Prevalence/incidence of low back pain and associated risk factors among nursing and medical students: A systematic review and meta-analysis

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Abstract

Objective

To summarize evidence regarding the prevalence and incidence of low back pain and associated risk factors in nursing and medical students.

Literature Survey

The protocol was registered with PROSPERO (CRD42015029729). Its reporting followed the PRISMA guidelines. Seven databases were searched until August 2020 to identify relevant studies.

Methodology

Two independent reviewers screened, extracted, and evaluated the risk of bias of the selected studies. Meta-analyses were used to estimate 12-month prevalence/incidence rates of low back pain and associated risk factors in these students. Levels of evidence for risk factors were determined by the updated Guidelines for Systematic Reviews in the Cochrane Collaboration Back Review Group.

Synthesis

Sixteen studies involving 7,072 students were included. The pooled 12-month prevalence rates of low back pain for nursing and medical students were 44% (95% confidence interval (95%CI): 27%-61%) and 53% (95%CI:44%-62%), respectively. The 12-month incidence of low back pain in nursing students ranged from 29% to 67%. No incidence rate was reported in medical students. Strong/moderate-quality evidence supported that final year of study (pooled odds ratio (OR) from 5 studies =1.96, 95%CI: 1.13-3.40), anxiety (OR ranging from 3.12 to

4.61), or high mental pressure or psychological distress (OR ranging from 1.37 to 4.52) was associated with a higher 12-month low back pain prevalence in both student groups. Moderate-quality evidence suggested that prior history of low back pain (pooled OR from 2 studies =3.46, 95%CI: 1.88-6.36) was associated with a higher 12-month low back pain incidence in nursing students. Similarly, moderate-quality evidence suggested that female medical students (pooled OR from 2 studies =1.77, 95%CI: 1.09-2.86) demonstrated a higher 12-month low back pain prevalence than male counterparts.

Conclusions

Although it is impossible to alter non-modifiable risk factors for low back pain, universities may develop and implement proper strategies to mitigate modifiable risk factors in these students. (300 words)

Keywords: Low back pain, nursing and medical students, risk factors, systematic review, meta-analysis

Introduction

Low back pain (LBP) is a common musculoskeletal complaint among nurses and doctors.[1,2] A national health survey in Taiwan highlighted that up to 68% of nurses experienced LBP in the past 12 months,[1] while approximately 58% of Tunisian nurses complained of LBP in the last 12 months.[3] Similarly, the 12-month prevalence of LBP in Turkish physicians was 63.3%.[2] In addition to pain, LBP adversely affects the personal and professional life of sufferers. For instance, over one-third of nurses with LBP reported difficulty with sleep and daily function.[4] Up to 77% of nurses took LBP-related sick leaves, with an annual mean of 2.03 days.[4]

Although the first episode of LBP in the general population commonly occurs in the early thirties and the highest prevalence of LBP occurs at ages between 45 and 60 years old,[5] Growing evidence suggests that nursing and medical students tend to develop LBP during their college years.[6-8] The 12-month prevalence of LBP in nursing or medical students has been found to be as high as 65%,[6,9] whereas the reported 12-month prevalence rates of LBP among university student athletes and young adults were 39%[10] and 42%,[11] respectively; much lower than nursing or medical students. Since an early onset of LBP in young adults may heighten the risk of future LBP recurrence,[12,13] the presence of LBP in nursing or medical students may adversely affect their everyday functioning[6-8] and day-to-day practice after graduation.[4]

Since nursing and medical students are potential major stakeholders in the healthcare system, multiple studies have investigated risk factors for LBP in these students.[7,14-18] While many risk

factors (e.g., final year of study, or anxiety) have been identified in individual studies,[16.19] no systematic reviews have summarized common and discipline-specific risk factors for LBP among these students, which can inform the development of more effective screening and prevention strategies for high risk students and to guide future research directions,[20] Accordingly, the current review and meta-analysis aimed to summarize and critically analyse the evidence regarding the prevalence/incidence of LBP and associated risk factors among nursing and medical students.

Methodology

The current review protocol was registered with PROSPERO (CRD42015029729). Its reporting followed the guidelines of the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA).[21]

Literature search

A systematic search was conducted in seven electronic databases (MEDLINE, CINAHL, PsycINFO, PEDro, SPORTDiscus, Cochrane library and Web of Science) from the inception of the databases to August 31, 2020. This project was part of a large systematic review project examining various types of musculoskeletal pain in different healthcare students. Therefore, the search strategies included various types of musculoskeletal pain (in addition to keywords for "low back pain"). No limits were applied on the search of databases for the language. The search string involved the combinations of medical subject headings (MeSH) and keywords

related to: (1) various body regions that allowed an examination of articles focused on LBP; (2) pain; (3) healthcare related fields; (4) students; and (5) risk factors. The exact search strategy is shown in **Appendix 1**. 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 to identify additional relevant publications. Although the original systematic review protocol planned to summarize evidence regarding risk factors for all musculoskeletal pain conditions among healthcare students, our initial title and abstract screening results showed that the topic was too broad to be summarized in a single systematic review. Therefore, we focused on the prevalence/incidence of the most common musculoskeletal problem (i.e., LBP) and associated risk factors in the two most common healthcare student populations (i.e., medical and nursing students).

Eligibility criteria

Cross-sectional and cohort studies were eligible for inclusion if they involved nursing and/or medical students (population), the respective prevalence/incidence and potential risk factors for non-specific LBP (exposure), and the odd ratios of risk factors (outcome). Only papers published in English were included although no limits for the language were applied on the search of databases. Non-specific LBP was defined as pain or discomfort between the 12th rib and inferior gluteal folds without a specific cause (e.g., cancer or fracture).[22] Studies were excluded had they investigated individuals with specific LBP (e.g., infections, traumatic

injuries, cancer, major systemic diseases or congenital diseases). Additionally, conference proceedings, editorials, letters to editors, and animal or cadaveric studies were excluded.

Study selection

Citations identified from databases were organized using EndNote X8 (Thomson Reuters, USA). After removing duplicates, two reviewers (KL and JB) independently screened the titles and abstracts of candidate citations based on the selection criteria. Piloting of the selection process was performed on the first 100 citations. Any disagreement was discussed to ensure the consistency between reviewers. Any disagreement was resolved by a third reviewer (AW). All abstracts were then screened independently by two reviewers. Studies denoted as eligible by either reviewer were included for full-text screening. Relevant reviews were included for full-text reading to identify relevant primary studies for screening. The full-text screening procedure was identical to the abstract screening procedure. The risk of bias was not used as a criterion to select studies for inclusion.

Data extraction

The two reviewers (KL and JB) extracted the data. The extracted information included: authors, year of publication, study location, study design, data collection methods, response and/or attrition rates, participants' characteristics, definitions of non-specific LBP, potential risk factors for LBP, the respective statistics (e.g., odds ratios or relative risks), and prevalence/incidence of LBP. Additionally, the type of statistical model used, covariates used

for adjustment were obtained. Unadjusted (simple) and adjusted (multivariable) associations reported between the risk factors and LBP, along with details on any adjustment factors were extracted. If multiple included articles reported data from the same cohort, only the publication that had the most comprehensive reporting of prevalence/incidence or risk factors for LBP in nursing and/or medical students was considered for the data pooling in meta-analysis.

Risk of bias assessments

Depending on the study design of the included studies, two different risk of bias assessment tools were used. Cross-sectional studies was assessed by the Appraisal tool for Cross-Sectional Studies (AXIS),[23] which includes 20 questions assessing the methodological quality of an article.[23] To facilitate the risk of bias determination, the questions in the original AXIS were rearranged into six domains (objectives and design, study participation, handling of non-respondents, outcome measures, statistical analysis, and reporting) (Table 1). If one and two or more questions were scored as "no" in a given domain, the domain was classified as having moderate and high risk of bias, respectively. Similarly, the quality of prospective studies were evaluated by the Quality In Prognosis Studies (QUIPS) tool,[24] which has been recommended by the Cochrane Prognosis Methods Group.[25] Specifically, the tool contains six domains (study participation, study attrition, prognostic factor measurement, outcome measurement, study confounding comparability, and statistical analysis and reporting). Each domain was scored based on several prompting questions. An overall domain assessment was then performed.[26]

The overall quality of each included study regardless of the study design was evaluated by Hayden et al's decision rule (Table 1).[25] Two reviewers independently performed quality assessment for each study and compared their rating results; any discrepancies in quality ratings were resolved by consensus.

Data synthesis

The information obtained from the included studies was organized by type of factors and summarized using a narrative approach. Evidence tables and figures were used to present qualitative and quantitative data where appropriate. All meta-analyses were conducted through Review Manager 5.3 (Cochrane Collaboration Software). Heterogeneity across studies were assessed by the chi-square test and I^2 statistics. Heterogeneity was evaluated statistically using the I^2 statistic, with I^2 values of 25, 50, and 75% representing low, moderate, and high degrees of heterogeneity respectively.[27]

When two or more studies reported prevalence/ incidence rates of LBP in nursing or medical students within the same follow-up or recall period, the pooled rate was estimated using a random effect model. Since different studies might have slightly different definitions of prevalence or incidence, the definitions of these terms in each included study are presented in Table 2. Results were presented as percentages and 95% confidence intervals (95%CI) for each type of students. If prevalence/incidence rates were not explicitly reported in an included study,

the rates were estimated from the number of LBP cases and the number of asymptomatic respondents reported during the study period, if possible.

When two or more different included studies reported the odds ratio (OR) of a particular risk factor for greater LBP prevalence or incidence in nursing and/or medical students, relevant data were pooled and expressed as respective OR and 95%CI using random effect models. Since characteristics of nursing and medical students are comparable (e.g., curricula and age), data from both groups were pooled in the meta-analyses of common risk factors. The pooled ORs results were reported as adjusted (AORs) or unadjusted (UORs) ORs for greater LBP prevalence/incidence depending on whether the primary studies adjusted for other confounders. However, as not all studies reported both AORs and UORs, the meta-analyses were conducted for either 12-month prevalence or 12-month incidence of LBP based on the available information. Further, OR was estimated from mean differences using the Hasselblad and Hedge's method,[28] and the equations suggested by Borenstein et al.[29] If meta-analyses were inappropriate, results were summarized narratively. We acknowledged that the covariates used in the models were not identical and a set of core covariates was not identified in the analysed studies. Therefore, these pooled estimates are strictly tentative and could only provide a general overview of the relationship between these factors and the outcomes of interest.

Levels of evidence

The statistical significance and methodological quality of the included articles were used to determine the levels of evidence of risk/protective factors for LBP. The levels of evidence were classified into strong, moderate, limited, and very limited according to the criteria listed in Table 1.[30,31]

Results

The searches yielded 5,075 potential citations as described in the PRISMA flowchart **(Figure 1)**. After removing duplicates, 3,308 citations were eligible for the title and abstract screening. Sixteen articles from 15 cohorts[6,7,9,14-19,32-38] were finally included after reviewing 218 full-text articles. The other 202 full-text articles were excluded because they were irrelevant to nursing and medical students (n = 84), unrelated to LBP (n = 65), not investigating risk factors for low back pain (n = 33), or involving a mix of musculoskeletal problems (n = 20). The excluded full-text articles are listed in Appendix 2.

Study characteristics

From the 16 studies included, 13 peer-reviewed articles[7,9,14-19,32-34,37,38] were cross-sectional designs and the other three were prospective cohort studies[6,35,36] published between 1997 and 2020 (14 of them were published after 2005) (**Table 2**). Two articles originated from the same study.[17,36] Six studies focused on nursing students (n = 2,249), [6,16-18,34-36] eight involved medical students (n = 4,401)[7,9,14,15,19,32,33,37] and one covered both student groups (n=422).[38] These studies were conducted in Australia,[6.14,16,17,36] China,[15] Ethiopia,[38] France,[37] Hong Kong,[35]

Hungary,[9] India,[18.19] Serbia,[7] Singapore,[32] Sweden[34] and the USA.[33] Thirteen studies used convenience sampling.[6,7,9,14-18,32-37] Two used stratified random sampling.[19,38] Fourteen studies used self-administered questionnaires to collect exposure and outcome data.[7,9,14-16,18,19,32-34,37,38] whereas one study captured exposure data with both self-administered questionnaires and physical examinations.[17,36] The response rates in the included cross-sectional studies ranged from 45% to 100%. The follow-up rate of the three prospective studies varied from 55% to 91%.[6,35,36] The median number of participants per study was 336 (ranging from 49 to 1,243).

Risk of bias assessments

The included articles displayed high (n = 6), moderate (n = 8), and low (n = 2) risk of bias (**Table 3**). Some common bias/methodological issues in the included cross-sectional studies were not justifying the sample size,[7,9,14,15,18,32-34,37] not using probability sampling methods[7,9,14-18,32-34,37], and not addressing non-responder bias.[7,9,14-18,32-34,37] Two included articles did not report statistical findings of all potential risk factors mentioned in the methods section, whereas one reported risk factors that were not considered in the method section.[6,18,35] The three included cohort studies did not report the characteristics of dropout participants nor explained the handling of missing data.[6,35,36] Two of them did not attempt to collect information from dropout participants nor provided reasons for attrition.[6,35] These two studies also did not define confounders in their statistical analyses.[6,35]

Prevalence and Incidence of LBP among nursing and medical students

Fourteen and two included studies investigated the prevalence[6,7,9,14-19,32-37] and incidence[6,35,36] of LBP in our target populations, respectively (**Table 2**).

Prevalence of LBP

For nursing students, 7-day,[6,16] 2-month,[35] 3-month,[34] 12-month,[6,16,17,18,34,35,36,38] 26-month,[35] and lifetime[16] prevalence were reported. Similarly, point,[7,15,19] 7-day, [15,33] 3-month,[32] 12-month,[7,9,14,15,19,38] and lifetime[7] prevalence rates were reported in medical students. Point prevalence refers to the proportion of people with LBP in a given sample at a particular point in time. The pooled 12-month prevalence rates of LBP in nursing and medical students were 44% (95%CI: 27% to 61%) [6,16,18,34,35] and 53% (95%CI: 44% to 62%),[7,9,14,15,19] respectively (**Figure 2).** The other pooled prevalence rates are presented in **Appendix 3.**

Incidence of LBP

Two included prospective studies reported the incidence rate of LBP among nursing students.[35,36] Mitchell and O'Sullivan[36] followed 107 nursing students with no or mild LBP at baseline, and found that 29% of them had developed significant LBP at the 12-month follow-up. Cheung [35] reported the 2-, 12- and 26-month cumulative incidences of LBP among full time nursing students to be 45%, 67% and 83%, respectively. However, the incidence rate reported by Feyer et al[6] was not considered in the present review because their follow-up was conducted one year after graduation, when most participants had been working as nurses.

Risk factors

Forty-three potential risk factors were investigated in the included studies (**Appendices 4 and 5**). Given the large number of potential risk factors, this section mainly summarizes those factors with strong to limited evidence. Four risk factors were common in both student groups. Strong evidence showed that final year nursing/medical students were twice more likely to have a higher LBP prevalence rate than freshmen (pooled UOR from 5 studies with 1,820 participants: 1.96, 95%CI: 1.13 to 3.40). Additionally, moderate evidence supported that the presence of anxiety (AOR for the presence of anxiety: 4.61, 95%CI: 1.92 to 11.08; UOR for anxiety: 3.12. 95%CI: 1.75 to 5.55; from 2 studies with 295 participants), or high mental pressure or psychological distress were related to a higher 12-month LBP prevalence (AOR: ranging from 1.37 to 2.90; from 2 studies with 377 participants) or 12-month incidence (AOR: ranging from 2.49 to 4.52; from 2 studies with 252 participants) in these students. Limited evidence substantiated that depressive symptoms were associated with a higher 12-month LBP prevalence (**Appendix 4**).

Some risk factors were found in nursing students but not investigated in the included studies involving medical students. Moderate evidence corroborated that prior history of LBP (pooled AOR from 2 studies with 811 participants: 3.46, 95%CI: 1.88 to 6.36) was related to a higher 12-month LBP incidence. Limited evidence suggested that moderate physical activity was associated with a higher 12-month LBP incidence, while smaller lumbar flexion angles when

transferring a 5kg weight at the waist level was associated with a higher 12-month LBP prevalence (**Appendix 4**).

Similarly, some risk factors for LBP were investigated in medical students but not in nursing students. Moderate evidence supported that female medical students had a higher 12-month LBP prevalence than male counterparts (pooled AOR from 3 studies with 1,384 participants: 1.77, 95%CI: 1.09 to 2.86; pooled UOR from 2 studies with 461 participants: 1.58, 95%CI: 1.14 to 2.17). Limited evidence suggested that 'abnormal' body posture, family history of LBP, using a backpack, doing monotonous tasks, working/studying without a table, and regular exercise were independent risk factors for a higher 12-month LBP prevalence in medical students (**Appendix 4**).

Discussion

This is the first systematic review and meta-analysis to summarize evidence regarding the incidence/prevalence of LBP and associated risk factors in nursing and/or medical students. Our findings underscore the high prevalence of LBP in both student groups. Although 43 potential risk factors for LBP were investigated, most of them had very limited or limited evidence. Some significant risk factors for LBP were common in both student groups, while other factors were only investigated in nursing or medical students.

The final year of study was the only common risk factor for LBP in both nursing and medical students with strong evidence. Although speculative, the higher risk of LBP in final year students may be ascribed to their gradual increase in study load and practical training, which usually involve repetitive work, awkward posture, and manual handling of patients.[39,40] This level of workload and stress may be similar to students' actual clinical practice in the future and worsen their LBP prevalence over time.[41,42] Alternatively, the higher risk of LBP may reflect the cumulative impacts of physical and psychological factors (e.g., anxiety, stress)[6,15,19,35,36] on LBP development in these students. Although final year students are older, age is not necessarily a significant risk factor for LBP in young adults[43] or university students.[44,45] Therefore, the higher prevalence of LBP in final year nursing and medical students may be program-specific and triggered by some abovementioned factors.

The high 12-month prevalence of LBP in the first-year nursing or medical students indicate that some of them may have had LBP prior to their nursing or medical school admissions. In this review, the reported 12-month prevalence rates of LBP in nursing and medical students ranged from 40.2% to 70.1%,[16,34] and from 32.5% to 52.4%,[14,18,19] respectively (**Appendix 4**). Although these prevalence rates varied across studies, some reported rates are comparable to those reported in adolescents aged between 9 and 18 years (ranging from 26.0% to 50.8%).[46,47,48] These findings highlight the potential importance of identifying high risk first-year students so that timely interventions can be provided.

Anxiety and stress are associated with LBP in both nursing and medical students.[6,15,19,35,36] It is known that the central nervous system plays an important role in the bidirectional associations between LBP and psychological distress.[49] The imbalance of serotonin and norepinephrine secondary to chronic pain/stress may increase pain perception and mood regulation.[49] Psychological distress can selectively increase the supraspinal transmission of nociceptive signals and plasma adrenaline level, resulting in pro-inflammatory responses that increase pain perception.[50] Since highly competitive nursing and medical programs involve both didactic and clinical coursework,[51,52] these students usually experience high levels of anxiety, stress, and even depression.[51,52] Our findings highlight the importance of monitoring and improving the psychological wellbeing of these students to minimize their psychosomatic symptoms.

While clinical work is an essential element of nursing/medical education to equip students with hands-on clinical skills, these activities may put students at risk of psychological distress and occupational hazards (e.g., patient transfer).[51,53,54] Considering that nurses (68.3% to 77.1%) and medical doctors (63.3%) have considerably higher 12-month prevalence of LBP than the general adult population (38%),[1,2,55] clinical works may increase the risk of LBP in nursing or medical students. However, the current review found inconsistent associations between clinical works and LBP in medical students (**Table 3**).[15,32] Since clinical works (e.g., surgical rotations) are often assigned within the curriculum, the number of contact hours may be highly related to the year of studies. Therefore, it is difficult to discern the impact of clinical work on the occurrence of LBP in observational studies. Future prospective studies should evaluate changes

in physical and psychological wellbeing, and LBP immediately after clinical work so as to quantify the impacts of this factor on LBP.

A prior history of LBP was highly related to LBP in nursing students. It is known that a history of LBP is associated with subsequent or recurrent LBP within 1 year in adults.[13,56,57] These findings, together with our results, highlight that LBP recurrence is common.[56] Since acute LBP can cause immediate paraspinal muscle atrophy that cannot be restored spontaneously, rehabilitation exercise and education should be given to mitigate the risk of recurrent LBP in nursing students.[58]

The higher prevalence of LBP in female medical students concurs with studies in youths.[59,60] Compared to men, women have higher pain sensitivity,[61,62] which may increase their higher likelihood of reporting LBP. Elevated oestrogen levels in female may also induce joint and ligament laxity, which may be related to LBP.[63] Further, it has been speculated that smaller muscle mass in females may increase their risk of musculoskeletal pain.[64] Since paraspinal muscles (e.g., multifidus) are important lumbar stabilizers,[65] reduced paraspinal muscle mass or function (e.g., endurance) may be related to acute/chronic LBP.[66,67] Collectively, these factors may put female medical students at a higher risk of developing LBP.

The included studies had some limitations. First, 11 out of the 14 included studies were cross-sectional, which prevented the determination of causal relations between risk factors and LBP.

Second, although many included studies examined multiple potential risk factors, some only reported the statistics of significant risk factors. The non-significant risk factors were simply omitted or stated as "non-significant".[6,18,35] Such non-reporting bias might have overestimated the effect sizes of some risk factors in the meta-analysis. Third, since several risk factors were only found significant in separate single low-quality studies, these findings should be interpreted with caution. Future prospective research should consider all key risk factors identified in the current review to determine the modifiable and non-modifiable risk/prognostic factors for LBP in nursing and medical students. Fourth, the included studies used diverse statistical analyses. Some studies investigated bivariate correlations between risk factors and LBP without adjusting for confounders,[16,18,19,32,33] which might not reveal the true strength of correlations. For studies involving multivariate analyses,[6,14,15,17,19,34-36] the adjusted confounders varied considerably among studies, which introduced heterogeneity to the pooled analysis. That said, the adjusted OR of a given risk factor in multivariate models still revealed the relative influence of the risk factor after accounting for the effects of other risk factors or confounders.

The current review had several strengths. First, the protocol was registered with PROSPERO. Second, systematic searches of multiple databases, as well as standardized screening, data extraction, risk of bias assessments, and meta-analysis procedures were adopted to ensure comprehensiveness of the reported data. Third, levels of evidence of risk factors were reported according to the *Updated Method Guidelines for Systematic Review in the Cochrane*

Collaboration Back Review Group,[30] which allows the synthesis of evidence across studies with various methodological heterogeneity and quality to inform clinical decision making.

It is noteworthy that the current review had some limitations. Although some factors (e.g., prior history of LBP) were found to be related to LBP in nursing students, it remains unclear whether these factors are program-specific because they were not examined in medical students. Therefore, future studies are warranted to explore this possibility. Since this review only included English peer-reviewed articles, it might have missed relevant studies in other languages. Further, funnel plots were not conducted to estimate publication bias because none of the meta-analysis involved 10 or more studies.[27] That said, publication bias is less likely to occur in prevalence and risk factor studies.[68]

Implications

Considering the pervasiveness of LBP among nursing and medical students, relevant senior nursing and medical school management may consider allocating more resources to lower the risk of LBP in these students. Specifically, given the high workload and mental demand of nursing and medical curricula, many students may experience psychological distress at some points in their studies.[51,52,69] The introduction of mental hygiene and counselling services to these students during their junior years may help prevent/mitigate psychological problems through timely self-recognition and consultation so as to lower their risk of LBP. Additionally, education on effective handling of patients can be delivered to all nursing and medical

students,[70] while LBP prevention programs[58] may be given to high-risk individuals (e.g., final year students, or those with a history of LBP).

Our findings lay the foundation for future research. Some identified factors in the current review may mediate or moderate the relationships between other risk factors and LBP. For example, the observed effects of year of study on LBP may reflect the combined effects of more intense practical training, higher study pressure, and longer study hours. Future studies should disentangle the relative contributions of these factors, and clarify the causal relations between the reported risk factors and LBP so that proper preventive strategies can be developed and implemented.

Conclusions

The current review highlights the high prevalence of LBP among nursing and medical students. Modifiable (e.g., anxiety) and non-modifiable (e.g., final year of study) risk factors for LBP in these populations were summarized. Our findings suggest the possible importance of implementing regular screening for physical and psychosomatic symptoms in nursing and medical students, organizing talks and campaigns to raise their awareness of LBP, and providing timely rehabilitation to lower their risk of LBP. Future research should investigate the effectiveness of various preventive strategies in reducing the occurrence of LBP in these students.

Conflicts of interest

There was no conflicts of interest in preparing the manuscript.

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Table 1. Determination of the overall risk of bias of an included study and the determination of levels of evidence for a given risk factor.

Risk of bias of a given study
• **High risk of bias**: The study was rated *high* in at least one domain. • **Moderate risk of bias**: The study was rated *moderate* in at least one domain, and the other domains were *low*. • **Low risk of bias**: The study was rated as *low* in all six domains.
Levels of evidence of a given risk factor
• **Strong evidence:** pooled results based on two or more studies, at least two of them are of high quality; or consistent narrative findings in multiple high-quality studies. • **Moderate evidence:** statistically significant pooled findings from multiple statistically heterogeneous studies, at least one of which is of high quality; or consistent findings from multiple studies with at least one high quality study. • **Limited evidence:** results from one high quality study, or consistent findings from multiple moderate or low-quality studies • **Very limited evidence:** results obtained from one moderate or low-quality study • **Conflicting evidence:** inconsistent findings

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/ Follow-up rate (if applicable)**	**Definitions of LBP, and definitions of prevalence/incidence**	**Prevalence/incidence**	**Statistical tests; Potential risk factors investigated**
Cross-sectional studies						
Nursing students						
Backaberg et al, 2014 [34]	Sweden/ Cross-sectional	224 nursing students/16%/24.6 (4.3)yr	Convenience sampling/64%	Musculoskeletal discomfort and/or symptoms (e.g., pain or numbness) in lower back-pelvis-hip during the past week, the past 3 months, or the past 12 months	12m prevalence: 40% (95%CI: 30.6% to 43.3%) 3m prevalence: 37% (95%CI: 30.6 to 43.3%)	Multiple logistic regression; Age, sex, BMI categories, year of Study
Mitchell et al, 2008 [16]	Australia/ Cross-sectional	897 nursing students/ 9%/ 26.7 (8.9)yr	Convenience sampling/ 54%	Any ‘‘ache, pain or discomfort’’ in the location between T12 to gluteal folds on a body diagram Lifetime, 12-month and 7-day LBP prevalence rates were obtained using a modified version of Nordic Low Back Questionnaire	Lifetime prevalence: 79% 12m prevalence: 71% 7d prevalence: 30%	Chi-square, independent t-test, simple logistic regression; Year of study

Mitchell et al, 2009[17]	Australia/ Cross-sectional	170 nursing students/0%/ unclear (range:18 to 35)yr	Convenience sampling/ 10%	Symptoms from the region of the back between L1 and the gluteal folds 12m prevalence: Significant LBP for people who scored at least 3 of the following 4 criteria: 1. Lifetime LBP severity > 4/10 for their worst ever LBP on a visual analogue pain scale 2. > 1 week of LBP in prior 12 months (to distinguish people with a single, very short episode of LBP 3. LBP requiring treatment or medication or a reduction in activity in the last 12 months 4. LBP disability levels with >20% on the Oswestry Disability Index at the time of assessments	12m prevalence:79%	Chi-square analysis, One-way ANOVA, Kruskal-Wallis test, multiple logit ordinal regression (proportion odds model): Socio-economic status, marital status, compensation history, physical activity level, depression level, anxiety level, stress level, individual beliefs regarding the impact of back pain, coping style, past pain experience, BMI, sitting angles, standing angles, functional postural angles, performance measures

				Mild LBP: some pain in the previous 12 months		
Singh et al, 2010[18]	India/ Cross-sectional	317 nursing students/ Unclear/22.5 (9.3)yr	Convenience sampling /88%	Musculoskeletal pain (ache, pain, or discomfort) occurring within the specified body site (e.g., back) during the previous 12 months	12m prevalence: 58.7%	Simple logistic regression; Year of study
Medical students						
Aggarwal et al, 2013[19]	India/ Cross-sectional	160 medical students/54%/20.6 (2.6)yr	Stratified random sampling/100%	Pain in the lumbar region. 12m prevalence: LBP occurrence in the past year Point prevalence: LBP at the time of survey.	12m prevalence: 47.5% Point prevalence: 32.5%	Chi-square test, Independent t-test, Mann-Whitney test, multiple logistic regression; Age, weight, BMI, monotonous work, anxiety, study satisfaction, depression, playing outdoor sports, physical exercise, yoga, weight lifting, using backpacks/college bags, watching TV, working on personal computer/laptop, smoking, alcohol intake, coffee intake, travelling by public transport, driving,

						meeting friends/going to parties, wearing heels, family history of LBP, body posture, study place
Amelot et al, 2019[37]	France/ Cross-sectional	1,243 medical students/ 52%/22.3(2.9)yr	Convenience sampling/ 68.9%	Modified Standardised Nordic Questionnaire	Prevalence (time period not specified) :72.1%	Chi-square test or Fisher's exact test, Multiple logistic regression Gender, year of study, exercise frequency, exercise type
Chan & Koh, 2007 [32]	Singapore/ Cross-sectional	909 medical students/ 60%/ unclear (range: 17-25)yr	Convenience sampling/85%	Musculoskeletal complaints that encountered daily or frequently (more than three times per week) in the last 3 months.	3m prevalence: (218+338)/909 =61.2%	Chi-square test; Year of study, Clinical year
Liu & Palmer, 2012 [33]	USA/ Cross-sectional	49 osteopathic medical students/ 49%/ 24.4 (1.86)yr	Convenience sampling/ unclear	Not available 7d prevalence: LBP during the 7 days prior to the study	7d prevalence: 49%	Fisher's exact test; Exercise, prolonged sitting, frequent running, or biking
Piko et al, 1997[9]	Hungary/ Cross-sectional	691 medical students/39%/ unclear (range: 18 to 31)yr	Convenience sampling/ 71%	Not available 12m prevalence Backache during the past 12 months	12m prevalence: 65.4% (Estimated from a graph)	No statistical analysis was conducted; Sex
Smith et al, 2005[15]	China/	207 fourth year medical students/unclear/22.24	Convenience sampling/ 92%	Musculoskeletal disorder (presented as	12m prevalence: 40.1%	Multiple logistic regression;

	Cross-sectional	(SD unclear)yr		ache, pain or discomfort) occurring in lumbar region in an updated version of the Standardised Nordic Questionnaire 12m, 7d, and point prevalence: LBP during three recall periods (1 year, 1 week, or ongoing)	7d prevalence: 20.8% Point prevalence: 17.9%	Male, mental pressure, depression, alcohol drinker, tobacco smoker, regular exercise, clinical practice, increasing age, increasing height, increasing weight
Smith & Leggat, 2007[14]	Australia/ Cross-sectional	254 medical students/ 39%/19.7 (3.0) yr	Convenience sampling/ 97%	Musculoskeletal pain (presented as ache, pain, or discomfort) in lumbar region in the previous 12-month period using in an updated version of the Standardised Nordic Questionnaire discomfort occurring within the specified body site during the previous 12-month period	12m prevalence: 51.6%	Chi-square test, multiple logistic regression Female, alcohol intake, tobacco smoking, year of study, exercise, age
Vujcic et al, 2018[7]	Serbia/ Cross-sectional	533 medical students/ 34%/22.46(0.95)yr	Convenience sampling /86%	Pain in the area between the inferior margin of the 12th rib and inferior gluteal folds Lifetime prevalence:	Lifetime prevalence: 75.8% 12m prevalence: 59.5%	Chi-square test; Sex

				Having ever suffered LBP at some point in their lives. 12m prevalence: the presence of LBP in the last year, Point prevalence: the presence of LBP at the moment of filling out the questionnaire	Point prevalence: 17.2% Chronic LBP prevalence: 12.4%	
Medical and Nursing students						
Wami et al, 2020[38]	Ethopia/ Cross-sectional	372 Medical students, 50 Nursing students/ 43%/ Age range:19 to 29 yr	Stratified sampling /100%	Musculoskeletal symptoms (presented as ache, pain or discomfort) occurring in lumbar region in the previous 12 months using a Standardised Nordic Questionnaire	12m prevalence: 54%	Logistic Regression; Year of study
Prospective cohort studies						
Nursing students						
Cheung, 2010[35]	Hong Kong Special Administrative Region/ Prospective (2-years)	355 nursing students/ 12%/20.89 (3.19)yr	Convenience sampling /91%/73%	Musculoskeletal problems (such as aches, pains, discomfort or numbness) which lasted for at least one day in the lumbar region	2m cumulative incidence: 45% 12m cumulative incidence: 67% 26m cumulative incidence: 83%	Chi-square test, multiple Logistic regression; History of low back problems, headache, low mood, feeling tense, under stress,

				No clear definition for 2m, 12m, and 26m incidence		period pain, fatigue, anxiety, physical activities, constant tiredness, static loads, not being able to get going
Feyer et al, 2000[6]	Australia / Prospective (3 years)	694 nursing students/15%/23.7 (7.4)yr	Convenience sampling/100%/55%	Not available 12m prevalence Having LBP in the past 12 months. Point prevalence Having LBP at the time of collection of the questionnaire 6m incidence: new episode of LBP in the last 6-month interval	12m prevalence: 67% Point prevalence: 31% Did not report incidence within the training period	Generalised estimating equations, logistic regression; General health, history of LBP, part time work, life events, job satisfaction
Mitchell et al, 2010[36]	Australia/ Prospective (12 months)	117 nursing students/0%/21.7(3.93)yr	Convenience sampling /33%/91%	Not available 12m incidence: New onset LBP over a 12-month period	12m incidence: 26.5%	Simple logistic regression; multiple logistic regression; Socio-economic status, marital status, compensation history, physical activity level, depression level, anxiety level, stress level, individual beliefs regarding the impact of back pain, coping style,

						past pain experience, BMI, sitting angles, standing angles, functional postural angles, performance measures

BMI = body mass index, LBP = low back pain; MSD = musculoskeletal disorders; MSP = musculoskeletal pain; PC = personal computer; TV = television; yr = years; 1m= one month; 12m = twelve months; 26m = twenty-six months; 3m = three months; 2m = two months; 7d = seven days

Table 3. Risk of Bias Assessment of the included studies

Appraisal tool for Cross-Sectional Studies (AXIS)[23]																										
Study	**Objective and study deign**			**Study participation**						**Handling of non-respondents**				**Outcome measures**			**Statistical analysis**			**Reporting**							**Risk of Bias**
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**	
Aggarwal et al, 2013[19]	Y	Y	L	Y	Y	Y	Y	Y	L	NA	N	NA	L	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Low
Amelot et al, 2019[37]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	H	Y	Y	L	Y	Y	L	Y	N	Y	Y	Y	N	M	Moderate
Backaberg et al, 2014[34]	Y	Y	L	N	Y	Y	Y	Y	M	N	Y	N	H	Y	Y	L	Y	Y	L	Y	Y	Y	Y	N	N	M	High
Chan & Koh, 2007 [32]	Y	Y	L	N	Y	Y	Y	Y	M	N	N	N	M	Y	Y	L	N	Y	M	Y	Y	Y	Y	Y	N	L	Moderate
Liu & Palmer, 2012[33]	Y	Y	L	N	Y	Y	Y	Y	M	N	Y	N	H	Y	Y	L	Y	N	M	Y	Y	Y	Y	Y	N	L	High
Mitchell et al, 2008[16]	Y	Y	L	Y	Y	Y	Y	Y	L	N	N	N	M	Y	Y	L	Y	N	M	Y	Y	Y	Y	Y	N	L	Moderate
Mitchell et al, 2009[17]	Y	Y	L	Y	Y	Y	Y	Y	L	N	N	N	M	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Moderate
Piko et al, 1997[9]	Y	Y	L	N	Y	Y	?	Y	H	N	N	N	M	Y	Y	L	Y	N	M	Y	Y	Y	Y	N	N	M	High
Singh et al, 2010[18]	N	Y	M	N	Y	Y	Y	Y	M	N	N	N	H	Y	Y	L	N	N	H	N	N	N	Y	N	N	H	High
Smith et al,	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

2005[15]																											
Smith & Leggat, 2007[14]	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
Vujcic et al, 2018[7]	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
Wami et al, 2020[38]	Y	Y	L	Y	Y	Y	Y	Y	H	NA	N	NA	L	Y	Y	L	Y	Y	L	Y	Y	Y	Y	Y	N	L	Low
% of studies that have "yes" /no bias	92	100		31	92	100	92	100		15	85	15		100	100		85	69		92	85	92	100	73	77		

Quality of Prognosis Studies Risk of Bias Assessment Instrument for Prognostic Factor Studies[24]																																						
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**	**5**	**S**	**1**	**2**	**3**	**4**	**5**	**S**	**1**	**2**	**3**	**S**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**S**	**1**	**2**	**3**	**4**	**S**	
Cheung 2010[35]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	N	N	N	U	**H**	Y	Y	Y	P	N	**M**	Y	Y	Y	**L**	Y	N	P	Y	N	Y	Y	**H**	Y	U	N	U	**H**	**High**
Feyer et al 2000[6]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	N	P	N	U	**H**	Y	Y	Y	N	N	**H**	Y	Y	Y	**L**	Y	N	Y	Y	Y	Y	Y	**M**	Y	Y	Y	Y	**L**	**High**
Mitchell et al 2010[36]	Y	Y	Y	Y	Y	Y	Y	**L**	Y	Y	Y	N	U	**M**	Y	Y	Y	Y	N	**L**	Y	Y	Y	**L**	Y	Y	Y	Y	N	Y	Y	**M**	Y	Y	Y	Y	**L**	**Moderate**

*For item number 13 and 19 in the AXIS, a point is awarded when the number is "N"

H = High; L = Low; M = Moderate; N = No; NA = Not available; Y = Yes;

Figure Legends

Figure 1. Flow diagram of the systematic review according to PRISMA guidelines.
LBP = low back pain
Figure 2. Forest plots of 12-month prevalence rates of low back pain in medical and nursing students