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REVIEW ARTICLE

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Risk factors for episodes of back pain in emerging adults. A systematic review

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Abstract

Background and Objective: The transition from adolescence to adulthood is a sensitive period in life for health outcomes, including back pain. The objective was to synthesize evidence on risk factors for new episodes of back pain in emerging adults (18–29 years).

Methods: The protocol was registered in PROSPERO (CRD42016046635). We searched Medline; EMBASE; AMED and other databases up to September 2018 for prospective cohort studies that estimated the association between risk factor(s) and self-reported back pain. Risk factors could be measured before or during the age range 18–29 years, and back pain could be measured during or after this age range, with at least 12 months between assessments. Risk factors assessed in ≥3 studies were summarized. Risk of bias was assessed using a 6-item checklist.

Results: Forty-nine studies were included with more than 150 different risk factors studied. Nine studies had low risk of bias, 26 had moderate and 14 had high risk of bias. Age, sex, height, body mass index (BMI), smoking, physical activity level, a history of back pain, job satisfaction and structural imaging findings were investigated in three or more studies. History of back pain was the only risk factor consistently associated with back pain after adjustment (nine studies).

Conclusion: There is moderate quality evidence that a history of back pain is a risk factor for back pain. There are inconsistent associations for age, sex, height, BMI, smoking and activity level. No associations were found between job satisfaction and structural imaging findings and back pain.

Significance: Emerging adulthood is a transitional period of life with changes in life style, potentially influencing future musculoskeletal health. This systematic review included 49 articles evaluating more than 150 potential risk factors for back pain, one of the most prevalent musculoskeletal disorders. No consistent results were found for life style factors such as physical activity level or BMI, both highlighted as important risk factors in previous literature. Importantly, a previous episode of back pain was a consistent risk factor for a new episode of back pain across several studies, and further investigation of risk factors for the first back pain episode is needed.

1 | INTRODUCTION

Back pain, mostly in the lower back, is an enormous global health problem in low-income as well as in high-income countries (Hartvigsen et al., 2018). It is strongly associated with activity limitations and work restrictions, and is the leading cause of years lost to disability (YLD) worldwide (Global Burden of Disease Study, 2015; Vos et al., 2012). Consequently, back pain leads to substantial economic costs for individuals, families and societies. This is seen particularly in high-income countries with highly developed healthcare systems (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006; Murray & Lopez, 1996). The Global Burden of Disease Study 2010 showed an overall prevalence of back pain of 9.2% (Vos et al., 2012), with the highest prevalence found in females and those aged 40–80 years. Back pain appears mostly without a clear pathologic cause. According to the Lancet series from 2018, individuals with physically demanding occupations or comorbidities, and those with lifestyle risk factors such as smoking, obesity and low physical activity level seem to be most at risk (Hartvigsen et al., 2018). Often, modifiable and non-modifiable factors occur at the same time in complex interactions influenced by psychological and social contexts and socioeconomic status (Hartvigsen et al., 2018). The period of transition from adolescence to adulthood – "emerging adulthood (Arnett, 2000)" – has attracted relatively little attention in the back pain literature, despite the high prevalence of low back pain (up to 30%) in the age range associated with this life stage (Hoy et al., 2012). Emerging adulthood, roughly capturing the age range between 18–29 years of age (Arnett, Zukauskiene, & Sugimura, 2014) is characterized by transitions (Swanson, 2016) involving exposure to new educational and workplace environments, the strengthening and loosening of social and family ties, romantic relationships and changing lifestyles. We hypothesized that exposures and transitions in this life stage may be relevant to the risk of back pain, and in turn be impacted by back pain at this time. Reviews on risk factors for low back pain in younger populations are performed primarily on adolescents, focusing on growth and maturation (Swain et al., 2018) and exposure to sports (Trompeter, Fett, & Platen, 2017). Calvo-Munoz and colleagues (Calvo-Munoz, Kovacs, Roque, Gago Fernandez, & Seco Calvo, 2018) systematically reviewed 61 longitudinal studies on young individuals from childhood to adolescence, and found inconsistent results on associations between low back pain and demographic, clinical, biological, family, psychological, ergonomic and lifestyle factors, but consistent associations with older age and participation in competitive sports. From a life course perspective, investigating risk factors for back pain in children, adolescents and emerging adults would help reinforce the concept of sensitive periods for intervention, and may identify preventive interventions with impact throughout the life course (Dunn, 2010). To our knowledge, there are no systematic reviews on risk factors for episodes of back pain in emerging adults. Thus, the purpose of this study was to summarize risk factors for new episodes of back pain in emerging adults in a systematic review of the literature.

2 | METHODS

The systematic review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher et al., 2010; Appendix S1). The study protocol has been published in the PROSPERO database (CRD42016046635).

2.1 | Search strategy

The search strategy was developed according to the PICO model involving; Participants (emerging adults [18–29 years]), Intervention/Exposure (risk factors), Comparison/No exposure (healthy controls) and Outcome (self-reported back pain). Two research librarians and the first author (BEØ) at Oslo Metropolitan University performed the systematic searches in collaboration with the authors. Electronic searches were conducted from inception to mid-September 2018. We searched the following databases: Medline; EMBASE; AMED; PSYCHINFO; Cinahl; SPORTSDiscus; Scopus and Web of Science. The search strategy covered a broad range of potential risk factors including a variety of terms and keywords, adapted as appropriate for each database (Appendix S2). The total hits were imported into EndNote library where duplicates where removed. Two authors (ATT and GH) hand searched reference lists of studies that were included, and two authors (BEØ and GH) hand searched reference lists of previous relevant systematic reviews (Chen, Liu, Cook, Bass, & Lo, 2009; Dario et al., 2015; Dionne, Dunn, & Croft, 2006; Hamberg-van Reenen, Ariens, Blatter, Mechelen, & Bongers, 2007; Hartvigsen, Leboeuf-Yde, Lings, & Corder, 2000; Hoogendoorn, van Poppel, Bongers, Koes, & Bouter, 2000; Huguet et al., 2016; Leboeuf-Yde, 1999, 2000a, 2000b; Pincus, Burton, Vogel, & Field, 2002; Shiri, Karppinen, Leino-Arjas, Solovieva, & Viikari-Juntura, 2010; Sitthipornvorakul, Janwantanakul, Purepong, Pensri, & Beek, 2011; Smith & Leggat, 2007).

2.2 | Study criteria and selection

Inclusion criteria were a) prospective cohort studies; b) participants aged 18–29 years (either at time of risk factor measurement and/or outcome measurement); c) outcome of an episode of back pain at least 12 months after risk factor measurement. The outcome was a new episode of back pain. This included studies where the authors reported that their outcome was a "first episode" of back pain. Back pain had to be measured either during the period of emerging adulthood (age 18–29 years) or in adulthood (age 30 years and above). The risk factors had to be measured either during adolescence (up to age 18 years) or during emerging adulthood (age 18–29 years). Risk factors reported as being measured in a pain free condition prior to the outcome were considered. Only full-length publications in English or Scandinavian languages were included. Studies were excluded if they involved individuals with back pain caused by specific pathologies (fracture, ankylosing spondylitis, spondyloarthritis, spinal stenosis, infection, neoplasm or metastasis), or specific conditions (pregnancy) and disc herniation with radiating pain. Three authors (GH, ATT and BEØ) independently selected studies retrieved from the searches. Disagreements were resolved through discussions. In cases where consensus could not be reached, another author (MG) was approached for selection of studies.

2.3 | Risk of bias assessment

The risk of bias assessment for each study was performed using questions adapted from Hayden, Windt, Cartwright, Cote, and Bombardier (2013) and recently recommended (Riley et al., 2019). The assessment tool included questions covering six important criteria when evaluating validity and bias of studies on prognostic factors: *study participation* (did the study sample represent the population of interest?); *study attrition* (did data from participants not lost to follow-up accurately represent the sample?); *risk factor measurement* (were the risk factors similarly measured for all study participants?); *outcome measurement* (was the outcome similarly measured for all the study participants?), *confounding measurement* (were important potential confounding factors accounted for in the regression analyses?), and *analyses* (were the statistical analyses appropriate and was the primary outcome reported?). Each criterion was judged on the basis of the reporting of the studies. The included studies were divided between two pairs of authors (BEØ and MG; GH and ATT). For each included study each pair of authors independently carried out the risk of bias assessments in which the six criteria were given either low, medium or high risk of bias. Each study was then given a "total risk of bias assessment score" as follows: *low* if five or six criteria had low risk of bias; *moderate* if four criteria had low risk of bias and *high* if one to three criteria had low risk of bias (last column Table 2). In cases where the majority of criteria were moderate risk of bias, a total *moderate* risk of bias was given. Disagreements were resolved with a discussion to reach consensus. Disagreements that could not be resolved were referred to a third review author (one author from the other pair). The operationalization of each criterion is reported in Appendix S3.

2.4 | Data extraction and synthesis

Two pairs of authors (GH and ATT, MG and BEØ) carried out the data extraction on the following variables: author and study year, population source, sample size eligible at study inception, sample size at follow-up assessment, participant age and sex, length of follow-up, back pain measurement and reported risk factors for back pain. To be able to get an overview of the risk factors for back pain, we mapped the potential risk factors from each study according the International Classification of Functioning, Disability and Health (ICF) domains a) body functions, b) body structures, c) activities and participation and contextual factors (environmental and personal; Appendix S4).

We conducted a descriptive narrative synthesis of risk factors. In the interest of identifying consistent, reproducible findings on risk factors, we summarized reported results from the studies from both unadjusted and adjusted statistical analyses for factors that had been investigated by three or more studies. We emphasized results from the adjusted analyses when interpreting and presenting the summary. For studies using the same study participants, we extracted results from the study with best methodological quality. Meta-analysis was not performed due to study heterogeneity (clinical and statistical diversity).

3 | RESULTS

3.1 | Summary of study characteristics

A total of 11,346 studies appeared in the searches and 49 were included in this systematic review (Figure 1) with over 125,000 study participants followed-up. Ten studies (Harkness, Macfarlane, Nahit, Silman, & McBeth, 2003; Mikkonen et al., 2016, 2013, 2008, 2012; Mitchell et al., 2010; Nemoto et al., 2013, 2012; Power, Frank, Hertzman, Schierhout, & Li, 2001; Smith, Russell, & Hodges, 2009) reported risk factors for first episode of back pain, two reported risk factors for a new episode (Mostardi, Noe, Kovacik, & Porterfield, 1992; Videman, Ojajarvi, Riihimaki, & Troup, 2005) and 30 reported risk factors for a mixture of participants with first episode and a new episode of back pain (Adams, Mannion, & Dolan, 1999; Auvinen et al., 2010; Baranto, Hellstrom, Cederlund, Nyman, & Sward, 2009; Cholewicki et al., 2005; Claeys et al., 2015; Coenen et al., 2017; Feyer et al., 2000; Greene, Cholewicki, Galloway, Nguyen, & Radebold, 2001; Hestbaek, Korsholm, Leboeuf-Yde, & Kyvik, 2008; Hestbaek Leboeuf-Yde, & Kyvik, 2006a, 2006b; Hestbaek, Leboeuf-Yde, Kyvik, & Manniche, 2006; Kanchanomai, Janwantanakul, Pensri, & Jiamjarasrangsi, 2015; Kato et al., 2017; Kroner-Herwig, Gorbunova, & Maas, 2017; Lake, Power, & Cole, 2000; Lallukka et al., 2017; Lunde, Koch, Hanvold, Waersted, & Veiersted, 2015; Lundin, Hellstrom,

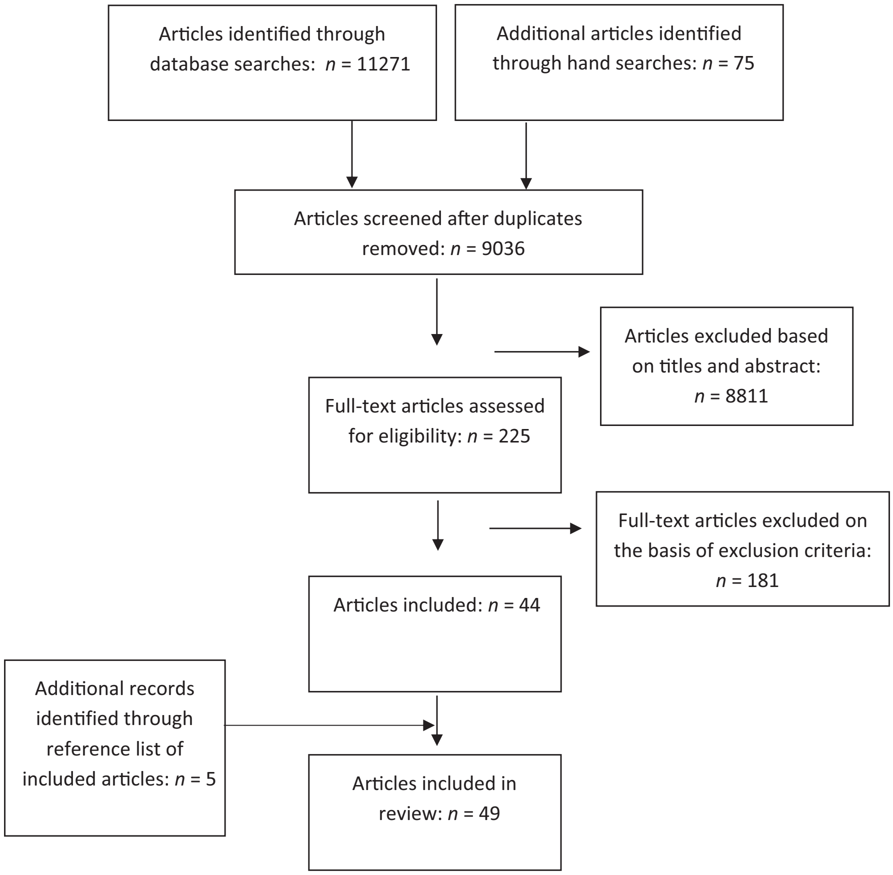

FIGURE 1 Flow diagram of included studies

Nilsson, & Sward, 2001; Mannion, Dolan, & Adams, 1996; Monnier, Djupsjöbacka, Larsson, Norman, & Äng, 2016; Nadler, Wu, Galski, & Feinberg, 1998; Ogon et al., 2001; Poussa et al., 2005; Roy & Lopez, 2013; Salminen, Erkintalo, Laine, & Pentti, 1995; Salminen, Erkintalo, Pentti, Oksanen, & Kormano, 1999; Silfies, Cholewicki, Reeves, & Greene, 2007; Van Nieuwenhuyse et al., 2009; Zack, Levin, Krakov, Finestone, & Moshe, 2018). Seven studies did not report the status of new or first episode of back pain (Brady et al., 2016; Cheung, 2010; Hayes, Smith, & Taylor, 2014; Hertzberg, 1985; Klaber Moffett, Hughes, & Griffiths, 1993; Lee et al., 1999; Rosenhagen, Niederer, Vogt, & Banzer, 2018). The population sources included health care workers (n = 4 studies; Adams et al., 1999; Mannion et al., 1996; Mostardi et al., 1992; Van Nieuwenhuyse et al., 2009), athletes or university students (n = 18; Baranto et al., 2009; Cheung, 2010; Cholewicki et al., 2005; Claeys et al., 2015; Feyer et al., 2000; Greene et al., 2001; Hayes et al., 2014; Kanchanomai et al., 2015; Kato et al., 2017; Klaber Moffett et al., 1993; Lee et al., 1999; Lunde et al., 2015; Lundin et al., 2001; Mitchell et al., 2010; Nadler et al., 1998; Rosenhagen et al., 2018; Silfies et al., 2007; Videman et al., 2005) and population cohorts (n = 15), such as the British and Northern Finland Birth Cohorts (Auvinen et al., 2010; Brady et al., 2016; Coenen et al., 2017; Hestbaek et al., 2008, 2006b; Hestbaek, Leboeuf-Yde, & Kyvik, 2006a; Hestbaek et al., 2006; Lake et al., 2000; Lallukka et al., 2017; Mikkonen et al., 2016, 2013, 2008, 2012; Power et al., 2001; Smith et al., 2009). Five studies included participants from government-funded schools (Hertzberg, 1985; Ogon et al., 2001; Poussa et al., 2005; Salminen et al., 1995, 1999), and five studies included soldiers or military personnel (Monnier et al., 2016; Nemoto et al., 2013, 2012; Roy & Lopez, 2013; Zack et al., 2018; Table 1). One study investigated participants from different work sites (Harkness et al., 2003), and another used a prospective cohort from a paediatric pain study (Kroner-Herwig et al., 2017). Study participants were from countries in Europe, USA, Asia and Australia at the time of inclusion in the studies. All studies were written in English language. The average age at baseline ranged from 14 to 27 years, and the average follow-up time varied from 1 to 25 years. The reported prevalence of back pain varied between 4% and 71% at the follow-up time point. According to mean age and follow-up time as shown in Table 1, 19 studies measured the risk factors in adolescence with the outcome back pain in emerging and young adulthood (Auvinen et al., 2010; Coenen et al., 2017; Hertzberg, 1985; Hestbaek et al., 2008, 2006a; Hestbaek et al., 2006b, 2006; Lee et al., 1999; Lunde et al., 2015; Lundin et al., 2001; Mikkonen et al., 2016, 2013, 2008, 2012; Ogon et al., 2001; Poussa et al., 2005; Rosenhagen et al., 2018; Salminen et al., 1995, 1999), 19 studies measured both the risk factors and back pain in

TABLE 1 Study characteristics in alphabetical order

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Adams et al. (1999)	Healthy pain free health care workers Volunteered: 403	Included: 403 (100%)	At 1 year: 399 (99%) At 2.5 year: 363 (90%)	27 (18–40) Females: 371 (92%) Males: 32 (8%)	2.5	Onset of low back pain requiring medical attention or time off from work Serious pain: 12 months: 11% 36 months: 25% Any back pain: 12 months 40% 36 months: 73%
Auvinen et al. (2010)	The 1986 Northern Finland Birth Cohort (subcohort of those living within 100 km of Oulo) Population: 9,479 Invited: 2,969	Included: 2012 (68%)	At 2 year: 1773 (88%)	16 (15–19) Females: 981 (55%) Males: 792 (45%)	2	Self-reported 6-month prevalence of low back pain at 18 years Consultation for low back pain: Girls: 6.1% Boys: 5.4%)
Baranto et al. (2009)	Swedish male top athletes and a control group with non-athletes (randomly selected from University of Uppsala in 1988–1990)	Included: 71 Controls: 21	At 15 year: 61 (86%) (35 had MRI) Controls: 11 (50%) (10 had MRI)	Athletes: 26 (18–41) Controls: 28 (22–48) Males: 54 (100%)	15	Self-reported questionnaire of moderate or severe low back pain Back pain: 71% Non-athletes: 75%
Brady et al. (2016)	The Australian Longitudinal Study of Women's Health (2000–2012) Invited: 9,688	Included: 9,671 (99.8)	At 12-year: 7,955 (82%)	24.6 (20.6–28.6)	12	Self-reported low back pain in the last 12 months Back pain sometimes or often: 50%
Cheung (2010)	Three cohorts (I-III) of nursing students from universities in Hong Kong Eligible: 388	I: 158 (100%) II: 107 (97%) III: 90 (75%)	At 12 months: I: 112 (71%) II: 100 (91%) III: 47 (39%)	I: 19.5 (0.99) II: 19.4 (1.1) III: 25.1 (3.7) Males/females I: 35/123 II: 27/80 III: 15/75	26 months	Nordic Musculoskeletal Pain Questionnaire Cumulative incidence of low back pain at 26 months: I: 86.5% II: 79.7% III: 80%
Cholewicki et al. (2005)	College athletes from Yale varsity Population: 303	Included: 299 (98%)	At 2–3 years: 292 (98%)	19.4 (1.4) Males: 144 (49%) Females: 148 (51%)	2–3	Self-reported history of low back pain causing missing at least 3 days of practice or competition Low back pain: 11%
Claeys et al. (2015)	Belgium university students	Volunteered: 104	At 2 years: 90 (87%)	Cases: 19.1 (1.6) Controls: 19.2 (3.7) Male: 18 (20%) Female: 72 (80%)	2	Oswestry Disability Index and low back pain on numeric rating scale (NRS) No pain at baseline and follow-up: 24% Not pain at baseline, but pain at follow-up: 33% Pain at baseline but no pain at follow-up: 10% Pain at baseline and follow-up: 32%

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Coenen et al. (2017)	Western Australian Pregnancy Cohort (Raine) Study Population: 2,900 Invited: 2,826	Included: 1,249 (44%) who had data on 2/3 time points	At 3–5 years: 1,249 (100%) for sex, and <700 for risk factors.	17 at baseline, 22 at third follow-up	3–5	Nordic musculoskeletal pain questionnaire (pain in the last month) Low back pain at 17 years: 400 (32%) At 20 and 22 years: 562 (45%)
Feyer et al. (2000)	Nursing students at Sydney University Eligible: 694	Included: 694 (100%)	315 (45%)	Age: 23.7 (7.4) Males: 104 (15%) Females: 590 (85%)	4	Repeated self-reported questionnaire Of those with low back pain at baseline: 53% Of those without low back pain at baseline: 36%
Greene et al. (2001)	College athletes from Yale varsity Recruited: 679	Included: 679 (100%)	1-year: 679 (100%) 524 (78%) answered satisfaction with coaches questions 561 (83%) answered satisfaction with teammate questions	19 (1) Males: 422 (62%) Females: 257 (38%)	1	Self-reported questionnaire and visit to general practitioner because of low back pain Low back pain during last year: 6.8%
Harkness et al. (2003)	Newly employed workers (from 12 diverse occupational groups) Eligible: 1,186	Included: 1,081 (91%) Eligible for follow-up without LBP: 788	1 year: 625 (79%) 2 years: 430 (86%)	Median 23 (interquartile range 21–28) Males: 504 (64%) Females: 284 (36%)	1 and 2	Self-reported new onset low back pain 1 year: 19% 2 years: 81 (19%)
Hayes et al. (2014)	Dental hygiene students at University of Newcastle, Australia Eligible: 75	Included: 50 (67%)	At 1 year: 51 (68%) At 2 years: 41 (55%)	25.8 Females: 45 (90%) Males: 5 (10%)	3	Standardized Nordic Questionnaire Baseline: 62% had any low back symptoms At 2 years: 68.3%
Hertzberg, (1985)	Four annual cohorts of pupils from Røros Eligible: 316	Included: 302 (96%)	295 (98)	16 Males: 150 (49%) Females: 152 (51%)	9–12	Self-reported low back pain. Onset and duration of pain Any episode of back pain: 56%
Hestbaek et al. (2006) (The course…)	Danish twin register: born between 1972 and 1982 Population: 11,428 Responders: 9,600 (84%)	Included: 9,569 (99%)	At 8 years follow-up: 6,540 (57% of included, and 68% of the study sample)	17.4 (3.1)(12–22) Males: 2,949 (43%) Females: 3,835 (57%)	8	Nordic Back Pain Questionnaire (> 30 days vs. <30 days during the past year) Low back pain the past year: Males: 7% Females: 12%

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Hestbaek Leboeuf-Yde and Kyvik (2006a), Hestbaek et al. (2006) ("Is comorbidity…")	Danish twin register: born between 1972 and 1982 Population: 11,428	9,600 (84%)	6,554 (68%)	17.3 (11–22) years Included: Males: 4,654 (48%) Females: 4,946 (52%) Follow-up: Males: 2,868 (44%) Females: 3,682 (56%)	8	Nordic Back Pain Questionnaire (> 30 days vs. <30 days) Any low back pain: Excluding those with LBP at baseline: between 9% and 14%
Hestbaek et al. (2006b) ("Are lifestyle factors…")	Danish twin register: born between 1972 and 1982 Population: 11,428	9,609 (84%)	6,554 (68%)	17.3 (11–22) Males: 4,590 (49%) Females: 4,873 (51%) At follow-up: Males: 2,867 (44%) Females: 3,676 (56%)	8	Nordic Back Pain Questionnaire (> 30 days vs. <30 days) Any low back pain: 35% Persistent: 6%
Hestbaek et al. (2008)	Danish twin register: born between 1972 and 1982 Eligible: <18 years and living with their parents: 4,854	Included: 4,771 (98%)	3,245 (68%)	14.6 (1.69) Males: 50% Females: 50%	8	Nordic Back Pain Questionnaire (> 30 days vs. <30 days) Any low back pain: 43% Persistent: 9%
Kanchanomai et al. (2015)	Undergraduate health students at Thammasat University Thailand Eligible: 33,000 Invited: 3,545 Volunteered: 2,614	Included: 2,511 (71%) Physical examination: 684 (19%)	524 (77%)	19.4 (1.1) Males: 138 (26%) Females: 386 (74%)	1	Nordic questionnaire of pain lasting >24 hr during the past 3 months Prevalence of low back pain: 31%
Kato et al. (2017)	Fukushima Medical University Eligible: unclear	Included: 95	At follow-up: 94 (99%)	Age not given Males: 43 (45.7%) Females: 51 (54.2%)	2	Self-reported questionnaire of new onset low back pain the previous 3 months+ the presence of low back pain interfering with daily living Prevalence at 2 years not given
Klaber Moffett et al. (1993)	Female nursing students in Great Britain Eligible: unclear	Included: 376	20-month follow-up time: 199 (53%)	18–21 (18–4)	20 months	Self-reported questionnaire of pain Prevalence: 64%
Kroner-Herwig et al. (2017)	Paediatric pain study in southern Lower Saxony, Germany Included at baseline: 8,800 randomly drawn from community registries	Included: 5,542 (63%)	At 9 year follow-up: 1,488 (27%)	22.4 (19–27) Males: 43.6% Females: 56.4%	9	Self-reported questionnaire of back pain the last 6 months Prevalence: 43%

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Lake et al. (2000)	1958 British birth cohort Eligible: 17,733	At age 23:12,065 (68%)	At age 33:11,407 (73%) (but 8,863, 73%) according to sex distribution)	23 Males: 4,395 (49.5%) Females: 4,468 (51.5%)	10	Self-reported 1 year incidence of back pain for over a day Any back pain over 10 years: 54% Persistent: males: 11%, females 14% Incident: males: 27%, females 21%
Lallukka et al. (2017)	The Young Finns Study Eligible: 1,265	Included: 943 (75%)	At follow-up: 738 (76%)	Baseline: 18–24 years Follow-up: 39–45 years Males: 324 (44%) Females: 414 (56%)	21	Radiating pain and LBP the last days during the preceding 12 months Prevalence of local LBP: Females: 36.2% Males: 34%
Lee et al. (1999)	Student volunteers Eligible: unclear	Unclear	Included 67	17 (2) (13–26) Males: 30 (45%) Females: 37 (55%)	5	Back pain leading to work absence and/or requiring medical attention Prevalence of low back pain: 27%
Lunde et al. (2015)	Students in 13 technical schools in Oslo, but for this study: hairdressing, electrical installation and media Invited: 496	Included: 420 (85%)	Response rates differed over 21 time points over 6.5 years from 100% at baseline. 7% missed all the follow-ups.	17.5 (1.2) Males: 153 (36%) Females: 267 (64%)	6.5	Nordic questionnaire on musculoskeletal symptoms (measured low back pain the previous month every 4th month over 6.5 years) The mean prevalence of any low back pain during follow-up: 39%
Lundin et al. (2001)	Athletes and non-athletes initially part of radiology study of the spine Eligible: 173	Included: 173 (100%)	162 (94%)	Males: 16–25 Females: 14–25 Males: 147 (85%) Females: 26 (15%)	12–15	Self-reported questionnaire of back pain during the last year or caused inability to work the last three years Prevalence of moderate and severe: 60%
Mannion et al. (1996)	Healthy volunteers from local health care hospitals Recruited: 403	Included: 403 (100%)	At follow-up: 403 (100%)	27 (18–39) Males: 32 (8%) Females: 371 (92%)	1.5	Self-reported questionnaire of any back pain in the last 6 months Prevalence of any back pain: 40% Prevalence of serious back pain: 79 (20%)
Mikkonen et al. (2008)	Northern Finland Birth Cohort 1986. Subcohort living within 100km of Oulu Population: 9,479 Eligible: 2,969	Included: 1987	At follow-up: 1525 (76%)	16 Males: 908 (46%) Females: 1,079 (54%)	2	Self-reported low back pain or consulted healthcare for it during the past 6 months Prevalence: Any low back pain: 56% Pain requiring consultation: 6%

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Mikkonen et al. (2012)	Northern Finland Birth Cohort. Subcohort living within 100km of Oulu Population: 9,479 Eligible: 2,951	Included: 2,951	Follow-up: 1984 (67%)	16 Males: ca. 45% Females: about 55%	2	Self-reported low back pain or consulted healthcare during the past 6 months Prevalence: Without pain at baseline: 29% in females, and 19% in males. Pain requiring consultation: 2% Persistent pain: 53% in females and 46% in males. Pain requiring consultation: 19% in females and 17% in males
Mikkonen et al. (2013)	Northern Finland Birth Cohort. Subcohort living within 100km of Oulu Population: 9,479 Eligible: 2,951	Included: 2,951	At follow-up: 1,660 (56%)	16 Males: 732 (44%) Females: 928 (56%) Subcohort for waist circumference: 786 (males: 340, Females: 446)	2	Self-reported questionnaire of any low back pain or consulted health care Prevalence at 18 years: Females: 63% Males: 47%
Mikkonen et al. (2016)	Northern Finland Birth Cohort. Subcohort living within 100km of Oulu Population: 9,479 Eligible: 2,951	Included: 2012 (68%)	At follow-up: 1625 (55%)	16 Males: 712 (44%) Females: 913 (56%)	2	Self-reported questionnaire of any low back pain or consulted healthcare Prevalence of low back pain at 18 years if no pain at 16 years: Females: 46% (5% had consulted physician) Males: 32% (4% of had consulted a physician)
Mitchell et al. (2010)	Nursing students in Australia Eligible: 590 Recruited: 199	Included: 117 (20%)	107 (91%)	21.7 (4) Females: 107 (100%)	1	Nordic Pain Questionnaire Prevalence of low back pain: 29%
Monnier et al. (2016)	Swedish armed forces Eligible: 288	Included: 192 (67%)	Follow-up: 118 (61% of included)	23.6 (4.3) Males: 118 (100%)	1	Self-reported questionnaire of any back pain Prevalence at 1 year: 50%
Mostardi et al. (1992)	Female nurses in tertiary community hospital Eligible: 171	Included: 171 (100%)	At follow-up: 171 (100%) Age group <30 years: 69	Group of ≤30 years: 26.0 (2.6) (21–30) Females: 171 (10%)	2	Low back pain and injury history questionnaire Prevalence: 9%(not divided in age under 30)
Nadler et al. (1998)	College athletes at varsity sports in 1994 Eligible: Unclear	Included: 257 (100%)	Follow-up: 257 (100%)	Not available Males: 170 (66%) Females: 87 (34%)	1	Any athlete requiring treatment for low back pain by the team trainer Prevalence of low back pain: 9.3% Females: 15% Males: 6%

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Nemoto et al. (2012)	Japanese Self Defense Forces Eligible: 84	Selected: 45 (54%)	Follow-up: 40 (89%)	18.1 (0.3) Males: 40 (100%)	25	Postal letter with questions of history of low back pain Prevalence of low back pain: 60%
Nemoto et al. (2013)	Japanese Self Defense Forces Eligible: 90	Included in 1990:84 (93%)	Follow-up: 84 (100%)	18.3 (0.5) Males: 84 (100%)	20	Self-reported questionnaire (letter) Prevalence: 52%
Ogon et al. (2001)	Student adolescents alpine elite skiers Eligible: 120	Included: 120 (100%)	At follow-up: 120 (100%)	17 (range 14–20) Males: 78 (65%) Females: 42 (35%)	2	Standardized diary Incidence: 12.5%
Poussa et al. (2005)	All fourth-grader school children in the western school district of Helsinki in 1986 Eligible: 1,060	Included: 1,060 Baseline: 855 (81%)	430 (41%)	13.8 Males: 222 (52%) Females: 208 (48%)	8	Questionnaire on low back pain eight or more days during the past year Cumulative incidence in females: from 18.4% to 78.9%. In males: from 16.9% to 78.4%
Power et al. (2001)	1958 Birth cohort England, Wales, Scotland Population: 17,414 Eligible: 11,407	Included: 5,781 (51%)	Followed-up: 5,781 (100%)	23 Males: 2,825 (48.9%) Females: 2,956 (51.1%)	10	Self-reported questionnaire of low back pain: "have you ever had back pain" and "how old were you when you first had back pain lasting fore than one day" Low back pain 9.9% Females: 8.8% Males: 11%
Rosenhagen et al. (2018)	Healthy subjects from annual sports medical examination in Hesse, Germany Population: 836 Eligible: 789 (166 cases and 623 controls)	789	At follow up: 64 (8%) (19 cases and 45 controls)	14.7 (2.3) years Males: 33 (51%) Females: 31 (49%)	7	Chronic non-specific LBP > 13 weeks the last 12 months (not specified how it was measured) Prevalence of low back pain: 25% Females: 69% Males: 31%
Roy and Lopez (2013)	Brigade Combat team, Afghanistan Eligible: 3,500	Included: 1,194 (34%)	At follow-up: 805 (67.5%)	26.2 (5,6) Males: 758 (94%) Females: 47 (6%)	1	Self-reported questionnaire. History of low back pain in five groups: 24.9%–27.7%
Salminen et al. (1995)	All 8th graders at the comprehensive schools of Turku Population: 1503 Eligible: 1,377 (91.6%)	Included: 80 (40 cases/40 controls)	Followed-up: 62 (31 pairs)	15 Males: 29 (47%) Females: 34 (53%)	3	Self-reported questionnaire of low back pain past 12 months Prevalence of low back pain: Unclear

(Continued)

TABLE 1 (Continued)

Authors	Population source (*n*) and eligible (*n*)	Participants at baseline, *n* (% of eligible)	Participants at follow-up, *n* (% of included)	Age at baseline, years (sd or range) Females: *n* (%) Males *n* (%)	Years of follow-up	Low back pain assessment and prevalence (%) at follow-up
Salminen et al. (1999)	All 8th graders at the comprehensive schools of Turku Population: 1503 Eligible: 1,377 (91.6%)	Included: 76 (38 case drawn from 107 with low back pain + 38 matched controls)	Followed-up: 57	15 Males: 29 (47%) Females: 33 (53%)	9	Self-reported questionnaire Prevalence in cases: 11/31 (35%)
Silfies et al. (2007)	Yale University varsity athletes Eligible: unclear	Included: 292	Followed-up: 292 (100%)	19.5 (1) Females: 148 (51%) Males: 144 (49%)	2–3	Self-reported electronic questionnaire of low back pain that caused the athlete to seek medical attention and miss 3 days of sport activity Prevalence at follow-up: 11% Females: 6% Males: 5%
Smith et al. (2009)	Australian Longitudinal Study on Women Health 1996 Eligible: 3,202 (67%)	Included: 2,943 (91%)	Followed-up: 2,943 (91%)	18–23 Females: 2,943 (100%)	2–4	Self-reported questionnaire og low back pain during last 12 months Prevalence: 37%
Van Nieuwenhuyse et al. (2009)	Belgian Low Back Cohort: Workers in health care institutions Eligible: 1672	Included: 1,041 (62%)	At follow-up: 692 (73%)	26 (3) Females: 415 (60%) Males: 277 (40%)	1	Self-reported questionnaire of low back pain Prevalence: 12.5%
Videman et al. (2005)	Four classes of female nursing students in Finland Population: 308	Included: 255 (83%)	1 year after graduation: 197 (77%) 5 years after graduation 174 (68%)	22.6 (4.5) Females: 174 (100%)	7.5	Self-reported questionnaire of days of back pain in the last year One-year prevalence for the first year after graduation: 57%
Zack et al. (2018)	Israel Defence Forces database of male soldiers	All subjects in driving or administrative positions: 80,599	At follow-up: 80,599	19.06 (1.4) Males: 80,599 (100%)	3	Interviewed by a physician about low back pain history Annual incidence: 0.65%–2.49%

TABLE 2 Study quality assessment

Study	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Confounding measurement	Analysis	Risk of bias
Adams et al. (1999)	Moderate	Low	Low	Low	Moderate	Low	Moderate
Auvinen et al. (2010)	Low	Moderate	Low	Low	Low	Low	Low
Baranto et al. (2009)	High	High	Moderate	Low	High	High	High
Brady et al. (2016)	Low	Low	Low	Moderate	Low	Low	Low
Cheung, (2010)	Low	Moderate	Low	Low	Low	Low	Low
Cholewicki et al. (2005)	Low	Moderate	Low	Moderate	Low	Low	Moderate
Claeys et al. (2015)	Moderate	Low	Low	Low	Low	Low	Low
Coenen et al (2017)	Low	Moderate	Low	Low	Moderate	Low	Moderate
Feyer et al. (2000)	Low	Moderate/High	Low	Moderate	Low	Low	Moderate
Greene et al. (2001)	Low	Moderate	High	Moderate	High	Moderate	High
Harkness et al. (2003)	Low	Moderate	Low	Moderate	Low	Low	Moderate
Hayes et al. (2014)	Moderate	High	High	Low	High	High	High
Hertzberg (1985)	Low	Low	Moderate	Moderate	Moderate	High	Moderate
Hestbaek et al. (2006) (Is..)	Low	Low	Low	Low	Moderate	Low	Low
Hestbaek et al. (2006) (The..)	Low	Moderate	Moderate	Low	Moderate	Low	Moderate
Hestbaek et al. (2006) (Are..)	Low	Low	Low	Low	Moderate	Low	Low
Hestbaek et al. (2008)	Low	Low	Low	Low	Moderate	Low	Low
Kanchanomai et al. (2015)	High	Moderate	Low	Low	Moderate	Low	Moderate
Klaber Moffett et al. (1993)	Moderate	High	Low	Moderate	Low	Moderate	Moderate
Kato et al. (2017)	Moderate	Low	Low	Low	Moderate	Low	Moderate
Kroner-Herwig et al. (2017)	Low	High	Low	Low	Moderate	Low	Moderate
Lake et al. (2000)	Low	Low	Low	Low	Low	Low	Low
Lallukka et al. (2017)	Moderate	Moderate	Low	Low	Low	Low	Moderate
Lee et al. (1999)	High	Low	Low	Low	Moderate	High	Moderate
Lunde et al. (2015)	Low	Moderate	Low	Low	Low	Low	Low
Lundin et al. (2001)	High	Low	High	Moderate	High	High	High
Mannion et al. (1996)	High	High	Low	High	High	Moderate	High
Mikkonen et al. (2008)	Moderate	High	Low	Low	Low	Low	Moderate
Mikkonen et al. (2012)	Moderate	High	Low	Low	Low	Low	Moderate
Mikkonen et al. (2013)	Moderate	High	Low	Low	Low	Low	Moderate
Mikkonen et al. (2016)	High	High	Low	Low	Low	Low	Moderate

(Continues)

TABLE 2 (Continued)

Study	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Confounding measurement	Analysis	Risk of bias
Mitchell et al. (2010)	Moderate	High	Low	Low	Low	Low	Moderate
Monnier et al. (2016)	Moderate	High	Low	Low	Low	Low	Moderate
Mostardi et al. (1992)	High	Low	Low	Moderate	High	High	High
Nadler et al. (1998)	High	Low	Low	Moderate	High	High	High
Nemoto et al. (2012)	Low	High	Low	Moderate	High	Moderate	Moderate
Nemoto et al. (2013)	Moderate	Low	Low	Moderate	Low	Low	Moderate
Ogon et al. (2001)	Low	Low	Low	Moderate	High	Moderate	Moderate
Poussa et al. (2005)	Moderate	High	High	Moderate	High	High	High
Power et al. (2001)	Low	High	Low	Moderate	Low	Low	Moderate
Rosenhagen et al. (2018)	Moderate	High	Low	Moderate	High	High	High
Roy et al. (2013)	Moderate	High	Moderate	High	High	Moderate	High
Salminen et al. (1995)	High	High	Low	High	High	High	High
Salminen et al. (1999)	Moderate	High	Moderate	Moderate	High	High	High
Silfies et al. (2007)	High	Low	Moderate	Low	High	High	High
Smith et al. (2009)	Low	High	Low	Moderate	Moderate	Low	Moderate
Van Nieuwenhuyse et al. (2009)	Moderate	High	High	Moderate	High	High	High
Videman et al. (2005)	Low	Moderate	High	Low	Moderate	Moderate	Moderate
Zack et al. (2018)	Low	Low	Low	Low	High	Moderate	Moderate

Note: Study Participation: The study sample represents the population of interest; Study Attrition: Data from participants not lost to follow-up accurately represent the sample; Prognostic factor measurement: The risk factor is similarly measured for all participants; Outcome measurement: The outcome is similarly measured for all participants; Confounding measurement: Important potential confounding factors are accounted for; Analysis: The analysis is appropriate and all primary outcomes are reported.

TABLE 3 Risk factors for episodes of back pain in emerging adults assessed in three or more studies

Risk factor	Number of study participants at follow-up	Results from *unadjusted* statistical analyses from studies that reported unadjusted results	Results from *adjusted* statistical analyses from studies that reported adjusted results	Risk of bias
Age	2,266	No association: $n = 6$ (Hayes 2014, Kanchanomai 2015, Nemoto 2012, Nemoto 2013, Videman 2005, Silfies 2007)	No association: $n = 1$ (Greene 2001) Association for that higher age lowers risk of back pain: $n = 1$ (Adams 1999)	Moderate/high
Sex	7,758	No association: $n = 1$ (Kanchanomai 2015) Women higher risk than men: $n = 2$ (Adams 1999, Nadler 1998)	No association: $n = 1$ (Greene 2001) Men higher risk than women: $n = 1$ (Power 2001)	Moderate/high
Body mass index	40,435	No association: $n = 7$ (Adams 1999, Mitchell 2010, Nemoto 2013, Nemoto 2012, Poussa 2005, Power 2001, Salminen 1995)	No association: $n = 3$ (Hestbaek 2008, Hestbaek 2006 Are lifestyle factors…, Van Nieuwenhuyse 2009) Positive Association: $n = 3$ (Brady 2016, Lake 2000, Lunde 2015)	Moderate
Body height	947	Positive association for serious back pain, but not for any back pain: $n = 1$(Adams 1999)	Positive association: $n = 1$ (Monnier 2016) No association. $n = 1$ (Poussa 2005)	Moderate/high
Smoking	17,991	No association: $n = 4$ (Adams 1999, Nemoto 2012, Nemoto 2013, Videman 2005) Positive association: $n = 2$ (Mitchell 2010, Smith 2009)	No association: $n = 2$ (Lunde 2015, Mikkonen 2008) Positive association: $n = 2$ (Hestbaek 2006 Are lifestyle factors…, Power 2001)	Moderate
Physical activity/inactivity level	18,401	No association: $n = 4$ (Mannion1996, Nemoto 2013, Power 2001, Smith 2009)	No association: $n = 4$ (Claeys 2015, Kanchanomai 2015, Kato 2017, Lunde 2015) Positive Association: $n = 1$ (Mitchell 2010) Positive association between inactivity and low back pain: $n = 1$ (Brady 2016)	Moderate
History of back pain	89,808	Positive association: $n = 1$ (Zack 2018)	Positive association: $n = 9$ (Adams 1999, Feyer 2000, Greene 2001, Hestbaek 2006 Is comorbidity…, Kroner-Herwig 2017, Mikkonen 2013,Monnier 2016, Roy 2013, Videman 2005) No association: $n = 1$ (Kato 2017)	Moderate
Job satisfaction	6,700	No association: $n = 3$ (Feyer 2000, Harkness 2003, Videman 2005)	No association: $n = 1$ (Power 2001)	Moderate
Structural imaging findings	331	No association: $n = 3$ (Baranto 2009, Lundin 2001, Nemoto 2012)	No association: $n = 1$ (Nemoto 2013)	High

Note: n, number of studies. Positive association means that if the risk factor is present, the risk of back pain is increased (e.g. a smoker has higher risk of back pain). Negative association means that if the risk factor is present, the risk of back pain is decreased (e.g. a smoker has lower risk of back pain). Number of study participants is from column #4 in Table 1. In Lunde et al. number was unavailable and the included participants were counted. In cases with several follow-ups, the number of study participants from the longest follow-up was chosen. In cases where a study presented both unadjusted and adjusted analyses, we chose to present results from the adjusted analyses only. In crude analyses for BMI and physical activity and adjusted analysis for history of back pain, Adams and Mannion found the same results from the same study participants. We excluded Mannion in both these cases. Body height was measured in several articles, however, either was height only adjusted for in the analysis or no results were shown, resulting in three papers that reported proper results for height.

emerging and young adulthood (Adams et al., 1999; Cheung, 2010; Cholewicki et al., 2005; Claeys et al., 2015; Feyer et al., 2000; Greene et al., 2001; Harkness et al., 2003; Hayes et al., 2014; Kanchanomai et al., 2015; Klaber Moffett et al., 1993; Mannion et al., 1996; Mitchell et al., 2010; Monnier et al., 2016; Mostardi et al., 1992; Roy & Lopez, 2013; Silfies et al., 2007; Smith & Leggat, 2007; Van Nieuwenhuyse et al., 2009; Zack et al., 2018) and nine studies measured risk factors in emerging adulthood and back pain in adulthood (Baranto et al., 2009; Brady et al., 2016; Kroner-Herwig et al., 2017; Lake et al., 2000; Lallukka et al., 2017; Nemoto et al., 2013, 2012; Power et al., 2001; Videman et al., 2005; two studies did not report the exact age span (Kato et al., 2017; Nadler et al., 1998)).

3.2 | Study quality

The risk of bias assessment revealed that nine studies had low risk of bias, 26 studies had moderate risk of bias and 14 studies had high risk of bias (Table 2). The criteria where most studies had high risk of bias were *Study Attrition* ($n = 21$) and *Confounding measurement* ($n = 17$).

3.3 | Risk factors for back pain

More than 150 potential risk factors were investigated in the 49 studies included (Appendix S4). Among all potential risk factors investigated, there were nine risk factors investigated in three or more studies. These were age, sex, height, body mass index (BMI), smoking, physical activity level, a history of back pain, job satisfaction and structural imaging. The reported results for each of these risk factors and the overall quality of evidence are presented in Table 3. Nine studies reported a significant association between a history of back pain and a new episode of back pain in adjusted analyses (Adams et al., 1999; Feyer et al., 2000; Greene et al., 2001; Hestbaek et al., 2006b; Kroner-Herwig et al., 2017; Mikkonen et al., 2013; Monnier et al., 2016; Roy & Lopez, 2013; Videman et al., 2005; Table 3). Inconsistent associations were reported from adjusted analyses between back pain and age, sex, height, BMI, smoking and physical activity level. One study reported adjusted analysis for job satisfaction and one other for structural imaging findings, both reported no association to back pain. Of the nine studies that showed an association between a history of back pain and a new episode of back pain, five studies measured both the risk factor and back pain within 18–29 years of age (Feyer et al., 2000; Greene et al., 2001; Monnier et al., 2016; Roy & Lopez, 2013; Videman et al., 2005). Two studies measured the risk factor in emerging adulthood, and back pain in adulthood (Adams et al., 1999; Kroner-Herwig et al., 2017) and two assessed the risk factor before emerging adulthood and outcome in emerging adulthood (Hestbaek et al., 2006b; Mikkonen et al., 2013). The nine studies included more than 9,000 study participants, and the risk of bias was moderate in six of the studies, high in two, and low in one of the nine studies.

4 | DISCUSSION

This systematic review summarizes the evidence for risk factors for back pain in emerging adults. Nine risk factors were investigated in three or more studies, revealing that having a history of back pain consistently seems to be a risk factor for a new episode of back pain in emerging adults. Inconsistent results were found for age, sex, height, BMI, smoking and physical activity level with studies reporting both associations and no associations in adjusted analyses. The results for job satisfaction and structural imaging findings showed no association both in unadjusted and adjusted analyses, but only one study had conducted adjusted analysis for job satisfaction and one other for structural imaging findings. This systematic review showed that a history of back pain was a consistent risk factor for future episodes of back pain in young people across many studies. The studies with adjusted analysis included in total over 9,000 study participants and had overall moderate study quality. Previous reviews on other populations show similar findings. For instance, da Silva et al.(da Silva et al., 2017) reported that a history of previous episodes of back pain was the only significant predictor for low back pain in adults, but the result was based on two studies only (Hancock et al., 2015; Stanton et al., 2008). Taylor et al. systematically reviewed risk factors for first-time low back pain, and for a new episode from a pain free baseline in subjects 18 years or older (Taylor, Goode, George, & Cook, 2014). They reported that no consistent risk factor emerged as predictive of first-time low back pain, but that a history of low back pain was a consistent predictor of future incident low back pain for those who were pain free at baseline. Our intention was also to distinguish risk factors for first and new episode of back pain. It was however, challenging to ascertain if included studies had investigated first ever episode of low back pain, new episodes of low back pain or a mixture of both. Although some studies defined their outcome as a first episode of back pain, it was apparent even in these studies that a history of previous episodes was a risk factor, underlining the difficulty in identifying a true, single point of onset for back pain (Adams et al., 1999; Mannion et al., 1996). According to the present systematic review, conflicting results were found for smoking and BMI as possible risk factors for back pain in adjusted analyses. Huguet et al. reported moderate quality evidence for a trend that regularly smoking in childhood or adolescence may be associated with later low back pain (Huguet et al., 2016). Their results were based on four studies in which two of them are included in our review (Hestbaek et al., 2006a, 2006; Mikkonen et al., 2008) and they show opposite results in adjusted analyses. Their other two studies that showed an association between smoking and low back pain investigated in children and adolescents, thus a direct comparison with data from this report could not be done. In line with our results, Huguet found no association between pain and BMI. However, with different age groups and pain sites included in the two reviews comparisons of the results could not be directly done. O'Sullivan and colleagues summarized their work from the Raine Study cohort in Australia where they found that low back pain is prevalent at the age of 14 years and it increases to adult prevalence by 22 years of age. They stated that predictors of disabling low back pain in adolescence, as in adults, are multidimensional, including female sex, negative back pain beliefs, poor mental health status, somatic complaints, involvement in sports and altered stress responses. (O'Sullivan, Smith, Beales, & Straker, 2017). This has not been demonstrated in other studies. Lack of replicable high quality studies and inconsistent results for risk factors for back pain on adolescents and emerging adults highlight the need to address these age spans more rigorously. Importantly, trajectories for long-term musculoskeletal health may start to manifest and emerge during these complex transitionary periods. Furthermore, emerging adulthood is a period of life when implementation strategies for lifestyle changes may be effective (Wing et al., 2016).

4.1 | Strength and limitations of the study

This systematic review was conducted and reported in accordance with the PROSPERO protocol and the PRISMA guidelines (Appendix S1). The systematic searches were performed by one librarian and replicated by another librarian with comprehensive search strategies in all the relevant databases and in close collaboration with the authors. The search results included studies from four continents and covered both registry and population cohort studies. Our initial intention was to investigate modifiable risk factors for back pain in emerging adults, aged 18–29 years, however we decided to expand the scope of the review and included studies with either the outcome, risk factor(s) or both measured in the age span 18–29 years. Thus, some of the studies included study populations aged 16 years at baseline and 18 years at follow-up while other studies included study participants in the upper limit of the age span. The wide age span led to a number of distinctive sample frames being used, for example school for recruiting adolescents; more selective universities/workplaces/military for recruiting people in emerging adulthood; and population cohorts and registries generally capable of moving across both. Consequently, these data provided strong evidence to explore comparative risk factors across different life stages. We were unable to perform a meta-analysis as only a few studies had measured the same risk factor and the outcome measurement differed in terms of back pain duration and often included a mixture of study participants with both first and new episodes of back pain. Finally, we intended to apply the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework for assessing quality of evidence if that was possible (Guyatt et al., 2011). However, it was challenging to use the GRADE framework appropriately for the included cohort studies, due to large heterogeneity in the study samples, statistical analyses and handling of possible confounders.

4.2 | Implications

We found little evidence to support or refute our theory that exposures and transitions in emerging adulthood may be relevant to the risk of back pain. Future studies should examine more carefully the effect of key transitions or developmental processes occurring in emerging adulthood to inform whether or how interventions may need to be adapted to different stages of life. High quality prospective cohort studies evaluating risk factors for first ever episode of back pain with frequent follow-ups over several years, and with a comprehensive set of measured risk factors, including biological, psychological and social factors, are needed.

5 | CONCLUSION

There is moderate quality evidence that a history of back pain is a risk factor for new episodes of back pain in emerging adults. There are no or unclear associations for age, sex, height, BMI, smoking and activity level. No associations were found between job satisfaction and structural imaging findings and episode of back pain.

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CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTIONS

All authors fulfilled the Vancouver rules for authorship. All authors discussed the research question and participated in the searches, the extraction of data or the quality assessment. All authors discussed the results and commented on the manuscript. All authors approved the submitted version of the manuscript. Britt Elin Øiestad takes the responsibility for the integrity of the work as a whole.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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