CHAPTER 3

Obesity in older adults is associated with an increased prevalence and incidence of pain

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Abstract

Cross-sectional studies suggest an association between BMI and pain. This prospective study investigated the associations of measured BMI and waist circumference with prevalent and incident pain in older adults.

The study included participants of the Longitudinal Aging Study Amsterdam (LASA), aged 55-85 years at baseline (1992-1993). Pain was assessed using a subscale of the Nottingham Health Profile at baseline (N=2000), after 3 years (N=1478), and 6 years (N=1271) of follow-up.

The overall prevalence of pain was 32.7% at baseline and increased significantly with higher quartiles of BMI or waist circumference. After adjustment for age, education, depression, smoking, physical activity and chronic diseases, multiple logistic regression analyses showed odds ratios (ORs(95% CI)) for prevalent pain of 2.16 (1.32-3.54) in men and 1.93 (1.26-2.95) in women comparing the highest with the lowest quartile of BMI. Of the participants without pain at baseline, those in the highest quartile of BMI had a two-fold increased odds for incident pain after 3 years of follow-up. After 6 years of follow-up, ORs for incident pain were 2.34 (1.17-4.72) in men and 2.78 (1.36-5.70) in women. Additional adjustment for weight change did not change these associations. Similar results were found for the associations between waist circumference and pain. Exploring the reversed causal relation, analyses showed no significant associations between prevalent pain and weight gain.

In conclusion, the prevalence of pain is higher among obese older men and women compared to their normal weight peers. Furthermore, obese older adults are at increased odds to develop pain.

Introduction

Controversy remains about the health consequences of obesity in old age. Studies show contrasting relations between obesity in old age and (disease-specific) mortality (1-3). However, for the aging population, longevity is currently considered of less importance than healthy aging. Valuing the relevance of obesity in old age should consider health and functional outcomes that are known to influence the quality of life. Because of the growth of the absolute number of older adults and the increasing prevalence of obesity in old age, the number of obese older adults is strongly increasing over time (4, 5). Further research on obesity in older adults and its consequences is needed.

Pain can have large consequences for the quality of life. Among older adults, pain is shown to be a common problem, but it is not a normal consequence of aging (6). Prevalence rates between 40.7% (for hip or knee pain among persons aged 65 and over (7)) and 73.5% (any painful area out of 10 among persons aged 65 and over (8)) are found in population-based samples of older adults. The large variation in prevalence rates between studies may be due to the fact that many different questionnaires were used to assess pain. These studies focus on prevalence rates of pain in specific parts of the body, but only limited knowledge about overall body pain is available.

Few cross-sectional, population-based studies investigated the association between obesity and pain in older adults. Positive associations of BMI with knee, hip and back pain (9) and lower limb joint pain (10) have been reported in older adults. Patterson et al. (11) identified neck, back and joint pain and frequent headaches among the conditions associated with obesity in older adults (50-76 yr). Furthermore, research on the influence of obesity on health related quality of life (HRQoL) reported a negative association of obesity with the pain domain of HRQoL (12-14).

To our knowledge, there are no prospective studies investigating the association between obesity and the development of pain in older adults. This type of studies is crucial, since in cross-sectional investigations the direction of the association remains unclear; obesity may precede the pain or pain may lead to obesity. Furthermore, no study on pain used measures of obesity other than BMI. Abdominal obesity is suggested to be a stronger indicator explaining the association between obesity and several health outcomes (15-18). Therefore, the aim of the present study was to examine the association between obesity, assessed using both BMI and waist circumference, and the prevalence and incidence of overall body pain in a population-based sample of older men and women.

Methods

Study sample

Data for this study were collected in the Longitudinal Aging Study Amsterdam (LASA), a prospective study on predictors and consequences of changes in autonomy and well-being in the aging population in the Netherlands. Details on the sampling and data collection procedures have been described elsewhere (19, 20). Briefly, a representative sample of older men and women (aged 55-85 years), stratified by age, sex, urbanicity and expected 5-year mortality, was drawn from the population registers of 11 municipalities in three regions of the Netherlands. In total, 3107 subjects were enrolled in the baseline examination (1992-1993). Examinations consisted of a main (N=3107) and a medical interview (N=2671) in the participants' home and a self-administered questionnaire (N=2303) and were repeated after 3 and 6 years of follow-up. Trained nurses performed the medical interviews and collected the self-administered questionnaires.

Of the 2195 subjects who participated in both interviews and completed the self-administered questionnaire at baseline, 2000 were included in the cross-sectional analyses of this study. Reasons for exclusion of subjects were: absence of data on pain (N=70), missing data on BMI (N=65) and/or missing data on waist circumference (N=120). Of the initial 2000, 1756 subjects participated in the 3-year follow-up examination. Reasons for loss to follow-up were: death (N=190); refusal (N=31); loss of contact (N=7) and 16 persons were too frail to participate. Data on pain after 3 years of follow-up were available for 1478 participants. After 6 years of follow-up, 1489 of the initial 2000 participants were involved in the examinations. Between the 3-year and the 6-year follow-up measurements 200 participants died. Further reasons for loss of follow-up were refusal to participate (N=43) and loss of contact (N=4), 20 persons were too frail to participate. Therefore, data on pain were available for 1271 persons.

Pain

Pain was assessed by a self-administered questionnaire. The pain scale used was based on a subscale of the Dutch version of the Nottingham Health Profile (21, 22). The six items included were the following: ‘I am in pain when I am standing’; ‘I find it painful to change position’; ‘I am in pain when I am sitting’; ‘I am in pain when I walk’; ‘I have unbearable pain’ and ‘I am in constant pain’. Response categories were ‘yes’ and ‘no’. The total score ranged from 0 (no pain) to 6 (pain at all six items). The internal reliability of the pain scale in this study was satisfactory (Chronbach’s alpha was 0.77). The pain score was used as a continuous variable as well as a dichotomous variable with categories ‘no pain’ (score 0) and ‘any pain’ (scores 1-6). The item ‘I have unbearable pain’ is the only item that possibly indicates the intensity of the pain experienced. Therefore, a higher pain score does not necessarily indicates more severe pain, rather more daily situations in which the pain is experienced.

In longitudinal analyses, a dichotomous variable for incident pain was used, as well as a continuous variable for the change in pain score. Incident pain was defined as no pain (pain score =0) at baseline and a score of 1 to 6 at follow-up. Furthermore, a continuous variable for the difference in pain scores between baseline and follow-up was used. The continuous difference in pain scores was computed by subtracting the baseline score from the follow-up score.

When participants had missing values on one or more items of the pain questionnaire, they were still included in the analyses (except when all items were missing). Preliminary analyses showed that excluding persons with one or more missing values from the linear and/or the logistic regression analyses, it did not affect the results.

Anthropometry

All anthropometric measures used were obtained during the medical interview. BMI was calculated as measured body weight (kg) divided by measured height (m) squared. Height was measured using a stadiometer. Body weight was measured with light clothing only, using a calibrated balance beam scale. Waist circumference (cm) was measured in standing position, midway between the lower rib and the iliac crest after a normal expiration. The usefulness of the standard WHO classification of overweight and obesity in older adults has been questioned (2). In addition, approximately two-third of our study population fell in the overweight/obesity categories according to the WHO criteria. Therefore, we reported our results using sex-specific quartiles of BMI and waist circumference, as well as the continuous measures per standard deviation increase. The quartiles and standard deviations according to both anthropometric measures were constructed again for the study sample used in the longitudinal analyses.

Potential confounders and effect modifiers

Potential confounders assessed at baseline included measures of physical and mental health and lifestyle determinants. Participants were asked for their highest education level completed, ranging from primary to university education. Responses were categorized as low (elementary school or less), moderate, and high (higher vocational, college or university education). Smoking behavior was based on self-report (never, former, current). Physical activity in the previous two weeks was assessed during the main interview using a validated questionnaire (23). Information on the frequency and duration of walking outdoors, bicycling, light and heavy household activities and a maximum of two different sport activities was obtained. Total physical activity was expressed in minutes per day. Depressive symptoms were measured using a Dutch version of the Center for Epidemiologic Studies Depression (CES-D) (self-report) scale (range 0-60) (24). Participants were considered depressed when their score was 16 or higher. The presence of chronic diseases was assessed by self-report during the main interview. Chronic diseases included were pulmonary disease, cardiac disease, diabetes mellitus, arthritis, stroke and peripheral atherosclerosis (25).

Statistical analyses

Baseline characteristics were compared between persons without pain and with pain using a Chi squared test for categorical variables and an independent T test for continuous variables. P-values were considered significant if less than 0.05 and were based on two-sided tests. All analyses were conducted separately for men and women because both the prevalence of overweight and obesity and the prevalence of pain varied by gender. Also, the distribution of fat is known to differ between men and women and a better understanding of potential differences in the associations of BMI and waist circumference with pain might be established when stratifying the study sample by gender.

Analyses to investigate the cross-sectional association between BMI and pain prevalence were conducted using Chi square tests and multiple logistic (pain dichotomous) and linear (continuous pain score) regression analyses. Potential confounders were subsequently added in three regression models. In the first model, the association was adjusted for age and education. In the second model additional adjustment was made for depression, smoking and physical activity. Finally, in the third model, because of possible mediating effects, adjustment for chronic diseases was made. Results are presented as odds ratios (OR) with 95% confidence intervals (CI) or as regression coefficients with standard errors (SE) and P-values. Interaction effects of age, education, physical activity, depression and chronic diseases were tested by adding interactions terms (e.g. BMI x age, waist x age, BMI x level of education etc.). The interaction effects were tested in the cross-sectional analyses and in the association after 6 years of follow-up. An interaction effect with p-value <0.1 was considered significant. Trends across the BMI quartiles in the odds ratios were tested by using the ordinal quartile variables as continuous variables in the regression analyses.

The association between BMI at baseline and the incidence of pain after 3 or 6 years of follow-up was analyzed among participants without pain at baseline (N=1027 after 3 years and N=895 after 6 years of follow-up) using multiple logistic regression. Adjustments for potential confounders were made according to the same models described for the cross-sectional analyses. In addition, the association between BMI and the change in pain score was investigated in all participants of the follow-up measurements using multiple linear regression analyses. Additional adjustment for baseline pain score was made. All analyses were repeated using waist circumference instead of BMI as the independent variable.

Results

The prevalence of pain at baseline was 25.6% in men and 39.7% in women (Table 1). Men who reported pain had an average pain score of 2.19 (SD 1.29), the mean pain score of women with pain was 2.28 (SD 1.44). According to the WHO guidelines, 42.4% of the women was overweight, while 25.5% had a BMI of ≥30 kg/m^2 and would be considered obese. In men, these percentages were 51.7% and 9.5%, respectively. Only 19 persons were underweight defined by a BMI of less than 18.5 kg/m^2. According to WHO guidelines for waist circumference, 34.5% of the men and 17.6% of the women were overweight (94-102 cm in men and 80-88 cm in women), while 36.6% and 72.7% would be defined obese (≥102 cm in men and ≥88 cm in women). In both men and women, participants who reported pain were generally older, had a higher BMI and a larger waist circumference, were less physically active and were more often depressed (Table 1). Men with pain were less educated compared to men without pain at baseline. All measured chronic diseases were more prevalent among men and women with pain, accept for cancer which was equally prevalent in women with and without pain (Table 1).

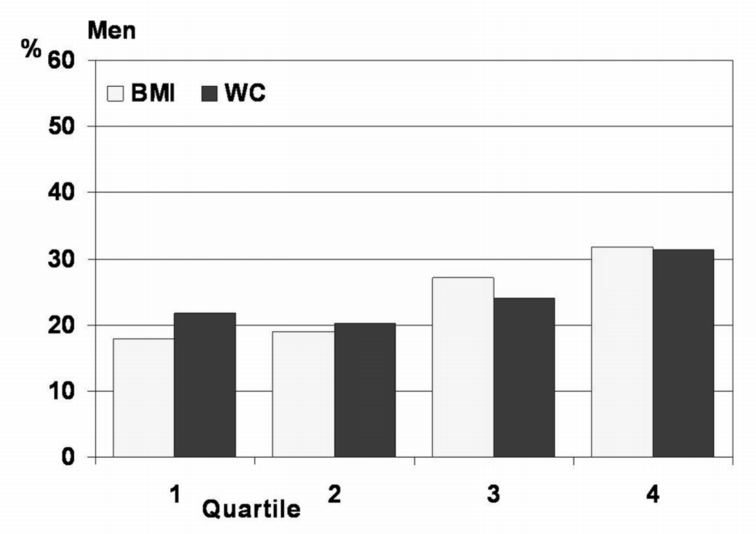
Cross-sectional analyses

In both men and women, the prevalence of pain was higher in higher quartiles of BMI (Figure 1, trends across the quartiles, P-values ≤ 0.001). The lowest prevalence rates of pain were not found in the lowest but in the second quartiles of BMI and waist circumference. Repeating the analyses after excluding the 19 persons with underweight (BMI <18.5 kg/m^2), the lowest prevalence rates were found in the lowest quartiles of BMI and waist circumference in men and the lowest quartile of BMI in women. After adjustment for age and education, persons in the highest quartile of BMI were more likely to have prevalent pain (Table 2, model 1). Depression, physical activity and chronic diseases did not explain an important part of this association (model 2). ORs were attenuated after adjustments for chronic diseases (model 3). Of the individual diseases, arthritis accounted for the largest decrease, but the association remained significant.

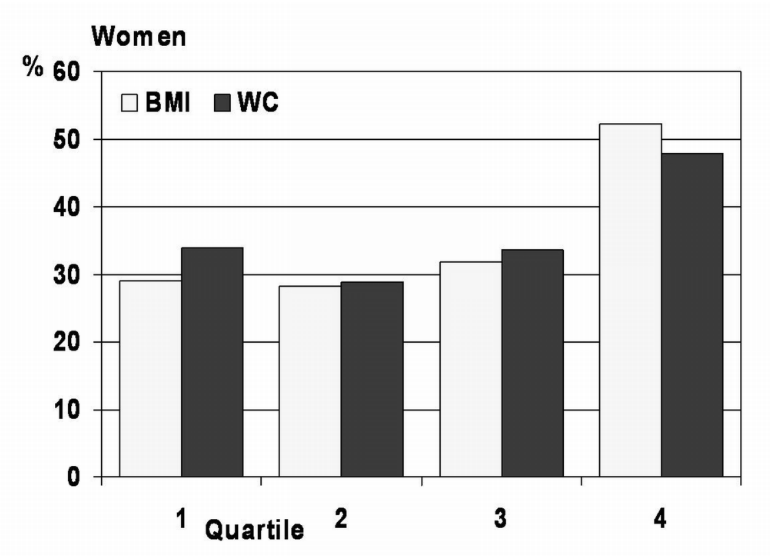
After adjustment for all potential confounders, logistic regression analyses showed higher ORs for prevalent pain with increasing BMI (per SD) in both men and women (Table 2). Compared to the lowest quartile of BMI, fully adjusted ORs (CI) of 2.16 (1.32-3.54) in men and 1.93 (1.26-2.95) in women were found in the highest quartile. Similar ORs were found for the association between waist circumference and pain (Table 2). A significant linear trend was found across the quartiles for all associations (all P-values ≤ 0.02).

Figure 1. Percentage of older men (a) and women (b) with reported pain at baseline, according to sex-specific quartiles of BMI or waist circumference.

a)



b)



Fully adjusted multiple linear regression analyses also showed significant associations between higher BMI (per SD increase) and a higher continuous pain score. In men, the regression coefficient was 0.105 (SE=0.035, P=0.003); the regression coefficient in women was 0.150 (SE=0.044, P≤0.001). Regression coefficients found for the association between waist circumference and the continuous pain score were 0.103 (SE=0.034, P=0.003) in men and 0.155 (SE=0.044, P≤0.001) in women.

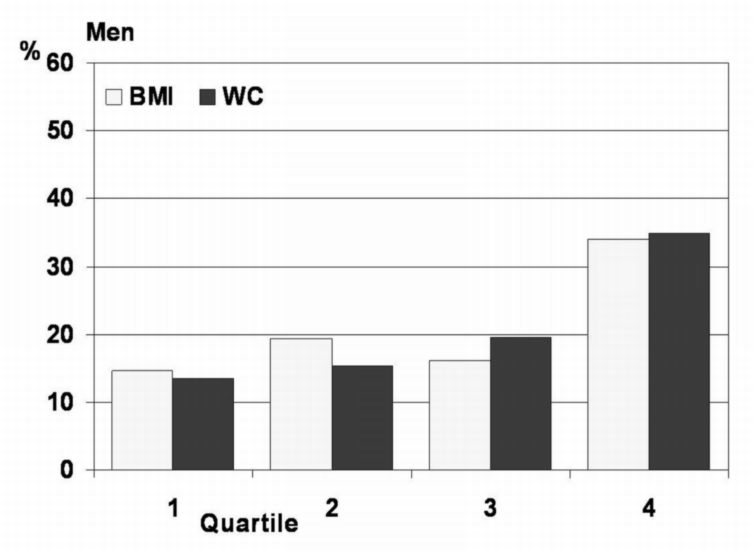
Of all considered interaction effects, the only significant interaction was found in women between waist circumference and physical activity (P=0.027). The association between waist circumferences and pain was less strong in women who were more physically active as compared to women who were less physically active. In men, effect modification was observed between BMI and diabetes (P=0.014) and cancer (P=0.094) and between waist circumference and diabetes (P=0.069). The associations were stronger in men with diabetes, the association of waist circumference with pain was less strong in men with cancer. P-values of the other effect modifiers tested were all higher than 0.10.

Longitudinal analyses

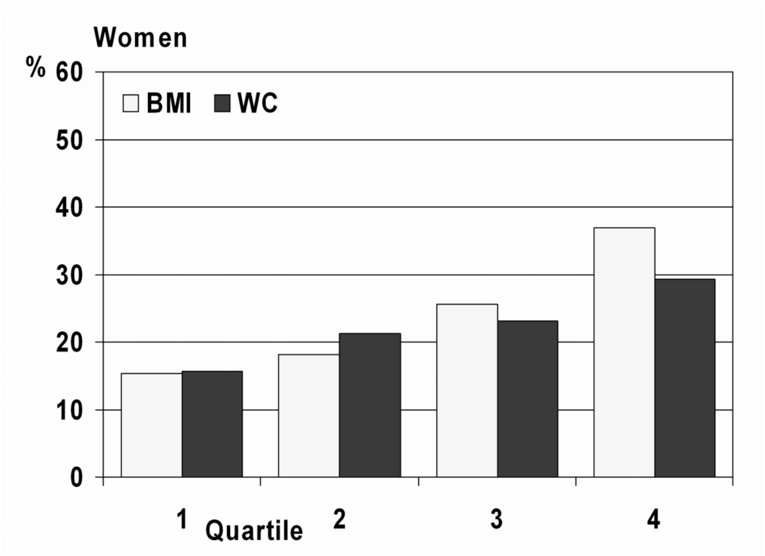
Of the men without pain at baseline (N=576), 13.2% developed pain during the 3-year follow-up period, the incidence of pain after 3 years of follow-up was 19.1% in women (N=451). Because the results did not change after adjustment for the potential confounders, only the results of the fully adjusted analyses are shown. The ORs (CI) for incident pain during the 3-year follow-up period in men and women were 1.36 (1.02-1.80) and 1.24 (0.94-1.64) per SD higher BMI. Comparing the highest quartile of BMI with the lowest, ORs (CI) for incident pain were 2.23 (1.08-4.61) in men and 1.86 (0.88-3.93) in women. The ORs (CI) for incident pain per SD increase of waist circumference were not significant (1.23 (0.94-1.62) in men and 1.03 (0.79-1.36) in women). Men and women in the highest quartiles of waist circumference did not have significantly higher ORs (CI) compared to those in lowest quartiles (1.86 (0.88-3.95) and 1.11 (0.47-2.65) respectively). Considering all participants with data on pain at 3-year follow-up (N=1478), multiple linear regression analyses showed no significant association between BMI or waist circumference and the 3-year change in pain score during the follow-up period (results not shown).

Figure 2. Percentage of older men (a) and women (b) without pain at baseline, with reported incident pain after 6 years of follow-up, according to sex-specific quartiles of BMI or waist circumference.

a)



b)



Of the men without pain at baseline (N=469) 20.7% reported incident pain after 6 years of follow-up, 23.2% of the women (N=426) developed pain during the 6-year follow-up period. In both men and women, a significant trend across the BMI or waist circumference quartiles was found (Figure 2) (P-values ≤ 0.01). Adjusted ORs were two to three fold higher for the highest quartile of BMI compared to the lowest quartile (Table 3). The association of BMI with the change in pain score was considered in all participants with data on pain at 6-year follow-up (N=1271). The change of the pain score during 6 years of follow-up was significantly related to a SD increase in BMI in women 0.207 (SE=0.051, P≤0.0001), but not in men 0.043 (SE=0.048, P=0.371). Similar ORs (Table 3) and regression coefficients (0.138 (SE=0.050, P=0.006) in women and 0.073 (SE=0.045, P=0.108) in men) were found for waist circumference.

Longitudinally, significant effect modification by age was observed for the association between both BMI (P=0.014) and waist (P=0.042) and incident pain in men, but not in women. Using stratified analyses by age group, the associations were more pronounced in the young-old men (55-70 y) but no longer significant in the old-old men (70+ y). In the young-old men, the OR (CI) for incident pain after 6 years of follow-up per SD increase of BMI was 1.82 (1.22-2.71) and the OR (CI) was 1.89 (1.27-2.82) per SD increase of waist circumference. In the old-old men ORs (CI) were 1.03 (0.67-1.57) and 1.20 (0.82-1.75), respectively. A significant interaction effect was found between BMI and cancer in men (P=0.063), the association between BMI and pain was less strong in men with cancer.

Table 1. Characteristics of the study sample according to baseline pain status.

Sex	Men (N=1012)			Women (N=988)		
Pain status	**No pain**	**Pain**	**P value**	**No Pain**	**Pain**	**P value**
N (%)	753 (74.4)	259 (25.6)		596 (60.3)	392 (39.7)	
Age(y) (SD)	69.4 (8.3)	71.5 (9.1)	< 0.01	67.9 (8.1)	71.0 (8.5)	< 0.01
BMI(kg/m^2) (SD)	25.8 (3.1)	26.6 (3.3)	< 0.01	26.8 (4.0)	28.3 (5.1)	< 0.01
Waist Circumference (cm) (SD)	98.5 (9.8)	101.6 (10.1)	< 0.01	94.3 (11.5)	98.1 (12.7)	< 0.01
Physical activity (min/day)(SD)	145 (106)	124 (93)	< 0.01	211 (114)	191 (111)	< 0.01
Smoking status (%)						
Current	31.5	34.7		15.8	17.6	
Former	61.4	57.1	0.47	29.0	32.1	0.31
Never	7.0	8.1		55.2	50.3	
Education (%)						
Low	25.5	37.5		46.1	52.0	
Medium	33.1	27.5	< 0.01	33.4	29.8	0.19
High	41.5	17.9		20.5	18.1	
Depressive symptoms (%)	6.3	17.6	< 0.01	10.8	25.7	< 0.01
Chronic conditions						
Lung disease	10.1	19.3	< 0.01	7.9	12.2	0.02
Cardiovascular disease	21.2	30.9	< 0.01	10.4	19.6	< 0.01
Arthritis	13.4	49.4	< 0.01	28.5	62.5	< 0.01
Atherosclerosis	6.8	18.9	< 0.01	3.9	15.6	< 0.01
Diabetes Mellitus	5.2	8.9	0.03	4.9	7.9	0.05
Stroke	4.0	12.0	< 0.01	2.2	5.9	< 0.01
Cancer	5.6	8.9	0.06	10.4	11.7	0.51

Table 2. Odds ratios (OR) for prevalent pain at baseline.

	Model 1		**Model 2**		**Model 3**	
Men (n =1012)	OR	95% CI	OR	95% CI	OR	95% CI
BMI						
per SD (3.15 kg/m^2)	1.29	1.11-1.46	1.36	1.17-1.59	1.24	1.05-1.47
< 23.9 kg/m^2	1.0		1.0		1.0	
≥ 23.9 - < 26.0 kg/m^2	1.23	0.79-1.92	1.33	0.83-2.14	1.27	0.76-2.12
≥ 26.0 - < 27.8 kg/m^2	1.79	1.17-2.74	2.03	1.27-3.21	1.74	1.05-2.87
≥ 27.8 kg/m^2	2.26	1.49-3.45	2.61	1.67-4.10	2.16	1.32-3.54
Waist circumference						
per SD (9.95 cm)	1.32	1.14-1.53	1.35	1.16-1.58	1.23	1.04-1.45
< 93 cm	1.0		1.0		1.0	
≥ 93 - <99 cm	1.14	0.74-1.75	1.21	0.76-2.91	1.17	0.65-1.76
≥ 99 - <105.4 cm	1.43	0.94-2.19	1.68	1.06-2.64	1.41	0.86-2.31
≥ 105.4 cm	1.92	1.27-2.91	2.04	1.32-3.16	1.66	1.03-2.67
Women (n = 988)	OR	95% CI	OR	95% CI	OR	95% CI
BMI						
Per SD (4.52 kg/m$^{2)}$	1.39	1.12-1.59	1.40	1.21-1.62	1.34	1.15-1.57
< 24.2 kg/m^2	1.0		1.0		1.0	
≥ 24.2 - < 27.2 kg/m^2	0.94	0.65-1.36	0.99	0.66-1.47	0.95	0.62-1.45
≥ 27.2 - < 30.2 kg/m^2	1.19	0.82-1.74	1.17	0.78-1.74	1.13	0.73-1.74
≥ 30.2 kg/m^2	2.17	1.49-3.16	2.21	1.48-3.29	1.93	1.26-2.95
Waist circumference						
Per SD (12.12 cm)	1.30	1.14-1.49	1.31	1.14-1.52	1.32	1.13-1.54
< 87 cm	1.0		1.0		1.0	
≥ 87 - < 95 cm	0.82	0.56-1.20	0.79	0.53-1.17	0.74	0.48-1.14
≥ 95 - < 104 cm	1.14	0.78-1.66	1.16	0.78-1.73	1.24	0.81-1.90
≥ 104	1.86	1.27-2.72	1.85	1.23-2.78	1.80	1.16-2.79

[a] Odds ratios (OR) with 95% confidence intervals (CI) for prevalent pain at baseline per standard deviations (SD) increase and according to quartiles of BMI or waist circumference; [b] Model 1: Adjusted for age and education, model 2: Additionally adjusted for depression, smoking and physical activity, model 3: Additionally adjusted for chronic diseases.

Table 3. Odds ratios (OR) for incident pain after 6 years of follow-up.

Men (N = 469)	**OR**	**95% CI**	**Women (N = 426)**	**OR**	**95% CI**
BMI			BMI		
per SD (2.99 kg/m^2)	1.40	1.09-1.81	per SD (4.33 kg/m^2)	1.66	1.26-2.18
< 24.0 kg/m^2	1.00		< 24.4 kg/m^2	1.00	
≥ 24.0 < 26.2 kg/m^2	1.07	0.52-2.19	≥ 24.4 < 27.1 kg/m^2	1.02	0.56-2.23
≥ 26.2 < 27.9 kg/m^2	0.84	0.44-2.02	≥ 27.1 < 30.0 kg/m^2	1.67	0.91-3.49
≥ 27.9 kg/m^2	2.34	1.17-4.72	≥ 30.0 kg/m^2	2.78	1.36-5.70
Waist circumference			Waist circumference		
per SD (9.83 cm)	1.49	1.15-1.93	per SD (11.73 cm)	1.34	1.03-1.76
< 92.7cm	1.00		< 86.9 cm	1.00	
≥ 92.7 < 98.6 cm	1.16	0.54-2.49	≥ 86.9 < 94.5 cm	1.28	0.64-2.57
≥ 98.6 < 104.9 cm	1.37	0.65-2.87	≥ 94.5 < 103 cm	1.71	0.85-3.46
≥ 104.9 cm	2.76	1.35-5.61	≥ 103 cm	1.99	0.95-4.20

[a] Odds ratios(OR) with 95% confidence intervals(CI) for incident pain after 6 years of follow-up per standard deviations (SD) increase and according to quartiles of BMI or waist circumference.

[b] Adjusted for age, education, depression, smoking, physical activity and chronic diseases.

Additional analyses

In order to be able to compare our results with studies using WHO criteria, analyses were also performed using the WHO categorizations of obesity instead of using sex-specific quartiles. ORs(CI) for incident pain after 6 years of follow up in obese persons (BMI ≥30 kg/m^2) compared to normal weight persons (18.5 ≤ BMI < 25 kg/m2) were 2.21(0.94-5.18) in men and 2.80(1.42-5.53) in women. For men and women with a high-risk waist circumference (≥102cm and ≥88cm) the ORs(CI) were 2.44(1.31-4.57) and 1.59(0.65-3.88) compared to those with a normal (<94cm and <80cm) waist. However, these results should be carefully interpreted since the categories according the WHO criteria were unevenly distributed and the reference groups were small.

To investigate the role of (body) weight change during follow-up in the associations under study, we additionally adjusted for 6-year weight change in the longitudinal analyses. The associations between the anthropometric measures and incidence of pain were marginally attenuated, but remained significant, suggesting no confounding by weight change. Furthermore, effect modification by weight change was considered, no significant interaction was found between weight change and the anthropometric measures. The associations in weight stable (weight change ≤0.5% of body weight) participants, were not different from those in subjects whom either lost (weight los <0.5%) or gained (weight gain >0.5%) weight.

As reported, BMI and waist circumference at baseline were associated with an increased odds of pain at follow-up. To explore whether pain at baseline was also associated with an increased BMI or waist circumference at follow-up, reversed analyses were performed. Pain was not associated with weight gain, defined by ≥5% increase of bodyweight during 6 years of follow up. Using the same covariables used in model 3 of the initial analyses, ORs(CI) for weight gain in participants with pain compared to participants without pain were 0.88 (0.47-1.66) in men and 1.26 (0.77-2.06) in women. In addition, no association was found between the continuous pain score and weight change in men (B=-0.41, SE= 0.26, P=0.11). In women, a significant regression coefficient of 0.50(SE=0.19, P=0.007) was found for the association of the pain score with weight change(kg) after 6 years of follow-up with adjustment for potential confounders.

Discussion

In our study sample of older persons, almost 40% of the women and 25% of the men reported pain. A clear positive association was found between the level of overweight and the prevalence and incidence (after 6 years of follow-up) of pain in older men and women. Persons in the highest quartile of BMI were twice as likely to have pain compared to the lowest. Two to three-fold higher ORs were found for incident pain after 6 years of follow-up comparing the highest with the lowest quartile of BMI. Similar associations were found when waist circumference was used as an indicator of obesity.

As reported in previous studies (8, 10), we found that prevalence rates of pain were higher in women than in men. Although the type of pain which was investigated differed widely between studies, the ORs for prevalent pain in overweight/obese persons compared to normal weight persons of our study are similar to previously reported results (9-11). Adamson et al. (10) found approximately two-fold increased risks for prevalent lower limb joint pain in obese compared to non obese individuals aged 58 years. The ORs in that study ranged from 1.49 for ankle pain to 2.42 for knee pain after adjustment for potential confounders. Andersen et al. (9) found increasing (sex-, race-, and age-specific) prevalence rates of knee, hip and back pain with higher BMI categories among U.S. adults aged 60 years and over. In a study conducted by Patterson and colleagues (11), ORs of 1.8 in men and 1.5 in women were found for neck, back or joint pain and ORs of 1.2 and 1.6 for frequent headaches, comparing severely obese (BMI ≥35 kg/m^2) with normal weight (BMI 18.5-25 kg/m^2) older adults. Even after excluding persons with osteoarthritis the associations with neck, back and joint pain remained.

Previous studies were not able to identify whether the pain was a cause or a consequence of obesity because of their cross-sectional design. The prospective design of the present study therefore contributes to our understanding of the association between obesity and pain. Our results suggest that obesity is more likely to be a cause of the development of pain, rather than a consequence of in older men and women. Longitudinal analyses also showed that the association of BMI with incident pain was stronger after 6 than after 3 years of follow-up, especially in women, increasing to a two to three-fold higher OR comparing the highest with the lowest quartiles of BMI. This suggests that the consequences of overweight in older adults regarding pain may become particularly important on the long-term.

In contrast to previous studies, the present study used two different obesity indicators, both objectively measured. It has been suggested that waist circumference is a better indicator of obesity and obesity-related health risk as compared with BMI, particularly in elderly (4, 15, 17). However, only small differences between the associations of BMI and waist circumference with the prevalence and incidence of pain were found. General obesity and abdominal obesity seem to influence pain to a similar extent. Additional analyses including both BMI and waist circumference in a single model showed that the association of BMI with pain remained more apparent than the association of waist circumference with pain (results not shown).

The present study assessed overall body pain rather than pain in specific parts of the body. The questionnaire used to assess pain in this study did not include questions about the severity or the chronicity of the pain, nor the pain site. As a result, no conclusions about an association between obesity and pain severity, chronicity and site can be made. However, the fact that pain was assessed by a questionnaire which contained questions about pain in situations and activities relevant to daily life (standing, walking, sitting and changing position) favors the use of the subscale of the Nottingham Health Profile questionnaire to assess pain. A limitation of the study is that treatment of pain was not taken into account. The fact that a large part of the sample experienced pain (even though pain medication might have been used) suggests that pain might be undertreated in our study population as suggested in previous studies (6). However, if indeed some subjects did not report pain because they were treated for pain, this would lead to an underestimation of the true associations.

Our data showed that the odds of developing pain is higher in persons with higher BMI or waist circumference at baseline, even after taking weight change into account. Disease history and severity, and changes in potential confounders during the follow-up period were not taken into account in longitudinal analyses. Chronic diseases were added to the final model because they could possibly mediate in the association between obesity and pain. One could argue that adjustments for chronic diseases should therefore not be made. The pain caused by the diseases present at baseline could also be caused by obesity. In this case, the association would be underestimated when adjustments for chronic diseases are made. After adding chronic diseases to the model, the association between obesity and pain in older adults was somewhat attenuated but remained statistically significant, even after adjustment for arthritis. Thus, the relationship existed independent of the presence of chronic diseases (at baseline).

The mechanisms explaining the association between overweight and pain may be multifactorial. In our study, chronic diseases present at baseline only explained a very small part of the association. Wear and tear of the body by the increased mechanical load with higher BMI or waist circumference has previously been suggested to be a cause of the association (26). Studies considering the association between BMI and joint pain have found a greater influence of BMI on weight bearing joints than on other joints (10). In our study, additional analyses using a dichotomous pain score based only on the weight bearing activities (standing, changing position and/or walking) of the pain questionnaire as dependent variable were carried out. In men, ORs were similar to the ORs found using all items of the pain scale to construct the dichotomous outcome pain and in women the ORs were somewhat higher (results not shown). Metabolic factors, which are particularly associated with abdominal obesity, have also been proposed as a possible explanation for the association between overweight and pain (26). Because no differences in the associations with pain between BMI and waist circumference were found, this explanation seems less likely. The interaction effect found between waist circumference and physical activity in women indicates that physical activity might be a protective factor in the association between obesity and pain. The interaction effect, however, was not found in men or in the longitudinal analyses. Clearly, further research is needed to determine underlying mechanisms.

Lamb et al. (27) found a strong interaction between pain and obesity in the association with mobility. The risk of mobility limitations in obese women with pain was found to be greater than could be attributed to the additive effects of pain and obesity. Negative consequences of pain such as immobility, (functional) disability and depression are reported to be more frequent and more severe in overweight and/or obese persons (27, 28). Thus, the quality of life in obese older adults will be negatively affected not only by the pain itself, but also by the stronger negative consequences of pain on for example mobility.

Few intervention studies considered weight loss in relation to pain reduction. In a meta-analyses of four studies, meta-regression models showed inconsistent results regarding positive effects of weight loss on pain in obese patients diagnosed with knee osteoarthritis after a lifestyle intervention (29). In severely obese subjects, surgical obesity treatment has been shown to reduce the frequency of musculoskeletal pain (30). These results suggest that obese persons with pain might benefit from a weight loss intervention. However, future studies are needed to confirm these findings.

It can be concluded that obese older men and women with obesity have a higher risk of developing pain during daily activities. The current study importantly contributes to the understanding of the causal direction of the association between obesity and pain, and may contribute to the future development of effective interventions. Because of the high prevalence of pain in older adults and the consequences for the quality of life, development of pain might be a well communicable health consequence to emphasize towards obese patients in the clinical setting. Future research is required to investigate whether loosing weight would be beneficial in obese older adults with pain or in older adults at increased risk to develop pain because of their obesity.

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