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Injury profile, Biomechanical Hazards, and Holistic Health Benefits of Table Tennis: A narrative Review

Filip Chmielnicki, ORCID https://orcid.org/0009-0000-2314-1699
E-mail chmielnicki.filip6@wp.pl
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Gabriela Chwajta, ORCID https://orcid.org/0009-0004-0658-2096
E-mail gabriela.chwajta@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Gabriela Kaczor, ORCID https://orcid.org/0009-0002-4908-3591
E-mail gabi456654@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Barbara Cepielik, ORCID https://orcid.org/0009-0001-4068-2750
E-mail barbaracepielik12@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Weronika Cichocka, ORCID https://orcid.org/0009-0009-7581-1733
E-mail wera011012@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Gabriela Pirga, ORCID https://orcid.org/0009-0004-6558-3590
E-mail gabigabi20014@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Martyna Antos, ORCID https://orcid.org/0009-0009-9663-1811
E-mail a.martyna28@wp.pl
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Kacper Paczosa, ORCID https://orcid.org/0009-0005-2778-7493
E-mail paczosakacper@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Klaudia Jędruszko, ORCID https://orcid.org/0009-0002-3072-0626
E-mail klaudiajedruszko01@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Dominika Budzeń, ORCID https://orcid.org/0009-0008-3533-6520
E-mail budzen.dominika@gmail.com
Medical University of Lublin, Aleje Racławickie 1, 20-059 Lublin, Poland

Corresponding Author
Filip Chmielnicki, E-mail chmielnicki.filip6@wp.pl

Abstract

Background: Table tennis is a dynamic, asymmetrical racket sport with low acute injury rates. However, repetitive execution of technically demanding strokes exposures athletes to significant biomechanical loading and overuse disorders.

Aim: This review evaluates table tennis injury epidemiology, biomechanical mechanisms of overuse syndromes, preventive strategies, and the physical, cognitive, and neurorehabilitative benefits of participation.

Materials and Methods: A narrative review was conducted using PubMed, Scopus, and Web of Science databases, focusing on contemporary studies and landmark publications relevant to injury mechanisms, prevention, and health benefits.

Results: Epidemiological data show a low overall injury incidence (~3.6%, or 10 injuries per 1,000 exposure hours), with over 50% occurring during training. Repetitive topspin forehand and backhand strokes increase loading on the shoulder, upper extremity, and lumbopelvic region, contributing to overuse disorders. Prevention strategies emphasize core stability, muscular symmetry correction, eccentric strengthening, load monitoring, and recovery. Beyond competition, table tennis induces favorable cardiovascular, metabolic, and cognitive adaptations, enhancing neuroplasticity. Emerging evidence supports table tennis-based interventions for Parkinson's disease, showing improvements in balance, motor performance, and mobility.

Conclusions: Table tennis poses distinct biomechanical challenges but offers substantial health benefits. Targeted prevention is essential for competitive athletes, while recreational play serves as a safe, engaging activity supporting cognitive health and healthy aging.

Keywords: table tennis; sports injuries; biomechanics; injury prevention; neurorehabilitation; Parkinson's disease.

1. Introduction

Table tennis is one of the most popular racket sports worldwide and is characterized by a unique combination of speed, precision, technical skill, and tactical decision-making. Competitive play requires rapid reactions, precise visuomotor coordination, and the ability to perform repeated high-velocity movements under constantly changing conditions. Modern playing styles, particularly those based on topspin-oriented techniques, place considerable demands on both the neuromuscular and musculoskeletal systems.

Although table tennis is generally regarded as a safe non-contact sport, repetitive and predominantly unilateral movement patterns may contribute to the development of overuse-related musculoskeletal disorders. The shoulder complex, elbow, lumbar spine, and lower extremities are particularly exposed to repetitive mechanical loading during training and

competition. As a result, understanding the biomechanical factors associated with injury development has become an important area of research within sports medicine and rehabilitation.

In recent years, scientific interest in table tennis has extended beyond injury prevention and athletic performance. Owing to its combination of physical exertion and continuous cognitive engagement, the sport has increasingly been investigated as a health-promoting activity. During play, participants are required to integrate visual information, anticipate opponents' actions, adjust movement strategies, and make rapid decisions, while simultaneously performing repeated whole-body movements. These characteristics distinguish table tennis from many traditional forms of exercise and may contribute to a broad range of physical and cognitive benefits.

Particular attention has recently been directed toward the potential role of table tennis in healthy ageing and neurorehabilitation. Preliminary studies suggest that regular participation may support balance, coordination, executive functioning, and overall quality of life. Moreover, table tennis-based interventions have shown promising results in individuals with Parkinson's disease, where improvements in motor performance, postural control, and functional mobility have been reported. Although the underlying mechanisms remain incompletely understood, the combination of physical activity, sensorimotor stimulation, and cognitive challenge may provide a valuable therapeutic stimulus.

Therefore, the aim of this review was to summarize current evidence regarding the epidemiology of injuries in table tennis, describe the biomechanical mechanisms associated with common overuse disorders, discuss contemporary prevention and rehabilitation strategies, and examine the physical, cognitive, and neurorehabilitative benefits associated with participation in this sport.

2. Research Materials and Methods

This study was designed as a narrative review of the literature focusing on sports injuries, biomechanics, injury prevention, and health-related outcomes associated with table tennis participation.

A literature search was conducted in May 2026 using the PubMed, Scopus, and Web of Science databases. Additional searches were performed through Google Scholar to identify potentially relevant publications not retrieved through the primary databases. The search

strategy combined terms related to table tennis with concepts associated with sports traumatology, biomechanics, rehabilitation, and health promotion.

The following keywords and keyword combinations were used: “table tennis”, “sports injuries”, “overuse injuries”, “biomechanics”, “kinetic chain”, “shoulder injury”, “lateral epicondylitis”, “low back pain”, “injury prevention”, “neuromuscular training”, “physical activity”, “cognitive function”, “neuroplasticity”, and “Parkinson’s disease”.

Studies were considered eligible if they investigated at least one of the following topics: (1) epidemiology and risk factors of table tennis-related injuries, (2) biomechanical mechanisms associated with musculoskeletal loading and injury development, (3) prevention or rehabilitation strategies relevant to table tennis players, or (4) physical, cognitive, and neurorehabilitative effects of table tennis participation. Original research articles, systematic reviews, scoping reviews, and clinically relevant review papers published in peer-reviewed journals were considered for inclusion.

Publications unrelated to table tennis, conference abstracts, editorials, duplicate records, and studies lacking sufficient methodological or scientific detail were excluded from the review.

Particular attention was given to recent literature published within the last decade. However, earlier studies were also included when they represented landmark publications or provided important theoretical and clinical foundations for understanding injury mechanisms, movement biomechanics, or health-related adaptations associated with table tennis.

After screening the available literature and assessing its relevance to the objectives of the review, twenty-four publications were selected for detailed analysis. The evidence was synthesized using a qualitative narrative approach and organized into four thematic areas: injury epidemiology, biomechanical mechanisms of injury, injury prevention and rehabilitation, and health-related benefits of table tennis participation.

3. Research results

3.1. Incidence and Characteristics of Injuries According to the International Literature

Available epidemiological evidence indicates that table tennis is associated with a relatively low risk of injury compared with many other racket sports, including tennis and badminton. A systematic review involving 873 athletes reported an overall musculoskeletal injury prevalence of 3.6%, corresponding to approximately 10 injuries per 1,000 hours of exposure. Similar findings have been described in subsequent studies, supporting the view that acute traumatic injuries are relatively uncommon in table tennis [1–3].

Current data suggest that competitive level may influence injury risk more strongly than sex. Although slightly higher injury rates have been reported in male players than in female

players, the observed differences have not reached statistical significance. In contrast, injury occurrence appears to increase with competitive demands, with the highest rates reported during major international tournaments such as the Olympic Games and the Asian Games. This trend is likely related to greater training volumes, higher match intensity, and cumulative physical loading among elite athletes [1,2,4].

An important characteristic of table tennis is the substantial proportion of injuries occurring during training. More than half of all reported cases are sustained during practice sessions rather than competition. Moreover, the majority of injuries are classified as mild and do not require prolonged interruption of sports participation. Overuse disorders account for most musculoskeletal complaints, whereas acute traumatic injuries represent a considerably smaller proportion of reported cases [1,2].

Taken together, the available literature indicates that the principal health burden in table tennis is associated with repetitive mechanical loading rather than acute trauma. Consequently, preventive efforts should focus primarily on reducing cumulative overload and optimizing long-term training management.

3.1.1. Upper Extremity Biomechanics and Overuse Syndromes (Forehand/Backhand)

Modern table tennis relies on highly coordinated and predominantly asymmetrical movement patterns in which technical proficiency is a major determinant of performance. Among offensive techniques, the topspin stroke is both the most frequently used and one of the most biomechanically demanding. Efficient stroke execution requires coordinated interaction between the lower limbs, trunk, shoulder girdle, and upper extremity, allowing force to be transferred through successive body segments. This mechanism enables the generation of high racket velocity while maintaining stroke accuracy and spin production. Repetition of these movements during training and competition exposes the musculoskeletal system to substantial cumulative loading and contributes to the development of sport-specific overuse disorders [1,5].

The topspin forehand is considered one of the most powerful offensive strokes in table tennis. Biomechanical studies have shown that racket velocity is strongly influenced by internal shoulder rotation and arm adduction during the acceleration phase. However, effective force production depends on coordinated contributions from the entire body, particularly the lower extremities. Relationships have been demonstrated between racket speed and hip extension on the dominant side, hip flexion on the contralateral side, and coordinated ankle motion. The combination of dynamic weight transfer and rapid trunk rotation increases mechanical stress on both the shoulder complex and the lumbopelvic region. Therefore, adequate strength,

mobility, and neuromuscular control across all participating segments are essential not only for performance but also for limiting excessive tissue loading [1,5].

The biomechanical profile of the topspin backhand differs from that of the forehand. Kinematic analyses suggest that force generation is initiated primarily within the trunk and shoulder girdle before being transferred distally to the upper limb. During the acceleration and ball-contact phases, efficient stroke execution requires substantial activation of the scapular stabilizers and deltoid musculature. The final phase of racket acceleration depends largely on coordinated elbow extension and wrist dorsiflexion. Deficits in scapular control, shoulder stability, or neuromuscular coordination may alter movement mechanics and increase stress on the shoulder complex and lateral elbow structures during repetitive training [1,5].

These biomechanical demands are reflected in the injury profile observed among competitive players. Both forehand and backhand topspin strokes expose the shoulder girdle to repetitive rotational forces. Recurrent arm elevation, rapid acceleration, and repeated internal rotation may increase stress on the rotator cuff tendons and contribute to conditions such as subacromial impingement syndrome and rotator cuff tendinopathy. Long-term participation may also promote muscular imbalances within the shoulder girdle, altering the relationship between agonist and antagonist muscle groups. When accompanied by impaired scapular stabilization, these adaptations may disrupt normal scapulohumeral rhythm and further increase mechanical stress on periarticular tissues [1,5,6,11].

Lateral epicondylitis is another common overuse condition associated with table tennis. The repetitive combination of elbow extension and wrist dorsiflexion during backhand strokes places considerable eccentric and concentric loading on the wrist extensor tendons at their attachment to the lateral epicondyle. Over time, repeated mechanical stress may result in microtrauma, tendon degeneration, pain, and reduced grip strength. Although individual biomechanics, training volume, and recovery practices also influence injury development, repetitive loading associated with high-frequency backhand execution appears to play an important role in the pathogenesis of lateral elbow disorders in competitive players [1,5].

3.1.2. Lumbopelvic, Spinal, and Lower Extremity Pathomechanics

Although table tennis is often perceived primarily as an upper-extremity sport, effective stroke production depends on coordinated force generation throughout the entire body. The lower limbs and trunk play a central role in generating and transferring force during topspin strokes, making the lumbopelvic region particularly vulnerable to repetitive mechanical stress.

Rapid trunk rotation performed from an asymmetrical stance with sustained hip and knee flexion places substantial demands on the lumbar spine and surrounding structures. Repeated exposure to these movement patterns may contribute to low back pain, one of the most frequently reported musculoskeletal complaints among competitive players. Chronic loading may also promote postural adaptations, including asymmetries of the trunk and pelvis, which can alter movement mechanics and increase susceptibility to recurrent symptoms [1,5,6,7,20].

The lower extremities are equally important in maintaining performance and movement efficiency. Biomechanical studies indicate that high racket velocity is associated with coordinated lower-limb actions, particularly dominant-side hip extension and contralateral hip flexion. During match play, athletes repeatedly perform explosive accelerations, decelerations, and rapid changes of direction from low playing positions. These actions generate considerable loading within the hip and knee joints and may increase stress on the quadriceps mechanism and patellar tendon. Over time, repetitive unilateral demands may influence muscular balance, joint mobility, and force-distribution patterns within the lumbopelvic–hip complex, potentially contributing to the development of overuse-related disorders [1,5,6].

Neuromuscular fatigue represents an additional factor influencing injury risk. Competitive table tennis is characterized by repeated high-intensity actions separated by relatively short recovery periods. As fatigue develops, movement precision, joint stability, and neuromuscular control may gradually decline. Reduced proximal stability can lead to compensatory movement strategies and alter force distribution throughout the body, increasing mechanical stress on more vulnerable structures, including the shoulder, elbow, wrist, and ankle. These changes may lower tissue tolerance to repetitive loading and facilitate the development of overuse symptoms [4,8,9].

The injury profile observed in table tennis reflects these biomechanical demands. Most reported musculoskeletal conditions are chronic soft-tissue disorders rather than acute traumatic injuries. Tendinopathies, tenosynovitis, mild muscle strains, and ligament sprains constitute the majority of cases described in the literature. Upper-extremity complaints are commonly associated with high stroke repetition volumes, whereas lower-extremity disorders are more closely related to repeated accelerations, decelerations, and directional changes. Current evidence suggests that injury development is multifactorial and influenced by the interaction of training load, movement asymmetry, fatigue, recovery status, muscular imbalances, and neuromuscular control deficits [1,2,4,6,7,8].

Given these factors, physical conditioning remains a key component of injury prevention. Athletes with higher levels of strength, muscular endurance, and neuromuscular efficiency appear better equipped to tolerate the repetitive demands of training and competition. Consequently, contemporary prevention programmes should extend beyond the correction of isolated deficits and incorporate comprehensive strength training, neuromuscular conditioning, fatigue monitoring, recovery management, and sport-specific physical preparation [4,8,9].

3.2. Preventive Strategies and Contemporary Physical Therapy Approaches

Effective injury prevention in table tennis should address the repetitive and asymmetrical demands imposed by sport-specific movement patterns. Because stroke production depends on efficient force transfer between the lower limbs, trunk, and upper extremities, maintaining adequate trunk stability and lumbopelvic control is considered an important component of injury prevention. Training programmes aimed at improving neuromuscular control of the deep stabilizing musculature, including the transversus abdominis, multifidus, diaphragm, and pelvic floor muscles, may enhance movement efficiency and reduce excessive spinal loading. Commonly used interventions include dynamic stabilization exercises, progressive plank variations, anti-rotational training, and proprioceptive drills [4,5,6,7,8,10,11].

Long-term participation in table tennis may also contribute to sport-specific muscular asymmetries. For this reason, preventive conditioning programmes should incorporate exercises targeting the posterior chain, external shoulder rotators, and scapular stabilizers. Strengthening the middle and lower trapezius muscles, rhomboids, and other scapular stabilizing structures may help maintain normal scapulohumeral mechanics and reduce stress on the rotator cuff tendons and subacromial region [4,5,6,7,8,10,11].

Exercise-based interventions are widely used to improve tissue resilience and reduce the risk of overuse injuries. Eccentric and isometric strengthening programmes have demonstrated beneficial effects in the management of tendon-related disorders by improving load tolerance and supporting tissue adaptation. In athletes presenting with lateral epicondylitis, rehabilitation commonly includes progressive resistance exercises for the wrist extensors, frequently combined with manual therapy and soft-tissue treatment techniques. Similar principles are applied to the lower extremities, where eccentric quadriceps training,

plyometric exercises, and proprioceptive programmes are used to improve dynamic joint stability and reduce stress on the patellar tendon, knee, and ankle structures [1,5,9,10,12].

Given that a considerable proportion of injuries occur during training rather than competition, appropriate management of training load and recovery is essential. Injury-prevention strategies should balance training volume and intensity with adequate recovery periods to minimize the accumulation of excessive fatigue. Sleep plays a particularly important role in musculoskeletal recovery, neuromuscular function, and cognitive performance. Additional recovery methods, including sports massage, hydrotherapy, pneumatic compression, and self-myofascial release techniques, are frequently used to support post-exercise regeneration. Foam rolling, in particular, has been associated with reductions in perceived muscle soreness and improvements in short-term recovery outcomes [1,8,9,13,14].

Overall, the most effective prevention programmes appear to be those that combine individualized load management, strength and neuromuscular training, correction of functional asymmetries, and evidence-based recovery strategies. Such a comprehensive approach may reduce the risk of overuse injuries while supporting long-term athletic performance and musculoskeletal health [1,8,9,13,14].

3.3. Health Benefits of Playing Table Tennis

Beyond its competitive dimension, table tennis represents a form of physical activity that combines cardiovascular exercise, motor coordination, and cognitive engagement. Owing to its intermittent nature, the sport involves both aerobic and anaerobic energy systems. Regular participation has been associated with improvements in cardiorespiratory fitness, blood pressure regulation, and several markers of metabolic health, including body composition, insulin sensitivity, and lipid profile. In addition, the repeated performance of multidirectional movements may contribute to the development of balance, agility, and lower-limb muscular endurance, supporting functional mobility across different age groups [15,16, 17].

Table tennis has also attracted attention for its potential effects on cognitive functioning. Successful play requires continuous integration of visual information, sensorimotor coordination, anticipation, and rapid decision-making. Neuroimaging and behavioral studies suggest that long-term participation may be associated with adaptations in brain regions involved in executive functioning, attention, working memory, and motor control. In older

adults, regular engagement has been linked to improvements in processing speed, reaction time, and selected executive functions. Although current evidence does not support definitive conclusions regarding dementia prevention, the cognitive demands of table tennis may make it a useful component of strategies aimed at maintaining cognitive health during ageing [15,16,18,19,21].

Growing interest has also focused on the potential role of table tennis within neurorehabilitation programmes, particularly for individuals with Parkinson's disease. The sport combines physical activity with continuous sensory, motor, and cognitive stimulation, creating a challenging environment for motor learning and functional adaptation. Preliminary intervention studies have reported improvements in balance, gait performance, postural control, and functional mobility following structured table tennis training. Proposed mechanisms include enhanced sensorimotor integration, increased attentional engagement, and exercise-related neuroplastic adaptations. However, the available evidence remains limited by small sample sizes and relatively short intervention periods. Further randomized controlled trials are needed to clarify the clinical effectiveness of table tennis-based interventions and to establish evidence-based rehabilitation recommendations [22, 23, 24].

4. Discussion

The present review highlights the multifaceted nature of table tennis as a sport that combines relatively low rates of acute injury with substantial biomechanical demands. Although injury incidence remains lower than that reported in many other racket sports, the available evidence indicates that long-term participation may expose athletes to repetitive mechanical loading capable of contributing to overuse-related musculoskeletal disorders. This observation emphasizes the importance of considering not only injury frequency but also the cumulative effects of sport-specific movement patterns on the musculoskeletal system.

A consistent finding across the reviewed studies is the central role of biomechanics in both performance and injury development. Modern table tennis relies heavily on topspin-based techniques that require coordinated force generation and transfer across multiple body segments. The shoulder complex, lateral elbow structures, and lumbopelvic region appear particularly vulnerable to repetitive loading because of their involvement in stroke production and stabilization. While the overall injury burden is relatively modest, the predominance of chronic overuse conditions suggests that training-related exposure may represent a more

important determinant of injury risk than competition alone. This observation is supported by epidemiological data indicating that a substantial proportion of injuries occur during training sessions rather than during tournament play.

The reviewed literature also reinforces the importance of comprehensive prevention strategies. Contemporary approaches increasingly emphasize neuromuscular control, movement quality, management of sport-specific asymmetries, and appropriate regulation of training loads. Such recommendations are consistent with broader evidence from sports medicine demonstrating that injury prevention is most effective when it addresses the interaction between physical conditioning, movement mechanics, recovery, and workload management. In practical terms, these findings highlight the need for collaboration between coaches, physiotherapists, and strength and conditioning specialists to ensure that performance development is accompanied by adequate injury-prevention measures. Such an interdisciplinary approach may help balance performance development with long-term athlete health.

An additional observation emerging from the literature is the unique position of table tennis among physical activities. Unlike many traditional exercise modalities, the sport simultaneously challenges cardiovascular fitness, sensorimotor coordination, visuospatial processing, and rapid decision-making. This combination of physical and cognitive demands may explain why table tennis has attracted increasing attention as a health-promoting activity across different age groups. The available evidence suggests that regular participation may contribute not only to improvements in physical fitness and metabolic health but also to the maintenance of selected cognitive functions and overall quality of life.

Particular interest has recently focused on the potential application of table tennis in neurorehabilitation. Preliminary studies involving individuals with Parkinson’s disease have reported favorable effects on balance, gait performance, postural control, and functional mobility. Although the mechanisms underlying these outcomes remain incompletely understood, proposed explanations include enhanced sensorimotor integration, motor learning processes, increased attentional engagement, and exercise-induced neuroplastic adaptations. At present, however, the available evidence should be interpreted cautiously. Most studies have involved relatively small participant groups, short intervention periods, and limited follow-up, restricting the generalizability of their findings. Consequently, the therapeutic potential of table tennis appears promising but has not yet been fully established.

Several limitations of the current evidence base should also be acknowledged. Considerable heterogeneity exists among studies with respect to injury definitions, exposure assessment, study populations, and methodological approaches. Many epidemiological investigations rely on retrospective data collection and self-reported injury histories, increasing susceptibility to recall bias. Furthermore, the literature examining health-related and neurorehabilitative outcomes remains relatively limited compared with the growing body of biomechanical research. These methodological constraints make direct comparisons between studies difficult and highlight the need for more standardized research protocols.

Future investigations should focus on prospective longitudinal studies examining the relationship between training exposure, biomechanical loading, and injury development. Additional randomized controlled trials are needed to evaluate the effectiveness of specific prevention programmes and to clarify the role of table tennis within neurorehabilitation. Advances in wearable technologies, inertial measurement systems, and movement-analysis techniques may further improve the identification of biomechanical risk factors and support the development of individualized prevention and rehabilitation strategies.

Overall, the findings of this review suggest that table tennis should be viewed not only as a competitive sport but also as a valuable model for studying the interaction between biomechanics, health promotion, and rehabilitation. Its unique combination of physical, cognitive, and coordinative demands offers opportunities for both athletic development and broader clinical applications, although further high-quality research is required to strengthen the current evidence base.

5. Conclusions

Table tennis combines relatively low rates of acute injury with substantial sport-specific biomechanical demands. Although most reported health problems are related to overuse rather than acute trauma, appropriate conditioning, load management, and injury-prevention strategies may help reduce the risk of musculoskeletal disorders in competitive players.

Current evidence suggests that the benefits of table tennis extend beyond athletic performance. Regular participation has been associated with favorable effects on physical fitness, balance, metabolic health, and selected aspects of cognitive functioning. Emerging research also

indicates potential applications in neurorehabilitation, particularly among individuals with Parkinson's disease.

Overall, table tennis should be regarded not only as a competitive sport but also as a versatile form of physical activity with potential value in health promotion, rehabilitation, and healthy ageing. Further high-quality longitudinal and randomized studies are needed to strengthen the evidence base and clarify the long-term clinical implications of these findings.

Disclosure

Author Contributions

Conceptualization: Filip Chmielnicki, Gabriela Chwajta, Dominika Budzeń, Martyna Antos, Kacper Paczosa
Methodology: Filip Chmielnicki, Kacper Paczosa, Gabriela Pirga, Barbara Cepielik
Software: Filip Chmielnicki, Gabriela Pirga, Martyna Antos
Check: Gabriela Chwajta, Weronika Cichocka
Formal analysis: Martyna Antos, Kacper Paczosa, Gabriela Kaczor
Investigation: Filip Chmielnicki, Dominika Budzeń, Gabriela Kaczor,
Resources: Gabriela Chwajta, Klaudia Jędruszko, Barbara Cepielik
Data curation: Martyna Antos, Klaudia Jędruszko, Weronika Cichocka
Writing-rough preparation: Filip Chmielnicki, Gabriela Kaczor, Dominika Budzeń
Writing-review and editing: Gabriela Chwajta, Weronika Cichocka, Kacper Paczosa
Project administration: Filip Chmielnicki

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The authors declare no conflict of interest.

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In preparing this work, the author(s) used ChatGPT for language improvement and grammatical correction. After using this tool/service, the author(s) have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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