

Musculoskeletal disorders among children and young people: prevalence, risk factors and preventive measures: a scoping review

Executive summary



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Executive summary

Main conclusions

This literature review focuses on musculoskeletal disorders (MSDs) among children and young people, paying special attention to young workers. The objective of the review is to identify the prevalence of and main risk factors for MSDs and the main preventive measures or intervention strategies.

In many cases, MSD problems begin in childhood, when inappropriate postures are combined with little sports activity (Rodríguez-Oviedo et al. 2018). Suffering from musculoskeletal pain in childhood or adolescence increases the risk of having it as an adult (Kovacs et al. 2011), possibly through the development of maladaptive beliefs, behaviours and attitudes related to the earlier pain events (Michaleff et al. 2014). The already high prevalence of MSDs among children (Calvo-Muñoz et al. 2013, Kamper et al. 2016b) raises the issue of young workers coming into the workplace with pre-existing musculoskeletal problems that have the potential to be exacerbated by work. If MSDs in children can be prevented, entry into a cycle of recurring episodes may be delayed and the prevalence of adult MSDs may be decreased (Hill and Keating 2015).

This report shows how important it is to adopt a 'life course' approach to studying musculoskeletal conditions and musculoskeletal health. Such an approach has the potential for a better understanding of how and why musculoskeletal conditions occur over the life course and how musculoskeletal health can be promoted. Its adoption 'improves prevention for all workers (young and older), and reduces the damage to workers' health while limiting early exit from work and improving the sustainability of work in jobs that have high physical demands' (Belin et al. 2016). In this context, the lifelong impact of musculoskeletal pain needs to be considered.

We found the prevalence of MSDs to be already quite high in schoolchildren and young people (7 to 26.5 years old), with ~30 % on average suffering from an MSD. However, apprentices and young workers or students (15 to 32 years old) show a slightly higher average prevalence of MSDs of ~34 %.

There are several reasons for the rather high prevalence rates in children and young people. MSDs can be caused by acquired, individual or congenital risk factors. Most of the acquired risk factors, i.e. physical, psychological, socioeconomic and environmental risk factors, are largely preventable.

A considerable number of preventable, non-work-related risk factors have been suggested to be associated with a higher risk of MSDs in children and adolescents: malnutrition and overweight; very low and very high levels of physical activity, leisure activities or poor sleep; smoking and alcohol consumption; bad or incorrect postures caused by extended sitting, excessive use of electronic devices, backpack loads or playing an instrument; sports injuries; mental health problems; social status; and weather conditions. However, current studies show inconsistent results, and currently no definite evidence supports the association of most of these factors with a higher risk of MSDs in children and young people. This could certainly also be attributed to the limitations of some of the existing studies.

Work-related risk factors for young workers comprise physical workload, long-term unnatural working positions, repetitive work, working under pressure, bullying, job insecurity, professional challenges and extreme weather conditions. There is a lack of studies on young workers in occupations with high exposure to noise, vibration, heat or cold, and to physically demanding work factors such as working in awkward positions, handling heavy loads and repetitive work. Nevertheless, studies that examined specific sectors and occupations (e.g. professional musicians and workers in the health care sector) found young workers to be at high risk of developing MSDs.

Established interventions to prevent or reduce MSDs involve education, physical exercises, manipulative therapy and ergonomic measures. In general, education is effective in increasing knowledge, sensitivity and awareness regarding musculoskeletal discomfort and pain in children as well as in young people. However, increased knowledge does not necessarily lead to improved behaviour. Physical exercises are promising interventions to prevent or reduce musculoskeletal discomfort. Yet, sustainable effects can only be achieved by strict adherence to these exercise regimes. Ergonomic equipment combined with physical exercise also showed a positive effect in the prevention or reduction of MSDs. Manipulative therapy seems to be effective in children or young people with long-lasting or chronic pain.

In summary, irrespective of scientific evidence on the contribution of certain factors to the risk of developing MSDs, the prevalence among children, adolescents and workers is quite high. There is an urgent need for early promotion of musculoskeletal health in children and young people. Maintaining long-term adherence to a combination of education, physical training and ergonomic measures promises the best results in sustainably preventing or reducing MSDs for (working) life.

What did we find?

Prevalence of MSDs among children and young workers

Studies indicate that even children and young people are experiencing MSDs. The prevalence of MSDs in children and young people (7 to 26.5 years old) who are still going to school, college or university, etc. and who have not yet entered the labour market is quite high at ~30 % (pre-labour market prevalence).

The average prevalence in young workers (15 to 32 years old) who have entered the labour market is slightly higher, at ~34 % (work-related prevalence).

Whereas in the pre-labour market, the prevalence among girls is considerably higher than among boys, this varies in young workers according to the level of exposure.

In both pre-labour market young people and young workers, the prevalence is comparable between the countries considered. When considering the publication year of the corresponding studies no time trends over the past 10 years were detected.

Risk factors for MSD development

Generally, MSDs can be caused by acquired or congenital risk factors, or by other diseases. In this review we investigated only acquired, preventable and individual risk factors. Acquired risk factors are those that are largely preventable, namely physical, psychological, socioeconomic and environmental risk factors. In the studies we identified, a considerable number of preventable and individual risk factors for developing MSDs in children and young people was analysed.

Pre-labour market MSD risk factors in children and adolescents

Many factors have been suggested to be associated with a higher risk of developing MSDs or aggravating an already existing MSD in children and adolescents. Within the framework of this scoping review, we identified the following potential risk factors for MSDs in children and adolescents:

- physical factors:
 - nutrition and weight:
 - nutrition
 - body weight
 - lifestyle:
 - physical (in)activity
 - leisure activities
 - sleeping habits
 - smoking
 - alcohol consumption
 - bad or incorrect postures:
 - extended sitting
 - use of electronic devices
 - backpack load
 - playing an instrument
 - sports
- mental health/psychosocial factors
- socioeconomic factors

- environmental conditions
- individual factors:
 - gender
 - age/pubertal status.

In the following sections, the results of the studies are summarised.

Physical factors

Nutrition and weight

Nutrition. A direct association between vitamin D deficiency and fracture risk in children could not be shown. Dairy calcium and protein intakes seem to have limited effects on bone mineral density and fractures.

Body weight. Overall, the evidence suggests that an increased body mass index (BMI) is correlated with a higher risk of developing MSDs in children and adolescents. Overweight and obese children have a higher risk for lower extremity injuries or pain in particular. Estimates for the association between BMI and back or neck pain are inconsistent. There is weak evidence that overweight and obese children have a higher risk for back or neck pain. Incorrect body postures are more frequent among children and adolescents who are overweight and obese.

Lifestyle

Physical (in)activity. In general, both extremes of activity levels (i.e. very low and very high levels of physical activity) are associated with back pain or increased injury risk in children and adolescents, while moderate physical activity might be protective. Moreover, there were positive correlations between levels of activity, bone health and self-esteem.

Leisure activities. Playground-related injuries and leisure activities still lead to high numbers of injuries in children.

Smoking. The association between lower back pain in adolescents and tobacco consumption is controversial. There is a definite link, but pain is causing adolescents to smoke rather than vice versa. Adolescents suffering from back pain are more likely to smoke.

Alcohol consumption. No association was found between alcohol consumption and back pain.

Lack of sleep. There is a positive association between lack of sleep and back pain in children and adolescents. The quality of sleep seems to predict neck, lower back and shoulder pain.

Bad or incorrect postures

Extended sitting. A prolonged sedentary position, especially with incorrect posture, seems to be associated with lower back pain in children and adolescents, with a dose-response relationship between increased sedentary behaviour and unfavourable health outcomes.

Use of electronic devices. There seems to be an association between computer or smartphone use and musculoskeletal pain in children and adolescents, although only heavy computer use is significantly associated with neck, shoulder, hand/wrist or back pain. Reviews found the evidence for an association between moderate screen time and neck/shoulder or lower back pain to be insufficient.

Backpack load. The association between carrying school bags and back pain is debatable and seems to be weak. Schoolbag load, schoolbag carrying time and the way a backpack is carried have an inconsistent impact on back pain.

Playing an instrument. Musculoskeletal pain is highly prevalent among children and students playing musical instruments intensively.

Mental health/psychosocial factors

Depression, anxiety and distress may be important determinants in adolescent musculoskeletal pain.

Socioeconomic factors

The connections between socioeconomic factors (higher social class, education, residence) and MSDs in children and adolescents were found to be inconsistent. It appears that in the long run low socioeconomic status might be a risk factor for the onset of musculoskeletal pain, although clearly the relationship is complex.

Environmental factors

One study demonstrated that warm temperatures could increase the fracture risk in children.

Individual factors

Gender. On average, musculoskeletal pain is more common in girls than in boys. Generally, there is a positive association between female gender and back pain.

Age. Prevalence increases from childhood to adolescence, with a further increase in young adulthood.

Work-related risk factors for MSDs in young workers

Our search for scientific literature revealed that most studies regarding work-related MSD risk factors are performed in adults without discussing separate age groups (e.g. young people). Only very few studies, focusing on certain occupational sectors such as health care or professional music, explicitly addressed young workers.

Within the framework of this scoping review, we identified the following work-related risk factors for MSDs in young people:

- physical factors:
 - physical workload
 - long-term unnatural working positions that are occupation-/industrial sector-related (e.g. health care professionals, musicians)
- psychosocial factors
- socioeconomic factors
- environmental conditions
- individual factors:
 - gender.

The results of the studies and reviews are summarised as follows.

Physical factors

Physical workload. High physical demands, awkward trunk postures or extraordinarily long working hours are associated with musculoskeletal problems in young workers.

Occupation/industrial sector related. There is a lack of studies on occupations with high exposure to noise, vibration, heat or cold, and to physically demanding work factors such as working in awkward positions, handling heavy loads and repetitive work. Instead, only two small clusters of studies were identified that researched specific sectors, most notably professional musicians and workers in the health care sector. In both sectors young workers are at high risk of developing MSDs, mainly as a result of long-term unnatural working positions.

Psychosocial factors

Psychosocial factors such as job insecurity, work-family imbalance and exposure to hostile work environments have an influence on MSD prevalence in young workers. Low back pain-related sick leave turns out to be associated with an unstimulating psychosocial work environment.

Socioeconomic factors

In one study, associations between workers' perceived connection to their trade union and neck or back pain were identified in young workers: the higher the perceived connection to the union of unionised apprentices, the lower the odds of reporting neck and back pain.

Environmental factors

Extreme environmental conditions (e.g. high temperatures) increase the risk of occupational injuries among young workers.

Individual factors

Gender. Relationships between gender and MSD risk in young workers correspond to varying exposures that differ between sectors and tasks.

Sports as a risk factor for MSDs in children and young people

Furthermore, sports were identified as a risk factor for both child and young amateur athletes and child and young professional athletes. In general, exercise has many positive effects on health, but some of the positive effects are lost on account of sports injuries. The reported injuries range from knee injuries (anterior cruciate ligament injury, meniscus) and fractures, concussion and muscle injuries to lower back pain and other injuries. A concern regarding the long-term consequences of youth sports injuries is the risk of developing osteoarthritis at a young age.

Preventive measures

Most MSDs caused by physical or psychosocial factors are preventable and manageable. The available studies show that health can effectively be improved by various types of interventions: education (e.g. school curricula, education sessions, presentations, materials or courses aimed at changing knowledge, attitudes and skills), exercises (e.g. movement or muscle strengthening programmes, physical syllabi, mind-body techniques, gym lessons and exercise training), manipulative therapy (e.g. physiotherapy activities, soft tissue treatment, chiropractic manipulation and correction of habitual positions), ergonomic measures (specially designed seats, desks, computer accessories or lifting equipment and adjustment of the worker's environment), orthopaedic aids/protective equipment and sports injury prevention programmes (warm-up, exercises and neuromuscular training):

- prevention of MSDs in children and adolescents:
 - prevention or reduction of musculoskeletal pain:
 - education
 - physical exercise
 - manipulative therapy
 - ergonomics
 - prevention of injuries/accidents:
 - education
 - physical exercise
- prevention of MSDs in young workers:
 - prevention or reduction of musculoskeletal pain:
 - education
 - physical exercise
 - psychophysical re-education
 - biofeedback
 - manipulative therapy
 - ergonomics
 - prevention of work-related injuries:
 - education

- neuromuscular training
- prevention of sports injuries:
 - education
 - warm-up programmes, exercises
 - neuromuscular training
 - protective equipment.

In the following, the findings on interventions' effectiveness are summarised.

Prevention of MSDs in children and adolescents

Prevention or reduction of musculoskeletal pain

Education

In general, education (e.g. school curricula, education sessions, presentations, materials, courses aimed at changing knowledge, attitudes and skills) is effective in increasing knowledge and awareness about musculoskeletal discomfort and pain in both children and young people. Nevertheless, increased knowledge does not necessarily lead to improved behaviour; therefore, the efficacy of school-based educational programmes alone in preventing MSDs is poor.

Exercise

Exercises (e.g. movement or muscle strengthening programmes, physical syllabi, mind-body techniques, gym lessons and exercise trainings) are promising interventions that have rapid success in the prevention or reduction of MSDs. For sustainable effects, long-term adherence should be encouraged.

Manipulative therapy

When education or exercise interventions are applied, adding manipulative therapy (e.g. physiotherapy activities, soft tissue treatment, chiropractic manipulation and correction of habitual position) does not have added value. Nevertheless, manipulative therapy may be effective in children with long-lasting or chronic pain.

Ergonomics

Ergonomic equipment (specially designed seats, desks, computer accessories or lifting equipment) in addition to training has a positive effect. The combination of these two measures is an example of a good practice or intervention that can easily be transferred to other activities and occupational applications.

Prevention of childhood accidents

Accidents and injuries can effectively be reduced by injury prevention education programmes and moderate physical activity.

Prevention of MSDs in young workers

Prevention or reduction of musculoskeletal pain

Studies on professional musicians and health care professionals demonstrate that various training programmes are useful to improve musculoskeletal symptoms and learn basic ergonomic principles. In both professions, musculoskeletal pain is highly prevalent, and educational, physical and ergonomic interventions improve quality of work and life. It was proposed by many authors that MSD prevention programmes should be promoted early in education and training. Although there is a lack of comparative studies on young people in many sectors, conclusions from the health care or professional music sectors could be mainstreamed or transferred into other sectors as examples of good practice.

Prevention of workplace injuries

The results of the few studies identified suggest that there could be advantages in strengthening occupational safety and health as well as in neuromuscular education. One approach could be to widely teach occupational safety and health skills in a comprehensive approach as part of vocational diplomas.

Prevention of sports injuries

There is increasing evidence that many sports-related injuries are preventable. Some risk factors (muscle performance, strength deficits, coordination or endurance) are modifiable, and therefore could be targeted in injury prevention programmes. The field of sports medicine, in which a vast number of studies (some of the highest quality) exist, shows that prevention of sports injuries is effective. Programmes developed in this sector can be applied to other areas. Knowledge gained from sports injury prevention could, for example, be transferred to sectors to help prevent work or leisure accidents.

What did we do to find this?

The extensive literature review conducted within the framework of this project was based on the principles of a scoping review. As a method of knowledge synthesis, scoping reviews have the potential to advance health care practice, policy and research. A scoping review 'addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesising existing knowledge' (Colquhoun et al. 2014). A scoping review is consequently less likely to address very specific research questions or to assess the quality of included studies. Nevertheless, scoping reviews search and select the literature in the same systematic way as systematic reviews.

In our review, there were two principal research questions: one on the prevalence of MSDs among children, young people and young workers and the associated MSD risk factors and one on preventive actions or interventions and their effects.

What is the prevalence of MSDs among children, young people, and young workers?
What is the prevalence of MSDs among children, young people and young workers exposed to certain risk factors?

What is the link between MSDs and risk factors in children, young people and young workers?

What is the effectiveness of actions or interventions to prevent MSDs or to promote good musculoskeletal health among children, young people and young workers compared with no action or a comparator intervention?

Our search was limited to papers published as of 2010 and to studies performed in Europe, Australia, Canada, Israel, New Zealand and the USA. We explicitly included systematic, scoping and narrative reviews published as of 2010 to capture summaries of research conducted before 2010 and/or in other countries. The search identified 7 896 articles, of which 596 articles were eligible for this scoping review, with 52 on the prevalence of MSDs, 448 on risk factors and 96 on interventions.

We screened and selected all identified studies according to defined inclusion/exclusion criteria. The entire study selection process was documented and presented in a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) flow chart (Moher et al. 2009; Moher et al. 2015; Liberati et al. 2009). For the selected studies, we extracted and documented the bibliographical data, including publication type and country of the study, and data on population group and age, type of disease, disease location, described risk factors and applied interventions. To support the greater breadth of our scoping review, both qualitative and quantitative study designs were included. As scoping reviews are designed to provide an overview of the existing evidence base regardless of quality, we did not formally assess the methodological quality of the included studies.

We conducted an explorative statistical analysis to determine the extracted prevalence values. While we always grouped and compared pre-labour market and work-related prevalence values, we also investigated differences between MSD locations, gender, midpoint ages, countries and years of publication.

We investigated which risk factor(s) were analysed in the individual studies, extracted the studies' findings on the corresponding impacts and compiled these by describing and summarising the main study results.

Regarding the focus of interventions, we assigned the studies to one of six categories: (1) educational measures, (2) physical exercises, (3) manipulative therapy, (4) ergonomic measures, (5) neuromuscular training and (6) protective equipment/orthopaedic aids. We extracted and compiled the studies' results narratively.

What further research is required?

This literature review shows that MSDs in children and young workers in industrialised countries are of high importance, with prevalence estimates of about 30–34 % on average. However, the reported prevalence of MSDs varies greatly according to the different studies (0.5–91%). This is mainly explained by limitations related to the methodology or data used. We — as well as the authors of the included studies or reviews — had to cope with several methodological challenges in MSD research, which mostly came down to inconsistencies in (1) defining what counts as musculoskeletal pain, (2) limiting the time in which the pain must have occurred and (3) choosing outcome measures. This impedes comparison and/or analysis of the findings from different studies. We recommend at least having a systematic way of recording musculoskeletal pain and injuries to improve the quality of the available data, and this should serve as a basis for identifying risk factors and developing prevention programmes.

Many risk factors could be identified, but for most of them no consistent results could be found. There is currently no evidence available for the association between most potential factors and a higher risk of MSDs in children and young people. In fact, for most of the factors, different studies with similar designs and methodological quality have led to contradictory conclusions. This is partly because there is a lack of high-quality studies investigating risk factors for MSDs in children and in young adults.

The group of young workers is difficult to describe in many aspects. Many studies investigate workers in general and do not focus on young workers. The subgroup of young workers is only rarely addressed in specific studies. However, having studies focusing on this group of workers is of great importance, as young workers still have their whole working lives before them. Although heavy lifting in health care workers, strained body postures in dentists and excessive practising in musicians undoubtedly constitute exemplary work-related risk factors, it is astonishing that no studies were identified in other sectors and/or occupations that are known for heavy physical work and which employ many young people (e.g. construction, agriculture). There is a lack of studies on professions with high exposure to noise, vibration, heat or cold, and professions with physically demanding work factors. Therefore, future research needs to target sectors (in the framework of prevention schemes/interventions or research) in which young workers are at the highest physical risk of suffering from MSDs. Moreover, little is known about the impact of psychosocial, socioeconomic and environmental factors on MSDs in young workers. These factors are relevant in sectors with higher levels of job insecurity (precarious jobs) or hostile work environments, and more research is needed. Altogether, better knowledge of young workers (on work-related MSDs and on OSH in general) is very important when it comes to the promotion of sustainable musculoskeletal health across the working life course.

There are only a few low-quality studies addressing the topic of prevention in this field. Preventive measures to address many of the risk factors identified are available and their efficacy has been proven, but child- or youth-oriented implementation is still insufficient. Regarding the labour market, there is an urgent need for prevention campaigns and interventions to focus on children. In general, prevention campaigns and interventions should systematically integrate a life course approach to MSD prevention, which means that they should consider and control MSD risks across the entire workforce, irrespective of age.

Interventions involving a combination of actions (educational interventions and exercises) have a higher chance of being successful than standalone actions. This is even more important because there is a difference between improving our knowledge of the body's mechanics and changing our behaviour towards a healthy lifestyle. Yet, combined approaches (education plus training plus ergonomics) were not identified at all in the studies examined. We recommend interventions with a sectoral approach or those focusing on a specific population. Such targeted approaches allow the development of specific

programmes or preventive measures (e.g. educational comic books, demonstrations plus exercises, classes on body posture as part of classes that teach young people to play a musical instrument).

In sports injury prevention, effective programmes have been developed that might be applied to other sectors. However, further research is needed to evaluate the detailed effect of the training measures, the effect of prevention programmes on different sports, the necessary number and duration of prevention programmes and the identification of athletes at risk, who are most likely to benefit from the successful application of prevention programmes. Concerning the evaluation of interventions' efficacy, studies should consider not only increasing knowledge as a key outcome but also behavioural change. Moreover, studies should investigate the psychological determinants of attaining the health behaviours sought. Long-term evaluation studies are currently missing, and those studies should assess whether behavioural change or knowledge gained at a young age is retained throughout a person's professional life.

In conclusion, this scoping review is in accordance with other reviews, which found methodological inconsistency and weakness in studies with widely varying results. To estimate the prevalence of MSDs in a more precise and nuanced way (e.g. for subpopulations such as teenage boys and girls or hairdressers aged 20–30 years), as well as the dose-response relationship between a certain risk factor and a certain MSD or the efficacy of a certain intervention programme, both systematic reviews and more high-quality studies are needed. Studies should be conducted on a large scale and should be of high quality to provide information to guide clinicians in the treatment of children, adolescents and young workers with MSDs. Additionally, those studies could support the development of evidence-based health promotion programmes targeting the prevention of musculoskeletal pain.

Furthermore, there is a need to use psychometrically, clinically meaningful and standardised outcome measures for pain, function, health care use and physical activity. Such standardisation will increase the clinical applicability of the research and facilitate the pooling of study results.

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