TPM Vol. 32, No. S1, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

COMPARISON OF CHANGES IN PULMONARY FUNCTION TESTS (PFTS) PRE- AND POST-BLOOD DONATION

VIJAYALAKSHMI SIVASUBRAMANIAN*[1], PRASANTHGURURAJ[2], GANGADHARAN VADIVELU[3], DR. ABIRAMI[4]
[1]POST GRADUATE
[2]DEPARTMENT OF RESPIRATORY MEDICINE, SAVEETHA MEDICAL COLLEGE AND HOSPITAL, SAVEETHA UNIVERSITY,SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES (SIMATS), CHENNAI, TAMIL NADU
[3]PROFESSOR AND HEAD OF THE DEPARTMENT
[4]TUTOR, DEPARTMENT OF CONSERVATIVE DENTISTRY & ENDODONTICS, SREE BALAJI DENTAL COLLEGE & HOSPITAL, CHENNAI, INDIA
*CORRESPONDING AUTHOR NAME:VIJAYALAKSHMI SIVASUBRAMANIAN

Abstract:

Background:

Blood donation plays a crucial role in public health, addressing the urgent need for blood supplies. Whole blood donation involves the removal of about 500 ml of blood, approximately 10% of the total blood volume, triggering compensatory mechanisms involving the sympathetic nervous system and the renin–angiotensin–aldosterone system. Evaluating pulmonary function before and after blood donation can help ensure donor safety and identify any respiratory concerns.

Aim and Objective:

This study aims to assess the changes in pulmonary function before and after blood donation, providing insights into the implications for donor safety and comfort.

Methodology:

A prospective observational study was conducted at Saveetha Medical College, Chennai, from December to April. Pulmonary function tests (PFTs), including Spirometry, Peak Expiratory Flow Rate (PEFR), and Breath-hold tests, were performed on 100 blood donors before and after donation. The inclusion criteria were donors aged 18 to 65 years, while those who did not consent to PFTs were excluded.

Results:

Significant improvements in pulmonary function parameters were observed post-donation. Forced Vital Capacity (FVC) increased from 79.69 (SD = 10.135) to 81.98 (SD = 11.969) ($t = 4.383$, $p < 0.001$). Forced Expiratory Volume in one second (FEV1) rose from 80.13 (SD = 10.612) to 82.08 (SD = 11.902) ($t = 3.747$, $p < 0.001$). Forced Expiratory Flow at 25-75% (FEF25-75) improved from 85.03 (SD = 18.798) to 87.38 (SD = 20.385) ($t = 2.984$, $p = 0.004$). PEFR increased from 442.70 (SD = 95.34) to 471.50 (SD = 87.89) ($t = 7.635$, $p < 0.001$).

Conclusion:

This study demonstrates significant short-term improvements in pulmonary function following blood donation, highlighting the effectiveness of the body's compensatory mechanisms. Further research is needed to understand the long-term effects of repeated donations. Implementing strategies such as pre-hydration and applied muscle tension during phlebotomy could enhance donor safety and experience.

Keywords: Blood Donation, Pulmonary Function, Spirometry, Peak Expiratory Flow Rate, Donor Safety

INTRODUCTION

Blood donation plays a critical role in public health, addressing the urgent need for blood supplies in medical settings. The total blood volume in an average human is approximately five Liters, with red blood cells containing haemoglobin, a protein essential for oxygen transport and carbon dioxide removal[1, 2]. Whole blood donation involves the removal of about 500 ml of blood, roughly 10% of the total blood volume, leading to a temporary reduction in the oxygen-carrying capacity of the body[3, 4]. This reduction triggers various compensatory mechanisms involving the sympathetic nervous system, the renin–angiotensin–aldosterone system, and erythropoietin release, to restore hemodynamic stability [5, 6].

Performing Pulmonary Function Tests (PFT) in blood donors serves several important purposes. Firstly, it helps ensure the overall health and well-being of potential donors by assessing their respiratory function. Adequate pulmonary function is crucial during and after the blood donation process, as compromised respiratory function could lead to complications[7]. Secondly, PFT can help identify individuals with underlying respiratory conditions that might contraindicate blood donation, ensuring the safety of both the donor and the blood recipient[8].

Introducing pre- and post-PFT in blood donors represents a cutting-edge paradigm shift in donor care. By assessing respiratory function both before and after blood donation, we embark on a novel journey of real-time health monitoring. The pre-PFT acts as a baseline, aiding in the identification of potential respiratory concerns before the donation process, allowing for personalized care and minimizing risks associated with compromised pulmonary function. The post-PFT, conducted after donation, serves as an immediate feedback mechanism, gauging the impact of blood donation on respiratory parameters and providing valuable insights into the overall impact of blood donation on respiratory health[9]. This study aims to evaluate the changes in pulmonary function before and after blood donation, providing insights into the potential implications for donor safety and comfort.

MATERIALS AND METHOD

Study Design:

This was a prospective observational study conducted to evaluate the pulmonary function of blood donors before and after donation.

Participants:

Blood donors were recruited from the Department of Transfusion Medicine at Saveetha Medical College, Chennai, between December and April. Pulmonary function tests (PFTs), including Spirometry, Peak Expiratory Flow Rate (PEFR), and Breath-hold tests, were conducted on each donor both before and after blood donation.

Ethical consideration:

The study was conducted in compliance with the Declaration of Helsinki and approved by the Institutional Ethics Committee at Saveetha Medical College. All participants provided written informed consent prior to enrolment.

Procedures:

Pulmonary function tests (PFTs), including Spirometry, Peak Expiratory Flow Rate (PEFR), and Breath-hold tests, were conducted on each donor both before and after blood donation.

Inclusion Criteria:

The study included donors who were eligible for blood donation. Specifically, individuals aged 18 to 65 years were considered for participation.

Exclusion Criteria:

Potential donors who did not consent to perform the pulmonary function tests were excluded from the study.

Results:

A total of 100 patients were included in this study. The following sections present the detailed analysis and interpretation of the pre- and post-intervention pulmonary function test (PFT) readings, along with their correlations.

Comparison of Pre and Post Pulmonary Function Test Readings

The effectiveness of the intervention was evaluated by comparing pre and post readings of Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV1), and Forced Expiratory Flow at 25-75% of the pulmonary volume (FEF25-75) using paired samples t-tests.

Forced Vital Capacity (FVC): The mean FVC increased significantly from 79.69 (SD = 10.135) before the intervention to 81.98 (SD = 11.969) after the intervention ($t = 4.383$, $p < 0.001$). This indicates a notable improvement in the patients' lung capacity post-intervention (Figure 1).Forced Expiratory Volume in one second (FEV1): The mean FEV1 showed a significant increase from 80.13 (SD = 10.612) pre-intervention to 82.08 (SD = 11.902) post-intervention ($t = 3.747$, $p < 0.001$). This suggests an enhancement in the patients' ability to expel air from their lungs in one second after the intervention (Figure 2).Forced Expiratory Flow at 25-75% (FEF25-75): The mean FEF25-75 increased significantly from 85.03 (SD = 18.798) before the intervention to 87.38 (SD = 20.385) after the intervention ($t = 2.984$, $p = 0.004$). This improvement highlights better performance in the mid-range of the pulmonary volume (Figure 3).

Comparison of Pre and Post Peak Expiratory Flow Rate:

The comparison of pre and post readings for PEFR was conducted using paired samples t-tests to determine the intervention's impact on this parameter.Peak Expiratory Flow Rate (PEFR): The mean PEFR significantly increased from 442.70 (SD = 95.34) pre-intervention to 471.50 (SD = 87.89) post-intervention ($t = 7.635$, $p < 0.001$). This significant improvement indicates enhanced maximal speed of expiration following the intervention (Figure 4).

Correlation Between PEFR and Breath Hold:

We assessed the correlation between PEFR (both pre and post) and Breath Hold using Pearson's correlation coefficient.Pre-intervention PEFR and Breath Hold: There was no significant correlation between pre-intervention PEFR and Breath Hold ($r = 0.188$, $p = 0.060$), indicating that initial PEFR did not significantly influence Breath Hold capacity.Post-intervention PEFR and Breath Hold: A moderate significant correlation was found between post-intervention PEFR and Breath Hold ($r = 0.237$, $p = 0.018$), suggesting that improvements in PEFR were associated with better Breath Hold performance post-intervention.

Correlation Between Pulmonary Function Tests (Pre and Post) and Breath Hold:

Pearson's correlation was also used to examine the relationship between other PFT measures and Breath Hold.Pre-intervention PFTs and Breath Hold, FVC: No significant correlation was observed between pre-intervention FVC and Breath Hold ($r = 0.183$, $p = 0.068$).FEV1: There was no significant correlation between pre-intervention FEV1 and Breath Hold ($r = 0.120$, $p = 0.235$).FEF25-75: No significant correlation was found between pre-intervention FEF25-75 and Breath Hold ($r = 0.107$, $p = 0.287$).Post-intervention PFTs and Breath Hold, FVC: The correlation between post-intervention FVC and Breath Hold was not significant ($r = 0.114$, $p = 0.260$).FEV1: No significant correlation was observed between post-intervention FEV1 and Breath Hold ($r = 0.032$, $p = 0.749$).FEF25-75: Similarly, post-intervention FEF25-75 did not show a significant correlation with Breath Hold ($r = 0.029$, $p = 0.753$).

Correlation Between Pre and Post Pulmonary Function Tests:

Finally, we examined the correlations between pre and post PFT readings.FVC: There was a strong significant correlation between pre and post FVC ($r = 0.9014$, $p < 0.0001$).FEV1: A strong significant correlation was found between pre and post FEV1 ($r = 0.8994$, $p < 0.0001$).

FEF25-75: The correlation between pre and post FEF25-75 was also strong and significant ($r = 0.8508$, $p < 0.0001$).PEFR: The correlation between pre and post PEFR was strong and significant ($r = 0.9184$, $p < 0.0001$).

DISCUSSION

Whole blood donation involves the removal of approximately 10% of total blood volume, leading to various compensatory mechanisms, including activation of the sympathetic nervous system and the renin–angiotensin–aldosterone system[10]. Despite the essential nature of these mechanisms, the physiological impact on lung function during the donation process remains underexplored[11]. This study sought to address this gap by comparing pre- and post-donation pulmonary function tests (PFTs) in a cohort of donors.

The results of this study indicate significant improvements in several pulmonary function parameters following blood donation. Forced Vital Capacity (FVC) increased significantly from a mean of 79.69 (SD = 10.135) to 81.98 (SD = 11.969) post-intervention ($t = 4.383$, $p < 0.001$). Similarly, Forced Expiratory Volume in one second (FEV1) showed a significant rise from 80.13 (SD = 10.612) to 82.08 (SD = 11.902) post-intervention ($t = 3.747$, $p < 0.001$). Forced Expiratory Flow at 25-75% of pulmonary volume (FEF25-75) also increased significantly from 85.03 (SD = 18.798) to 87.38 (SD = 20.385) ($t = 2.984$, $p = 0.004$). Additionally, Peak Expiratory Flow Rate (PEFR) saw a significant improvement from 442.70 (SD = 95.34) to 471.50 (SD = 87.89) post-intervention ($t = 7.635$, $p < 0.001$).

Previous studies provide a context for interpreting these findings. Cheung Cara Hor Yine found that pre-hydration with oral rehydration salts (ORS) significantly mitigated the reduction in stroke volume (SV) and cardiac output (CO) during phlebotomy, with ORS being more effective than water[12]. This supports the notion that adequate hydration before blood donation could enhance hemodynamic stability and improve pulmonary function post-donation. Similarly, applied muscle tension (AMT) has been shown to improve hemodynamic profiles, suggesting its potential benefit in reducing vasovagal reactions (VVR) during blood donation, particularly in young donors[13].

Maurizio Rizzi et al. reported that repeated blood donations significantly reduce the diffusing capacity of the lung for carbon monoxide (DLCO) and alveolar-capillary membrane diffusing capacity (Dm)[14]. Our study's findings of significant improvements in FVC, FEV1, FEF25-75, and PEFR post-donation might seem contradictory. However, it is essential to consider the short-term effects observed in our study compared to the long-term impact of repeated donations discussed by Maurizio Rizzi et al. The immediate improvements could be attributed to the body's acute compensatory mechanisms post-donation, while long-term repeated donations might lead to chronic pulmonary function decline.

In another study, Cara H. Y. Cheung et al. demonstrated that performing AMT during phlebotomy resulted in higher SV, higher CO, and lower systemic vascular resistance (SVR) compared to controls[15]. These hemodynamic improvements align with our findings, suggesting that the body's compensatory mechanisms can effectively maintain or even enhance pulmonary function immediately following a single blood donation. The significant correlations found between pre and post PFT readings further emphasize the reliability of these acute changes.

Our findings indicate a need for further research to understand the long-term pulmonary function implications of repeated blood donations. While our study shows immediate improvements in pulmonary function, it remains crucial to monitor these parameters over extended periods to identify any potential adverse effects. The incorporation of pre-hydration and AMT could be beneficial strategies to enhance donor safety and comfort, potentially increasing donor retention rates.

CONCLUSION

This study demonstrates significant short-term improvements in pulmonary function following blood donation, as evidenced by increased FVC, FEV1, FEF25-75, and PEFR. These findings suggest that the body's compensatory mechanisms effectively maintain or enhance lung function immediately post-donation. However, long-term studies are necessary to assess the impact of repeated blood donations on pulmonary health. Implementing strategies such as pre-hydration and applied muscle tension during phlebotomy could improve donor safety and experience, potentially addressing the decline in blood donation rates. These interventions could ensure better management of donor health, fostering a more reliable blood supply system.

REFERENCES

1. Velasquez MT, Menitove J, Skelton MM, Cowley Jr AW. Hormonal responses and blood pressure maintenance in normal and hypertensive subjects during acute blood loss. Hypertension. 1987;9(5):423-8.
2. Franchini M, Targher G, Montagnana M, Lippi G. Iron and thrombosis. Annals of hematology. 2008;87:167-73.
3. Mancia G, Parati G, Pomidossi G, Casadei R, Di Rienzo M, Zanchetti A. Arterial baroreflexes and blood pressure and heart rate variabilities in humans. Hypertension. 1986;8(2):147-53.
4. Parati G, Di Rienzo M, Bertinieri G, Pomidossi G, Casadei R, Groppelli A, et al. Evaluation of the baroreceptor-heart rate reflex by 24-hour intra-arterial blood pressure monitoring in humans. Hypertension. 1988;12(2):214-22.
5. Fountain JH, Kaur J, Lappin SL. Physiology, renin angiotensin system. 2017.
6. Castilaw E. Stride by Stride: Assessing the Impact, Advantages, and Disadvantages of Running-Specific Prostheses. 2024.
7. Ponce M, Sankari A, Sharma S. Pulmonary Function Tests. 2022 Sep 3. StatPearls [Internet] Treasure Island (FL): StatPearls Publishing. 2023.
8. Peng TC, Liao KW, Lai HL, Chao YFC, Chang FM, Harn H-J, et al. The physiological changes of cumulative hemorrhagic shock in conscious rats. Journal of biomedical science. 2006;13(3):385-94.
9. Haberthür C, Schächinger H, Seeberger M, Gysi CS. Effect of non-hypotensive haemorrhage on plasma catecholamine levels and cardiovascular variability in man. Clinical physiology and functional imaging. 2003;23(3):159-65.
10. Myers DJ, Collins RA. Blood donation. StatPearls [Internet]: StatPearls Publishing; 2023.
11. Raghuwanshi B, Maheshwari A. Impact of alternative strategies to improve the pool of blood donation by off-hour donation: A pilot study and its future prospects. Journal of family medicine and primary care. 2021;10(9):3288-91.
12. Cheung CHY. Prevention of vasovagal reactions in blood donors. 2021.

13. France CR, Ditto B, Wissel ME, France JL, Dickert T, Rader A, et al. Predonation hydration and applied muscle tension combine to reduce presyncopal reactions to blood donation. Transfusion. 2010;50(6):1257-64.
14. Rizzi M, Cristiano A, Frassanito F, Macaluso C, Airoldi A, Vanni S, et al. Could lung function be modified by repeated blood donations? European Journal of Internal Medicine. 2016;34:68-71.
15. Cheung CH, Khaw ML, Leung WS, Tam SY, Chu CY, Lee CK, et al. Effects of performing applied muscle tension during recovery after phlebotomy in young, first-time donors: a pilot study. International Journal of Environmental Research and Public Health. 2021;18(19):10541.

Authors contribution:

Vijayalakshmi Sivasubramanian collected and interpreted the data. PrasanthGururajand Gangadharan Vadivelu drafted the manuscript. Gangadharan Vadivelu critically reviewed and revised the manuscript. All authors contributed equally and agreed to be accountable for all aspects of the work.

Acknowledgement:

The authors extend their gratitude to Dr. Kevin Kumar Vijayakumar, M. Tech., Ph.D., from Grace Polyclinic, Madurai, for his valuable guidance and support in the preparation of this case report.

Tables:

Table 1: Comparison of Pre and Post Pulmonary Function Test Readings

Measure	Stage	Mean	SD	t-value
FVC	Pre	79.69	10.135	4.383**
	Post	81.98	11.969	
FEV1	Pre	80.13	10.612	3.747**
	Post	82.08	11.902	
FEF25-75	Pre	85.03	18.798	2.984**
	Post	87.38	20.385	

Significant at 1% level

Table 2: Comparison of Pre and Post Peak Expiratory Flow Rate

Measure	Stage	Mean	SD	t-value
Peak Expiratory Flow Rate	Pre	442.70	95.34	7.635**
	Post	471.50	87.89	

Significant at 1% level

Table 3: Correlation Between PEFR (Pre and Post) and Breath Hold

Measure	Pearson Correlation	p-value
PEFR (Pre) and Breath Hold	0.188	0.060
PEFR (Post) and Breath Hold	0.237*	0.018

Significant at 5% level

Table 4: Correlation Between Pulmonary Function Tests (Pre) and Breath Hold

Measure	Pearson Correlation	p-value
FVC (Pre)	0.183	0.068
FEV1 (Pre)	0.120	0.235
FEF25-75 (Pre)	0.107	0.287

Table 5: Correlation Between Pulmonary Function Tests (Post) and Breath Hold

Measure	Pearson Correlation	p-value
FVC (Post)	0.114	0.260
FEV1 (Post)	0.032	0.749
FEF25-75 (Post)	0.029	0.753

Table 6: Correlation Between Pre and Post Pulmonary Function Tests

Groups	FVC (Post)	FEV1 (Post)	FEF25-75 (Post)	PEFR (Post)
FVC (Pre)	**0.9014******	**0.8469******	**0.3283*****	0.04055
FEV1 (Pre)	**0.7703******	**0.8994******	**0.5736******	0.1414
FEF25-75 (Pre)	0.1866	**0.4527******	**0.8508******	**0.3358*****
PEFR (Pre)	0.04306	0.1285	**0.2293***	**0.9184******

Values in bold indicate significant differences.
**p < 0.05; ** p < 0.01; *** p < 0.001; **** p < 0.0001*

Figures

Figure 1: Comparison of Pre and Post Readings of FVC

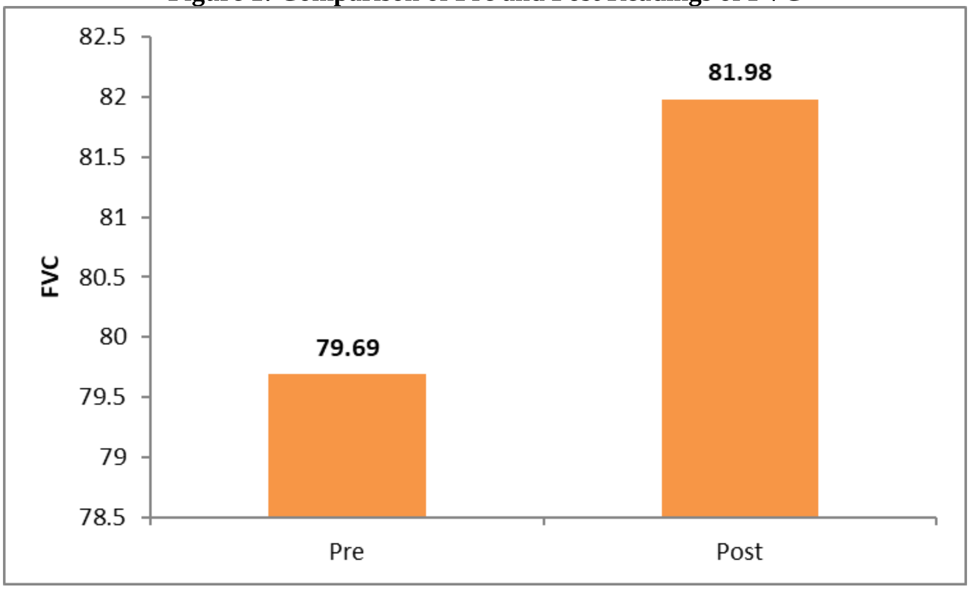

Figure 2: Comparison of Pre and Post Readings of FEV1

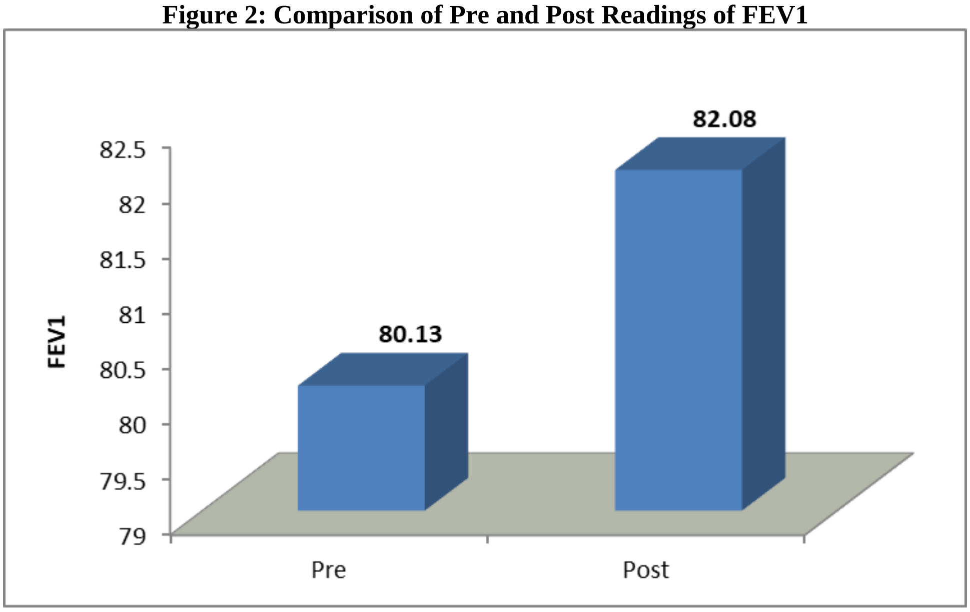

Figure 3: Comparison of Pre and Post Readings of FEF25-75

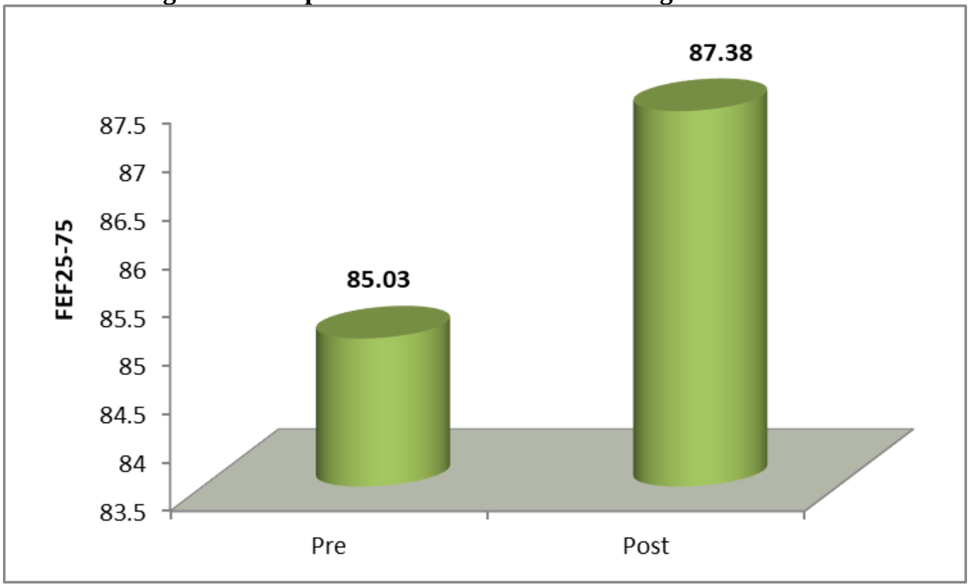

Figure 4: Comparison of Pre and Post Readings of PEFR