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Distribution and prevalence of musculoskeletal pain co-occurring with persistent low back pain: a systematic review

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Abstract

Background: Co-occurring musculoskeletal pain is common among people with persistent low back pain (LBP) and is associated with more negative consequences than LBP alone. The distribution and prevalence of musculoskeletal pain co-occurring with persistent LBP has not been systematically described, which hence was the aim of this review.

Methods: Literature searches were performed in MEDLINE, Embase, CINAHL and Scopus. We considered observational studies from clinical settings or based on cohorts of the general or working populations involving adults 18 years or older with persistent LBP (≥4 wks) and co-occurring musculoskeletal pain for eligibility. Study selection, data extraction and risk of bias assessment were carried out by independent reviewers. Results are presented according to study population, distribution and location(s) of co-occurring pain.

Results: Nineteen studies out of 5744 unique records met the inclusion criteria. Studies were from high-income countries in Europe, USA and Japan. A total of 34,492 people with persistent LBP were included in our evidence synthesis. Methods for assessing and categorizing co-occurring pain varied considerably between studies, but based on the available data from observational studies, we identified three main categories of co-occurring pain – these were axial pain (18 to 58%), extremity pain (6 to 50%), and multi-site musculoskeletal pain (10 to 89%). Persistent LBP with co-occurring pain was reported more often by females than males, and co-occurring pain was reported more often in patients with more disability.

Conclusions: People with persistent LBP often report co-occurring neck pain, extremity pain or multi-site pain. Assessment of co-occurring pain alongside persistent LBP varies considerably between studies and there is a need for harmonisation of measurement methods to advance our understanding of how pain in different body regions occurs alongside persistent LBP.

Systematic review registration: PROSPERO CRD42017068807.

Keywords: Low back pain, Comorbidity, Musculoskeletal pain, Prevalence, Systematic review
Background
Low back pain (LBP) is common and a worldwide leading and growing cause of disability with enormous costs [1]. For some people, due to multifactorial reasons [1], LBP persists and becomes a long-lasting condition [2, 3]. Individuals with persistent LBP commonly present with a range of additional health problems and diseases such as sleep disorders, anxiety and depression [4–7], as well as co-occurring musculoskeletal pain [8–11]. Musculoskeletal pain in other body sites is also found to be significantly associated with new-onset LBP [12].

Persistent LBP with co-occurring musculoskeletal pain is reported to be more frequent and distinctly different from persistent LBP that occur alone [13–15]. The presence of co-occurring musculoskeletal pain is associated with poor prognosis, more negative health outcomes, and increased health care utilization [5, 16–20]. Persons with LBP have increased likelihood of co-occurring pain elsewhere in the spine [8], but LBP has also been found to cluster with lower extremity pain [21]. Yet, the current scientific literature on persistent LBP lack an overview of the distribution and prevalence of co-occurring pain sites.

Persistent LBP is often treated as a condition on its own – irrespective of musculoskeletal comorbidity, but may need to be viewed beyond just a regional pain site problem [9]. Despite common prognostic factors across different musculoskeletal pain sites [22], different LBP phenotypes (i.e., different definitions of LBP), may have different prognoses and benefit from different management approaches. To improve patient outcomes, it is important to identify these LBP phenotypes and get a better insight into the prevalence of this multifaceted and complex problem.

The overall aim of this systematic review was therefore to critically appraise and summarize the literature dealing with the distribution and prevalence of co-occurring musculoskeletal pain among people with persistent LBP. The research questions addressed were: (1) What are the patterns of distribution of co-occurring musculoskeletal pain (i.e., number of co-occurring pain sites, distribution across body quadrants, combination of sites and general pattern) among people with persistent LBP? (2) What is the prevalence of co-occurring musculoskeletal pain among people with persistent LBP? (3) Is there an association between pain patterns and/or number of pain sites and age, sex, or LBP-related disability?

Methods
The protocol for this review was prospectively registered in the PROSPERO database (CRD42017068807) and published [23]. This systematic review was reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement [24] (Additional file 1).

Eligibility criteria
We considered observational studies (i.e., longitudinal and cross-sectional cohort studies), from clinical settings or based on cohorts of the general or working populations involving adults 18 years or older. We included studies investigating persistent LBP (e.g., pain within the anatomical region below the twelfth thoracic vertebra and the inferior gluteal fold), with or without radiation to the legs, with a duration of at least 4 wks. Furthermore, eligible studies had to assess co-occurring musculoskeletal pain (i.e., number of co-occurring pain sites and distribution across body sites) in individuals with persistent LBP. Peer-reviewed studies published in the English, Dutch, Danish, Norwegian, Portuguese, Spanish, or Swedish languages, understood by the authors of this paper, were screened for eligibility. Studies including individuals with LBP of specific pathological origin (e.g., fracture, tumour, inflammatory diseases, systemic diseases, infection, structural deformity) were excluded, as were studies including pregnant women and studies dealing with post-surgical persistent LBP. Studies with other study designs (e.g., randomised controlled trials) as well as studies with a study sample of < 100 individuals with persistent LBP were post-protocol decided to be excluded due to their limited possibility to assess prevalence.

Database search strategy
The literature search was performed with no restrictions on date, publication type, or language within the following bibliographic databases: MEDLINE and Embase (via Ovid), CINAHL, and Scopus (for forward citation tracking), from the earliest records published to August 2nd, 2019. We updated the search on October 26th, 2020 in Medline (via Ovid) only, as there were no unique hits in the other databases and since majority of relevant studies in systematic reviews are reported to be found within a limited number of databases without introducing bias or changing results [25]. Search terms covered the following domains: LBP, co-occurring musculoskeletal pain, and number of pain sites/pain patterns, combined with study design. Pilot searches were performed on the search terminology to ensure its all-inclusiveness. The design and execution of the searches were supervised by a research librarian (see Additional file 2 for the search strategy). The reference lists of included articles and related reviews within the topic were scrutinised, and forward citation tracking was performed on key articles in order to identify any further studies. PROSPERO was inspected for ongoing or recently completed systematic reviews to identify additional articles not identified in
the bibliographic databases. We did not search additional grey literature as originally planned as we do not expect to find any relevant epidemiological studies here as opposed to literature on interventions where very few relevant studies or questionable vested interests may have an impact on the results [26]. The identified articles were downloaded to and managed in EndNote X9 [27].

**Study selection**
Relevant records were selected through a two-stage screening process by three independent reviewers (CKØ, MSJ and TFC), where one reviewer (CKØ) screened all and the other two (MSJ and TFC) shared the screening of the retrieved records. In the first stage, titles and abstracts were screened with the reviewers blinded to each other’s selections. Disagreements were discussed and resolved by a fourth independent reviewer (BN) if necessary. The studies considered not to be relevant, or that clearly did not meet the inclusion criteria, were excluded, and full-text articles of the remaining studies were obtained. Studies relevant for the topic, but with uncertain relevance for the current review were taken to the second stage for further consideration. In the second stage, the same reviewers made the final selection based on screening of the full text articles against the eligibility criteria. If necessary, study authors were contacted for additional information to resolve questions about eligibility. Consensus meetings were used to resolve any disagreement by consulting a fourth reviewer (JH). Reasons for exclusion were recorded.

**Data extraction**
Data from the included articles were extracted into pre-tested forms by two independent author pairs (CKØ + MLF/JH and TFC + MLF/JH), each pair including an experienced reviewer. Disagreements were resolved first by discussion or if necessary by a third independent group of reviewers (MSJ, BN and PJM). Data extraction included: main characteristics of the included articles, definition of LBP, prevalence of co-occurring musculoskeletal pain by anatomical location, number of co-occurring pain sites and/or pattern of distribution of co-occurring musculoskeletal pain, association between the pain pattern and/or number of pain sites and LBP-related disability, and other information relevant for the critical appraisal. We contacted two study authors by e-mail as additional information was required regarding missing data to calculate prevalence (see Table 3 for details).

**Risk of bias assessment**
We used a modified version of the Risk of Bias Tool for Prevalence Studies to assess the risk of bias [47] (see Additional file 3 for details). For the purpose of this systematic review, the tool was slightly modified; in item 1, the wording was changed from “Was the study’s target population a close representation of the national population in relation to relevant variables?” to “Was the study population representative of the target population?” whereby randomly selected or consecutively selected samples were appraised as low risk of bias and convenience samples as high risk of bias. Furthermore, item 6 was defined for LBP only and we left the example in item 7 open with regards to which study instrument that was used apart from that it must have been validated. This modified risk of bias tool was piloted to ensure that reviewers were consistent in their appraisal. Two reviewer pairs independently performed the risk of bias assessment (CKØ + JH and TFC + MLF). The overall risk of bias (i.e., low, moderate, or high) was determined for each included article based on the reviewers’ consensus, given the responses to the items in this tool. With low overall risk of bias further research is very unlikely to change the confidence in the estimate, moderate overall risk of bias indicate that further research is likely to have an important impact on our confidence in the estimate and may change the estimate, and high overall risk of bias imply that further research is very likely to have an important impact on our confidence in the estimate and is likely to change the estimate. All authors were involved in the final assessment of risk of bias. The GRADE approach was not used in this review for overall appraisal of the quality of the evidence due to lack of guidance for systematic reviews on prevalence data using this methodology [48].

**Data synthesis and analysis**
The results of the literature search, risk of bias assessment and data extraction are summarized in tables and figures. The proportion of participants with persistent LBP and co-occurring musculoskeletal pain are described as prevalences and subgrouped according to study population, distribution and location(s) of co-occurring pain. The precision of the prevalences was assessed with 95% confidence intervals (CI) calculated using the exact method in Stata (StataCorp, College Station, Texas, USA). Differences in age- and sex-specific prevalences and distribution pattern of co-occurring musculoskeletal pain are described but not pooled as few studies stratified on these factors. Furthermore, we were not able to assess LBP-related disability or possible differences between working versus general populations as intended, due to the limited reporting in the included articles.

**Results**
**Search results and study selection**
The study selection processes are illustrated in Fig. 1. A total of 7481 articles were identified through the
literature searches and through other sources. After removal of duplicates, 5744 articles were screened at title/abstract level and a total of 658 articles were screened at carried forward for full-text screening. Finally, 19 articles were considered eligible for this systematic review [28–46].

Study characteristics
The main characteristics of the included articles are presented in Table 1. Ten articles were based on data from the general population, two articles reported on working populations and seven articles reported on clinical populations. Study designs were cross-sectional (n=11), prospective (n=5), and retrospective (n=3); for prospective and retrospective studies, baseline data were considered. The articles were published between 1998 and 2019, while the data were collected between 1985 and 2017 (not reported in two articles). All the included articles were published in English, apart from one in Norwegian [37]. The articles originated from the Scandinavian countries (n=7), other European countries (n=5), USA (n=4) and Japan (n=3). A total of 34,492 individuals with persistent LBP and co-occurring musculoskeletal pain were included in our evidence synthesis. Participation rate varied from 19.4 to 100% in different studies while number of people analysed with persistent LBP varied from 100 to 7523. Age was reported both as mean, frequencies within age categories and quartiles, preventing us from reporting an overall mean age; however, most studies included middle-aged and older people (40 to ≥75 years of age). The proportion of females ranged from 48 to 68%, apart from the study with a working population that only included females. Ten of the 19 articles collected prevalence data with questionnaires (five with own questionnaire), and nine used a combination of questionnaires, interviews, and physical examination.

The definition of LBP was typically based on location combined with duration, and in some instances with pain intensity. All the included studies relied on information from questionnaires and interviews, and six studies included pain drawings [30, 31, 35, 38, 43, 44]. Five studies used current pain duration (ranging from ≥4 to 8 months to ≥12 months), and eight studies used both current and cumulative pain duration.
| 1st Author Year Country | Study design Year of study (baseline) | Sample size n invited (n at baseline [%]) | n analysed | Age (yrs) and sex mean [SD], age category n [%], quartile Q2 [Q1, Q3] (♀) | Method for assessing prevalence of persistent LBP and co-occurring musculoskeletal pain |
|-------------------------|--------------------------------------|------------------------------------------|------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Jiménez-Trujillo 2019 [37] Spain | Cross-sectional (2014) | approx. 37500b (22,321 [59.5]% [5189]) | | ▩ 18 to 34; 203 [6.3]% ▩ 35 to 54; 888 [27.3]% ▩ 55 to 74; 1265 [38.9]% ▩ ≥75; 894 [27.5]% | Questionnaire and Interview (EHIISS) |
| Fujii 2018 [34] Japan | Cross-sectional (2015) | 270,000 (52,353 [19.4]) | {3100} | | Questionnaire (own) |
| Takahashi 2018 [47] Japan | Cross-sectional (2011 to 2012) | 34,802 (14,364 [41.3]) | {1378}c | ▩ < 50; 101 [15.1]% ▩ 50 to 59; 158 [23.6]% ▩ 60 to 69; 263 [39.3]% ▩ ≥70; 147 [22.0]% | Questionnaire (own) |
| Nordstoga 2017 [43] Norway | Prospective cohort (1995 to 1997) | 93,898 (65,237 [69.5]) | {7523} | | Questionnaire (adapted SNQ) |
| Kamada 2014 [38] Japan | Cross-sectional (2009) | 6000 (4559 [76.0]) | {605} | | Questionnaire (modified KNEST) |
| Di Iorio 2007 [32] Italy | Cross-sectional (1998) | 1270 (958 [75.4]) | {306} | | Interview (own) Physical examination (including SPPB) |
| Weiner 2003 [48] USA | Cross-sectional (1997 to 1998) | 3075 (2766 [90.1]) | {208} | | Questionnaire (own) Physical examination (EPESE, Health ABC functional capacity scale) |
| Natvig 2001 [42] Norway | Cross-sectional (1994) | 4577a (2893 [63.2%]) | {531}a | ▩ 18 to 34; 35 [6.1]% 55 to 74; 522 [29.1]% ≥75; 200 [11.0]% | Questionnaire (SNQ) |
| Kjellman 2001 [39] Sweden | Retrospective cohort (1985) | 213 (213 [100]) | {100} | | Questionnaire or Interview (own + diagnostic codes) |
| Hoddevik 1999 [36] Norway | Cross-sectional (1994 to 1997) | 106,244 (67,338 [63.4]) | {6422} | | Questionnaire and Interview (own) |
| Andersen 2013 [30] Denmark | Prospective cohort (2004 to 2005) | 12,744 (9949 [78.1]) | {1089} | | Questionnaire (SNQ) |
| Parot-Schinkel 2013 [45] France | Cross-sectional (2002 to 2005) | NR (3710 [approx. 90]) | {616} | | Questionnaire (French version of SNQ) |
| Clinical population | | | | | |
| Rundell 2019 [46] USA | Prospective cohort (2011 to 2013) | 13376c (5239 [39.2%]) | {899} | | Interview (own + diagnostic codes) |
| Herman 2018 [35] USA | Cross-sectional (2016 to 2017) | 6342 (2024 [31.9%]) | {1129}b | | Questionnaire (own) |
| MacLellan 2017 [40] Ireland | Retrospective cohort (2011 to 2015) | 915 (915 [100]) | {416} | | Interview (own) Physical examination (5 physical performance tests) |
| Panagopoulos 2014 [44] Denmark | Prospective cohort (2011 to 2012) | 5791 (2974 [51.4]) | {2974} | | Questionnaire (own) |
| Elfving 2009 [33] Sweden | Prospective cohort (NR) | 362 (312 [86.2]) | {265} | | Questionnaire (own) |
weeks) as an inclusion criteria [35, 38–40, 42, 43], while 11 studies used accumulated pain duration within the past year (ranging from ≥3 to 6 months) or variations of accumulated ‘daily pain’ during the past year as inclusion criteria [28–34, 36, 37, 41, 45]. One study used ≥90 days of sickness absence due to LBP during a 2-year period as inclusion criteria [44] and another followed IASP Classification of Chronic Pain [46].

Critical appraisal
The risk of bias assessment is shown in Table 2. In the overall rating, 14 articles were judged to have a low risk of bias [29–35, 38–43, 46], three articles a moderate risk of bias [28, 36, 37], and two articles a high risk of bias [44, 45]. Overall, the internal validity was judged to be slightly better than the external validity, also, when the articles with an overall high risk of bias were excluded. Notably, seven of the 10 articles with general population samples were rated to have a high risk of non-response bias (item 4). The two articles on working populations had a low risk of bias on all items. For the studies on clinical populations with an overall low risk of bias (two high risk of bias studies disregarded), the risk of bias was mainly related to external validity and non-response bias.

Results of individual studies
Since the included studies were not considered sufficiently homogenous, we chose not to conduct a statistical meta-analysis and the results were therefore synthesised narratively. Table 3 provides a summary of the non-weighted prevalence of co-occurring musculoskeletal pain. Figure 2 gives an overall summary of the results in a forest plot and shows the results for the articles with low or moderate risk of bias. Studies with an overall high risk of bias were not included in the evidence synthesis. Based on the results from the individual articles, co-occurring pain could be grouped into three main categories: i) co-occurring axial pain, ii) co-occurring extremity pain, and iii) other co-occurring multi-site pain (from ≥1 pain site to pain in several body sites).

For co-occurring axial pain, the prevalence of neck and neck/shoulder pain ranged from 32 to 57% in the general population [28, 36], 58% in the working population [38], and from 18 to 54% in clinical populations [40, 41, 46].

For co-occurring extremity pain in the hip, knee, and foot the prevalence in the general population ranged from 20 to 48% [29, 30, 32–34], while in the working population the prevalence of co-occurring knee pain was 27% [38]. In clinical populations, the prevalence co-occurring buttock, leg, or foot pain was 50% [46], the prevalence of pelvic and pelvic-groin pain ranged from 6 to 28% [40, 46], and the prevalence of co-occurring shoulder-arm-hand pain was 17% in the only study that considered upper extremity pain [46].

In the general population the prevalence of any co-occurring pain in arms, legs, or joints were 43% [29] and other musculoskeletal pain 79% [37], while the prevalence of co-occurring pain in arms, legs, or joints was reported to be 89% and the prevalence of widespread pain (defined as pain in most of your body) was 30% in a clinical population [40]. Another clinical population study reported the prevalence of co-occurring chest-abdomen-groin pain (‘anterior trunk pain’) to be 20% [43]; yet another clinical population study reported the prevalence of co-occurring thorax pain to be 10%, and pain in other body sites 65% [46]. Headache was not part of our search strategy, but we have included the prevalences of

### Table 1 Main characteristics of the 19 included articles grouped by study population (Continued)

| 1st Author Year Country | Study design Year of study (baseline) | Sample size n invited (n at baseline [%]) (n analysed)a | Age (yrs) and sexb | Mean [SD], age category n [%], quartile Q2 [Q1, Q3] (c n [%]) | Method for assessing prevalence of persistent LBP and co-occurring musculoskeletal pain |
|-------------------------|--------------------------------------|------------------------------------------------------|-------------------|-------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Manchikanti 2003 [41] USA | Cross-sectional (NR) 2003–2006 (2006–2007) | 378 (378 [100]) (300) | LBP only: 52.0 [1.3] (83 [55.0]) | LBP + NP or TSP: 44.0 [1.1] (104 [69.0]) | Interview (own) Physical examination (diagnostic blocks) |
| Davies 1998 [31] UK | Retrospective cohort (1989 to 1992) | 5279 (5279 [100]) (2007) | 52.0 [41, 65] 3176 (60.2)c | Interview (own recorded on data form incl. 9 body sites from IASP Subcommittee on Taxonomy, 1986) |

Abbreviations: EHISS European Health Interview Survey for Spain, EPESE Established Populations for Epidemiologic Studies in the Elderly performance battery for lower extremity function, KNEST Knee Pain Screening Tool, LBP low back pain, NP neck pain, NR not reported, SD standard deviation, SNQ Standardised Nordic Questionnaire, SPPB Short Physical Performance Battery, TSP thoracic spine pain, Q1 lower quartile, Q2 median, Q3 upper quartile

a With persistent low back pain
b Data not published in paper and hence received after communication with first author or found in cited method paper
c Calculated by authors
d Includes moderate to very severe persistent low back pain (very mild and mild low back pain n=1594 were omitted from analysis)
e Unpublished data provided by first author that includes participants with persistent low back pain ≥8 wks n=531 (n=120 with localised persistent low back pain, n=167 with low back pain + 1–3 additional pain sites, n= 244 with low back pain + 4–9 additional pain sites)
headache in studies that otherwise was eligible, and it was reported to be 22 to 32% in the general population [28, 29] and 29% in a clinical population [40]. Additionally, headache was included in two studies that counted number of pain sites [35, 42].

Our results clearly indicate that additional pain sites are common among people with persistent LBP, but reported pain sites are dependent on which sites were asked for in the individual studies. Given a higher number of possible options of co-occurring pain sites,

| General population | 3. Author, year | 1. Target population representative | 2. Sampling frame representative of the target population | 3. Randomisation | 4. Non-response bias minimal | 5. Data collected directly from the subjects | 6. Acceptable definition of low back pain | 7. Instrument that measured the parameters of interest valid | 8. Same mode of data collection used for all subjects | 9. Length of the shortest prevalence period | 10. Numerator (a) and denominator (b) for the parameter of interest appropriate | Summary item on the overall risk of bias |
|---------------------|-----------------|----------------------------------|----------------------|----------------|----------------------------|---------------------------------|----------------------------|----------------------------|---------------------------------|-----------------------------|----------------------------------|---------------------------|
| Ĉermák et al., 2015 [37] | Y | Y | Y | N | Y | Y | N | Y | Y | Y | Low |
| Fuji, 2018 [34] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Takahashi, 2018 [47] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Nordtøya, 2017 [43] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Komedo, 2014 [48] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Di Iorio, 2007 [42] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Weinert, 2003 [48] | Y | Y | Y | Y | Y | Y | Y | Y | Y | Low |
| Nalven, 2001 [42] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Kjellman, 2001 [48] | Y | Y | Y | N | Y | Y | N | Y | Y | Moderate |
| Hoddveik, 1999 [46] | Y | Y | N | N | Y | Y | N | Y | N | Moderate |

| Working population | 3. Author, year | 1. Target population representative | 2. Sampling frame representative of the target population | 3. Randomisation | 4. Non-response bias minimal | 5. Data collected directly from the subjects | 6. Acceptable definition of low back pain | 7. Instrument that measured the parameters of interest valid | 8. Same mode of data collection used for all subjects | 9. Length of the shortest prevalence period | 10. Numerator (a) and denominator (b) for the parameter of interest appropriate | Summary item on the overall risk of bias |
|---------------------|-----------------|----------------------------------|----------------------|----------------|----------------------------|---------------------------------|----------------------------|----------------------------|---------------------------------|-----------------------------|----------------------------------|---------------------------|
| Øverås et al. 2013 [38] | Y | Y | Y | Y | Y | Y | Y | Y | Y | Low |
| Pain-SCheinelt, 2013 [45] | Y | Y | Y | Y | Y | Y | Y | Y | Y | Low |

| Clinical population | 3. Author, year | 1. Target population representative | 2. Sampling frame representative of the target population | 3. Randomisation | 4. Non-response bias minimal | 5. Data collected directly from the subjects | 6. Acceptable definition of low back pain | 7. Instrument that measured the parameters of interest valid | 8. Same mode of data collection used for all subjects | 9. Length of the shortest prevalence period | 10. Numerator (a) and denominator (b) for the parameter of interest appropriate | Summary item on the overall risk of bias |
|---------------------|-----------------|----------------------------------|----------------------|----------------|----------------------------|---------------------------------|----------------------------|----------------------------|---------------------------------|-----------------------------|----------------------------------|---------------------------|
| Ruebenk, 2019 [40] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Hermann, 2018 [35] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| MacLellan, 2017 [40] | Y | Y | Y | Y | Y | Y | Y | Y | Y | Low |
| Panagopoulos, 2014 [44] | Y | Y | Y | N | Y | Y | Y | Y | Y | Low |
| Elving, 2009 [43] | N | N | N | Y | N | Y | Y | N | Y | High |
| Merckx, 2003 [41] | N | N | N | Y | N | Y | Y | Y | Y | High |
| Davis, 1998 [32] | Y | Y | Y | Y | Y | Y | N | Y | Y | Low |

Abbreviations: Y yes (low risk of bias), N no (high risk of bias)

* Summary of overall risk of bias indicated by colour (green = low risk of bias, further research is very unlikely to change our confidence in the estimate; yellow = moderate risk of bias, further research is likely to have an important impact on our confidence in the estimate and may change the estimate; red = high risk of bias, further research is very likely to have an important impact on our confidence in the estimate and is likely to change the estimate).
### Table 3 Distribution and prevalence of co-occurring musculoskeletal pain among individuals with persistent low back pain grouped by study population

| 1st Author Year | Axial pain n/N (%) [non-weighted] ♀ / ♂ (if reported) | Extremity pain n/N (%) [non-weighted] ♀ / ♂ (if reported) | Other co-occurring MSK pain sites/no. of pain sites n/N (%) [non-weighted] ♀ / ♂ (if reported) | No. of options for pain sites and regions in addition to LBP |
|------------------|------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| **General population** |
| Jiménez-Trujillo 2019 [37] | + neck: 2963/5189 (57.1) ♀/♂ 2089/2963 (70.5) ♀/♂ 874/2963 (29.5) | + headache[^a] 1130/5189 (21.8) ♀/♂ 860/1130 (76.1) ♀/♂ 270/1130 (23.9) | + arms, legs or joints: 1336/3100 (43.1) | 2 (neck, headache) |
| Fujii 2018 [34] | + knee: 639/3100 (20.6) | + headache[^b] 1004/3100 (32.4) | + arms, legs or joints: 1336/3100 (43.1) | 3 (knee, headache, arms/legs/joints) |
| Takahashi 2018 [47] | + knee: 364/1378 (26.4) | + 1–2 pain sites: 2331/7523 (31.0) ♀/♂ 1180/2331 (50.6) ♀/♂ 1151/2331 (49.4) | + 3–8 pain sites: 4142/7523 (54.6) ♀/♂ 2978/4412 (67.5) ♀/♂ 1434/4412 (32.4) | 8 (neck, shoulders/upper arms, elbows, wrist/hands, upper back, hips, knees, ankles/feet) |
| Nordstoga 2017 [43] | + neck-shoulder: 32^a/100 (32.0) | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 4–9 pain sites ("widespread"): 244/531 (46.0) ♀/♂ 162/244 (66.4) ♀/♂ 82/244 (33.6) | 9 (head[^a], neck, shoulder, elbow, hand/wrist, upper back, hip, knee or ankle/foot) |
| Kamada 2014 [38] | + knee: 152/306 (50.3) | + 1–3 pain sites: 353/616 (57.3) ♀/♂ 145/353 (41.2) ♀/♂ 208/352 (59.2) | + 4–8 pain sites: 82/352 (23.6) ♀/♂ 32/82 (39.0) | 1 (neck/shoulder) |
| Di Iorio 2007 [32] | + hip: 62/306 (20.3) + knee: 87/306 (28.4) + foot: 99/306 (32.4) | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 4–9 pain sites ("widespread"): 244/531 (46.0) ♀/♂ 162/244 (66.4) ♀/♂ 82/244 (33.6) | 1 (other MSK) |
| Weiner 2003 [48] | + hip: 80/208 (38.7) + knee: 99/208 (47.6) | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 4–9 pain sites ("widespread"): 244/531 (46.0) ♀/♂ 162/244 (66.4) ♀/♂ 82/244 (33.6) | 1 (neck/shoulder) |
| Natvig 2001 [42] | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 4–9 pain sites ("widespread"): 244/531 (46.0) ♀/♂ 162/244 (66.4) ♀/♂ 82/244 (33.6) | 1 (other MSK) |
| Kjellman 2001 [39] | + neck-shoulder: 32^a/100 (32.0) | + 1–3 pain sites: 167/531 (31.5) ♀/♂ 100/167 (62.0) ♀/♂ 67/167 (40.1) | + 4–9 pain sites ("widespread"): 244/531 (46.0) ♀/♂ 162/244 (66.4) ♀/♂ 82/244 (33.6) | 1 (neck/shoulder) |
| Hoddevik 1999 [36] | + other MSK pain: 5057/6422 (78.7) ♀/♂ 3252/5057 (64.3) ♀/♂ 1805/5057 (35.7) | + other MSK pain: 5057/6422 (78.7) ♀/♂ 3252/5057 (64.3) ♀/♂ 1805/5057 (35.7) | + other MSK pain: 5057/6422 (78.7) ♀/♂ 3252/5057 (64.3) ♀/♂ 1805/5057 (35.7) | 1 (other MSK) |
| **Working population** |
| Andersen 2013 [30] | + neck-shoulder: 632/1089 (58.0) ♀/♂ 294/1089 (27.0) | + knee: ♀ 294/1089 (27.0) | 2 (neck/shoulder, knee) |
| Parot-Schinkel 2013 [45] | + pelvic or groin: 251/899 (27.9) | + 1–3 pain sites: 353/616 (57.3) ♀/♂ 145/353 (41.2) ♀/♂ 208/352 (59.2) | + 4–8 pain sites: 82/352 (23.6) ♀/♂ 32/82 (39.0) | 8 (neck, shoulder/arm, elbow/forearm, wrist/hand, upper back, hip/thigh, knee/foot, lower leg, ankle/foot) |
| **Clinical population** |
| Rundell[^a] 2019 [46] | + neck: 415/899 (46.2) | + pelvic or groin: 251/899 (27.9) | + headache[^a] 260/899 (28.9) | 6 (neck, pelvic/groin, headache, stomach, arms/legs/joints, widespread) |
| Herman 2018 [35] | + neck: 611/1129 (54.1) ♀ | + 1 pain site: 177/416 (42.6) ♀ | + 2 pain sites: 161/416 (38.7) ♀ | 1 (neck) |
| MacLellan 2017 [40] | + 1 pain site: 177/416 (42.6) ♀ | | + 2 pain sites: 161/416 (38.7) ♀ | 4 (knee, other MSK [not specified which other MSK for those with persistent LBP (i.e. upper- and lower extremity, spinal / headache[^a])]) |
persistent LBP only was reported to be 10–35% across populations (i.e., 10.4% [31]; 18.8% [42]; 21.3% [37]; 22.6% [35]; 29.4% [39]; 35.3% [46]). However, when fewer pain sites were considered the prevalence of persistent LBP only were markedly higher (i.e., 73.6% [30], and 74.9% [32], when the only option was co-occurring knee pain; 45.9% [41] with only co-occurring neck pain as option).

The prevalence of co-occurring neck pain was more than twice as high among females than among males in a general population study that reported on sex differences [28], while for co-occurring neck pain in a clinical population study, about 60% were females [46]. About 30% of those around 75 years reported co-occurring hip pain. Among those reporting co-occurring knee pain, the prevalence tended to increase with age (from 21% at age 45 up to 48% at age 74). Furthermore, the sex distribution among those reporting fewer additional pain sites was similar, while a higher proportion of those reporting a higher number of pain sites were females [31, 35, 39].

Four articles reported on co-occurring pain in relation to LBP-related disability. In the population-based study by Nordstoga et al. [31], persons who reported 3–8 additional pain sites had 16–27% lower probability of recovery from LBP over a 10–11 years period compared to persons with 1–3 additional pain sites. Similarly, in a clinical population of elderly, the Roland Morris Disability Questionnaire (RMDQ) score increased by 0.65 points (95% CI 0.43 to 0.86) for every additional pain site [40]. Additionally, co-occurring pelvic/groin pain, pain in arms, legs, or joints, and widespread pain were all associated with increased long-term LBP disability [40]. Furthermore, patients with persistent LBP who presented with co-occurring anterior trunk pain had significantly higher disability levels measured by RMDQ than those with localised LBP (adjusted group difference at baseline 2.41 [0.34 to 4.49], at 3 months 3.78 [1.37 to 6.18], at 12 months 2.89 [0.67 to 5.11]), but the presence of this co-occurring pain did not affect the rate of recovery of LBP [43]. Socioeconomic status was sparsely considered in the included articles. Though, MacLellan and co-workers [42] found patients with obesity and two or more additional pain sites (in a group where 67.5% had persistent LBP) to have a higher unemployment rate, being retired or unable to work because of disability, having two or more children, or being female compared with patients without any pain.

**Discussion**

To our knowledge, this is the first systematic review to appraise and summarise the evidence on the distribution and prevalence of co-occurring musculoskeletal pain among people with persistent LBP. Nineteen articles met the inclusion criteria of which 17 were considered to
have a low/moderate risk of bias with risks mainly related to external validity and non-response bias. Three categories of co-occurring pain were identified: (i) axial pain, (ii) extremity pain, and (iii) multi-site musculoskeletal pain. Across the study populations, about 20–60% of participants (n = 5020/10413) reported co-occurring axial pain while 6–50% reported co-occurring extremity pain (n = 3576/9592). Pain in multiple sites co-occurring with persistent LBP appears to be common, but the prevalence depends on how it is investigated. This is reflected in the varying prevalences reported for other co-occurring pain sites (i.e., 10–89%). The inconsistency in the number of response options for pain sites in addition to LBP may have affected our observations by masking actual co-occurring pain patterns. We were not able to draw any firm conclusions regarding the association between co-occurring pain and age, or sex. However, we observed that the majority of studies where co-occurring lower extremity pain was assessed included populations with a higher mean age, and that having more pain sites in addition to persistent LBP was more common among females. LBP-related disability in relation to co-occurring musculoskeletal pain was scantily reported but increasing number of pain sites was reported to reduce probability of recovery and decrease work ability.

Persistent LBP is a common component of multi-site pain [49], chronic pain [50], as well as chronic widespread pain [51, 52]. This is in line with our finding that co-occurring pain is common among individuals with persistent LBP.

Neck pain by itself is prevalent [53], but also commonly co-occurs with LBP [8]. In fact, the two have been
suggested to be the same clinical entity [54]. Also, lower extremity pain (i.e., excluding sciatica) has been reported to cluster with back pain [21]. This might be due to the lower extremities’ weightbearing function, and may also be seen in light of development of osteoarthritis, which is more common in lower extremity joints [55], and associated with older age [56]. We observed an up to 20% higher prevalence of hip and knee pain in the two studies from USA [34, 40] compared to the study from Italy [33], which may be related to general higher Body Mass Index in USA [57]. Few studies investigated co-occurring upper extremity pain, which is probably due to the way co-occurring pain was measured, that upper-extremity pain more commonly co-occur with neck pain, or that it is related to specific working populations not included in this review as seen in a study by Haukka and co-workers [58].

A high number of co-occurring pain sites was more common among females than men. This is in line with previous studies [14, 59] and has been explained by, for example, higher vulnerability among females [60], hormonal influence [61] and adverse physical working conditions and mental strain [62]. We were not able to stratify on age, but previous studies have reported LBP, as a central part of multi-site pain, among adolescents [63] and LBP with co-occurring pain sites has been associated with older age [64, 65].

Lastly, we observed decreased workability with increased number of co-occurring pain sites. This is in line with other studies, showing that co-occurring pain is a stronger driver of LBP disability than type of occupation [66]. This highlights the importance of considering co-occurring pain as a distinct risk factor for disability retirement [67, 68].

Methodological considerations

Strengths of this review include a published protocol with registration in PROSPERO, and adherence to PRISMA recommendations and other guidelines for systematic reviews of prevalence studies [69]. Our search was comprehensive and supervised by an experienced research librarian. Based on information given in the abstracts, it was difficult to assess eligibility. We therefore carried a total of 658 articles forward for full-text screening. This reflects the lack of studies considering persistent LBP in the context of co-occurring musculoskeletal pain and of suitable Medical Subject Headings terms and keywords to cover it. For critical appraisal we used ‘Risk of Bias Tool for Prevalence Studies’ which has been reported to have a high inter-rater agreement [47]. This tool uses overall summary risk of bias based on the rater’s judgment, which conforms with Grades of Recommendation, Assessment, Development and Evaluation (GRADE) and Cochrane approaches, rather than using cut-points from summary scores from numerical rating scales that has been discouraged [70]. We retrospectively restricted the study sample size to improve precision as also recommended by Munn et al. [71]. It is arguably inappropriate to conduct meta-analysis for prevalence studies due to the large heterogeneity and differences within characteristics of study populations, and a qualitative description of these variations across study populations has been encouraged instead [72, 73]. This heterogeneity negatively impact the overall certainty of the evidence.

The generalizability of our results is limited given relatively few studies within each co-occurring musculoskeletal area and population type, particularly working populations. Importantly, all articles originated from high-income countries. We also excluded studies with people reporting LBP of < 4 weeks duration. However, this was a pragmatic decision to, on the one hand, avoid inclusion of very few studies and capture studies including people with fluctuating persistent LBP [74], and on the other hand, avoid inclusion of shorter acute episodes of LBP. Definition of LBP varied among reviewed articles, with commonly data on localisation, duration, and sometime intensity, but none fulfilled the optimal definition of LBP for prevalence studies [75], which indicate that this definition is not well known and that awareness of this could be encouraged among researchers providing prevalence data.

For co-occurring musculoskeletal pain, number of pain sites in addition to LBP ranged from 1 to 9 with limited information on the nature of this co-occurring pain. This may have an impact on the observed patterns because the primary studies did not attempt to map underlying patterns of co-occurring pain sites. The problem with inconsistency in the number of pain sites asked for is also seen in other similar studies with variations from six to 26 pain sites [76–79] and a need for a set number of pain sites has been proposed [31].

Implications

Persistent LBP is very often accompanied by pain in other body regions and thus part of other pain or disease clusters. The available literature on this is, however, quite varied and therefore there is a need for more uniform means of measuring co-occurring musculoskeletal pain to allow for more robust data on the actual existing patterns and to provide better context and interpretability. Understanding how pain occur in patterns and clusters can help inform prognosis as well as clinical research, because certain pain patterns among those with persistent LBP may result in more consequences and require different prevention and treatment strategies [23]. Clinically, patients with LBP and a more complex clinical picture are known to get inadequate care [80–82]. This suggests a need for better guidance in clinical care and a move from single-site
guidelines [83] to recommendations that cover multi-care pathways for people with persistent LBP including their concomitant conditions [84]. However, this requires prioritising and investment by health authorities, not only to acquire the knowledge base needed to inform healthcare personnel, but also to empower patients to better self-manage if the goal is to decrease disability and costs [85].

Conclusions
Co-occurring pain among people with persistent LBP is common. Predominant co-occurring pain sites include axial, extremity and multi-site pain. A high number of co-occurring pain sites was also common, in particular among females, and observed more often with disability, and decreased work ability. In spite of most studies having an overall low risk of bias, there was substantial between-study heterogeneity and inconsistent reporting of co-occurring pain sites in the primary studies and we caution readers when interpreting the results.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12891-020-03893-z.

Additional file 1. PRISMA checklist.
Additional file 2. Search strategy.
Additional file 3. Risk of Bias Tool (Modified from Hoy D. et al. [25]).

Abbreviations
LBP: Low back pain; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; CKØ: Cecilie K. Øverås; MJ: Melker S. Johansson; TFC: Tarcisio F. de Campos; BN: Bård Natvig; JH: Jan Hartvigsen; MLF: Manuela L. Ferreira; PJM: Paul Jarle Mork; IASP: International Association for the Study of Pain; RMDQ: Roland Morris Disability Questionnaire; GRADE: Grades of Recommendation, Assessment, Development and Evaluation

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Authors’ contributions
JH, MF, and BN conceived the idea for this study, while CKØ, MJ, TC and PJM contributed to the study design. TC initiated the writing of this protocol, which CKØ completed and published in PROSPERO with critical revisions from all authors. The design and execution of the searches were done by CKØ supervised by a trained research librarian. CKØ, MJ, TC, MF, and JH assessed studies for inclusion and did the data extraction with assistance from BN and PJM when necessary. All authors were involved in the critical appraisal, the analysis and interpretation of data, and in the interpretation and formation of conclusions. CKØ drafted the report with critical revision and contribution from all authors. All authors have given their approval prior to publication of the final version of this systematic review article. The authors read and approved the final manuscript.

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Availability of data and materials
All the data generated and analysed during this study are included in this published article and its Additional files.

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Not applicable.

Consent for publication
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Competing interests
The authors declare that they have no competing interests.

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