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Effect of Obesity in The Outcomes of Patients Admitted to Intensive Care Unit

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ABSTRACT

Background: The physiological changes associated with obesity may impair the ability to withstand the stress of critical illness, and particularly in surgical postoperative patients, the effects on cardiovascular and respiratory systems may translate into prolonged time on a ventilator or intensive care unit survival.
Objectives: This review aiming at evaluation of the effect of obesity in patients admitted to intensive care unit.
Materials and Methods: An electronic search was conducted in Medline using this built search strategy. The search was limited to the human studies conducted in the last 10 years. The search resulted in 368 articles and after exclusion of irrelevant, duplicated, and review articles only 26 articles were included in this review. The information about general characteristics and outcomes of these studies were collected using data sheets.
Results: The predominance of weight has been consistently expanding around the world, and obesity itself is viewed as an interminable illness and additionally a noteworthy general medical issue. However, not very many information is accessible on the relationship amongst BMI and basic care result. Additionally, examine is expected to recognize vital associates of basic care in relationship to BMI with the goal that this data can be utilized to nurture patients and enhance results.
Conclusion: BMI demonstrated no noteworthy effect on bleakness or mortality in basically sick patients. Mortality in basic care was related with seriousness of sickness at affirmation and ICU-related intricacies.
Keywords: Obesity; BMI; Intensive Care; Mortality; Survival.

INTRODUCTION

Obesity is a growing health care problem. The recent increase in the percentage of obese people in the Western world is paralleled by the rise in the number of obese patients requiring care in the intensive care unit (ICU) [(1)]. The physiological changes associated with obesity may impair the ability to withstand the stress of critical illness, and particularly in surgical postoperative patients, the effects on cardiovascular and respiratory systems may translate into prolonged time on a ventilator or ICU survival[(2)].

The relationship between obesity and a patient's outcome in the ICU has been looked at by many researchers, particularly in medical patients, and many conclusions have been reached. Some studies found obesity related to increased mortality and morbidity, whereas others showed either no association or even decreased mortality and morbidity[(3)].

Basically, sick patients who were overweight had uniquely brought down 30-day and 1-year mortality chance in spite of having higher rates of numerous comorbidities and comparative affirmation keenness contrasted and their ordinary weight partners[(4)]. After one year of acute morbidity, even very obese patients had a critical survival advantage. The defensive impact of weight (termed the "obesity paradox") has also been reported in obese patients with specific diagnoses, including acute heart failure, chronic kidney disease, and HIV/AIDS[(5)]. This review aiming at evaluation of the effect of obesity in patients admitted to intensive care unit.

METHODS

An electronic search was conducted in Medline using this search strategy (obesity[Title/Abstract]) AND (intensive care[Title/Abstract] OR critical care[Title/Abstract] OR ICU[Title/Abstract] OR emergency department[Title/Abstract] OR ED[Title/Abstract])) AND (death[Title/Abstract] OR mortality[Title/Abstract] OR cure[Title/Abstract] OR discharge[Title/Abstract]).

The search was limited to the human studies conducted in the last 10 years. The search resulted in 368 articles and after exclusion of irrelevant, duplicated, and review articles only 26 articles were included in this review. The information about general characteristics and outcomes of these studies were collected using data sheets.

The study was done after approval of ethical board of King Khalid university.

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RESULTS

Our search identified 368 articles of which 26 articles met our inclusion criteria. Twenty four studies examined the effects of body mass index (BMI) on the mortality of adult patients admitted to ICU and, while two studies assessed the mortality among children admitted to ICU. The patients included in these studies underwent mechanical ventilation, stroke, sepsis, atrial fibrillation, renal dysfunctions, intracranial hemorrhage, pneumonia, coronary artery disease, deep vein thrombosis, emergency procedures and cancers. These 26 studies examined the effect of BMI on mortality in ICU (28-days, 30 days and 60-days). The sample size of recruited patients ranged from 91 in **Ward *et al.***[3] to 1,042,710 in the study conducted by **Harris *et al***[1]. In the included studies, 17 studies were retrospective, five were prospective, one pilot study and one prospective retrospective study, while 23 studies were single-center and only three were multi-central studies (Table 1).

Two included studies recruited children with age ranged from 2-18 years old in **Goh *et al.***[6], and the other with mean age of 9.3 years old in **Ward *et al.***[3]. All included studies used World Health Organization cut-offs to define obesity categories. Concerning the outcomes of obesity in the ICU, the length of stay (LOS) is estimated in some studies, 13 studies said that the LOS in the ICU increased as the BMI increased. However, two studies said that LOS were not affected by body weight [7,8] and two studies reported that the LOS decreased as BMI increased. In patients with morbid obesity, LOS increased in **Engel *et al.***[9], **Pieracci *et al***[10] **and Choi *et al***[11]**.** Two studies found no significant difference in LOS between obese and non-obese ICU admitted patients [12, 13].

Regarding the association between obesity and ICU mortality rate, five studies reported 30 days mortality [2, 11, 14-16], and one study reported 28 days mortality [17], while one study reported 60 days mortality [18]. Sixteen included studies found that mortality rate was reduced as the BMI increased [4, 6-10, 12-21]. All these studies were retrospective studies and single centered except a study conducted by **Lang *et al.***[15] **and** another study conducted by **Martino *et al***[18]. On another hand, four included studies reported an increase in ICU mortality associated with BMI [5, 22-24]**.** Most of these studies were prospective and single centered studies.

Studies with the highest mortality rates were reported in patients with certain medical conditions, mortality rate of 39% in patients with renal problems in Arabi, et al.[13], mortality rate of 31% in patients with atrial fibrillation [17]. In regards to stroke patients, a mortality rate of 30% in patients, while in cancer patients a mortality rate of 13.1% was found [16]. In addition, a mortality rate of 28.8% in patients with intracranial hemorrhage [22], a mortality rate of 25.7% in patients who were in mechanical ventilator [25], and mortality rate of 24.4% in patients with sepsis [18].

The highest length of ICU stay was reported in patients with emergency surgeries and certain medical conditions, LOS of 58 days reported [19] in patients with coronary artery disease (34%) and deep vein thrombosis (10%). However, regarding 55 days-LOS, which reported among 19% of patients with atrial fibrillation [17]. **Engel *et al***.[9] reported LOS of 47.5 ± 74.6 days in 37% of patients underwent emergency surgeries, LOS of 18.4 ± 9.7 days reported by **Papadimitriou-Olivgeris *et al***.[22] in 12.7% of patients with intracranial hemorrhage and 13% of patients with sepsis.

Table (1): The effect of obesity in patients' outcomes in the included studies

Study	Study design	Sample size And	Mean age of patients	Cause of admission to ICU	Other chronic diseases	Duration of stay	Death or mortality related to obesity
Harris *et al.*[1]	Retrospective cohort study	1,042,710 ICU stays	63.6 years	Trauma 4.1%, surgery 16.2%, and mechanical ventilation 34.4%	Diabetes 21.6%	2.4 days ICU Median (1.6–4.1 days)	5.1%
Atamna *et al.*[2]	A retrospective case–control study	1437	≥18 year	Pneumonia148 (44 %), UTI 117 (35 %), and stroke 12 (4 %)	DM 113 (34 %), CKD 62 (19 %), and hypertension 143 (43 %)	6 ± 8 days	30-day mortality 7.5 %
Papadimitriou-Olivgeris[22]	Single-center retrospective study	834	Obese 59.1 ± 14.8 and Non-Obese 56.3 ± 19.8	Intracranial Hemorrhage, sepsis, respiratory problems and trauma	Diabetes mellitus, COPD, chronic heart failure, chronic renal failure, malignancy	Non-obese 8.8 ± 11.4 Obese 18.4 ± 9.7 P= 0.004	Non-obese 141 (21.0%) Obese 47 (28.8%) P= 0.036
Ward *et al.*[3]	A cohort (2 clinical trials and 3 observational studies)	91	9.3 ±5	Pneumonia (47%), sepsis (13%), aspiration (16.5%), trauma (2%), and pulmonary Hemorrhage (3%)	Not-reported	Not-reported	Overall mortality was 20%
Devarajan *et al.* [4]	A retrospective study	Obesity I (n = 851), and in Obesity II/III (n = 525)			A retrospective study	Obesity I (n = 851), and in Obesity II/III (n = 525)	
Tafelski *et al.*[5]	A prospective study	Obesity I= 66, Obesity II/III= 62	Myocardial infarction, congestive HF and dialysis	COPD/asthma, diabetes, and hypertension		Obesity I= 66, Obesity II/III= 62	Myocardial infarction, congestive HF and dialysis
Wardell *et al.*[24]	A prospective observational cohort study	449 of non-obese, and 202 Obese,	Non-obese= 54.3±18.1, while obese= 57.7±16.4	Medical, surgical, and trauma causes	Cardiac failure, respiratory failure, and renal failure	Not-reported	Mortality rate in non-obese= 17.8%, in Obese= 19.3%
Utzolino *et al*.[17]	A retrospective cohort study	253	BMI 26 – 29.9, the mean age= 64, in BMI ≥ 30= 65	Atrial fibrillation, coronary artery disease and stroke	Diabetes mellitus, chronic kidney disease, and arterial hypertension	In BMI 26 – 29.9, LOS=37, and in BMI ≥ 30, LOS=55	Mortality rate at 28 days with BMI 26 – 29.9= 42%, and with BMI ≥ 30= 31%
Ferrada *et al.*[19]	A pilot study	341 Non-obese (*n* = 139) and Obese (*n* = 202)	Non-obese=47.1 % and Obese=46.8 %	DVT and CAD	DM, HTN, and COPD	Non-obese=42% and in obese= 58%	Mortality rate in non-obese= 15.80% and in obese 13.60%

Lee *et al*.[16]	A retrospective study.	306 non-obese and 198 obese	Obese patients were younger (60 vs. 63 years old	Stroke and malignancy	Diabetes, hyperlipidemia, asthma, and obstructive sleep apnea	Non-obese (LOS)= 5.9±6.5 and in obese (LOS)= 6.5±7.3	Mortality up to 30 days in non-obese= 36.9%, while in obese= 30.3%
Lang *et al.*[15]	A prospective multicentre study	1306	≥ 85 years	Acute myocardial infarction, cancer, and pulmonary disease	DM, Chronic heart diseases, and renal disease	Not-reported	Mortality at 30 days hazard ratio HR (in 25≤BMI<30) =0.9, while in BMI≥30= 0.8
Arabi *et al.*[12]	A retrospective cohort study	8670	62 years	Not-reported	DM and renal diseases	Not-reported	Mortality rate in BMI< 18.50= 52%, in BMI (18.50 to 24.99) = 44.2%, in BMI (25.0 to 29.99) = 41.1%, in BMI (30.0 to -39.99) =39%, in BMI (≥ 40) =33.5%
Pickkers *et al.* [21]	An observational Cohort Study	154308	62.0	Nonsurgical and Surgical causes		In BMI (30-34.9) = 1.5, in BMI (35_39.9) = 1.7, and in BMI (>40) = 1.2	In BMI (30-34.9) =12.4, in BMI (35_39.9) = 12.4, and in BMI (>40) =12.0
Abhyankar *et al.* [13]	A cohort study	16,812	65.9	Stroke	DM and HTN	In BMI (< 18.5) = 2.3, in BMI (18.5 to < 25) = 2.3, in BMI (25 to < 30) = 2.3, in (BMI ≥ 30) = 2.3	In BMI (< 18.5) = 18.8%, in BMI (18.5 to < 25) =14.6%, in BMI (25 to < 30) =10.4%, (BMI ≥ 30) = 10.4%
Sakr *et al.* [23]	A retrospective cohort study	3902	64.3 ± 15.7	Mechanical ventilation	Diabetes mellitus and heart failure (NYHA III-IV)	In underweight= 2, in normal BMI =3, in overweight =3, in obese= 3, and in morbidly obese= 5	In underweight= 24.5%, in normal BMI = 22%, in overweight =18.8%, in obese= 17.5%, and in morbidly obese= 25.7%
Gupta *et al*.[20]	A retrospective, single-institution, observational study	1792	65.9 ± 12.6	Not-reported	Not-reported	In normal BMI =6.6, in overweight =6.4, in obese I =6.2, in obese II = 7.8, in obese III= 9.4	In normal= 10.4%, in overweight= 7.9%, in obese I =7.4%, in obese II = 14.3%, in obese III =6.8%
King *et al.* [14]	A cohort study	18,746	67.5	Stroke	Diabetes	Not-reported	Mortality rate at 30-days post admission in underweight= 19.1%, in normal = 13.2%, in overweight= 10.5%, in obese= 7.7%, in morbidly Obese= 7%
Choi *et al.* [11]	A cohort study	224	In morbidly Obese=58.9 ± 6.4, and in non–morbidly= 59.0 ± 7.0	Not-reported	DM and HTN	In morbidly obese= 5.2 ±4.7 and in non–morbidly obsess=3.3 ± 1.8	30-day mortality rate in morbidly obese= 1.8% and in non–morbidly obese=0.6%

Goh *et al*. [6]	A retrospective cohort study	1146%	2–18 years	Not-reported	Cardiological causes	Not-reported	In normal weight =70%, in overweight =16.2%, and in obese=6.9%, in severely obese=6.9%
Hutagalung *et al*. [30]	A prospective, retrospective cohort study.	12,938	62.9 ± 14.3	Surgical, emergencies	Diabetes mellitus	Not-reported	In underweight =9.8%, in normal= 6.3%, in over weight= 5.4%, in obese= 5.7%, in very obese= 8.6%
Martino *et al*. [18]	A multicenter international observational study	8,813	60.2 ± 17.4	Sepsis	Cardiovascular	In normal =10.7, in overweight= 11.0, in obese= 11.5	60-days mortality in normal= 28.9%, in overweight= 24.9%, obese =23.1%
Le-Bert *et al*.[7]	A retrospective cohort study	396	76.9±4.5	Emergent surgery and cardiogenic shock	Diabetes mellitus	In normal= 90 hours, in over weight= 73 hours, in obese = 75 hours	In normal = 8%, in over weight =4.2%, in obese 4.3%
Lim *et al*. [8]	A retrospective cohort study	471	62±16	Not-reported	DM	In underweight= 12±17, in normal= 11±18, in over weight/obeys= 8±9	In underweight= 27%, in normal= 19%, in over weight/obese= 14%
Engel *et al*. [9]	A cohort study	10,590	66.2 ± 10.6	Emergent and urgent procedure status	DM	In underweight= 75.8±168.4, in normal= 44.7 ±90.2, in obese = 41.4 ± 90.0, in morbidly obese =47.5 ± 74.6	In underweight= 7%, in normal= 2%, in obese= 2%, in morbidly obese= 1%
Sakr *et al*. [25]	A prospective, multi center, observational study	2,878	58.4 ± 19.1	Sepsis	DM	In underweight= 2.8, in normal= 3.1, in overweight= 3.1, in obese= 3.6, in very obese= 4.1	In underweight= 19.2%, in normal BMI=17.9%, in overweight= 7.3%, in obese= 19.8%, in very obese= 19.8%
Pieracci *et al*.[10]	A cohort study	946	63.3 ±19.0	Not-reported	Not-reported	In underweight=12.7, in normal= 12.8, in overweight= 11.6, in obese= 15.7, in very obese= 18.8	In underweight= 22.6%, in normal= 17%, in overweight =11.2%, in obese=14.4%, in very obese=13.6%

DISCUSSION

Overweight and obese patients showed a clear survival benefit in terms of reduced risk of death in the ICU. These results agree with the finding of a new meta analysis [26] in which an approach to augment effect in overweight and obese patients in comparison with those with normal BMI was evident. The outcome of obesity may rely on the mixed case in the ICU. **Nasraway *et al*.**[27] found that morbid obesity was an autonomous hazard factor for death in these patients. The understanding of these outcomes might be constrained by the sample size in this study. In acute ill traumatized patients, **Bochicchio *et al*.**[28] announced that obese patients were 7.1 times more likely to die than non-obese patients subsequent changing.

Some limitations in this review. In the first place, body weight and height were not reliably measured. This imprecision is very normal, and most ICU specialists will recognize that weight and height are regularly evaluated instead of measured. Second, body weight at the season of ICU affirmation might be significantly unique in relation to a patient's ordinary body weight in view of volume depletion or overload; recent changes in BMI could not be taken into account and may have played a role in determining outcomes. These results are not easy to evaluate and modify for, even in tentatively outlined examinations. Third, we can't decide what number of the obese patients were admitted to the ICU since they were obese, and would not have required affirmation if their BMI had been normal.

Additionally, we can't decide if the more ICU remains in extremely obese patients were identified with continuous illness or calculated difficulties, with release identified with their high BMI. Several methodological issues may help to explain the discrepant literature regarding this relationship. That includes conflicting operationalization of the BMI variable. Some studies have considered BMI as continuous, according to percentile, by dichotomization around 27 kg/m^2, 30 kg/m^2, and 40 kg/m^2, by comparison of obese patients to normal weight patients, by comparison of morbidly obese patients to non-obese patients [(26)], and by grouping into four, five , and six categories, using variable cutoff points. As a result of such an error, elective clarifications must be considered. Variations in study populations with respect to demographics, acuity, or duration of ICU admission may influence baseline risk of adverse outcomes with respect to BMI **[(2)]**.

The studies found that acute sick patients have a higher level of recently framed, smaller adipocytes contrasted with sound controls **[(26)]**, and these adipocytes contain substantial collections of alternatively activated M2 macrophages that produce higher levels of a number of anti-inflammatory agents that increase insulin sensitivity and augment healing of wounds. Human macrophages have been appeared to switch between the M1 and M2 phenotypes in acute morbidity, so maybe one approach by which overweight and obesity are defensive against acute sickness may be a switch from M1 proinflammatory activation to replace M2 anti-inflammatory activation in the many macrophages that are now found in their adipose tissue contrasted with normal-weight individuals **[(29)]**. Although ordinary weight people have sufficient nutritional supply to satisfy daily metabolic needs, they might not have the stores important to assure organ performance during a period of fundamentally expanded metabolic request, like, acute morbidity. The necessity of nutritional intake for acute sick patients, and they discover that the benefit of elevated nutrition happened primarily in under- and normal-weight patients and a smaller percent of average weight people. Finally, variations in ICU practice may mediate the relationship between obesity and adverse outcomes during critical illness. For example, **Bochicchio *et al*.**[(28)] found that, despite similar acuity, obese trauma patients had a significantly increased number of ventilator-, urinary catheter-, and central venous catheter-days as compared to non-obese.

CONCLUSION

The predominance of weight has been consistently expanding around the world, and obesity itself is viewed as an interminable illness and additionally a noteworthy general medical issue. However, not very many information is accessible on the relationship amongst BMI and basic care result. Additionally, examine is expected to recognize vital associates of basic care in relationship to BMI with the goal that this data can be utilized to nurture patients and enhance results. BMI demonstrated no noteworthy effect on bleakness or mortality in basically sick patients. Mortality in basic care was related with seriousness of sickness at affirmation and ICU-related intricacies.

CONFLICT OF INTERESTS

The authors stated that no financial support was received and no conflict of interests

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