

Systematic Reviews and Meta- and Pooled Analyses

Obesity as a Risk Factor for Sciatica: A Meta-Analysis

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The aim of this study was to assess the associations of overweight and obesity with lumbar radicular pain and sciatica using a meta-analysis. We searched the PubMed, Embase, Scopus, and Web of Science databases from 1966 to July 2013. We performed a random-effects meta-analysis and assessed publication bias. We included 26 (8 cross-sectional, 7 case-control, and 11 cohort) studies. Both overweight (pooled odds ratio (OR) = 1.23, 95% confidence interval (CI): 1.14, 1.33; $n = 19,165$) and obesity (OR = 1.40, 95% CI: 1.27, 1.55; $n = 19,165$) were associated with lumbar radicular pain. The pooled odds ratio for physician-diagnosed sciatica was 1.12 (95% CI: 1.04, 1.20; $n = 109,724$) for overweight and 1.31 (95% CI: 1.07, 1.62; $n = 115,661$) for obesity. Overweight (OR = 1.16, 95% CI: 1.09, 1.24; $n = 358,328$) and obesity (OR = 1.38, 95% CI: 1.23, 1.54; $n = 358,328$) were associated with increased risk of hospitalization for sciatica, and overweight/obesity was associated with increased risk of surgery for lumbar disc herniation (OR = 1.89, 95% CI: 1.25, 2.86; $n = 73,982$). Associations were similar for men and women and were independent of the design and quality of included studies. There was no evidence of publication bias. Our findings consistently showed that both overweight and obesity are risk factors for lumbar radicular pain and sciatica in men and women, with a dose-response relationship.

back pain; hospitalization; intervertebral disc displacement; obesity; overweight; sciatica

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

Low back pain is the number 1 debilitating condition globally, and in 2010 it contributed 10.7% to the total number of years lived with disability (1). Among low back disorders, sciatica and lumbar disc herniation are the most persistent and disabling conditions (2). Lumbar radicular pain is defined as low back pain radiating to the leg below the knee level, while sciatica is defined as lumbar radicular pain along with clinical findings suggestive of nerve root compression (2, 3). Sciatica is usually caused by compression or irritation of one of the lumbosacral nerve roots, often due to derangement of a lumbar intervertebral disc such as lumbar disc herniation (4), although other causes for sciatica have also been reported (5).

The prevalence of lumbar radicular pain during the preceding 12 months ranges between 13% and 36% (6–8) and that of clinically defined sciatica between 2% and 5% (9–11). The incidence of lumbar radicular pain increases with age, whereas that of nonspecific low back pain tends to decrease with

age (12). Lumbar radicular pain and sciatica have poorer prognoses than nonspecific low-back-pain syndromes, and they can cause prolonged work disability (2, 13).

The etiologies of lumbar radicular pain and sciatica are not well known, but they seem to be multifactorial. Known risk factors for lumbar radicular pain and sciatica include occupational workload, such as carrying heavy items, bending, or kneeling (14, 15), and body height (16, 17). Lifestyle risk factors have also been suggested as possible risk factors for lumbar radicular pain and sciatica (18).

Obesity is a prevalent public health problem and is associated with various outcomes—in addition to cardiovascular diseases, obesity has recently been associated with musculoskeletal disorders (18, 19). Previously we conducted a systematic review on the associations of weight-related factors with lumbar radicular pain and sciatica (18). Based on a qualitative assessment of 13 studies, we found associations of weight-related factors with lumbar radicular pain or sciatica

in 1 out of 4 cross-sectional studies, 3 out of 4 case-control studies, and 3 out of 5 cohort studies. Thus, so far it is unknown whether only obesity is associated with lumbar radicular pain and sciatica or both overweight and obesity are associated. We also performed a meta-analysis on the relationships of overweight and obesity with nonspecific low back pain (19). Both overweight and obesity were associated with an increased risk of nonspecific low back pain.

So far, the roles of overweight and obesity in lumbar radicular pain or sciatica, as more specific or objectively assessed outcomes, have not been addressed with a meta-analysis. Our aim was to carry out a meta-analysis to estimate the magnitude of the associations of overweight and obesity with lumbar radicular pain and/or sciatica. To include studies published after our qualitative review, a period comprising the past 8 years, we updated our search and reassessed the previous studies regarding their eligibility for the meta-analysis.

METHODS

Search strategy

We conducted comprehensive literature searches in PubMed, Embase, Scopus, and Web of Science using predefined keywords (lumbar radicular pain *or* sciatic pain *or* sciatic syndrome *or* lumbosciatic syndrome *or* lumbosacral radicular syndrome *or* sciatica *or* intervertebral disk displacement *or* disc herniation *or* herniated lumbar disc *or* prolapsed lumbar disc *or* disc protrusion *or* herniated nucleus pulposus *or* spinal diseases *or* back pain *or* back disorders) and (BMI *or* body mass index *or* overweight *or* underweight *or* obesity *or* body weight *or* waist circumference *or* waist hip ratio). We used both Medical Subject Headings and text words in PubMed, and we used Emtree terms and text words in Embase. We included all languages, even though we did not identify any eligible non-English paper. We excluded case reports, reviews, guidelines, editorials, and letters. We checked the reference lists of included articles for additional studies. We looked at the full text of studies on the associations of smoking and physical activity/inactivity with lumbar radicular pain or sciatica for additional studies on weight-related factors (18). Moreover, we looked at the full text of studies on the associations of overweight/obesity, smoking, and physical activity/inactivity with low back pain to identify additional studies on lumbar radicular pain or sciatica (19, 20).

Selection of the studies

The first author (R.S.) assessed the titles, abstracts, and full texts of the studies found and investigated whether the studies examined the associations of weight-related factors with lumbar radicular pain or sciatica. We included cross-sectional and cohort studies as well as both population-based and hospital-based case-control studies in the systematic review. To be eligible for a meta-analysis, the studies had to report quantitative data on the association between overweight/obesity and lumbar radicular pain or sciatica. We also contacted several authors (16, 21–25) for additional information or results. Some of them (16, 22, 25) provided additional information or new results.

Quality assessment

Two reviewers (R.S. and T.L.) independently assessed the quality of the studies using the Effective Public Health Practice Project tool for observational studies (26). Summary quality scores may provide a useful overall assessment. However, the scales are not recommended for assessment of the quality of studies in systematic reviews (27). Therefore, we assessed 5 main domains: selection bias, performance bias, detection bias, confounding, and attrition bias (see Web Table 1, available at <http://aje.oxfordjournals.org/>). Studies conducted among volunteers, studies that included patients with lumbar radicular pain or sciatica without a control group, studies with a response rate less than 50%, and studies not reporting quantitative results that could be used to estimate odds ratios were excluded from the meta-analysis. Disagreements between the 2 reviewers were resolved by consensus.

Meta-analysis

We used World Health Organization recommended cutoff points for body mass index (BMI; weight (kg)/height (m)²) and defined overweight as BMI 25–29.9 and obesity as BMI ≥ 30 (28, 29). We performed meta-analyses for overweight or obesity and defined it as BMI ≥ 25 . We also included studies that reported an estimate for BMI ≥ 24 (30) or >24.3 (31) for overweight/obesity or an estimate for BMI >27.5 (32), ≥ 28 (30, 33), or ≥ 29 (31, 34, 35) for obesity. One study conducted among adolescents defined overweight or obesity by using internationally acceptable age-specific and sex-specific cutoff points for BMI (36), and it was also included in the meta-analysis.

For studies that analyzed BMI as a continuous variable (1-unit increase in BMI), we estimated the effect size by multiplying the log odds ratio by 5 for overweight and by 10 for obesity. For 1 study (37) that reported an estimate for a 1-standard-deviation increase in BMI, we estimated the effect size by dividing the log odds ratio by the standard deviation and then multiplying by 5 for overweight and by 10 for obesity.

We pooled the estimates for the subgroups of BMI to obtain an overall estimate for overweight or obesity. We also pooled the estimates for subgroups of the study population (e.g., men and women) to obtain an estimate for the total study population. We calculated a new estimate for overweight or obese subjects for studies that compared normal, overweight, or obese people with underweight subjects (31, 33–35). For these studies, we calculated standard errors from the natural logarithm of the confidence intervals, divided the relative risk/odds ratio for overweight or obesity by the relative risk/odds ratio for normal weight, and then estimated new confidence intervals for the obtained relative risk/odds ratio.

For studies that reported mean BMI in participants with or without sciatica, we calculated the standardized mean difference by dividing the difference between 2 mean values by the pooled standard deviation. We then converted the standardized mean difference to an odds ratio (38).

One cross-sectional study (39) did not report a confidence interval for the estimate. We calculated the standard error (SE) of the estimate from this study using the following formula: $SE = \log(\text{odds ratio})/Z \text{ value}$ (40).

We used a random-effects meta-analysis. The estimate from a random-effects meta-analysis is more conservative than that from a fixed-effect meta-analysis (40). Similar results were reported from cross-sectional, case-control, and cohort studies (Table 1). Therefore, we combined all designs in a single analysis. Four cohort studies reported the relative risk of hospitalization or surgery due to lumbar disc herniation (16, 33, 35, 41) for overweight or obese subjects. Since the incidence rate of lumbar disc herniation was below 1% in those studies, the odds ratios and relative risks were identical. Thus, we did not convert the relative risks to odds ratios.

We assessed the presence of heterogeneity across the studies by means of the I^2 statistic (42). The I^2 statistic shows the total variation across studies that is not due to chance. An I^2 statistic less than 25% indicates a small amount of inconsistency, and more than 50% indicates a large amount of inconsistency (43). We used meta-regression to determine whether study-level covariates accounted for the observed heterogeneity (44).

To assess publication bias, we used a funnel plot, which compared the sizes of the overweight/obesity effects with their standard errors. We used the Egger regression test to examine funnel plot asymmetry and the trim-and-fill method to

explore the number of missing studies due to publication bias (45, 46). Statistical significance for publication bias was based on a P value less than 0.10 (47). We used Stata, version 10 (StataCorp LP, College Station, Texas), for meta-analysis.

RESULTS

Our searches initially identified 5,303 abstracts (Web Figure 1). The first author (R.S.) looked at the full text of 491 relevant study reports on the associations between weight-related factors and low back pain or lumbar disc disorders. There were 43 relevant studies on the associations of weight-related factors with lumbar radicular pain or sciatica. We excluded 12 studies conducted among patient populations that did not have a control group, 2 studies on volunteers, 2 studies with no quantitative data for estimation of the odds ratio, and 1 study with a response rate of 40%. Finally, we included 8 cross-sectional studies, 7 case-control studies, and 11 cohort studies on the association between BMI and lumbar radicular pain or sciatica in the meta-analysis (Web Table 2). Of the 26 studies included in this meta-analysis, 8 studies were on lumbar radicular pain (6–8, 25, 30, 34, 37, 48),

Table 1. Associations of Study Design, Sex, and Methodological Quality With the Size of the Relationship Between Overweight or Obesity and Lumbar Radicular Pain or Sciatica (Sensitivity Analysis) in 26 Studies Included in a Meta-Analysis, 1966–2013

Study Characteristic	Overweight				Overweight or Obesity				Obesity			
	No. of Studies	OR	95% CI	I^2 , %	No. of Studies	OR	95% CI	I^2 , %	No. of Studies	OR	95% CI	I^2 , %
Total	17	1.17	1.12, 1.22	0	25	1.32	1.19, 1.46	86.9	19	1.36	1.25, 1.48	32.2
Study design												
Cross-sectional	5	1.15	1.06, 1.25	0	6	1.20	1.12, 1.28	1.6	7	1.37	1.21, 1.56	23.4
Case-control	3	1.15	1.02, 1.30	17.1	7	1.45	1.05, 2.00	95.4	3	1.34	1.17, 1.54	0
Cohort	9	1.19	1.12, 1.25	0	12	1.26	1.16, 1.38	47.7	9	1.40	1.18, 1.65	50.4
Sex of participants												
Men	9	1.24	1.15, 1.33	0	13	1.26	1.18, 1.34	0	10	1.37	1.21, 1.54	0
Women	9	1.15	1.09, 1.22	0	13	1.23	1.14, 1.33	37.3	9	1.33	1.19, 1.49	36.6
Confounding												
Weak	10	1.15	1.10, 1.21	0	12	1.19	1.13, 1.25	23.3	10	1.30	1.18, 1.43	30.9
Moderate/strong	7	1.23	1.12, 1.35	0	13	1.43	1.16, 1.77	90.6	9	1.47	1.28, 1.69	16.2
Selection bias												
Weak	7	1.16	1.08, 1.25	22.0	11	1.47	1.18, 1.82	94.1	8	1.48	1.21, 1.82	69.0
Moderate/strong	10	1.18	1.11, 1.25	0	14	1.23	1.17, 1.28	0	11	1.36	1.25, 1.47	0
Performance bias												
Weak	7	1.18	1.11, 1.25	0	10	1.39	1.12, 1.73	93.6	7	1.35	1.22, 1.50	0
Moderate/strong	10	1.16	1.09, 1.23	3.6	15	1.22	1.14, 1.31	37.6	12	1.40	1.23, 1.59	50.3
Detection bias												
Weak	8	1.14	1.07, 1.21	0	16	1.34	1.13, 1.58	90.8	8	1.34	1.21, 1.48	0
Moderate/strong	9	1.19	1.12, 1.26	0	9	1.25	1.16, 1.36	45.9	11	1.41	1.24, 1.60	49.3
Attrition bias												
Weak	11	1.16	1.10, 1.23	15.4	17	1.36	1.18, 1.56	91.2	13	1.38	1.23, 1.55	51.7
Moderate/strong	6	1.20	1.09, 1.32	0	8	1.25	1.16, 1.34	0	6	1.37	1.22, 1.55	0

Abbreviations: CI, confidence interval; OR, odds ratio.

7 were on clinically defined sciatica (9–11, 35, 39, 49, 50), 8 were on hospitalization due to sciatica (16, 17, 22, 23, 31–33, 51), and 4 were on surgery due to lumbar disc herniation (22, 24, 41, 52). One study (22) assessed the association of overweight with hospitalization due to sciatica, as well as surgery due to lumbar disc herniation. Of the 26 studies included in the review, 17 studies reported results for overweight, 25 reported results for overweight/obesity, and 19 reported results for obesity.

Overweight/obesity and lumbar radicular pain or sciatica

The pooled odds ratio for lumbar radicular pain was 1.23 (95% confidence interval (CI): 1.14, 1.33; $I^2 = 0\%$; $n = 19,165$) for overweight and 1.40 (95% CI: 1.27, 1.55; $I^2 = 0\%$; $n = 19,165$) for obesity (Figure 1). The pooled odds ratio for physician-diagnosed sciatica was 1.12 (95% CI: 1.04, 1.20; $I^2 = 0\%$; $n = 109,724$) for overweight and 1.31

(95% CI: 1.07, 1.62; $I^2 = 63.9\%$; $n = 115,661$) for obesity (Figure 2).

The odds ratio for hospitalization due to sciatica was 1.16 (95% CI: 1.09, 1.24; $I^2 = 0\%$; $n = 358,328$) for overweight and 1.38 (95% CI: 1.23, 1.54; $I^2 = 0\%$; $n = 358,328$) for obesity (Figure 3). For surgery due to lumbar disc herniation, the studies reported estimates only for overweight/obesity (Figure 3). The pooled odds ratio was 1.89 (95% CI: 1.25, 2.86; $I^2 = 79.7\%$; $n = 73,982$).

Heterogeneity and meta-regression

In this meta-analysis, the estimates of studies on the association between obesity and clinically defined sciatica were moderately heterogeneous ($I^2 = 63.9\%$; Figure 2), and those of studies on the association between overweight/obesity and surgery due to lumbar disc herniation were highly heterogeneous ($I^2 = 79.7\%$; Figure 3).

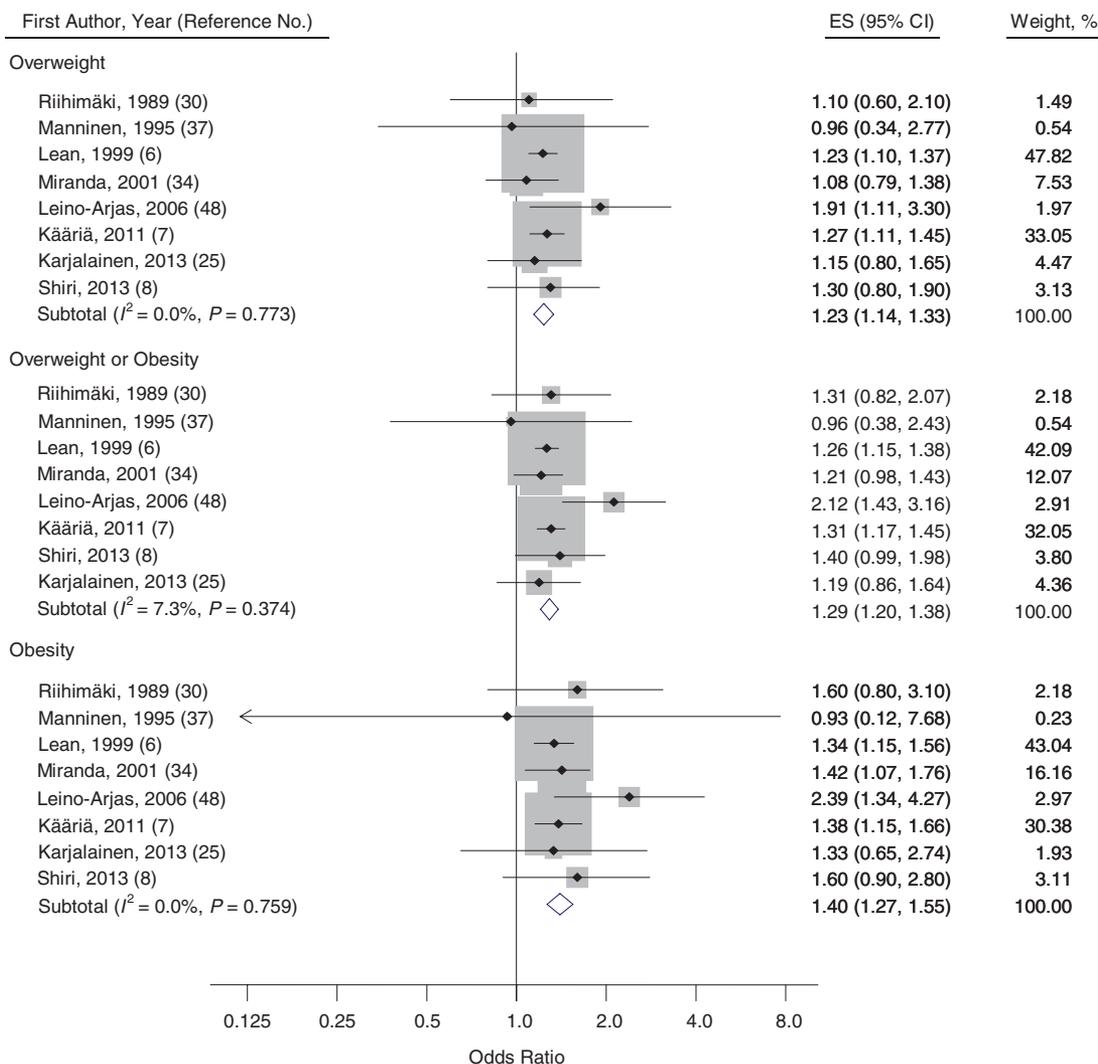


Figure 1. Results of a meta-analysis of the association of overweight or obesity with lumbar radicular pain, 1966–2013. The size of the gray shaded area indicates the weight of each study. Horizontal lines show the 95% confidence intervals (CIs). ES, effect size.

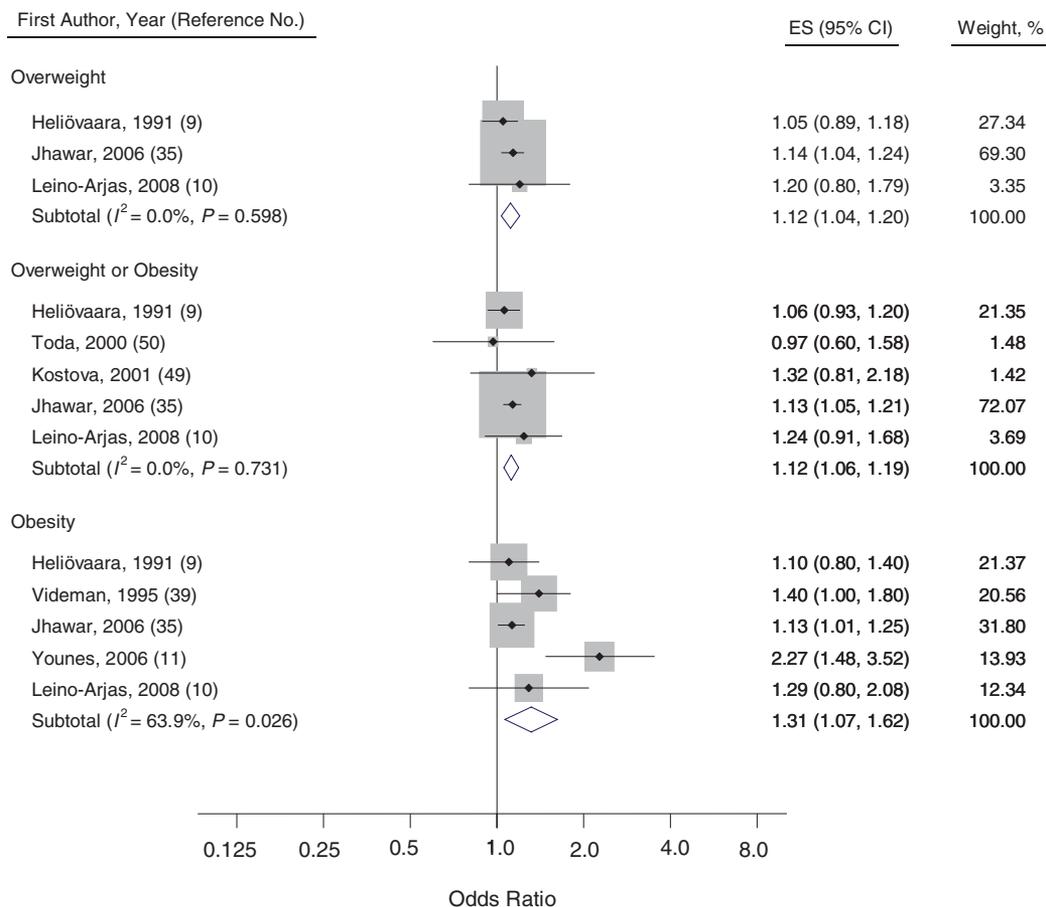


Figure 2. Results of a meta-analysis of the association of overweight or obesity with physician-diagnosed sciatica, 1966–2013. The size of the gray shaded area indicates the weight of each study. Horizontal lines show the 95% confidence intervals (CIs). ES, effect size.

In the meta-regression of the 25 studies on the association between overweight/obesity and lumbar radicular pain or sciatica, the heterogeneity across studies was significantly related to the type of outcome. The heterogeneity was not explained by study design, selection bias, performance bias, detection bias, attrition bias, or adjustment for potential confounders. Moreover, heterogeneity was not related to the use of BMI as a continuous variable or the use of BMI as a categorical variable with 2, 3, or more categories.

After the exclusion of 1 study (11) from the meta-analysis on the association between obesity and clinically defined sciatica, the variation across studies disappeared and the I^2 statistic dropped from 63.9% to 0%. For surgery due to lumbar disc herniation, the I^2 statistic also dropped from 79.7% to 0% when 2 case-control studies conducted in adults (24, 52) (pooled OR = 2.57, 95% CI: 2.28, 2.88; $I^2 = 0\%$) were analyzed separately from 2 cohort studies conducted in adolescents (22, 41) (pooled OR = 1.39, 95% CI: 1.03, 1.87; $I^2 = 0\%$).

Sensitivity analysis

In stratified analyses of all outcomes combined (Table 1), the effect sizes were smaller in the studies that controlled their

estimates for potential confounders than in studies that reported unadjusted estimates or controlled their estimates for a few confounders only. In separate meta-analyses of different outcomes, only the odds ratio for physician-diagnosed sciatica among obese persons was attenuated in the studies that controlled for potential confounders (for overweight, OR = 1.11, 95% CI: 1.03, 1.20 ($I^2 = 0\%$); for obesity, OR = 1.13, 95% CI: 1.02, 1.24 ($I^2 = 0\%$)) (9, 35). The estimates were similar for lumbar radicular pain (overweight: OR = 1.22, 95% CI: 1.09, 1.36 ($I^2 = 0\%$); obesity: OR = 1.39, 95% CI: 1.21, 1.61 ($I^2 = 0\%$)) (7, 25, 34, 37) and hospitalization due to sciatica (overweight: OR = 1.16, 95% CI: 1.07, 1.27 ($I^2 = 19\%$); obesity: OR = 1.40, 95% CI: 1.22, 1.61 ($I^2 = 14.3\%$)) (16, 17, 23, 32).

The associations of both overweight and obesity with lumbar radicular pain or sciatica were similar in men and women. The pooled odds ratio for obesity was 1.37 (95% CI: 1.21, 1.54) in men and 1.33 (95% CI: 1.19, 1.49) in women. The effect sizes were similar according to study design and according to the presence or absence of selection bias, performance bias, detection bias, and attrition bias. Slight variation in the effect sizes between different types of study designs was due to the unequal distribution of the different types of outcomes.

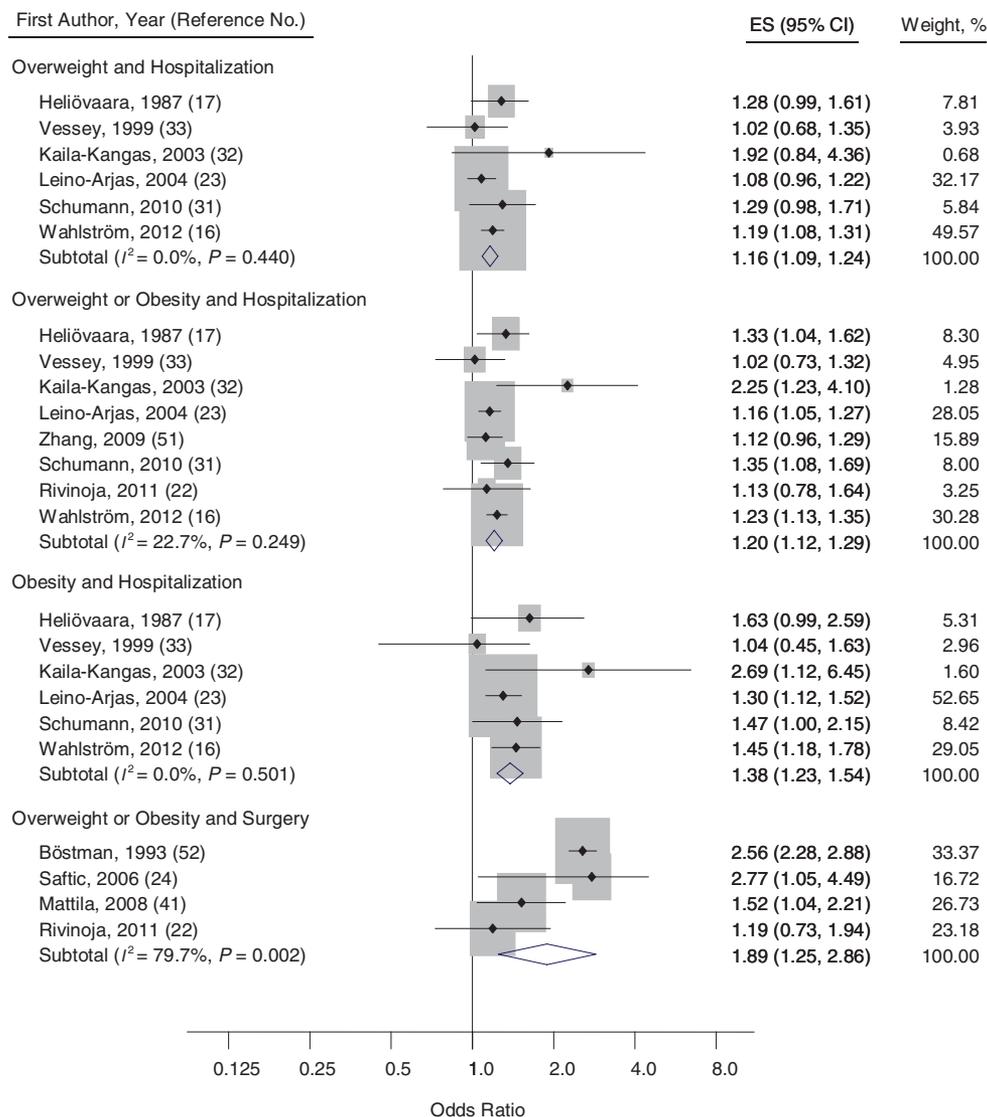


Figure 3. Results of a meta-analysis of the associations of overweight, overweight/obesity, and obesity with hospitalization due to sciatica and of the association of overweight/obesity with surgery due to sciatica, 1966–2013. The size of the gray shaded area indicates the weight of each study. Horizontal lines show the 95% confidence intervals (CIs). ES, effect size.

Publication bias

The pooled odds ratio from 26 studies on overweight/obesity (7 studies) or obesity (19 studies) was 1.45 (95% CI: 1.26, 1.66). The funnel plot of data from the 26 studies included in the meta-analysis was symmetrical (Figure 4). The P value for the Egger test was 0.107. No missing study due to publication bias was imputed using the trim-and-fill method.

DISCUSSION

This meta-analysis showed that both overweight and obesity are consistently associated with an increased risk of lumbar radicular pain and sciatica, with a dose-response relationship among both men and women.

We studied a wide range of outcomes, from self-reported symptoms to objectively assessed outcomes such as clinically verified sciatica with nerve root entrapment, hospitalization, and surgery due to lumbar disc herniation. Although self-reported radicular pain is a subjective outcome, we considered it clinically relevant, since it is associated with poorer quality of life, more functional limitations, and increased use of health-care services compared with nonspecific low back pain (53). We found consistent results for all outcomes. The associations of overweight and obesity with lumbar radicular pain and sciatica were modest. The strengths of the associations were similar to those for nonspecific low back pain (19).

There were sex differences in the prevalence, incidence, and recovery rates of our outcomes of interest; for example,

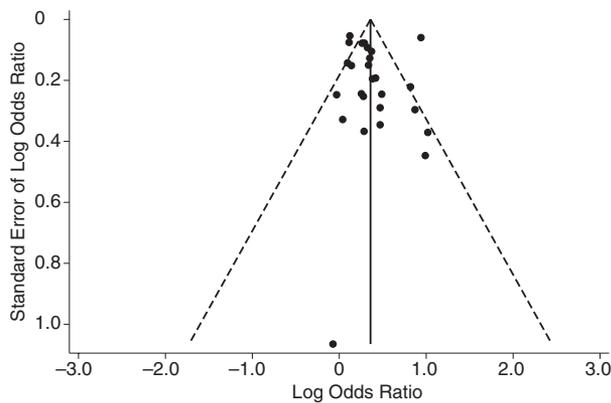


Figure 4. Publication bias in studies on the associations of overweight/obesity (7 studies) or obesity (19 studies) with lumbar radicular pain or sciatica, 1966–2013.

self-reported lumbar radicular pain is more prevalent among women (25), and they seem to experience slower recovery from severe sciatica (54), while men have a higher incidence of hospitalization and surgery due to sciatica (22, 55). However, our meta-analysis showed no sex difference in the association between overweight/obesity and lumbar radicular pain or sciatica. A previous meta-analysis on the associations between obesity and nonspecific low back pain showed stronger associations for women than for men (19). Differences between age groups in the associations of overweight and obesity with lumbar radicular pain and sciatica may also exist. However, the studies included in this meta-analysis did not report any age-specific results.

The mechanisms by which obesity increases the risk of lumbar radicular pain and sciatica are not known. Obesity contributes to the development of chronic, low-grade inflammation through release of inflammatory mediators from excess adipose tissue (56). Obesity-related chronic inflammation may lead to the development of sciatica or the persistence of sciatica symptoms. Leptin is one of the adipocyte-derived adipokines, and high serum leptin levels are associated with obesity and with the development of knee osteoarthritis independently of BMI (57). Leptin is suspected to be involved in reorganizing the cytoskeleton of nucleus pulposus cells (58), but the role of fat tissue-derived leptin in the association between obesity and sciatica is not known.

Obesity may slow down the healing of a disc injury. In a large trial of patients with sciatica (59), obese patients had less improvement in their back-related disability than nonobese patients. The slower recovery was observed irrespective of the type of treatment (i.e., conservative or surgical). Moreover, obesity increases the risk of recurrent disc herniation after lumbar microdiscectomy (60).

Obesity may also interfere with the nutrition of the intervertebral discs, leading to an impaired healing process. In a 3-year follow-up study of sciatica patients (61), BMI was the strongest predictor of incident lumbar artery occlusion, which also suggests that impairment of nutrition can be one of the pathways of obesity's relationship with sciatica.

The results of any meta-analysis depend on the data from the original studies, and publication bias can distort the findings. There was no evidence of publication bias, however. Small studies on lumbar radicular pain or sciatica with nonsignificant results for overweight/obesity have been published due to the fact that the main aim in many of those studies was not to examine the relationship of overweight/obesity with lumbar radicular pain or sciatica. Overweight/obesity in these studies was used as a covariate for adjustment purposes. Furthermore, the associations of overweight and obesity with lumbar radicular pain or sciatica may have been underestimated in studies that did not use the World Health Organization-recommended BMI cutoff points to define overweight and obesity.

Our sensitivity analyses showed that the findings of this meta-analysis are robust. The observed association between overweight/obesity and sciatica did not differ between men and women and was independent of the designs and response rates of the included studies, as well as of the assessment method used for weight and height (self-reported or measured). Moreover, the associations of overweight/obesity with lumbar radicular pain and hospitalization due to sciatica appeared not to be confounded. Exclusion of the studies that did not control for potential confounders attenuated the association of obesity with clinically defined sciatica only. However, the subgroup analysis for clinically defined sciatica had low statistical power because only 2 studies controlled their estimates for potential confounders.

In conclusion, the findings of this study consistently show that both overweight and obesity are risk factors for lumbar radicular pain and sciatica, with a dose-response relationship among both men and women.

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