# Different Respiratory Modalities among Patients undergoing Cardiac Surgeries regarding Post-Operative Pulmonary Complications Rate: Comparative Study

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**Abstract**

**Background:** Patients post-cardiac surgeries are developed restrictive pulmonary impairment postoperatively. Different respiratory modalities are used to reduce pulmonary complications. **Aim:** to compare between patients using different respiratory modalities post-cardiac surgeries regarding pulmonary complications rate. **Design:** Descriptive comparative research design. **Subject:** 150 patients post-cardiac surgeries, divided into three groups (A, B & C), 50 for each group. Group (A) practiced deep breathing and coughing exercises, Group (B) used incentive spirometer and the group (C) used all previous respiratory modalities. **Setting:** This study was conducted at cardiovascular hospital affiliated to Ain Shams University. **Tools:** Patients' demographic & clinical data form and postoperative pulmonary complications assessment sheet. **Results:** The studied patients post-cardiac surgeries in group (C) who practiced different respiratory modalities had lower post-operative pulmonary complications rate than the patients in other groups (A & B) with statistical significant difference $p < 0.01$. **Conclusion:** Using of different respiratory modalities had significant positive effective on reducing post-operative pulmonary complication rate among patients post-cardiac surgeries. **Recommendation:** the importance of using different respiratory modalities for all patients' post-cardiac surgeries in other setting.

**Key wards:** Different respiratory modalities, Post-operative pulmonary complications, Cardiac surgeries.

## Introduction

Postoperative pulmonary complications (PPCs) are adverse changes occurring in respiratory system resulting from; reducing of the pulmonary reserve. It occurs in 8.0% with valves surgeries and 5.4% with coronary artery bypass graft (CABG) ***(Pramanik et al., 2020).***

Atelectasis is common PPCs occurring in 3.86% after cardiopulmonary bypass (CPB), followed by 1.54% for respiratory failure and 0.58% for pneumonia ***(Naveed et al., 2017).*** Bronchospasm is unusual complication with less than 20 cases have been published ***(Lin et al., 2021).*** Acute respiratory failure (ARF) is developed in 3.5% of cardiac surgery with 15.1% mortality in mild & moderate case and 75% in severe case ***(Eremenko & Zyulyaeva, 2019).***

Different respiratory modalities are a routine prescribed exercises employed with medical direction for treating, controlling, and caring of patients with cardiopulmonary deficiencies ***(Cook et al., 2022).*** Specific deep breathing exercises (DBEs) include; pursed-lip, diaphragmatic breathing and coughing exercises helping in air-way clearance and improving breathing efficiency.

Also, Incentive spirometery (IS) is one of mechanical device helps in re-inflate collapsed lung and re-enforce a pattern of breathing ***(Sweity et al., 2021).*** So; ***p***re-operative patient training on modalities is responsibility of medical staff to prepare them for surgery and ensure post-operative continuity and recovery ***(Lauck & Smith, 2022).***

## Significance of the study

Post-operative pulmonary complications remain a leading cause of morbidity and mortality, prolong hospital stays and increase costs particularly within the first week post-surgery. Approximately 7% of patients with normal preoperative lung function and 70% of patients with risk are affected PPCs ***(Hess et al., 2020).***

The estimates suggest more than one million PPCs occur annually in USA, with 46 200 deaths and 4.8 million additional hospitalization days ***(Fernandez-Bustamante et al., 2017).*** According to the statistical department affiliated to Ain Shams University in 2018, around 1828 patients were undergoing cardiac surgery annually with 4.5% mortality.

Respiratory modalities considered as a major component of patient care post-cardiac surgeries, but there was a lack of scientific clinical trials describes the most effective model for reducing or preventing the PPCs among cardiac patients. Hopefully, this study will generate attention to be used as a guide for providing care for such patients to enhance the quality of care and decrease morbidity and mortality.

## Aim of the study:

The study was conducted to compare between patients using different respiratory modalities post-cardiac surgeries regarding pulmonary complications rate.

**Research hypothesis:**

The study hypothesized that there was a significant difference in PCs rate among patients post-cardiac surgeries who practiced all different respiratory modalities (DBEs, coughing exercise and the use of IS) versus other groups.

**Subject and Methods:**

**Design:** descriptive comparative research design was used in this study.

It is a non-experimental design designed to discover relationships among the studied variables and degree of association among them.

**Setting:**

This study was conducted at cardiothoracic surgical wards (1& 2) and intensive care unit (ICU) at cardiovascular hospital affiliated to Ain Shams University hospitals which is one of cairo largest hospital and treats a greater number of patients with cardiovascular diseases.

The selected first ward located at the 6th floor and had 54 beds distributed in 27 rooms. The second ward located at the 7th floor and had 34 beds distributing in 23 rooms while the postoperative ICU located at 8th floor and had 10 beds.

**Subject:** A purposive sample of 150 patients based on the following criteria

**Inclusion criteria:** adult patients, had preoperative ejection fraction < 50%, had first time sternotomy for CABG, mitral valve replacement (MVR) and/ or aortic valve replacement (AVR) with the total bypass time ≥ 150 minutes.

**Exclusion criteria:** Patients with preoperative angina at rest, atelectasis, bronchospasm, pleural effusion, pneumonia, respiratory failure, neurological disorders affect respiratory system and mechanical ventilated ≤ 24hrs.

The sample size was 150 patients, calculated by power analysis (80%) with 5% significance level (two sided), chose based on the following Equation:

$$\frac{2(Z_{\alpha/2} + Z_{\beta})^2 P(1-P)}{(p_1 - p_2)^2}$$ ***(Rosner, 2015).***

The recruited patients were divided into 3 groups (A, B and C), 50 for each group. group (A) practiced 3 sets of pursed lip followed by 5 of diaphragmatic breathing then 3 sets of coughing exercises per hour as a respiratory modality, Group (B) utilized the IS, 5 sets / 1hr and Group (C) applied all respiratory modalities.

**Tools of data collection:**

**I. Patients demographic and clinical data form:** It was developed by investigator based on relevant literature review ***(Abuo-omar & Farid, 2018; Nashef & Bosco, 2018; Miskovic & Lumb, 2017; Mitchell et al., 2016).*** It used to collect data about; patient's age, gender, education, residence, Body mass index (BMI), saturation of oxygen ($SaO_2$) and hemoglobin level.

**II. Patients' post-operative pulmonary complications assessment sheet*:*** It was a developed by investigator based on relevant literature review ***(Mazo, et al., 2016; Akhtar et al., 2013; Al-qubati et al., 2013).*** It was used to monitor (5) PPCs; atelectasis, pleural effusion, pneumonia, bronchospasm and ARF from 2nd and 4th day post-operative. Each complication was monitored for its subjective and objective criteria which confirmed by the physician.

❖ **Scoring system:**

Each confirmed complication was categorized into" yes" for present and took one score & " No" for not present and took zero score. The total complications mean score of patients in each group was calculated then compared.

**Tool validity and reliability** the tools validity was done through; face and content, self-validity by 7 medical-surgical nursing expertises at faculty of nursing, Ain Shamus University (3 professors and 4 assistant professors). Tools validity ranged between (71.5%) to (100%) for face and content and (9.6) to (9.9) for self-validity. Cronbach alpha was ranged between (0.93) to (0.98). For the used tools, some items were added, omitted or rephrased.

$$\alpha = \frac{N.\bar{r}}{1 + (N-1).\bar{r}}$$

**A pilot study** was carried on 20% of the study subject (10 patients) of each group. It was used to estimate ambiguity, feasibility and applicability of the used tools. Also, it helped the investigator to estimate how long it would take to complete the used tools. Some modification was done so, the patients in pilot study were excluded from the current research.

**Ethical considerations**

Ethical approval was obtained from research ethics committee affiliated to faculty of nursing, Ain Shamus University.

An official permission was obtained from the medical and nursing directors at cardiovascular hospital affiliated to Ain Shamus University and written consent was obtained from the studied patients.

After that; clarifying the study aim, maintaining anonymity, privacy and confidentiality of patients were assured. The patients informed that, the withdrawal was allowed without any pressure.

**Field work:**

- The investigator visited the selected study setting 3 days / week in morning and afternoon shifts and data collected from each group sequentially and took about 3 months.
- The investigator applied the following technique in collecting data:
- Firstly meeting about 3-5 patients / week in each group 3 days pre-cardiac surgeries.
- The first tool namely, patient's demographic and clinical data form was filled by the investigator and took about 30 minutes for each patient.

- Training session for half an hour was conducted by investigator individually for each patient in each group regarding the respiratory modalities to be utilized and written instructional pamphlet was given in simple Arabic language.

- Each Patient in different groups practiced the used respiratory modalities two days proceed the surgery and two days following it.

- After that; the second tool namely post-operative pulmonary complications was filled by investigator in 4th day among patients post-cardiac either in ICU or wards according to stability of the patients condition and took about 10- 15 mins for each patient.

**Statistical design:**

Statistical package for the social sciences (SPSS) version 26 was used to data analysis. Quantitative variables presented in $\bar{x} \pm SD$. Qualitative variables were presented in frequency and percentage. Non-parametric Chi-square and Kruskal Wallis tests were used to detect the group differences. Spearman's test used to measure the correlation between variables.

**Limitations of study:**

Unavailable ISs stored place in the hospital to be utilized by patients pre and post-cardiac surgeries which necessitated the investigator for handing them by their relatives until requested.

**Results:**

**Table (1):** Number and percentage distribution of patients in different groups regarding their demographic characteristics showed that; the age of 46%, 44% & 42% respectively of patients in different groups (A, B & C) were 50 - < 60 years. Also, 58%, 72% & 66% were males. In addition, 48% of patients in groups (A and B) and 30% of group (C) were secondary educated. Furthermore, 70%, 72% & 58% respectively of them lived in urban with no statistical significant difference between the three groups $P > 0.05$.

**Table (2):** Number and percentage distribution of the studied patients in different groups (A, B & C) regarding clinical data presented that; 45%, 40% & 46% respectively of them were obese. Also, 56%, 44% & 54% respectively had $O_2$ saturation < 90%. Moreover; 58% respectively of patients in (A & C) had hemoglobin level ≥ 10mg/dl before surgery opposite 72% of group (B). Fortunately; there was 84%, 82% & 88% respectively of patients had chronic diseases. Of them 33.3%, 36.6% & 40.9% developed diabetes mellitus (DM) and 47.6%, 51.2% & 56.8% respectively had hypertensive without statistical significant difference between groups $P > 0.05$.

**Table (3):** comparison between the studied patients in different groups regarding PPCs exposure risk illustrated that; no statistical significant differences between groups (A and B), (B and C) and (A and C) $p\ value$ <0.05.

**Figure (1):** illustrates that, there was a statistical significant difference in PPCs mean scores of patients in different groups (A, B & C) regarding development of postoperative atelectasis, pleural effusion, pneumonia, bronchospasm and ARF at $p\ value > 0.05$.

**Table (IV):** Correlation between PPCs and demographic characteristics among patients in different groups revealed that, a positive correlation between atelectasis, pleural effusion and age in group (A) at $p$ <0.01. Also, there was a positive correlation between ARF and age in group (B) at $p$ value 0.05. In addition; there was a negative correlation between atelectasis, pleural effusion and gender in group (A) at $p\ value$ <0.05.

**Table (V):** Correlation between PPCs and patients clinical data revealed that; there was a positive correlation between atelectasis and BMI in group (A) at $p$ value 0.026. Furthermore, there was a negative correlation between occurrence of atelectasis, pleural effusion, pneumonia, bronchospasm, ARF and decrease level of hemoglobin (Hb) than 10 mg/dl and $SaO_2$ than 90% in group (B) at $p\ value < 0.05$.

**Table (1):** Number and percentage distribution of the studied patients in different groups regarding their demographic characteristics (No. 50 for each group).

| Variables | Group (A) | | Group (B) | | Group (C) | | $\chi 2$ |
|---|---|---|---|---|---|---|---|
| | NO. | % | NO. | % | NO. | % | *P value* |
| **Age** | | | | | | | |
| 40 - < 50 years | 13 | 26 | 15 | 30 | 10 | 20 | |
| 50 - < 60 years | **23** | **46** | **22** | **44** | **21** | **42** | **2.533** |
| 60 - 70 years | 14 | 28 | 13 | 26 | 19 | 38 | **0.865** |
| $\bar{\chi} \pm$ SD | **55.2±9.0** | | **55.3±9.2** | | **57.5± 8.4** | | |
| **Gender** | | | | | | | |
| Male | **29** | **58** | **36** | **72** | **33** | **66** | **2.178** |
| Female | 21 | 42 | 14 | 28 | 17 | 34 | **0.337** |
| **Education level** | | | | | | | |
| Not educated | 7 | 14 | 6 | 12 | 6 | 12 | |
| Primary | 9 | 18 | 9 | 18 | 15 | 30 | **5.601** |
| Secondary | **24** | **48** | **24** | **48** | **15** | **30** | **0.469** |
| Highly | 10 | 20 | 11 | 22 | 14 | 28 | |
| **Patient's residence** | | | | | | | |
| Urban | **35** | **70** | **36** | **72** | **29** | **58** | **2.580** |
| Rural | 15 | 30 | 14 | 28 | 21 | 42 | **0.275** |

$\bar{\chi}$ ± SD: Mean ± Stander deviation; $\chi 2$: Chi Square test and insignificant = $P - value > 0.05$.

**Table (2):** Number and percentage distribution of the studied patients in different groups regarding their clinical data (No. 50 for each group).

| Variables | Group (A) | | Group (B) | | Group (C) | | $\chi 2$ |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | *P value* |
| **Body mass index (kg/M2)** | | | | | | | |
| Thin (<18.5) | 1 | 2 | 0 | 0 | 0 | 0 | |
| Normal (18.5- 24.9) | 6 | 12 | 9 | 18 | 5 | 10 | |
| Increase weight (25 -29.9) | 16 | 23 | 21 | 42 | 22 | 44 | **5.408** |
| Obesity (≥ 30) | **27** | **45** | **20** | **40** | **23** | **46** | **0.493** |
| $\bar{\chi} \pm$ SD | **30.50±4.93** | | **29.96±5.74** | | **30.41±4.92** | | |
| **Oxygen saturation (SaO2%)** | | | | | | | |
| < 90% | **28** | **56** | **22** | **44** | **27** | **54** | **1.655** |
| ≥ 90% | 22 | 44 | 28 | 56 | 23 | 46 | **0.437** |
| **Hemoglobin level before surgery (mg/dl)** | | | | | | | |
| < 10mg/dl | 21 | 42 | 14 | 28 | 21 | 42 | **4.414** |
| ≥10mg/dl. | **29** | **58** | **36** | **72** | **29** | **58** | **0.1100** |

$\bar{\chi}$ ± SD: Mean ± Stander deviation; *Numbers are not mutually exclusive; $\chi 2$: Chi Square test and insignificant at $P - value >$ 0.05.

**Table (3):** Comparison between the studied patients in different groups regarding post-operative pulmonary complications exposure risk (No. 50 for each group).

| Pulmonary complications | Group (A) | | Group (B) | | Group (C) | | Total | | Odd ratio Confidence Interval 95% | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | GA:GB | | GB:GC | | GA:GC | |
| | No. | % | No. | % | No. | % | No. | % | risk | *P value* | risk | *P value* | risk | *P value* |
| **Atelectasis** | 9<br>3# | 18<br>33.3 | 4 | 8 | 3 | 6 | 16<br>3# | 10.6<br>18.75# | 0.396 (0.11-1.38) | 0.137 | 0.734 (0.16-3.46) | 0.695 | 0.291 (.074-1.15) | 0.065 |
| **Pleural effusion** | 7<br>3# | 14<br>42.8 | 4 | 8 | 3 | 6 | 14<br>3# | 9.3<br>21.42# | 0.534 (0.15-1.95) | 0.338 | 0.734 (0.16-3.46) | 0.695 | 0.392 (0.095-1.61) | 0.182 |
| **Pneumonia** | 2 | 4 | 4 | 8 | 1 | 2 | 7 | 4.6 | 2.087 (0.36-11.95) | 0.400 | 0.235 (0.03-2.18) | 0.169 | 0.490 (0.043-5.58) | 0.558 |
| **Bronchospasm** | 3 | 6 | 3 | 6 | 1 | 2 | 7 | 4.6 | 1.00 (0.19-5.21) | 1 | 0.320 (0.03-3.18) | 0.307 | 0.320 (0.032-3.18) | 0.307 |
| **ARF** | 5<br>3# | 10<br>60 | 2 | 4 | 1 | 2 | 8<br>3# | 5.3<br>37.5# | 0.375 (0.07-2.03) | 0.240 | 0.490 (0.04-5.58) | 0.558 | 0.184 (0.021-1.63) | 0.092 |

G: group; #: death and insignificant at $P - value > 0.05$.

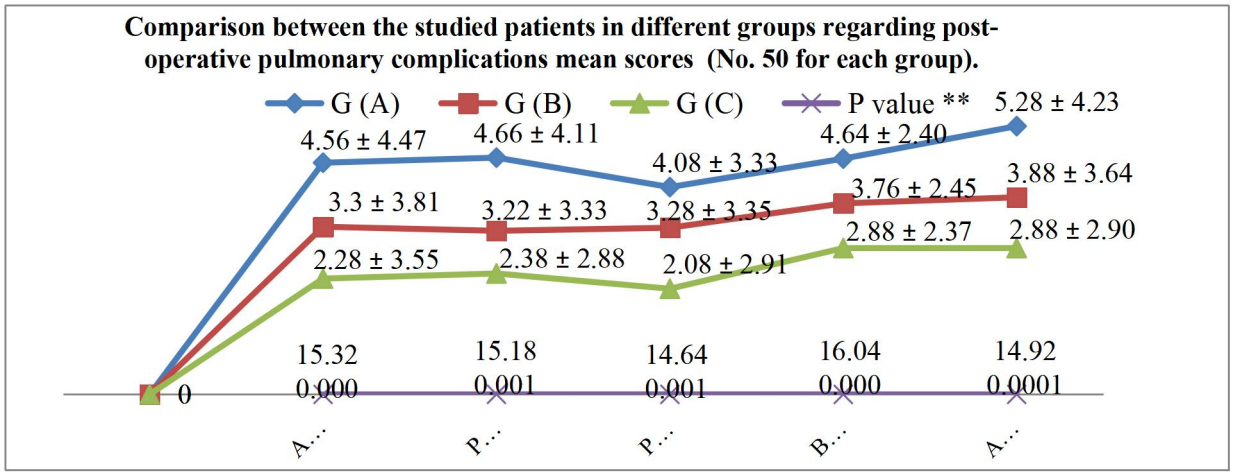


**Figure (1):** This figure illustrate that, there was statistical significant difference between the studied patients in different groups (A, B and C) regarding development of PPCs mean scores at $p\ value < 0.01$.

**Table (4):** Correlation between postoperative pulmonary complications and demographic characteristics among the studied patients in different groups.

| variables | Group (A) $r_s$ $P-value$ | | | | | Group (B) $r_s$ $P-value$ | | | | | Group (C) $r_s$ $P-value$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **Age (60 - 70 years)** | 0.403** 0.004 | 0.372* 0.008 | 0.043 0.769 | 0.056 0.702 | 0.217 0.129 | 0.156 0.279 | 0.156 0.279 | 0.259 0.70 | 0.211 0.142 | 0.319* 0.024 | 0.214 0.136 | 0.214 0.136 | 0.129 0.372 | 0.084 .0560 | 0.243 0.089 |
| **Gender (Male)** | -0.293* 0.039 | -0.343* 0.013 | 0.033 0.082 | -0.044 0.076 | - 0.149 0.030 | - 0.184 0.020 | - 0.184 0.020 | - 0.184 0.020 | - 0.158 0.275 | -0.127 0.378 | - 0.181 0.208 | - 0.181 0.208 | 0.199 0.166 | - 0.103 0.479 | 103 0.479 |
| **Education (Secondary educated)** | -0.241 0.091 | -0.188 0.191 | - 0.140 0.332 | 0.116 0.424 | - 0.210 0.143 | 0.145 0.315 | 0.145 0.315 | 0.104 0.472 | - 0.216 0.133 | -0.019 0.896 | - 0.182 0.205 | - 0.182 0.205 | 0.036 0.804 | - 0.119 0.412 | - 0.119 0.412 |
| **Patient's residence (Urban)** | -0.193 0.179 | -0.138 0.338 | 0.089 0.538 | -0.165 0.251 | - 0.218 0.128 | - 0.020 0.892 | - 0.020 0.892 | - 0.184 0.020 | - 0.158 0.275 | -0.127 0.378 | 0.126 0.382 | 0.126 0.382 | 0.168 0.244 | - 0.122 0.400 | 0.168 0.244 |

G: group.
1: Atelectasis; 2: Pleural effusion; 3: Pneumonia; 4: Bronchospasm and 5: ARF.
$r_s$: Spearman correlation coefficient test.
$r_s \geq 0.25$ to <0.75 moderate correlation; * significant at $p - value < 0.05$ or **0.01.

**Table (5):** Correlation between postoperative pulmonary complications and clinical data among the studied patients in different groups.

| Variables | Group (A) $r_s$ $P-value$ | | | | | Group (B) $r_s$ $P-value$ | | | | | Group (C) $r_s$ $P-value$ | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| **BMI (Obese)** | 0.316* 0.026 | -0.202 0.160 | 0.000 1.000 | -0.108 0.455 | -0.192 0.182 | 0.112 0.437 | 0.112 0.437 | 0.169 0.242 | 0.120 0.408 | 0.198 0.168 | -0.096 0.506 | -0.096 0.506 | 0.025 0.865 | 0.144 0.320 | 0.163 0.257 |
| **SaO2 < 90%** | 0.004 0.977 | -0.009 0.949 | 0.230 0.108 | 0.115 0.425 | -0.161 0.264 | -0.048 0.742 | -0.048 0.742 | -0.197 0.170 | -0.297* 0.036 | -0.033 0.820 | 0.105 0.469 | 0.105 0.469 | 0.155 0.283 | -0.132 0.361 | 0.155 0.283 |
| **Hb < 10mg/dl** | -0.023 0.873 | 0.110 0.448 | -0.033 0.820 | -0.126 0.382 | 0.014 0.926 | -0.309* 0.029 | -0.309* 0.029 | -0.309* 0.029 | -0.030 0.836 | -0.327* 0.020 | -0.263 0.065 | -0.263 0.069 | 0.137 0.342 | 0.137 0.342 | -0.149 0.303 |

BMI: body mass index; $SaO_2$: saturation of oxygen; Hb: hemoglobin.
1: Atelectasis; 2: Pleural effusion; 3: Pneumonia; 4: Bronchospasm and 5: ARF.
Spearman correlation coefficient test.
$r_s \geq 0.25$ to <0.75 moderate correlation; * significant at $p - value < 0.05$ or **0.01.

## Discussion

The PPCs remain main issues after cardiac surgeries. The incidence of PPCs ranged from 2%-to-23% in non-cardiothoracic surgery. Such complications are frequent among cardiac surgical but poorly documented. ***(Fischer et al., 2022).*** Preoperative DBE or / and IS training is associated with an absolute risk reduction of 20% in PPCs ***(Sorour et al., 2019).***

A potential effect of using one modality versus others on PPCs rate among patients post-cardiac surgeries hadn't been demonstrated so far, the current study conducted to compare between patients using different respiratory modalities post-cardiac surgeries regarding pulmonary complications rate.

The current study revealed that, there was no statistical significant difference between the studied patients in different groups regarding their demographic characteristics indicating the groups were homogenous or matched that was important to ensure comparability of the three different groups.

Regarding age, the current study finding showed that; more than two fifths of studied patients in groups (A, B & C) had age ranged from 50 - < 60 years with mean 55.2±9.0, 55.3±9.2 & 57.5±8.4 respectively. The investigator's point of view that, aging can cause changes in the heart and blood vessels that may increase the person's risk of developing cardiovascular diseases.

This is in accordance with **Musharraf et al., (2020)** who reported that; the mean age ± stander deviation was 56.68 +/- 11.65 years among the patients in their study entitled "Open Heart Surgery at a Newly Developed Cardiac Center in Karachi: A Step Towads Affordable Cardiac Care in Pakistan" on 127 patients.

Concerning gender the present study result displayed that, less than three fifths of patients in group (A), less than three quarters from group (B) and two thirds of group (C) were males. This could be attributed to men's coping with stressful events may be less adaptive physiologically, behaviorally and emotionally contributing to their increased risk for coronary heart diseases (CHDs).

This is contradicted with **Udzik et al., (2020)** who found that; less than half of the total studied samples were males in their study entitled "Cardiac Complications Following Cardiac Surgery Procedures" on 552 cardiac surgery patients which divided into 274 males and 278 females groups.

One of the noticeable finding of this study that; less than half of groups (A and B) and less than one third of group (C) were secondary educated. This could be attributed to end of basic education in Egypt at secondary education level based on **Shalaby et al., (2016)**

This result is contradicted with **Girgin et al., (2021)** who reported that, more than three fifths of intervention group and more than half of control group were primary educated in their study entitled "The Effect of Pulmonary Rehabilitation on Respiratory Functions, and the Quality of Life, following Coronary Artery Bypass Grafting: A Randomised Controlled Study" on 50 patients undergoing CABG surgery divided into equal intervention and control groups in Turkey.

As regard to patients' residence, the present study showed that, less than three quarters of patients in groups (A & B) and less than three fifth of group (C) were lived in urban. This may due to increase level of stress and pollution among persons who live in country than village which put them at risk for cardiac diseases.

The results of **Salah et al., (2020)** goes in same line with groups (A & B) which revealed that, less than three quarters of control group lived in urban in their study entitled "Effect of Digital Cardiac Rehabilitation Program on Self Efficacy of Patients with Coronary Artery Diseases" which conducted on 100 Egyptian patients with coronary artery diseases (CADs) who divided into equal study and control groups.

Pertaining to clinical data, the present study revealed that, there was no statistical significant difference between the studied patients in three different groups regarding BMI, $SaO_2$ and hemoglobin level.

Concerning BMI; more than two fifths of patients in groups (A & C) and two fifths of group (B) were obese with mean 30.50±4.93, 29.96±5.74 & 30.41±4.92. From the investigator's opinion, obesity is independent risk factors for development and progression of coronary heart disease. weight can be add to fatty material building up in the arteries. If such arteries that carry blood to heart get damaged and clogged it can lead to a heart attack.

This is incongruent with **Huo et al., (2022)** who found that, the BMI among patients discontinued clopidogrel prior surgery group was 30.1± 6.2 and patients continued was 29.9 ± 6.1 in their cohort study

entitled "Impact of Clopidogrel Stop Interval on Major Adverse Bleeding Events in Cardiac Surgery" which conducted on 5748 patients underwent cardiac surgical procedures divided into two equal groups; patients discontinued clopidogrel prior surgery and patients continued in Nova Scotia, Canada.

Related to $SaO_2$, the present study finding revealed that, more than half of studied patients in group (A & C) and more than two fifths of group (B) had $SaO_2$ less than 90%. That may be due to effect of coronary artery diseases which lead to low $SaO_2$ which sequentially leads to a serious deterioration in patient's status.

This is incongruent with **Shahood et al., (2022)** who reported that, the preoperative $SaO_2$ mean in intervention group was 97.3% and 97.2 for control in the study titled "The effect of preoperative chest physiotherapy on oxygenation and lung function in cardiac surgery patients: a randomized controlled study" performed on 100 patients underwent cardiac surgery in Pécs Clinical Centre, Hungary, London and divided into 46 intervention and 54 control groups.

Current study result revealed that, more than half of patients in groups (A & C) and more than two thirds of group (B) had hemoglobin level less than 10 mg/dl before surgery. The investigator views that; anemia is both a general risk factor for cardiovascular diseases and a predictor of adverse outcomes in patients with acute coronary syndrome.

This goes in the same line with **Değirmencioğlu et al., (2022)** who reported that; hemoglobin level of nonsurgical group was 11.1±2.1 in their study entitled "Comparison of Pericardiocentesis in Post-Cardiac Surgery and Nonsurgical Patients with Pericardial Tamponade" which conducted on 2,450 patients underwent Pericardiocentesis and divided into nonsurgical group and postsurgical groups in Istanbul, Turkey.

The odds ratio between groups revealed that; there were no statistical significant differences between groups (A & B), (B & C) and (A & C) regarding PPCs exposure risk where $P\ value$ <0.05. This could be attributed to all studied patients in the three different groups at risk for PPCs and the group (C) who utilized the different respiratory modalities had low risk.

This is in accordance with **Kotta & Ali, (2021)** who reported that; there were no statistical significant differences between the participants receiving IS compared to those receiving physiotherapy regarding the risk of PCs in their study titled "Incentive spirometry for prevention of postoperative pulmonary complications after thoracic surgery" on 7,549 patients at Royal Papworth Hospital, Cambridge, United Kingdom

Comparison between the studied patients in different groups regarding PPCs mean scores presented that; a statistical significant difference between groups A, B & C where the mean of group (A) was the greatest in overall PPCs (atelectasis, pleural effusion, pneumonia, bronchospasm and ARF) followed by group (B) then group (C) and $p \leq (0.001)$ revealed that the modality practiced by group (C) who utilized different respiratory modalities was the most effective in reducing PPCs than others.

This study finding is supported the study hypothesis which stated that, there was a significant difference in PCs rate among patients post cardiac surgeries who practiced all different respiratory modalities (deep breathing exercise, coughing exercise and the use of incentive spirometer) versus other groups.

This study result is contradicted with comparative study done by **Vitomskyi, (2021)** who noticed that; no statistical significant difference between the mean score of the three groups regarding their post-operative pulmonary function test at $p\ value$ > (0.05) in their study entitled "Comparison of three respiratory physical therapy techniques and their impact on pulmonary function restoration among cardiac surgery patients in hospital settings" on 126 Ukraine patients divided into control group (CG), IS group (ISG) and inspiratory muscle training group (IMTG). However such study wasn't used combined respiratory modalities.

A correlation between PPCs and demographic characteristics of this study presented that; a positive correlation between atelectasis, pleural effusion and age in group (A) at $p\ value$ <0.01. Also, there was a positive correlation between age and ARF in group (B) at $p\ value$ 0.024. The investigator viewed that; function of lung decreases with increasing age. This is congruent with **Culley et al., (2022)** who mentioned that; atelectasis area increases by age in review article titled "Perioperative Pulmonary Atelectasis: Clinical Implications" at USA.

Regarding correlation between PPCs and gender the current study revealed that; a negative correlation between atelectasis, pleural effusion and gender in group (A) at $p\ value$ < (0.05) reflected that; the males are more affected by PPCs than females. This goes in the same line with **Miskovic & Lumb, (2017)** who reported that; male gender considers non modifiable risk factors for PPCs in a review article entitled "Postoperative pulmonary complications".

Concerning correlation between PPCs and BMI in the present study, there was a positive correlation between atelectasis and BMI in group (A) at $p\,value$ 0.026. This finding indicated that the obese patients are more liable to atelectasis. This is in the same line with **Tegegne et al., (2021)** who found that obesity considered a risk for developing PPCs among the patients in a study titled "Perioperative risk stratification and strategies for reducing postoperative pulmonary complications following major surgery in resource limited areas: a systematic review".

Related correlation between PPCs and hemoglobin, the current finding exhibited that there was a negative correlations between occurrence of atelectasis, pleural effusion, pneumonia, bronchospasm, ARF and decrease Hb level than 10 mg/dl and $SaO_2$ than 90% in group (B) at $p\,value <$ 0.05, this reflecting that; decrease $SaO_2$ and Hb level are factors associating with developing of PPCs among patents post-cardiac surgeries. This supported by **Tegegne et al., (2021)**.

**Conclusion:**

Using different respiratory modalities had statistical significant positive effective on reducing PPCs rate among patient's post-cardiac surgeries in group (C) versus than other groups.

Fortunately, the study findings supported the research hypothesis that there was a significant difference in PCs rate among patients post-cardiac surgeries who practiced all different respiratory modalities (DBEs, coughing exercise and the use of IS) versus other groups.

**Recommendation:**

Continuous Bite-sized teaching sessions should be provided for all patients undergoing cardiac surgeries regarding utilizing of different respiratory modalities.

An illustrated Arabic booklet about different respiratory modalities should be available for all patients undergoing cardiac surgeries.

Further studies should be replicated on a wider scale to include a larger sample size in a different setting and with a longitudinal strategy.

Further study is recommended to evaluate the prospective of further interventional trials on PPC rate among patient's post-cardiac surgeries using a care bundle in combination with different respiratory modalities.

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