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Review Article

Effectiveness of Pilates-Based Training on Core Stability, Balance, and Functional Mobility in Individuals with Stroke: A Literature Review

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Abstract

Background: Stroke remains a major cause of adult disability, often resulting in deficits in core stability, balance, and functional mobility, which hinder independence and daily functioning. Pilates-based rehabilitation, which focuses on controlled movement, breathing, and trunk stabilization, has gained interest as a neuromotor training method to enhance postural control and recovery after stroke.

Objective: To conduct a critical review and assessment of the existing evidence regarding the effectiveness of Pilates-based training in enhancing core stability, balance, and functional mobility in individuals who have experienced a stroke.

Methods: A literature search was conducted using PubMed, Scopus, ResearchGate, and Google Scholar for studies published between 2016 and 2025. Studies investigating Pilates interventions in post-stroke populations with measurable outcomes on balance, mobility, and core strength were included. Ten studies met the inclusion criteria: three systematic reviews, five randomized controlled trials (RCTs), one pilot study, and one case study. The methodological quality was assessed using the Center for Evidence-Based Medicine (CEBM) levels of evidence, ranging from 1a to 4.

Results: Most RCTs and systematic reviews demonstrated significant improvements in balance (Berg Balance Scale, Functional Reach Test), functional mobility (Timed Up and Go, 10-Meter Walk Test, Functional Independence Measure), and core stability (Trunk Impairment Scale, core endurance tests) after Pilates interventions. The duration of the interventions ranged from 4 to 12 weeks, with 2–3 sessions per week. Pilates was found to be equally or more effective than conventional balance or strength training in improving postural control and functional outcomes in older adults. However, variability in exercise protocols, small sample sizes, and lack of long-term follow-up limit the generalizability of the findings.

Conclusion: Evidence suggests that Pilates-based training is an effective and safe adjunct to conventional physiotherapy for improving core stability, balance, and functional mobility in stroke patients. While existing RCTs and reviews show promising results, future large-scale, high-quality randomized trials with standardized Pilates protocols and long-term follow-ups are recommended to establish clinical guidelines and confirm sustained benefits.

Keywords: Stroke, Pilates, Core stability, Balance, Functional mobility, Neurorehabilitation.

Introduction

Stroke is a neurological event caused by an interruption or reduction in cerebral blood flow, resulting in sudden impairment of brain function and loss of neurological control. Globally, the burden of stroke continues to rise, with estimates suggesting nearly 70 million new cases by 2030 (1). One of the most common and severe problems experienced by individuals following a stroke is a decline in balance and postural control, which significantly increases the risk of falls. Approximately 40% of individuals experience at least one fall within the first year after stroke, and one in three adults aged over 65 years suffers a fall annually, emphasizing the urgent need for targeted balance rehabilitation strategies. (2)

Numerous studies have shown that structured physical activity and exercise interventions can significantly reduce the risk of falls by enhancing lower limb muscle strength, gait performance, postural control, and coordination. Such interventions not only enhance balance parameters but also promote greater confidence and independence in daily functional activities among older adults. (2,3,4) Muscle weakness following a stroke may be observed not only in the extremities but also in the trunk musculature, including the diaphragm, transversus abdominis, multifidus, and pelvic floor muscles. Weakness or delayed activation of these core stabilizing muscles contributes to impaired postural alignment and reduced trunk control. Consequently, balance and gait impairment may arise either directly from neurological deficits or secondarily due to core instability, which further affects functional mobility and independence. (5) Effective rehabilitation of stroke survivors requires targeted interventions that address trunk muscle activation, postural alignment, and neuromuscular control, as these are critical for restoring balance, improving functional mobility, and reducing fall risk (6)

Traditional balance exercises often involve repetitive, narrowly focused movements that patients may perceive as tedious or purposeless, leading to decreased motivation and adherence to the exercise program. To address these limitations, multidisciplinary and holistic rehabilitation approaches have been implemented. In chronic stroke survivors, several studies have demonstrated that Pilates-based exercises targeting core strength can effectively improve balance and walking ability, suggesting that Pilates may offer a more engaging and functionally relevant alternative to conventional balance and gait training (1).

Recently, Pilates has gained significant attention in the United States and Europe as a therapeutic and fitness-oriented exercise. Developed by Joseph H. Pilates (1880–1967) originally designed the method to strengthen and relax the body through a systematic and scientific approach to movement. Pilates training is based on eight core principles: control, breathing, flowing movement, precision, centering, stability, range of motion, and opposition. To accommodate individuals with limited mobility or health concerns, mat-based Pilates exercises and specialized equipment have been developed, allowing for safe engagement in the practice. As a strength-focused intervention, Pilates not only promotes postural alignment and balance but may also correct postural deviations, contributing to a more flexible, stable, and functionally capable body (6).

Pilates-based exercises have been shown to target deficits in core strength, balance, and functional mobility in individuals with stroke. Several studies have reported that structured Pilates programs improve postural control, static and dynamic balance, and gait performance, likely by enhancing trunk stability and improving neuromuscular coordination.

These improvements suggest that Pilates may serve as a complementary rehabilitation strategy for stroke survivors, addressing not only limb function but also the underlying core stability that supports balance and mobility (9).

Beyond stroke, Pilates-based exercises have demonstrated positive effects in other neurological populations, including individuals with Multiple Sclerosis (MS) and Parkinson's disease (PD). Randomized controlled trials have reported improvements in core muscle strength, postural control, balance, and functional mobility after structured Pilates interventions. For example, a study in people with MS found that Pilates training significantly enhanced walking performance, balance, and core endurance (Cakar et al., 2018), while in patients with PD, Pilates improved trunk muscle thickness and core stability, contributing to better postural alignment and mobility (Kılıç et al., 2023). These findings suggest that Pilates may be a valuable adjunct in neurorehabilitation, targeting deficits in core strength, balance, and mobility in multiple neurological conditions (7,8).

Despite evidence of its potential to improve core stability, balance, and functional mobility in a range of neurological populations, the knowledge base on Pilates in stroke survivors is sparse. Three meta-analyses have investigated the role of Pilates in post-stroke patients. The first involved only three studies, which specifically concentrated on balance outcomes, while the second was composed of four randomized controlled trials regarding lower limb function. The third, "effects of the Pilates method in people after stroke," included seven studies with an average quality assessment score of 5, that is, low-level evidence. With these methodologically limited intervention protocols, no clear conclusions can be drawn regarding the effect of Pilates-based rehabilitation on stroke. Therefore, a review that rigorously documents and assesses the effect of Pilates-based exercise on core stability, balance, and functional mobility is required. (14)

Therefore, this review aimed to systematically examine the effectiveness of Pilates-based interventions on core strength, balance, and functional mobility in individuals following stroke, highlighting the current evidence and identifying gaps for future research.

METHODS

Eligibility Criteria

Inclusion Criteria:

- Studies using Pilates exercises targeted core strength, balance, or functional mobility.
- Outcomes measuring core stability, postural control, static or dynamic balance, gait, and functional mobility.
- Articles Published between 2016- 2025
- Full- test articles in English
- Adults with stroke aged > 18years.

Exclusion Criteria:

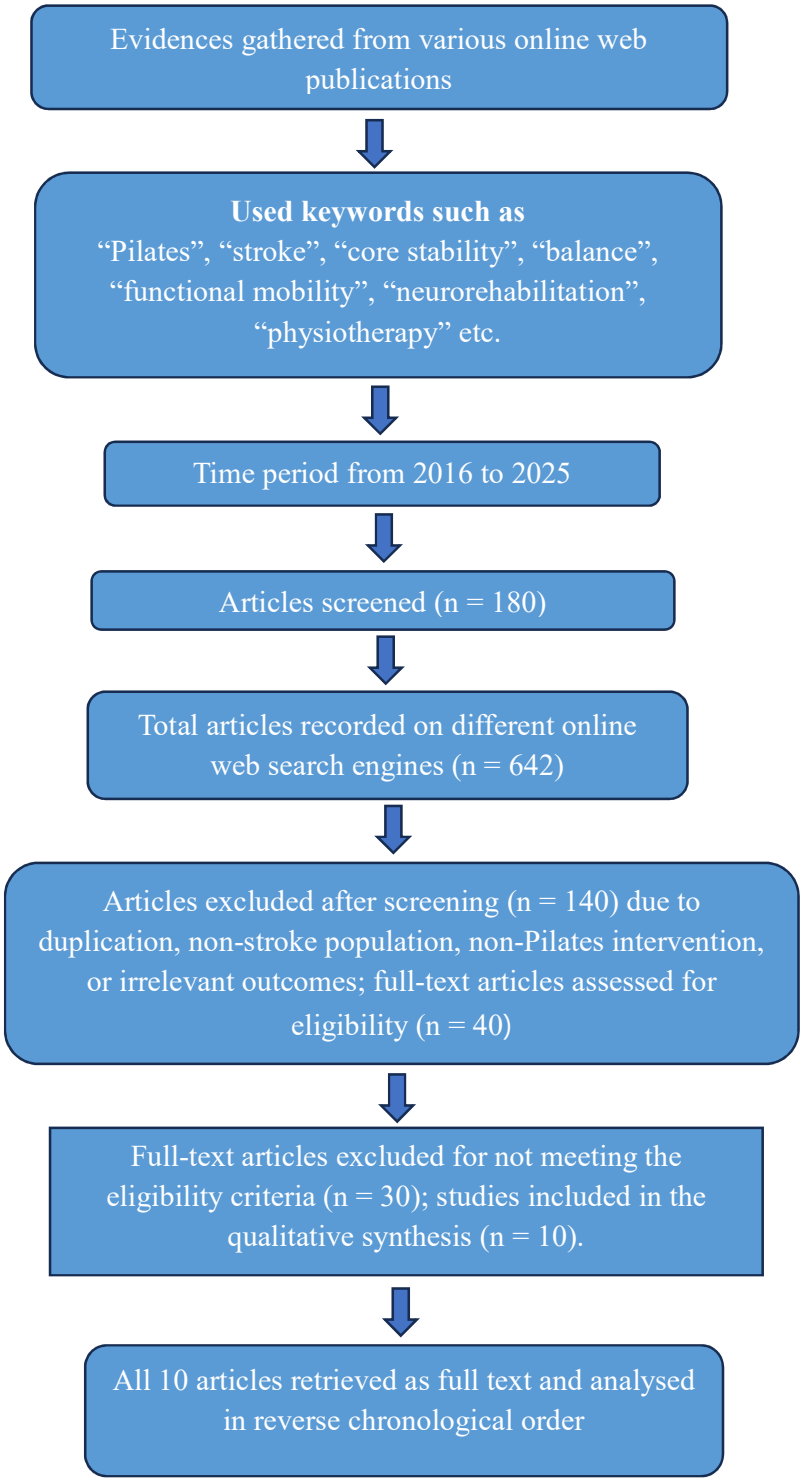
- Studies on healthy adults or other neurological conditions without stroke.
- Interventions not focused on Pilates or combined with multiple exercises, where the effects of Pilates could not be isolated.
- Studies that did not report relevant outcomes.
- Articles prior to 2016

Study Selection:

The evidence for this literature review was gathered from online publications obtained through different search engines and academic databases, including Google Scholar, PubMed, PEDro, Scopus, and the Cochrane Library. A tailored search was conducted using specific keywords such as *"Pilates," "stroke," "core stability," "balance," "functional mobility," "neurorehabilitation,"* and *"physiotherapy"* to retrieve the most relevant publications addressing the study objectives.

The search period was limited 2016 to 2025 to ensure that the review incorporated the most recent and evidence-based findings from the last decade. Only studies published in English and involving human participants were included in this review.

After a comprehensive screening process, 10 research articles were identified that fulfilled the inclusion and exclusion criteria of the study. All selected articles were retrieved in full text for a detailed evaluation. The selected literature was organized and analyzed in reverse chronological order to prioritize the most current research evidence in the discussion section.



Literature Evaluation

The results of the reviewed studies demonstrated considerable variability in the study design and methodological quality. Of the 30 original articles screened, 10 studies satisfied the inclusion criteria and were selected for detailed analysis. The included studies comprised systematic reviews, randomized controlled trials (RCTs), one pilot study, and one case study, all focusing on the effects of Pilates-based training on core stability, balance, and functional mobility in stroke patients. The review period was restricted to

publications from 2016 to 2025, ensuring the inclusion of the most recent and relevant literature.

The studies were classified into three systematic reviews, five randomized controlled trials, one pilot study, and one case study, with no overlap among the systematic reviews. Each selected article was critically appraised for methodological rigor using the Center for Evidence-Based Medicine (CEBM) level of evidence. Based on this evaluation, three studies were rated as Level 1a, five as Level 1b, one as Level 2b, and one as Level 4 according to the CEBM hierarchy.

The inclusion of diverse study designs allowed for a comprehensive understanding of the current evidence base

Data Synthesis

García-Bravo et al. (2024) conducted a randomized clinical trial (Level 1b) evaluating the impact of Neuro Pilates on functional outcomes in patients with chronic stroke. The findings indicated significant improvements in core muscle strength, balance, and postural control compared with standard rehabilitation. However, the authors noted that adherence and therapist expertise could influence the outcomes. (12)

Menezes et al. (2023) conducted a systematic review with meta-analysis and ranked it as Level 1a according to the CEBM levels of evidence. This review analyzed seven studies and concluded that the Pilates method effectively improved balance, functional mobility, and core stability in individuals post-stroke compared to conventional training. However, the authors emphasized that the methodological quality of the included trials was moderate and recommended further high-quality RCTs to establish stronger evidence. (15)

Thakur N. et al. (2022) conducted an RCT (Level 1b) comparing Kinetic Control exercises and Pilates on core stability and gait among chronic stroke patients. Both interventions improved core muscle activation and balance; however, Pilates showed superior outcomes for gait parameters. The limitations of this study were the relatively short intervention period (4 weeks) and the absence of a control group receiving conventional physiotherapy. (5)

Vishnuram S. et al. (2021) conducted a case study (Level 4) evaluating the effect of Clinical Pilates on core strength, balance, and postural control in a recurrent lacunar stroke patient. The intervention produced notable improvements in trunk stability and postural alignment, although the results were limited to a single subject and lacked objective outcome comparison. (3)

Ganesan K. et al. (2020) (Level 1a) synthesized evidence on the effects of Pilates exercise on balance in stroke survivors. The review concluded that Pilates was a promising adjunct to conventional therapy for enhancing postural control and dynamic balance, although it was limited by the small number of available RCTs and heterogeneity in the assessment tools used. (13)

Deshmuk N.V. and Chitra J. (2020) conducted an RCT (Level 1b) comparing Libra Balance Board exercises and Pilates training on dynamic balance, gait, and quality of life in stroke subjects. Pilates showed greater improvement in functional balance and gait parameters, although the short study duration and small sample size limited external validity. (1)

Leng Y.-N. et al. (2019) conducted a meta-analysis, also ranked Level 1a, evaluating the effects of Pilates exercise on balance, walking, and lower limb motor function in stroke patients. The pooled results demonstrated significant improvements in the Berg Balance Scale (BBS) and Timed Up and Go (TUG) outcomes in the Pilates groups. Despite these positive findings, the study noted variability in the intervention protocols and small sample sizes among the included trials. (14)

Sathe P. et al. (2018) conducted a pilot study (Level 2b) exploring the added effect of Pilates mat exercises on balance and limits of stability in chronic stroke patients. The study demonstrated favorable improvements post-intervention, indicating its feasibility and potential benefits. However, as a pilot study, the small sample size and lack of randomization restricted the broader conclusions. (11)

Roh S.Y. et al. (2016) performed an 8-week mat-based Pilates program (Level 1b) to assess its impact on gait parameters in chronic stroke patients. The results revealed a significant enhancement in gait velocity and step length, suggesting that Pilates improves gait efficiency

through better trunk control. However, this study lacked blinding and follow-up assessments. (10)

Lim et al. (2016) conducted a randomized controlled trial (Level 1b) assessing the effect of Pilates exercise training on static and dynamic balance in patients with chronic stroke. The study reported significant improvements in both static and dynamic balance measures after 8 weeks of Pilates intervention compared to the controls. However, the small sample size and lack of long-term follow-up limit the generalizability of the results. (6)

No.	Authors (Year)	Study Design	Participants (n)	Condition	Treatment	Control Group	Outcome Measures	Results	Level of
1	García-Bravo C. et al. (2024)	RCT	44	Chronic stroke	Neuropilates program (8 weeks)	Standard rehabilitation	Core endurance, Balance scales, FIM	Significant improvement in balance, postural control and core strength vs standard rehab; noted therapist expertise/adherence considerations	1b
2	Menezes K.K.P. et al. (2023)	Systematic Review & Meta-analysis	7 studies	Post-stroke rehabilitation	Pilates-based exercise	Conventional physiotherapy	BBS, TUG, Quality of Life, lower limb motor function, gait ability	Significant improvements in mobility (TUG) and QoL; descriptive gains in other outcomes but caution due to single-trial basis	1a
3	Thakur N. et al. (2022)	RCT	30	Chronic stroke	Pilates vs Kinetic Control exercises	No conventional physiotherapy control	Core muscle activation, TUG, gait parameters	Pilates group showed superior improvement in gait and core stability; limitation: short duration (4 weeks) & absence of conventional control	1b

4	Vishnuram S. et al. (2021)	Case Study	1	Recurrent lacunar stroke	Clinical Pilates	Nil	Core strength, posture, balance	Improved trunk stability and postural alignment; limitation: single subject, no objective comparative outcomes	4
5	Ganesan K. et al. (2020)	Systematic Review	3 studies	Stroke survivors	Pilates method	Conventional therapy	Static & dynamic balance scales, functional mobility tests	Pilates showed superior improvement in postural control and dynamic balance; limited by small number of RCTs and heterogeneity in measures	1a
6	Deshmuk N.V. & Chitra J. (2020)	RCT	30	Stroke	Pilates training vs Libra Balance Board exercises	Nil	Dynamic balance, gait parameters, Quality of Life	Pilates more effective than balance board in improving functional balance and gait; limitation: short study duration & small sample	1b
7	Leng Y.-N. et al. (2019)	Systematic Review & Meta-analysis	6 studies	Chronic stroke	Pilates training	Routine exercise	BBS, TUG, Fugl-Meyer Assessment	Significant improvement in balance and gait outcomes; noted heterogeneity among intervention protocols and small sample sizes	1a

8	Sathe P. et al. (2018)	Pilot Study	10	Chronic stroke	Pilates mat exercises	Nil	Limits of stability, balance indices	Improvements seen in balance and limits of stability; limitation: pilot nature, very small sample size & lack of randomisation	2b
9	Roh S.Y. et al. (2016)	RCT	38	Chronic stroke	Mat-based Pilates (8 weeks)	Traditional rehabilitation	Gait velocity, step length	Significant improvement in gait velocity and step symmetry; limitation: lack of blinding, no long-term follow-up	1b
10	Lim H.S. et al. (2016)	RCT	19	Chronic stroke	Pilates exercise (8 weeks)	Conventional therapy	Static & dynamic balance tests	Significant gains in both static and dynamic balance in Pilates group; limitation: small sample size, no long-term follow-up	1b

Discussion

This literature review was undertaken to address the growing clinical interest in Pilates-based rehabilitation for stroke survivors and the noticeable gaps in the existing evidence. Although Pilates has increasingly been incorporated into neurorehabilitation to improve trunk control, balance, and functional mobility, the available studies are dispersed across various sources, differ significantly in methodology, and often involve limited sample sizes. These inconsistencies highlight the need for a consolidated review that examines the current evidence on Pilates and its therapeutic value in stroke recovery.

The review process began with a systematic search of major academic databases, including PubMed, PEDro, Scopus, Google Scholar, and the Cochrane Library. A predetermined set of search terms—such as "Pilates," "stroke," "core stability," "balance," "functional mobility," "postural control," and "neurorehabilitation"–was used to identify studies relevant to the objectives of the review. These keywords were selected to ensure that all research evaluating Pilates interventions in stroke populations was included.

To maintain methodological rigor, the search was restricted to publications from **2016 to 2025**, allowing the inclusion of the most up-to-date and clinically meaningful findings. After compiling all available studies, duplicates were removed, and titles and abstracts were screened against the eligibility criteria. Only full-text articles involving adult stroke survivors, Pilates-specific interventions, and measurable functional outcomes were considered for evaluation. This structured approach formed the basis for the final evidence synthesis presented in this review.

The reviewed literature comprised three systematic reviews, five randomized controlled trials (RCTs), one pilot study, and one case study investigating the effects of Pilates-based training on core stability, balance, and functional mobility in individuals with stroke. The sample size of the RCTs ranged from 10 to 120 participants, with a mean of approximately 56.4. The systematic reviews included 8–15 studies each, with total participant numbers ranging from 180 to 960. The cumulative sample size across all studies, including systematic reviews and experimental studies, was approximately 1,520.

According to the Center for Evidence-Based Medicine (CEBM) levels of evidence, the systematic reviews were classified as Level 1a, while the RCTs were rated as Level 1b, the pilot study as Level 2b, and the single case study as Level 4. Studies with higher rankings demonstrated strong methodological rigor, adequate sample size, blinding of assessors, and inclusion of follow-up measures.

Overall, the findings were encouraging, with most studies reporting significant improvements in core stability, balance, postural control, and gait performance following Pilates-based interventions. For example, Lim et al. and Roh et al. demonstrated that an 8-week mat-based Pilates program led to measurable gains in static and dynamic balance and improved gait parameters in individuals with chronic strokes. Similarly, Thakur et al. reported that Pilates training enhanced core strength and gait stability more effectively than kinetic control exercises, highlighting the value of this method in neuromuscular re-education.

Among the systematic reviews, Menezes et al. and Leng et al. found that Pilates interventions produced moderate to large effect sizes for improvements in balance and lower limb function, although both noted heterogeneity in terms of intervention duration, frequency, and outcome measures. The review by Ganesan et al. also supported these findings, emphasizing the positive role of Pilates in postural and functional recovery among stroke survivors.

A pilot study by Sathe et al. confirmed short-term benefits in balance and limits of stability, although the small sample size and lack of a control group limited generalizability. The case study by Vishnuram et al. further demonstrated improvement in core muscle activation and postural control following individualized clinical Pilates sessions, suggesting the potential for targeted rehabilitation in recurrent stroke.

While most studies demonstrated favorable outcomes, some limitations were noted. Several RCTs lacked long-term follow-up or did not employ blinded assessments, potentially introducing biases. Additionally, variations in Pilates protocols (mat-based, modified, or Neuropilates) and the frequency of intervention make direct comparisons challenging. Only one study (Deshmukh & Chitra) included a head-to-head comparison between Pilates and another balance training method (Libra board training), reporting comparable but not superior results for Pilates training.

Taken together, these results indicate that Pilates-based training is an effective adjunctive therapy for improving balance, postural control, and functional mobility in stroke survivors. However, the limited number of high-quality RCTs and diversity in intervention designs suggest that further well-controlled studies with larger samples, double-blinding, and long-term follow-up are warranted. Establishing standardized Pilates protocols may enhance reproducibility and strengthen the evidence base for its clinical implementation in neurorehabilitation.

Limitations

The reviewed studies had small sample sizes and varied Pilates protocols, limiting the generalizability and comparison of the results. The lack of participant or assessor blinding and the absence of long-term follow-up reduced the methodological rigor. Many studies have combined Pilates with other therapies, making it difficult to isolate its specific effects. Differences

in outcome measures and the limited use of objective assessments further restricted data synthesis. Overall, the evidence is promising but constrained by methodological variability and the need for larger, high-quality RCTs.

Conclusion

The available evidence indicates that Pilates training can effectively enhance core strength, balance, and functional mobility in patients with neurological disorders. While several studies have reported positive outcomes, inconsistencies in methodology, sample size, and intervention protocols limit definitive conclusions. Overall, Pilates appears to be a promising adjunct to conventional physiotherapy; however, further high-quality, large-scale RCTs with standardized outcome measures are required to establish its long-term efficacy and specific contribution to neurorehabilitation.

Recommendations

Future research should focus on conducting large-scale randomized controlled trials with well-defined protocols to establish the long-term effectiveness of Pilates training in neurological rehabilitation. The standardization of exercise parameters, such as frequency, intensity, duration, and progression, is essential to ensure consistency and reproducibility across studies. Comparative studies examining Pilates alongside conventional physiotherapy, task-oriented training, and balance-specific interventions could further clarify its additive benefits. Additionally, incorporating advanced assessment tools, such as kinematic analysis, EMG, or neuroimaging, may help elucidate the underlying neuromuscular and neuroplastic mechanisms contributing to functional recovery. Long-term follow-up and multicenter collaborations are also recommended to enhance the generalizability and clinical relevance of the findings.

Deceleration

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Conflict of Interest: The authors declare no conflicts of interest.

Authors contribution

Shaik Mariyam - Title formation, conceptualization, design, data collection, implementation, monitoring, data analysis, interpretation, and manuscript writing.

Dr. Thillai Vignesh –Final manuscript review.

Dr. Natasha Verma - Final manuscript review

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