International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	THERAPEUTIC CLIMBING IN REHABILITATION: A NARRATIVE REVIEW
ARTICLE INFO	Władysław Hryniuk, Julia Kwiecińska, Jacek Sitkiewicz, Alicja Toczyłowska, Mateusz Muras, Łukasz Bialic, Lidia Mądrzak, Marta Korchowiec, Wiktor Chrzanowski, Katarzyna Krzyżanowska. (2025) Therapeutic Climbing in Rehabilitation: A Narrative Review. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3446
DOI	https://doi.org/10.31435/ijitss.3(47).2025.3446
RECEIVED	30 May 2025
ACCEPTED	01 July 2025
PUBLISHED	12 July 2025
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THERAPEUTIC CLIMBING IN REHABILITATION: A NARRATIVE REVIEW

Władysław Hryniuk *(Corresponding Author, Email: wlad.hryniuk@gmail.com)*
University Clinical Hospital in Opole, aleja Wincentego Witosa 26, 46-020 Opole, Poland
ORCID ID: 0009-0009-8653-468X

Julia Kwiecińska
University Clinical Hospital in Opole, aleja Wincentego Witosa 26, 46-020 Opole, Poland
ORCID ID: 0009-0004-0924-6063

Jacek Sitkiewicz
Silesian Centre for Heart Diseases in Zabrze, Marii Skłodowskiej-Curie 9, 41-800 Zabrze, Poland
ORCID ID: 0009-0006-0889-0652

Alicja Toczyłowska
University Clinical Hospital in Opole, aleja Wincentego Witosa 26, 46-020 Opole, Poland
ORCID ID: 0009-0007-3155-0573

Mateusz Muras
University Clinical Hospital in Opole, aleja Wincentego Witosa 26, 46-020 Opole, Poland
ORCID ID: 0009-0003-4536-6006

Łukasz Bialic
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warszawa, Poland
ORCID ID: 0000-0003-4837-5920

Lidia Mądrzak
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warszawa, Poland
ORCID ID: 0009-0005-9516-911X

Marta Korchowiec
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warszawa, Poland
ORCID ID: 0009-0008-3365-4728

Wiktor Chrzanowski
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warszawa, Poland
ORCID ID: 0009-0008-0820-1452

Katarzyna Krzyżanowska
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warszawa, Poland
ORCID ID: 0009-0009-3306-0804

ABSTRACT

Introduction and objective: Climbing has recently emerged as a promising form of movement therapy, combining physical and psychological benefits. This review aims to provide a comprehensive overview of current evidence regarding the therapeutic application of sport climbing—particularly bouldering and top-rope climbing—in rehabilitation settings. It focuses on its use in treating postural defects, neurological disorders, psychiatric conditions, and developmental disorders in children.

Review methods: The review is based on studies retrieved from PubMed, Google Scholar, ResearchGate, and other scientific databases. Included materials comprise clinical and preclinical studies, randomized trials, case reports, and reviews related to the use of sport climbing in rehabilitation.

State of knowledge: Therapeutic climbing has demonstrated benefits across diverse clinical populations, including individuals with chronic low back pain, scoliosis, multiple sclerosis, Parkinson's disease, traumatic brain injury, cerebral palsy, ADHD, and autism spectrum disorders. Reported outcomes include improved balance, coordination, muscle strength, proprioception, mood regulation, and cognitive function. Climbing is also associated with enhanced motivation and social integration. However, limitations remain, such as the lack of standardised protocols, a scarcity of high-quality RCTs, and limited long-term data.

Conclusion: Climbing integrates physical exertion, neuromotor coordination, and emotional engagement, making it a multifaceted rehabilitation tool. Its ability to promote neuroplasticity and whole-body engagement suggests significant untapped potential. Nonetheless, to validate its clinical utility and ensure safety, there is a need for robust, standardised research and structured implementation protocols supervised by qualified professionals.

KEYWORDS

Climbing, Rehabilitation, Movement Therapy, Mental Health, Pediatrics, Sensorimotor Integration

CITATION

Władysław Hryniuk, Julia Kwiecińska, Jacek Sitkiewicz, Alicja Toczyłowska, Mateusz Muras, Łukasz Bialic, Lidia Mądrzak, Marta Korchowiec, Wiktor Chrzanowski, Katarzyna Krzyżanowska. (2025) Therapeutic Climbing in Rehabilitation: A Narrative Review. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3446

Introduction.

In the domain of rehabilitation and sports medicine, there is an increasing interest in movement therapies that not only demonstrate physiotherapeutic efficacy but also promote a high level of patient involvement. One form of physical activity that is gaining prominence as a potential tool to support the therapeutic process is sport climbing. Originally associated with extreme challenges, this activity is now being increasingly adapted to clinical and rehabilitative settings.

Sport climbing is characterised by a complex movement profile, involving numerous musculoskeletal, nervous, and proprioceptive components. The activity demands a high level of muscular strength, as well as precise postural control and motor coordination. From a neuromuscular re-education perspective, this makes climbing a valuable and appealing option [1,2]. The body of the climber functions as an integrated biomechanical system, in which movement patterns – such as wall pulls, hangs or dynamic jumps – generate significant loads, especially in the upper limbs .

A substantial body of scientific evidence supports the efficacy of climbing as a therapeutic intervention for patients suffering from a range of physical health problems. Clinical studies have demonstrated that top rope climbing can enhance range of motion and alleviate symptoms in patients diagnosed with haemophilia and advanced arthropathy, without resulting in joint deterioration [3]. It is evident that regular climbing training, encompassing bouldering, can enhance balance, coordination, and the strength of both upper and lower limbs. This has significant applications in both fall prevention and post-traumatic therapy [4].

However, the intensive loading of specific muscle groups carries the risk of overload, particularly in the shoulders, spine, and fingers [5]. Postural patterns that are characteristic of climbers have also been shown to lead to alterations in spinal curvature and compensatory muscle strains, such as contractures of the pectoral muscles[6].

In addition to its physical and functional benefits, climbing is increasingly recognised for its potential role in mental health rehabilitation. In recent years, there has been growing interest in the integration of physical activities with a complex psychomotor profile into psychiatric therapies. Climbing – and particularly bouldering, a rope-free form of climbing performed on low walls with protective mats – has shown promising therapeutic effects in the treatment of psychiatric disorders, including depression, anxiety, and cognitive impairments. Research indicates that such interventions can reduce psychiatric symptoms, improve emotional regulation, and foster a sense of empowerment and self-efficacy [7].

The objective of this paper is to provide a comprehensive review of the extant literature concerning the utilisation of sport climbing as a rehabilitation support strategy. The discussion encompasses the physical, functional, and psychological benefits of this form of therapy, as well as its potential limitations and risks. The paper also identifies significant research gaps, including the absence of standardisation in therapeutic protocols, the paucity of studies incorporating control groups, and the dearth of long-term data.

Objective

To provide a comprehensive overview of current scientific evidence on the therapeutic use of sport climbing—particularly bouldering and top-rope climbing—in rehabilitation. The review aims to assess its physical, neurological, and psychological benefits across various patient populations, and to identify potential clinical applications, limitations, and areas for future research.

Biomechanical aspects of climbing

1. Activation of muscle groups

The flexors of the fingers (m. flexor digitorum profundus, m. flexor digitorum superficialis), the muscles of the forearm and the muscles of the arms, including the m. biceps brachii, show the greatest involvement in climbing. The muscles of the back, including the m. latissimus dorsi and the parallelogram muscles, also play an important role [8,9]. The specific muscles targeted vary depending on the type of grip and body position employed. For instance, the "lock-off" position (where the elbow joint is flexed) has been shown to engage the muscles of the shoulder, pectoralis major, and the stabilising muscles of the scapula [1].

2. The significance of the lower limbs

Despite the common association of climbing with upper limb activity, the effective use of the lower limbs is crucial to the economy of movement. The quadriceps of the thigh, the gluteal muscles and the ischiofemoral group are responsible for straightening the knees and hips, allowing the body to move dynamically upwards [8]. The ability to control the position of the hips and the development of eccentric force have been demonstrated to affect the quality and efficiency of movement in the vertical plane.

3. Foot muscle function

The muscles of the foot, particularly those responsible for toe flexion and the muscles that facilitate pronation and supination, play a pivotal role in ensuring the foot is positioned accurately on the grips. Frequently, the contact surface is confined to a diminutive area, such as the tip of a climbing shoe. This necessitates a superior level of neuromuscular control in the foot and ankle joint [2].

4. Neurophysiological conditions of climbing

Climbing activates numerous structures of the central and peripheral nervous system. The cerebellum, a key player in motor coordination and correction of errors, assumes a particularly salient role. Concurrently, the prefrontal and motor cortex, integral to the planning and initiation of motor sequences, also demonstrate significant involvement [10]. The motor complexity inherent to climbing necessitates continuous neuromotor adaptation to changing environmental conditions.

5. Sensory-motor integration

The effective performance of climbing tasks is contingent upon the integration of sensory information – that is to say, visual, proprioceptive and vestibular – with motor responses. The activation of the sensory cortex and sensorimotor pathways facilitates the dynamic adjustment of muscle tone and body position to the demands of current movement [11]. It can therefore be concluded that climbing training has the capacity to stimulate neuroplasticity, which has applications in the domain of neurological rehabilitation.

6. Central stabilisation and deep muscle function

Climbing necessitates the stabilisation of the body both locally and globally. The deep muscles of the trunk, including the transversus abdominis, multifidus m., diaphragm and pelvic floor muscles, play a pivotal role in ensuring spinal stability during dynamic limb movements [8,12]. The absence of sufficient central control results in compensation and the application of excessive loads to the limbs.

7. Importance of the spine

The vertebral column constitutes the axial load-bearing structure between the limbs, whilst concurrently enabling the adaptation of posture to changing climbing conditions. During movement, the spine undergoes complex rotations, flexions and extensions, a process facilitated by the superficial and deep muscles of the back. It is imperative to stabilise the lumbar and thoracic spine when executing dynamic movements and hovers with the trunk fully extended. Abnormalities in spinal control can result in overloads, especially in the cervical and lumbar segments, thus emphasising the importance of central stabilisation training [8].

Orthopaedic rehabilitation using therapeutic climbing

1. Climbing for Chronic Low Back Pain

A randomized controlled study by Engbert and Weber demonstrated significant improvements in pain levels and functional capacity among patients with chronic low back pain following a therapeutic climbing intervention, underscoring its efficacy as a dynamic alternative to conventional physiotherapy approaches [13]. Similar benefits were reported by Kim and Seo, whose study observed enhanced muscle activation and improved quality-of-life outcomes (as measured by SF-36) in patients with lower back pain participating in a therapeutic climbing program [14].

2. Climbing in the Management of Scoliosis

Climbing has also shown promise in managing spinal deformities. Yuan et al. reported that scoliosis-specific physiotherapeutic exercises, including climbing modalities, resulted in notable improvements in posture and spinal curvature in patients with mild juvenile scoliosis [15]. These findings are in line with Berdishevsky et al.'s comprehensive review, which emphasized climbing's role as part of scoliosis-specific training across several international schools of thought [16]. The review highlighted that climbing fosters trunk stabilization and promotes symmetrical muscle engagement, both of which are critical in scoliosis management.

3. Climbing After Upper Limb Fractures

Exercise has been shown to reduce impairment and improve activity levels following upper limb fractures. Bruder et al. systematically reviewed the evidence and concluded that targeted therapeutic exercise, which may include climbing-based regimens, plays a crucial role in functional recovery [17]. Climbing's closed kinetic chain characteristics and progressive load modulation make it particularly suited for post-fracture rehabilitation, offering both load-bearing and range-of-motion benefits in a controlled environment.

The use of therapeutic climbing in neurological rehabilitation

1. Parkinson's disease

It is evident that regular participation in a therapeutic climbing programme can result in significant functional benefits for patients diagnosed with Parkinson's disease. In a randomised controlled trial, a 12-week climbing intervention was shown to significantly improve motor function as measured by the MDS-UPDRS-III scale, outperforming the effects of classical balance and stretching exercises [18]. In addition, a favourable change in posture was observed, as indicated by a decrease in C7SVA following the intervention [19]. Furthermore, patients reported improvements in range of motion, balance, muscle strength and body awareness, which significantly translated into improved well-being and psychosocial functioning [20].

2. Multiple sclerosis (MS)

It is evident that therapeutic climbing can serve as an efficacious element within a comprehensive rehabilitation management strategy for individuals diagnosed with multiple sclerosis. A body of research suggests that this type of activity has the potential to enhance various aspects of physical fitness, including balance, proprioception and coordination. Moreover, subjects participating in climbing programmes reported heightened motivation for therapy, a sense of agency, and positive self-evaluation. A further study yielded a 32.5 per cent reduction in fatigue levels, in addition to improvements in cognitive functions such as movement planning and attention [21].

3. Traumatic brain injury (TBI)

The utilisation of therapeutic climbing as a therapeutic modality for patients suffering from traumatic brain injury has also been documented. It has been demonstrated that due to the repetition of movement patterns that are characterised by a high degree of complexity, there is a stimulation of neuroplasticity and sensory-motor integration processes. Research has demonstrated that patients suffering from TBI demonstrate enhancements in eye-hand coordination, postural stabilisation, and the control of upper limb movements. It is important to note that climbing also has a positive impact on self-esteem and mental health, including through teamwork and the ability to overcome individual physical limitations [22].

4. Children with cerebral palsy (MPD)

In the treatment of children diagnosed with cerebral palsy, the incorporation of adaptive climbing as a supplementary modality to conventional rehabilitation has been demonstrated to be a highly effective strategy. A plethora of studies have demonstrated that climbing training has the capacity to enhance muscle strength, balance, and social skills [23]. Furthermore, research has demonstrated that a hand therapy approach with a primary focus on climbing activities has been shown to enhance various parameters in patients diagnosed with MPD. These include an increase in wrist joint range of motion, grip strength, and body awareness [24]. Whilst these results are encouraging, they pertain to adults and further research is required to ascertain whether analogous outcomes can be achieved in children.

The use of therapeutic climbing in the treatment of psychiatric disorders

1. Depression and affective symptoms

A mounting body of empirical evidence suggests that bouldering can serve as an effective adjunctive intervention for depression. In a randomised controlled trial, Luttenberger et al. demonstrated that bouldering psychotherapy (BPT) was not inferior to standard cognitive-behavioural therapy (CBT) in terms of effectiveness in treating depression in a group setting [25]. A notable study by Karg et al. compared BPT with general physical activity, demonstrating a significantly greater reduction in depressive symptoms in the climbing intervention group [26].

Long-term data also demonstrate the persistence of the therapeutic effects of bouldering. According to Schwarz et al., a 12-month follow-up assessment revealed that the mental health benefits achieved through bouldering psychotherapy were sustained over time, indicating the long-term efficacy of this intervention[27]. These findings are further substantiated by pilot studies, which demonstrated a significant reduction in depressive symptoms following several weeks of climbing interventions [28].

It is important to note that the therapeutic effect of climbing is not solely a consequence of physical activity per se. Stelzer et al. conducted a study with a control for the level of general physical activity and yet reported a significant reduction in depressive symptoms. This suggests that additional factors such as cognitive and emotional engagement may also be a contributing factor [29].

2. Anxiety disorders and emotion regulation

Climbing, as an activity that necessitates exposure to moderate psychophysical stress within a safe environment, can be regarded as a form of controlled exposure. A study by Kleinstäuber et al. found that patients suffering from a major depressive episode experienced improvements in their ability to regulate emotions immediately after climbing sessions [30]. It is hypothesised that this mechanism may also apply in the context of anxiety disorders, particularly those related to the avoidance of stressful situations.

3. Cognitive functions, self-evaluation and decision-making processes

The positive impact of therapeutic climbing on executive functions, including concentration, working memory, cognitive flexibility and planning, has been well-documented. Kratzer et al. observed an increase in self-efficacy among participants in bouldering therapy, which translated into their functioning in everyday life outside the therapeutic context [31].

Conversely, Medernach and Memmert conducted an experimental study in which they demonstrated that bouldering, as a task requiring dynamic adaptation to changing conditions, stimulates the development of decision-making abilities and adaptive problem-solving strategies [32]. Consequently, the activity may provide a foundation for enhancing cognitive functioning and self-regulatory processes, which are pivotal in mood disorders and related conditions.

4. Social integration and motivation

Climbing, particularly in a group context, has been demonstrated to function as a medium for facilitating social reintegration. Michelsen et al. demonstrated that consistent engagement in therapeutic activities incorporating climbing elements fosters heightened intrinsic motivation, enhanced mood, and augmented social integration among patients undergoing psychiatric rehabilitation [33]. It is evident that such interventions, due to their low-threshold nature and appeal to participants, have the potential to serve as a valuable component of therapeutic programmes for individuals diagnosed with psychiatric disorders.

Rehabilitation of children and adolescents - use of climbing in the treatment of developmental disorders and sensory integration

1. Application to children with ADHD

It has been demonstrated that children diagnosed with attention deficit hyperactivity disorder (ADHD) responded positively to adapter climbing programs. Angelini et al. observed that children's participation in an adapted climbing program led to improvements in attention, impulse control, and overall cognitive functioning [34]. Concurrent findings were reported by Kadiyeva and Blagii, indicating a favorable impact of climbing on cognitive function and self-regulated behavior [35]. Furthermore, Lee and Song's case study documented a substantial reduction in hyperactivity symptoms and enhanced self-regulation in a child diagnosed with ADHD who engaged in climbing activities while wearing a weighted vest [36].

2. Supporting children with ASD

For children diagnosed with autism spectrum disorders (ASD), climbing has been demonstrated to be an effective tool for promoting social and cognitive development. In their seminal study, Kaplan-Reimer et al. pioneered the use of stimulus control procedures in the instruction of climbing skills in children diagnosed with ASD. This innovative approach not only rendered this form of therapy more accessible but also significantly enhanced its efficacy [37]. Climbing provides an opportunity for the formation of social relationships, the cultivation of a sense of agency, and the development of adaptive skills in a controlled environment.

3. Sensory integration

Climbing activities meet many of the criteria for Ayres Sensory Integration®-based therapy, combining motor challenges with intensive vestibular and proprioceptive stimulation. A systematic review by Schoen et al. showed that activities such as climbing can significantly improve emotional regulation and adaptive functioning in children with sensory integration disorders [38]. Climbing movements require planning, balance, coordination, and the conscious engagement of the entire body, which makes this form of therapy attractive and effective.

4. Application in child psychiatry

Climbing has also demonstrated positive outcomes in pediatric patients who have been admitted to the hospital for treatment of mental health disorders. In a pilot study, Müller et al. observed that inpatient climbing elicited positive emotional responses and a reduced mental tension. These results suggest that climbing may improve treatment tolerance and increase motivation for therapy[39].

Safety in climbing therapy

1. Types and mechanisms of injury

The most prevalent injuries associated with climbing pertain to the upper extremities, particularly the tendon structures of the fingers and shoulders. A comprehensive analysis of 201 injury cases revealed that micro-injuries and overloads predominate, particularly among individuals who engage in intensive training or lack adequate technical preparation [40]. In the younger population and novice climbers, the risk increases with improper belaying and poorly chosen levels of exercise difficulty [41].

2. Risk minimisation strategies

The objective of reducing the risk of injury is achieved through progressive adjustment of loads to the patient's capabilities, proper warm-up, and technically correct execution of exercises. The selection of the appropriate type of belay (e.g., "top rope") and the utilization of certified equipment are also paramount. The integration of elements of central stabilization and postural re-education has been demonstrated to provide additional support for injury prevention [28,41].

3. Safe implementation of therapy

The implementation of climbing as a therapeutic intervention necessitates a preliminary evaluation that includes a medical qualification and an assessment of potential contraindications. These contraindications may include unstable cardiovascular disease, balance disorders, severe psychiatric disorders, or a lack of patient cooperation. The qualification process should be conducted by a multidisciplinary team [40,41].

Substantive supervision during the session is equally important. The presence of qualified specialists (e.g., a physiotherapist or climbing therapist) makes it possible to adjust the difficulty on an ongoing basis, monitor for signs of overload, and ensure a rapid response in adverse situations [28].

Limitations and gaps in the literature

1. Quality of research

The preponderance of literature in this field is rooted in case studies and pilot studies, with the paucity of high-quality randomized controlled trials (RCTs) remaining an exception [25]. This limitation precludes the ability to draw definitive conclusions regarding the efficacy of climbing therapy.

2. Diversity of interventions

The forms of climbing utilized in these studies, such as bouldering and belay climbing, vary considerably, which hinders the ability to make comparisons and formulate clinical recommendations. However, there is a paucity of standardized treatment protocols [41].

3. Short-term nature of the data

The majority of studies in this field have focused exclusively on short-term effects, neglecting to assess the durability of the results or their impact on the patient's daily functioning. Long-term observations are scarce [28].

Conclusion and Discussion

The therapeutic benefits of climbing, particularly in its bouldering and top-rope forms, have been demonstrated to be a multifaceted intervention that integrates physical exertion, neuromotor coordination, and psychosocial engagement. The application of this technique has been supported by an expanding corpus of scientific literature, which has demonstrated its efficacy in a range of medical specialties, including orthopaedic rehabilitation, neurological therapy, psychiatric support, and the treatment of developmental disorders in children and adolescents. The reported benefits of this technique include increased muscular strength, proprioceptive enhancement, improved balance, and positive psychological effects such as reduced depressive symptoms and better emotional regulation.

The capacity of climbing to engage not only musculoskeletal structures but also the central and peripheral nervous systems is particularly promising. This engagement has been shown to promote neuroplasticity, motor learning and sensory integration. These qualities suggest that climbing is not merely another form of physical activity, but rather a complex therapeutic tool that offers meaningful engagement, challenge, and adaptability across a wide range of clinical populations.

It is imperative to emphasise the significance of effective implementation, encompassing meticulous medical qualification, risk management, and supervision by trained professionals. The absence of standardised therapeutic protocols and long-term outcome studies remains a critical limitation in current research, underlining the necessity for more robust and methodologically rigorous trials.

A particularly noteworthy element of the present analysis lies in the observation of biomechanical diversity in climbing movements. The section entitled "Biomechanical aspects of climbing" provides a comprehensive illustration of the extensive activation of multiple body systems, including the upper and lower limbs, trunk stabilisers, foot muscles, and sensory-motor circuits. Collectively, these systems reflect the inherent complexity and adaptability of the human body during climbing. This diversity of movement patterns suggests that the potential applications of climbing therapy may extend far beyond the current scope of evidence. Conditions involving motor deficits, postural control, proprioception, or central stabilization may all benefit from carefully tailored climbing interventions.

In light of this, it is argued that therapeutic climbing should not be viewed solely through the lens of current clinical applications. Instead, it should be regarded as a platform for broader rehabilitative strategies, with the potential to redefine standards in modern movement therapy upon further scientific validation.

Disclosures

Conceptualisation: Władysław Hryniuk

Methodology: Władysław Hryniuk, Katarzyna Krzyżanowska

Software: Władysław Hryniuk, Katarzyna Krzyżanowska

Check: Jacek Sitkiewicz, Julia Kwiecińska, Wiktor Chrzanowski

Formal analysis: Władysław Hryniuk, Jacek Sitkiewicz, Julia Kwiecińska

Investigation: Władysław Hryniuk, Jacek Sitkiewicz

Resources: Władysław Hryniuk, Łukasz Bialic, Mateusz Muras, Alicja Toczyłowska, Marta Korchowiec

Data curation: Władysław Hryniuk, Łukasz Bialic, Alicja Toczyłowska, Mateusz Muras, Marta Korchowiec, Lidia Mądrzak

Writing – rough preparation: Władysław Hryniuk, Lidia Mądrzak, Julia Kwiecińska

Writing – review and editing: Władysław Hryniuk, Wiktor Chrzanowski
Project administration: Władysław Hryniuk
All authors have read and agreed with the published version of the manuscript.

Funding Statement:
The study did not receive special funding.

Institutional Review Board Statement:
Not applicable.

Informed Consent Statement:
Not applicable.

Data Availability Statement:
Not applicable.

Acknowledgments:
Not applicable.

Conflict Of Interest:
The authors declare no conflict of interest.

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