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The Relationship between Mechanically Ventilated Patients' Outcomes and Body Mass Index at Intensive Care Unit

Shaimaa Ibrahim Mohammed[1], Baghdad Hussein Mahmoud[2], Ahmed Shaaban Attia[3]

1. *Demonstrator in Critical Care Nursing Department MTI University[1],*
2. *Assistant Professor of Medical-Surgical Nursing Faculty of Nursing - Helwan University[2],*
3. *Lecturer of Critical Care Nursing, Faculty of Nursing – Helwan University[3].*

Abstract

Background: Mechanical ventilation is a life-saving intervention commonly used in intensive care units to support patients with respiratory failure. However, the outcomes of mechanically ventilated patients can vary significantly based on numerous factors, including underlying comorbidities, severity of illness, and nutritional status. Body mass index (BMI), has emerged as a potential predictor of clinical outcomes in critically ill patients. **Aim:** This study aimed to assess the relationship between mechanically ventilated patients outcomes and body mass index at intensive care unit. **Design:** A descriptive correlational research design was used. **Setting:** the study was conducted in the Surgical Intensive care units at surgical hospitals of Ain Shams University hospital in Egypt**. Subjects:** A purposive sample of (60) patients from both genders in surgical intensive care units. **Tools:** Three tools were used to collect data, **Tool (I):** Patients Structured Interviewing Questionnaire which included two parts:- **Part I:** Patients Demographic Characteristics. **Part II:** Patients Medical data. **Tool (II):** Burns Wean Assessment Program (BWAP) checklist. **Tool (III):** Sequential Organ Failure Assessment Questionnaire (SOFA score**). Results:** The study finding revealed that, 46.7% of the studied patients were in category of overweight and 53.3% of the studied patients their total score of Burns wean assessment was difficult. 75% of the studied patients total score of SOFA was severe, which the patients had severe organ dysfunction**. Conclusion:** there was highly statistically significant negative correlation between the studied patients' total BWAP, BMI and total SOFA score with p- value (**0.001**). **Recommendations:** A collaborative approach involving respiratory therapists, nurses, and physicians can enhance patient care during the weaning process. Regular team meetings to discuss patient progress. Regular team meetings to discuss patient progress may improve outcomes.

Keywords: Body mass index, Mechanically ventilated patient

Introduction:

Overweight and obesity are associated with numerous comorbidities and risk factors for life-threatening complications. They are also strongly associated with increased long-term mortality. In contrast, multiple studies have found that overweight and mildly obese patients have lower short-term mortality rates than their leaner counterparts, after both cardiac and non- cardiac surgery. Furthermore, a similar phenomenon has been observed in non -surgical populations **(Plečko et al., 2021).**

Obesity is associated with difficult mask ventilation, including the need for two-provider ventilation or airway adjuncts, likely because of mask fit challenges, increased upper airway resistance, and reduced respiratory system compliance. Data are less clear as to BMI's specific

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impact on difficult tracheal intu bation. Large operating room studies suggest small or no risk differences in patients with BMI ≥ 35 to 40 kg/m2 **(Anderson & Shashaty., 2021).**

Obesity is a chronic disease associated with cardiovascular disease, chronic kidney disease, diabetes mellitus, some cancers, and musculoskeletal disorders. It has become one of the most important public health problems in many high - and middle-income countries, entailing a heavy economic burden. The prevalence of obesity is steadily increasing worldwide and, on average, approximately one in five patients admitted to the intensive care unit is obese **(Decruyenaere et al., 2020).**

Interestingly, the obesity survival paradox has been described in certain diseases such as community -acquired pneumonia, where despite the increased risk of developing pneumonia, an inverse association could be observed between obesity and mortality. To the contrary, in the 2009 H1N1 pandemic, obesity was identified as an independent risk factor of severe disease, hospitalization and death **(Földi et al., 2023).**

Previous studies have reported that obesity causes an increase in the duration of intensive care unit (ICU) stay, the use of mechanical ventilation, hospital infection rates and the use of hospital resources. However, recent studies have given conflicting results as although obesity was associated with increased morbidity in critically ill patients, it did not affect mortality **(Massone et al., 2024).**

Even, lower mortality was found in obese and morbid obese patients with acute respiratory distress syndrome. This situation was first defined as "obesity survival paradox" in 1999, since an increase in survival with increasing BMI has been identified in patients undergoing hemodialysis **(çınar et al., 2022).**

Significance of The Study:

Mechanical ventilation is a lifesaving management approach for critically ill patients. Therefore, it requires a multidisciplinary team approach with some predictions of patient's progress or outcomes and a comprehensive nursing care to enhance these patient's outcomes. However, mechanically ventilated patients experience many problems such as difficulty in weaning from mechanical ventilators. Prolonged stay in the ICU, and repeated mechanical ventilation after disconnection. These problems were more frequent among obese and underweight patients. However, limited data on the effect of BMI on outcomes of mechanically ventilated patients were reported ***(Mostafa, 2023).***

Obesity has become a global epidemic with prevalences rising both in developed and developing countries. Front runners in 2020 are the United States of America (USA, 36%) and Australasia (30%), with a prevalence expected to increase in the USA until 50% by 2030, whereas European countries have prevalences between 20 and 30%. The percentage of patients with obesity in the intensive care unit (ICU) can be expected to increase concomitantly or even more since obesit y increases the risk for a more severe disease course with more need for ICU admission and mechanical ventilation as has been shown in trauma, traumatic brain injury patients, out-of-hospital cardiac arrest ***(Jong, 2020)***.

In Egypt, obesity is a serious epidemic issue. According to reports, 35.3% of Egyptian adults are obese. Obesity has serious mechanical damaging effects on respiratory system via altered pulmonary biomechanics, enhancing and worsening the airway hyper responsiveness (AHR), narrowing and resistance, especially when lower respiratory tract infections are present ***(Mohammed et al, 2023)***

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Aim of the Study:

This study aimed to assess the relationship between mechanically ventilated patients outcomes and body mass index at intensive care unit. This aim will be achieved through the following objectives:

- Assess the mechanically ventilated patients' outcomes at ICU.
- Assess the mechanically ventilated patients' body mass index at ICU
- Assess the relationship between mechanically ventilated patients' outcomes and body mass index at intensive care unit.

Research questions:

- What are the mechanically ventilated patients' outcomes at ICU?
- What are the mechanically ventilated patients' body mass indexes at ICU?
- What is the relationship between mechanically ventilated patients' outcomes and body mass index at ICU?

Subjects and Methods: -

Research design:

Descriptive correlational research design was utilized in this study.

It is a type of research method that involove two variables in order to establish a statistically corresponding relationship between them **(Bradaschia et al., 2021).**

Setting

The study conducted in the Surgical Intensive care units at the surgical hospital affiliated to Ain Shams University Hospitals. It is one of the largest university hospitals in Egypt, and it receives patients from all governorates of Egypt. It consists of 2 units; there are in the first floors, the first unit is located at the left side from the entrance door and it contains 8 mechanical ventilators and the second is at the right side from the entrance door and it contains 15 mechanical ventilators. Each unit contains 20 beds, and the numbers of occupied beds estimated about 35 beds/ day **.**

Subjects:

A purposive sample of (60) adult patients from both genders admitted to hospital with different diagnosis and different body mass index, some patients came connected to mechanical ventilator from admission at emergency unit and other patients connected ventilators after entering ICU .

Tool of data collection

Data was collected using three tools as the following: -

Tool I: Patients' Structured Interviewing Questionnaire: which developed by the investigator based on literature review and divided into two parts:

Part I: Patients Demographic Characteristics, which us ed to assess the patient's medical data as age, gender, level of education, marital status, occupation, level of education, and previous hospitalization.

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Part II: Patients Medical data: which used to assess Patients medical diagnosis, past medical history, intubation, mode of ventilation, vital signs, length of ICU stay and the patient's weight and height.

Tool II: BURNS Wean Assessment Program (BWAP) checklist. which adopted from **(Burns 1998)**, which provided a more comprehensive assessment of weaning readiness. It is used to monitor the progress of 10 weaning for the mechanically ventilated patients through general and respiratory assessment. The BWAP is 26 items checklists, it covers five major areas o f assessment. The first one is Daily assessment for readiness to wean, the second is Safety screen for sedation removal, The third is Spontaneous awakening trial safety screen, The fourth is Spontaneous breathing trial safety screen that include: Adequate oxygenation, Hemodynamic stability and the fifth is Perform spontaneous breathing trial and the sixth is Physician to consider extubation.

Scoring system:

The score is determined by the investigator observation which each item is assessed in the fourth week of admission if present=1 and not present=0, Which difficult status range from (6 – 10) and easy and successful state (11– 26), and total score 26.

Tool III: Sequential organ failure assessment (SOFA score) questionnaire: it was effective method to describe organ dysfunction /failure in critically ill patients, each organ graded from 0 (normal) to 4 (the most abnormal) providing score of 0 to 24 patients, the greater the score, the worse condition. This tool was adopted from **Vincent (1996)**. It was used to determine the extent of a patient's organ function or rate of dysfunction during their ICU stay.

Field work:

- Approval was obtained from a scientific ethical committee of the faculty of nursing at Helwan University and the study subjects individually and a written informed consent obtained from each participant prior to data collection.
- Data collection started and completed within five months from April (2024) until the end of August (2024). Data collection was done 3 days/week by the investigator in the morning and afternoon shifts.
- The investigator introduced herself and explained the purpose of the study to intensive care unit nurses and to each patients. The purpose of the study was simply explained to the patients' family who agree to participate in the study prior to any data collection.
- The investigator starts with structured interviewing tool to take present and past medical history, assess the conscious level, assess body mass index, mode of ventilation, the second tool is BURNS Wean Assessment Program (BWAP) checklist and the third tool is Sequential organ failure assessment (SOFA score) questionnaire.
- The investigator started to collect data from patients when they admitted.

Statistical Analysis:

The collected data were organized, categorized, tabulated and statistically analyzed using thestatistical package for social science (SPSS) version 25. Quantitative data were presented as mean and standard deviation (SD) while qualitative data were expressed as frequency and percentage. **Chi-square test ($X2$)** was used as a test of significance to test relations between quantitative variables. The observed differences and associations were considered as follow

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- P > 0.05 was considered not- significant **(NS).**
- P < 0.05 was considered Significant**(S).**
- p< 0.001 was considered highly Significant **(HS)**

Result:

Table (1): indicates that, **58.3%** of the studied patients were females as well as in age of (50 ≤60 years) with Mean±SD **50.86±11.36**, **86.7%** of the studied patients were married. Concerning to educational level; **48.3%** of the studied patients graduated from universities, **3.3%** of them had secondary education. Regarding occupation; **56.7%** of the studied patients were housewives while 8.3% of them have manually worked. **76.6%** of the studied patients previously admitted to hospitals (once, twice & third), while **23.4%** of them haven't admitted to hospitals before. **95%** of the studied patients were not smoker and **96.7%** lives in urban area.

Figure (1): revealed that; that; 58.3% of the studied patients were aged from 50≤ 60years old, while 13.3% were from 20< 30 years old, with a mean of **50.86±11.36**

Table (2): shows that, **48.3%** of the studied patients diagnosed with neurological diseases, while **5%** of them diagnosed with cardiovascular diseases. Concerning to chronic diseases; **60%** of the studied patients had no history of chronic diseases, while 3.3% of them had a history of kidney diseases. **78.2%** of the studied patients ventilated on SIMV mode while **1.7%** of them ventilated on CMV and PS modes. Mean±SD of BMI for the studied patients was **26.87±5.43** which **46.7%** were in category of (overweight 25 – 29.5), while only **5%** of them were in category of (underweight < 18.5). **98.3%** of the studied patients had a normal body temperature between 36.4- 37.4ºC, while **1.7%** had hyperthermia >38 ºC. regarding to pulse and respiratory rate; **88.3%** of the studied patients had a normal pulse and respiratory rate, while **11.7%** of them had a bradycardia and bradypnea. **73.3%** of the studied patients had a normal blood pressure, while **11.7%** of them had hypotension. **53.3%** of the studied patients their length of ICU stay was < 7 days, while only **10%** of them their length of ICU stay was between 14 – 21 day.

Table (3): clarifies that **88.3%** of the studied patients answered with "yes" for the question of "Is pain present?", while only **3.3%** of them answered with "yes" for the statement of "Trial of the underlying cause for acute respiratory failure". **95%** of the studied patients answered with "yes" for the question of "PH < 7.25 0R PaCo2 abnormal", while only **10%** of

them answered with "yes" for the statement of "Pao2/Fio2< 150mmHg or Spo2 < 88%on Fio2≤ 0.4 and PEEP ≤ 5 , PI < 10".

Table (4): represents that; **86.7%** of the studied patients their respiration (PaO2/FiO2, mmHg) was <100 (with respiratory support). Regarding Liver (Bilirubin, mg/dL (µmol/l)); **61.7%** of the studied patients was (Normal<1.2) as well as **65%** of them, their Central Nervous System Glasgow Coma Score was between (6-9).

Table (5): reveals that; the mean ± standard deviation value of total patients' SOFA score was 16.30± 5.52. **75%** of the studied patients their total score was (12-24) which means the patients have severe organ dysfunction, while minority of them **1.7%** their total score was (1-5).

Figure (2): revealed that; **53.3%** of the studied patients their total score was (Difficult →6 – 10) and **46.7%** of them their total score was (Easy and successful→11 – 26) with a mean of **10.21±3.21**.

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Table (6): shows that, there was a statistically significant relation between the total BWAP, gender and Education level with (P-Value= 0.023 and 0.046 Respectively) .

Table (1): Frequency and percentage distribution of Demographic Characteristics of the Studied Patients (n=60).

Items	Studied Patients (n = 60)	
	No	%
Age in years:		
• 20 < 30 years.	8	13.3
• 30 < 40 years.	5	8.4
• 40 < 50 year	12	20
• 50 ≤60 year	35	58.3
Mean±SD	**50.86±11.36**	
Gender:		
• Male.	25	41.7
• Female.	35	58.3
Marital status:		
• Single.	7	11.7
• Married.	52	86.6
• Widow	1	1.7
Educational Level:		
• Not read and write.	9	15
• Read and write.	20	33.3
• Secondary Education.	2	3.3
• University Education.	29	48.4
Occupation:		
• Official work	12	20
• Retired	9	15
• Manual work	5	8.3
• Housewife	34	56.7
Previous Hospitalization:		
• No.	14	23.4
• Once.	11	18.3
• Twice	30	50
• Third	5	8.3
Place of Residence:		
• Urban	58	96.7
• Rural	2	3.3
Smoking:		
• No.	57	95
• Yes.	3	5

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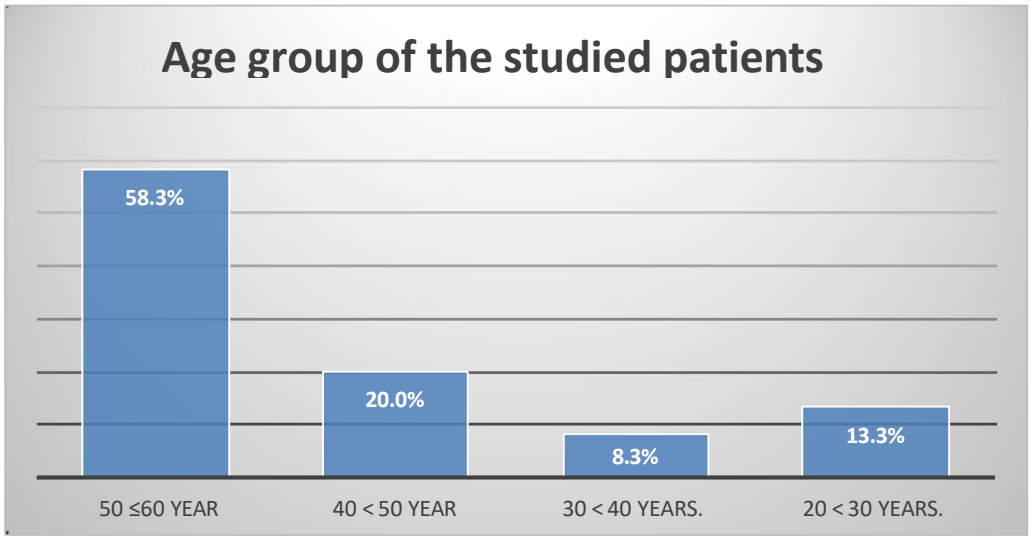

Figure (1): percentage distribution of age among of the studied patients (n=60**)**

Table (2): Frequency and percentage distribution of patients' medical data (n=60).

Items	N	%
Diagnosis:		
• Respiratory diseases	14	23.3
• Heart diseases	5	8.3
• Neurological diseases	29	**48.4**
• Cardiovascular diseases	3	**5**
• GIT disorder	8	13.3
• Renal disorder	1	1.7
Chronic diseases:		
• No	36	60
• Diabetes	12	20
• Heart diseases	6	10
• Hypertension	4	6.7
• Kidney diseases	2	**3.3**
Time of Intubation:		
• On admission	54	89.9
• One day	1	1.7
• Two days	1	1.7
• Three days	3	5
• More than three days	1	1.7
Mode of Ventilation:		
• CMV	1	**1.7**
• SIMV	47	**78.2**
• CPAP	4	6.7
• A/C	7	11.7
• PS	1	1.7

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Body mass index:		
• Underweight < 18.5	3	5
• Normal 18.5 – 24.5	16	26.7
• Overweight 25 – 29.5	28	**46.7**
• Obesity ≥ 30	13	21.6
Mean±SD	**26.87±5.43**	
Temperature:		
• Normal 36.4- 37.4ºC	59	**98.3**
• Hyperthermia >38 ºC	1	**1.7**
Pulse:		
• Normal	50	**83.3**
• Tachycardia	7	**11.7**
• Bradycardia	3	**5**
Respiratory rate:		
• Normal	47	78.3
• Tachypnea	9	15
• Bradypnea	4	6.7
Blood pressure:		
• Normal	44	**73.3**
• Hypertension	9	15
• Hypotension	7	**11.7**
Length of ICU stay:		
• < 7 days	32	**53.3**
• 7 – 13 day	22	36.7
• 14 – 21 day	6	**10**
Pulse:		
• Normal	50	**83.3**
• Tachycardia	7	**11.7**
• Bradycardia	3	**5**
Respiratory rate:		
• Normal	47	78.3
• Tachypnea	4	15
• Bradypnea	3	6.7
Blood pressure:		
• Normal	44	**73.3**
• Hypertension	9	15
• Hypotension	7	**11.7**
Length of ICU stay:		
• < 7 days	32	**53.3**
• 7 – 13 day	22	36.7
• 14 – 21 day	6	**10**

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Table (3): Frequency and percentage distribution of Patients' BURNS Wean Assessment Program (BWAP) Checklist (n=60).

Items	Studied Patients			
	No		Yes	
	N	%	N	%
A. Daily assessment for readiness to wean				
• Trial of the underlying cause for acute respiratory failure	58	96.7	2	3.3
B. Safety screen for sedation removal				
• Is sedation used for active seizures or alcohol withdrawal?	56	93.3	4	6.7
• Is patients is agitated?	56	90	6	10
• Is paralytics agent used Is patients is agitation?	58	96.7	2	3.3
• Is myocardial ischemia occurring in past 24h?	36	60	24	40
• Is Normal intracranial pressure present?	31	51.7	29	48.3
C. Spontaneous awakening trial safety screen				
• Is anxiety present?	50	83.3	10	16.7
• Is agitation present?	49	81.7	11	18.3
• Is pain present?	7	11.7	53	88.3
• Respiration rate 35 breath/min for 5 min	28	46.7	32	53.3
• SPO2 88% for 5 min	10	16.7	50	83.3
• Acute cardiac arrhythmia	30	50	50	30
• Two or more signs of respiratory distress (60 >HR 120, use of accessory muscles, abdominal paradox, diaphoresis, marked dyspnea).	33	55	27	45
D) Spontaneous breathing trial safety screen				
1- Adequate oxygenation				
• Pao2/Fio2< 150mmHg or Spo2 < 88%on Fio2≤ 0.4 and PEEP ≤ 5 , PI < 10.	54	90	6	10
• PH < 7.25 0R PaCo2 abnormal.	3	5	57	95
• Respiration rate >35breaths/min.	9	15	51	85
• Rapid shallow breathing index > 105.	28	46.7	32	53.3
2- Hemodynamic stability				
• Active myocardial ischemia (chest pain, ST changes, new onset arrhythmia).	35	58.3	25	41.7
• Clinically important hypotension (>5mcg/kg/min dopamine • or dobutamine>0.04mcg/kg/min norepinephrine).	29	48.3	31	51.7
• Heart rate >140 bpm.	44	73.3	16	26.7
E. Perform spontaneous breathing trial (during 30-120min)				
• Respiratory rate>35 breathing/min, change in>50%.	37	61.7	23	38.3

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• Heat rate>120 bpm, change in 20%.	27	45	33	55
• 90mmHg>systolic blood pressure>180mmHg, change in>20%.	28	46.7	32	53.3
• Two or more signs of respiratory distress(Use of accessory muscles, abdominal paradox, diaphoresis, marked dyspnea)one or more.	36	60	24	40

Table (4): Frequency and percentage distribution of Total Patients' BURNS Wean Assessment Program (BWAP) checklist (n=60).

Items	N	%
Respiration (PaO2/FiO2mmHg):		
• Normal >400	6	10
• <400	0	0
• <300	1	1.6
• <200 (with respiratory support)	1	
• <100 (with respiratory support)	52	
Coagulation Platelets x103/mm3:		
• Normal >150	14	23.3
• <150	18	30
• <100	9	15
• <50	5	8.4
• <20	14	23.3
Liver (Bilirubin, mg/dL (µmol/l)):		
• Normal<1.2	37	61.7
• 1.2-1.9	8	13.3
• 2-5.9	9	15
• 6-11.9	4	6.7
• >12	2	3.3
Cardiovascular (Hypotension):		
• No hypotension	24	40
• MAP <70 mm Hg	26	43.4
• Dopamine <5 or dobutamine (any dose)	5	8.3
• Dopamine >5 or epinephrine <0.1 or norepinephrine <0.1	3	5
• Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1	2	3.3
Central Nervous System Glasgow Coma Score:		
• Normal 15	1	1.7
• 10-12	3	5
• 6-9	39	65
• <6	17	28.3

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Renal/ • Normal <1.2 • 1.2-1.9 • 2-3.4 • 3.5-4.9 • >5	 18 13 6 10 13	 30 21.7 10 16.6 21.7
Creat: • Normal <1.2 • 1.2-1.9 • 2-3.4 • 3.5-4.9 • >5	 18 16 5 14 7	 30 26.7 8.3 23.3 11.7
Urine Output (UOP): • 0 • 1 • 2 • 3 • 4	 10 1 0 21 28	 16.9 1.7 0 30.5 50.9

Table (5): Percentage Distribution of total patients' SOFA Score (n=60

Items	Mean ± SD	N	%
Total SOFA Score: 1– 5 = mild organ dysfunction 6– 11= moderate organ dysfunction 12-24= severe organ dysfunction	16.30± 5.52	 1 14 45	 **1.7** 23.3 **75**

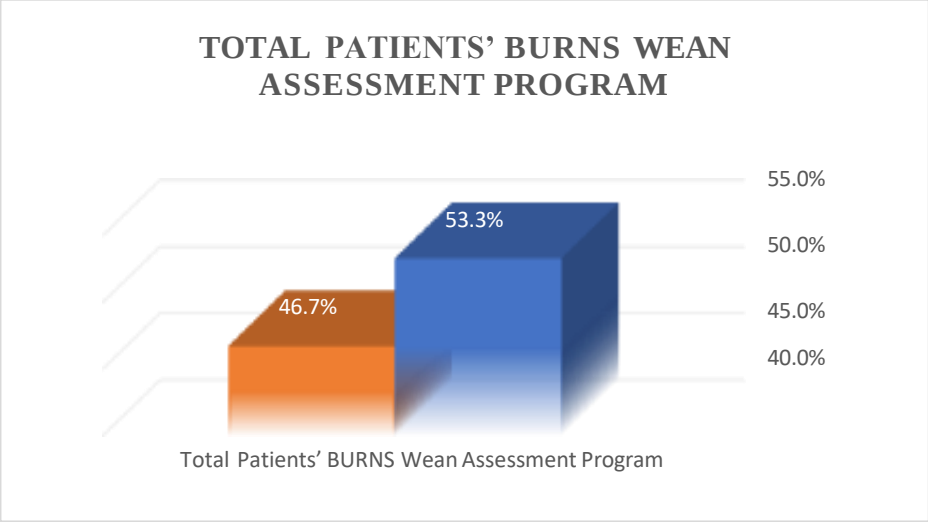

Figure (2): Bar graph representing Total Patients' BURNS Wean Assessment Program

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Discussion

Concerning the demographic data of the studied patients , the present study showed that, the majority of patients in the ICU under mechanical ventilation were females, aged primarily between 50 and 60 years. This result is in accordance with **(Shen et al., 2020)** which about " Demographic predictors of ICU outcomes in ventilated patients ", who reported that, older adults, especially those with chronic conditions, are more susceptible to severe illness requiring ventilatory support.

As well, these results were in line with **Tosun & Duman , (2021) :** in their study " Socioeconomic status and ICU health outcomes", who reported that, about half of the patients were housewives, which suggests a possible socioeconomic factor affecting health outcomes, as has been noted in recent studies linking occupational backgrounds and health outcomes in critical care.

The current study findings revealed that nearly half of the patients were diagnosed with neurological diseases, while a minority had cardiovascular or renal disorders. As well, this finding was in line with Esquinas, et al., (2021): who stated that, The prevalence of neurological issues as a primary diagnosis may reflect the increasing age and comorbidities in ICU populations, as neurological diseases often correlate with advanced age and other risk factors.

In relation to Synchronized Intermittent Mandatory Ventilation (SIMV) Patints , the study result illustrated that, A significant portion of patients was ventilated on Synchronized Intermittent Mandatory Ventilation (SIMV), which accounted more than three quarters of . In agreement with **Chiumello, et al., (2023)** in the study titled “Ventilation strategies and outcomes in mechanically ventilated patients” who reported that SIMV is commonly used due to its compatibility with spontaneous breathing efforts, which is beneficial in weaning patients off ventilation. The findings reflect a global trend favoring SIMV over more restrictive modes, as SIMV is linked to shorter ICU stays and improved patient tolerance.

As regards to Body Mass Index (BMI) and Mechanical Ventilation, the patients had a mean Body Mass Index of 26.87, with a notable percentage classified as overweight or obese. Higher BMI has been associated with prolonged mechanical ventilation and increased ICU stays, as excess body weight can impair respiratory mechanics and increase complications. This result is in accordance with **Maurizio, et al., (2022)** who reported that, the prevalence of overweight patients in the ICU highlights the importance of considering BMI in respiratory care plans, as obesity often necessitates extended ventilation support and adjustments in ventilator settings.

As regards to the mean BURNS Wean Assessment Program (BWAP) score of 10.21, with more than half of the patients scoring in the "difficult" category for weaning. The highest difficulty in weaning could be attributed to factors such as high BMI, age, and neurological complications. This result is in accordance with **(Shen et al., 2020)** who highlighted that, patients with high SOFA scores, particularly in parameters like coagulation and respiratory rate, face challenges during the weaning process.

Conclusion

More than half of the studied patients, their total score Burns wean assessment program was (difficult 6-10). Three quarters of the studied patients, their total score of SOFA was (12-24), which the patients had severe organ dysfunction. Also, there was statistically significant relation between total BWAP and demographic characteristics (gender and educational level). Also there was a highly significant relation between total BWAP and (mode of ventilation, temperature and length of ICU stay). In addition there was a highly significant relation between SOFA score and

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(diagnosis, body mass index and length of ICU stay). Finally, there was no statistically significant correlation between total patients BWAP and total patients SOFA.

Recommendations

Based upon the study results of the current study, the following recommendations were suggested:

- Nutritional status of critically ill mechanically ventilated patients must be considered in their management.
- Development of a comprehensive assessment tool that facilitate inspection and early detection problems and complications among mechanically ventilated patients.
- Intensive care unit (ICU) teams should incorporate Body Mass Index (BMI) assessment as a routine component of patient evaluation, particularly for those requiring mechanical ventilation.
- Tailored care plans should be developed for patients with abnormal BMI (underweight, overweight, or obese), with attention to their specific physiological and respiratory needs to optimize outcomes.

Recommendations for furthers researches:

- Replication of the study on a larger sample selected from different hospitals for generalization of the study results.
- Future research should also explore additional confounding factors—such as nutritional status, sarcopenia, and comorbid conditions—that may influence this relationship.

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