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ORIGINAL CONTRIBUTIONS

Bariatric Surgery, Clinical Outcomes, and Healthcare Burden in Hispanics in the USA

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Abstract

Introduction/Purpose Bariatric surgery (BS) has emerged as a cornerstone procedure to prevent and treat obesity-related comorbidities. As the Hispanic population continues to grow in the USA, their importance to the healthcare system cannot be understated. We aimed to assess the use of BS and related healthcare outcomes in Hispanics using a national database.

Materials and Methods Case-control study using the 2010 to 2014 National Inpatient Sample datasets. BS use in Hispanics compared to non-Hispanics was the primary outcome. Secondary outcomes included inpatient mortality, morbidity, resource use, length of hospital stay, hospital costs, and total hospitalization charges. Propensity scores were used to match Hispanic patients with BS with non-Hispanic patients with BS using sex, age, and Charlson Comorbidity Index as covariates. A multivariate model was then used to adjust for additional confounding factors.

Results From the 105,435 patients who underwent BS, a propensity-matched cohort of 20,440 was created (10,945 Hispanics). Mean (SD) age was 45 (17.2) years, and 73,594 (69.8%) were women. The prevalence of BS in Hispanics was 21/100,000 persons (281/100,000 admissions) compared to 36/100,000 persons (337/100,000 admissions) for non-Hispanics. On multivariate analysis, Hispanics displayed adjusted propensity-matched odds of 0.88 of having BS ($P < 0.01$). No differences were seen in the surgical approach performed. Hispanics and non-Hispanics had similar mortality, morbidity, hospital length of stay, and costs.

Conclusion Despite higher obesity rates, the use of BS is lower in Hispanics. For those who underwent BS, no difference in clinical outcomes and minor differences in resource use were observed.

Keywords Bariatric surgery · Ethnic disparities · Obesity · Outcomes research

Introduction

Hispanics are disproportionately affected by extreme obesity and associated comorbidities [1]. In 2003, Hispanics became the largest ethnic minority in the USA, surpassing African Americans (18.1% vs 13.4% of the total population according to the National Census, respectively) [2, 3]. Furthermore, the Hispanic population continues to grow faster than any other ethnic group in the USA, for which its importance to the healthcare system cannot be understated.

Bariatric surgery (BS) is now a well-established treatment with proven efficacy in weight reduction; improved management of diabetes mellitus, hypertension, and steatohepatitis; and reduced rates of other obesity-related adverse effects, even long-term mortality [4]. Disparities in access to BS have been reported in different ethnic minorities in the USA [5, 6].

There is conflicting evidence on how ethnicity affects BS acceptance, clinical outcomes, adverse effects, healthcare utilization, and economic impact. Most studies suggest decreased BS use and decreased response to treatment in ethnic minorities [7, 8]; however, a study published in 2015 showed no ethnic differences in patients who underwent BS after adjusting for multiple socioeconomic factors [5]. Among those who underwent surgery, comorbidity burden was comparable between all ethnic minorities and white patients [5].

To date, no national study has examined the effect of Hispanic ethnicity in the use of BS, clinical outcomes, and economic implications. For this reason, we aimed to explore

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the use of BS among Hispanics in the USA, as well as several outcomes (i.e., inpatient mortality, morbidity, resource utilization and inpatient economic burden) using a national database.

Materials and Methods

Study Design and Data Source

We performed a cross-sectional analysis of the National Inpatient Sample (NIS), a database developed and overseen by the Healthcare Cost and Utilization Project (HCUP), which is sponsored by the Agency for Healthcare Research and Quality (AHRQ) under the US Department of Health and Human Services. The NIS is the largest publically available, inpatient, all-payer database in the USA. The examined datasets for the years 2010 to 2014 contain data from January 2010 to December 2014 on more than 35 million inpatient admissions. These admissions are a 20% stratified sample of over 4000 nonfederal acute care hospitals from more than 40 states and are representative of 95% of hospital discharges nationwide [9].

The NIS provides a principal diagnosis, defined as the primary discharge diagnosis, as well as 24 other secondary diagnoses in the dataset. The dataset also includes codes for up to 15 procedures performed during the hospital stay. It allows determining the length of hospital stay, hospitalization costs, and total hospitalization charges [10] and permits calculations of inpatient disease prevalence, which is the relative frequency of a condition coded as a discharge diagnosis.

Patient Population

All patients with *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) procedural code for BS (i.e., 43.89, 44.95, 44.93, 44.69, 44.68, 45.91, 44.93, 45.51, 44.39, 43.7, 44.38, and 44.95) were

Table 1 Comparison of patient characteristics between Hispanics and non-Hispanics (pre-matching)

Characteristic[a]	Hispanics (*n* = 92,025)	Non-Hispanics (*n* = 371,464)	*P* value
Age, mean (SD)	45.3	50.8	< 0.01
Sex, female, no. (%)	69.5	69.4	0.93
Income in zip code, USD, %			< 0.01
1–37,999	31.8	23.8	
38,000-47,999	23.4	26.5	
48,000-63,999	25.2	26.5	
> 64,000	19.7	23.3	
Insurance, %			< 0.01
Medicare	20.6	29.5	
Medicaid	23.6	10.4	
Private	49.7	56.2	
Self-pay	6.1	3.9	
CCI score, %			< 0.01
0	46.4	43.8	
1–2	40.7	42.3	
> 3	12.9	13.9	
Weekend admission, %	5.9	5.9	0.97
Hospital region, %			< 0.01
Northeast	25.9	22.6	
Midwest	8.2	23.9	
South	32.8	37.2	
West	33.1	16.5	
Urban location, %	98.5%	94.3%	< 0.01
Hospital size, %			0.02
Small	18.9	16.1	
Medium	22.2	27.5	
Large	58.9	56.4	
Hospital teaching status, %	60.0%	60.1%	0.96

CCI Charlson Comorbidity Index, *USD* US dollar

[a] Pre-Matching

included in the study. Patients were stratified by different surgery subtypes by associating additional ICD-9-CM codes. Only patients under 18 years of age were excluded.

Definition of Variables

Effect-modifying variables were classified as patient characteristics (i.e., age, sex, ethnicity, insurance status, income in patient zip code) and hospital characteristics (i.e., region, urban location, teaching status, number of beds). According to the US Census Bureau, the USA is divided into four distinct geographic regions: Northeast, South, Midwest, and West. Data from every patient's vital status at the end of hospitalization, length of hospital stay measured in days, hospital costs, and total hospitalization charges were extracted from the dataset. The Deyo adaptation of the Charlson Comorbidity Index, a validated tool for dataset analysis, was used to control for existing comorbidities [11].

Outcomes

The primary outcome of this study was the general and inpatient prevalence of BS in Hispanic patients when compared to patients of other ethnicities (non-Hispanic). Furthermore, odds of BS use were stratified by all effect-modifying variables (i.e., patient and hospital characteristics). Secondary outcomes were inpatient mortality, morbidity (i.e., shock, multiorgan failure, intensive care unit stay, and total parenteral nutrition [TPN] use), imaging use (i.e., abdominal ultrasound, abdominal computed tomography, and endoscopic retrograde cholangiopancreatography), surgeries performed, length of hospital stay, hospitalization charges, and hospital costs. Hospitalization charges correspond to the financial resources billed by the institution, while hospital costs are the net amount of money invested by the institution in patient care. The HCUP provides cost-to-charge ratios for each admission, which is multiplied by the total charges to obtain costs. Both costs and charges were adjusted for inflation using the Consumer Price Index.

Table 2 Comparison of patient characteristics between Hispanics and non-Hispanics

Characteristic	Hispanics ($n = 92{,}025$)	Non-Hispanics ($n = 371{,}464$)	*P* value
Age, mean (SD)	45.5 (17.1)	46.0 (17.3)	< 0.01
Sex, female, no. (%)	64,233 (69.8)	252,967 (68.1)	0.37
Income in zip code, USD, %			< 0.01
1–37,999	37.1	23.5	
38,000–47,999	27.0	27.5	
48,000–63,999	21.6	28.0	
> 64,000	14.3	20.1	
Insurance, %			0.12
Medicare	21.7	21.1	
Medicaid	28.8	29.4	
Private	45.0	44.6	
Self-pay	4.5	4.9	
CCI score, %			0.19
0	43.3	44.9	
1–2	42.2	39.3	
> 3	13.5	15.8	
Weekend admission, %	5.8	7.3	0.11
Hospital region, %			0.01
Northeast	24.5	23.8	
Midwest	6.6	6.8	
South	33.4	34.1	
West	35.5	35.4	
Urban location, %	99.5	95.1	< 0.01
Hospital size, %			0.26
Small	25.6	24.3	
Medium	23.3	29.9	
Large	51.1	45.8	
Hospital teaching status, %	76.7	73.8	0.50

Post-matching

CCI Charlson Comorbidity Index, *USD* US dollar

Statistical Analysis

Discharge-level weights published by the HCUP were used to estimate the number of patients undergoing BS. Fisher's exact test was used to compare proportions and Student's *t* test was used to compare means. Propensity score was used to create two matching cohorts in patients who underwent BS: Hispanics and non-Hispanics. Table 1 shows the baseline characteristics of the cohorts before matching, while Table 2 shows the baseline characteristics after matching. A multivariate regression model was created to calculate propensity scores with the following covariates: sex, age, Charlson Comorbidity Index, insurance status, median income in the patient's zip code, and hospital region, urban location, number of beds, and teaching status. Population estimates were obtained from the National Census Bureau. All statistical analyses were conducted using STATA, Version 13 (StataCorp LLC).

Results

A total of 666,854 patients underwent BS during the study period: 463,464 (69.5%) were white; 98,694 (14.8%), African-American; 92,025 (13.8%), Hispanic; and 12,670 (1.9%), other. A propensity-matched cohort of 20,440 patients was created, of which 10,945 were Hispanics. Mean (SD) patient age was 45 (17.2) years, and 73,594 (69.8%) were women. The prevalence of BS in Hispanics was 21/100,000 persons (281/100,000 admissions) compared to 36/100,000 persons (337/100,000 admissions) for non-Hispanics (Fig. 1) [12].

On multivariate analysis, Hispanics displayed adjusted propensity-matched odds of 0.88 ($P < 0.01$) of having BS when compared to non-Hispanic, but there was no difference in odds of specific subtype of surgery. All outcomes are displayed in Tables 3 and 4.

Secondary Outcomes

Hispanics undergoing BS did not display different mortality, morbidity, or hospital length of stay compared to non-Hispanics (Tables 3 and 4). Likewise, there was no difference in subtype of BS performed when compared to non-Hispanics. However, on sub-stratification for surgery type, Hispanic patients undergoing RYGB did display increased odds of undergoing CT abdomen and additional adjusted hospital costs, charges, and length of hospital stay compared to non-Hispanics. Hispanic patients who underwent sleeve gastrectomy displayed decreased odds of TPN and multiorgan failure, while having increased odds of undergoing abdominal ultrasound when compared to non-Hispanics (Tables 3 and 4).

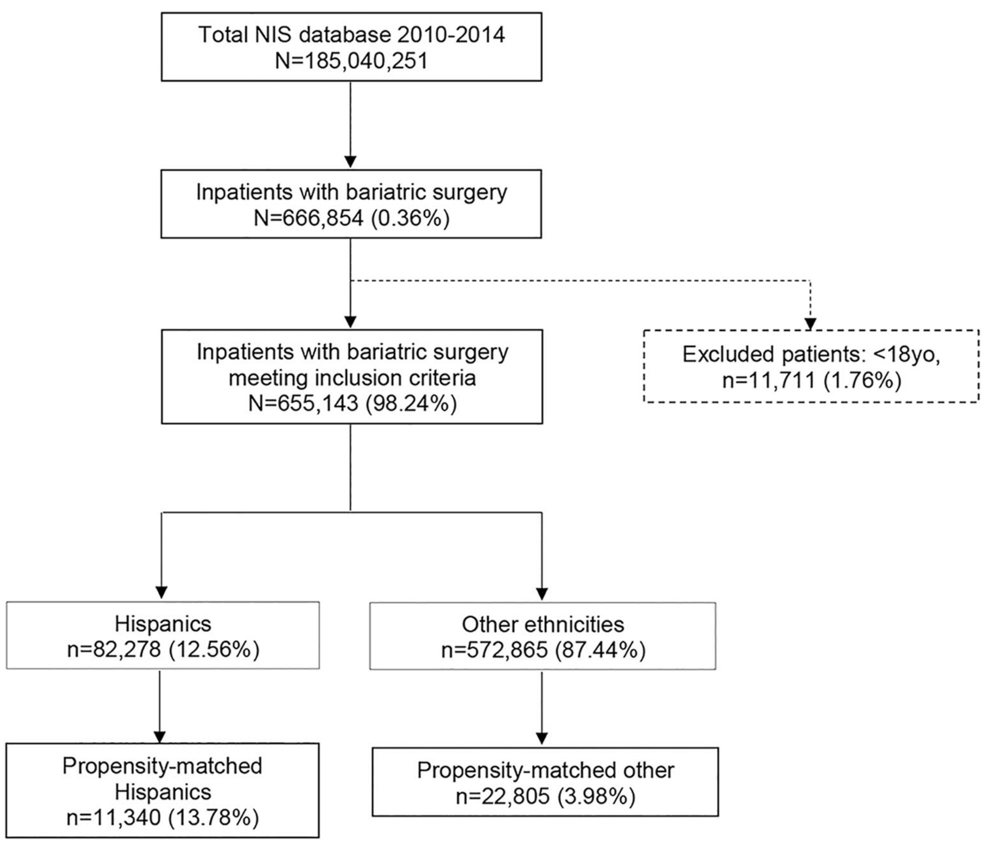

Fig. 1 Patient study selection and matching. NIS, National Inpatient Sample; yo, years old

Table 3 Outcomes and healthcare utilization of bariatric surgery in Hispanics

Variable	Adjusted odds ratio	95% CI	*P* value
Bariatric surgery overall	0.88	0.78–0.99	0.03
RYGB	0.97	0.82–1.14	0.71
Sleeve gastrectomy	0.84	0.52–1.36	0.49
Band	0.93	0.65–1.33	0.68
Mortality	1.01	0.56–1.82	0.97
RYGB	1.24	0.92–1.68	0.16
Sleeve gastrectomy	0.68	0.43–1.09	0.11
Shock	0.65	0.44–0.97	0.13
RYGB	1.16	0.91–1.48	0.22
Sleeve gastrectomy	0.79	0.57–1.10	0.17
ICU	0.86	0.64–1.15	0.32
RYGB	1.17	0.98–1.39	0.07
Sleeve gastrectomy	0.80	0.60–1.07	0.13
TPN	0.87	0.64–1.20	0.40
RYGB	1.02	0.86–1.22	0.81
Sleeve gastrectomy	0.67	0.48–0.94	0.02
Abdominal CT	2.55	0.84–7.77	0.09
RYGB	2.49	1.60–3.89	< 0.01
Sleeve gastrectomy	1.54	0.59–4.02	0.37
Abdominal ultrasound	2.31	0.85–6.32	0.10
RYGB	1.05	0.68–1.66	0.80
Sleeve gastrectomy	2.58	1.43–4.63	< 0.01
Multiorgan failure	0.83	0.63–1.10	0.19
RYGB	1.09	0.93–1.29	0.28
Sleeve gastrectomy	0.74	0.57–0.95	0.02

CT computed tomography, *ICU* intensive care unit, *RYGB* Roux-en-Y gastric bypass, *TPN* total parenteral nutrition

Discussion

Our study suggests that Hispanics are less likely to undergo BS in the USA. The NIS is the largest inpatient database available in the country, with representation of 20% of all hospitalizations, stratified by geographic location, thus reducing the chances of selection bias. The creation of propensity-matched cohorts further reduces selection bias. We have adhered to the recommendations on Methodological Standards in Research Using the NIS published by Khera et al. [13].

Our findings parallel the published literature, showing that ethnic disparities are not only present in obesity and obesity-related comorbidities but also in access to effective treatments for obesity. Greater than two-thirds of patients undergoing BS were from the southern and western regions of the USA, which reflect the higher rates of observed obesity in those locations [14]. Our findings are in exact concordance to this geographic distribution observed in other studies, as more than two-thirds of the patient population undergoing BS was from the southern and western regions of the USA. In addition, the majority of patients in both study cohorts underwent BS at urban teaching hospitals with large hospital volume. Although there were statistical differences between the cohorts in terms of hospital characteristics, it is the author's opinion that these are not clinically significant.

The higher incidence of obesity in Hispanics can be explained by genetics, diet, amount of physical activity, psychosocial factors, and income [1, 7]. Some risk factors are present as early as the preschool years. Access to BS, however, is determined by sociocultural factors (e.g., self-perceived obesity, health literacy), healthcare access (e.g., geography, insurance status, language barriers, and socioeconomic status), and even psychosocial stress. Although there were no differences between the Hispanic and non-Hispanic cohorts after matching in terms of insurance coverage, the cohorts did differ in the pre-matching setting. Proportionately, more Hispanics were on Medicaid coverage and less so on Medicare when compared to non-Hispanics. Overall, the cohort of Hispanics was composed of proportionately more patients with low median income, which may evidence another factor contributing to the disparity. A telephone survey showed that Hispanics are more willing to consider BS than non-Hispanic after adjustment for body mass index (BMI) and sociodemographics. Strategies to increase the use of BS in Hispanics should be multidisciplinary and include awareness campaigns, education, and improved access to BS centers.

A "Hispanic Obesity Paradox" has been reported in the literature and suggests that despite having higher rates of obesity, Hispanics display an average of two additional years in life expectancy compared to white patients [15, 16]. This study could not evaluate this factor, as the only outcomes it examines are the ones during the index admission for bariatric surgery. Therefore, a study examining long-term outcomes in Hispanic patients who underwent BS would be warranted to appropriately address this issue.

There is debate on the impact of ethnicity in clinical outcomes following BS. Some reports show decreased reduction on metabolic syndrome and less improvement in lipid profile in Hispanics [17, 18]. Another study shows no difference in percent of excess weight loss or perioperative mortality among Hispanics compared to non-Hispanics [19]. Current analysis reveals that, despite lower use of BS, clinical outcomes (i.e., mortality and complications) and healthcare use were similar between our study groups. Increased research spending, awareness, and access to treatment in Hispanics are proposed to combat the alarming obesity epidemic and prevent increasing disparities [7].

Our study has limitations inherent to retrospective research. The ICD-9-CM code for BS has not been validated but is clearly identified in hospital coding. No stratification was made between indications for BS (e.g., BMI or BMI with adverse effects). Despite our matching efforts and statistical approach, stratification and sampling bias cannot be totally

Table 4 Economic burden of bariatric surgery in Hispanics versus non-Hispanics

Variable	Hispanics, mean	Non-Hispanics, mean	*P* value
Crude hospital costs, USD	28,098	27,157	0.26
RYGB	25,333	24,521	0.19
Sleeve gastrectomy	19,668	19,354	0.83
Crude hospital charges, USD	117,248	108,869	0.90
RYGB	92,405	90,924	0.66
Sleeve gastrectomy	77,925	68,726	< 0.01
Crude length of stay (days)	7.4	8.2	< 0.01
RYGB	6.3	6.8	0.09
Sleeve gastrectomy	5.2	5.3	0.10
Variable	Adjusted mean	95% CI	*P* value
Additional hospital costs, USD	1848	− 2073 to 5770	0.36
RYGB	1716	625–2807	< 0.01
Sleeve gastrectomy	− 778	− 3184 to 1627	0.53
Additional hospital charges, USD	14,504	− 2404 to 31,413	0.09
RYGB	11,206	6835–15,576	> 0.01
Sleeve gastrectomy	− 4032	− 14,407 to 6644	0.45
Additional length of stay (days)	0.3	− 0.9 to 1.5	0.60
RYGB	0.5	0.2–0.7	< 0.01
Sleeve gastrectomy	− 0.1	− 0.7 to 0.6	0.89

USD US dollar

prevented in any analysis of administrative data [13]. Khera et al. [13] have raised concerns of performing NIS analysis in data collected after 2011 due to a frame shift on the hospital pool that share data with HCUP. We have accounted for these changes by assigning new weights to patients on a year-by-year basis, which is a valid methodology recommended by HCUP [13]. Lastly, inpatient medication use or outpatient costs incurred by BS could not be estimated.

Conclusion

Despite higher obesity rates seen in Hispanics, their use of BS is lower in a national sample. This finding suggests ethnic disparities in access to BS. For those who underwent BS, no difference in inpatient mortality, morbidity, or resource use was observed, further illustrating that the factors affecting BS use in Hispanics are probably related to healthcare access, personal beliefs, socioeconomics, or other cultural factors rather than biologic differences and clinical variables. Further studies are needed to identify the specific factors that compose these disparities, measure their impact, and trace the best strategies to assess them.

Compliance with Ethical Standards

Conflict of Interest The authors declare no conflict of interests.

Ethics Statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. For this type of study, formal consent was not required.

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