Effect Of Incentive Spirometry On Post Operative Pulmonary Complications After Bariatric Surgery: A Cross Sectional Study

Original Article

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ARTICLE INFORMATION

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ABSTRACT

Objective: The main objective of this research was to check the efficacy of Incentive spirometer on pulmonary complication after bariatric surgery.

Material and Methods: : The study was conducted in Superior University for duration of 4 months. It was descriptive cross-sectional study. Data was collected from 140 bariatric patients at Shalamar Hospital Lahore, selected via convenient sampling. Adults with a BMI >25, both with and without postoperative pulmonary complications, were included. Data was gathered via questionnaires and analyzed using SPSS 26.0 and Med Calc 14.0. Ethical approval and informed consent were obtained.

Results: The study examined the efficacy of spirometry based on smoking history, oxygen levels, comorbidities, respiratory support, respiration rate, and frequency. Non-smokers showed the highest efficacy in 3-ball spirometry (50.43%), while smokers had the lowest efficacy. Pulmonary complications, especially atelectasis, improved efficacy with 2-ball and 3-ball spirometry (17.86% and 34.29%, respectively). In contrast, patients without complications showed imporved efficacy with 3 ball spirometry (39.29%). Hypoxic patients demonstrated moderate efficacy, with normal oxygen levels showing the highest efficacy (46.43%). Patients with no respiratory support performed best (56.83%) with 3-ball spirometry. Statistical analysis revealed that all differences were significant ($p \leq 0.05$).

Conclusion: Incentive spirometry, particularly 3-ball spirometry, was most effective in reducing postoperative pulmonary complications in bariatric surgery patients, especially for non-smokers and those with normal oxygen levels and no significant respiratory issues. Further research will be needed to refine spirometry frequency and develop targeted interventions for patients with comorbidities.

Introduction:

Obesity is a condition where a person has too much body fat, and it is influenced by both genetics and the environment, making it difficult to manage through dieting alone. There is a difference between being overweight and being obese. Being overweight means having more body weight than is considered healthy. Obesity, on the other hand, means having a large amount of body fat. While all obese people are overweight, not everyone who is overweight is considered obese. (1).

The number of overweight and obese people worldwide has doubled since 1980, with nearly one-third of the global population now affected. Obesity harms nearly every part of the body and is a major public health issue. It increases the risk of diseases like diabetes, heart disease, certain cancers, joint problems, and mental health disorders. These conditions can lower quality of life, reduce work productivity, and raise healthcare costs. In the U.S., the annual healthcare cost for one obese person was $1,901 in 2014, totaling $149.4 billion nationwide. Europe also faces high direct and indirect costs..(2).

Recent increases in obesity have led to a significant rise in the number of people affected by severe and morbid obesity. Bariatric surgery is now considered an effective treatment for patients with morbid obesity or severe obesity with health issues that don't respond to medical treatments. This surgery has been linked to a lower incidence of new diabetes, remission of existing diabetes, reduced use of prescription drugs, improved quality of life, and lower mortality rates.(3)

Bariatric surgery has become a key treatment for obesity, reducing the risk of death from obesity-related complications by 28% compared to traditional treatments. It is strongly linked to lasting weight loss, remission of type 2 diabetes, and improvements in related conditions like high cholesterol, high blood pressure, and cardiovascular issues. Additionally, bariatric surgery lowers the mortality rate by 92% for diabetes, 60% for cancer, and 52% for coronary heart disease. (4).

Bariatric surgery is the best treatment for obesity and related health problems. The most common types are Roux-en-Y gastric bypass (RYGBP) and sleeve gastrectomy (SG). SG, introduced in 1988, is popular because it's simple, easy to learn, and helps with weight loss. However, it has two main issues: a high chance of weight regain and gastro-esophageal reflux disease (GERD). Mini-gastric bypass (MGB), a newer procedure developed by Rutledge, is becoming popular because it's safe, simple, and gives good results. (5)

Obesity, a known cardiovascular risk factor, can also lead to significant respiratory problems. These range from mild changes in breathing to severe conditions like obesity hypoventilation syndrome. Obese individuals often have higher rates of asthma, COPD, and sleep apnea, which can worsen breathing issues. Hypoventilation is commonly underdiagnosed and typically identified during complications or when evaluating for sleep apnea. Obese patients are also at higher risk for postoperative issues such as atelectasis, pneumonia, pleural effusion, pulmonary embolism, and ARDS. (6).

Postoperative patients are particularly prone to respiratory complications, with those undergoing abdominal or thoracic surgeries being at an elevated risk. Incentive spirometry (IS), an inhalation-based prophylactic technique, is widely used in clinical settings to mitigate these risks. The device encourages patients to mimic natural deep sighs, promoting periodic increases in lung volume to prevent complications such as atelectasis. Given its status as the preferred prophylactic method in many hospitals, numerous studies have evaluated its efficacy. Evidence suggests that IS supports respiratory function and reduces the incidence of pulmonary complications, making it a cornerstone in postoperative care.(7)

Incentive spirometry (IS) is a widely used intervention to prevent postoperative pulmonary complications, such as atelectasis, and to promote recovery by improving lung function. In 2018, study emphasized that patient education and proper device placement significantly enhance compliance and confidence, with 73.8% of patients reporting improved confidence after brief instruction. Effective IS use supports respiratory health and accelerates recovery, making it a valuable tool in postoperative care.(8)

In 1983 a study, researchers compared respiratory therapies for preventing complications after abdominal surgery. They found that intermittent positive pressure breathing (IPPB), incentive spirometry (IS), and deep breathing exercises (DBE) all reduced pulmonary complications compared to no treatment. IS was particularly effective in upper abdominal surgeries, shortening hospital stays without causing side effects seen with IPPB(9).

In 2022 a study investigated the role of physiotherapy in improving recovery after upper abdominal surgery, where postoperative complications are common. Conducted as a randomized case series, the study included 40 patients from March 2021 to August 2022 who received tailored physiotherapy interventions, including breathing exercises, thoracic mobility exercises, and incentive spirometry, starting from the first postoperative day until discharge. Results showed significant improvements in thoracic expansion and oxygen-haemoglobin saturation levels, indicating better respiratory function and oxygenation. The study highlighted the benefits of physiotherapy in post-surgical recovery, recommending further research with larger samples and longer follow-up periods to refine its effectiveness. (10)

In 2023 study in India at Burdwan Medical College evaluated the impact of incentive spirometry (IS) on lung function after abdominal surgery. 80 patients were split into two groups: one received chest physiotherapy, and the other received IS with physiotherapy. The IS group showed slightly improved lung function, such as higher PEFR, but the differences were not statistically significant. The study concluded that IS, combined with breathing exercises and early mobilization, helps prevent lung complications post-surgery.(11)

In 2024 a study examined the effects of incentive spirometry and deep breathing exercises on lung function and hemodynamic indicators in patients undergoing gastric sleeve surgery. Conducted at Imam Khomeini Hospital in Tehran with 75 participants, the study divided patients into two intervention groups—one using an incentive spirometer and the other practicing deep breathing exercises—while a control group received no special intervention. Results showed that neither method significantly improved oxygen levels, blood pH, or heart rate during or after surgery ($P>0.05$), though both helped improve blood pressure ($P<0.05$). Additionally, there was no significant difference in post-surgical lung complications among the groups. In conclusion, while incentive spirometry and deep breathing exercises improved oxygenation and heart rate before surgery, they had no major effect during or after surgery and did not prevent lung complications, with neither method proving superior to the other.(12)

ISM (Incentive Spirometry) devices are either flow-oriented or volume-oriented. Flow-oriented ISM devices consist of a chamber with 3 interconnected columns in which lightweight plastic floats are seated. The chamber is connected to a flexible tube with a mouthpiece through which the patient inhales, attempting to raise the floats through inspiratory flow created by negative intrathoracic pressure. Volume-oriented IS devices consist of a flexible tube with a mouthpiece connected to a chamber that has volume measurements displayed. When the patient inhales, a piston in the chamber rises to the maximum volume of air displaced.(13)

Three-ball incentive spirometry (Flow oriented) is a respiratory therapy device used to encourage deep breathing and prevent pulmonary complications, particularly in postoperative patients. It consists of a chamber with three small balls or discs inside a column. The patient inhales deeply through a mouthpiece, causing the balls to rise as air flows into the lungs. This action helps to achieve and sustain maximal inspiration, promoting lung expansion and improving airflow. By using the spirometer regularly, patients can prevent atelectasis (lung collapse) and pneumonia, which are common postoperative respiratory complications (14)

METHODOLOGY:

This study employed a cross-sectional research design and was conducted in the Surgical ICU, male and female surgical wards, and private rooms at Shalamar Hospital, Lahore. The sample size was calculated using the formula for cross-sectional studies, with a 95% confidence level ($Z \approx 1.96$) and a prevalence rate of 0.10. (15)

This resulted in a required sample size of 140 participants. Convenient sampling was used for data collection, which took place over a period of 4 months.

The inclusion criteria were patients aged 18 to 60 years, with a BMI above 25, and experiencing postoperative pulmonary complications following bariatric surgeries such as sleeve gastrectomy, mini gastric bypass, or sleeve redo surgery. Exclusion criteria included patients with a BMI below 25, those undergoing other abdominal surgeries, patients without teeth, or those under 18 years of age. Ethical considerations involved obtaining informed consent from participants, ensuring confidentiality by anonymizing and securely storing data, and receiving ethical approval from the Institutional Review Board (IRB) of Superior University.

Data was collected using a questionnaire designed by the supervisor and gathered from the SICU, GOT, surgical wards, and private rooms on the day of discharge. The statistical analysis was performed using IBM SPSS Statistics 26.0 and MedCalc 14.0. Descriptive statistics and cross-tabulations were used to assess the effects of incentive spirometry on pulmonary complications, comorbidities, smoking status (smokers vs. non-smokers), oxygen levels (normal vs. hypoxia), and respiratory rates (high vs. normal). A Chi-square test was used for statistical significance testing.

RESULTS:

Data of 140 patients of bariatric patients was taken from Shalamar hospital Lahore. In this study , the effect of Incentive spirometry by variables like smoking history , pulmonary complications , Comorbidities ,oxygen level ,additional respiratory support Respiratory rate and Frequency observed with 3ball Spirometry(Incentive Spirometry) was evaluated.

Table 1 Efficacy of Spirometer on smoking History

EFFICACY OF SPIROMETER	**smoking history**		**Types of pulmonary complications**		**comorbidities**	
	Smokers	Non Smokers	No Complications	Atelectasis	Osa	Osa\Copd
Effects On 1 Ball Spirometry	2.14%	2.86%	0.71%	4.29%	0.71%	4.29%
Effects On 2 Ball Spirometry	10.71%	10.71%	3.57%	17.86%	3.57%	17.86%
Effects On 3 Ball Spirometry	17.14%	50.43%	39.29%	34.29%	39.29%	34.29%

In this table effect of incentive spirometry shown on smoking History, Types of Pulmonary Complications and comorbidities with P value is evaluated. For smoking history, smokers showed lower efficacy, with 1-ball spirometry at 2.14%, 2-ball at 10.71%, and 3-ball at 17.14%. Non-smokers demonstrated higher efficacy, with 1-ball at 2.86%, 2-ball at 10.71%, and 3-ball at 50.43%. Regarding pulmonary complications, patients with no complications had 1-ball at 0.71%, 2-ball at 3.57%, and 3-ball at 39.29%, while those with atelectasis had 2-ball at 17.86% and 3-ball at 34.29%. For comorbidities, OSA patients had 2-ball at 3.57% and 3-ball at 39.29%, while OSA+COPD patients had 2-ball at 17.86% and 3-ball at 34.29%

Table 2 Table Effect of Incentive Spirometry Shown on Oxygen Level

Efficacy Of Spirometer	**Oxygen Level**		**Additional Respiratory Support**			**Respiratory Rate**	
	Normal Oxygen Level	Hypoxia	None	Nasal Canula	Cpap\Bipap	High Respiration	Normal Respiration
Effects On 1 Ball Spirometry	1.43%	3.57%	0.72%	2.16%	2,16%	2.86%	2.14%
Effects On 2 Ball Spirometry	3.57%	17.86 %	4.32%	12.23%	4.32%	7.86%	13.57%
Effects On 3 Ball Spirometry	46.43%	27.14 %	56.83%	16.55%	0..72%	8.57%	65%

In this table effect of incentive spirometry shown on Oxygen level on room air ,Additional Respiratory support and Respiratory Rate, Frequency Observed with P value , In terms of oxygen levels, those with normal oxygen levels had 1-ball at 1.43%, 2-ball at 3.57%, and 3-ball at 46.43%, while hypoxic patients had 1-ball at 3.57%, 2-ball at 17.86%, and 3-ball at 27.14%. Regarding respiratory support, patients with no additional support showed 1-ball at 0.72%, 2-ball at 4.32%, and 3-ball at 56.83%, while those using a nasal cannula had 2-ball at 12.23% and 3-ball at 16.55%, and CPAP/BIPAP patients had 1-ball at 2.16%, 2-ball at 2.16%, and 3-ball at 0.72%. For respiratory rate, high respiration showed 1-ball at 2.86%, 2-ball at 7.86%, and 3-ball at 8.57%, while normal respiration showed 1-ball at 2.14%, 2-ball at 13.57%, and 3-ball at 65%.

Table 3 Effect of Incentive Spirometry Shown on Frequency Observed with P-Value

Efficacy Of Spirometer	**Frequency Observed Of Spirometry**		
	4 Times A Day	8 Times A Day	12 Times A Day
Effects On 1 Ball Spirometry	2.86%	2.14%	0%
Effects On 2 Ball Spirometry	5.70%	15%	0.71%
Effects On 3 Ball Spirometry	0.00%	52.14%	21.43%

In this table effect of incentive spirometry shown on Frequency Observed with P value , Finally, for spirometry frequency, 4 times a day showed 1-ball at 2.14%, 2-ball at 5.70%, and 3-ball at 0%, 8 times a day showed 1-ball at 2.14%, 2-ball at 15%, and 3-ball at 52.14%, and 12times a day showed 1-ball at 0%, 2-ball at 0.71%, and 3-ball at 21.43%.

Statistical Significance (P-values):

The p-values of 0.02, 0.01, and 0.01 indicate that the differences in the efficacy of spirometry tests across smoking history, pulmonary complications, and comorbidities are statistically significant.

The p-values for all categories are ≤ 0.05, indicating that the differences observed in the efficacy of spirometry across oxygen levels, respiratory support, respiratory rate, and frequency are statistically significant

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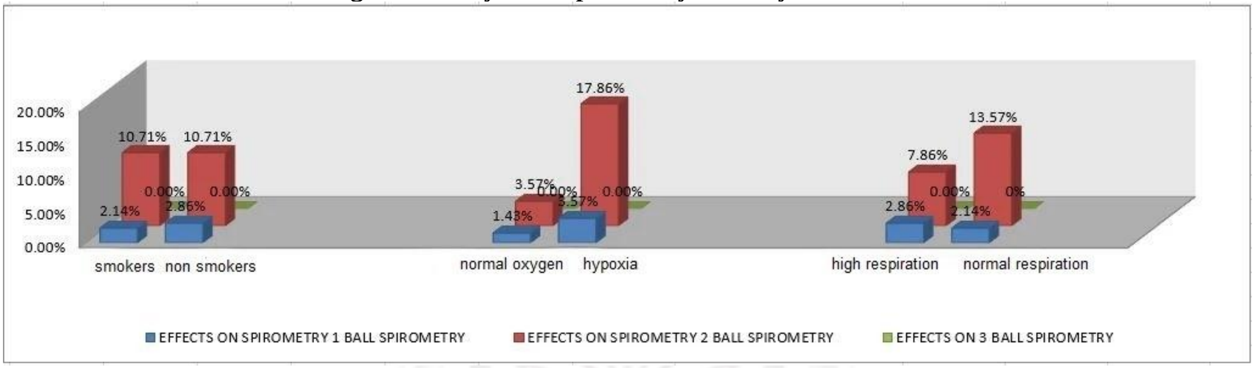
Figure 1: Analysis on The Efficacy Of Spirometers In Patients With Pulmonary Complications

The analysis on the efficacy of spirometers in patients with pulmonary complications reveals interesting findings. Among patients without any pulmonary complications, 0.71% were able to pick 1 ball with 600 ml, 3.57% picked 2 balls with 900 ml, and 39.29% picked 3 balls with 1200 ml. In contrast, among patients with atelectasis, a pulmonary complication, 4.29% picked 1 ball with 600 ml, 17.86% picked 2 balls with 900 ml, and 34.29% picked 3 balls with 1200 ml. This shows a higher proportion of patients without complications demonstrating better spirometer performance, particularly with the higher volumes of 900 ml and 1200 ml

Figure 2 Analysis of Spirometry Efficacy In Smokers



The analysis of spirometry efficacy in smokers and non-smokers, considering oxygen levels and respiratory rates, reveals distinct patterns

- **Smokers vs Non-Smokers**: Smokers show lower performance overall in spirometry. For 1 ball spirometry, 2.14% of smokers and 2.86% of non-smokers were able to achieve this. For 2-ball spirometry, 10.71% of both smokers and non-smokers were able to reach this level. However, for 3-ball spirometry, smokers performed worse at 17.14%, while non-smokers performed significantly better at 50.43%.
- **Oxygen Levels**: When comparing oxygen levels, individuals with a **normal oxygen level** showed better spirometry performance across all levels. For 1 ball spirometry, 1.43% of individuals with normal oxygen levels succeeded, while 3.57% of those with hypoxia achieved this. For 2-ball spirometry, 3.57% of individuals with normal oxygen levels succeeded, while 17.86% of those with hypoxia performed at this level. Most notably, for 3-ball spirometry, 46.43% of individuals with normal oxygen levels succeeded, while only 27.14% of individuals with hypoxia managed to pick 3 balls.
- **Respiratory Rate**: Regarding **respiratory rate**, individuals with **normal respiration** performed better in spirometry compared to those with high respiration. For 1 ball spirometry, 2.86% of individuals with normal respiration succeeded, compared to 2.14% with high respiration. For 2-ball spirometry, 7.86% of individuals with normal respiration succeeded, compared to 13.57% with high respiration. For 3-ball spirometry, individuals with normal respiration showed remarkable performance, with 65% achieving 3 balls, in contrast to just 8.57% with high respiration.
- In summary, non-smokers generally perform better than smokers, and individuals with normal oxygen levels and normal respiration rates show the highest efficacy in spirometry.

DISCUSSION:

The purpose of this research was to evaluate "the efficacy of incentive spirometry on post-operative pulmonary complications after bariatric surgery", using a sample size of 140 patients .Data was collected from Shalamar hospital Lahore(SICU, Surgical wards ,Private rooms),patients consent was taken before taking data, sampling technique was convenient sampling technique, study type was Cross sectional study The sample size was determined based on previous studies, and the findings were statistically significant, with p-values less than 0.05 in all relevant categories. Statistical analysis was performed by using IBM SPSS Statistics 26.0 and Med Calc 14.0.7. Descriptive statistics , cross tabs were used between the effect of incentive spirometry to types of pulmonary complications, comorbidities frequency observed, smokers and nonsmokers, normal oxygen level and hypoxia, high respiratory rate and normal respiratory rate, Chi-square test was used.

This section discusses the key findings in relation to the study's objectives and existing literature.

In a 2003 study involving 876 patients undergoing abdominal surgery, researchers compared the effectiveness of incentive spirometry and conventional chest physiotherapy in preventing pulmonary complications. They found no significant difference in the incidence of complications between the two groups: 15.8% with incentive spirometry and 15.3% with chest physiotherapy. Additionally, there were no disparities in clinical signs, chest radiograph abnormalities, pathogen presence in sputum, respiratory failure rates, or hospital stay duration. The study concluded that both prophylactic methods are equally effective in managing patients post-abdominal surgery(16)

In 15 December 2018 a study investigated the effectiveness of Incentive Spirometry in improving respiratory status among post-operative patients following major abdominal surgery at Billroth Hospitals. Using a true experimental design with 60 randomly selected patients, the research aimed to assess pre-test and post-test respiratory statuses and examine any associations with demographic variables. Results showed that a majority (73.33%) of patients achieved good respiratory status post-treatment, with 26.67% achieving excellent status. The study concluded that Incentive Spirometry significantly enhances respiratory outcomes in this patient group, independent of demographic factors (17).

In another study conducted on April 17, 2018, focused on assessing the impact of incentive spirometry on postoperative breathing patterns among abdominal surgery patients in hospitals across Makkah. Using a quantitative quasi-experimental design, 100 patients were divided into two groups: a control group receiving standard care and a study group receiving preoperative education on incentive spirometry and practicing it postoperatively. Early findings showed significant improvements in breathing patterns and vital signs within the first two days post-surgery in the study group compared to controls, although differences were not sustained by the third day. The study concludes that incentive spirometry effectively supports lung health by enhancing diaphragmatic mobility, preventing postoperative pulmonary complications, and aiding in secretion clearance following abdominal surgery (18).

In 2021, a study in India investigated the effectiveness of incentive spirometry in improving expiratory muscle strength after abdominal surgery. The study included 30 patients, divided into two groups: Group A (15 patients), which received both inspiratory and expiratory muscle training with the spirometer, and Group B (15 patients), which received only inspiratory training. The study measured maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) using a respiratory pressure meter .Results showed that while MIP improved from the second to the seventh postoperative day, the change was not statistically significant ($P>0.05$). However, MEP showed a significant improvement in Group A ($P<0.05$).The study concluded that using incentive spirometry for both inspiratory and expiratory muscle training significantly improves expiratory muscle strength, in addition to inspiratory muscle strength, in patients after abdominal surgery.(19)

The results in my study demonstrate that non-smokers experienced significantly better outcomes with incentive spirometry, particularly in the 3-ball spirometry test, with an efficacy of 50.43%. In contrast, smokers showed lower efficacy, particularly in 1-ball spirometry (2.14%). This aligns with existing literature suggesting that smoking history can impair respiratory function and reduce the effectiveness of post-operative interventions like incentive spirometry. Smokers are more prone to respiratory complications such as atelectasis and pneumonia, which can affect the success of spirometry in improving pulmonary function. Non-smokers, on the other hand, have better baseline lung function, making them more responsive to spirometry interventions.

Patients who developed atelectasis as a post-operative complication showed moderate improvement with incentive spirometry. The 3-ball spirometry showed an efficacy of 34.29%, which is a meaningful improvement, particularly when compared to patients with no complications (39.29%). These findings are consistent with previous research, which shows that incentive spirometry helps in preventing and treating atelectasis by improving lung expansion and reducing the risk of collapsed lung tissue after surgery. This supports the use of spirometry as a preventive measure for pulmonary complications in bariatric surgery patients.

Patients with comorbidities such as Obstructive Sleep Apnea (OSA) and Chronic Obstructive Pulmonary Disease (COPD) exhibited lower efficacy in spirometry. Patients with OSA showed 39.29% efficacy in 3-ball spirometry, while those with OSA and COPD had an efficacy of 34.29%. These results indicate that comorbid conditions like OSA and COPD could hinder the efficacy of incentive spirometry, possibly due to the chronic nature of these diseases and their impact on overall pulmonary function. This finding is consistent with literature that suggests that patients with existing respiratory conditions may require more intensive management and may not respond as effectively to standard post-operative interventions like incentive spirometry.

Oxygen levels had a significant impact on the efficacy of spirometry. Patients with normal oxygen levels showed the highest efficacy across all spirometry types, especially in 3-ball spirometry, where the efficacy was 46.43%. In contrast, hypoxic patients showed a reduced response to spirometry, particularly in the 3-ball spirometry test (27.14%). This finding underscores the importance of maintaining adequate oxygenation levels in the post-operative period. Hypoxia, a common complication in bariatric surgery patients, can impair lung function and limit the effectiveness of spirometry in improving pulmonary function. This highlights the need for close monitoring and early intervention in hypoxic patients to optimize spirometry outcomes.

The role of respiratory support in enhancing spirometry outcomes was also evident in this study. Patients who did not require additional respiratory support showed the highest efficacy in 3-ball spirometry (56.83%), while those requiring Nasal Cannula and CPAP/BIPAP support showed lower efficacy (16.55% and 0.72%, respectively). This suggests that while spirometry is effective in improving pulmonary function, its efficacy may be diminished when patients are already receiving respiratory support, possibly due to the severity of their respiratory issues. CPAP/BIPAP users, in particular, might have more advanced respiratory problems that limit the effectiveness of spirometry as an intervention.

The findings also suggest that respiratory rate plays a crucial role in the effectiveness of incentive spirometry. Patients with normal respiration showed the highest efficacy in 3-ball spirometry (65%), indicating that patients with normal respiratory function are better able to utilize spirometry effectively. In contrast, patients with high respiration rates showed much lower efficacy, especially in 3-ball spirometry (8.57%). Elevated respiratory rates may be a sign of stress or respiratory distress, which could interfere with the proper use of the spirometer and reduce its effectiveness.

The frequency of spirometry (4, 8, or 12 times a day) did not significantly impact the overall efficacy, although a slight increase in efficacy was observed with "8 times a day" spirometry. The 3-ball spirometry efficacy was 52.14% in this group, which was higher than the 0% efficacy seen in the 4 times a day group. This suggests that more frequent spirometry may be somewhat beneficial, but the effect is limited and might plateau beyond a certain frequency. This finding is consistent with the notion that while frequent use of spirometry can aid in pulmonary recovery, there may be diminishing returns after a certain threshold of use.

The p-values in this study (≤ 0.05) indicate that the observed differences in spirometry efficacy based on factors such as oxygen levels, comorbidities, and respiratory support are statistically significant. This strengthens the conclusion that the variables studied have a meaningful impact on the effectiveness of incentive spirometry in reducing post-operative pulmonary complications in bariatric surgery patients.

Summary:

In summary, the findings of this study indicate that incentive spirometry is effective in reducing post-operative pulmonary complications, particularly for patients with normal oxygen levels, no respiratory support, and no significant comorbidities. Non-smokers and patients without respiratory complications like Atelectasis benefit the most from spirometry. However, patients with "comorbidities" such as OSA, COPD, and those requiring "respiratory support" (e.g., CPAP/BIPAP) show less benefit from the intervention, suggesting that additional or alternative interventions may be necessary for these patients.

This study provides strong evidence supporting the use of incentive spirometry as an important tool in "post-operative care" for bariatric surgery patients, especially in those at lower risk for pulmonary complications. However, further research may be required to explore optimal spirometry frequency and tailored interventions for patients with respiratory comorbidities or severe post-operative complications.

Limitations:

The use of convenient sampling was necessary due to the limited four-month data collection period, but it presents some limitations. Being a single-center study, the findings may not be generalizable to other settings. The sample composition may not fully represent all bariatric surgery patients, and the short-term focus excludes long-term effects. Comorbidities like OSA and COPD were not fully accounted for, and the lack of a control group makes it unclear if improvements were solely due to spirometry. Variations in patient compliance, technique, and confounding factors such as medications and surgical methods were also unaccounted for. Additionally, detailed pulmonary complication data were not collected, limiting insights into specific outcomes. Despite these constraints, the study provides important findings, emphasizing the need for broader, more controlled research.

CONCLUSION:

This study demonstrates that incentive spirometry with higher lung capacity (3-ball spirometry, 1200 ml) is more effective in reducing postoperative pulmonary complications after bariatric surgery compared to 1-ball (600 ml) and 2-ball (900 ml) spirometers. Patients using 3-ball spirometry showed improved oxygen levels, normal respiratory rates, and fewer complications, with a lower need for additional respiratory support. While no significant difference was observed between the 1-ball and 2-ball groups, the findings highlight the importance of higher capacity incentive spirometry in improving respiratory outcomes. These results suggest that incorporating 3-ball spirometry into postoperative care protocols may benefit bariatric surgery patients. Further research with larger sample sizes is recommended to validate these findings.

<u>Recommendation for non- bariatric patients:</u>

Beyond bariatric surgery, these results have broader implications for other surgical populations. Incentive spirometry is a low-cost, non-invasive intervention that could potentially be adopted in non-bariatric surgeries, such as cardiac, thoracic, and upper abdominal procedures, where pulmonary complications are common. By improving lung function and reducing postoperative respiratory distress, the routine use of high-capacity spirometry could lead to shorter hospital stays, lower healthcare costs, and improved patient recovery rates.

Additionally, cost-effectiveness is a key factor in considering widespread adoption. Incentive spirometers are relatively inexpensive compared to advanced respiratory therapies, making them a viable option for hospitals and healthcare systems aiming to improve postoperative outcomes while minimizing costs. Further research with larger sample sizes and in diverse surgical populations is recommended to explore its effectiveness across different procedures and patient groups, ensuring its optimal integration into clinical practice.

<u>Concluding Comments:</u>

1. The collected questionnaire responses were analyzed using SPSS 26.0 and MedCalc 14.0. Descriptive statistics were used to summarize patient characteristics and spirometry efficacy. Cross tabs chi-square tests were applied to assess associations between spirometry use and pulmonary outcomes. To ensure validity, the questionnaire was reviewed by Supervisor (Pulmonologist).

2. The choice of 8 versus 12 times per day for spirometry use was based on existing pulmonary rehabilitation guidelines and clinical feasibility. Studies suggest that performing incentive spirometry at least 8 times per day is sufficient for lung expansion and secretion clearance, while a higher frequency of 12 times per day may provide additional benefits in high-risk patients (e.g., those with severe obesity or pre-existing respiratory conditions). However, excessive spirometry use could lead to patient fatigue and reduced compliance. Therefore, the frequency threshold was selected to balance efficacy with patient adherence and practicality in a clinical setting.

REFERENCES:

1. 1.Amin Baig A. Obesity in Pakistan; Current and Future Perceptions. Current Trends in Biomedical Engineering & Biosciences 2018;17(2).

2. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism. 2019 Mar;92:6-10. doi: 10.1016/j.metabol.2018.09.005. Epub 2018 Sep 22. PMID: 30253139.
3. Booth HP, Khan O, Fildes A, Prevost AT, Reddy M, Charlton J, Gulliford MC, King's Bariatric Surgery Study Group. Changing epidemiology of bariatric surgery in the UK: cohort study using primary care electronic health records. Obesity Surgery. 2016 Aug;26:1900-5.
4. .Rabec C, de Lucas Ramos P, Veale D. Respiratory complications of obesity. Arch Bronconeumol. 2011 May;47(5):252-61. English, Spanish. doi: 10.1016/j.arbres.2011.01.012. Epub 2011 Apr 1. PMID: 21458904
5. Wang FG, Yu ZP, Yan WM, Yan M, Song MM. Comparison of safety and effectiveness between laparoscopic mini-gastric bypass and laparoscopic sleeve gastrectomy: a meta-analysis and systematic review. Medicine. 2017 Dec 1;96(50):e8924.
6. . Abbas K, Gul F, Kazmi SN. Implications of bariatric surgery and recommendations for Pakistan. Annals of Medicine and Surgery. 2022 Jun 1;78.
7. Rupp M, Miley H, Russell-Babin K. Incentive spirometry in postoperative abdominal/thoracic surgery patients. AACN advanced critical care. 2013 Jul 1;24(3):255-63.
8. Martin TJ, Patel SA, Tran M, Eltorai AS, Daniels AH, Eltorai AE. Patient factors associated with successful incentive spirometry. Rhode Island Medical Journal. 2018 Nov 1;101(9):14-8.
9. Celli BR, Rodriguez KS, Snider GL. A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgery. American Review of Respiratory Disease. 1984 Sep:12-5
10. Gugnani A, Nandini Kushwaha KS, Variyani PS, Sharma S, Vyas N, Uniyal R, Chauhan A, Shrivastava G, Nair V. Reviving Vitality: An analysis of Physiotherapy's Effects on Postoperative Cases of Upper Abdominal Surgery. Journal for ReAttach Therapy and Developmental Diversities. 2023 Oct 18;6(9s (2)):1569-77.
11. Maity B, Choudhury A, Banerjee C. THE EFFICACY OF INCENTIVE SPIROMETRY IN RESTORING BASELINE LUNG CAPACITY AFTER UPPER ABDOMINAL AND MIDLINE LAPAROTOMY: A RANDOMISED CASE CONTROL STUDY. Int J Acad Med Pharm. 2023;5(3):1961-6.
12. 12 Farzanmehr F, Nasiri-Formi E, Kiany F, Akbari H. Comparing the Effect of Incentive Spirometry and Deep Breathing Exercise on Hemodynamic Indicators and Pulmonary Complications During and after Gastric Sleeve Surgery. Journal of Mazandaran University of Medical Sciences. 2024 Jan 10;33(228):84-93.
13. Eltorai AE, Szabo AL, Antoci Jr V, Ventetuolo CE, Elias JA, Daniels AH, Hess DR. Clinical effectiveness of incentive spirometry for the prevention of postoperative pulmonary complications. Respiratory care. 2018 Mar;63(3):347-52.
14. Craven JL, Evans GA, Davenport PJ, Williams RH. The evaluation of the incentive spirometer in the management of postoperative pulmonary complications. *Br J Surg*. 1974 Sept:793-797.
15. Pantel H, Hwang J, Brams D, Schnelldorfer T, Nepomnayshy D. Effect of incentive spirometry on postoperative hypoxemia and pulmonary complications after bariatric surgery: a randomized clinical trial. JAMA surgery. 2017 Nov:422-8.
16. Hall JC, Harris J, Tarala R, Tapper J, Chnstiansen K. Incentive spirometry versus routine chest physiotherapy for prevention of pulmonary complications after abdominal surgery. The lancet. 1991 Jan :953-1000
17. 17 . 1. Susila C, Dhanalakshmi G. Incentive spirometry on respiratory status among post operative patients subjected to major abdominal surgery.. The Journal of Nursing Trendz 2018 Dec:22-24.
18. Al-Harbi W. The effect of using incentive spirometry on postoperative breathing pattern among abdominal surgery. 2018 Aug:34-35
19. Gayathiri T, Anandhi D. Efficacy of incentive spirometry in expiratory muscle training following abdominal surgery. Biomedical and Pharmacology Journal. 2021 Mar 30;14(1):335-41.

CONFLICT OF INTEREST

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DATA SHARING STATEMENT

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