

Quality of life and physical activity participation in adolescent girls with idiopathic scoliosis treated with bracing

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Received: 2026-02-04 ○ Revised: 2026-03-20 ○ Accepted: 2026-05-20 ○ Published: 2026-06-06

ABSTRACT

Introduction: Adolescent idiopathic scoliosis (AIS) is a common musculoskeletal condition that predominantly affects adolescent girls and often requires prolonged brace treatment. Although bracing is effective in preventing curve progression, it may negatively influence physical comfort, emotional well-being, and psychosocial functioning. Quality of life has therefore become an essential outcome in the management of AIS. Physical activity, particularly swimming, is frequently recommended as a safe form of exercise for adolescents with scoliosis; however, evidence on its association with quality of life during brace treatment remains limited.

Research Methodology: This study employed a quantitative cross-sectional design involving 50 adolescent girls aged 10–18 years diagnosed with idiopathic scoliosis and undergoing brace treatment for at least six months. Participants were selected using purposive sampling. Quality of life was assessed using the Brace Questionnaire (BrQ), covering eight domains. Physical activity participation was measured by swimming frequency and categorised as low (1–2 times/week) or high (≥ 3 times/week). Data were analysed using univariate statistics, independent t-tests, and multivariate regression analysis.

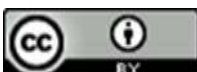
Results: The mean total quality-of-life score indicated a moderate level of quality of life among participants. Higher participation in physical activity was significantly associated with better physical and emotional functioning, vitality, and overall quality of life ($p < 0.05$). Adolescents who swam three or more times per week had higher total quality-of-life scores than those who swam fewer times per week. No significant differences were observed in self-esteem and social functioning domains.

Conclusion: Regular physical activity, particularly swimming, is positively associated with improved quality of life among adolescent girls with idiopathic scoliosis undergoing brace treatment. Integrating safe physical activity promotion into conservative scoliosis management may enhance both physical and psychosocial well-being.

Keywords: Adolescent; Brace Treatment; Physical Activity; Quality of Life; Scoliosis



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INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a common spinal deformity that emerges during the growth spurt of adolescence and disproportionately affects girls (Gonen Aydin et al., 2020). Characterized by a three-dimensional curvature of the spine with no identifiable underlying cause, AIS has a reported prevalence of approximately 1–3% among adolescents worldwide (Alnahidh & Altalhab, 2020). Although AIS is not directly life-threatening, its long-term implications extend beyond physical deformity, influencing functional capacity, psychological well-being, and social participation. Consequently, AIS represents not only a clinical concern but also a broader public health issue that requires comprehensive, adolescent-centred management (Bunge et al., 2007).

Conservative treatment, particularly spinal bracing, remains the primary intervention for adolescents with mild to moderate scoliosis to prevent curve progression during skeletal growth (Paraguas, 2025). While bracing has demonstrated effectiveness in reducing the need for surgical intervention, prolonged brace use is frequently associated with adverse physical and psychosocial effects (Güttinger et al., 2025). Adolescents undergoing brace treatment often report discomfort, restricted mobility, fatigue, and bodily pain. In addition, wearing a visible brace during a critical developmental stage may negatively affect self-esteem, body image, emotional regulation, and peer relationships. These challenges are especially salient for adolescent girls, who tend to be more sensitive to body image and social acceptance.

Given these multidimensional impacts, quality of life (QoL) has emerged as a crucial outcome indicator in the management of AIS, complementing traditional biomedical measures such as curve magnitude and radiographic progression (Khoudri, 2024). Health-related quality of life encompasses physical functioning, emotional well-being, vitality, social engagement, and school participation, domains highly relevant to adolescents' daily lives. Evidence consistently indicates that adolescents receiving brace treatment may experience reduced QoL, particularly in the physical and emotional domains. However, QoL outcomes vary considerably across individuals, suggesting the influence of modifiable behavioral and contextual factors (Hidayati et al., 2022).

Physical activity is widely recognized as a key determinant of physical health, psychological resilience, and social development during adolescence. Regular physical activity contributes to musculoskeletal strength, emotional regulation, and stress reduction, while also supporting social interaction and a sense of normalcy (Moradi et al., 2022). Despite these benefits, adolescents with AIS often reduce or avoid physical activity due to fear of pain, uncertainty regarding safety, or perceived limitations associated with brace use (Ha et al., 2022). This reduction in activity may further exacerbate physical deconditioning and psychosocial distress, creating a negative cycle that adversely affects quality of life. Among various forms of physical activity, swimming is often recommended for adolescents with scoliosis due to its low-impact nature and minimal spinal loading (Palomargareta & Astutik, 2024). The buoyancy of water allows symmetrical muscle activation and reduces gravitational stress on the spine, making swimming a potentially suitable and safe activity during brace treatment. Although swimming is commonly advised in clinical practice, empirical evidence examining its association with quality-of-life outcomes among brace-treated adolescents remains limited and inconsistent (Rara Dewi Putri Rahmadani et al., 2024).

A critical gap in the existing literature lies in the insufficient exploration of the relationship between physical activity participation and quality of life among adolescent girls with idiopathic scoliosis who are undergoing brace treatment. Many previous studies have focused predominantly on clinical outcomes or psychological distress, with less attention given to everyday lifestyle

behaviors such as physical activity. Furthermore, available evidence is largely derived from high-income countries, limiting its applicability to developing country contexts where access to supportive services, health education, and structured rehabilitation programs may differ substantially.

The novelty of the present study lies in its focused examination of physical activity participation, specifically swimming, and its association with multiple domains of quality of life among adolescent girls receiving conservative scoliosis treatment. By using a scoliosis-specific quality-of-life instrument and emphasising a modifiable behavioural factor, this study contributes to a more holistic understanding of adolescent health in the context of chronic musculoskeletal conditions. From a public health perspective, identifying accessible and safe strategies to enhance quality of life during brace treatment may inform more comprehensive scoliosis management programs that integrate physical, psychological, and social dimensions of care.

RESEARCH METHODOLOGY

Study Design

This study employed a quantitative, cross-sectional design to examine the relationship between physical activity participation and quality of life among adolescent girls with idiopathic scoliosis undergoing brace treatment. The cross-sectional design was selected to allow simultaneous assessment of exposure (physical activity participation) and outcome (quality of life) within a defined population at a single point in time.

Study Setting and Period

The study was conducted between January and June 2025 in a rehabilitation and orthotic–prosthetic service setting, involving adolescents receiving conservative scoliosis management with spinal bracing.

Population and Sample

The study population consisted of adolescent girls diagnosed with adolescent idiopathic scoliosis (AIS) who were undergoing brace treatment. A total of 50 respondents were recruited using a purposive sampling technique, based on predefined inclusion and exclusion criteria.

Inclusion Criteria

Participants were eligible if they:

- Were female adolescents aged 10–18 years
- Had a confirmed diagnosis of idiopathic scoliosis
- Had been using a spinal brace for at least six months
- We were not undergoing surgical treatment
- We're in good general health
- Provided informed consent (with parental consent for minors)

Exclusion Criteria

Participants were excluded if they:

- Had congenital or neuromuscular scoliosis
- Had a history of spinal surgery
- Had severe neurological disorders
- Had communication or cognitive limitations that could interfere with questionnaire completion

Variables

Independent Variable: Physical activity participation, measured by the frequency of swimming activities per week

Dependent Variable: Quality of life

Covariates: Age and duration of brace use

Data Collection Instruments

Data were collected using a structured questionnaire consisting of two main components: Demographic and Clinical Characteristics, Including age, duration of brace use, and frequency of swimming activity.

Quality of Life Assessment

Quality of life was measured using the Brace Questionnaire (BrQ), a scoliosis-specific instrument designed for adolescents undergoing brace treatment. The BrQ consists of 34 items covering eight domains:

- Physical functioning
- Emotional functioning
- Self-esteem and body image
- Vitality
- Social functioning
- School activity
- Bodily pain

General health perception

The BrQ has demonstrated good validity and reliability in assessing health-related quality of life among adolescents with idiopathic scoliosis.

Measurement of Physical Activity

Physical activity participation was assessed by self-reported swimming frequency per week, as swimming is commonly recommended as a safe, low-impact exercise for adolescents with scoliosis. Physical activity was categorized into:

Low participation: 1–2 times per week

High participation: ≥ 3 times per week

Data Collection Procedure

Data were collected electronically using online questionnaires distributed through secure messaging applications to ensure accessibility and convenience. Participants completed the questionnaire independently, with guidance provided when necessary to ensure accurate responses.

Data Analysis

Data analysis was performed using SPSS and included the following steps: Univariate Analysis: Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarise participant characteristics and quality-of-life scores. Bivariate Analysis: Independent t-tests were conducted to examine differences in quality-of-life domain scores based on physical activity participation.

Ethical Considerations

This study received ethical approval from the relevant institutional ethics committee. Written informed consent was obtained from all participants and their parents or guardians. Confidentiality and anonymity of participant data were strictly maintained throughout the research process.

RESULT

This section presents the study's findings on the quality of life of adolescent girls with idiopathic scoliosis undergoing brace treatment, with particular emphasis on participation in physical activity. The results are organized to describe respondent characteristics, distribution of

quality-of-life scores across domains, and the relationship between swimming frequency and quality of life. Univariate, bivariate, and multivariate analyses are reported to highlight significant differences and predictors influencing overall quality of life during brace treatment.

Table 1. Bivariate Analysis of Quality-of-Life Domains

Characteristics	n	%
Age (years)		
10–11	7	14.0
12–15	28	56.0
16–18	15	30.0
Duration of brace use		
6–12 months	19	38.0
>12 months	31	62.0
Physical activity participation (swimming)		
1–2 times/week	30	60.0
≥3 times/week	20	40.0

The majority of respondents were aged 12–15 years (56.0%), indicating that most participants were in early to mid-adolescence. More than half of the adolescents had been using a spinal brace for over 12 months (62.0%), suggesting prolonged exposure to brace treatment. Regarding physical activity participation, most respondents reported swimming one to two times per week (60.0%), while a smaller proportion engaged in swimming three or more times per week (40.0%). Overall, these findings reflect a predominantly mid-adolescent sample with long-term brace use and moderate levels of physical activity participation.

Table 2. Distribution of quality-of-life scores based on BRQ domains

Quality of Life Domain	Mean	SD
Physical functioning	73.8	9.1
Emotional functioning	74.5	8.7
Self-esteem & body image	68.1	9.7
Vitality	72.6	8.9
School activity	76.9	8.4
Bodily pain	65.3	10.1
Social functioning	78.6	9.2
Total quality of life score	72.4	8.6

The overall mean total quality-of-life score was 72.4 ± 8.6 , indicating a moderate level of quality of life among adolescents undergoing brace treatment. The highest mean scores were observed in the social functioning (78.6 ± 9.2) and school activity (76.9 ± 8.4) domains, suggesting that most adolescents were able to maintain social interactions and academic activities. In contrast, lower mean scores were found in the bodily pain (65.3 ± 10.1) and self-esteem and body image (68.1 ± 9.7) domains, indicating that physical discomfort and appearance-related concerns were the most affected aspects of quality of life. The remaining domains, physical functioning, emotional functioning, and vitality, showed moderate scores, reflecting a balance between physical limitations and psychosocial adaptation during brace use.

Table 3. Analysis of quality-of-life domains by physical activity participation

Quality of Life Domain	1–2 times/week (Mean $\pm$ SD)	≥ 3 times/week (Mean $\pm$ SD)	<i>p</i> -value
Physical Functioning	70.9 $\pm$ 8.4	78.1 $\pm$ 7.2	0.021
Emotional Functioning	71.8 $\pm$ 8.1	78.6 $\pm$ 7.4	0.032
Vitality	69.7 $\pm$ 8.6	77.1 $\pm$ 7.9	0.018
Self-esteem & Body Image	66.4 $\pm$ 9.3	70.7 $\pm$ 9.8	0.087
Social Functioning	76.9 $\pm$ 8.8	81.3 $\pm$ 9.1	0.064
Total Quality of Life Score	70.1 $\pm$ 8.1	76.2 $\pm$ 7.8	0.027

Independent t-test; significance level $p < 0.05$

The analysis demonstrated that adolescents who participated in swimming three or more times per week had significantly higher quality-of-life scores compared to those with lower physical activity participation. Statistically significant differences were observed in physical functioning, emotional functioning, vitality, and overall quality of life ($p < 0.05$). Although higher mean scores were also observed in the self-esteem, body image, and social functioning domains among more physically active adolescents, these differences did not reach statistical significance. These findings suggest that regular physical activity, particularly swimming, is positively associated with key physical and psychological dimensions of quality of life among adolescent girls undergoing brace treatment for idiopathic scoliosis.

The results indicate that adolescents who engaged in swimming three or more times per week had significantly better quality-of-life outcomes than those with lower physical activity levels. Significant improvements were found in physical functioning, emotional functioning, vitality, and overall quality of life. Although self-esteem and social functioning scores were higher among more physically active adolescents, these differences were not statistically significant. Overall, regular swimming was positively associated with enhanced physical and psychological well-being in adolescent girls undergoing brace treatment for idiopathic scoliosis.

DISCUSSION

This study examined the quality of life of adolescent girls with idiopathic scoliosis undergoing brace treatment. It explored the role of physical activity participation, particularly swimming, in shaping quality-of-life outcomes. The findings demonstrate that overall quality of life among respondents was moderate, with notable variation across domains and a significant association between higher physical activity frequency and improved physical, emotional, and vitality-related outcomes. These results underscore the multifactorial nature of quality of life in adolescents receiving conservative scoliosis management and highlight physical activity as a potentially modifiable determinant.

The moderate overall quality-of-life score observed in this study is consistent with previous literature, indicating that brace treatment, while clinically effective in preventing curve progression, often imposes physical and psychosocial burdens on adolescents (Rizkiya & Pratolo, 2023). Prolonged brace use has been associated with discomfort, movement restriction, and emotional strain, which may collectively suppress quality-of-life perceptions (Sam et al., 2024). The predominance of respondents aged 12–15 years is particularly relevant, as early to mid-adolescence represents a critical developmental stage characterised by rapid physical changes, heightened body awareness, and increased sensitivity to peer acceptance. Brace wear during this period may therefore intensify emotional responses and influence self-perception, contributing to the moderate quality-of-life outcomes observed (Tapado, 2025).

Domain-specific analysis revealed that bodily pain and self-esteem/body image were the lowest-scoring aspects of quality of life (Wakuma, 2025). This finding aligns with existing evidence indicating that pain and discomfort are common consequences of brace treatment, especially during prolonged daily wear. Persistent pressure, skin irritation, and restricted mobility may contribute to physical discomfort, which in turn can reduce vitality and participation in daily activities (Yu et al., 2023). Lower scores in the self-esteem and body image domain further reflect the psychosocial impact of visible brace use among adolescent girls, who may experience embarrassment, self-consciousness, or concerns about physical appearance. These psychosocial challenges are well documented and underscore the importance of addressing emotional and psychological well-being alongside physical treatment goals (Sunarto et al., 2023).

Conversely, relatively higher scores in the social functioning and school activity domains suggest that many adolescents maintained social relationships and academic engagement despite brace use (Sunarto et al., 2026). This finding may indicate adaptive coping mechanisms and supportive environments that facilitate continued participation in daily life (Gusma & Indasah, 2022). Family support, peer acceptance, and school accommodations may play a protective role in preserving social and educational functioning (Yusuf et al., 2021). From a public health perspective, these results highlight the value of supportive social contexts in mitigating the negative impact of chronic orthopaedic conditions during adolescence (Chukwuemeka et al., 2024).

A central contribution of this study is the demonstrated association between physical activity participation and quality-of-life outcomes. Adolescents who engaged in swimming three or more times per week exhibited significantly higher scores in physical functioning, emotional functioning, vitality, and overall quality of life compared to those with lower activity levels (Murray et al., 2020). These findings suggest that regular physical activity may help counteract some of the physical and psychological challenges associated with brace treatment. Swimming, as a low-impact and symmetrical activity, allows adolescents to remain active without excessive spinal loading, potentially reducing pain and enhancing mobility (Vij et al., 2022).

The significant improvement in emotional functioning among more physically active adolescents is particularly noteworthy. Physical activity has been shown to promote psychological well-being through multiple mechanisms, including stress reduction, mood enhancement, and increased self-efficacy. For adolescents undergoing brace treatment, regular swimming may also provide a sense of normalcy and autonomy, helping them feel less defined by their medical condition. This psychological benefit may partially explain the higher vitality scores observed among adolescents who engage in greater physical activity (Dodge et al., 2022).

Although differences in self-esteem and social functioning were not statistically significant, higher mean scores in these domains among more active adolescents suggest a positive trend. The lack of statistical significance may be attributable to the relatively small sample size or the cross-sectional design, which limits the ability to capture longer-term psychosocial adaptations. Nonetheless, these trends suggest that sustained physical activity engagement may contribute to gradual improvements in self-confidence and social participation over time.

The findings of this study have important implications for the conservative management of scoliosis and adolescent health promotion. Traditionally, brace treatment has been perceived as a limiting factor for physical activity, leading some adolescents to adopt sedentary behaviors due to fear of pain or uncertainty about activity safety. The present results challenge this perception by demonstrating that regular, appropriate physical activity is not only feasible but also beneficial for quality of life during brace treatment. Integrating physical activity counseling into scoliosis

care may therefore represent a practical strategy to enhance both physical and psychosocial outcomes.

Several limitations should be considered when interpreting these findings. The cross-sectional design precludes causal inference, and reliance on self-reported physical activity may introduce recall bias; additionally, the focus on swimming limits generalizability to other forms of physical activity. Future longitudinal studies with larger samples and objective measures of physical activity are warranted to elucidate further the causal pathways linking physical activity and quality of life in adolescents with idiopathic scoliosis. This study reinforces the importance of adopting a holistic, adolescent-centred approach to scoliosis management. While brace treatment remains essential for clinical outcomes, attention to physical activity participation and psychosocial well-being is critical for optimizing quality of life. Promoting safe and regular physical activity, such as swimming, may serve as a valuable adjunct to conservative treatment and support healthier developmental trajectories for adolescents with idiopathic scoliosis.

CONCLUSION

This study concludes that the overall quality of life of adolescent girls with idiopathic scoliosis undergoing brace treatment is at a moderate level. The lowest quality-of-life scores were observed in the bodily pain and self-esteem/body image domains, indicating that physical discomfort and psychosocial concerns remain significant challenges during prolonged brace use. Importantly, greater participation in physical activity, particularly regular swimming, was significantly associated with better physical functioning, emotional well-being, vitality, and overall quality of life. These findings suggest that appropriate physical activity plays a meaningful role in supporting both physical and psychological adaptation during conservative scoliosis management.

Healthcare providers should integrate structured physical activity guidance, particularly safe, low-impact activities such as swimming, into brace treatment programs for adolescents with idiopathic scoliosis. Multidisciplinary collaboration involving clinicians, families, and schools is recommended to encourage continued physical activity and provide psychosocial support. Future research should employ longitudinal designs with larger samples to examine causal relationships and explore the effects of different types of physical activity on quality-of-life outcomes.

Acknowledgement

The authors would like to express their sincere gratitude to STIKES Bethesda Yakkum Yogyakarta for the academic support and facilitation provided throughout the research process. Appreciation is also extended to the orthotic and prosthetic clinic in Mojokerto for their cooperation and assistance during data collection. The authors are grateful to all adolescent participants and their families for their willingness to participate and for their valuable contributions to this study.

Conflict of Interest

There are no potential conflicts of interest relevant to this article.

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