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The Impact of Intercostal Stretch Technique and Core Conditioning Exercises on Cardiopulmonary Function in Diabetic Patients: A Comprehensive Analysis

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ABSTRACT
Diabetes mellitus is a prevalent endocrine disorder associated with chronic hyperglycaemia and metabolic abnormalities. Diabetic patients often experience respiratory symptoms and are at an increased risk of pulmonary diseases. Physiotherapy management has the potential to mitigate diabetes-related complications, and the intercostal stretch technique and core conditioning exercises have shown promising results in improving outcomes in diabetic patients. This comparative study aimed to evaluate the effectiveness of intercostal stretch technique and core conditioning exercises in improving cardiopulmonary function in 30 diabetic subjects. The participants were randomly assigned to two groups: Group A received intercostal stretch technique with conventional chest physiotherapy, while Group B received core conditioning exercises with conventional chest physiotherapy. The study assessed outcomes such as VO2 max (measured by heart rate), chest expansion (measured by inch tape), and peak expiratory flow rate (PEFR, measured by a peak flow meter). The measurements were recorded before and after the intervention in both groups. Both groups showed improvements in VO2 max, chest expansion, and PEFR. However, Group A, which received the intercostal stretch technique, demonstrated better improvement compared to Group B, which underwent core conditioning exercises. The intercostal stretch technique was found to significantly improve pulmonary function in diabetic patients compared to core conditioning exercises. These findings suggest that the intercostal stretch technique may be a valuable addition to physiotherapy interventions for managing cardiopulmonary complications in diabetic patients.
Keywords: *diabetes mellitus, intercostal stretch technique, core conditioning exercises, cardiopulmonary function, pulmonary function, physiotherapy, respiratory symptoms.*

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INTRODUCTION

Diabetes mellitus (DM) is a global epidemic characterized by a chronic disorder of carbohydrate, fats, and protein metabolism. It presents a defective or deficient insulin secretion response, affecting the use of carbohydrates and resulting in various complications that impact multiple organs, including the lungs. The prevalence of type 2 DM, in particular, is projected to increase exponentially in the coming decades, leading to lower functional capacity and higher rates of comorbid diseases. Diabetic patients frequently experience respiratory symptoms and are at an increased risk of pulmonary diseases. The pathophysiology of type 2 DM involves increased hepatic production of glucose, resistance to the action of insulin, and impaired insulin secretion. Insulin resistance is caused by various factors such as abnormal insulin molecules, excessive amounts of circulating antagonists, and target defects. Over time, beta cells become unable to sustain hypersecretion, resulting in the development of DM [1-4]. Type 2 diabetes is associated with numerous signs and symptoms, including slow-healing sores, blurred vision, fatigue, muscle weakness, gait impairment, unintended weight loss, frequent infections, increased thirst, and frequent urination. Several risk factors contribute to the development of type 2 DM, such as higher BMI, fat distribution, inactivity, family history, age, pre-diabetes, and gestational diabetes. The diagnosis of DM involves the presence of symptoms such as polyuria, polydipsia, polyphagia, and weight loss, along with specific criteria for plasma or whole blood glucose levels. Treatment for patients with type 2 DM depends on various factors, including body weight, current eating habits, physical activity levels, blood glucose levels, and the duration of diabetes [5]. Medications such as metformin, sulfonylureas, meglitinides, thiazolidinedione's, dipeptidyl peptidase-4 inhibitors, glucagon-like peptide-1 receptor agonists, and sodium-glucose cotransporter-2 inhibitors may be prescribed to manage the condition. Complications associated with type 2 DM include decreased pulmonary function, nerve damage (neuropathy), heart and blood vessel disease, kidney

damage, eye damage, slow healing, decreased exercise endurance capacity, gait imbalance, increased fall risk, reduced muscle strength, and decreased physical fitness. Intercostal stretch technique involves applying pressure to the upper border of a rib to stretch the intercostal muscles downward, thereby improving chest wall mobility and chest expansion. This technique has been shown to enhance expired tidal volume, decrease dyspnoea, and improve gaseous exchange in humans. Core conditioning exercises focus on improving chest wall mobility and lung function. These exercises aim to strengthen inspiratory muscles and enhance exercise endurance capacity [6]. They involve various movements and breathing techniques to improve respiratory efficiency and gas exchange. The purpose of this study is to comprehensively analyze the immediate effects of the intercostal stretch technique and core conditioning exercises on cardiopulmonary function in diabetic patients. The study aims to evaluate parameters such as VO2 max, chest expansion, and peak expiratory flow rate (PEFR) to assess the effectiveness of these interventions. By investigating the impact of these techniques, the study aims to provide valuable insights into improving lung capacity, exercise endurance capacity, and overall pulmonary function in diabetic patients. Thus, this study focuses on the intercostal stretch technique and core conditioning exercises as potential interventions for improving cardiopulmonary function in diabetic patients. By addressing the specific needs of this patient population, these techniques offer promise in enhancing respiratory function and physical endurance [7-9]. The findings of this study have significant implications for physiotherapy practice and highlight the importance of incorporating targeted interventions in the management of diabetic patients.

MATERIAL AND METHODS

Ethics: Ethical clearance was obtained from the ethical committee of Mahatma Gandhi Medical College and Hospital to conduct the study on diabetic patients. Informed consent was obtained from all participants prior to their inclusion in the study.

Study Design: This study employed a comparative design to assess the impact of two interventions on cardiopulmonary function in diabetic patients. The participants were divided into two groups: Group A received the intercostal stretch technique with conventional chest physiotherapy (n=15), and Group B received core conditioning exercises with conventional physiotherapy (n=15).

Participants: A total of 30 diabetic patients aged 18 years or older were selected from Mahatma Gandhi Hospital in Jaipur. Participants were included if they were hemodynamically stable, conscious, awake, and diagnosed with type 2 diabetes. Patients with malignancy, chest infection, severe neurological impairments, rib fractures, untreated haemothorax or pneumothorax, severe haemoptysis, large pleural effusion, or unstable cardiovascular conditions were excluded from the study.

Outcome Measures: The primary outcome measure was VO2MAX, calculated using the formula 15 × (HR max / HR rest), where HR max was calculated using the formula 220 - age. Resting heart rate was measured using a pulse oximeter in a sitting position. Secondary outcome measures included chest expansion, measured at the xiphoid level using an inch tape, and peak expiratory flow rate (PEFR), measured by asking the patient to take a deep breath and blow into a peak flow meter.

Materials Used: The materials used in the study included a peak flow meter, an inch tape for chest expansion measurement, a recording sheet, a cardio-respiratory assessment chart, couch pillows, and a pulse oximeter.

Procedure: A total of 30 diabetic patients were divided into two groups: Group A received intercostal stretch technique along with conventional chest physiotherapy (CCPT), and Group B received core conditioning exercises along with CCPT. Both groups underwent a 30 to 45-minute physiotherapy treatment session. Data were collected before and after the treatment session. VO2MAX was calculated using the mentioned formula, chest expansion was measured using an inch tape, and PEFR was measured using a peak flow meter.

Statistical Analysis: Descriptive statistics were used to summarize the data. Statistical analysis was performed to compare the outcomes between the two groups using appropriate tests, such as t-tests or chi-square tests. The significance level was set at $p < 0.05$.

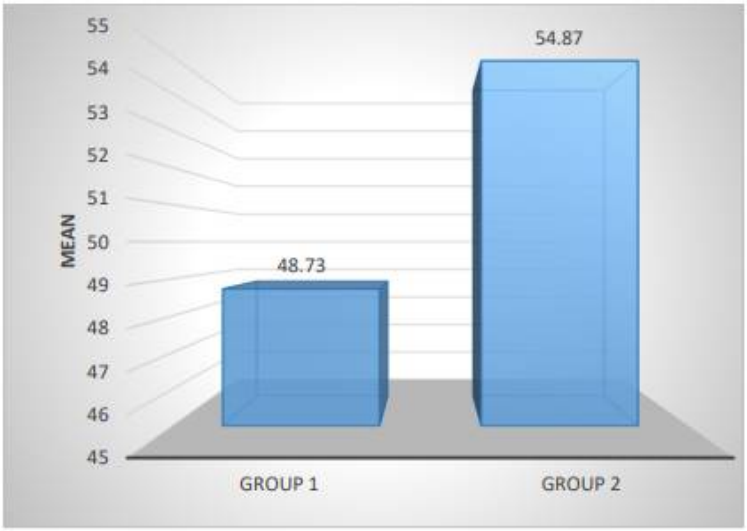
Hypothesis: The alternative hypothesis stated that the intercostal stretch technique is significantly more effective in improving VO2MAX, chest expansion, and PEFR in diabetic patients compared to core conditioning exercises. The null hypothesis stated that there is no significant difference between the two interventions. The obtained results led to the rejection of the null hypothesis in favor of the alternative hypothesis, indicating the superiority of intercostal stretch technique with CCPT over core conditioning exercises with CCPT for diabetic patients.

RESULTS

Data Acquisition and Management: A total of 30 diabetic patients were included in the study, and measurements were taken for Vo2 max, chest expansion, and peak expiratory flow rate (PEFR). The assessment of improvement was conducted before and after the treatment sessions, all of which were performed under supervision.

Data Analysis: Statistical analysis was performed using the Mann-Whitney U-test to compare the effectiveness of treatment in diabetic patients regarding Vo2 max, chest expansion, and PEFR in each group before and after treatment. Out of the 30 subjects included in the study, there were 17 males and 13 females. Group A consisted of 15 patients receiving the intercostal stretch technique along with conventional chest physiotherapy, while Group B consisted of 15 patients receiving core conditioning exercises along with conventional chest physiotherapy.

Comparison of Mean Age of Patients in Both Groups (Graph 1): The mean age in Group A was 48.73 years, while in Group B, it was 54.87 years. There were 11 males and 4 females in Group A, and 6 males and 9 females in Group B. The level of significance was set at P≤0.05.

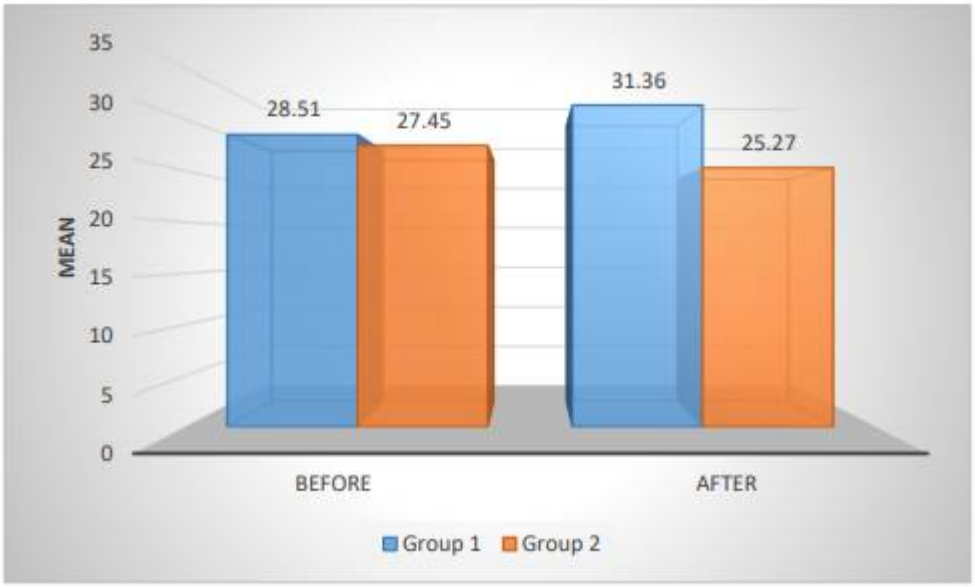


Graph 1 Comparison of Mean Age of Patients in Both Groups

Gender Distribution of the Study (Graph 2): In Group A, there were 11 males and 4 females, while in Group B, there were 6 males and 9 females. The level of significance was 0.06.

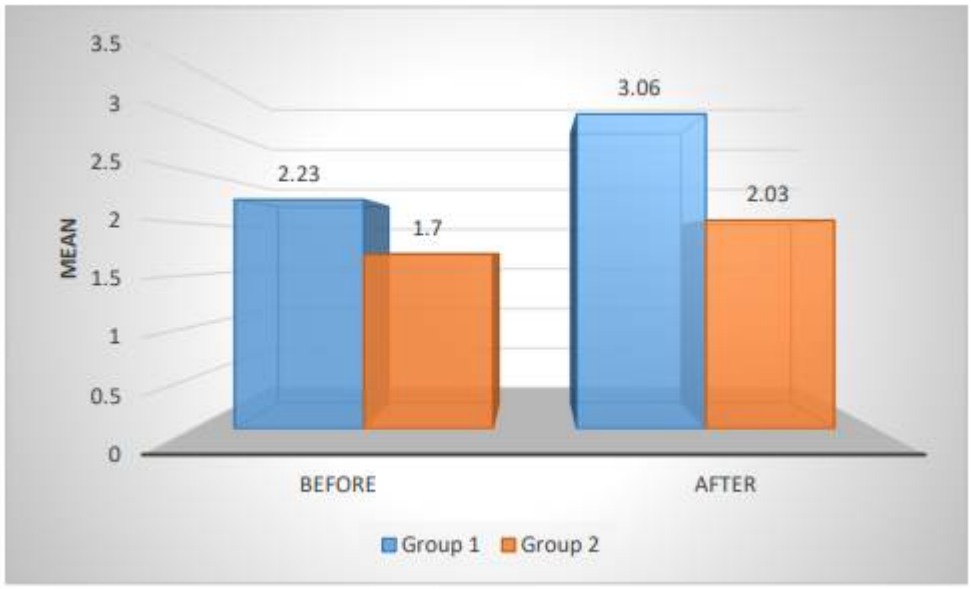
Graph 2 Gender Distribution of the Study

Intergroup Comparison of Study Variable Vo2 max (Graph 3): Before the treatment session, the mean Vo2 max in Group A was 28.51, and in Group B, it was 27.45. After the treatment session, Group A showed a significant increase in mean Vo2 max to 31.36, while Group B exhibited a decrease to 25.27. The level of significance was set at P≤0.05.



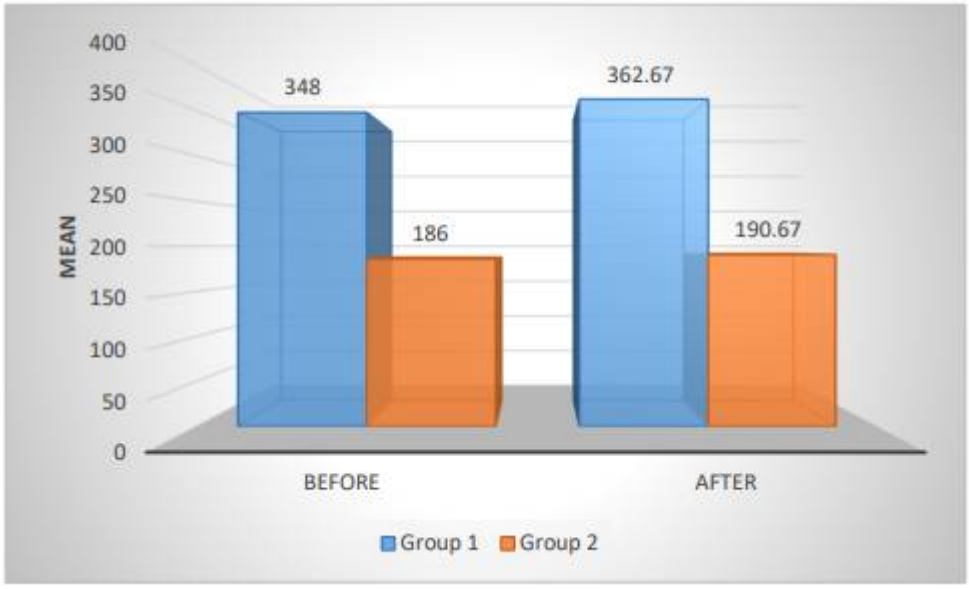
Graph 3 Intergroup Comparison of Study Variable Vo2 max

Intergroup Comparison of Study Variable Chest Expansion (Graph 4): Before the treatment session, Group A had a mean chest expansion of 2.23, while Group B had a mean of 1.70. After the treatment session, Group A showed a significant increase to 3.06, while Group B increased to 2.03. The level of significance was set at P≤0.05.



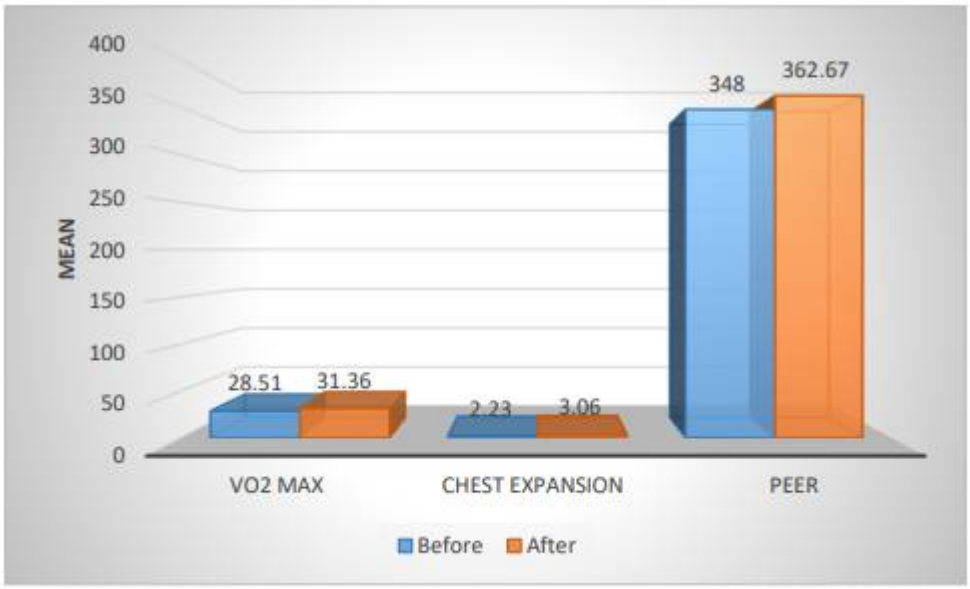
Graph 4 Intergroup Comparison of Study Variable Chest Expansion

Intergroup Comparison of Study Variable PEFR (Graph 5): Before the treatment session, Group A had a mean PEFR of 348.00, and Group B had a mean of 186.00. After the treatment session, Group A increased to 362.67, while Group B increased to 190.67. The level of significance was set at P≤0.05.



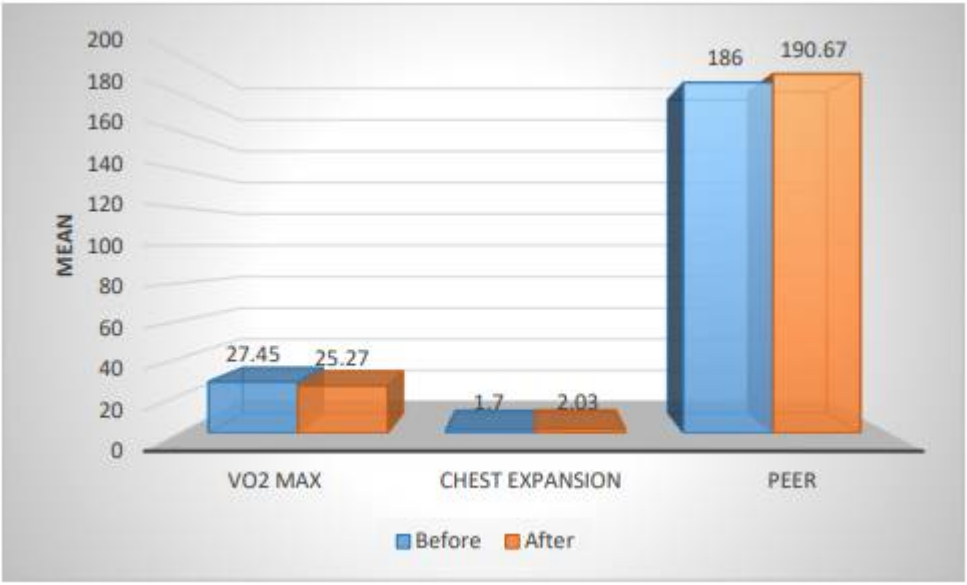
Graph 5 Intergroup Comparison of Study Variable PEFR

Intragroup Comparison of Study Variables - Group A (Graph 6): Within Group A, significant improvements were observed in Vo2 max, chest expansion, and PEFR before and after the treatment sessions. The level of significance was set at P≤0.05.



Graph 6 Intragroup Comparison of Study Variables - Group A

Intragroup Comparison of Study Variables - Group B (Graph 7): Similarly, within Group B, significant improvements were observed in Vo2 max, chest expansion, and PEFR before and after the treatment sessions. The level of significance was set at P≤0.05.



Graph 7 Intragroup Comparison of Study Variables - Group B

These results demonstrate the effectiveness of the intercostal stretch technique and core conditioning exercises, along with conventional chest physiotherapy, in improving cardiopulmonary function in diabetic patients. The improvements in Vo2 max, chest expansion, and PEFR highlight the potential of these interventions in managing cardiovascular complications in individuals with diabetes.

DISCUSSION

The present study aimed to investigate the immediate effects of the intercostal stretch technique and core conditioning exercises on cardiopulmonary function in diabetic patients. The findings provide valuable insights into the potential benefits of these interventions in improving respiratory function, exercise capacity, and overall cardiovascular health in individuals with diabetes. *Key Findings*: The primary outcome measures evaluated in this study included vo2 max, chest expansion, and peak expiratory flow rate (PEFR). In Group A, which received the intercostal stretch technique along with conventional chest physiotherapy, significant improvements were observed in all outcome measures (vo2 max, chest expansion, and PEFR) within the group. In Group B, which received core conditioning exercises along with conventional chest physiotherapy, chest expansion and PEFR showed significant improvement within the group, but vo2 max did not show significant improvement. Comparison between Group A and Group B revealed that Group A showed better improvement in vo2 max, chest expansion, and PEFR compared to Group B. These findings suggest that the intercostal stretch technique was more effective in improving cardiopulmonary function in diabetic patients compared to core conditioning exercises. *Strengths and Limitations*: One of the strengths of this study is its focus on comparing the effects of the intercostal stretch technique and core conditioning exercises in diabetic patients, which is a relatively underexplored area. The study utilized outcome measures that are commonly used in assessing cardiopulmonary function [10-13]. However, several limitations should be acknowledged. The sample size was small, and the study duration was short. These factors may have influenced the generalizability of the findings. Future studies with larger sample sizes and longer durations are needed to validate the results. Additionally, the frequency of the treatment sessions could have been increased to assess the potential long-term effects of the interventions. *Interpretation and Implications*: In the context of the available evidence, this study adds to the growing body of literature on the beneficial effects of physiotherapy interventions in diabetic patients. While previous studies have demonstrated the effectiveness of interventions such as chest proprioceptive neuromuscular facilitation (intercostal stretch technique) and core conditioning exercises in improving respiratory function and chest expansion in various populations, their effects in diabetic patients have not been extensively investigated [14].

The findings of this study suggest that incorporating the intercostal stretch technique and core conditioning exercises into the physiotherapy management of diabetic patients can lead to improvements in cardiopulmonary function. These interventions have the potential to enhance respiratory function, physical endurance, and overall cardiovascular health in diabetic individuals. *Future Research Directions*: To further enhance the understanding of the underlying mechanisms and long-term effects of these interventions, future research should consider expanding the sample size and extending the duration of the

study. Additionally, investigations into the optimal frequency and duration of the treatment sessions are warranted [15-18]. Furthermore, the inclusion of control groups receiving no intervention or alternative interventions would provide a more comprehensive evaluation of the effects of the intercostal stretch technique and core conditioning exercises in diabetic patients.

CONCLUSION

In conclusion, this comprehensive analysis highlights the immediate effects of the intercostal stretch technique and core conditioning exercises on cardiopulmonary function in diabetic patients. The findings suggest that both interventions can improve respiratory function in this population, with the intercostal stretch technique showing superior results. These findings contribute to the available evidence and emphasize the potential benefits of incorporating these interventions into the physiotherapy management of diabetic patients. Further research is needed to explore the underlying mechanisms and optimize the implementation of these interventions to enhance patient care and inform health policy.

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CONFLICT OF INTEREST*:*

The authors declare no conflicts of interest related to this study.

FUNDING

This study received no specific funding.

AUTHOR'S CONTRIBUTION

All the authors have provided substantial contribution in the research paper from start to finish as recommended by guidelines. We have not submitted the same or the substantial part of the article/study in any other journal for publication simultaneously and it is also not submitted for presentation in any other conference.

ETHICAL APPROVAL

The study protocol was approved by the Institutional and conducted in accordance with ethical guidelines and regulations.

INFORMED CONSENT

Informed consent was obtained from all participants before enrolment in the study. The submitted manuscript has maintained confidentiality throughout and the identity of all the participants is not revealed in any form.

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