	6 (3.0%)	1.18	0.15 (1)	0.7011
PASE score	85.85 (32.78)	81.20 (36.19)	−4.64	1.89 (1997)	0.0586
Weight adj. energy intake (kcal/d)	1,593.70 (463.17)	1,489.00 (438.13)	−104.70	3.06 (1994)	0.0022
Somatic comorbidities					
Diabetes	246 (13.7%)	40 (19.7%)	1.55	5.30 (1)	0.0213
MI/angina/CHF	281 (15.7%)	49 (24.1%)	1.72	9.36 (1)	0.0022
Cancer	79 (4.4%)	11 (5.4%)	1.25	0.44 (1)	0.5070
No. of chronic diseases	1.85 (1.39)	2.32 (1.51)	0.47	−4.52 (1997)	<.0001
No. of prescription medications	1.07 (1.30)	1.31 (1.43)	0.24	−2.45 (1997)	0.0145
Cognitive variable					
Demented (MMSE<24)	678 (37.8%)	106 (52.2%)	1.80	15.68 (1)	<.0001
Obesity variables					
Overall obesity					
BMI	23.93 (3.44)	23.86 (3.52)	−0.07	0.28 (1997)	0.7789
Body fat index (BFI)	8.40 (2.25)	8.23 (2.20)	−0.16	0.98 (1997)	0.3270
Percentage of body fat	34.62 (5.27)	34.13 (5.22)	−0.49	1.25 (1997)	0.2102
Abdominal obesity					
Waist circumference (cm)	85.50 (9.59)	86.97 (9.05)	1.47	−2.08 (1996)	0.0376
Relative truncal fat (RTF)	0.517 (0.054)	0.519 (0.053)	0.002	−0.45 (1997)	0.6509
Waist hip ratio	0.92 (0.08)	0.93 (0.07)	0.01	−2.14 (1996)	0.0327
Abdominal % fat	34.59 (6.30)	33.66 (6.38)	−0.93	1.99 (1991)	0.0468
Overall and abdominal obesity					
BMI ≥ 25 and waist hip ratio>0.85	586 (32.7%)	66 (32.5%)	0.99	0.002 (1)	0.9693

[a] Based on chi square test for dichotomous and categorical variables and on independent t test for continuous variables.

Table 2a

Characteristics of male participants at baseline with respect to central obesity status

Variable	Mean (SD)/Freq (%)		Mean diff/OR	t-test (df)/Wald (df)	P value[a]
	Waist hip ratio <median (n=998)	Waist hip ratio ≥median (n=1002)			
Sociodemographic variables					
Age	72.46 (5.11)	72.32 (4.90)	−0.14	0.64 (1998)	0.5243
Education primary or below	578 (57.9%)	629 (62.8%)	1.23	4.92 (1)	0.0266
Lifestyle variables					
Current smoker	122 (12.2%)	116 (11.6%)	0.94	0.20 (1)	0.6548
Current alcohol use	236 (23.7%)	235 (23.5%)	0.99	0.01 (1)	0.9185
PASE score	98.53 (50.52)	96.04 (50.06)	−2.48	1.10 (1998)	0.2701
Weight adj. energy intake (kcal/d)	2,102.10 (574.86)	2,096.80 (594.98)	−5.26	0.20 (1996)	0.8408
Somatic comorbidities					
Diabetes	100 (10.0%)	193 (19.3%)	2.14	33.11 (1)	<.0001
MI/angina/CHF	148 (14.8%)	218 (21.8%)	1.60	15.88 (1)	<.0001
Cancer	50 (5.0%)	37 (3.7%)	0.73	2.07 (1)	0.1502
No. of chronic diseases	1.79 (1.48)	2.14 (1.60)	0.34	−4.98 (1987)	<.0001
No. of prescription medications	0.92 (1.25)	1.35 (1.45)	0.43	−7.09 (1957)	<.0001
Depression variables					
Baseline GDS score	2.90 (2.73)	3.04 (2.84)	0.13	−1.06 (1997)	0.2893
Baseline GDS ≥8	83 (8.3%)	86 (8.6%)	1.04	0.05 (1)	0.8253
Cognitive variable					
Demented (MMSE<24)	106 (10.6%)	121 (12.1%)	1.16	1.05 (1)	0.3061

[a]Based on chi square test for dichotomous and categorical variables and on independent t test for continuous variables.

Table 2b

Characteristics of female participants at baseline with respect to central obesity status

Variable	Mean (SD)/Freq (%)		Mean diff/OR	t-test (df)/Wald (df)	P value
	Waist hip ratio <median (n=1012)	Waist hip ratio≥median (n=987)			
Sociodemographic variables					
Age	71.61 (5.10)	73.58 (5.43)	1.97	−8.37 (1982)	<.0001
Education primary or below	778 (76.9%)	877 (88.9%)	2.40	48.43 (1)	<.0001
Lifestyle variables					
Current smoker	25 (2.5%)	12 (1.2%)	0.49	4.15 (1)	0.0416
Current alcohol use	29 (2.9%)	22 (2.2%)	0.77	0.82 (1)	0.3661
PASE score	87.55 (33.17)	83.11 (33.04)	−4.44	3.00 (1997)	0.0028
Weight adj. energy intake (kcal/d)	1,618.00 (464.12)	1,547.60 (456.60)	−70.39	3.42 (1994)	0.0007
Somatic comorbidities					
Diabetes	113 (11.2%)	173 (17.5%)	1.69	16.26 (1)	<.0001
MI/angina/CHF	146 (14.4%)	184 (18.6%)	1.36	6.41 (1)	0.0113
Cancer	40 (4.0%)	50 (5.1%)	1.30	1.43 (1)	0.2312
No. of chronic diseases	1.72 (1.37)	2.08 (1.42)	0.36	−5.72 (1997)	<.0001
No. of prescription medications	0.97 (1.23)	1.23 (1.38)	0.26	−4.42 (1957)	<.0001
Depression variables					
Baseline GDS score	2.86 (2.78)	3.18 (2.91)	0.33	−2.57 (1996)	0.0101
Baseline GDS ≥8	88 (8.7%)	115 (11.7%)	1.39	4.79 (1)	0.0287
Cognitive variable					
Demented (MMSE<24)	326 (32.2%)	458 (46.4%)	1.82	41.85 (1)	<.0001

[a]Based on chi square test for dichotomous and categorical variables and on independent t test for continuous variables.

Table 3a

Baseline or persistent depressive symptoms and 4-year change in obesity - Male

	Abdominal obesity								
	Waist circumference			RTF			Waist hip ratio		
	β	t (df)	p-value	β	t (df)	p-value	β	t (df)	p-value
Baseline depression									
Sociodemographics[a]	−0.0999	−0.18 (1559)	0.8599	0.0018	0.74 (1561)	0.4572	0.0007	0.14 (1559)	0.8892
+Overall obesity[b]	0.2170	0.41 (1558)	0.6791	0.0018	0.74 (1560)	0.4617	0.0029	0.59 (1558)	0.5556
+Lifestyle and diseases[c]	−0.0554	−0.10 (1549)	0.9224	0.0020	0.82 (1551)	0.4145	0.0010	0.19 (1549)	0.8460
Persistent depression									
Sociodemographics[a]	−0.9803	−0.98 (1434)	0.3258	0.0032	0.75 (1435)	0.4537	−0.0038	−0.42 (1434)	0.6752
+Overall obesity[b]	−0.7604	−0.82 (1433)	0.4109	0.0032	0.75 (1434)	0.4562	0.0005	0.06 (1433)	0.9498
+Lifestyle and diseases[c]	−0.8590	−0.86 (1424)	0.3900	0.0027	0.62 (1425)	0.5376	−0.0024	−0.27 (1424)	0.7881

[a] Linear regression analyses adjusted for corresponding baseline obesity measure, age and education.

[b] Previous model plus baseline BMI for abdominal obesity measures.

[c] Previous model plus smoking, alcohol, demented, physical activity, diabetes, myocardial infarction/angina/congestive heart failure, cancer, number of chronic diseases, number of medications taken and weight adjusted energy intake.

Table 3b

Baseline or persistent depressive symptoms and 4-year change in obesity - Female

	Abdominal obesity								
	Waist circumference			RTF			Waist hip ratio		
	β	t (df)	p-value	β	t (df)	p-value	β	t (df)	p-value
Baseline depression									
Sociodemographics[a]	−1.8111	−2.97 (1578)	0.0031	−0.0025	−1.45 (1579)	0.1485	−0.0067	−1.27 (1578)	0.2033
+Overall obesity[b]	−1.3543	−2.39 (1577)	0.0170	−0.0025	−1.44 (1578)	0.1487	−0.0064	−1.24 (1577)	0.2162
+Lifestyle and diseases[c]	−1.8010	−2.93 (1564)	0.0034	−0.0025	−1.41 (1565)	0.1577	−0.0076	−1.43 (1564)	0.1516
Persistent depression									
Sociodemographics[a]	−1.3045	−1.29 (1402)	0.1961	−0.0024	−0.86 (1403)	0.3892	0.0012	0.14 (1402)	0.8896
+Overall obesity[b]	−0.4428	−0.47 (1401)	0.6357	−0.0025	−0.87 (1402)	0.3861	0.0023	0.27 (1401)	0.7907
+Lifestyle and diseases[c]	−1.2469	−1.24 (1389)	0.2159	−0.0024	−0.84 (1390)	0.3990	0.0006	0.07 (1389)	0.9414

[a] Linear regression analyses adjusted for corresponding baseline obesity measure, age and education.

[b] Previous model plus baseline BMI for abdominal obesity measures.

[c] Previous model plus smoking, alcohol, demented, physical activity, diabetes, myocardial infarction/angina/congestive heart failure, cancer, number of chronic diseases, number of medications taken and weight adjusted energy intake.

Table 4a

Baseline or persistent abdominal obesity and 4-year change in depressive symptoms- Male

Variable	**Mean (SD)**		**Adj. OR***	**Wald (df)**	**P value**
	4-y FU depression				
	GDS<8 (n=1484)	**GDS≥8 (n=82)**			
Abdominal obesity					
Baseline waist circumference (cm)	87.21 (8.78)	87.16 (10.12)	0.998	0.022 (1)	0.8818
Baseline relative truncal fat (RTF)	0.560 (0.056)	0.552 (0.058)	0.789	0.012 (1)	0.9146
Baseline waist hip ratio	0.922 (0.064)	0.923 (0.068)	0.509	0.125 (1)	0.7237
Variable	Freq (%)		Adj. OR*	Wald (df)	P value
	4-y FU depression				
	GDS<8 (n=1161)	GDS≥8 (n=70)			
Abdominal obesity[a]					
Persistent waist circumference > median	545 (46.9%)	29 (41.4%)	0.608	2.894 (1)	0.0889
Persistent relative truncal fat (RTF) > median	645 (50.9%)	28 (41.8%)	0.701	1.464 (1)	0.2263
Persistent waist hip ratio > median	534 (50.4%)	28 (45.2%)	0.571	3.474 (1)	0.0623

[a] Baseline and 4y FU > median comparing with baseline and 4y FU < median

* Adjusted OR, logistic regression adjusted for baseline depression, age, education, smoking, alcohol, demented, physical activity, diabetes, Myocardial infarction/angina/congestive heart failure, cancer, number of chronic diseases, number of medications taken and weight adjusted energy intake.

Table 4b

Baseline or persistent abdominal obesity and 4-year change in depressive symptoms -Female

Variable	**Mean (SD)**		**Adj. OR***	**Wald (df)**	**P value**
	4-y FU depression				
	GDS<8 (n=1459)	**GDS≥8 (n=128)**			
Abdominal obesity					
Baseline waist circumference (cm)	85.46 (9.67)	86.77 (8.64)	1.004	0.171 (1)	0.6797
Baseline relative truncal fat (RTF)	0.517 (0.054)	0.511 (0.054)	0.037	3.117 (1)	0.0775
Baseline waist hip ratio	0.916 (0.079)	0.933 (0.072)	3.469	0.896 (1)	0.3439
Variable	Freq (%)		Adj. OR*	Wald (df)	P value
	4-y FU depression				
	GDS<8 (n=1077)	GDS≥8 (n=90)			
Abdominal obesity[a]					
Persistent waist circumference > median	452 (42.0%)	42 (46.7%)	1.094	0.142 (1)	0.7062
Persistent relative truncal fat (RTF) > median	640 (50.0%)	51 (43.2%)	0.710	2.632 (1)	0.1047
Persistent waist hip ratio > median	440 (47.1%)	51 (64.6%)	1.655	3.530 (1)	0.0603

[a] Baseline and 4y FU > median comparing with baseline and 4y FU < median

* Adjusted OR, logistic regression adjusted for baseline depression, age, education, smoking, alcohol, demented, physical activity, diabetes, Myocardial infarction/angina/congestive heart failure, cancer, number of chronic diseases, number of medications taken and weight adjusted energy intake.