Obesity as a Risk Factor for Low Back Pain
A Meta-Analysis

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Study Design: A meta-analysis.

Objective: To update the current knowledge about the association between overweight, obesity, and low back pain (LBP) risk, we conducted a meta-analysis of published cohort studies.

Summary of Background Data: The association between obesity and LBP risk has been the research focus in the past decade. However, available data from studies on the association between obesity and LBP remains debatable.

Methods: An extensive English language literature retrieval regarding the association between overweight, obesity, and the risk of LBP incidence was conducted on PubMed and EMBASE databases through December 2015. Meta-analysis for all the included literature was performed by STATA 12.0 to summarize test performance with Forest plots after a heterogeneity test. Moreover, subgroup and sensitivity analyses were performed to examine the potential candidate-effect factors.

Results: A total of 10 cohort studies including 29,748 subjects satisfied the predefined eligibility criteria. The pooled odds ratio (OR) for overweight and obesity compared with normal weight was 1.15 [95% confidence interval (CI), 1.08–1.21) and 1.36 (95% CI, 1.18–1.57), respectively. Moreover, subgroup analysis proved that increased body mass index was associated with an increased incidence of LBP in both men (overweight: pooled OR = 1.16, 95% CI, 1.04–1.31; obesity: pooled OR = 1.36, 95% CI, 1.15–1.61) and women (overweight: pooled OR = 1.24, 95% CI, 1.04–1.50; obesity: pooled OR = 1.40, 95% CI, 1.08–1.82). There was no evidence of publication bias.

Conclusions: Our findings consistently show that overweight and obesity are risk factors for LBP in men and women. Maintaining a healthy body weight may be one of the factors preventing the occurrence of LBP.

Level of Evidence: Level 1.

Key Words: overweight, obesity, low back pain, meta-analysis

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Low back pain (LBP) is well documented to be an extremely common health problem; it is seen as a substantial personal, community, and financial burden globally.[1–3] The diseases with the largest number of years lived with disability in 2010 in the United States were LBP, major depressive disorder, other musculoskeletal disorders, neck pain, and anxiety disorders.[4] LBP is an important factor affecting quality of life in middle-aged and elderly people.[5] As the population ages, the global number of individuals with LBP is likely to increase substantially over the coming decades.[1]

LBP can be caused by a strain of the muscle, arthritis, and degeneration of the bony vertebrae.[6] Comorbid factors with psychological disorders and multiple medical problems, including obesity, smoking, lack of exercise, increasing age, and lifestyle factors, are considered as risk factors for LBP.[7] Several reviews and a meta-analysis investigating the relationship between weight-related factors and LBP have been published.[5,8–11] A meta-analysis showed that obesity was associated with an increased incidence of LBP in men but not in women and overweight was not associated with the incidence of LBP in both sexes.[5] Body weight was considered a possible weak risk indicator of LBP in a review.[9] Several reviews reported that weight or body mass index (BMI) was not a significant predictor of LBP.[8,10,11] These studies had conflicting results in regards to the association between obesity, sex, and LBP.

Because of these reasons, we systematically reviewed the association between overweight, obesity, and LBP risk by meta-analyzing relevant published cohort studies. Furthermore, this meta-analysis detected whether the risk of LBP differs between sexes.

MATERIALS AND METHODS

Search Strategy

A systematic search was performed in the PubMed and EMBASE databases using the keywords "body mass index," "BMI," "overweight," or "obesity" in combination with "low back pain." The search was confined to all the studies published in English before December 2015.

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Furthermore, the reference lists of relevant articles were reviewed to search for additional studies.

Selection Criteria

Studies were included in the meta-analysis if they fulfilled the following criteria: (1) cohort studies in which LBP incidence was an outcome; (2) clear definition of overweight and obesity as defined by the BMI in kg/m^2; and (3) reported effect estimates of the relative risk, hazard ratio, or odds ratio (OR) with 95% confidence intervals (CI).

Articles were excluded by the following criteria: (1) duplicate of previous publication; (2) reviews, comments, meeting abstracts, or other kinds of literature; and (3) case-control studies or cross-sectional studies.

Assessment of Methodological Quality

The Newcastle-Ottawa Scale was used to assess the quality of included studies.[12] The Newcastle-Ottawa Scale is based on 3 major components: selection of the study groups (0–4 stars), comparability of cases and controls (0–2 stars), or cohorts, and ascertainment of exposure or outcome (0–3 stars). A study awarded ≥ 6 stars is considered a high-quality study.

Data Extraction

All data were extracted independently by 2 reviewers according to the above-mentioned selection criteria. The data were extracted using a standardized data extraction form, including the first author's name, publication year, country, population, age and number of participants, tools used for anthropometry, correction factor, and corrected relative risk, hazard ratio, or OR estimates. The extracted results of each reviewer were exchanged for examination after the process, and the difference was resolved by discussion with a third investigator.

Statistical Analysis

BMI was categorized as follows: <18.5, 18.5–24.9, 25.0–29.9, and ≥ 30 for underweight, normal weight, overweight, and obese, respectively, according to WHO categories.[13] Studies that defined overweight or obesity by using BMI percentiles were also included in the meta-analysis.[14,15] Meta-analysis was performed for each individual study using STATA 12.0 (StataCorp., College Station, TX). Briefly, the analysis software produced Forest plots as a schematic description of the meta-analysis results. Subgroup analyses were carried out based on sex (male and female), tools used for anthropometry (self-reported and measured), and population (occupational and general).

The statistical heterogeneity among studies was tested with the Cochrane χ^2 (Q test) and I^2 statistic.[16,17] For the Q statistic, statistical significance was set at $P < 0.1$. When heterogeneity was detected, the random-effects model was used.[18] To evaluate the potential for publication bias, a visual inspection of asymmetry in funnel plots was performed, and the symmetry of the funnel plot was assessed by using the rank correlation method (Begg test) and regression analysis (Egger test) ($P < 0.05$ was considered to be representative of a statistically significant publication bias).[19,20] We also conducted a sensitivity analysis in which 1 study was removed and the rest were analyzed to confirm the stability of the overall result.

RESULTS

Characteristics of Studies Included in the Meta-Analysis

All potentially eligible studies investigating the relationship between overweight/obesity and LBP were identified. A flow chart describing the process of study selection is shown in Figure 1. A total of 959 potentially relevant studies were identified by a primary computerized literature search. Through a comprehensive selection, 10 cohort studies representing 29,748 subjects were included in the analysis.[14,15,21–28] The main characteristics of the studies that were included in the meta-analysis are summarized in Table 1.

Association of Overweight, Obesity, and Risk for LBP

As shown in Figure 2, we compared the overweight category with normal weight to estimate the pooled OR. There was a statistically significant association between overweight and the incidence of LBP (pooled OR = 1.15, 95% CI, 1.08–1.21). In Figure 2, the meta-analysis revealed a statistically significant association between obesity and the incidence of LBP compared with normal weight (pooled OR = 1.36, 95% CI, 1.18–1.57).

Subgroup Analysis

The results of subgroup analysis based on sex, tools used for anthropometry, and population are presented in Figure 3. Increased BMI was associated with an increased incidence of LBP in both men (overweight: pooled OR = 1.16, 95% CI, 1.04–1.31; obesity: pooled OR = 1.36, 95% CI, 1.15–1.61) and women (overweight: pooled OR = 1.24, 95% CI, 1.04–1.50; obesity: pooled OR = 1.40, 95% CI, 1.08–1.82). Similar results were

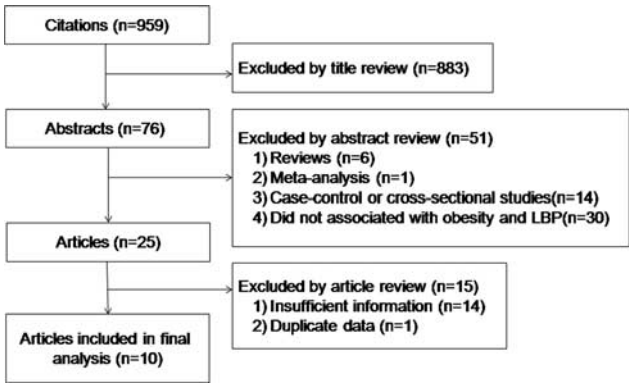

FIGURE 1. Flow diagram of study selection process. LBP indicates low back pain.

TABLE 1. Characteristics of the Included Cohort Studies on Overweight/Obesity and Low Back Pain

References	Country	Population	Age	No. Participants	Tool Used	Study Quality	Adjustment for Covariates
Heuch et al[21]	Norway	General	30–69	18882	Measured	8	Age, education, smoking, work status, physical activity, blood pressure, lipid levels, and time between last meal and blood sampling
Shiri et al[22]	Finland	General	24–39	1224	Measured	8	Age, educational status, occupational status, and smoking
Jensen et al[24]	Denmark	Occupational	Mean = 35	847	Self-reported	6	Age, smoking, social support at work, and influence at work
Zhao et al[23]	Australia, UK, New Zealand	Occupational	21–67	928	Self-reported	6	Demographic, occupational, health, and work-related psychosocial factors
Van Nieuwenhuyse et al[25]	Belgium	Occupational	Mean = 26	322	Self-reported	7	Fingertip-to-floor distance, age, and sex
Miranda et al[26]	Finland	Occupational	19–67	1676	Self-reported	6	Age, heavy lifting, awkward postures, whole-body vibration, smoking, and physical exercise
Andersen et al[27]	Denmark	Occupational	Not given	1513	Self-reported	6	Age, occupational group, and intervention group
Leino-Arjas et al[28]	Finland	Occupational	Not given	544	Measured	7	Age and occupational class
Mustard et al[15]	Canada	General	4–16	1039	Self-reported	7	Full model
Lake et al[14]	UK	General	23	2773	Self-reported	7	BMI at age 7, social class, and psychological distress at 23 y

found in the relation between overweight, obesity, and risk of LBP in both the self-reported studies (overweight: pooled OR = 1.11, 95% CI, 1.02–1.19; obesity: pooled OR = 1.23, 95% CI, 1.11–1.35) and the measured studies (overweight: pooled OR = 1.28, 95% CI, 1.06–1.54; obesity: pooled OR = 1.48, 95% CI, 1.07–2.04). When stratifying for population, overweight was associated with an increased risk of LBP in the occupational population (pooled OR = 1.14, 95% CI, 1.02–1.27), but not in the general population (pooled OR = 1.15, 95% CI, 0.92–1.44). Obesity was associated with an increased risk of LBP in both the occupational population (pooled OR = 1.39, 95% CI, 1.07–1.80) and the general population (pooled OR = 1.31, 95% CI, 1.16–1.48).

Publication Bias and Sensitivity Analysis

No publication bias was found in the literature on BMI and LBP risk in the "overweight" and "obesity" groups based on either Egger test ($P = 0.70$ and 0.10, respectively) or Begg test ($P = 1.00$ and 0.15, respectively). The results of sensitivity analysis are presented in Figure 4. There was no significant variation in the pooled OR by excluding any of the studies, supporting the robustness of our results.

DISCUSSION

Among the 10 cohort studies included in our meta-analysis, evidence showed that overweight and obesity were associated with an increased incidence of LBP. When stratified by the degree of obesity, the overweight studies were associated with a slightly increased risk of LBP, and the results of the obesity studies demonstrated a stronger risk effect. In the subgroup analysis based on sex and tools used for anthropometry, similar trends were observed.

This study is a meta-analysis using current data on the association between obesity and LBP incidence. Although a meta-analysis was previously published, our results are noteworthy because some of our results differ from previous studies and are more reliable because of strictly structured subgroup analysis.

Shiri et al[5] reported that obesity was associated with an increased incidence of LBP in men but not in women and overweight was not associated with the incidence of LBP in both sexes. A previous study by Jensen et al[24] showed that overweight and obesity do not increase the risk for developing LBP among newly educated female health care workers. However, the results of this study's subgroup analysis were inconsistent with those results. Similar to several studies, we found that the risk of LBP does not significantly differ between sexes.[21,28] The present study showed that overweight and obesity could increase the risk of LBP in both men and women.

When we used self-reported height and weight at study entry to calculate BMI, the small error that exists is generally systematic, with an overestimation of height and an underestimation of weight, especially at higher weight.[29–31] Consequently, we could observe a stronger association in the measured studies. The measured studies were more accurate, and the conclusions drawn from them were more credible.

The results of the subgroup analysis demonstrated a stronger association between BMI and LBP in the occupational population than in the general population. Most of the occupational population in this meta-analysis consisted of health care workers and industry workers who were likely to work in a more complex occupational

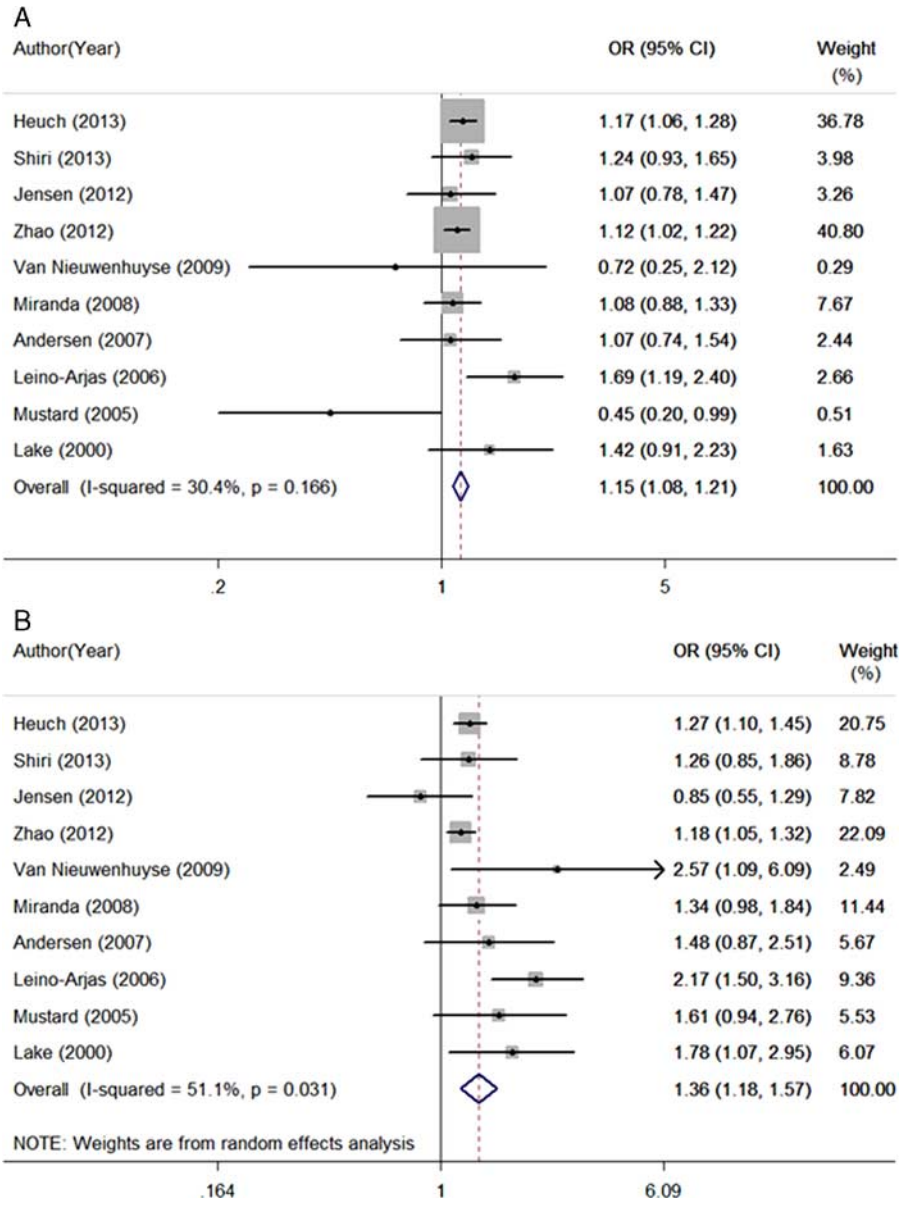

FIGURE 2. Forest plot for the association between overweight (A), obesity (B), and the low back pain risk. CI indicates confidence interval; OR, odds ratio. full color online

environment than the general population. Hence, the difference of LBP risk between the 2 populations may result from the effect of interaction between overweight, obesity, and environment on LBP.[23] Thus, prevention of LBP among the occupational population should focus on weight control and improvement of the work environment.

A major strength of this study was the large number of participants from cohort studies, allowing a much greater possibility of reasonable conclusions. We incorporated a maximal bias adjustment in the pooled estimate; thus, the effect of potential confounders was minimized. Furthermore, there was a lack of significant evidence of publication bias. The whole study was proved to be reliable by the result of sensitivity analysis.

However, there were a few limitations in our study. First, although most included studies were adjusted for potential confounders, we could not rule out the possibility that some other unmeasured factors might be partly responsible for the observed association. Second, the BMI data were collected at baseline, and these data might have changed during the follow-up period. Thus, it is not possible to determine the effects of change in BMI on LBP. Third, the outcomes did not include information on the frequency and severity of LBP in some studies. Finally, evidence in this meta-analysis largely originated from Europe, Australia, and Canada, with fewer from other regions. The association identified in this work may therefore not be applicable to other regions such as Asia,

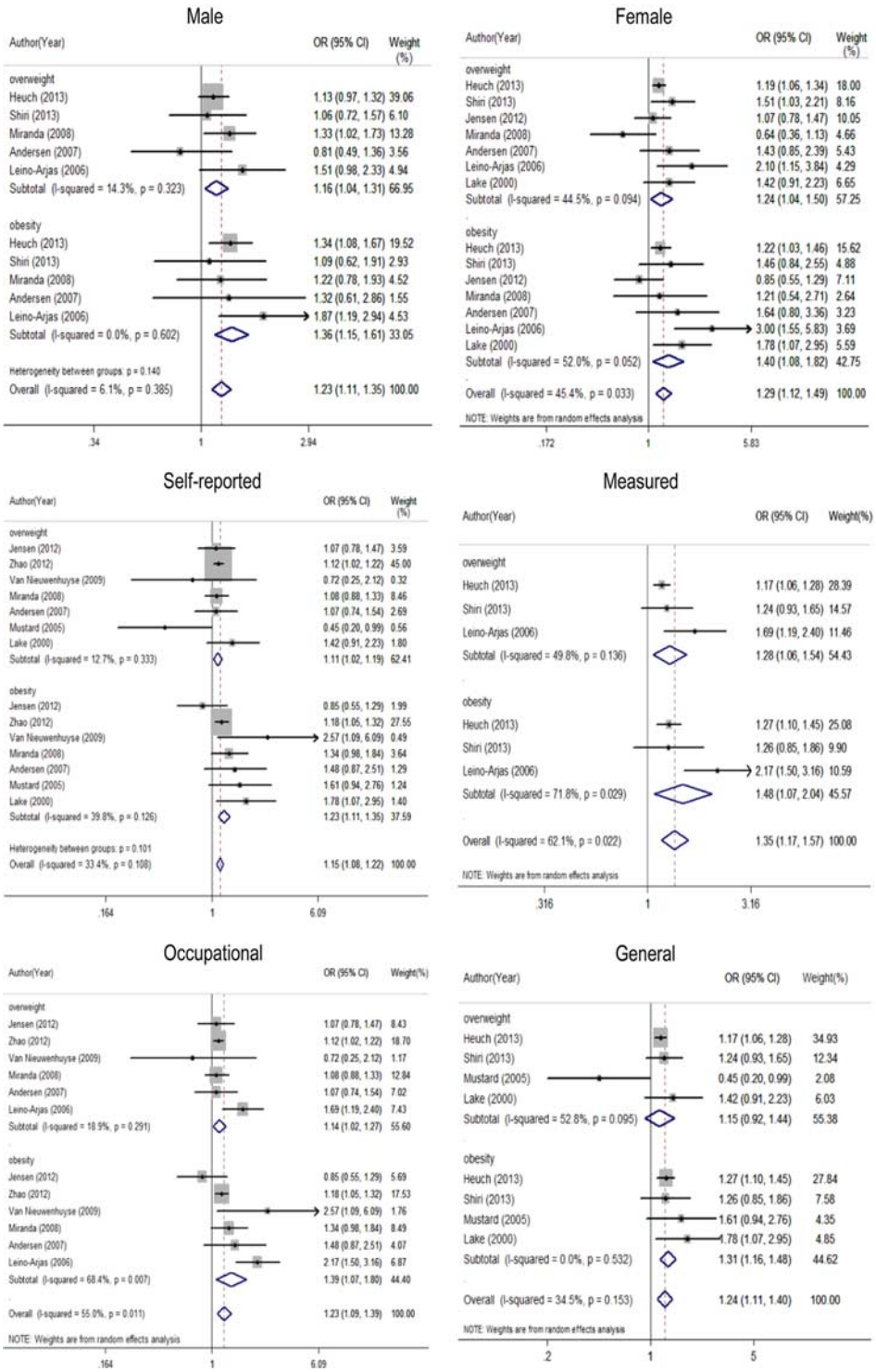

FIGURE 3. Subgroup analysis of overweight, obesity, and the risk of low back pain. CI indicates confidence interval; OR, odds ratio. full color online

South America, and Africa, thus further studies from these regions are welcomed.

In conclusion, the results of this meta-analysis show that overweight and obesity are positively associated with the risk of LBP in both men and women. These findings also indicate that maintaining a healthy body weight may be one of the factors preventing the occurrence of LBP.

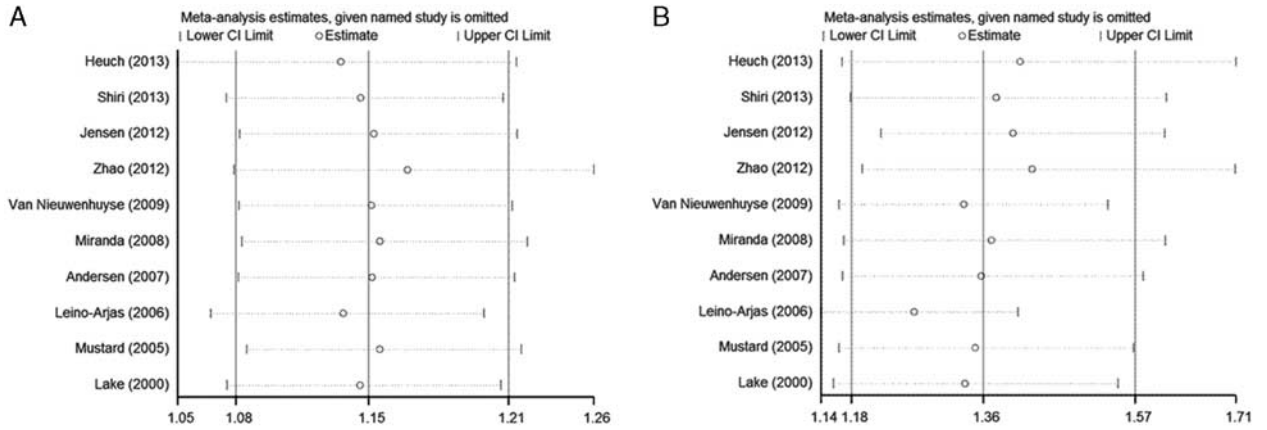

FIGURE 4. Sensitivity analysis of overweight (A), obesity (B), and the risk of low back pain. CI indicates confidence interval.

REFERENCES

1. Hoy D, Bain C, Williams G, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum*. 2012;64:2028–2037.
2. Hoy D, Brooks P, Blyth F, et al. The epidemiology of low back pain. *Best Pract Res Clin Rheumatol*. 2010;24:769–781.
3. Walker BF. The prevalence of low back pain: a systematic review of the literature from 1966 to 1998. *J Spinal Disord*. 2000;13:205–217.
4. Murray CJ, Atkinson C, Bhalla K, et al. The state of US health, 1990-2010: burden of diseases, injuries, and risk factors. *JAMA*. 2013;310:591–608.
5. Shiri R, Karppinen J, Leino-Arjas P, et al. The association between obesity and low back pain: a meta-analysis. *Am J Epidemiol*. 2010;171:135–154.
6. Goodman DM, Burke AE, Livingston EH. JAMA patient page. Low back pain. *JAMA*. 2013;309:1738.
7. Manchikanti L, Singh V, Falco FJ, et al. Epidemiology of low back pain in adults. *Neuromodulation*. 2014;17(suppl 2):3–10.
8. Taylor JB, Goode AP, George SZ, et al. Incidence and risk factors for first-time incident low back pain: a systematic review and meta-analysis. *Spine J*. 2014;14:2299–2319.
9. Leboeuf-Yde C. Body weight and low back pain. A systematic literature review of 56 journal articles reporting on 65 epidemiologic studies. *Spine (Phila Pa 1976)*. 2000;25:226–237.
10. Mirtz TA, Greene L. Is obesity a risk factor for low back pain? An example of using the evidence to answer a clinical question. *Chiropr Osteopat*. 2005;13:2.
11. Jones GT, Macfarlane GJ. Epidemiology of low back pain in children and adolescents. *Arch Dis Child*. 2005;90:312–316.
12. Hartling L, Milne A, Hamm MP, et al. Testing the Newcastle Ottawa Scale showed low reliability between individual reviewers. *J Clin Epidemiol*. 2013;66:982–993.
13. World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. *World Health Organ Tech Rep Ser*. 1995;854:1–452.
14. Lake JK, Power C, Cole TJ. Back pain and obesity in the 1958 British birth cohort. cause or effect? *J Clin Epidemiol*. 2000;53:245–250.
15. Mustard CA, Kalcevich C, Frank JW, et al. Childhood and early adult predictors of risk of incident back pain: Ontario Child Health Study 2001 follow-up. *Am J Epidemiol*. 2005;162:779–786.
16. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002;21:1539–1558.
17. Ioannidis JP, Patsopoulos NA, Evangelou E. Uncertainty in heterogeneity estimates in meta-analyses. *BMJ*. 2007;335:914–916.
18. Dersimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7:177–188.
19. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994;50:1088–1101.
20. Egger M, Davey Smith G, Schneider M, et al. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. 1997;315:629–634.
21. Heuch I, Heuch I, Hagen K, et al. Body mass index as a risk factor for developing chronic low back pain: a follow-up in the Nord-Trondelag Health Study. *Spine (Phila Pa 1976)*. 2013;38:133–139.
22. Shiri R, Solovieva S, Husgafvel-Pursiainen K, et al. The role of obesity and physical activity in non-specific and radiating low back pain: the Young Finns study. *Semin Arthritis Rheum*. 2013;42:640–650.
23. Zhao I, Bogossian F, Turner C. The effects of shift work and interaction between shift work and overweight/obesity on low back pain in nurses: results from a longitudinal study. *J Occup Environ Med*. 2012;54:820–825.
24. Jensen JN, Holtermann A, Clausen T, et al. The greatest risk for low-back pain among newly educated female health care workers; body weight or physical work load? *BMC Musculoskelet Disord*. 2012;13:87.
25. Van Nieuwenhuyse A, Crombez G, Burdorf A, et al. Physical characteristics of the back are not predictive of low back pain in healthy workers: a prospective study. *BMC Musculoskelet Disord*. 2009;10:2.
26. Miranda H, Viikari-Juntura E, Punnett L, et al. Occupational loading, health behavior and sleep disturbance as predictors of low-back pain. *Scand J Work Environ Health*. 2008;34:411–419.
27. Andersen JH, Haahr JP, Frost P. Risk factors for more severe regional musculoskeletal symptoms: a two-year prospective study of a general working population. *Arthritis Rheum*. 2007;56:1355–1364.
28. Leino-Arjas P, Solovieva S, Kirjonen J, et al. Cardiovascular risk factors and low-back pain in a long-term follow-up of industrial employees. *Scand J Work Environ Health*. 2006;32:12–19.
29. Palta M, Prineas RJ, Berman R, et al. Comparison of self-reported and measured height and weight. *Am J Epidemiol*. 1982;115:223–230.
30. Stewart AW, Jackson RT, Ford MA, et al. Underestimation of relative weight by use of self-reported height and weight. *Am J Epidemiol*. 1987;125:122–126.
31. Stevens J, Keil JE, Waid LR, et al. Accuracy of current, 4-year, and 28-year self-reported body weight in an elderly population. *Am J Epidemiol*. 1990;132:1156–1163.