https://doi.org/10.48047/AFJBS.6.Si3.2024.2113-2128

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Effect of Passive Range of Motion Exercise on Hemodynamic Parameters on Mechanically Ventilated Patients

Mohamed Mohamed Ibrahim El-dosoky Omar[1*], Amal Bakr Abo El-Ata[2], Mona Abed El-Rahman Mohamed[2], Heba Abd El-Reheem Abd El-Reheem[3]

1. Assistant lecturer of Medical Surgical Nursing, (M.Sc. Nursing, 2020), Faculty of Nursing – Port Said University, Egypt.
2. Professor of Medical Surgical Nursing, Faculty of Nursing, Port Said University, Egypt.
3. Assistant Professor of Medical Surgical Nursing, Faculty of Nursing, Port Said University, Egypt.

Email: mohamedomar20@nur.psu.edu.eg

Corresponding auther: Mohamed Mohamed Ibrahim El-dosoky Omar

Article History
Volume 6, Issue Si3, 2024
Received:18 Apr 2024
Accepted:20 Jun 2024
doi: 10.48047/AFJBS.6.Si3.2024.2113-2128

ABSTRACT

Background: Mechanically ventilated patients (MVPs) admitted to intensive care units (ICUs) suffer from immobility and prolonged bed rest, which can be detrimental and have negative consequences on hemodynamic parameters. **Aim:** This study aims to explore the effect of passive range of motion exercise on hemodynamic parameters among patients with mechanical ventilation. **Subjects and Method:** The study design was quasi-experimental. A purposeful sampling of adult patients with mechanical ventilation (555) was recruited from ICUs of Egypt Health Care Authority Hospitals in Port Said City that include El-Salam hospital, Al-Zhour hospital and El-Shefaa Medical Complex. **Tools of Data collection: Tool I:** Patients' Health Profile that includes two parts; **Part 1:** Patients' personal data, **Part 2:** Patients' health assessment. **Tool II:** Hemodynamic parameters assessment. **Results:** this study revealed a remarkable improve in mean scores of hemodynamic parameters were noted at five minutes, twenty minutes, and sixty minutes after the implementation of the passive range-of-motion exercise with statistically significant differences. **Conclusion:** the present study showed a positive relation between passive range-of-motion exercise and hemodynamic parameters among patients with mechanical ventilation. **Recommendation:** The study suggested that the passive range-of-motion exercise were crucial for treatment of patients with mechanical ventilation and should be introduced into routine clinical practice on the ICU.

Keywords: *Passive Range-of-Motion Exercise, Hemodynamic Parameters, Mechanically Ventilated Patients*.

INTRODUCTION

Intensive care unit patients are frequently sedated and immobile. In addition to increasing the length of stay (LOS) in the hospital, immobility can cause cognitive loss, psychological disorders, muscle weakness, and difficulty weaning off mechanical ventilation (MV) (Key, 2023). Long-term consequences include acquired weakness, physical debility, and neuropsychiatric dysfunction on the ICU and Post-Intensive Care Syndrome (PICS) is a set of health issues that linger after a critical illness while a patient is in the ICU and may continue after the patient returns home as a problem with the patient's body, thoughts, feelings, or mind and may impact the patient's and the family's quality of life (Yundari et al., 2023).

Additionally, early mobilization of patients on mechanical ventilation has a history and shown to be safe, feasible, and effective in enhancing physical health, improving the efficiency of breathing through enhanced ventilation/perfusion pairing, increasing lung efficiency, and assisting in the clearance of airway secretions. Furthermore, it prevents the detrimental consequences of immobility, raises consciousness levels and physical capacity, improves cardiovascular health, and promotes psychological well-being (Bolin, 2021).

Hemodynamic parameters are general terms that reflect changes in the cardiopulmonary system. Heart rate (HR), respiratory rate (RR), blood pressure (BP), central venous pressure (CVP) and oxygen saturation (SPO2) are the most important physiologic parameters (Putu, Sukraandini, Wiasa, & Sudarmika, 2023).

Instability of hemodynamic parameters can last for several days or weeks, delaying physical activity therapies that could lead to impairment (Yundari et al., 2023). Critically patients should take part in passive exercise. Patients in the early stages of a serious illness can use it until the patient is healthy enough to move on to more active interventions. This could be the reason. Nonetheless, it seems that the patient's tolerance for exercise is what restricts the use of mobilization. Subsequently has been proposed that common bedside physiologic parameters, such as oxygen saturation, respiratory rate, blood pressure, heart rate, and behavioral pain response, can be used to determine a patient's exercise tolerance (Ghiassi, Nattanmai, Arora, 2022) .

Stretching exercises and range of motion (ROM) are critical to restoring joint mobility in patients with chronic diseases or following acute injuries or surgeries. In order to assist prevent additional damage to tendons, muscles, joints, and ligaments, these exercises are essential for promoting flexibility, minimizing adhesions between skin and bones, rebuilding fibrosis, and enhancing muscle and connective tissue extensibility (Sudrajat, Yetti, & Waluyo, 2021).

Passive range of motion (PROM) exercise can improve joints that have become immobile owing to an underlying medical condition. The nurse maneuvers the limb or region of the body around the inflexible joint, softly extending the muscles and reminding the patient to move properly, without patient having to undertake any movement themselves. Passive exercise has several benefits, including easing the transition off of a ventilator, reducing time spending in the ICU, improving overall health, enhancing respiratory function through improved clearance of airway secretions, and perfusion matching. It also helps prevent the negative effects of immobility, improve physical ability and consciousness levels, improve cardiovascular status, and improve psychological well-being (Elsayed, Dahroug, & Halawa, 2020).

Manipulating the body permissible bounds is referred to as passive exercise without exerting deliberate effort as contracting muscles. Critically ill patients can get the passive activities manually from nurses or therapists, or machines like cycle ergometers or continuous passive motion devices (Wang, et al., 2021) can administer them. Passive exercise can be helpful for Mechanically Ventilated patients (MVPs) who cannot endure progressive activities, provided it is administered safely. Additionally, it will minimize time spending in hospitals, ease transition off a ventilator, and enhance overall health and quality of life (Iliadis, 2020).

Continuous passive range of motion following surgery has been shown to reduce discomfort and accelerate the healing process. After an injury or surgery, scar tissue is randomly deposited, and range of motion facilitates the alignment of this scar tissue along the tissue's lines of stress. These leaves more robust scar and might aid avert more injuries. Morever, the nurse has to keep the patient's range of motion pleasant and avoid damaging tissues by going overboard (Jacob, et al., 2021).

Significance of the study

Patients on mechanical ventilation are frequently placed on rigorous bed rest; due to intensity of illness and medications they are given (as neuromuscular blocking agents and sedatives), they may even be rendered immobile. Extended bed rest and inactivity affect numerous biological systems and physical functioning. Thus, in order to minimize thrombus and embolus development, passive range-of-motion exercises to help patients using a ventilator can enhance circulation, which in turn can improve physiological measurements including HR, RR, BP, SpO2, and CVP (Wang, et al., 2021).

In the end, there are few researches evaluating how PROM exercises affect hemodynamic parameters in MVPs in Egypt. Therefore, to determine how this type of exercise affects critical ill patients, it is crucial to assess how well PROM exercises improve patients' hemodynamic parameters in sedated and intubated bed-restricted patients. Ideally, this inquiry will draw interest and serve as inspiration for more investigations in the field.

Aim of the study

This study aimed to explore effect of passive range-of-motion exercises on hemodynamic parameters on mechanically ventilated patients.

This achieved through the following research objectives:

1 -Assess hemodynamics parameters on mechanically ventilated patients.

2- Apply passive range-of-motion exercises on mechanically ventilated patients.

3- Evaluate how passive range-of-motion exercise affect hemodynamics parameters among patients on mechanical ventilation.

Research Hypothesis

- Application of a passive range-of-motion exercise will improve hemodynamics parameters among patients on mechanical ventilation.

Subjects And Methods

The subjects and methods for this study were depicted under four main designs as follows:

I-Technical Design:

The technical design comprises details about the Research Design, Study Setting, Subjects, and Tools for data gathering.

Research Design:

Aquasi-experimental research design (One group pre & post-test) was used.

Study Setting:

The research was conducted at the ICUs of the El-Salam Hospital, Al-Zhour Hospital, and El-Shefaa Medical Complex in Port Said City, which are hospitals associated with the Egypt Health Care Authority. El-Salam Hospital's ICU, which has two rooms and twenty beds, treats patients who have serious postoperative problems like severe burns, severe trauma, excessive sedation, and respiratory failure. Ten beds spread across two rooms make up the ICU at Al-Zhour Hospital, which treats patients with neurological diseases following surgery. The El-Shefaa Medical Complex's ICU, which has 30 beds spread across four rooms, treats patients who have serious postoperative problems as respiratory failure, cardiothoracic surgery, complicated spinal surgery, and postpartum hemorrhage. The three units have both people and advanced technology. In the chosen ICUs, the nurse-to-patient ratio is almost 1:2.

Study Sample:

A purposeful sampling of adult patients with mechanical ventilation and admitted to the aforementioned setting during the study period was involved in present study.

Inclusion Criteria:

The study included adult patients on mechanical ventilation who were above the age of 18, regardless of gender, and who were conscious or semiconscious enough to be able to give oral consent.

Exclusion criteria :

This study excluded patients with actual deep vein thrombosis, amputation, joint dislocation, subluxation, extremities fractures, and spinal injuries. All of these conditions are associated with vascular and orthopedic issues.

Sample Size:

Using the Steven Thimpsone equation at research's 95% confidence power, The sample size was established using statistics (Dawson-Saunders &Trapp, 2001).

$$n = \frac{N \times P\ (1-P)}{(N\ -1x\ (d2\ /\ Z2) + P\ (1-\ P)}$$

n = Sample Size

N = Total Society Size (1850 patients/ year)

d = Error Percentage(0.05) =

P = Percentage of availability of the character and objectivity.(0.158) =

Z = The corresponding standard class of significance 95.(1.96) =%

The sample selected from each hospital was calculating, to be as follow (taking 30% from total patients) :

Name of hospital	Total number of pts./year	Sample selected
Al-Zhour	500	150
Al-Salam	650	195
El-Shefaa Medical Complex (Al-Tadamon Hospital previously)	700	210
Total	**1850**	**555**

***Total number of patients from statistical department in each hospital per 2022.**

Tools of Data Collection :

Data acquired using two tools, as shown below:

Tool I: Patients' health Profile :

This tool was developed by the researcher after reviewing relevant literatures (Rezvani, 2022; Wang, 2020; Hickman et al., 2020; Gilson, 2019; Santos et al., 2019) to assess patients' personal data and patients' health relevant assessment. It divided into two parts:

Part 1 : Patients' Personal Data:

It included the patient's age, sex, marital status, level of education, and employment, among other personal information.

Part 2: Patients' health assessment:

It included the admittance date, medical diagnosis, previous medical history, and previous surgery history, smoking, and type of intubation, ventilation mode, sedation, and vasopressors use.

Tool II: Hemodynamic parameters assessment (pre & post implementation of Range of Motion Exercises):

This tool was developed by Stiller, Phillips, & Lambert (2004) to assess hemodynamic parameters on mechanically ventilated patients. It translated into Arabic by the researcher. It includes patients' hemodynamic parameters as Respiratory Rate (RR), Heart Rate (HR), Diastolic Blood Pressure (DBP), Systolic Blood Pressure (SBP), central venous pressure (CVP) and Percutaneous Oxygen Saturation (SPO2) which monitored by using an electronic monitoring .

II. Operational design:

The Operational design contained a preliminary phase, validity & reliability tests, fieldwork, and a pilot study.

Preliminary phase:

It comprised a review on associated literature, diverse investigations, and conceptual understanding of many elements of the problems through use of books, research articles, the internet, and monthly publications.

Validity :

The validity of hemodynamic parameter evaluation was stated by nine professionals in the fields of medicine and nursing who reviewed tools for relevance, clarity, comprehensiveness, understanding, and applicability, revised tools, and no changes made based on their recommendations.

Reliability:

The Cronbach's alpha (α) coefficient was utilized to evaluate the internal consistency of the instrument, which obtained a value of (0.81) for hemodynamics parameters.

Pilot study:

One-tenth (56 patients) of the study participants participated in a pilot research who were chosen at random to assess feasibility, applicability, and objectivity of study instrument to estimate appropriate time required to complete the questionnaire. Based on the pilot research's findings, no modifications were made. Patients participated in pilot study were eliminated from study sample.

Fieldwork:

Before beginning data collecting, official approval was obtained from the administrative authority. Mechanically ventilated patients met inclusion criteria enrolled in study. The researcher spent three days a week visiting the intensive care units of Egypt Health Care Authority Hospitals in Port Said City, which included El-Salam Hospital, Al-Zhour Hospital, and El-Shefaa Medical Complex. The study had four phases: assessment, planning, implementation, and evaluation. The researcher collected data using pre-constructed tools. Hemodynamic parameters were measured four times (pre-intervention, 5, 20, and 60 minutes after intervention). An electronic monitoring system was used to monitor the hemodynamic parameters.

Assessment phase:

This phase was carried out by the researcher after the tools were prepared and the study sample was recruited. This was followed by gathering baseline data. Data were collected from patients on mechanical ventilation in intensive care units. The researcher presented himself to the patients and obtained their consent for participation in research, and then conducted interviews with them. During the interview, the researcher demonstrated range of motion exercises to the patients. The confidentiality of all obtained information was rigorously maintained.

Planning and implementation phase:

Based on the information obtained from assessment, the researcher designed passive exercises with main goal of improving the hemodynamic parameters of mechanically ventilated patients. The exercises were implemented in the ICUs of Egypt Health Care Authority Hospitals in Port Said City, based on the information gathered from the initial assessment and recent literature.

Passive Range-of-Motion exercise implementation:

Passive exercises comprises twinty minutes exercises for both the lower and upper limbs (one session per day). In addition, the researcher performed 10 repeating both upper and lower extremities passive exercises on each patient on lying supine. Lower extremity passive exercises include toe extension and flexion, ankle plantar dorsiflexion, flexion, inversion, and version, knee extension, and flexion, and hip extension, flexion, adduction, abduction, and external and internal rotation. Upper extremity passive exercises include finger extension and flexion, wrist extension, and flexion, radial, and ulnar deviation, elbow extension, and flexion, pronation, and supination, and shoulder extension, flexion, adduction, and abduction.

Furthermore, passive exercise lasted roughly twinty minutes every day. The researcher got the hemodynamic parameters in four periods, as follows: Phase 1 (time 0) includes baseline measurements (HR, RR, SBP & DBP, CVP, and SpO2) before to exercise. Furthermore, in Phase 2 (time 1), the researcher examined the hemodynamic parameters 5 minutes after implementing the exercises. Also, in Phase 3 (time 2), the researcher examined the hemodynamic parameters 20 minutes after implementing the exercises. Finally, in Phase 4 (time 3), the researcher assessed the hemodynamics parameters 60 minutes after implementing the exercises.

Before beginning the rest time, the critical care nurse completed duties such as repositioning, applying suction, assessment, and cleanliness procedures to decrease the impact of other activities on study findings. After complete the exercises, patients must rest to approximately 60 minutes before the researcher takes the final reading. At the end of the rest time, Tool II recorded the patient's hemodynamic data (HR, RR, SBP & DBP, CVP, and SpO2).

Evaluation phase :

After the implementation stage, the researchers began measuring hemodynamics parameters across all four stages described previously and assess data to determine outcomes in the results by Tool II.

(III) Administrative Design:

The director of Egypt Health Care Authority Hospitals in Port Said City granted official approval for data collecting upon receipt of a formal letter from the vice dean of the Faculty of Nursing at Port Said University. The researcher and mechanically ventilated patients met and discussed goals and objectives of study in order to enhance cooperation during the phase. Additionally, oral consent was sought prior to beginning data collection.

Ethical Consideration:

The Scientific Research Ethics Committee at Port Said University's Faculty of Nursing provided approval. In addition, all ethical issues were considered throughout the investigation, include describe purpose of study to director of Egypt Health Care Authority Hospitals in Port Said City in order to obtain permission to conduct the research. Furthermore, the researcher explains studys' purpose to each participant so that he understands the significance of his involvement. However, participants were given an overview of the study in brief and assurance that any information acquired should kept confidential and only used to the purpose of study.

Additionally, the researcher notifies study participants that they have the opportunity to withdraw.

(IV) Statistical design:

The data gathered was corrected, organized, saved, tabulated, and analyzed using the percentage and number distributions. The Statistical Package for Social Sciences (SPSS) package version 16 was used for statistical analysis. Proper statistical tests employed to evaluate a significant statistical difference between the study's variables. The following statistical methods were used: Percentage, Chi-square (X2), Pearson correlation coefficient (r), and proportional probability of error (P-value). For all statistical tests, the significance level is set at 5% (p-value).

Results

Table (1) illustrates that 55.9 % of studied mechanically ventilated patients were males. Regarding age, 38.2 % of studied mechanically ventilated patients were in an age group more than 60 years with mean ± SD (49.5 ± 13.5). As regard to marital status, 45.9% were married. Concerning educational level, 35.9 % of studied mechanically ventilated patients had moderate education, and 41.8 % of studied patients performed manual work.

Table (2) revealed that most of studied mechanically ventilated patients had DM, HTN, Renal impairments, Respiratory disorders, Neurological disorders, GIT disorders and autoimmune disorders, 65.8 % of the studied mechanically ventilated patients had not any past surgical diagnosis. As regards to Smoking, 53.7 % of them were Smokers for more than 20 years. In relation to Intubation type, 74.2 % of studied mechanically ventilated patients on endotracheal tube, 54.2 % of studied mechanically ventilated patients on SIMV mode. Regarding Vasopressors use, 50.1 % of studied mechanically ventilated patients not use any Vasopressors.

Table (3) demonstrates a significant rise in the Heart Rate (HR) mean scores at the five, twenty, and sixty-minutes (81.77 ± 13.0, 83.21 ± 13.52, 84.34 ± 13.21 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001).

Table (4) shows a significant increase in the Respiratory Rate (RR) mean scores at five, twenty, and sixty-minutes (17.93 ± 2.72, 18.55 ± 2.38, 18.92 ± 2.80 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001).

Table (5) illustrates a remarkable decrease in the mean scores of the Systolic (SBP) were noted at 5 minutes, 20 minutes and 60 minutes (124.4 ± 14.66, 120.2 ± 14.90, 119.3 ± 11.79 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001). The results shows a remarkable decrease in the mean scores of the Diastolic (DBP) were noted at 5 minutes, 20 minutes and 60 minutes (78.95 ± 11.08, 76.71 ± 10.53,74.61 ± 8.75 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001).

Table (6) demonstrates a slight increase in the mean scores of the percutaneous oxygen saturation (SPO2) were noted at 5 minutes, 20 minutes, and 60 minutes (96.07 ± 2.46, 96.36 ± 2.54, 96.47 ± 2.55 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001).

Table(7) revealed that the same mean scores of Central venous pressure (CVP) were noted at 5 minutes, 20 minutes, and 60 minutes(7.75 ± 2.18, 7.83 ± 2.26, 7.93 ± 2.37 respectively) after implementation of passive exercises with a statistically significant differences were noted (P>0.001).

Table (1): Distribution of the studied mechanically ventilated patients accord to personal data (n = 555)

Item	Frequency (N)	Percentage (%)
Sex		
Male	310	55.9
Female	245	44.1
Age / years		
18 < 30	33	5.9
30 < 40	77	13.9
40 < 50	89	16.0
50 < 60	144	25.9
> 60	212	38.2
Mean ±SD	49.5 ± 13.5	
Marital status		
Single	33	5.9
Married	255	45.9
Divorced	122	22.0
Widowed	145	26.1
Education Level		
Illiterate	66	11.9
Basic education	155	27.9
Moderate	199	35.9
Higher	135	24.3
Occupation		
Manual work	232	41.8
Office work	113	20.4
Not work	210	37.8

Table (2): Distribution of the studied mechanically ventilated patients accord to health assessment (n = 555)

Item	Frequency (n)	Percentage (%)
Medical diagnosis*		
DM	334	60.2
HTN	434	78.2
Renal impairments	224	40.4
Respiratory disorders	511	92.1
Neurological disorders	200	36.0
GIT disorders	134	24.1
Past surgical diagnosis		
Yes	190	34.2
No	365	65.8
Surgical history (n = 190)		
GIT Surgery	34	6.1
Neurosurgery	45	8.1
Orthopedic surgery	33	5.9

Endocrine surgery	34	6.1
Oncology surgery	22	4.0
Laparoscopic surgery	22	4.0
Smoking		
Yes	298	53.7
No	257	46.3
If yes smoking duration / years (n = 298)		
Less than 10	33	5.9
10-20	88	15.9
More than 20	177	31.9
Intubation type		
Tracheostomy	143	25.8
Endotracheal Tube	412	74.2
Ventilator mode		
SIMV	301	54.2
A/C	110	19.8
PSV	55	9.9
CPAP	78	14.1
Other	11	2.0
Vasopressors use		
Yes	277	49.9
No	278	50.1

***: Selection not mutually exclusive**

Table (3): Heart Rate (HR) pre and post implementation of passive range-of-motion exercises among mechanically ventilated patients (n= 555)

Heart Rate (HR)	**Baseline (Pre)**	**Post**			**F**	**p**
		5 min.	**20 min.**	**60 min.**		
Min – Max. Mean ± SD. Median	60.0 – 110.0 79.54 ± 12.57 80.0	60.0 – 115.0 81.77 ± 13.0 83.0	62.0 – 113.0 83.21 ± 13.52 85.0	60.0 – 112.0 84.34 ± 13.21 86.0	466.686*	<0.001*
Sig. bet. periods		<0.001*	<0.001*	<0.001*		

Table (4): Respiratory Rate (RR) pre and post implementation of passive range-of-motion exercises among mechanically ventilated patients (n= 555)

Respiratory Rate (RR)	**Baseline (Pre)**	**Post**			**F**	**p**
		5 min.	**20 min.**	**60 min.**		
Min – Max. Mean ± SD. Median	11.0 – 22.0 17.04 ± 2.65 18.0	11.0 – 24.0 17.93 ± 2.72 19.0	14.0 – 22.0 18.55 ± 2.38 19.0	12.0 – 24.0 18.92 ± 2.80 19.0	235.064*	<0.001*
Sig. bet. periods		<0.001*	<0.001*	<0.001*		

Table (5): Blood Pressure (BP) pre and post implementation of passive range-of-motion exercises among mechanically ventilated patients (n= 555)

Blood pressure	Baseline (Pre)	Post			F	p
		5 min.	20 min.	60 min.		
Systolic (SBP)						
Min – Max.	100.0 – 150.0	90.0 – 140.0	90.0 – 140.0	90.0 – 140.0	281.118*	<0.001*
Mean ± SD.	127.1 ± 15.88	124.4 ± 14.66	120.2 ± 14.90	119.3 ± 11.79		
Median	130.0	130.0	120.0	120.0		
Sig. bet. Periods		<0.001*	<0.001*	<0.001*		
Diastolic (DBP)						
Min – Max.	60.0 – 100.0	60.0 – 90.0	60.0 – 90.0	60.0 – 90.0	202.016*	<0.001*
Mean ± SD.	80.83 ± 11.78	78.95 ± 11.08	76.71 ± 10.53	74.61 ± 8.75		
Median	80.0	80.0	80.0	80.0		
Sig. bet. Periods		<0.001*	<0.001*	<0.001*		

Table (6): Percutaneous Oxygen Saturation (SPO2) pre and post implementation of passive range-of-motion exercises among mechanically ventilated patients (n= 555)

Percutaneous Oxygen Saturation (SPO_2)	Baseline (Pre)	Post			F	p
		5 min.	20 min.	60 min.		
Min – Max.	91.0 – 99.0	89.0 – 100.0	89.0 – 100.0	88.0 – 100.0	56.078*	<0.001*
Mean ± SD.	95.79 ± 2.31	96.07 ± 2.46	96.36 ± 2.54	96.47 ± 2.55		
Median	96.0	97.0	97.0	97.0		
Sig. bet. periods		<0.001*	<0.001*	<0.001*		

Table (7): Central Venous Pressure (CVP) pre and post implementation of passive range-of-motion exercises among mechanically ventilated patients (n= 555)

Central venous pressure (CVP)	Baseline (Pre)	Post			F	p
		5 min.	20 min.	60 min.		
Min – Max.	4.0 – 18.0	4.0 – 19.0	4.0 – 18.0	4.0 – 18.0	16.086*	<0.001*
Mean ± SD.	7.79 ± 2.30	7.75 ± 2.18	7.83 ± 2.26	7.93 ± 2.37		
Median	8.0	8.0	8.0	8.0		
Sig. bet. periods		<0.001*	<0.001*	<0.001*		

Discussion

Critically ill patients requiring mechanical ventilation are often confined to their beds for extended durations. This confinement increases the chance of dysfunction in many organ systems, which can often worsen the underlying illness. Routine daily interventions of critically ill patients increase tissue oxygen needs and necessitate higher output from the cardiac and respiratory systems. Physical therapy, including passive exercises, helps to strengthen muscles, shortens the duration of delirium, improves patients' quality of life, and, as a result, minimizes

ICU and hospital admissions. Immobility can lead to muscle loss, difficulty weaning off ventilator, cognitive deficits, and delayed discharge from hospital (Gupta et al., 2021; Wang et al., 2021; Yang et al., 2023).

Passive range-of-motion exercise help all of the body's systems function properly. Furthermore, prolonged bed rest and mobilization may be beneficial to improving outcomes and facilitating early patient mobilization in critical care. In critically ill patients, hemodynamic parameter instability can last for days or weeks, delaying active mobility therapies and potentially leading to disability. Hemodynamic measurements are vital for correct diagnosis, daily monitoring, and treatment of critically ill patients. The most important essential physiological parameters are respiratory rate (RR), heart rate (HR), oxygen saturation (SPO2), blood pressure (BP), and monitoring of central venous pressure (CVP) (Vieira et al., 2020) .

The current study showed that studied patients were having chronic morbid diseases that affected activity levels, altered health, and patient tolerance to stressors as mechanically ventilated. The findings were consistent with Rezvani et al., (2022) noted that most of studied patients were having chronic diseases such as hypertension, diabetes mellitus, and respiratory failure, and that affected activity levels, and patient tolerance to stressors as the mechanical ventilator. A study by Wang et al. (2020) investigated impact of early mobilization in patients need mechanical ventilator on ICU and reported that the main underlying disease require for mechanical ventilation among studied patients was respiratory disorders .

The present study demonstrated that passive range of motion exercises increase Heart Rate (HR) in mechanically ventilated patients. This is explained by the fact that the lungs and heart may require extra oxygen within passive activities to satisfy demand of increasing the HR and RR. (Claudia et al., 2022). Furthermore, HR is the key cardiovascular system component responsible for modulating cardiac output)Rezvani et al., 2022). The current study's findings revealed an increase in HR in mechanically ventilated patients. This finding supported by Wang et al., (2021) proposed that early mobilization in patients on ventilator in the ICU may result in increased HR after exercises due to oxygen consumption and increased cardiac output. Furthermore, Rezvani et al., (2022) discovered a substantial increase in heart rate and pulse over time during efforts.

Several studies have revealed that muscle tension induced by passive motions can lead to higher HR by activating tendinous mechano-receptors and causing simultaneous muscle stretching and shortening, as in typical passive mobilization (Claudia et al., 2022, Watanabe et al., 2023, Pinkaew et al., 2020). It also activates vagal nerves and stimulates baroreceptors, helping to regulate the cardiovascular system. Another aspect that may contribute to increased HR is the activation of big muscle groups (such as the hip, knee, or shoulder) (Yang et al., 2023; Wang et al., 2021).

The finding of increasing HR in mechanically ventilated patients were inconsistent with Bolin (2021) who analyzed effect of early mobilization on patients with ventilator and demonstrated that the early activity group shows a considerable rise in heart rate after surgery. Other researchers, however, discovered no relation between heart rate and passive exercises in the studied patients. Also, Previous and contemporary investigations have found no substantial change in heart rate during the mobilization of critically ill patients or after major surgery .

The present study revealed that passive range of motion exercises increase Respiratory Rate (RR) in patients on mechanical ventilation. This finding can be read as the fact that respiratory rate increased throughout each vigorous passive exercises and reverted to assessment values after exercises, implying physical activity enhance respiratory function (Hickmann et al., 2020). However, passive range of motion exercises in Intesive Care Units can aid in the removal of residual airway secretions, as well as exercise therapy aimed at improving respiratory function. Furthermore, early movement, posture, and exercise help address the weakening that arises during clinical practice (Putri et al., 2021).

Several studies have demonstrated that increased RR due to an increasing metabolic rate caused by exercise (Trinity & Richardson, 2019, Watanabe et al., 2023; Pinkaew et al., 2020). Hickmann et al. (2020) assess the impact of sitting away from bed and physical activity on lung oxygen supply in patients with serious illnesses and found that physical activity with active process ergometry in the ICU slightly raised HR, RR, and sense of dyspnea, which is regarded as a usual reaction to exercise. In addition, the utilization of vigorous exercise distinguishes our intervention due to its intensity and length .

The results of increasing Respiratory Rate (RR) in mechanically ventilated patients were inconsistent with Pinkaew et al., (2020), who demonstrated that, while passive movements of the lower extremity on patients in ventilation raised RR, these variations were not empirically and significantly different. Furthermore, Amidei et al. (2020) found no significant statistical change in the dependent variable of respiratory rate when passive movements of the lower extremities were included as an independent variable in the study .

The present study demonstrated that passive exercises decreased Blood Pressure (BP) in mechanically ventilated patients. This can be due to the fact that passive exercises provides physiological and psychological effects. Also, the physiological impact of passive exercises are changing functions of body by decreasing pulse, blood pressure and altering hormonal levels (Rezvani et al., 2022). Moreover, Exercise can also improve blood flow to the tissue by promoting nutrition exchange, tissue oxidation, and the elimination of metabolic waste. Additionally, psychological passive range-of-motion exercises might enhance good emotions and lower stress and anxiety levels (Esmealy et al., 2023).

The findings of decreasing Blood Pressure (BP) in mechanically ventilated patients were supported by Indriani et al., (2023) who observed that during the progressive mobilization, patients' SBP and DBP significantly decreased approaching stability. Furthermore, this is supported by Watanabe et al. (2023), who discovered that with time, the intervention group's patients' SBP and DBP readings significantly decreased toward normal values. Moreover, the passive movement may increase blood flow to the stroke patient's paralyzed tissues. Furthermore, a study by Hartoyo, Shobirun, Budiyati, and Rachmilia (2017) found that following escalating level immobilization, participants' SBP and DBP increased .

The results of decreasing Blood Pressure (BP) in mechanically ventilated patients were inconsistent with Claudia & Iosif, (2022) who demonstrated that the hemodynamic parameters (SBP, DBP) did not significantly differ between both the control and the experimental groups. Furthermore, Ahmed's (2019) study revealed that the mechanically ventilated group's heart rates were altered primarily during the active activity; this alteration was noted at the conclusion of the workout. Moreover, systolic blood pressure changed, while diastolic blood pressure did not change. Thus, increases in heart rate or systolic blood pressure were not clinically significant.

The present study illustrated that passive range-of-motion exercises increase percutaneous oxygen saturation (SPO2) in patients on mechanical ventilators. This finding suggests that heart muscles fatigue occurred because of increased HR, which subsequently turn affected cardiac output and significantly raised SPO2. Passive range of motions exercises improve respiratory system and enhance inhalation and exhalation (Ghiassi et al., 2022).

The findings of increasing the percutaneous oxygen saturation (SPO2) in mechanically ventilated patients were consistent with Putri et al. (2021) who noted an increase in the SPO2 score among the participants who engaged in physical activity. According to Rocha et al. (2023), HR, DP, BP, and SPO2 were assessed subsequent to implemente of passive exercises.

In addition, Ghiassi (2022) showed that physical exercise considerably alters heart rate, cardiac output, and SPO2, which is consistent with our findings.

Furthermore, a study by Rezaeikia et al. (2020) evaluated the impact of passive movements on hemodynamic parameters of patients using mechanical ventilation; taking into account the higher oxygen demand during exercise, the study only found increased oxygen absorption and oxygen saturation. Furthermore, Rezvani et al. (2022) found that all groups of subjects who engaged in physical activity had better oxygen saturation. The study assessed the effect of early mobilization on respiratory parameters in patients on mechanical ventilation with respiratory distress. Breathing frequency increased throughout each physical exercise and, following exercise, returned to baseline values in the majority of instances .

The results of increasing the percutaneous oxygen saturation (SPO2) in patients on mechanical ventilation were inconsistent with Rezaeikia et al., (2020), who found that the SPO2 value did not change significantly during experimental method. Furthermore, no discernible differences in the SPO2 value were found between two-staged mobilization techniques in an observational study that looked at fundamental hemodynamic parameters on cardiovascular technological advancements (Corsini et al., 2022).

According to a study by Astuti et al. (2021), sitting, standing, and walking are associated with rising heart rate as well as both diastolic and systolic blood pressure additionally, mild to moderate dyspnea was slightly increased by passive range-of-motion exercises, and this increase may linked with increases in heart rate and frequency of breathing. This is supported by Yang et al. (2023), who examined the effects of early mobilization for patients with critical illnesses and found that, both at rest and following mobilization, there was an increase in myocardial oxygen consumption, the double product, and heart rate. While these changes did not pose a risk to the patient's health, the acute response following exercise that resulted .

The present study demonstrated that passive range-of-motion exercises had no changes in Central venous pressure (CVP) in mechanically ventilated patients, This finding was agreement with Putu et al., (2023), who discovered any significant differences on CVP values during before and after a passive range of motion exercise. These findings are consistent with prior research by Ahmed (2019). A research by Yundari et al., (2023) found no major fluctuations in CVP averages over the research phases. Furthermore, Jacob et al., (2021) found the same results when investigating the early mobilization for patients using vasoactive drugs on emergency rooms.

Conclusion

The current study's findings supported the concept that passive range-of-motion exercises improve hemodynamic parameters among patients on mechanical ventilation. Furthermore, among patients on mechanical ventilation, there was a positive correlation found between passive exercises and hemodynamics parameters.

Recommendations

The current study's conclusions lead to the following recommendations, which state that passive range-of-motion exercises should be a regular part of ICU clinical practice and are crucial to the overall treatment of patients on mechanical ventilation. In addition, passive range-of-motion exercises are tips for ICU nurses to preserve hemodynamic stability in ICU patients and to broaden understanding of hemodynamic therapy. Moreover, guidelines for various Passive Range of Motion Exercises based on patient tolerance should be developed to promote patient safety and prevent adverse consequences such as hemodynamics instability. It is also advised that early mobilization be included in critically ill patients' routine care, and that information regarding these patients' post-ICU follow-up be included in future studies.

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