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Management of Scheuermann's Disease: A Literature Review

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Abstract

Background. Scheuermann disease is a developmental spinal pathology, typically manifesting during adolescence, characterized by thoracic or thoracolumbar hyperkyphosis. It represents the most frequent etiology of kyphotic spinal deformity in this age group, with a prevalence of 1% to 8%. While many cases remain asymptomatic, progressive spinal deformity can lead to chronic back pain, neurological issues, restrictive respiratory impairment, and significant psychosocial distress.

Aim. The primary objective of this literature review is to comprehensively present the available conservative and surgical treatment modalities for patients diagnosed with Scheuermann's disease and to analyze the complex challenges associated with selecting the appropriate therapeutic strategy.

Material and methods. A literature search was conducted across databases including PubMed, Scopus, and Web of Science to identify relevant studies. This primary electronic search was additionally supplemented by a manual search of reference lists to ensure comprehensive coverage of the topic.

Results. Conservative protocols integrating physiotherapy and spinal orthoses yield statistically significant vertebral remodeling in skeletally immature cohorts with mild to moderate curves. Conversely, operative interventions, primarily exclusive posterior or combined anterior and posterior fusions, are generally considered for rigid deformities exceeding 70 to 75 degrees. Further clinical parameters substantiating the necessity for surgical correction include intractable back pain, concurrent neurological symptoms, restrictive pulmonary impairment,

documented continuous progression of the deformity, and profound psychosocial distress arising from diminished self-esteem. While operative treatment can provide definitive structural correction, these procedures carry notable inherent risks, including surgical site infections, acute neurological compromise, and proximal junctional kyphosis.

Conclusion. The management of Scheuermann's disease necessitates an individualized therapeutic approach. Conservative management remains the optimal initial modality, particularly during the active growth period, while surgical intervention is warranted for patients with severe deformity progression, debilitating somatic symptoms, or significant aesthetic concerns that impair their quality of life.

Keywords: Scheuermann's disease; Juvenile kyphosis; Spinal deformity; Spinal orthosis; Bracing; Spinal fusio

1. Introduction

Scheuermann's disease is a pathology characterized by spinal deformity, predominantly affecting the thoracic spine (typical type or type 1) or the thoracolumbar spine (atypical type or type 2) ^[1]. During adolescence, it is recognized as the most frequent etiology of thoracic and thoracolumbar hyperkyphosis ^[2]. Currently, the pathogenesis of Scheuermann's disease remains a subject of ongoing debate among researchers ^[3, 4]. The prevalence within the general population varies depending on the publication, with most reported ranges spanning from 1% to 8%; however, a significant proportion of cases remain asymptomatic ^[5-7]. Per the criteria established by the Scoliosis Research Society, the physiological range of thoracic kyphosis is 20° to 45° ^[8], while the mean angle in the pediatric population is reported at 44.0° (SD = 10.9) ^[9]. Radiological diagnosis relies on the evaluation of the Sorensen criteria^[10]. These criteria for Scheuermann disease are defined as anterior vertebral body wedging of at least 5 degrees involving a minimum of three adjacent vertebrae, accompanied by thoracic hyperkyphosis with a Cobb angle of at least 40 to 45 degrees. Furthermore, additional radiographic findings frequently include lengthening of the vertebral bodies, endplate irregularities, and intraosseous

disc herniations, commonly known as Schmorl nodes ^[4, 11, 12]. Additionally, alterations in the architecture of the thoracic spine can lead to anatomical modifications of the thoracic cage and associated restrictive respiratory impairment ^[11]. In the population of patients who develop clinical symptoms, individuals frequently report chronic pain, particularly affecting the lower back, alongside neurological issues ^[2, 12]. Moreover, there may be an elevated risk of depression, anxiety, and diminished self-esteem related to the cosmetic aspects of the deformity ^[13]. The primary objective of this literature review is to comprehensively present the available treatment modalities for patients diagnosed with Scheuermann disease and to analyze the complex challenges associated with selecting the appropriate therapeutic strategy.

2. Methods

2.1 Search Strategy

A comprehensive literature search was conducted across three primary electronic databases: PubMed, Scopus, and Web of Science. The search strategy was explicitly designed to identify relevant studies published between January 2010 and October 2025. To ensure rigorous data extraction, the results were restricted exclusively to articles published in the English language. The retrieval process utilized a combination of specific keywords formulated into the following Boolean logic sequence:

("Scheuermann's disease" OR "Scheuermann" OR "juvenile kyphosis" OR "Scheuermann's kyphosis" OR "juvenile discogenic disease"). In addition to the electronic database queries, the reference lists of all eligible full text articles and relevant systematic reviews were manually screened. This supplementary step was implemented to identify and recover any critical citations that might not have been indexed during the primary search phase.

2.2 Eligibility Criteria

Studies were selected based on the following criteria:

Population: Studies involving human subjects with a confirmed diagnosis of Scheuermann's kyphosis;

Intervention: Articles evaluating therapeutic modalities, including conservative management (e.g., physiotherapy, bracing) and surgical interventions;

Outcomes: For conservative management and surgical studies, reporting of radiological (e.g., Cobb angle), clinical (e.g., pain scores), or functional outcomes was required;

Study Design: The review included meta-analyses, systematic reviews, randomized controlled trials, as well as prospective and retrospective cohort studies. Only articles with full-text availability were considered.

2.3 Exclusion Criteria

Records were excluded if they met any of the following conditions:

Interventions involving experimental methods not currently established in routine clinical practice;

Editorials, isolated case reports, and expert opinion pieces were excluded from the analysis;

Studies conducted on animal models or in vitro.

2.4 Study Selection and Data Extraction

Citations retrieved from the databases were imported into EndNote (v.21) for de-duplication. The selection process followed a two-stage screening hierarchy. Initially, titles and abstracts were screened for relevance. Subsequently, the full texts of potentially eligible articles were retrieved and scrutinized. The designated reviewers independently evaluated the studies against the pre-defined inclusion and exclusion criteria. Any discrepancies regarding study eligibility were settled through consensus discussions. The identification process was conducted manually, without the use of automated screening tools. To illustrate the literature search and screening strategy, a flow diagram adapted from the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was constructed. The detailed selection process, including the number of included and excluded studies at each stage, is presented in (Figure 1).

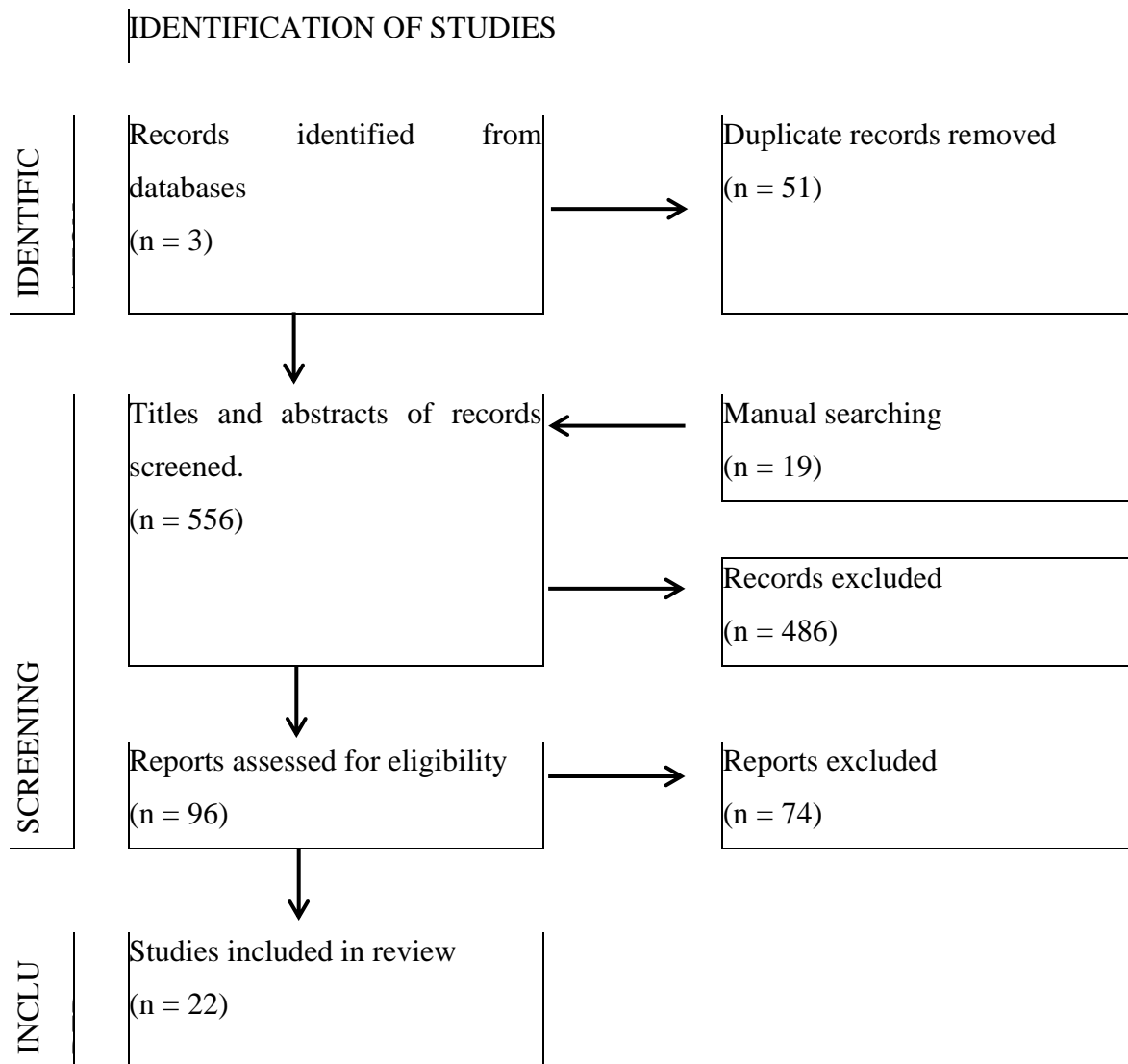


Figure 1. Summary of the literature retrieval and screening process.

2.5 Literature Search

The literature search identified 607 potential records. Following deduplication, 556 articles were screened by title and abstract. To ensure comprehensive coverage, manual searching was performed on the reference lists of included studies and relevant reviews, identifying 19 additional records. Consequently, a total of 96 full-text articles were assessed for eligibility. Ultimately, 22 studies met the inclusion criteria and were included in the final analysis. The complete selection flow is depicted in the diagram (Figure 1).

3. Results

3.1 Conservative Management

Regarding non-operative strategies for patients with mild to moderate Scheuermann's disease, current literature predominantly highlights the combined use of physiotherapy and rigid bracing. Precisely establishing the most effective treatment modality based on the severity of the curvature remains challenging. There is no clear consensus among authors on this matter, and the therapeutic decision ultimately seems to rely on the individual clinical picture of the patient.

3.1.1 Physiotherapeutic Modalities

In cases involving low magnitude, asymptomatic, or mildly symptomatic curves, physiotherapy serves as a frequently employed conservative treatment modality. Within this context, physical therapy interventions are the most commonly reported approaches, with a strong emphasis on independent daily exercises. These regimens primarily incorporate active spinal movements, thoracic extension, exercises designed to reduce lumbar lordosis, the avoidance of prolonged static postures, and postural corrections aimed at preventing the exacerbation of thoracic kyphosis^[14]. While reports indicate that the appropriate implementation of physiotherapy alone can alleviate pain and offer modest benefits in mitigating the risk of deformity progression, its efficacy in actively reducing the curve magnitude remains a subject of controversy^[7, 15-17].

3.1.2 Implementation and Specifics of Brace Treatment

Determining the exact range of kyphotic curve magnitude that definitively indicates brace therapy remains challenging. While authors frequently report a target curve range of 45–70°^[16, 18], there are also attempts to manage curves exceeding 70° using this method; however, researchers highlight the need for further studies in this area^[4, 19]. A crucial factor influencing the success of this therapy is the brace wear time. Literature suggests that, by analogy to scoliosis treatment, the brace should be worn for 21 hours per day until the patient reaches skeletal maturity^[12], although a shorter daily duration may also prove effective^[17]. Regarding the specific type of brace utilized in Scheuermann's disease management, bracing efficacy is frequently evaluated using the Milwaukee brace^[14]. This posterior-opening cervico-thoracolumbosacral orthosis (CTLSO) consists of a thermoplastic pelvic girdle from which vertical bars extend, providing support for pads, a corrective sling, and a neck ring^[14, 15]. Furthermore,

there is an observable growing interest among authors in modern bracing modalities, such as the Newly Anti-Kyphosis brace [15].

3.1.3 Clinical Perspectives on Conservative Treatment

A Delphi consensus study was conducted among 15 specialists focused on the management of Scheuermann's disease during the SOSORT meeting in Lyon [19]. The questionnaire addressed the routine implementation of conservative treatment modalities in their daily clinical practice. Regarding the specific focus of physical exercises for patients at risk of brace treatment, the experts prioritized postural self-control and auto-elongation. Furthermore, lifestyle modifications were strongly advised; patients are encouraged to avoid prolonged sitting and to frequently alter their sitting position. Specific recommendations included adopting a prone position for activities such as reading or watching television, and sitting on the edge of a chair with alternate hip extension. Prior to initiating treatment, the assessment protocol focuses heavily on clinical presentation. The panel reached a consensus that curve rigidity, anatomical location, and local pain are the critical determinants. Interestingly, in contrast to scoliosis management, the Cobb angle was deemed less significant during this initial evaluation. Typically, a course of physiotherapy is prescribed before bracing is considered. When bracing is indicated, the biomechanical rationale is to reduce mechanical stress on the anterior wall of the vertebral body. The experts defined the primary goals of bracing as the restoration of proper muscular alignment and the unloading of thoracolumbar discs to facilitate normal development. To support this, specific physiotherapy exercises should be performed at home daily for approximately 20 minutes. The primary indications for early intervention include significant rigidity, the overall size of the curve, and the Cobb angle, with the optimal treatment window being the onset of puberty. The standard protocol suggests that the brace be worn for approximately two years, with discontinuation recommended at the cessation of growth (Risser stage 5). Specifically for cases of juvenile kyphosis, the panel identified the polyethylene Milwaukee brace as the optimal orthosis, noting that a part-time wearing schedule can be sufficient.

3.1.4 Impact of Bracing on Vertebral Remodeling

A retrospective study evaluated the impact of bracing on a cohort of 158 patients. [20]. The mean duration of therapy was 28.42 ± 12.07 months, with a mean follow-up of 128.3 ± 11.07 months (approximately 10 years). The daily brace wear time was at least 18 hours. The authors

established a statistically significant effect of bracing on vertebral remodeling, which resulted in an improved radiographic presentation. These improvements were quantified using several metrics, including the Cobb angle for curve magnitude and the anterior wedging angle (Alpha) of the apex vertebra. Crucially, the therapeutic intervention contributed to a sustained long term reduction of both the global Cobb angle and the localized anterior wedging angle of the apex vertebra. The mean radiographic outcomes, including standard deviations (SD), are summarized in (Table 1). Other reports also support the positive impact of bracing on the remodeling of vertebral wedging in patients who have not yet reached skeletal maturity. Specifically, a statistically significant reduction ($p < 0.001$) in the thoracic curvature angle was observed, with values decreasing from a mean of 63.24 (SD = 9.96°) to 36.5 (SD = 13.4°) over 22 months of combined physiotherapy and bracing. Notably, three patients (2.5%) required surgical intervention due to a lack of improvement during conservative treatment [14]. Furthermore, certain studies suggest that a statistically significant reduction in the kyphotic angle by 26.77° (SD = 19.76°) may be achievable even in patients presenting with more severe curvatures ranging from 75° to 90°. According to these findings, it was observed that only a single patient (4.5%) in the cohort managed with combined bracing and physiotherapy ultimately required surgical intervention due to curve progression.

Table 1. Mean spinal curvature angles and standard deviation associated with bracing therapy

	Pre-treatment	Post-treatment	Long-term follow-up (10 years)
Cobb	57,6 (SD = 6,31)	43,28 (SD = 7,871)	44,49 (SD = 7,421)
Alpha	14,43 (SD = 2,535)	8,571 (SD = 3,589)	8,654 (SD = 3,573)

Source: [20]

3.1.5 Discussion

When evaluating the efficacy of this treatment modality, it is crucial to consider the risk of underestimated outcomes resulting from poor patient compliance. Adherence to the therapy is particularly influenced by physical and psychosocial challenges, as well as the individual's desire to avoid surgery, baseline pain intensity, and the fear of disease progression [21]. Furthermore, patients undergoing brace treatment frequently report sleep disturbances and difficulties with standing up [15, 16, 22]. Notably, attention must be drawn to the recurrence of excessive kyphosis following the discontinuation of brace therapy. According to one report,

approximately one-third of patients experienced a loss of correction over the follow-up period [2].

3.2 Operative Management

When considering surgical intervention, establishing a definitive indication based solely on the magnitude of the kyphotic curve remains challenging. A meta-analysis and other literature typically cite curve magnitudes exceeding 70–75° as a relative indication for surgery [23, 24], however, some studies consider angles greater than 60° as sufficient grounds for operative treatment [2]. Additional factors that may corroborate the necessity for surgery include intractable back pain, the presence of neurological symptoms, restrictive pulmonary impairment, significant progression of the deformity, and psychosocial issues related to the patient's appearance and self-esteem [12, 25, 26]. Furthermore, some studies evaluating the therapeutic efficacy of surgical modalities suggest that operative correction may be considered in patients over 16 years of age, given the diminished spinal flexibility and poor compliance associated with conservative management [2].

3.2.1 Available Surgical Approaches

Although several surgical modalities are available for the treatment of Scheuermann's disease, reliable guidelines establishing a single optimal method are currently lacking. Nevertheless, all these interventions share core principles, specifically the release of thoracic spine structures, correction of the hyperkyphosis, and instrumented spondylodesis [25]. The most frequently employed strategies identified in the reviewed literature include posterior-only fusion and combined anterior release with posterior fusion. A meta-analysis comprising 6 studies sought to evaluate the efficacy of these surgical options [23]. The findings suggest that the posterior-only approach is superior to combined or anterior-only techniques regarding operative efficiency, demonstrating the shortest surgical duration and minimized blood loss. However, the authors noted that further investigation is required to definitively compare postoperative complication rates across these methods. When comparing the correction effect between these approaches, no statistically significant differences were observed. However, there are strong arguments indicating that skeletal maturity and curve characteristics must be carefully considered during the decision making process. Specifically, while the combined anterior and posterior approach is often preferred for adult patients presenting with more rigid deformities, the exclusive posterior technique is generally considered appropriate for skeletally immature

patients during their active growth period [16, 27]. Furthermore, attention must be drawn to the risks of hemothorax, pleural effusion, pneumothorax, and great vessel injury associated with the anterior approach [15]. Nevertheless, the implementation of video thoracoscopic surgery techniques may significantly mitigate these risks [15, 24].

3.2.2 Risks Associated with Surgical Intervention

Surgical intervention carries inherent risks; studies have reported a 3.9-fold increase in the probability of postoperative complications when compared to surgical correction for idiopathic scoliosis [24]. In a retrospective study conducted by the Scoliosis Research Society [28], 683 surgical procedures for Scheuermann's kyphosis were evaluated in a cohort of 610 patients with a mean age of 20.8 years (SD = 10.3). The authors observed an overall complication rate of 14% across all procedures. Upon stratifying the patients into two age cohorts, those aged 19 years or younger and those older than 19 years, the complication rate was 12% in the younger group compared to 22% in the older demographic. This variance was found to be statistically significant. Regarding the surgical techniques employed, 345 patients (57%) were treated utilizing a combined anterior-posterior (AP) approach, performed either in stages or as a single-day procedure, whereas 265 patients (43%) underwent a posterior-only (PO) approach. The most frequently reported operation-related adverse events were surgical site infections (3.8%) and acute neurological complications (1.9%), which included spinal cord injuries (0.6%). Furthermore, procedure-related complications resulted in the mortality of four patients; however, the difference in mortality rates between the age groups did not reach statistical significance. Moreover, in cases of anterior spinal fusion, acute respiratory adverse events were observed immediately postoperatively in patients who underwent thoracotomy; however, in 95% of cases, these respiratory parameters returned to baseline within a 2-year follow-up period [29]. Regarding the long-term complications of surgical intervention for Scheuermann's kyphosis, authors enumerate several issues, including pseudarthrosis resulting in recurrent deformity, implant failure, as well as distal and proximal junctional kyphosis (PJK) [15]. Current literature indicates that PJK has emerged as the most significant challenge in spinal deformity surgery [30]. Radiographically, PJK is defined by the presence of a Cobb angle greater than 10° and a progression of at least 10° compared to preoperative measurements, assessed between the lower endplate of the upper instrumented vertebra and the upper endplate of the vertebra two levels above. While some cases of PJK remain asymptomatic, approximately 10% of affected patients require revision surgery due to proximal junctional failure (PJF) [31]. The clinical presentation

of PJF can include localized pain, neurological deficits, and gait abnormalities ^[30]. A meta-analysis based on two studies demonstrated no significant difference in the incidence of postoperative PJK between the anterior-posterior and posterior-only cohorts ^[23].

3.2.2 Discussion

Operative management is generally considered appropriate for symptomatic individuals presenting with progressive kyphosis unresponsive to brace therapy. Nevertheless, every case warrants individualized assessment, taking into account the patient's age alongside the risk tolerance of both the patient and, when applicable, their parents. Considering patient perspectives regarding postoperative satisfaction, one study indicated an overall satisfaction rate of 96% following a mean follow up period of 75 months. Specifically, 45% of the cohort reported pain relief, 36% experienced no change, and 18% noted a deterioration in pain levels. Regarding self-image, improvements were observed in 45% of patients, 41% reported no change, while 14% experienced deterioration ^[15].

3.3 Limitation of the Identified Evidence

This article has presented a clinical perspective on the management of Scheuermann's disease, supported by scientific evidence including a meta-analysis and numerous original studies. However, the existing literature is prone to bias, underscoring the necessity for long-term, prospective studies to directly compare surgically and conservatively managed patients. Such research should comprehensively evaluate motor function, mental health, quality of life, and deformity recurrence following specific treatment modalities, particularly in individuals presenting with borderline curve severity. Although certain studies approach this issue holistically, the authors themselves have acknowledged that their findings were not of clinical importance ^[2]. Ultimately, the currently available scientific evidence appears insufficient to establish standardized treatment protocols. The most significant clinical uncertainty pertains to patients with a kyphotic curve magnitude ranging between 70° and 90°. The initial literature search strategy did not exclude peer-reviewed articles based on access restrictions. Nevertheless, during the course of manual searching, we identified certain studies whose abstracts appeared highly relevant to the scope of our work; however, these were ultimately excluded from the final analysis due to inaccessible full texts behind paywalls.

4. Conclusion

The reviewed literature underscores the necessity for an individualized approach when selecting therapeutic strategies for Scheuermann's disease. For asymptomatic or mildly symptomatic patients presenting with deformities of low to moderate magnitude, conservative management, specifically physical therapy of varying intensities, serves as an appropriate initial intervention within a stepwise therapeutic paradigm. Conversely, for patients at the more advanced end of the clinical spectrum, the implementation of a Milwaukee brace should be considered. Notably, conservative management remains the optimal modality during the active growth period. Moreover, substantial discrepancies persist between conservative and surgical centers, not only concerning the qualification criteria for specific interventions but also regarding the preferred therapeutic options. Surgical intervention may be warranted in patients demonstrating severe disease progression, debilitating somatic symptoms, or aesthetic concerns that significantly impair their quality of life.

Disclosure

Author Contributions

Conceptualization: Kamil Pielusiński; **Methodology:** Kamil Pielusiński, Karolina Borkowska and Andrzej Domański; **Validation:** Andrzej Domański, Julia Domańska and Nadia Hornig; **Formal Analysis:** Kamil Pielusiński, Karolina Borkowska, Alicja Pyzik and Anna Polakowska; **Investigation:** Kamil Pielusiński, Oliwia Mróz, Alicja Pyzik and Julia Domańska; **Writing – Original Draft Preparation:** Kamil Pielusiński; **Writing – Review & Editing:** Kamil Swoboda, Michał Olejnik, Anna Polakowska, Oliwia Mróz and Nadia Hornig; **Visualization:** Kamil Pielusiński, Kamil Swoboda and Michał Olejnik; **Supervision:** Kamil Pielusiński. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflicts of interest.

AI Declaration

The authors declare that AI tools (Gemini Pro) were used solely to improve language and readability.

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