Developing School-based Early Intervention Strategies for Spinal and Postural Health in Primary School Children: A SWOT-based Conceptual Analysis

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Abstract

Spinal and postural health during childhood has attracted increasing attention because of its potential implications for physical development, functional performance, and long-term musculoskeletal well-being. Primary schools provide an accessible setting for promoting healthy movement behaviors, identifying concerning postural changes, and facilitating timely professional assessment. However, uncertainties regarding intervention effectiveness, screening practices, professional responsibilities, and implementation resources complicate the development of comprehensive school-based strategies. This study aimed to examine the strengths, weaknesses, opportunities, and threats associated with school-based early intervention for spinal and postural health in primary school children and to propose a theoretically informed strategic framework for implementation. A conceptual analysis informed by narrative literature synthesis was undertaken using the Strengths, Weaknesses, Opportunities, and Threats (SWOT) framework. Relevant perspectives from pediatric spinal health, exercise rehabilitation, school health promotion, and implementation science were integrated to identify strategic determinants and develop corresponding intervention pathways. School-based interventions offer advantages in population accessibility, continuity, educational integration, and opportunities for early recognition of postural concerns. Nevertheless, insufficient professional expertise, heterogeneous intervention protocols, uncertain long-term effectiveness, and limited assessment capacity represent important internal weaknesses. Opportunities arise from multidisciplinary collaboration, family engagement, preventive health initiatives, and technological development, whereas diagnostic uncertainty, inappropriate intervention practices, resource inequalities, and potential stigmatization constitute major external threats. Effective school-based spinal and postural health promotion requires a differentiated approach integrating universal movement education, targeted functional support, professional referral, and continuous implementation evaluation. The proposed SWOT-based framework provides a conceptual foundation for developing feasible, equitable, and evidence-informed intervention strategies while identifying priorities for future empirical validation.

Keywords

Spinal health, Primary school children, Early intervention, Strengths, Weaknesses, Opportunities, and Threats analysis, School-based health promotion

Introduction

Spinal and postural health represents an important component of children's musculoskeletal development, particularly during periods characterized by rapid physical growth, changing movement behaviors, and increasing educational demands. Throughout primary school, children experience progressive changes in body proportions, muscular coordination, balance control, and habitual physical activity. These developmental processes interact with individual characteristics and environmental conditions, potentially influencing spinal alignment, postural control, and functional movement. Postural variations are common in childhood. It is critical to distinguish normal developmental features from clinically significant spinal abnormalities. This distinction helps develop suitable prevention and intervention strategies.

Among pediatric spinal conditions, idiopathic scoliosis has received considerable clinical attention because of its

potential progression during skeletal growth. Scoliosis is a three-dimensional spinal deformity conventionally defined by a radiographic Cobb angle of at least 10 degrees in combination with vertebral rotation. Its clinical course varies according to skeletal maturity, curve magnitude, and other individual characteristics [1]. Importantly, scoliosis should not be equated with general postural asymmetry, habitual slouching, or reduced trunk stability. While some postural deviations may reflect modifiable functional characteristics, structural spinal deformities require appropriate clinical evaluation and individualized management.

The possibility of identifying spinal abnormalities during childhood has encouraged consideration of school-based screening and early intervention. However, the benefits and limitations of systematic scoliosis screening remain debated. The United States Preventive Services Task Force concluded that available evidence was insufficient to determine the overall balance of benefits and harms associated with screening asymptomatic adolescents for idiopathic scoliosis [2]. This uncertainty highlights the need to distinguish general school-based health promotion from clinical screening and diagnosis. It also suggests that early intervention should not automatically be interpreted as medical treatment for presumed spinal pathology.

Primary schools nevertheless offer substantial opportunities for promoting musculoskeletal health. Their organizational structure enables repeated educational exposure, supervised physical activity, and collaboration among teachers, families, and health professionals. School-based strategies may therefore extend beyond the detection of abnormalities to include movement literacy, functional exercise, postural awareness, and appropriate referral when clinically concerning signs are observed.

Despite these potential advantages, developing comprehensive interventions remains challenging. Many programs emphasize isolated exercise routines or posture correction without sufficiently addressing intervention mechanisms, developmental appropriateness, profe ssional competencies, implementation conditions, and long-term sustainability. Furthermore, evidence derived from clinical rehabilitation populations cannot necessarily be generalized to unselected primary school children. Consequently, the central challenge is not merely identifying potentially beneficial exercises but determining how heterogeneous evidence can inform safe, equitable, and feasible school practices.

To address this problem, the present study employs SWOT framework to examine the strategic conditions influencing school-based spinal and postural health interventions. By integrating clinical, educational, organizational, and implementation perspectives, this conceptual analysis seeks to identify relevant developmental pathways and propose a structured framework for early intervention. The intended contribution is to connect evidence-informed musculoskeletal health promotion with the practical requirements of primary school environments.

Analytical perspective and scope

This study adopts a conceptual and narrative analytical approach rather than an empirical research design. Its purpose is to synthesize established knowledge, identify implementation-related challenges, and construct a coherent strategic framework for school-based spinal and postural health promotion. No original participant data, interviews, experimental observations, or statistical estimates were generated.

SWOT analysis was selected because it enables systematic consideration of both internal organizational characteristics and external contextual influences. Strengths and weaknesses represent factors associated with the design and delivery of school-based interventions, whereas opportunities and threats reflect broader educational, clinical, technological, and institutional conditions. Previous methodological discussions have highlighted the usefulness of SWOT analysis for organizing complex strategic problems while emphasizing the need to move beyond descriptive categorization toward theoretically meaningful interpretation [3].

The present analysis therefore considers the school-based intervention program, rather than the individual child or a particular exercise, as its primary unit of analysis. Internal factors include program flexibility, professional competence, assessment procedures, instructional resources, and organizational capacity. External factors include healthcare collaboration, educational priorities, technological developments, social inequalities, regulatory expectations, and prevailing clinical evidence.

To strengthen the analytical usefulness of SWOT, the

study additionally adopts a strategy-matching perspective informed by the Threats, Opportunities, Weaknesses, and Strengths (TOWS) matrix. This approach links internal and external conditions to generate four strategic orientations: strengths-opportunities (SO), strengths-threats (ST), weaknesses-opportunities (WO), and weaknesses-threats (WT) [4]. These relationships provide a structured basis for developing practical intervention recommendations rather than presenting four disconnected categories.

The conceptual scope encompasses primary school children, approximately 6-12 years of age, while recognizing that school entry ages and educational systems vary internationally. It addresses general spinal and postural health promotion, the recognition of potentially concerning abnormalities, and the appropriate implementation of exercise-based strategies. Particular attention is given to core stability training, movement education, and functional postural control because these approaches may be incorporated into existing physical education activities.

A critical distinction is maintained between universal preventive activities and condition-specific clinical treatment. Universal activities may be delivered to broadly healthy school populations, whereas children with suspected scoliosis, persistent symptoms, neurological abnormalities, or known spinal disorders require individualized clinical consideration. The framework does not assume that routine postural education prevents structural scoliosis or that general strengthening exercises constitute an adequate substitute for specialized treatment.

The analysis draws conceptually on peer-reviewed clinical research, systematic reviews, school health models, strategic management literature, and implementation science. Because no systematic search protocol, exhaustive study selection process, or formal evidence-quality assessment was undertaken, the resulting framework is intended as a theory-informed proposal rather than a definitive clinical guideline.

Conceptualizing the core topic

School-based early intervention for spinal and postural health consists of coordinated practices. These practices include education, physical activity, observation, and referral, and they aim to support healthy musculoskeletal development and enable timely responses to emerging health concerns. This conception differs from narrowly defined corrective training because it considers children's developmental characteristics, everyday environments, and access to professional care.

Three interrelated dimensions are central to this framework. The first is spinal health, which concerns the anatomical and functional integrity of the spine, including clinically relevant abnormalities requiring professional assessment. The second is postural health, which encompasses the capacity to maintain and adapt body alignment during static and dynamic activities without unnecessary discomfort or functional restriction. The third is intervention implementation, which concerns how evidence-informed practices can be delivered consistently, safely, and equitably within educational settings.

Clinical guidance on idiopathic scoliosis emphasizes individualized conservative management according to curve characteristics, skeletal growth, and clinical risk, including the potential roles of observation, bracing, and physiotherapeutic scoliosis-specific exercises [5]. These principles have important implications for school-based programs.

Although physical education may support general fitness and functional movement, school personnel should not independently prescribe scoliosis-specific treatment without appropriate clinical expertise.

Exercise-based interventions are particularly relevant because muscular coordination, trunk control, and movement competence are potentially modifiable through structured physical activity. Core stability training, for example, typically involves exercises designed to improve the coordination and functional control of trunk and pelvic musculature. The theoretical rationale includes improved neuromuscular coordination, dynamic stability, proprioceptive integration, and the capacity to control body position during movement. These mechanisms are plausible contributors to functional postural performance, but their relationship with structural spinal changes requires careful interpretation.

A Cochrane systematic review examining therapeutic exercises for adolescent idiopathic scoliosis identified considerable uncertainty regarding treatment effects because of limitations in the available evidence, including methodological heterogeneity, relatively small studies, and differences among exercise approaches [6].

Consequently, the rationale for incorporating general exercise into schools should primarily emphasize movement competence, musculoskeletal function, and health education rather than unverified claims about scoliosis prevention or structural correction.

Within this perspective, early intervention should follow a differentiated model. At the universal level, schools may provide developmentally appropriate physical activity, movement education, and opportunities to vary prolonged static positions. At the targeted level, children experiencing functional movement difficulties or recurring musculoskeletal complaints may receive additional assessment and appropriately supervised support. At the clinical level, children exhibiting concerning signs should be referred to qualified healthcare professionals.

This differentiation also clarifies the meaning of successful intervention. For universal school programs, relevant outcomes may include participation, movement confidence, functional performance, comfort, and health-related knowledge. For clinically diagnosed spinal disorders, outcomes must correspond to established clinical standards and may include curve progression, symptoms, functional limitations, and quality of life. Treating these outcomes as interchangeable would undermine both scientific interpretation and intervention safety.

Accordingly, school-based spinal and postural health promotion should be understood as an integrated preventive and supportive process rather than a standardized therapeutic protocol applicable to all children.

SWOT analysis

Strengths

The principal strength of school-based spinal and postural health interventions lies in their population reach and organizational continuity. Primary schools provide regular access to children across multiple developmental stages, enabling health-promoting activities to be incorporated into established educational routines. Compared with interventions requiring repeated clinical appointments, appropriately designed school programs may reduce certain logistical barriers related to scheduling, transportation, and access to exercise facilities.

Another strength concerns the adaptability of exercise-based approaches. General trunk stabilization, balance exercises, functional movement activities, and age-appropriate strengthening tasks can often be delivered using relatively simple equipment. These activities may be adapted to different developmental abilities and integrated into physical education lessons or structured activity breaks. The potential for progressive task modification also supports individualized participation without requiring every child to follow an identical exercise prescription.

Clinical research provides a preliminary rationale for considering trunk stabilization within broader musculoskeletal interventions. A randomized controlled trial recruited adolescents with idiopathic scoliosis. It found greater improvements in lumbar apical vertebral rotation and pain-related quality of life when core stabilization exercises were combined with conventional rehabilitation. However, not all measured outcomes showed significant between-group differences [7]. These findings suggest potential therapeutic value in a specific clinical context but do not establish comparable effects among asymptomatic primary school children.

The educational setting offers additional advantages beyond exercise delivery. Teachers can introduce concepts related to movement variation, bodily awareness, physical activity participation, and help-seeking behaviors. Repeated educational exposure may reinforce understanding and encourage the development of sustainable movement habits.

Collectively, these strengths indicate that schools possess an advantageous organizational platform for delivering universal musculoskeletal health promotion. However, the value of this platform depends on whether activities remain developmentally appropriate, professionally supervised where necessary, and clearly differentiated from clinical treatment.

Weaknesses

Despite favorable organizational conditions, substantial limitations exist within school-based spinal and postural health programs. One weakness is the absence of standardized intervention protocols that can be confidently applied across heterogeneous primary school populations. Existing exercise studies vary in duration, frequency, supervision, exercise selection, and outcome assessment. Such heterogeneity complicates the identification of universally applicable training characteristics.

Furthermore, evidence obtained from specialized clinical interventions cannot be directly transferred to ordinary physical education. For example, randomized research has demonstrated benefits of supervised Schroth physiotherapeutic scoliosis-specific exercises when added to standard care among adolescents with diagnosed idiopathic scoliosis [8]. However, Schroth exercises differ fundamentally from general postural education and conventional core strengthening in their therapeutic objectives, individualization, and professional requirements. Treating these approaches as equivalent would obscure important distinctions in intervention specificity.

A second weakness relates to professional competence. Physical education teachers are usually skilled in movement instruction and classroom management. However, their training may not cover pediatric spinal pathology, clinical examination, or condition-specific rehabilitation. Without clear professional boundaries, educators may have difficulty distinguishing functional movement limitations from symptoms requiring medical evaluation.

Assessment capacity represents another limitation. Visual observations of standing posture are influenced by growth, movement habits, measurement procedures, and examiner judgment. Informal postural observations cannot establish a diagnosis of structural scoliosis, while repeated measurements using poorly standardized procedures may produce misleading interpretations.

Finally, limited instructional time and competing curricular demands may undermine program consistency. Even well-designed interventions may experience difficulties related to staff turnover, inconsistent delivery, insufficient parental involvement, and limited opportunities for longitudinal follow-up. These weaknesses suggest that successful implementation depends not only on the theoretical value of exercise but also on professional training, procedural standardization, and organizational support.

Opportunities

The growing recognition of schools as settings for comprehensive health promotion creates opportunities to integrate spinal and postural health into existing educational and preventive structures. Schools do not need to develop separate corrective exercise programs. Instead, they can integrate musculoskeletal health into broader initiatives. These initiatives promote physical activity, health literacy, student well-being, and supportive learning environments.

The Whole School, Whole Community, Whole Child model provides a relevant perspective by emphasizing collaboration among educational institutions, families, healthcare providers, and community organizations [9]. Applied to spinal and postural health, this approach supports a transition from fragmented interventions toward coordinated educational and health services.

Multidisciplinary collaboration represents a particularly important opportunity. Partnerships involving physical education teachers, school nurses, pediatric clinicians, physiotherapists, and rehabilitation specialists may facilitate more appropriate program development. Such collaboration could improve teacher training, establish referral procedures, and support the adaptation of exercise activities to individual needs.

Technological developments may offer additional possibilities. Digital educational materials, video-supported exercise instruction, and secure communication systems could facilitate consistent delivery and improve communication between schools and families. However, these applications should be considered potential implementation support rather than established solutions, particularly where evidence of clinical effectiveness or measurement validity remains limited.

Opportunities also emerge from increasing attention to inclusive physical education. A spinal and postural health program designed around movement competence rather than appearance-based conformity may benefit children with diverse physical abilities and developmental characteristics. Integrating these principles into ordinary school activities could promote participation while minimizing unnecessary medicali zation.

Together, these opportunities indicate that the development of school-based interventions may be strengthened through institutional integration, interprofessional cooperation, and context-sensitive innovation.

Threats

The most consequential external threat is the possibility of inappropriate clinical interpretation. In school environments, visible asymmetry, rounded shoulders, or habitual postural positions may be mistaken for evidence of structural spinal pathology. Such misclassification can

generate unnecessary parental concern, inappropriate exercise prescriptions, and referrals lacking adequate clinical justification.

Conversely, overconfidence in school-based exercise programs may delay appropriate medical assessment when genuine spinal abnormalities are present. This risk is especially relevant for children with progressive asymmetry, persistent pain, neurological symptoms, or previously diagnosed conditions requiring specialist monitoring. General exercise promotion should therefore remain distinct from medical management.

Social and psychological consequences constitute additional threats. Programs that emphasize an idealized upright posture or classify children according to visible bodily differences may unintentionally reinforce negative body image, peer comparison, or stigmatization. Children's movement experiences should therefore be framed around functional capability, comfort, and participation rather than conformity to a single postural appearance.

Resource inequalities may also affect implementation. Schools serving socioeconomically disadvantaged communities may have fewer trained personnel, limited facilities, or reduced access to professional referral networks. If interventions rely heavily on specialized equipment, paid external services, or continuous digital access, existing inequalities could become more pronounced.

Technological innovation introduces additional governance challenges, particularly when photographs, videos, or identifiable movement data are collected from children. Inadequate consent procedures, unclear data ownership, insecure storage, and unvalidated automated assessments may undermine trust and expose children to unnecessary privacy risks.

These threats demonstrate that early intervention should be evaluated not only according to its potential health benefits but also according to safety, proportionality, equity, and the ethical consequences of implementation.

Development strategies

The SWOT findings indicate that school-based spinal and postural health interventions should follow a coordinated strategy rather than depend on a single exercise modality or isolated educational activity. Four complementary strategic pathways are proposed through the interaction of internal capabilities and external conditions.

SO strategy: Integrating spinal health into comprehensive school health promotion

The SO strategy seeks to capitalize on schools' organizational accessibility and existing physical activity infrastructure while utilizing opportunities for broader health promotion and multidisciplinary collaboration.

A practical approach involves embedding spinal and postural health education into established physical education curricula. Rather than creating an independent medicalized training program, schools could incorporate activities promoting trunk control, balance, muscular endurance, coordination, and movement variability within age-appropriate lessons.

Core stability exercises may form one component of this approach, particularly when embedded in varied functional movements rather than repeated static posture correction. Educational content should emphasize that healthy movement involves adaptability and that no single sitting or standing position can be assumed to prevent spinal disease.

The strategy should also encourage family engagement through accessible educational resources. Parents may be informed about the importance of regular physical activity, the distinction between postural variation and suspected spinal pathology, and appropriate pathways for seeking professional advice.

This integration-based approach offers a potentially sustainable model because it builds on existing educational structures while avoiding the unnecessary expansion of schools' clinical responsibilities.

WO strategy: Establishing professional support and standardized implementation procedures

The WO strategy addresses limitations in professional expertise, assessment consistency, and intervention standardization by utilizing opportunities for interprofessional cooperation and institutional support.

Schools should establish clear distinctions between general movement instruction, functional support, and clinical assessment. Physical education teachers may deliver universal movement activities, while health professionals should guide decisions involving suspected structural abnormalities, significant symptoms, or individualized therapeutic intervention.

A standardized implementation framework could specify essential educational content, acceptable activity characteristics, supervision expectations, documentation

procedures, and criteria for seeking medical advice. Such guidance should remain sufficiently flexible to accommodate differences in school resources and children's functional abilities.

Professional development represents an important component of this strategy. Teacher training should emphasize musculoskeletal health literacy, develop mentally appropriate exercise progression, inclusive communication, and recognition of warning signs. It should not imply that brief training qualifies teachers to diagnose scoliosis or prescribe specialist rehabilitation.

The updated consolidated framework for implementation research highlights the importance of intervention characteristics, organizational context, implementation processes, and the needs of individuals involved in implementation [10].

Applying these principles would enable schools to identify local barriers before program introduction and adapt delivery procedures without compromising essential safety requirements.

ST strategy: Developing risk-sensitive and child-centered intervention pathways

The ST strategy combines the accessibility of school-based health promotion with safeguards against diagnostic error, inappropriate exercise, and psychological harm. A differentiated three-level intervention pathway is proposed.

Level 1 (Universal health promotion): All children may participate in inclusive movement education, general strengthening, balance activities, and age-appropriate physical activity. Participation should be based on educational and developmental objectives rather than presumed pathology.

Level 2 (Targeted functional support): Children experiencing recurring functional difficulties or musculoskeletal discomfort may receive additional attention through established school health procedures. Support should remain within staff competencies, with professional assessment where indicated. This level should not be interpreted as a school-based diagnosis or treatment of scoliosis.

Level 3 (Clinical referral and coordinated management): Children exhibiting concerning symptoms, progressive asymmetry, or known spinal conditions should be directed toward qualified healthcare professionals. Where a clinical exercise program has been prescribed, schools may support participation through appropriate accommodation and communication with families and clinicians.

This differentiated approach reduces the likelihood that universal educational activities will be mistaken for clinical treatment. It also supports proportionate responses to individual needs without unnecessarily labeling children as having spinal abnormalities.

Risk-sensitive implementation additionally requires non-stigmatizing communication. Educational messages should avoid describing ordinary postural variation as deformity or suggesting that children are responsible for developing structural spinal disorders because of everyday sitting habits.

WT strategy: Establishing evaluation, quality assurance, and equity safeguards

The WT strategy focuses on preventing implementation weaknesses from interacting with external threats in ways that compromise safety, effectiveness, or equitable access.

A central recommendation is to establish a minimum standard for program delivery. This standard should include age-appropriate activity selection, clearly defined responsibilities, safe participation procedures, referral arrangements, and basic documentation of implementation quality. Schools unable to meet specialist supervision requirements should avoid introducing individualized therapeutic exercises intended for diagnosed spinal deformities.

Evaluation should extend beyond short-term changes in posture. The Reach-Effectiveness-Adoption-Implementation-Maintenance (RE-AIM) framework identifies reach, effectiveness, adoption, implementation, and maintenance as important dimensions for assessing the public health impact of interventions [11]. These dimensions provide a suitable foundation for examining whether school-based programs reach relevant populations, are adopted by schools, are delivered as intended, and remain sustainable.

For universal interventions, evaluation may include physical activity participation, functional movement measures, movement-related confidence, health literacy, student acceptability, and adverse events. Where clinically diagnosed conditions are involved, appropriate health outcomes should be determined by qualified professionals.

Equity safeguards are equally important. Program materials should be accessible to children with different

physical abilities, family circumstances, and educational needs. Schools should avoid introducing unnecessary costs, mandatory digital monitoring, or assessment procedures that disproportionately exclude disadvan taged students.

Taken together, these four strategies establish a conceptual implementation pathway connecting universal health promotion, professional collaboration, individualized risk management, and sustainable organizational evaluation.

Discussion

The present analysis suggests that developing effective school-based interventions for spinal and postural health requires a conceptual shift from posture correction toward integrated musculoskeletal health promotion. This distinction is important because conventional interpretations of postural intervention often assume that visible alignment represents a direct indicator of spinal health. Such assumptions overlook the complexity of musculoskeletal development, the adaptability of human movement, and the difference between functional postural characteristics and structural spinal deformities. The principal theoretical contribution of this study is the integration of strategic environmental analysis with differentiated intervention delivery. SWOT analysis identifies the internal capacities and external conditions affecting implementation, while the proposed intervention pathway clarifies how these determinants may influence decisions at universal, targeted, and clinical levels. This combination extends the analytical value of SWOT beyond organizational description toward the development of context-sensitive implementation strategies.

A second contribution concerns the distinction between intervention efficacy and implementation feasibility. Evidence that a particular exercise approach produces beneficial outcomes under controlled clinical conditions does not necessarily establish that the same approach can be delivered safely and effectively by school personnel. Clinical interventions often involve individualized assessment, specialist supervision, and carefully selected participants. School programs operate under different conditions, including larger groups, limited instructional time, and substantial variation in developmental characteristics.

The proposed framework therefore treats clinical evidence as a source of relevant principles rather than a universally transferable intervention protocol. This approach may reduce the tendency to overgeneralize findings from adolescents with diagnosed scoliosis to younger children without structural abnormalities.

A third contribution is the emphasis on proportionate prevention. Universal movement promotion may offer broad developmental and educational value, but its justification should not depend on claims that routine exercise prevents idiopathic scoliosis. Similarly, early recognition of concerning spinal signs may facilitate clinical assessment without requiring schools to adopt comprehensive diagnostic responsibilities. The effectiveness of an intervention system should therefore be understood partly through its capacity to provide an appropriate response to different levels of need.

The framework also highlights the relationship between intervention sustainability and professional boundaries. Programs are unlikely to remain effective if teachers are expected to perform clinical functions outside their training or if health professionals are not involved when specialized guidance is required. Sustainable implementation depends on clearly defined responsibilities, feasible delivery procedures, and supportive institutional relationships.

Finally, the analysis emphasizes equity as an essential consideration rather than a secondary implementation outcome. School-based interventions have the potential to increase access to health-promoting activities, but their advantages may be weakened if higher-resource schools obtain substantially better professional support than disadvantaged institutions. Future strategies should therefore assess how implementation conditions influence not only average outcomes but also the distribution of potential benefits and risks.

Overall, the proposed framework positions spinal and postural health as an interdisciplinary educational and public health concern while preserving the distinction between health promotion and clinical treatment.

Conclusion

School-based early intervention for spinal and postural health offers opportunities to support children’s musculoskeletal development through accessible movement education, functional exercise, and coordinated health promotion. However, successful implementation requires careful attention to professional

competence, intervention standardization, diagnostic boundaries, safety, and equitable access.

This SWOT-based conceptual analysis identifies important internal and external determinants of school-based intervention development and proposes four corresponding strategic pathways. These strategies emphasize integration into existing school activities, multidisciplinary professional support, differentiated intervention delivery, and continuous implementation evaluation.

The principal contribution of the proposed framework lies in connecting evidence-informed physical activity with context-sensitive educational and clinical coordination. By distinguishing universal health promotion from condition-specific treatment, the framework provides a theoretically grounded direction for developing safe, feasible, and sustainable school-based spinal and postural health programs. Future empirical research is required to validate its implementation pathways and establish their effectiveness across diverse primary school populations.

Limitations and future research

Several limitations should be considered when interpreting this conceptual analysis.

First, the study adopts a narrative rather than systematic evidence synthesis. Although relevant clinical, educational, and implementation literature informed the analysis, no exhaustive literature search, formal screening procedure, or structured certainty-of-evidence assessment was conducted. Consequently, the identified SWOT factors may not represent every relevant determinant, and their relative importance cannot be established quantitatively.

Second, SWOT analysis is inherently interpretive. The classification of factors as strengths, weaknesses, opportunities, or threats depends partly on how the intervention system and its operating environment are defined. Certain characteristics may also have context-dependent effects. For example, digital monitoring could improve implementation consistency in some settings while increasing costs and privacy concerns in others.

Third, the proposed framework has not undergone empirical validation. Its feasibility, acceptability, effectiveness, and cost implications remain uncertain. The analysis also draws partly on research involving adolescents with diagnosed spinal disorders, whose developmental and clinical characteristics may differ from those of younger primary school children.

Fourth, international differences in educational organization, healthcare access, professional regulation, and referral systems may limit direct transferability. Implementation strategies should therefore be adapted to local institutional and cultural conditions.

Future research should prioritize several complementary directions. Pragmatic school-based trials could evaluate the effects of developmentally appropriate movement programs on functional performance, musculoskeletal symptoms, movement confidence, and health-related knowledge. Longitudinal studies could examine intervention maintenance and developmental changes over time. Implementation research should investigate teacher readiness, parental acceptability, program fidelity, referral processes, and resource requirements.

Further work should also distinguish children with general functional postural concerns from those with clinically diagnosed spinal disorders. For scoliosis-specific populations, clinical outcomes and appropriate treatment pathways must remain central. Economic evaluations and equity-focused implementation studies would help determine whether proposed strategies can be delivered sustainably across different school settings.

These investigations would provide the empirical foundation necessary to refine the conceptual framework and establish which implementation strategies produce meaningful benefits under real-world educational conditions.

Funding

This work was supported by the Zhaoqing University College Students' Innovation and Entrepreneurship Training Programme (Grant No: X202610580101).

Acknowledgements

The authors would like to show sincere thanks to those technicians who have contributed to this research.

Conflicts of Interest

The authors declare no conflict of interest.

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