

# BMJ Open Psychometric properties and clinical utility of spinal health outcome measures in school-based interventions among children and adolescents: a systematic review protocol

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## ABSTRACT

**Introduction** Spinal health in children and adolescents has global implications, impacting school attendance, academic performance and physical activity. Effective school-based interventions are essential for promoting spinal health literacy, positive behaviours and academic success.

**Objectives** This review aims to collect data on school-based interventions for spinal health in children and adolescents over the past two decades. It will examine interventions such as education, exercise and appropriate furniture, focusing on outcomes including musculoskeletal pain, posture, sedentary behaviour and academic performance. Additionally, the review will describe the psychometric properties and clinical utility of the outcome measures used in these studies.

**Methods and analysis** The systematic review will adhere to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, employing the PICO framework to define criteria for participants, interventions, comparisons, outcomes and study designs. Only English studies published between 2004 and 2024 will be included. Relevant databases will be searched using specific keywords derived from the PICO framework. The Critical Appraisal Tool and the COSMIN Risk of Bias tool will be used to evaluate the methodological quality and risk of bias in the selected studies. Review authors will independently assess articles, resolving discrepancies through consensus. Statistical analyses will be performed using CADIMA V.2.2.4.2 April 2023.

**Results** Data will be collected based on various outcome measures, evaluated with an approved checklist and presented through descriptive narratives and tables. Findings will be disseminated via conference presentations, Faculty Research Day and publication in reputable journals.

**Ethics and dissemination** The study will adhere to the ethical principles outlined in the Declaration of Helsinki, ensuring a rigorous approach to minimise bias and guarantee valid results. Studies will be selected based on predetermined criteria following a consistent protocol. The findings will be disseminated through presentations and publication in peer-reviewed journals.

**PROSPERO registration number** The systematic review protocol is registered on PROSPERO (registration

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Adheres to Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols guidelines for systematic reviews.
- ⇒ Uses multiple databases to capture a wide range of studies.
- ⇒ Focuses on interventional studies in school settings for relevant insights.
- ⇒ Assesses the reliability of outcome measures used.
- ⇒ Resolves discrepancies in study selection through reviewer consensus.

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## INTRODUCTION

Musculoskeletal disorders, including back pain, are a significant public health concern, affecting individuals of all ages and currently serving as the leading cause of disability worldwide.<sup>1</sup> These disorders are particularly prevalent among children and adolescents, with spinal musculoskeletal pain notably common in this demographic.<sup>2</sup> The transition from childhood to adolescence often sees a marked increase in the incidence of spinal musculoskeletal pain.<sup>3</sup> Recent investigations have revealed a concerning rise in spinal musculoskeletal pain, encompassing neck pain and general back pain, among children and adolescents globally, particularly within the age group of 10–12 years.<sup>4,5</sup> Data suggest that the 1-year prevalence of back pain in adolescents varies between 18% and 33%, while neck pain affects approximately 15–23% of this demographic.<sup>6–8</sup> Notably, studies conducted in Africa have identified diverse prevalence rates of back pain among children and adolescents, with certain regions reporting figures ranging from 20%



to 40%.<sup>4,5</sup> These variations highlight the significant role of environmental, socioeconomic and cultural factors in influencing spinal health.

The ramifications of spinal musculoskeletal pain in this demographic are substantial, resulting in considerable physical limitations that hinder participation in daily activities, sports and academic endeavours. Children and adolescents suffering from chronic pain frequently report a diminished quality of life, increased school absenteeism and restrictions in social interactions.<sup>6</sup> Moreover, early onset of spinal pain may predispose individuals to chronic musculoskeletal disorders in later life, perpetuating a cycle of pain and disability.<sup>7,8</sup> At a societal level, the implications are equally concerning, as increased healthcare costs and reduced workforce productivity can arise from untreated spinal pain. According to the WHO's global burden of disease study, back pain ranks as the second leading cause of years lived with disability among adolescents, with neck pain closely following in eighth place.<sup>1</sup> This scenario underlines the pressing need for targeted interventions and preventive measures to address spinal health issues in children and adolescents, thereby ensuring that future generations can sustain a healthy and active lifestyle.

Spinal musculoskeletal pain often emerges in early life and tends to worsen with age, reaching prevalence rates in adolescents comparable to those in adults.<sup>9</sup> Evidence suggests that spinal pain experienced during childhood and adolescence can persist into adulthood, as recurrent episodes during this period are linked to the development of chronic pain later in life.<sup>10,11</sup> Longitudinal studies indicate that many children experience recurring episodes of spinal pain lasting more than 4 weeks, underscoring the enduring impact of these conditions.<sup>12,13</sup> The consequences extend beyond physical discomfort, significantly affecting overall well-being by influencing school attendance, engagement in physical activities, mental health, academic performance and sleep patterns. Recent research in Africa has also highlighted the importance of spinal health among children and adolescents, revealing varying rates of back pain in this population.<sup>14,15</sup>

The aetiology of spinal pain among this age group is multifaceted, involving factors such as heavy schoolbags, posture, prolonged sitting, psychological and social influences, age, gender and the type of school furniture used.<sup>16</sup> Research has shown that Ethiopian elementary school students who carry heavy schoolbags and commute for over 20 min to school are 3.5 times more likely to experience spinal musculoskeletal discomfort.<sup>17</sup> In Uganda, a significant association exists between spinal musculoskeletal pain and the burden of carrying heavy schoolbags, particularly in rural areas. Additionally, the use of inappropriate school furniture and improper positioning while using such furniture have been identified as risk factors for developing back pain.<sup>18</sup> A study conducted in India among school-aged children and adolescents (ages 5–16) revealed a significant correlation between musculoskeletal pain and

school absenteeism, daytime fatigue, feelings of sadness and sleep disturbances.<sup>19</sup>

## Rationale

The impact of spinal pain on health and well-being, as well as overall quality of life, is influenced by various factors and the ability to address this challenge effectively.<sup>14</sup> In children and adolescents, spinal pain is a significant global issue, leading to reduced school attendance, diminished academic performance and limited participation in physical activities.<sup>15</sup> This negatively affects physical well-being, as prolonged periods of sitting in uncomfortable positions can contribute to spinal misalignments and muscle fatigue. Therefore, implementing effective intervention strategies to promote spinal health is crucial.<sup>16</sup> School-based interventions are vital for enhancing health literacy, behaviours and academic achievements among students.<sup>17</sup> Interventions targeting back pain have successfully improved knowledge retention into adulthood without reinforcing fear-avoidance beliefs. Educating children and adolescents from a young age is essential for achieving optimal behavioural changes.<sup>18</sup>

The primary objective of this review is to summarise the evidence on the psychometric properties of outcome measures, aiding the selection of the most appropriate tools for evaluating spinal health and well-being. Additionally, reviewing existing evidence can help identify shortcomings in outcome measurement tools that need to be addressed for a comprehensive evaluation of spinal health.<sup>19</sup> Outcome measures are designed to provide insights that assist healthcare professionals in tailoring interventions to individual needs.<sup>20</sup> It is recommended to scrutinise the psychometric properties and clinical utility of outcome measures used to assess spinal health in school-based interventions to ensure they are reliable, valid, responsive, acceptable, feasible and tailored to the specific population and context.<sup>21–23</sup> Patient and Clinical-Reported Outcome Measures (PROMs) play a significant role in healthcare by improving patient care, identifying issues and guiding treatment strategies.<sup>24,25</sup> These measures address inquiries from both patients and healthcare professionals regarding functional status and quality of life, supporting clinical decision-making and enhancing healthcare initiatives.<sup>23,24</sup> Outcome measures are essential for evaluating healthcare interventions, establishing initial function levels before treatment and monitoring progress. In the era of evidence-based practice, objective measures are crucial for establishing credibility and the instruments should be user-friendly and comfortable to use.<sup>24</sup>

## Review objectives

The review objectives will include:

1. To obtain information from the last 20 years on school-based interventions aimed at improving spinal health/well-being for children and adolescents, such as education, exercise and the use of appropriate furniture with the main outcomes of interest including;

musculoskeletal pain, sleep quality, posture, weight of school bags, sedentary behaviour, screen time, academic performance, absenteeism and participation in physical activities.

2. To describe the psychometric properties and clinical utility of spinal health outcomes measures identified from school-based intervention studies promoting spinal health or well-being, including but not limited to changes in knowledge, behaviour, participation in sports, academic performance and relief of neck, upper back and lower back pain.
3. To appraise the psychometric properties and clinical utility of the outcome measures used in the intervention studies on spinal health and well-being.

### Methods and analysis

The review will adhere to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Protocols guidelines,<sup>26</sup> which are the standard practices for conducting systematic reviews. The participants, interventions, comparisons, outcomes and study designs (PICOS) will be defined according to these guidelines.<sup>27</sup> Only studies published in English will be included in this review.

### Protocol and registration

The PICOS framework, based on PRISMA guidelines, was crafted to detail PICOS. The systematic review protocol was recorded on PROSPERO, accessible at <https://www.crd.york.ac.uk/prospero/>.

### Criteria for considering studies for this review

#### Types of studies

Interventional research designs, including randomised controlled trials, quasi-experimental studies and crossover trials published in English between 2004 and 2024, will be included in this review. The choice of this time frame is based on several factors. The year 2004 represents a significant point in the evolution of spinal health outcome measures and methodologies, capturing the introduction and refinement of key psychometric tools essential for evaluating intervention effectiveness. Including studies up to 2024 ensures the incorporation of the most recent advancements, reflecting contemporary practices and knowledge. This time frame also allows for the examination of longitudinal trends in spinal health interventions. Overall, this 20-year span balances historical context with the latest evidence, enhancing the robustness and relevance of the study's findings.

#### Types of participants

This review will consider studies where interventions were conducted within schools that specifically targeted children or adolescents who were attending school.

#### Types of interventions

School-based interventions which may encompass educational initiatives, physical exercise programmes or the

promotion of proper furniture use aimed at enhancing spinal health and well-being in children and adolescents.

#### Types of outcome measures

This section outlines the evaluation of various outcome measures related to spinal health and well-being, including changes in knowledge or behaviour, participation in sports or physical activities and relief from spinal pain, such as discomfort in the neck, upper back or lower back. It is essential to differentiate between measures that can be assessed through traditional psychometric properties and those that do not align with these criteria. For the former, terms such as reliability, validity and responsiveness will be employed. For measures that cannot be fully assessed using these criteria, broader terminology like 'measurement properties' or 'evaluation criteria' will be used. Additionally, alternative evaluation methods, such as qualitative assessments or usability studies, will be considered for these measures. This approach will ensure a comprehensive evaluation of all outcome measures and addresses potential gaps in the assessment of those that fall outside traditional psychometric frameworks.

#### Exclusion criteria

This study will exclude intervention studies that are not school-based, does not aim to promote spinal health and well-being or involve participants not attending school.

### Search methods for identification of studies

#### Electronic searches

The search process will take place from 1 August 2024 to 30 November 2024 and will involve using a range of databases, including Scopus, CINAHL, Physiotherapy Evidence Database (PEDro), PubMed, Cochrane Library, Science Direct and Sabinet. To retrieve relevant information, specific keywords based on Medical Subject Headings and the Population, Intervention, Comparison, Outcome, and Study Design (PICOS) framework, as described in the Cochrane Handbook for Systematic Reviews of Interventions,<sup>28</sup> will be employed. These keywords, which are based on the PICOS framework, will be combined using the truncation 'AND' and 'OR'.<sup>29</sup>

To conduct a comprehensive search, two interrelated strategies (A and B) will be implemented. Strategy A will focus on identifying school-based intervention studies promoting spinal health and well-being in children and adolescents, particularly those aimed at reducing spinal musculoskeletal pain. This strategy will also encompass studies describing secondary outcomes related to scholastic attributes, sleep, postural hygiene, computer use, schoolbag carriage/weight, absenteeism, physical activity and sedentary behaviour in relation to spinal health. Strategy B will specifically target studies reporting on the psychometric properties of the outcome measures identified from Strategy A. This strategy will encompass a comprehensive array of psychometric terms to ensure thorough coverage of measurement quality aspects. The search will include various types of validity (eg, construct,



content, criterion), reliability measures (eg, test–retest, inter-rater, internal consistency), responsiveness indicators and metrics for clinical utility.

Statistical methods and concepts such as item response theory, factor analysis and measurement invariance will also be incorporated. To address clinical relevance, terms related to minimal clinically important difference (MCID), minimal detectable change (MDC) and SE of measurement (SEM) will be included. The search will also consider measurement limitations like floor and ceiling effects, as well as diagnostic accuracy metrics such as area under the curve (AUC) and receiver operating characteristic (ROC) curves. To align with patient-centred outcomes, terms related to PROMs will be integrated. This comprehensive approach aims to capture both the interventional elements and the quality of measurement for spinal health outcomes in school-based environments. Search terms will be customised for each database used. Additionally, the bibliographies of pertinent articles will be examined to identify further eligible studies for inclusion, ensuring a thorough and robust search process.

- ▶ **Intervention terms:** school-based OR intervention\* OR program\* OR Education OR Activities, Educational OR Educational Activity OR exercise OR Activity, Physical OR Physical Activities OR physical ergonomics OR ergonomics OR Furniture OR school desks OR desks OR tables OR chairs OR classroom furniture OR furniture dimensions OR ‘sitting posture’
- ▶ **Primary target area terms:** spinal health OR spinal pain OR neck pain\* OR neckache\* OR back pain OR backache\* OR lumbar pain
- ▶ **Secondary target area terms:** Absenteeism OR sleep OR sleeping habits\* OR posture\* OR computer screen time OR school bag OR school bag weight OR Weight-bearing OR Loadbearing OR Load-Bearing OR Load Bearing OR Axial Loading\*
- ▶ **Psychometric and outcome measurement terms:** Outcome Assessment, Health Care OR outcome measure\* OR Measure, Outcome OR Patient Reported Outcome Measures OR Patient Reported Outcomes OR psychometric\* OR Reproducibility of Results OR Finding Reproducibility OR reliability OR validity OR responsiveness\* OR evaluation studies OR clinical utility\* OR construct validity OR content validity OR criterion validity OR concurrent validity OR predictive validity OR discriminant validity OR convergent validity OR face validity OR internal consistency OR test-retest reliability OR inter-rater reliability OR intra-rater reliability OR Cronbach’s alpha OR item response theory OR factor analysis OR measurement invariance OR minimal clinically important difference OR MCID OR minimal detectable change OR MDC OR standard error of measurement OR SEM OR floor effect\* OR ceiling effect\* OR sensitivity OR specificity OR area under curve OR AUC OR receiver operating characteristic OR ROC OR Rasch analysis

### Selection of studies

The authors will acquire and evaluate abstracts and citations that have been identified through their searches. Subsequently, they will independently retrieve full-text articles to determine which studies are eligible for independent selection. In the event of any disagreements, a consensus will be reached to resolve them. Moreover, if any uncertainties arise, the authors of the articles will be contacted to seek clarification.

### Data extraction and management

The data extraction process will be carried out independently by the authors (YB, AH and LAN) using a data extraction form that is based on Chapter 5 of the Cochrane Handbook for Systematic Reviews of Intervention<sup>28</sup> for the full-text studies included in the analysis. The information to be gathered will include the study title, author(s), publication year, country, study design, sample size, sample composition (sex and age), description of intervention, outcome measures, outcome measurement tool(s) and the psychometric and utility properties of the outcome measures from the literature selected. Any discrepancies that arise will be resolved through consensus among the reviewers. In cases where a consensus cannot be reached, a third reviewer (QAL) will be consulted for assistance.

### Methodological appraisal and assessment for risk of bias

The assessment of appraisal and risk of bias will use two key tools: The Critical Appraisal Tool (CAT) and The COSMIN Risk of Bias tool. The CAT, comprising 13 items, will be employed to appraise studies evaluating psychometric properties of outcome measures, assessing the influence of each item on the methodological quality of procedures implemented in each paper.<sup>30</sup> The COSMIN Risk of Bias tool will evaluate the methodological quality of studies focusing on measurement properties, particularly suited for assessing studies on reliability, measurement error and other psychometric properties of PROMs, equipment and professional-reported outcome measures.<sup>31 32</sup> Using the COSMIN tool will allow for a systematic evaluation of the psychometric properties of outcome measures, including reliability (internal consistency, test–retest, inter-rater and intrarater), validity (content, construct and criterion), responsiveness and interpretability. For each measurement property, the COSMIN checklist will rate the quality of methods as ‘very good’, ‘adequate’, ‘doubtful’ or ‘inadequate’. This assessment aims to identify the potential risk of bias in the analysed studies, aligning with the Cochrane methodology for systematic reviews.<sup>33 34</sup> Review authors will independently score the included articles, resolving discrepancies by consensus.

### Data analysis

For data analysis, we will use CADIMA V.2.2.4.2 (April 2023), an online tool for systematic implementation and documentation of reviews and maps.<sup>35</sup> A descriptive

approach will explain findings due to discrepancies in data reporting across studies. Extracted data accuracy will be verified (AH) and cross-checked against trial reports through spot-checks by a different reviewer (QAL). Information will be compiled based on categories of outcome measures recognised and assessed with a previously approved checklist, with findings displayed through descriptive text and tables in Windows V.10. In analysing psychometric properties evaluated using the COSMIN tool, quality ratings for each measurement property across studies will be summarised. An overall assessment of each outcome measure's psychometric strength will be provided, properties of different measures used in school-based spinal health interventions will be compared and gaps in the psychometric evaluation of commonly used outcome measures will be highlighted. This comprehensive analysis will offer insights into the quality and appropriateness of outcome measures used in school-based spinal health interventions among children and adolescents.

### Ethics and dissemination

The research project will be grounded on the Declaration of Helsinki, which serves as the foundation for upholding ethical principles (<https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki>). Additionally, the study's methodology will be conducted with Scientific rigour, aiming to minimise bias and ensure the validity of the findings. The selection of studies for the review will strictly adhere to predefined eligibility criteria, and the protocol will be consistently followed throughout the process. The findings will be shared through presentations at conferences, Faculty Research Day and by being published in a reputable international and/or national journal.

### Patient and public involvement

It was not appropriate or possible to involve patients or the public in the design, or conduct, or reporting, or dissemination plans of our research.

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### REFERENCES

- 1 World Health Organization. Musculoskelet disord. 2023. Available: <https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-disorders>
- 2 Assiri A, Mahfouz A, Awadalla N, *et al*. Classroom Furniture Mismatch and Back Pain Among Adolescent School-Children in Abha City, Southwestern Saudi Arabia. *IJERPH* 2019;16:1395.
- 3 Fuglkjær SH, Vach W, Hartvigsen J, *et al*. Musculoskeletal pain distribution in 1,000 Danish schoolchildren aged 8–16 years. *Chiropr Man Therap* 2020;28:45.
- 4 Kędra A, Czaprowski D. Epidemiology of back pain in children and youth aged 10-19 from the area of the southeast of Poland. *Biomed Res Int* 2013;2013:506823.
- 5 Galán I, Ortiz-Pinto MA, Sánchez-Martínez F, *et al*. One-year prevalence of back and neck pain in adolescents. *Eur J Public Health* 2021;31.
- 6 Kamper SJ, Henschke N, Hestbaek L, *et al*. Musculoskeletal pain in children and adolescents. *Braz J Phys Ther* 2016;20:275–84.
- 7 Ben-Hyde J, Devan H, Baxter GD, *et al*. Back pain prevalence in adolescents: a systematic review. *Physiotherapy* 2019;105:e178–9.
- 8 Scarabottolo CC, Pinto RZ, Oliveira CB, *et al*. Back and neck pain prevalence and their association with physical inactivity domains in adolescents. *Eur Spine J* 2017;26:2274–80.
- 9 World Health Organization. Global burden of disease study. 2019. Available: <https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates>
- 10 El-Metwally A, Salminen JJ, Auvinen A, *et al*. Risk factors for development of non-specific musculoskeletal pain in preteens and early adolescents: a prospective 1-year follow-up study. *BMC Musculoskelet Disord* 2007;8:46.
- 11 Gordon S, Grimmer KA, Barras S. Assessment for incipient hospital-acquired deconditioning in acute hospital settings: A systematic literature review. *J Rehabil Med* 2019;51:397–404.
- 12 Hughes RG. Tools and strategies for quality improvement and patient safety. In: Hughes RG, ed. *Patient safety and quality: an evidence-based handbook for nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US), 2008. Available: <https://www.ncbi.nlm.nih.gov/books/NBK2682/>
- 13 Joergensen AC, Hestbaek L, Andersen PK, *et al*. Epidemiology of spinal pain in children: a study within the Danish National Birth Cohort. *Eur J Pediatr* 2019;178:695–706.
- 14 Hestbaek L, Leboeuf-Yde C, Kyvik KO, *et al*. The course of low back pain from adolescence to adulthood: eight-year follow-up of 9600 twins. *Spine (Phila Pa 1976)* 2006;31:468–72.
- 15 Jung K-S, Jung J-H, In T-S, *et al*. Effects of Prolonged Sitting with Slumped Posture on Trunk Muscular Fatigue in Adolescents with and without Chronic Lower Back Pain. *Med Bogota Colomb* 2020;57:3.
- 16 Dissing KB, Hestbaek L, Hartvigsen J, *et al*. Spinal pain in Danish school children - how often and how long? The CHAMPS Study-DK. *BMC Musculoskelet Disord* 2017;18:67.
- 17 Macfarlane GJ, Jones GT, Tysoe C, *et al*. The role of genetics in the development of musculoskeletal pain: a systematic review. *Pain* 2019;160:2441–50.



- 18 Mamou A, Rahmani A, Chkioua M, *et al.* Prevalence and Risk Factors of Low Back Pain among Tunisian Adolescents: A Schoolbased Study. *Ann Med Health Sci Res* 2021;11:1379–85.
- 19 Mikkelsen M, Salminen JJ, Auvinen A, *et al.* Musculoskeletal pain in children and adolescents: the influence of individual and parental factors. *Eur Spine J* 2016;25:1832–8.
- 20 Smith JA, McLoughlin M, Phillips C. Musculoskeletal pain in children and adolescents: A systematic review. *Physiother Can* 2021;73:141–57.
- 21 Tzeng JC, Huang KC, Lai YK, *et al.* The prevalence of musculoskeletal pain among school-aged children and adolescents: a systematic review. *J Chin Med Assoc* 2019;82:161–2.
- 22 Wang Q, Zhang J, Zeng H, *et al.* The impact of prolonged sedentary behavior on musculoskeletal health in children and adolescents: A systematic review. *Int J Environ Res Public Health* 2022;19.
- 23 Brink Y, Louw Q, Grimmer-Somers K. The quality of evidence of psychometric properties of three-dimensional spinal posture-measuring instruments. *BMC Musculoskelet Disord* 2011;12:93.
- 24 Brink Y, Maart RA, Louw QA. School-based interventions to improve spinal health of children and adolescents: a systematic review. *Physiother Theory Pract* 2022;38:2378–401.
- 25 Delele M, Janakiraman B, Bekele Abebe A, *et al.* Musculoskeletal pain and associated factors among Ethiopian elementary school children. *BMC Musculoskelet Disord* 2018;19:276.
- 26 Vitta A de, Bento TPF, Cornelio GP, *et al.* Incidence and factors associated with low back pain in adolescents: A prospective study. *Braz J Phys Ther* 2021;25:864–73.
- 27 Higgins JP, Thomas J, Chandler J, *et al.* *Cochrane handbook for systematic reviews of interventions*. 2nd edn. Chichester (UK): John Wiley & Sons, 2011.
- 28 Kohl C, McIntosh EJ, Unger S, *et al.* Online tools supporting the conduct and reporting of systematic reviews and systematic maps: a case study on CADIMA and review of existing tools. *Environ Evid* 2018;7:8.
- 29 Kriel RS. Perspectives of spinal health in school-going children and adolescents in the langeberg municipal district of south africa: a qualitative study. 2018. Available: <https://scholar.sun.ac.za/server/api/core/bitstreams/d7936062-1d81-4c0d-97ea-be9993eeb88c/content>
- 30 Kumar G, Chhabra A, Dewan V, *et al.* Idiopathic musculoskeletal pain in Indian children—Prevalence and impact on daily routine. *Rev Bras Reum (Eng Ed)* 2017;57:8–14.
- 31 Junge T, Wedderkopp N, Boyle E, *et al.* The natural course of low back pain from childhood to young adulthood - a systematic review. *Chiropr Man Therap* 2019;27:10.
- 32 Louw Q, Kriel RI, Brink Y, *et al.* Perspectives of spinal health within the school setting in a South African rural region: A qualitative study. *WOR* 2021;69:141–55.
- 33 Lucas NP, Macaskill P, Irwig L, *et al.* The development of a quality appraisal tool for studies of diagnostic reliability (QAREL). *J Clin Epidemiol* 2010;63:854–61.
- 34 Moher D, Shamseer L, Clarke M, *et al.* Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev* 2015;4:1.
- 35 Mookink LB, Boers M, van der Vleuten CPM, *et al.* COSMIN Risk of Bias tool to assess the quality of studies on reliability or measurement error of outcome measurement instruments: a Delphi study. *BMC Med Res Methodol* 2020;20:293.