Body Mass Index and Surgical Outcome in a Puerto Rican Population

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Objectives: To determine the impact of body mass index (BMI) on postoperative morbidity and 30-day mortality in the population served by the University of Puerto Rico (UPR)-affiliated hospitals.

Methods: We reviewed the surgical data entered into the UPR General Surgery Department database from January 1, 2014, through June 30, 2016. This database collects patient and procedural information from the UPR-affiliated hospitals. We compared the postoperative morbidity and 30-day mortality rates of 5 different BMI groups: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obese, classes I and II (30–39.9 kg/m^2), and morbidly obese (≥40 kg/m^2). Multivariable regression analyses, adjusted for age, gender, and surgery type, were used to evaluate the risks for each BMI category.

Results: Information on 9,856 patients was reviewed. The mean age of the sample population was 52 (±20) years; 57% were women and 43% were men. The postoperative morbidity and 30-day mortality rates of the underweight group were significantly higher than those of the normal-weight group (6.1% vs. 3.1% and 2.1% vs. 0.5%, respectively; p<0.001). The morbidly obese also had significantly higher (p<0.001) postoperative morbidity (5.3% vs. 2.1%) and 30-day mortality rates (2.7% vs. 0.5%) compared to normal-weight patients. The odds of 30-day mortality were significantly higher for the underweight (odds ratio [OR], 5.64; 95% confidence interval [CI], 2.47–12.92) and morbidly obese patients (OR, 7.23; 95% CI, 3.01–17.39). The overweight patients had no increased risk, and the obese patients had a slight increase in morbidity (OR, 1.54; 95% CI, 1.08–2.21) but no significant increase in 30-day mortality (p>0.05).

Conclusion: Patients at the extremes of the BMI have more postoperative complications and higher 30-day mortality rates than do patients with mid-range scores. [*P R Health Sci J 2018;37:165-169*]

Key words: Body mass index, Surgical morbidity, Surgical mortality

In the literature, the reports regarding how body mass index (BMI) might affect surgical outcomes are often conflictive (1–3). Often described is the so-called obesity paradox, which has been suggested as being linked to improved surgical outcomes for obese individuals (4–6).

A recent study evaluating BMI and mortality following cardiac surgery reported that overweight and obese patients had lower mortality rates and fewer adverse perioperative outcomes than did normal-weight patients (7). Though the exact mechanism of this paradox remains unknown, two of the mechanisms that have been proposed to lead to improved survival in obese patients are high metabolic reserves and body fat (8–9). However, very large studies using the database of the American College of Surgeons National Surgical Quality Improvement Program currently indicate that underweight (BMI<18.5 kg/m^2) and morbidly obese (BMI ≥ 40 kg/m^2) patients experience higher perioperative morbidity and mortality rates than do patients with normal BMIs (10–11). It appears that patients at the extremes of the BMI, particularly the underweight, have more postoperative complications. Those patients who, at the time of surgery, have BMIs that range from 18.5 to 39.9 kg/m^2 (normal weight, overweight, and class 1 or class 2 obesity) tend to have outcomes that are without complications or mortality (11).

Studies on the relationship between BMI and surgical outcome have not been performed on any Puerto Rican populations. Currently, the prevalence of overweight and obesity in the general population of Puerto Rico (12) is 66%, which is

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very close to the reported 71% prevalence in the population of the United States (13). Using the information collected in the Surgery Database of the University of Puerto Rico (UPR), we sought to assess the impact of BMI on surgical outcome.

Methods

We reviewed all the cases entered into the database of the UPR Department of General Surgery from January 1, 2014, through June 30, 2016, to analyze the impact of BMI on postoperative morbidity and mortality. This database compiles (by case) the basic demographic information and clinical data of each patient recorded there. It collects information from the surgical services of the UPR-affiliated hospitals (6 participating hospitals: 2 in academic centers and 4 that are community hospitals). The information obtained comes from the weekly reports generated by the residents of the different participating surgical services at the aforementioned hospitals. The data from those reports are extracted and compiled, creating an aggregate of information that describes the general surgical procedures performed at the affiliated institutions as well as characterizing the patients on whom those procedures were performed. Personal identifiers are not included in the aggregated data. For each patient, the following information is collected into the database: age, gender, BMI, and American Society of Anesthesiologists (ASA) physical status classification; the surgical procedure(s) received; and the surgical outcome(s) in terms of both morbidity and 30-day postoperative mortality. Compliant with the Health Insurance Portability and Accountability Act (HIPAA), this database of surgical procedures is both secure and confidential.

For our study the patients were grouped according to their BMIs into 5 categories, following the World Health Organization (WHO) classification (14). The categories were underweight (BMI<18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), obese (classes I and II) (BMI 30–39.9 kg/m^2), and morbidly obese (class III obesity) (BMI ≥ 40). For each group we evaluated the percentage of cases with an American Society of Anesthesiology (ASA) physical status classification of 3 or greater, which level of classification indicates the presence of severe systemic disease (prior to surgery). The ASA score was used as a measure of preoperative health status.

The study's aim was to analyze the relationship between BMI and postoperative morbidity and 30-day surgical mortality. To accomplish this, we compared the normal-weight BMI group (used as the reference group) with the other BMI groups, regarding postoperative morbidity, 30-day mortality, and overall adverse surgical outcome (morbidity and mortality combined).

Statistical analyses were performed with the software program SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, version 22.0. Armonk, NY: IBM Corp). Quantitative variables were expressed as means plus or minus standard deviations. Categorical variables were presented as frequencies and percentages. Differences between proportions were compared using the chi-squared test. Multivariable logistic regression analyses, adjusted for age, gender, and surgery type, were used to evaluate (for each BMI category) postoperative morbidity, 30-day mortality, and overall adverse surgical outcome risks. Results were considered significant when the p-value was less than 0.05.

This database was reviewed and approved by the Institutional Review Board (IRB) of the University of Puerto Rico Medical Sciences Campus.

Results

During the 2-and-a-half-year period of our study, the database of the UPR General Surgery Department collected information on 9,856 general surgical cases. The mean age of the group was 52 (±20) years. The gender distribution indicated that 57% were women and 43% were men. A normal-range BMI was present in 26.5% of the surgical population. By contrast, 42.3% were overweight and 23.3% were obese (class I or II), together representing the majority of the group. Underweight patients represented 4.0% and the morbidly obese (obesity class III) 3.8% of the surgical cases. The distribution of the BMI categories in our study is illustrated in the pie chart in Figure 1.

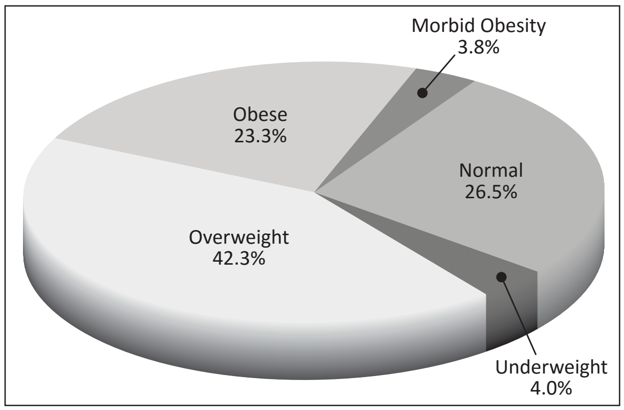

Figure 1. BMI distribution in the surgical population studied.

Compared with patients who had normal BMIs, the ones classified as overweight did not have significantly different outcomes regarding postoperative morbidity and 30-day mortality (Tables 1 and 2). The obese group had a slightly higher odds ratio of having a postoperative morbidity (OR, 1.54; 95% CI, 1.08–2.21), but did not have a significantly higher 30-day mortality rate (p>0.05).

Multivariable regression analysis, adjusting for age, gender, and surgery type, demonstrated that underweight and morbidly obese patients had poor outcomes (Tables 1 and 2). When the variables morbidity and 30-day mortality were combined to describe overall adverse surgical outcomes, we confirmed that the odds of an adverse outcome were much higher for the underweight (OR, 3.39; 95% CI, 2.21–5.22) and the morbidly obese patients (OR, 3.86; 95% CI, 2.44–6.11), as shown in Table 3.

Table 1. Postoperative morbidities of the different BMI groups.

	Group Total n	Morbidity n (%)	*P*	Odds Ratio	95% CI
Normal BMI 18.5–24.9 kg/m^2	2615	55 (2.1%)	---	---	---
Underweight BMI<18.5 kg/m^2	393	24 (6.1%)	<0.001	2.65	1.61, 4.37
Overweight BMI 25.0–29.9 kg/m^2	4171	81 (1.9%)	0.99	0.99	0.71, 1.42
Obese BMI 30.0–39.9 kg/m^2	2299	70 (3.1%)	0.02	1.54	1.08, 2.21
Morbidly Obese BMI ≥ 40 kg/m^2	378	20 (5.3%)	<0.001	2.94	1.72, 5.01
Total	9856	250 (2.5%)	---	---	---

Table 2. Surgical 30-day mortalities of the different BMI groups.

	Group Total n	30-day Mortality n (%)	*P*	Odds Ratio	95% CI
Normal BMI 18.5–24.9 kg/m^2	2615	12 (0.5%)	---	---	---
Underweight BMI<8.5 kg/m^2	393	12 (3.1%)	<0.001	5.64	2.47, 12.92
Overweight BMI 25.0–29.9 kg/m^2	4171	14 (0.3%)	0.61	0.82	0.38, 1.78
Obese BMI 30.0–39.9 kg/m^2	2299	16 (0.7%)	0.28	1.51	0.71, 3.24
Morbidly Obese BMI ≥ 40 kg/m^2	378	10 (2.7%)	<0.001	7.23	3.01, 17.39
Total	9856	64 (0.6%)	---	---	---

The ASA physical status classification, used as a measure of preoperative health status, indicated that the patients at the extremes of the BMI seemed to have severe systemic disease more frequently than their counterparts did when any of those patients came in for surgery. Underweight (OR, 1.76; 95% CI, 1.39–2.23) and morbidly obese patients (OR, 3.87; 95% CI, 3.06–4.89) had higher risks of having an ASA of 3 or more when presenting for surgery (Table 4).

Discussion

Our study found that patients who were underweight (<18.5 kg/m^2) and patients who were morbidly obese (≥ 40 kg/m^2) had significantly higher postoperative morbidity and 30-day mortality rates than did their non–extreme-range counterparts. Regarding 30-day mortality following surgery, patients in the underweight group had an odds ratio of 5.64 (95% CI, 2.47–12.92); for morbidly obese patients, that odds ratio was 7.23 (95% CI, 3.01–17.39).

The prevalences of overweight and obesity have been steadily increasing, both in the United States and in Puerto Rico (12–13). Although some reports indicate an increase in the odds of wound complications for overweight and obese (11) patients, an adverse effect of obesity on surgical outcome is statistically significant only in the morbidly obese (WHO, class III obesity) with a BMI greater than or equal to 40 kg/m^2 (2). Lesser degrees of obesity do not seem to have a significant effect on postoperative morbidity or 30-day mortality (3–6). Large-scale studies using the database of the American College of Surgeons National Surgical Quality Improvement Program have helped to provide this information in the United States (10–11).

However, there has been a growing debate in recent years on whether there is a possible need to develop different BMI cut-off points for different ethnic groups. Though the BMI values are age-independent and are the same for both genders, they may not correspond to the same degrees of fatness, because of the different body proportions found in some ethnic groups. In Asian and Pacific populations, attempts have been made to change the interpretation of BMI cut-offs (15–17). Our study found that the effect of BMI on surgical outcomes in the Puerto Rican group studied and the effects of such outcomes in North American

Table 3. Overall adverse surgical outcomes (morbidity and mortality combined).

	Group Total n (%)	Adverse Outcome n (%)	*P*	Odds Ratio	95% CI
Normal BMI 18.5–24.9 kg/m^2	2615	67 (2.6%)	---	---	---
Underweight BMI<8.5 kg/m^2	393	36 (9.2%)	<0.001	3.39	2.21, 5.22
Overweight BMI 25.0–29.9 kg/m^2	4171	95 (2.3%)	0.84	0.97	0.71, 1.33
Obese BMI 30.0–39.9 kg/m^2	2299	86 (3.7%)	0.01	1.55	1.12, 2.16
Morbidly Obese BMI ≥ 40 kg/m^2	378	30 (8.0%)	<0.001	3.86	2.44, 6.11
Total	9856	314 (3.2%)	---	---	---

Table 4. Frequency of a preoperative ASA ≥ 3 in the groups.

	Group Total n	ASA ≥ 3 n (%)	Odds Ratio	95% CI
Normal BMI 18.5–24.9 kg/m^2	2615	634 (24.4%)	---	---
Underweight BMI<18.5 kg/m^2	393	136 (34.6%)	1.76	1.39, 2.23
Overweight BMI 25.0–29.9 kg/m^2	4171	820 (19.8%)	0.76	0.67, 0.86
Obese BMI 30.0–39.9 kg/m^2	2299	600 (26.2%)	1.21	1.05, 1.38
Morbidly Obese BMI ≥ 40 kg/m^2	378	167 (44.7%)	3.87	3.06, 4.89
Total	9856	2357 (23.9%)	---	---

populations were not significantly different. In our study we found that patients at the extremes of the BMI had more postoperative complications and higher 30-day mortality rates. Patients with BMIs from 18.5 to 39.9 kg/m^2 fared well with regard to complications and mortality.

We selected the ASA physical status scale from the available variables in the Surgery Database as an estimate of each patient's preoperative health status. This scale (18) uses the following classification: I (normal healthy patient), II (patient with mild systemic disease), III (patient with severe systemic disease), IV (patient with severe systemic disease that is a constant threat to life), and V (moribund patient who is not expected to survive without the operation). The ASA physical status scale has demonstrated validity (19) as a marker of patient preoperative health status and has even been used as an indicator of perioperative risk and as an important element of a surgical mortality probability model (20). In our study, multivariate regression analysis demonstrated that the odds of an underweight (OR, 1.76; 95% CI, 1.39–2.23) or morbidly obese (OR, 3.87; 95% CI, 3.06–4.89) patient presenting with an ASA of 3 or higher are both relatively high.

The important public health implication of our findings is that weight management is a critical part of preventive medicine, and if such management is neglected, we may face higher medical expenses in terms of treating the attendant complications.

Among the limitations of our study is that the groups we used to draw conclusions (underweight and morbidly obese) included 4.0% (395 cases) and 3.8% (378 cases) of the 9,856 patients in the sample, which may be too small a sample from which to draw conclusions.

Another limitation is that our database obtained information from only the UPR-affiliated hospitals in Puerto Rico, a total of 6 participating hospitals (2 academic centers and 4 community hospitals). These data do not, however, comprehensively encompass our general population. Nonetheless, this study suggests that patients at the extremes of the BMI (either underweight or morbidly obese) are at a higher risk of postoperative morbidity and 30-day mortality than are patients not falling within either of those extremes.

Conclusion

Patients at the extremes of the BMI have more postoperative complications and higher 30-day mortality following general surgery than do those patients whose BMIs fall within the so-called normal range. This Puerto Rican group had findings similar to those of North American populations.

Resumen

Objetivo: Evaluar la relación entre índice de masa corporal (IMC) y morbilidad/mortalidad postoperatoria en los hospitales afiliados a la Universidad de Puerto Rico (UPR). Métodos: Examinamos los datos entrados a la base de datos del Departamento de Cirugía General de la UPR entre 1/1/2014 y 6/30/2016. Esta contiene información sobre cirugías realizados por los hospitales afiliados a la UPR. Comparamos morbilidad postoperatoria y mortalidad a 30 días entre cinco grupos: bajo peso (<18.5 kg/m^2), normo-peso (18.5-24.9 kg/m^2), sobrepeso (25.0-29.9 kg/m^2), obeso-clase, I-II (30-39.9 kg/m^2) y obeso mórbido (≥40 kg/m^2). Análisis de regresión, ajustado por edad, género y tipo de cirugía, fue utilizado. Resultados: Se evaluó la información de 9,856 pacientes. La edad media de los pacientes fue de 52±20, con una distribución por género de 57% mujeres y 43% hombres. Al comparar el grupo bajo peso con el grupo de peso normal, la morbilidad postoperatoria (6.1% vs. 2.1%) como la mortalidad a 30 días (3.1% vs. 0.5%) fueron significativamente (p<0.001) más altas. Los obesos mórbidos también mostraron una morbilidad postoperatoria (5.3% vs. 2.1%) y mortalidad a 30 días (2.7% vs. 0.5%) significativamente (p<0.001) mayor que los de peso normal. El riesgo de muerte a 30 días fue significativamente mayor en bajo peso (RM 5.64; 95% IC 2.47-12.92) y en obesidad mórbida (RM 7.23; 95% IC 3.01-17.39). El sobrepeso no causó un riesgo mayor, y la obesidad solo causó un pequeño aumento en la morbilidad (RM 1.54; 95% IC 1.08-2.21). Conclusion: Los pacientes en los extremos del IMC tienen más complicaciones postoperatorias y más mortalidad a 30 días.

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