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Review Article

Prevalence, Incidence, and Factors Associated With Non-Specific Chronic Low Back Pain in Community-Dwelling Older Adults Aged 60 Years and Older: A Systematic Review and Meta-Analysis

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Abstract: **Chronic low back pain (CLBP) is common among older adults. This systematic review aimed to summarize: (1) the prevalence and incidence of CLBP in older adults, and (2) demographic, psychological, and clinical factors positively/negatively associated with prevalence/incidence of CLBP among older adults. Four databases were searched to identify relevant publications. Ten studies (31,080 older adults) were included after being screened by 5 independent reviewers using predetermined criteria. The methodological quality of these studies was evaluated by standardized tools. The quality of evidence for all factors were appraised by modified GRADE for cohort studies. Twenty-eight and 1 factors were associated with a higher prevalence and a lower 5-year cumulative incidence of CLBP, respectively. No prognostic factor was identified. There was very limited to limited evidence that females, obesity, anxiety, depression, mental disorders, self-expectation of recovery, self-perceived health status, lifestyle (smoking, daily fluoride consumption), previous falls or lower body injury, retirement/disability due to ill health, family history of body pain, comorbidity (knee osteoarthritis, or chronic obstructive pulmonary disease with/without hypertension), weak abdominal muscles, leg pain, leg pain intensity, widespread pain, pain interference on functioning, use of pain medication, occupational exposure (driving for >20 years, or jobs involving bending/twisting for >10 years), disc space narrowing and severe facet osteoarthritis were significantly related to a higher prevalence of CLBP in older adults. However, very limited evidence suggested that intermediate level of leisure-time physical activity was associated with a lower prevalence of CLBP in older adults. Given the aging population and limited information regarding risk factors for CLBP in older adults, future high-quality prospective studies should identify relevant risk factors to help develop proper preventive and treatment strategies.**

Perspective: **Despite the high prevalence of non-specific chronic low back pain among older adults, there is only very limited to limited evidence regarding factors associated with a higher**

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prevalence of chronic low back pain in this population. Given the aging population, high-quality prospective studies are warranted to address this gap.

Key words: *Chronic low back pain, factors associated with CLBP, protective factors, geriatric, older adults.*

Low back pain (LBP) is a major musculoskeletal problem that causes functional limitations and suboptimal quality of life in older adults.[4,23,26,48] The United Nations has recently recognized that LBP is one of the leading causes of disability among individuals aged 60 years or over, leading to significant disability, as well as great economic and social costs.[61] A systematic review including 28 studies concluded that the prevalence of chronic low back pain (CLBP) (lasting for more than 3 months) progressively increased from the third decade of life to 60 years of age.[35] Further, a recent review of 35 studies revealed that 21% to 68% of individuals aged 60 years or older had CLBP in the last 12 months, substantiating a high prevalence of CLBP among older adults.[10] Since the world population of adults aged 60 years or older is estimated to double its size of 2015 by 2050 (reaching 2.1 billion),[61] it is critically important to identify risk factors for CLBP in older adults so that proper prevention and treatment strategies can be developed and implemented for high-risk individuals.

Since LBP was generally thought to be prevalent in the working population, most prior studies focused on identifying risk factors for LBP or CLBP in working-age adults.[18,25,42,47,55,70,72] Certain occupational exposures (eg, whole body vibration, frequently twisting or bending, and prolonged standing or sitting),[6,60] psychological variables (eg, depression, psychological distress, passive coping strategies, and fear-avoidance beliefs), and demographic parameters (eg, older age and women) are found to be related to the presence of LBP and/or CLBP in the working population.[13] However, these risk factors cannot be generalized to older adults with CLBP because they are often retired and have more comorbidities,[65] which may modify the effects of these risk factors.

Given the aging population, there is a growing number of studies investigating factors associated with increased CLBP prevalence/incidence among older adults.[68] Older adults with CLBP are often characterized by degenerative radiological changes (eg, disc space narrowing and osteophytes), multi-joint pain involving neck, hip and/or knee, and psychological problems (eg, depression and anxiety).[30,31,59] Although a prior literature review reported some factors associated with increased LBP prevalence in older adults (eg, spinal degeneration, or physical inactivity),[68] it did not specifically focus on factors related to a higher CLBP prevalence/incidence in older adults, which is the major cause of disability and high medical expenses in this population.[68] Therefore, the current systematic review and meta-analysis aimed to summarize: (1) the prevalence and incidence of CLBP in older adults; as well as (2) demographic, psychological, and clinical factors positively/negatively associated with the prevalence/incidence of non-specific CLBP among older adults.

Methods

The current review protocol was registered with PROSPERO (number: CRD42020222164). Its reporting followed the guidelines of the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA).[38]

Literature Search

A systematic search of four electronic databases (MEDLINE ALL (OVID interface), EMBASE (OVIS Interface), CINAHL Plus with Full Text (EBSCOhost interface), and APA PsycINFO (OVID interface)) was conducted by a health sciences librarian (ED) from database inception to November 20, 2020. The search string involved the combinations of medical subject headings (MeSH) and keywords related to: (1) older adults; (2) chronic; (3) low back pain; and (4) risk or prognostic factors. The complete search strategies for each database are shown in Appendix I. The reference lists of the included studies were screened for relevant articles. Forward citation tracking was conducted using Scopus. The corresponding authors of the included studies were contacted by emails to identify additional relevant publications.

Selection Criteria

Cross-sectional, or prospective or retrospective cohort studies were eligible for inclusion if they involved older adults aged 60 years or over (population), the respective prevalence/incidence and potential risk/protective/prognostic factors for non-specific CLBP (exposure), and the odd ratios of risk/protective/prognostic factors (outcome). The 60 years of age was chosen based on the recommendation of the Department of Economic and Social Affairs of the United Nations. Only papers published in English were included. There was no predetermined definition of non-specific CLBP because the definition might vary slightly across studies. Studies were excluded if they investigated individuals with specific CLBP (eg, infections, fracture, traumatic injuries, cancer, major systemic diseases, or congenital diseases). Studies that examined institutionalized seniors (ie, living in sheltered, residential, or nursing homes) were also excluded because they were more likely to have functional and cognitive impairment, dementia, and low self-rated health condition.[33] For studies investigating the risk/prognostic factors for CLBP in both community-dwelling and institutionalized older adults, only the information from the community-dwelling older

adults was extracted for analysis if available. Case reports, case series, conference proceedings, editorials, commentaries, letters to editors, and animal or cadaveric studies were excluded. The detailed inclusion and exclusion criteria are shown in Appendix II.

Study Selection

Citations identified from databases were organized using EndNote X9.2 (Thomson Reuters, USA). After removing duplicates, five independent reviewers (CW, RM, TK, JT, and ML) piloted the titles and abstracts of screening process on 200 citations. Any disagreements were discussed and resolved among these reviewers together with a senior reviewer (AW) to ensure consistency. Following the piloting, the remaining articles were equally divided into 5 sets. Each of the 5 reviewers reviewed 2 sets of abstracts so that each abstract was reviewed by 2 independent reviewers. Articles deemed to be eligible by either reviewer were retrieved for full-text screening. Relevant literature reviews were included for full-text reading to identify potential primary studies for screening. Full-text screening adopted the same screening process. Any disagreements between 2 reviewers were resolved by discussion. The senior reviewer (AW) arbitrated any persistent disagreement. Kappa coefficients were calculated to evaluate the agreements among the 5 reviewers at the title and abstract screening, and full-text screening stages.

Data Extraction

The five reviewers independently extracted data from included studies and counter checked the extracted data. The extracted information included: authors, year of publication, study design, study location, types of settings, data collection strategies, response and/or attrition rates, respondents' characteristics, definitions of non-specific CLBP, the prevalence/incidence of CLBP, potential risk/prognostic factors for non-specific CLBP, the corresponding statistics (eg, odds ratios (ORs) or relative risks (RRs)), and the duration of follow-up. Unadjusted and adjusted ORs of the risk/prognostic factors for non-specific CLBP were extracted. For multivariate statistical analyses, covariates used for adjustments were documented. For studies reporting both unadjusted and adjusted factors, the adjusted factors would be summarized in this review. If multiple included articles reported data from the same cohort, only the publication with the most comprehensive dataset on the prevalence/ incidence or risk/protective/prognostic factors for non-specific CLBP in older adults was used in the meta-analysis.

Risk of Bias Assessments

Two distinct risk of bias assessment tools were used based on the study design of the included studies. The quality of cross-sectional studies was assessed by the Appraisal tool for Cross-Sectional Studies (AXIS).[14,19–21] The quality of longitudinal cohort studies was assessed by the Quality In Prognosis Studies tool,[26] which was recommended by the Cochrane Prognosis Methods Groups (Table 1).[19] For each included study, quality assessments were performed by three independent reviewers (CW, JT and TK), the separate rating results were then compared. Any discrepancy in ratings were resolved by consensus. The agreements among the three reviewers were evaluated by Kappa coefficients.

Data Synthesis

Data extracted from the included studies was organized based on the prevalence/incidence rates and types of risk, protective, prognostic, or associated factors. Evidence of all investigated factors was summarized in tables and figures. If the data of a given factor could not be pooled for a meta-analysis due to clinical heterogeneity of the relevant included studies (eg, examining different period prevalence rates, different assessment methods for risk factors, or distinct definitions of CLBP or risk factors), the evidence of that factor was summarized qualitatively. All meta-analyses were conducted using the Comprehensive Meta-Analysis Version 3.3 (Biostat, Englewood, NJ). Random effect models were used for meta-analyses. Statistical heterogeneity of the included studies was assessed by chi-square tests and I^2 statistics. I^2 values were classified into low ($I^2 < 40\%$), moderate ($I^2 = 40–60\%$), and substantial ($I^2 > 60\%$) degrees of heterogeneity.[24] Funnel plots were planned to assess potential publication bias if the estimated

Table 1. Determination of overall risk of bias of the included studies and the quality of evidence for a given factor that is associated with chronic low back pain

Risk of bias of a study		
High risk of bias	:	A study graded as *high* in at least one domain.
Moderate risk of bias	:	A study graded as *moderate* in at least one domain, and rated as *low* in other domains.
Low risk of bias	:	A study graded as *low* in all six domains.
Quality of evidence		
High quality	:	It is very confident that the true effect lies close to that of the estimate of the effect.
Moderate quality	:	It is moderately confident that the true effect is likely to be close to the estimate of the effect, but it is possible that they may be substantially different.
Low quality	:	There is limited confidence in the effect estimate. The estimate of the effect may be substantially different from the true effect.
Very low quality	:	There is very little confidence in the effect estimate; The estimate of effect is likely to be substantially different from the true effect.
Conflicting evidence	:	Inconsistent findings.

association of a given factor was pooled from 10 or more included studies.

If 2 or more included studies reported the same types of prevalence/incidence rates (eg, point or 12-month) of non-specific CLBP in older adults, the respective prevalence/incidence rates were pooled for meta-analyses. Results were expressed as percentages and 95% confidence intervals (95% CIs). If an included study did not report prevalence/incidence rates, the rates were estimated from the number of CLBP cases and the total number of respondents during the study period, if possible.

Likewise, if 2 or more included studies reported ORs of a given factor that was related to a higher or lower prevalence/incidence of non-specific CLBP in older adults, these ORs were pooled for meta-analysis and the respective 95%CI was reported. Notably, since all primary studies reported adjusted ORs of these factors, pooled adjusted ORs (AORs) were reported. However, as the covariates in various multivariate models were not identical, the pooled AORs only provide an overview regarding the strength of association between a given factor and the corresponding prevalence/incidence rate.

Quality of Evidence

The quality of evidence of each identified factor that positively or negatively associated with non-specific CLBP in older adults was determined by modified Grading of Recommendations Assessments, Development and Evaluation (GRADE) for cohort studies based on the suggested criteria.[27] The evidence was classified as high, moderate, low, very low, or conflicting (Table 1).[29,64,67]

Subgroup Analysis and Sensitivity Analysis

A subgroup analysis of factors associated with CLBP in three life-stages of older adults was planned: the young-old (approximately 60–74 years), the middle-old (ages 75–84 years), and the old-old (over age 85 years). A sensitivity analysis was also planned based on the methodological quality of the included studies, if applicable.

Results

Database searches identified 5,751 potential studies, while additional 297 studies identified from other sources (Fig. 1). After duplication removal, 4,886 studies were eligible for the title and abstract screening. Ten[8,9,22,32,40,45,50,56,58,63] out of 368 full-text articles were included. Articles were excluded because they did not include older adults (n = 270) or non-specific CLBP (n = 67), or no mentioning of factors associated with the prevalence/incidence of non-specific CLBP (n = 21). Kappa coefficients for abstract screening, full-text screening, as well as AXIS and Quality in Prognosis Studies evaluations were 0.82, 0.69, 0.79, and 0.75, respectively ($P < .01$).

Study Characteristics

Five cross-sectional studies,[8,9,32,58,63] one retrospective cohort study,[40] and four prospective cohort studies[22,45,50,56] published between 2010 and 2020 were included (**Table 2**). These studies were conducted in

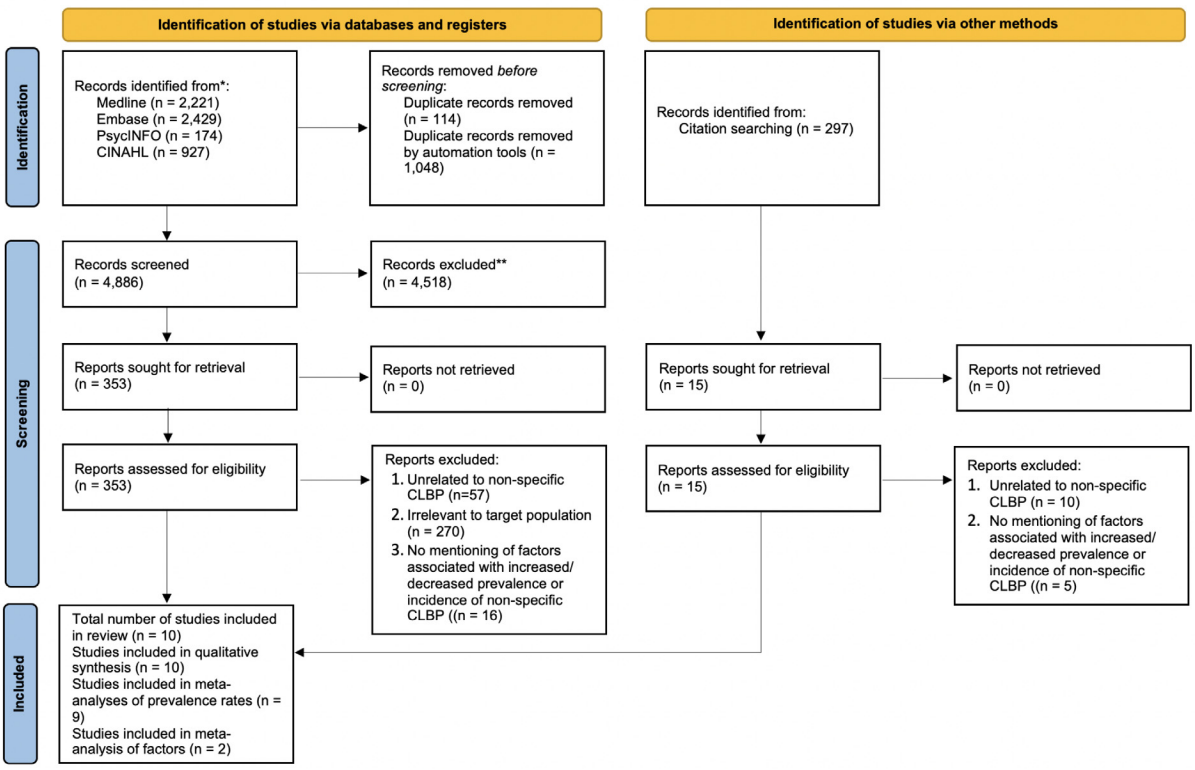


Figure 1. A flow diagram of the systematic review according to PRISMA guidelines. CLBP, chronic low back pain; LBP, low back pain.

France,[45] Japan,[32,56] Norway,[22] The Neverlands,[9,63] Spain,[8] Thailand,[40] and the USA.[50,58] Three studies defined CLBP as LBP lasting for more than 3 months.[22,32,63] Three studies defined CLBP as LBP persisting for at least 6 months,[40,50,56] and two studies defined CLBP as LBP lasting for more than 12 months,[9,58] Plouvier *et al.* used the term "persistent LBP 30" to describe LBP lasting for more than 30 days in the previous 12 months at both baseline and 10-year follow-up.[45] de Miguel-Díez *et al.* defined CLBP as chronic pain in the lumbar region in the last 12 months that was confirmed by a physician.[8]

The included studies used quota sampling (n = 6),[8,9,22,32,56] stratified random sampling (n = 2),[44,58] and convenience sampling (n = 2).[50,63] Self-administered questionnaires were the most common way to collect exposure and CLBP data (n = 6),[8,22,32,40,45,56] whereas three articles captured data using both self-administered questionnaires and radiographs.[9,58,63] One included study used both self-administered questionnaires and electronic medical records to collect exposure and CLBP data.[50] The response rates in the included studies ranged from 53.9% to 85.0%. The median number of participants per study was 1,928 (ranging from 38 to 25,450).

Risk of Bias Assessments

The included studies displayed high (n = 4) and moderate (n = 6) risk of bias (Table 3). Some common biases in the included cross-sectional studies were: no justification of sample size;[8,9,32,58,63] and no strategy in addressing or categorizing non-responders.[58,63] Further, no included longitudinal studies reported the characteristics of dropout participants nor explained the handling of missing data. Two longitudinal studies also did not collect the baseline characteristics of participants.[50,56]

Prevalence and Incidence of CLBP Among Older Adults

Nine included studies investigated various period prevalence rates,[8,9,22,32,40,45,50,58,63] and 1 study investigated the non-specific CLBP incidence[56] in older adults. One included study investigated both prevalence and incidence of non-specific CLBP in older adults[22] (Table 2**).** Point,[9,32,40,63] and 12-month[8,22,45,50,58] prevalence rates were reported (Table 2**)**. Four and 5 included studies were involved in the meta-analyses of point,[9,32,40,63] and 12-month[8,22,45,50,58] prevalence rates, respectively. The pooled point and 12-month prevalence rates of non-specific CLBP in older adults were 20.6% (95% CI: 19.4%−21.9%) and 36.1% (95% CI: 35.1%−37.1%), respectively (Fig. 2).

Two included prospective studies reported the incidence of non-specific CLBP among older adults.[22,56] Notably, Heuch *et al.* followed 2,954 asymptomatic older adults and found that 16.9% of them developed CLBP in the 12 months before their 11-year follow-up.[22] Solovev *et al.* found that the 5-year cumulative incidence of CLBP for older adults without CLBP at baseline was 14.5%.[56]

Factors Associated with CLBP

The included studies investigated 41 factors associated with CLBP in older adults (Table 4). Four meta-analyses of two studies revealed limited evidence that disk space narrowing was significantly related to higher point prevalence of CLBP (Fig. 3 and Table 4). Likewise, a meta-analysis of two studies showed very limited evidence that the presence of grade ≥2 osteophytes (as graded by the Lane atlas) at 2 more levels along L1/2 to L5/S1 levels was related to higher point prevalence of CLBP (Fig. 3 and Table 4). However, this result contradicted the finding from one included study, which found no significant association between the presence of grade ≥2 osteophytes at any level along L1/2 to L5/S1 levels and point prevalence of CLBP[63] (Table 4). Therefore, it remained unclear whether the grade ≥2 osteophytes was related to point prevalence of CLBP in older adults.

The qualitative syntheses revealed only very limited (n = 26) or limited (n = 1) evidence to support 27 factors that were significantly related to a higher point or 12-month prevalence of non-specific CLBP in older adults (Table 4). Interestingly, 1 factor was found to be significantly associated with a lower CLBP incidence. No included studies investigated prognostic factors in older adults with CLBP that could predict future presence or absence of CLBP. The following subsections report factors associated with higher point, and 12-month prevalence of CLBP in older adults, followed by a factor associated with a lower CLBP incidence in older adults.

Factors Associated With a Higher Prevalence of CLBP

Factors associated with a higher point prevalence of CLBP. There was limited evidence that greater disc space narrowing was associated with a higher point prevalence of CLBP in older adults [pooled AOR from two studies (3,518 older adults): ranging from 1.59 to 2.34)] (Table 4 and Appendix III). Very limited evidence also supported that prior injury of lower body, a history of falls, weaker abdominal muscle strength, family history of body pain, or increased daily fluoride consumption was associated with a higher point prevalence of CLBP in older adults (Table 4). There was insufficient data to conduct subgroup or sensitivity analysis.

Factors associated with a higher 12-month CLBP prevalence. Limited evidence suggested that poor self-perceived health condition was related to a higher 12-month CLBP prevalence [AOR ranging from 1.58 to 33.33 in two studies with 7,555 older adults)] (Table 4). There was very limited evidence that body mass index (BMI) >30 kg/m^2, anxiety, depression, mental disorder, smoking, widespread pain syndrome, presence of leg pain, higher leg pain intensity, greater pain interference of functioning, use of pain medication, or poor self-expectation for

Table 2. Characteristics of the included studies

Authors/ Year of publication	Country/Study design	Sample size/Percentage of male/Mean age (SD)	Recruitment method/Response rate/Attrition rate (if applicable)	Definitions of CLBP	Types of prevalence	Statistical tests; Potential risk factors investigated
			Cross-sectional studies			
de Miguel-Díez *et al.*, 2018 [8]	Spain/ Cross-sectional	2,335 individuals with COPD/ 47.4%/66.88 (14.64) y	Quota sampling/Unclear response rate	Chronic pain in the lumbar region of the back over the last 12 mo that was confirmed by a physician	12 m prevalence of CLBP: 44.8%	Multivariable logistic regression; COPD, age, sex, self-rated health, BP, mental disorder, BMI, use of pain medication, suffering chronic neck pain, suffering migraine
de Schepper *et al.*, 2010 [9]	The Netherlands/ Cross-sectional (nested in a prospective cohort study)	2,819 residents in Ommoord District, Rotterdam, the Netherlands/ 42.7%/Men: 65.3 (6.4) y; Women: 65.9 (6.8) y	Quota sampling/ Unclear response rate	Long lasting complaints of low back to be present for more than 1 y	Point prevalence of CLBP: 14.9%	Multivariate logistic regression; Disc space narrowing Osteophytes
Kato *et al.*, 2019 [32]	Japan/ Cross-sectional	38 consecutive elderly women/0%/ 77.7 (4.2) y	Quota sampling/ Unclear response rate	LBP for more than 3 mo, and a visual analog scale score for LBP of ≥20 mm (point prevalence)	Point prevalence of CLBP: 55.3%	Multivariate logistic regression; Abdominal trunk muscle strength, GLFS-25 Scores
Suri *et al.*, 2013[58]	USA/Cross-sectional (nested in a prospective epidemiologic study)	252 individuals from multidetector CT substudy of Framingham Heart Study Cohort/ 51.6% 67.4 (9.1) y	Random sampling from the Framingham Heart Study Cohort/ Unclear response rate	Response of "most of the days" and "all days" to the question "have you had back pain in the past 12 months?"	12m prevalence of CLBP: 22.6%	Multivariate logistic regression; Age, living alone, retired, presence of severe facet joint OA, number of joints with severe OA, presence of severe disc height narrowing, number of levels with severe narrowing
van den Berg *et al.*, 2017[63]	The Netherlands/ Cross-sectional (nested in a prospective cohort study)	699 participants in the Cohort Hip and Knee/20%/64.3 (5.1) y	Systematic sampling and convenience sampling/ Unclear response rate	LBP persisting longer than 3 mo	Point prevalence of CLBP >3 m: 59% CLBP >12 m: 51%	Multivariate logistic regression: Disc space narrowing, osteophytes
			Prospective Cohort studies			
Heuch, Heuch, Hagen, & Zwart, 2013[22]	Norway/ prospective (follow up for 11 yrs)	18,882 (2,954 for age group 60 −69 y) individuals without CLBP at baseline/ 46.3% Age range: 30-69 y 6,568 (1,284 for age group 60 −69 y) individuals with CLBP at baseline/ 40.6% Age range:30−69 y	Quota sampling/ 76.1%/ 43.3% (Dropout rate)	LBP persisting for at least 3 mo continuously during the past year.	12m incidence for people without CLBP at baseline: 17.2% (16.9% for age group 60−69 y) 12 m prevalence for people with CLBP at baseline:54.7% (53.6% for age group 60−69 y) Overall 12 m prevalence for people with and without CLBP at baseline: 26.9% (28.03% for age group 60-69 y)	Multivariate logistic regressions: BMI, age, education, work status, physical activity at work and in leisure time, smoking, blood pressure, and serum lipid levels.
Plouvier *et al.*, 2015[45]	France/ Prospective (follow up for 10 y)	1,360 individuals without LBP30 at baseline or 10-y follow-up in The Gazel Cohort "Gazel Low Back Pain" subpopulation / 100%	Random sampling from Gazel cohort/ 53.9%/ 36.2% dropout rate	LBP was defined as: "pain, discomfort or disability in this area, whether or not the pain radiates to the leg." Persistent LBP were LBP	12m prevalence for people with LBP30 at baseline: 50.3% Overall 12m prevalence for people with and without LBP30 at baseline: 21.5%	Univariate logistic regression; BMI, sleep disturbances; frequent depressive mood; psychosomatic disorders defined as frequent palpitations and/ or worries that make the subject

(*continued on next page*)

Table 2. Continued

Authors/ Year of publication	Country/Study design	Sample size/Percentage of male/Mean age (SD)	Recruitment method/Response rate/Attrition rate (if applicable)	Definitions of CLBP	Types of prevalence	Statistical tests; Potential risk factors investigated
		Age range: 58–67 y (mid-range = 63 y) 160 individuals with LBP30 at baseline and 10-y follow-up in The Gazel Cohort "Gazel Low Back Pain" subpopulation / 100% Age range: 58–67 y (mid-range = 63 y)		that lasted for >30 d in the previous 12 mo (LBP30 in the subsequent text) persisted for at least 10 y		physically ill; headache Multivariate logistic regression; duration of occupational exposure to bending/twisting occupational exposure to driving >20 y
Rundell *et al.*, 2017[50]	USA/ Prospective cohort (followed up at 6 and 18 mo from the first visit)	5,220 older adults presenting to primary care settings for new visits for back pain during 2011–2013 35.3%/73.8 (6.9) y	Convenience or Purposive sampling from electronic medical record/85% drop-out rate	Persistent back pain as pain NPRS ≥3/10 at the 6-mo follow-up	12 m prevalence: 50.7%	Multivariate logistic regression model; Age, race, education, marital status, employment, leg pain intensity (NPRS), leg pain present (Yes), pain interference (BPI), general health status (EQ-5D), smoking, expectation for recovery, positive anxiety screen, positive depression screen, osteoporosis, knee osteoarthritis, hip osteoarthritis, cervical pain, widespread pain syndromes, falls in prior 3 wk, comorbidities (Quan Comorbidity Index)
Solovev *et al.*, 2020[56]	Japan/ Prospective cohort	6,621 residents in the Murakami region/ 46.3% 60.1 y	Quota sampling/ Unclear dropout rate	Pain persistent for at least 6 months	5-year cumulative incidence of CLBP:14.5%	Multivariate logistic regression; The total amount of physical activity level, the leisure time physical activity level
			Retrospective Cohort Study			
Namkaew & Wiwatanadate, 2012[40]	Thailand/ Retrospective cohort	534 residents in San Kamphaeng District, Chiang Mai/48.1%/62 (9.1) y	Stratified quota sampling/ Unclear response rate	Suffering from low back (lumbar region) pain for over 6 months	Point prevalence of CLBP: 65.2%	Binary logistic regression; Average daily fluoride dose, family history of body pain, previous injury of the lower body

Abbreviations: 12 m, twelve months; BMI, body mass index; BP, blood pressure; BPI, brief pain inventory; CLBP, chronic low back pain; COPD, chronic obstructive pulmonary disease; EQ-5D, EuroQol-5D; GLFS-25, 25-question geriatric locomotive function scale; LBP, low back pain; NPRS, 11-point numeric pain rating scale; PHQ-4, patient health questionnaire–4; RMDQ, roland morris disability questionnaire; y, years.

Table 3. **Risk of bias assessments of the included studies**

Studies	Objective and study design			Study participation						Handling of non-respondents				Outcome measures			Statistical analysis			Reporting							Overall risk
Original item number	1	2	S	3	4	5	6	20	S	7	13*	14	S	8	9	S	10	11	S	12	15	16	17	18	19*	S	
de Miguel-Díez *et al.*, 2018 [8]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
de Schepper *et al.*, 2010 [9]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
Kato *et al.*, 2019 [32]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
Namkaew & Wiwatanadate, 2012 [40]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
Suri *et al.*, 2013[58]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
van den Berg *et al.*, 2017[63]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
% of studies that have "yes" /no bias	100	100		0	100	100	100	100		0	0	0		100	100		100	100		100	100	100	100	100	0		

Quality of Prognosis Studies Risk of Bias Assessment Instrument for Prognostic Factor Studies

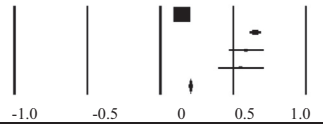
Study	Study participation								Study attrition						Prognostic factor measurements						Outcome measurements				Study confounding								Statistical analysis and reporting					Overall risk
	1	2	3	4	5	6	7	S	1	2	3	4	S		1	2	3	4	5	S	1	2	3	S	1	2	3	4	5	6	7	S	1	2	3	S	
Heuch, Heuch, Hagen, & Zwart, 2013[22]	Y	Y	Y	Y	Y	Y	N	**M**	N	U	Y	N	**H**		P	Y	Y	U	N	**H**	Y	Y	Y	**L**	N	Y	U	Y	N	U	Y	**H**	N		Y		Y	**M**	High
Plouvier *et al.*, 2015[45]	Y	Y	Y	Y	N	Y	Y	**M**	N	U	Y	P	**H**		Y	Y	Y	N	Y	**M**	Y	Y	Y	**L**	Y	Y	Y	Y	Y	Y	Y	**L**	Y		Y		N	**M**	High
Rundell *et al.*, 2017[50]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	U	N	N	**H**		Y	Y	Y	Y	Y	**L**	Y	Y	Y	**L**	Y	Y	Y	Y	U	Y	Y	**M**	Y		Y		Y	**L**	High
Rundell *et al.*, 2019[49]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	U	N	N	**H**		Y	Y	Y	Y	Y	**L**	Y	Y	Y	**L**	Y	Y	Y	Y	U	Y	Y	**M**	Y		Y		Y	**L**	High
Solovev *et al.*, 2020[56]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	U	N	N	**H**		Y	Y	Y	Y	U	**M**	Y	Y	Y	**L**	Y	Y	Y	Y	U	Y	Y	**M**	Y		Y		Y	**L**	High

Abbreviations: H, high; L, low; M, moderate; N, no; P, partial; U, unsure; Y, yes.

Study	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-score	P-value	Relative weight	Sample size
de Schepper et al., 2010	0.149	0.007	0.000	0.136	0.162	22.239	0.000	88.36	2819
Namkaew & Wiwatanadate, 2012	0.652	0.020	0.000	0.613	0.691	32.600	0.000	9.92	534
van den Berg et al., 2017	0.590	0.060	0.004	0.472	0.708	9.833	0.000	1.1	699
Kato et al., 2019	0.553	0.080	0.006	0.396	0.710	6.913	0.000	0.62	38
	0.206	0.006	0.000	0.194	0.219	32.747	0.000		

Statistics for each study

Point prevalence and 95% CI



Heterogeneity: Tau square=0.119, df=3(P<0.00001), I square=99.52%
Test for overall effect: Z=32.747 (P<0.00001)

Study	Point estimate	Standard error	Variance	Lower limit	Upper limit	Z-value	P-value	Relative weight	Sample size
Suri et al., 2013	0.230	0.030	0.001	0.171	0.289	7.667	0.000	2.7	252
Heuch et al., 2013	0.280	0.010	0.000	0.260	0.300	28.000	0.000	24.32	4238
Plouvier et al., 2015	0.220	0.010	0.000	0.200	0.240	22.000	0.000	24.32	1520
Rundell et al., 2017	0.510	0.010	0.000	0.490	0.530	51.000	0.000	24.32	5220
de Miguel-Diez et al., 2018	0.448	0.010	0.000	0.428	0.468	44.800	0.000	24.32	2335
	0.361	0.005	0.000	0.351	0.371	73.169	0.000		

Statistics for each study

12-month prevalence and 95% CI

Heterogeneity: Tau square=0.018, df=4(P<0.00001), I square=99.31%
Test for overall effect: Z=73.169 (P<0.00001)

Figure 2. Forest plots of the pooled point and 12-mo prevalence rates.

recovery was associated with a higher 12-month CLBP prevalence in older adults. Likewise, very limited evidence corroborated that female biological sex, retirement or disability due to ill health, knee osteoarthritis, severe facet joint osteoarthritis, chronic obstructive pulmonary disease with or without hypertension, higher Quan Comorbidity Index scores, occupational exposure to driving for >20 years, and occupational exposure to bending/twisting for >10 years were related to a higher 12-month prevalence of CLBP in older adults (Table 4).

Factor Associated With a Lower Incidence of CLBP

There was very limited evidence that intermediate level (1−3 METs/d) of leisure-time physical activity was associated with a lower 5-year cumulative incidence of moderate-to-severe CLBP in older adults (a U-shaped association).[56]

Discussion

This is the first systematic review to summarize the prevalence and incidence ~~rates~~ of non-specific CLBP alongside the associated factors in older adults. Our pooled 12-month prevalence of CLBP (36.1%) in older adults were much higher than that of those aged between 20 and 59 years (ranging from 4.2% to 19.6%).[35] Although 28 factors were found to be significantly associated with a higher prevalence of non-specific CLBP in older adults, the levels of evidence were mostly very limited. While some factors (eg, anxiety, depression, widespread pain, leg pain) are known to be closely related to CLBP in the working population,[48,62] others are age-related (eg, knee osteoarthritis, or retired due to ill health). Importantly, intermediate level of leisure-time physical activity was found to be a protective factor for CLBP development in older adults. These findings reveal a big knowledge gap in older adults with non-specific CLBP although such pain is ubiquitous among older adults.

Factors Associated With Increased Prevalence of CLBP

Despite the limited evidence, several factors deserve to be discussed or further investigated because these factors are either modifiable or have strong clinical implications.

Demographic Factors

Older adults with obesity had a higher 12-month CLBP prevalence than non-obese counterparts. Obesity is a known risk factor for CLBP in adults[22] because it may increase mechanical loading and induce meta-inflammatory effects on the spine.[53,67] As obesity is usually associated with other comorbidities (eg, knee osteoarthritis), which are independent risk factors for CLBP in older adults, it is paramount for older adults to maintain normal BMI. However, since BMI is a crude measurement of adiposity, future studies should use other measures (eg, bioelectrical impedance analysis of dual-energy X-ray absorptiometry) to quantify the real association between body composition and CLBP in older adults.

Compared to males, females are more vulnerable to CLBP regardless of age.[3,41,68] Their higher vulnerability may be ascribed to differences in genetic sensitivity, lower efficiency in pain coping[57] or diffuse noxious inhibitory controls,[51] as well as a higher susceptibility to experience temporal summation of mechanically[51] or chemically induced pain.[17] Additionally, postmenopausal women are more susceptible to musculoskeletal pain because of menopause-related musculoskeletal changes (eg, accelerated disc degeneration, osteoporosis, or sarcopenia).[69] Future research should investigate mechanisms underlying the higher prevalence of CLBP in older women or the effects of hormonal replacement treatment in reducing the severity or chronicity of LBP among older women.

Table 4. Association between potential risk factors and the prevalence/incidence of chronic low back pain (CLBP) in the included studies

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
				Demographics				
1. Age	Plouvier *et al.*, 2015[45]	The effect of age between 63–67 y (with reference to the 58–62 y group) on the prevalence of "Persistent" LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 65/607 (10.7%) AOR: 1.04 (Adjusted for occupational exposure to driving, occupational exposure to bending or twisting, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 0.73–1.47		Increased odds	Conflicting evidence
	Rundell *et al.*, 2017[50]	The effect of an additional year of age on the prevalence of persistent LBP in older adults (n = 5,520)	12-mo prevalence	AOR: 1.01 (Adjusted for sex, race, site)	AOR: 1.00–1.02			
	Suri *et al.*, 2013[58]	The effect of age ≥75 y (with reference to age <75 y) on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	Mean age (SD) among CLBP positive:69.6(9.1) AOR:1.5 (Adjusted for living alone, retirement, presence of severe facet joint osteoarthritis and presence of severe disk height narrowing)	AOR: 0.74–3.03			
2. Gender	Rundell *et al.*, 2017[50]	The effect of gender (female) on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.52 (Adjusted for age, race,,site)	AOR: 1.32–1.75		Increased odds	Very limited evidence
3. Race	Rundell *et al.*, 2017[50]	The effect of race (black) with reference to white people on the prevalence of persistent LBP in older adults (n = 5,520)	12-mo prevalence	AOR: 1.52 (Adjusted for age, sex, site)	AOR: 1.22–1.90		Increased odds	Conflicting evidence
		The effect of race (other) with reference to white people on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.07 (Adjusted for age, sex, site)	AOR: 0.85–1.33			
4. BMI	de Miguel-Díez *et al.*, 2018 [8]	The effect of BMI (25–29.9 kg/m^2) with reference to BMI <25 on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 1.28 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 0.99 to 1.65		No relation	Very limited evidence
		The effect of BMI (≥30 kg/m^2) with reference to BMI <25 on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 1.36(Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.03–1.80		Increased odds	Very limited evidence
	Heuch, Heuch, Hagen, & Zwart, 2013[22]	The effect of an additional increase in 1 BMI unit on the prevalence of CLBP among person age 60-69 y without CLBP at baseline (n =25,450)	12-mo incidence	Men: 182/1,375 (13.2%) Women: 318/1,570 (20.1%) AOR: men: 1.36 women: 1.10 (Adjusted for education, work status, physical activity at work and in leisure time, smoking, blood pressure, lipid levels, and time between last meal and blood sampling.)	AOR: Men: 1.01–1.82 Women: 0.92 –1.33		Increased odds	Conflicting evidence

(*continued on next page*)

Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
5. Education level	Rundell *et al.*, 2017[50]	The effect of higher education (high school graduate/GED or trade school) with reference to non-high school graduates on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.19 (Adjusted for age, sex, race, site)	AOR: 0.84–1.67		No relation	Very limited evidence
		The effect of higher education (some college) with reference to non-high school graduate the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.13 (Adjusted for age, sex, race, site)	AOR: 0.79–1.60			
		The effect of higher education (four-year college graduate) with reference to non-high school graduate on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.80 (Adjusted for age, sex, race, site)	AOR: 0.56–1.14			
		The effect of higher education (Professional or graduate degree) with reference to non-high school graduate on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.66 (adjusted for age, sex, race, site)	AOR: 0.46–0.95			
6. Marital status	Rundell *et al.*, 2017[50]	The effect of marital status (separated or divorced) with reference to married or partner on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.99 (adjusted for age, sex, race, site)	AOR: 0.80–1.23		No relation	Very limited evidence
		The effect of marital status (never married and single) with reference to married or partner on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.93 (adjusted for age, sex, race, site)	AOR: 0.67–1.29			
		The effect of marital status (widowed) with reference to married or partner on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.03 (adjusted for age, sex, race, site)	AOR: 0.85–1.24			
7. Living alone	Suri *et al.*, 2013[58]	The effect of living alone on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR:1.82 (Adjusted for age, retirement, presence of severe facet joint osteoarthritis and presence of severe disk height narrowing)	AOR: 0.79–4.21		No relation	Very limited evidence
				Retirement				
8. Retired or disabled due to ill health	Rundell *et al.*, 2017[50]	The effect of retirement or disability due to ill health with reference to full-time/ part-time employment on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 2.63 (Adjusted for age, sex, race, site)	AOR: 1.61–4.25		Increased odds	Very limited evidence

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Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
9. Retired or disabled not due to ill health	Rundell *et al.*, 2017[50]	The effect of retirement unrelated to ill health) with reference to full-time/ part-time employment on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.08 (Adjusted for age, sex, race, site)	AOR: 0.87–1.35		No relation	Very limited evidence
10. Retired	Suri *et al.*, 2013[58]	The effect of retirement with reference to full-time/ part-time employment on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR:1.88 (Adjusted for age, living alone, presence of severe facet joint osteoarthritis and presence of severe disk height narrowing)	AOR: 0.97–3.66		No relation	Very limited evidence
			Occupational exposure					
11. Occupational exposure to driving for >2 h/d	Plouvier *et al.*, 2015[45]	The effect of occupational exposure to driving (<10 y) on the prevalence of "Persistent" LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 24/283 (8.48%) AOR: 1.34 (Adjusted for age, occupational exposure to bending or twisting, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 0.76–2.38		No relation	Very limited evidence
		The effect of occupational exposure to driving (10-20 y) on the prevalence of "Persistent" (LBP30 in both 1996 and 2006) LBP30 in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 39/329 (11.9%) AOR: 1.50 (Adjusted for age, occupational exposure to bending or twisting , and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 0.89–2.54			
		The effect of occupational exposure to driving (>20 y) on the prevalence of "Persistent "LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 65/374 (17.3%) AOR: 2.20 (Adjusted for age, occupational exposure to bending or twisting, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 1.33–3.63		Increased odds	Very limited evidence
12. Occupational exposure to bending/twisting repeatedly, daily/almost daily	Plouvier *et al.*, 2015[45]	The effect of occupational exposure to bending or twisting (<10 y) on the prevalence of "Persistent" LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 23/308 (7.47%) AOR: 1.33 (Adjusted for age, occupational exposure to driving, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 0.72–2.46		Increased odds (for 10 y or more bending/ twisting	Very limited evidence
		The effect of occupational exposure to bending or twisting (10–20 y) on the prevalence of "Persistent" LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 48/325 (14.8%) AOR: 2.41 (Adjusted for age, occupational exposure to driving, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 1.39–4.18			

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Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
		The effect of occupational exposure to bending or twisting (>20 y) on the prevalence of "Persistent" LBP30 (LBP30 in both 1996 and 2006) in older adults (n = 1,520)	12-mo prevalence	"Persistent" LBP30 65/405 (16.0%) AOR: 2.44 (Adjusted for age, occupational exposure to driving, and for BMI, psychosomatic disorders, headache and do-it-yourself activities)	AOR: 1.41–4.23			
				Psychological factors				
13. Anxiety	Rundell *et al.*, 2017[50]	The effect of positive anxiety screen (PHQ-4) with reference to no anxiety symptoms on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.65 (adjusted for age, sex, race, site)	AOR: 1.33–2.03		Increased odds	Very limited evidence
14. Depression	Rundell *et al.*, 2017[50]	The effect of positive depression screen (PHQ-4) with reference to no depression symptoms on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 2.01 (Adjusted for age, sex, race, site)	AOR: 1.60–2.75		Increased odds	Very limited evidence
15. Mental disorder	de Miguel-Díez *et al.*, 2018 [8]	The effect of mental disorder (anxiety and/or depression) with reference to no mental disorder (anxiety and/or depression) on the prevalence of CLBP in older adults suffering COPD (n = 2,335)	12-mo prevalence	AOR: 1.60 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.24–2.05		Increased odds	Very limited evidence
				General health				
16. Osteoporosis	Rundell *et al.*, 2017[50]	The effect of osteoporosis on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.83 (Adjusted for age, sex, race, site)	AOR: 0.62–1.10		No relation	Very limited evidence
17 .Knee osteoarthritis	Rundell *et al.*, 2017[50]	The effect of knee osteoarthritis on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.40 (Adjusted for age, sex, race, site)	AOR: 1.10–1.79		Increased odds	Very limited evidence
18. Hip osteoarthritis	Rundell *et al.*, 2017[50]	The effect of hip osteoarthritis on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.62 (Adjusted for age, sex, race, site)	AOR: 0.99–2.65		No relation	Very limited evidence
19. COPD	de Miguel-Díez *et al.*, 2018[8]	The effect of COPD on the prevalence of CLBP in older adults (n = 2,335)	12-mo prevalence	AOR: 1.38 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.16–1.64		Increased odds	Very limited evidence
20. COPD and hypertension	de Miguel-Díez *et al.*, 2018[8]	The effect of high blood pressure diagnosed by a physician on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 1.50 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.20–1.87		Increased odds	Very limited evidence

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Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
21. Comorbidity	Rundell *et al.*, 2017[50]	The effect of an additional unit of Quan Comorbidity Index score on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.16 (Adjusted for age, sex, race, site)	AOR: 1.10 to 1.22		Increased odds	Very limited evidence
22. Self-perceived health status	de Miguel-Díez *et al.*, 2018[8]	The effect of self-rated suboptimal health (very poor/poor/Fair) with reference to self-rated good/ very good health on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 1.58 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.12–2.05		Increased odds	Limited evidence
	Rundell *et al.*, 2017[50]	The effect of an additional unit increase in EQ-5D score on the prevalence to persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.03 (Adjusted for age, sex, race, site)	AOR: 0.02–0.04			
			History of falls and lower body injury					
23. History of falls	Kato *et al.*, 2019[32]	The effect of a history of falls in previous 12 mos, as assessed by GLFS-25, on CLBP prevalence in elderly women (n = 38)	Point prevalence	AOR: 1.10 (factors in the logistic regression model are not listed)	AOR: 1.01–1.19		Increased odds	Very limited evidence
	Rundell *et al.*, 2017[50]	The effect of a fall in prior 3 weeks with reference to no fall history on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 0.94 (Adjusted for age, sex, race, site)	AOR: 0.71–1.24		Increased odds	Conflicting evidence
		The effect of falls twice or more in prior 3 weeks with reference to no fall history on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.84 (Adjusted for age, sex, race, site)	AOR: 1.09–3.10			
24. Previous injury of lower body	Namkaew & Wiwatanadate, 2012 [40]	The effect of a previous injury of lower body on the prevalence of CLBP in older adults (n = 534)	Point prevalence	AOR:1.62 (Adjusted factors were not reported)	AOR: 1.11–2.35		Increased odds	Very limited evidence
			Habit					
25. Smoking	Rundell *et al.*, 2017[50]	The effect of former smoker with reference to non-smoker on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.06 (adjusted for age, sex, race, site)	AOR: 0.92–1.21		No relation	Very limited evidence
		The effect of smoking (current smoker / quit smoking <1 year) with reference to non-smoker on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.55 (adjusted for age, sex, race, site)	AOR: 1.16–2.08		Increased odds	Very limited evidence

(*continued on next page*)

Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
26. Total amount of physical activity	Solovev *et al.*, 2020[56]	The effect of the 2nd Quartile of total PA (38.8 to 42.1 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,658)	5-y cumulative incidence	CLBP 208/1,658 (12.6%) AOR: 0.89 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.72–1.09		No relation	Very limited evidence
		The effect of the 3rd Quartile of total PA (42.1 to 48.0 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,653)	5-y cumulative incidence	CLBP 259/1,653 (15.7%) AOR: 1.10 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.90–1.34			
		The effect of the 4th Quartile of total PA (≥48.0 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,670)	5-y cumulative incidence	CLBP 267/ 1,670 (16.0%) AOR: 1.07 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.87–1.33			
		The effect of the 2nd Quartile of total PA (38.8 to 42.1 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,658)	5-y cumulative incidence	Serious CLBP 82/1,658 (5.0%) AOR: 0.81 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.59–1.10		No relation	Very limited evidence
		The effect of the 3rd Quartile of total PA (42.1 to 48.0 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,653)	5-y cumulative incidence	Serious CLBP 99/1,653 (6.0%) AOR: 0.92 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.68–1.24			
		The effect of the 4th Quartile of total PA (≥48.0 MET-hr/d) with reference to the 1st Quartile of total PA (<38.8 MET-hr/d) on the prevalence of CLBP in older adults (n = 1,670)	5-y cumulative incidence	Serious CLBP 119/ 1,670 (7.1%) AOR: 1.00 (Adjusted for sex, age, marital status, education, occupation, BMI, and smoking and drinking habit)	AOR: 0.74–1.36			
27. The amount of leisure time physical activity	Solovev *et al.*, 2020[56]	The effect of the low tertile of leisure-time PA (low; <1.0 MET-hr/d) with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n = 1,502)	5-z cumulative incidence	CLBP 218/ 1,502 (14.5%) AOR: 0.94 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.77–1.14		No relation	Very limited evidence
		The effect of the low tertile of leisure-time METs score with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n = 1,502)	5-y cumulative incidence	CLBP 218/ 1,502 (6.3%) AOR: 0.91 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.69–1.20			

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Table 4. Continued

Variables	*Study*	*Definition/ level of exposure (n = sample size)*	*Prevalence/incidence of LBP*	*Statistics (eg, odds ratio)*	*95% Confidence intervals*	*Results of meta-analysis*	*Association with LBP*	*Strength of evidence*
		The effect of the medium tertile of leisure-time PA (medium; 1.0 to 3.0 MET-hr/d) with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n = 1,571)	5-y cumulative incidence	CLBP 185/ 1,571 (11.8%) AOR: 0.75 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.61–0.92		Decreased odds	Very limited evidence
		The effect of the medium tertile of leisure-time METs score with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n = 1,571)	5-y cumulative incidence	CLBP 71/ 1,571 (4.5%) AOR: 0.75 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.48–0.89			
			The effect of the high tertile of leisure-time PA (high; ≥3.1 MET-hr/d) with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n = 1,563)	5-y cumulative incidence	CLBP 251/ 1,563 (16.1%) AOR: 1.03 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.84–1.27		No relation
Very limited evidence			The effect of the high tertile of leisure-time METs score with reference to no leisure PA (0 METs/d) on the prevalence of CLBP in older adults (n =1,563)	5-y cumulative incidence	CLBP 96/ 1,563 (6.1%) AOR: 0.87 (Adjusted for sex, age, marital status, education, occupation, BMI, smoking, drinking, and non-leisure-time physical activity)	AOR: 0.64–1.18		
				Spinal degeneration				
28. Disk space narrowing (presence versus absence)	* de Schepper *et al.*, 2010 [9]	The effect of presence of grade ≥1 disc space narrowing (as graded by the Lane atlas) at any of the L1/L2 to L5/S1 levels with reference to the absence of any disk space narrowing along L1 to S1 levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:1.6 (Adjusted for age, gender, BMI, BMD)	AOR: 1.2–2.0	Pooled AOR for point prevalence: 1.59, 95%CI:1.25–2.01	Increased odds	Limited evidence

(*continued on next page*)

Table 4. Continued

Variables	*Study*	*Definition/ level of exposure (n = sample size)*	*Prevalence/incidence of LBP*	*Statistics (eg, odds ratio)*	*95% Confidence intervals*	*Results of meta-analysis*	*Association with LBP*	*Strength of evidence*
	* van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥1 disc space narrowing (as graded by the Lane atlas) at any of the L1/L2 to L5/S1 levels with reference to the absence of any disk space narrowing along L1 to S1 levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.5 (Adjusted for age, BMI and sex)	AOR: 0.8–2.9			
	* de Schepper *et al.*, 2010[9]	The effect of presence of grade ≥1 disc space narrowing (as graded by the Lane atlas) at any of the L1/L2 to L4/L5 levels with reference to the absence of any disk space narrowing along L1 to L5 levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:1.8 (Adjusted for age, gender, BMI, BMD)	AOR: 1.4–2.2	Pooled AOR for point prevalence: 1.76, 95% CI:1.43–2.18		
	van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥1 disc space narrowing (as graded by the Lane atlas) at any of the L1/L2 to L4/L5 levels with reference to the absence of any disk space narrowing along L1 to L5 levels on the prevalence of CLBP in older adults (n =699)	Point prevalence	AOR:1.5 (Adjusted for age, BMI and sex)	AOR: 0.8–2.8			
	* de Schepper *et al.*, 2010[9]	The effect of presence of grade ≥1 disk space narrowing at 2 or more levels (as graded by the Lane atlas) between L1/L2 and L5/S1 levels with reference to no disk space narrowing at 2 or more lumbar disc levels on the prevalence of CLBP in older adults. (n = 2,819)	Point prevalence	AOR:2.2 (Adjusted for age, gender, BMI, BMD)	AOR: 1.8–2.8	Pooled AOR for point prevalence: 2.14, 95%CI: 1.73 to 2.65		
	* van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥1 disc space narrowing at 2 or more levels (as graded by the Lane atlas) between L1/L2 and L5/S1 levels with reference to no disc space narrowing at 2 or more lumbar disc levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.6 (Adjusted for age, BMI and sex)	AOR: 0.8–3.2			
	* de Schepper *et al.*, 2010[9]	The effect of presence of grade ≥1 disc space narrowing at 2 or more levels (as graded by the Lane atlas) between L1/L2 and L4/L5 levels with reference to no disc space narrowing at 2 or more lumbar disc levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:2.5 (Adjusted for age, gender, BMI, BMD)	AOR: 1.9–3.2	Pooled AOR for point prevalence: 2.34, 95%CI: 1.86–3.05		

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Table 4. Continued

Variables	*Study*	*Definition/ level of exposure (n = sample size)*	*Prevalence/incidence of LBP*	*Statistics (eg, odds ratio)*	*95% Confidence intervals*	*Results of meta-analysis*	*Association with LBP*	*Strength of evidence*
	* van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥1 disc space narrowing at 2 or more levels (as graded by the Lane atlas) between L1/L2 and L4/L5 levels with reference to no disc space narrowing at 2 or more lumbar disc levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.5 (Adjusted for age, BMI and sex)	AOR: 0.7–3.4			
29. Disk space narrowing (severity of narrowing)	van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥2 disc space narrowing at any of the L1/L2 to L5/S1 levels (as graded by the Lane atlas) with reference to the absence of grade <2 disc space narrowing between L1/L2 and L5/S1 levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.1 (Adjusted for age, BMI and sex)	AOR: 0.5–2.1		No relation	Very limited evidence
		The effect of presence of grade ≥2 disc space narrowing at any of the L1/L2 to L4/L5 levels (as graded by the Lane atlas) with reference to the grade <2 disc space narrowing between L1/L2 and L4/L5 levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:0.9 (Adjusted for age, BMI and sex)	AOR: 0.4–2.0			
	Suri *et al.*, 2013[58]	The effect of presence of any severe disc space narrowing (end plate in contact) between L2/L3 and L5/S1 levels (as graded by Videman *et al.* criteria) with reference to the absence of any severe disc space narrowing (end plate in contact) between L2/L3 and L5/S1 levels on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR:0.69 (Adjusted for age, living alone, retirement and presence of severe facet joint osteoarthritis)	AOR: 0.36–1.33		No relation	Very limited evidence
		The effect of an additional severe disc space narrowing level between L2/L3 and L5/S1 levels (as graded by Videman *et al.* criteria) on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR:0.89 (Adjusted for age, living alone, retirement and number of level with severe disk height narrowing)	AOR: 0.59–1.34			
30. Anterior/lateral osteophytes and disc space narrowing	* de Schepper *et al.*, 2010[9]	The effect of presence of grade ≥2 osteophytes (as graded by the Lane atlas) at 2 or more levels along L1/L2 to L5/S1 levels with reference to grade <2 osteophytes at 2 or more lumbar levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:1.6 (Adjusted for age, gender, BMI, BMD)	AOR: 1.3–2.0	Pooled AOR for point prevalence: 1.58, 95%CI: 1.29–1.94	Increased odds	Conflicting evidence

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Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
	* van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥2 osteophytes (as graded by the Lane atlas) at 2 or more levels along L1/L2 to L5/S1 levels with reference to grade <2 osteophytes at 2 or more lumbar levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.4 (Adjusted for age, BMI and sex)	AOR: 0.7–2.8			
	de Schepper *et al.*, 2010[9]	The effect of presence of grade ≥1 osteophytes (as graded by the Lane atlas) at any of the L1/L2 to L5/S1 levels with reference to the absence of any osteophytes at these levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:1.2 (Adjusted for age, gender, BMI, BMD)	AOR: 1.0–1.5			
		The effect of presence of grade ≥1 osteophytes (as graded by the Lane atlas) at any of the L1/L2 to L4/L5 levels with reference to the absence of any osteophytes at these levels on the prevalence of CLBP in older adults (n = 2,819)	Point prevalence	AOR:1.3 (Adjusted for age, gender, BMI, BMD)	AOR: 1.1–1.7			
		The effect of presence of grade ≥2 osteophytes at 2 or more levels (as graded by the Lane atlas) at any of the L1/L2 to L4/L5 levels with reference to grade <2 osteophytes at 2 or more lumbar levels on the prevalence of CLBP in older adults. (n = 2,819)	Point prevalence	AOR:1.4 (Adjusted for age, gender, BMI, BMD)	AOR: 1.1–1.8			
	van den Berg *et al.*, 2017[63]	The effect of presence of grade ≥2 osteophytes (as graded by the Lane atlas) at any of the L1/L2 to L5/S1 levels with reference to presence of grade <2 osteophytes at any of these levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:1.6 (Adjusted for age, BMI and sex)	AOR: 0.8–3.0			
		The effect of presence of grade 3 osteophytes (as graded by the Lane atlas) at any of the L1/L2 to L5/S1 levels with reference to presence of grade <3 osteophytes at any of these levels on the prevalence of CLBP in older adults (n = 699)	Point prevalence	AOR:0.9 (Adjusted for age, BMI and sex)	AOR:0.4–2.1			
31. Severe facet joint osteoarthritis	Suri *et al.*, 2013[58]	The effect of presence of any severe facet joint osteoarthritis between L2 to S1 level on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR: 2.15 (Adjusted for age, living alone, retirement and presence of severe disk height narrowing)	AOR: 1.13–4.08		Increased odds	Very limited evidence

(*continued on next page*)

Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
	Suri *et al.*, 2013[58]	The effect of an additional number of severe facet joint osteoarthritis between L2 to S1 level on the prevalence of CLBP in older adults (n = 252)	12-mo prevalence	AOR: 1.22 (Adjusted for age, living alone, retirement and number of level with severe disk height narrowing)	AOR: 1.04–1.42			
			Other body pain					
32. Cervical pain	de Miguel-Díez *et al.*, 2018 [8]	The effect of chronic cervical pain on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 7.75 (Adjusted for: age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 6.21–9.69		Increased odds	Conflicting evidence
	Rundell *et al.*, 2017[50]	The effect of presence of cervical pain on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.31 (Adjusted for age, sex, race, site)	AOR: 0.99–1.73			
33. Widespread pain syndrome	Rundell *et al.*, 2017[50]	The presence of self-reported widespread pain syndrome (pain in most of body) on the prevalence of persistent LBP in older adults (n =5,220)	12-mo prevalence	AOR: 2.03 (Adjusted for age, sex, race, site)	AOR: 1.52–2.72		Increased odds	Very limited evidence
34. Leg pain intensity	Rundell *et al.*, 2017[50]	The effect of an additional unit on leg pain intensity (NPRS) on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.13 (Adjusted for age, sex, race, site)	AOR: 1.09–1.17		Increased odds	Very limited evidence
35. Presence of leg pain (Yes)	Rundell *et al.*, 2017[50]	The effect of leg pain presence on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.87 (Adjusted for age, sex, race, site)	AOR: 1.63–2.14		Increased odds	Very limited evidence
36. Pain inventory	Rundell *et al.*, 2017[50]	The effect of an additional unit of Brief Pain Inventory score on the prevalence of persistent LBP in older adults (n = 5,520)	12-mo prevalence	AOR: 1.29 (Adjusted for age, sex, race, site)	AOR: 1.25–1.33		Increased odds	Very limited evidence
37. Use of pain medication	de Miguel-Díez *et al.*, 2018[8]	The effect of using pain medication on the prevalence of CLBP in older adults with COPD (n = 2,335)	12-mo prevalence	AOR: 1.79 (Adjusted for age, sex, sociodemographic characteristics, lifestyles, or comorbidities)	AOR: 1.42–2.25		Increased odds	Very limited evidence
38. Family history of body pain	Namkaew & Wiwatanadate, 2012[40]	The effect of the family history of body pain on the prevalence of CLBP in older adults. (n = 534)	Point prevalence	AOR:1.73 (Adjusted factors not reported)	AOR: 1.18–2.54		Increased odds	Very limited evidence
39. Self expectation for recovery	Rundell *et al.*, 2017[50]	The effect of poor expectation on the self-expectation for recovery rating scale on the prevalence of persistent LBP in older adults (n = 5,220)	12-mo prevalence	AOR: 1.17 (Adjusted for age, sex, race, site)	AOR: 1.11–1.19		Increased odds	Very limited evidence

(*continued on next page*)

Table 4. Continued

Variables	Study	Definition/ level of exposure (n = sample size)	Prevalence/Incidence of LBP	Statistics (eg, odds ratio)	95% Confidence intervals	Results of meta-analysis	Association with LBP	Strength of evidence
Other factor								
40. Daily fluoride consumption	Namkaew & Wiwatanadate, 2012[40]	The effect of an additional 1mg average daily fluoride dose on the prevalence of CLBP in older adults (n = 534)	Point prevalence	AOR:5.12 (Adjusted factors not reported)	AOR: 1.59–16.98		Increased odds	Very limited evidence
		The effect of living in an area with high fluoride water source (>=0.20 mg/kg/d) on the prevalence of CLBP in older adults (n = 534)	Point prevalence	AOR:1.58 (Adjusted factors not reported)	AOR: 1.10–2.28			
41. Abdominal trunk muscle strength	Kato *et al.*, 2019[32]	The effect of an additional muscle-strength value (kPa) measured by an exercise device for abdominal trunk muscles on CLBP prevalence in elderly women (n = 38)	Point prevalence	AOR: 1.41 (Adjusted factors not reported)	AOR: 1.03–1.92		Increased odds	Very limited evidence

Abbreviations: AOR, adjusted odds ratio (from multivariate analysis); BMD, bone mass density; BMI, body mass index; CLBP, chronic low back pain; COPD, chronic obstructive pulmonary disease; EQ-5D, EuroQol-5D; GED, general education development; GLFS, 25-question geriatric locomotive functional scale ; LBP30, low back pain over 30 days in 12 month; MET, metabolic equivalent of task ; NPRS, 11-point numeric pain rating scale; PA, physical activity; PHQ-4, patient health questionnaire-4 depression and anxiety screen; RMDQ, roland morris disability questionnaire; UOR, unadjusted odds ratio (from univariate analysis).

Psychological Factors

Similar to working-age adults, anxiety and depression were closely related to non-specific CLBP in older adults.[8,50] Psychological distress (eg, anxiety or depression) has been described to be associated with persistent or debilitating LBP in adults of all ages.[2,28] A prior longitudinal study showed that older adults with higher depressive symptom scores at baseline doubled the risk of having LBP 4 years later.[12] Likewise, Reid *et al.* found that depression was significantly related to disabling LBP in older adults aged 70 years or above.[48] Since persistent LBP may have a reciprocal effect on anxiety/depression[11,48] and late life depression is not uncommon, it is crucial for clinicians to evaluate the psychological well-being and clinicial outcomes of older patients with CLBP so that timely intervention can be provided.[66] Further, since patients' expectation or self-perceived health may influence the recovery or treatment outcomes of LBP,[16] clinicians should address patients' concerns/expectations and empower them to self-manage CLBP.

Clinical Factors

Multisite pain was associated with a high prevalence of CLBP. Older adults are susceptible to multisite musculoskeletal pain.[15,43] Approximately 25% to 43% of community-dwelling adults aged 65 years or older reported multisite musculoskeletal pain.[15] People with more painful sites have a higher risk of persistent LBP, which is less likely to be resolved.[49] Importantly, research showed that more painful sites at baseline predicted greater CLBP intensity and CLBP-related disability, as well as poorer health-related quality of life in older adults in the following 12 months.[49] Since older women with multisite pain may have poorer psychological health and need more pain medications,[7] multidisciplinary pain rehabilitation may benefit these patients by addressing their psychological problems and enhancing their self-management skills.[39,44]

Although spinal degeneration is not uncommon among people with or without non-specific CLBP, our review showed that the presence of disk space narrowing or osteophytes at two or more levels in the lumbar region was associated with a higher point prevalence of non-specific CLBP in older adults. This observation concurs with the findings of a systematic review that greater disc space narrowing was significantly associated with greater LBP prevalence.[46] It is possible that disk space narrowing alters spinal biomechanics and overloads nearby facet joints and ligaments, leading to LBP.[5,9] Interestingly, Suri and colleagues found that decreased disc height was significantly related to persistent LBP in individuals aged below 60 years, but not in adults aged 60 years or older.[58] This disparity may be due to changes in the source of LBP from discogenic-predominant in middle-aged individuals to facetogenic-predominant in older adults.[58] This hypothesis is partly supported by our review that the presence of severe facet joint degeneration in the lumbar region is related to a higher 12-month prevalence of CLBP in older adults.

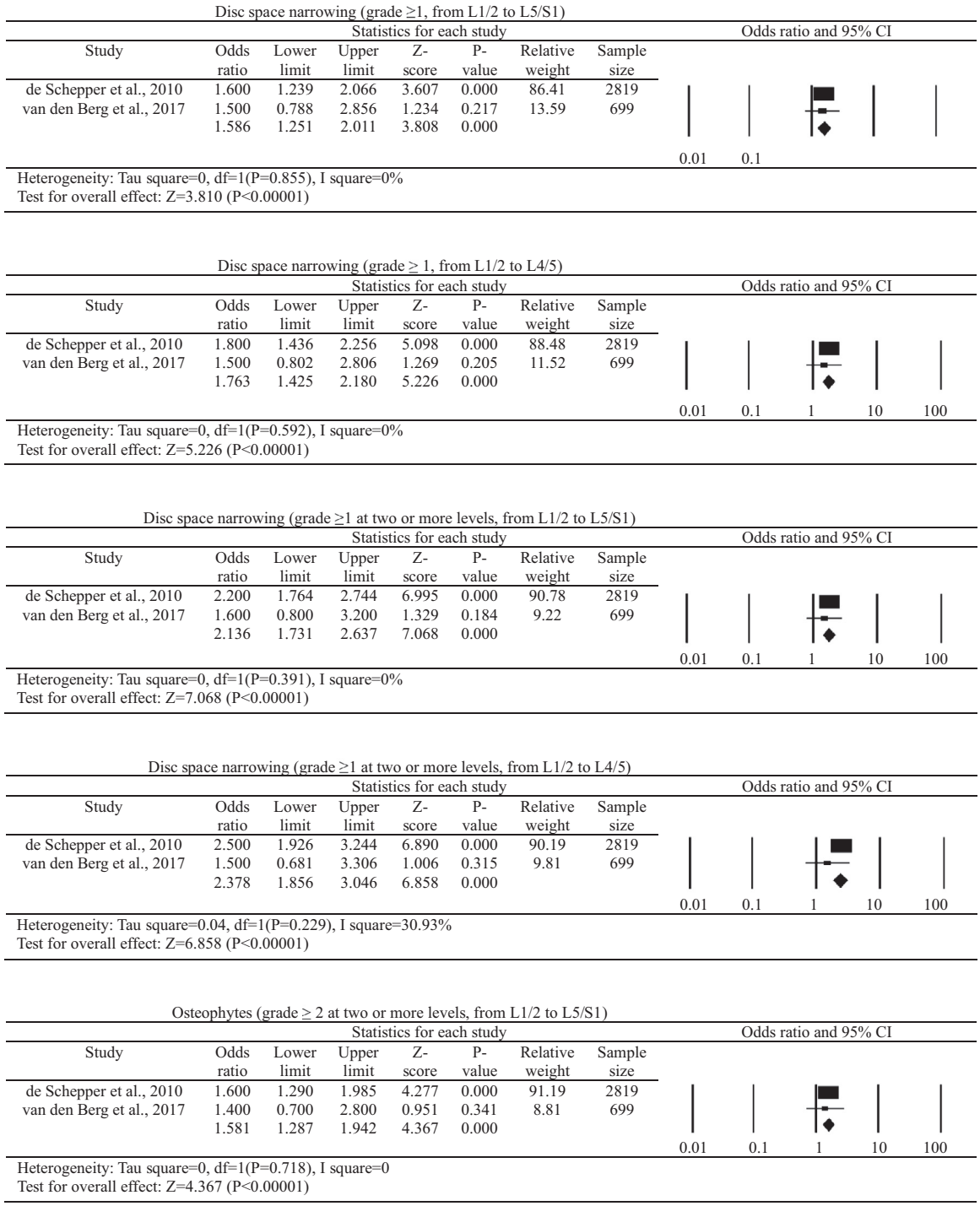

Figure 3. Forest plots of risk factors (disc space narrowing, disc space narrowing without L5/S1, disc space narrowing at 2 or more levels, disc space narrowing at 2 or more levels without L5/S1, osteophytes (grade ≥2) at 2 or more level) for point-prevalence of chronic low back pain.

Since facet joints and the intervertebral disc form a three-joint complex to support segmental movement and stability, any anomaly in this structure may transmit stress to other spinal structures[71] and result in CLBP in older adults. Future large-scale prospective studies are warranted to test this hypothesis.

Physical Activities

Leisure-time physical activity demonstrates a U-shaped association with non-specific CLBP in older adults.[56] This finding slightly differed from a prior systematic review, which concluded that active older adults (ie, those aged 70 years or older participating in a sport

or other leisure time physical activity, or being in the middle or upper third distribution of leisure time physical activity in a sample) had a lower risk of developing CLBP than inactive counterparts.[52] Although the exact benefits of leisure-time physical activity may have been confounded by non-leisure time physical activity, the consistent findings suggest that intermediate level of leisure-time physical activity may lower the risk of CLBP in older adults.[52] Since exercises have multiple beneficial effects on older adults (eg, reducing sarcopenia,[73] improving posture and muscle activation,[52] enhancing self-efficacy[34,36] and moods, as well as mitigating pain catastrophizing,[54] anxiety[37] and depression[1]), older people are recommended to exercise regularly regardless of their LBP status. Future studies can use wearable devices to quantify the effects of various domains (eg, household, work, commuting, and leisure time) and dimensions of physical activity (ie, frequency, intensity, type, and time) on the development or maintenance of non-specific CLBP in older adults.

Limitations

The current review had several limitations. Specifically, all included studies had moderate to high risk of bias in multiple domains (eg, sample size justification, attrition reporting, and consideration of confounders). Further, the included studies relied on self-reported questionnaires to evaluate factors associated with a higher prevalence/incidence of non-specific CLBP in older adults, which might be subject to recall bias. Future prospective studies may incorporate caregiver reporting of exposures and CLBP (especially for older people with mild cognitive impairment). As only English peer-reviewed articles were included in this review, relevant studies in other languages might have been missed. Future reviews should include relevant non-English articles to improve the comprehensiveness of evidence. Qualitative research may also be conducted to deepen the understanding of patients' expectations and factors that may have been missed in questionnaires.[70] Additionally, the definitions of non-specific CLBP slightly differed across the included studies, which prevented meta-analyses. Future research should establish a standard definition of non-specific CLBP to allow comparisons across studies. Importantly, many identified factors were reported in 1 or 2 low methodological quality cross-sectional studies, while only a few prospective studies investigated factors associated with CLBP incidence. Future high-quality prospective research is warranted to investigate the causal relationship between CLBP and factors that showed large odds ratios in the current review or those with a sound theoretical background. Those findings can help formulate proper preventive strategies for CLBP in older adults.

Strengths of This Review

The current review had multiple strengths. First, the protocol was registered with PROSPERO to improve transparency. Second, it adopted multiple database searches, as well as standardized screening, data extraction, risk of bias assessments, and meta-analysis procedures to ensure the comprehensiveness of findings. Third, levels of evidence of all factors were evaluated and summarized according to the GRADE for cohort studies.[27]

Overall, this is the first systematic review to comprehensively summarize evidence regarding various factors related to non-specific CLBP in older adults. Our results highlight the paucity and weaknesses of existing relevant literature. Given the ever-growing aging population and high prevalence of non-specific CLBP in older adults, there is an urgent need to identify risk and/or prognostic factors for non-specific CLBP in older adults so that high risk individuals can be identified, and proper prevention and management strategies can be developed and implemented.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jpain.2021.07.012.

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