Annals of Gastroenterology (2022) **35,** 249-259

Obese gastroparesis inpatient admissions: trends and outcomes from 2007-2017 in the United States

Dushyant S. Dahiya[a], Abhilash Perisetti[b], Mohammad Al-Haddad[c], Asim Kichloo[a], Rahul Sharma[d], Chin-I Cheng[e], Sumant Inamdar[d]

Central Michigan University College of Medicine, Saginaw, MI; Parkview Cancer Institute, Fort Wayne, IN; Indiana University School of Medicine, Indianapolis, IN, USA; University of Arkansas for Medical Sciences, Little Rock, AR; Central Michigan University College of Science and Engineering, Mt Pleasant, MI, USA

Abstract

Background The aim of this study was to investigate obese gastroparesis (GP) hospitalizations in the United States (US).

Methods We analyzed the National Inpatient Sample (NIS) from 2007-2017 to identify all adult obese (body mass index ≥30 kg/m^2) GP hospitalizations. These were compared with non-obese GP hospitalizations. The demographic trends, adverse outcomes, and healthcare burden were analyzed.

Results From 2007-2017, obese GP hospitalizations accounted for 13.75% of all GP hospitalizations in the US. There was an increasing trend in obese GP hospitalizations, from 2286 in 2007 to 47,265 in 2017 (P=0.0019), and in the proportion of obese GP hospitalizations, from 6.16% in 2007 to 17.96% in 2017 (P<0.001). Males, Blacks, Hispanics, and Asians showed a rising trend in obese GP hospitalizations. Although rates of upper endoscopy declined from 8.28% in 2007 to 5.36% in 2017 (P<0.001), obese GP hospitalizations had higher rates of upper endoscopy utilization (6.05 vs. 5.42%, P<0.001) compared to the non-obese cohort. Inpatient mortality for obese GP hospitalizations increased from 0.64% in 2007 to 1.10% in 2017 (P<0.001). Furthermore, we noted a rising trend in mean length of stay (LOS), from 4.64 in 2007 to 6.05 days in 2017 (P=0.0029), and mean total hospital charge (THC), from $22,306 in 2007 to $62,220 in 2017 (P<0.001) for obese GP hospitalizations.

Conclusions The prevalence of obese GP hospitalizations along with inpatient mortality, LOS, and THC rose significantly. However, the overall rate of upper endoscopy utilization has decreased for these patients.

Keywords Gastroparesis, obesity, trends, outcomes

Ann Gastroenterol 2022; 35 (3): 249-259

Conflict of Interest: None

Correspondence to: Dushyant Singh Dahiya, MD, Department of Internal Medicine, Central Michigan University College of Medicine, 1000 Houghton Ave, Saginaw, MI, 48603, USA, e-mail: dush.dahiya@gmail.com

Received 6 October 2021; accepted 16 February 2022; published online 25 March 2022

DOI: https://doi.org/10.20524/aog.2022.0702

Introduction

Gastroparesis (GP) is a chronic dysmotility disorder of the stomach characterized by delayed gastric emptying in the absence of mechanical obstruction [1,2]. The exact incidence and prevalence of GP in the general population is currently unknown as the lack of population-based studies and a symptomatic overlap with other conditions, such as functional dyspepsia, make it difficult to estimate the true rates [3]. Nonetheless, its impact on patients' quality of life and the United States (US) healthcare system has been evaluated [3,4]. Patients with GP may commonly present with symptoms such as nausea, vomiting, early satiety, postprandial fullness, and

upper abdominal pain [5]. This may lead to poor oral intake, resulting in severe dehydration and significant weight loss [6]. Hence, GP increases the risk of malnutrition.

Over the last decade, multiple studies have shown that obesity is highly prevalent in individuals with GP [7]. The high body mass index (BMI) noted in these individuals is likely due to the acquisition of "maladaptive" dietary habits to cope with the symptoms of GP [8]. In view of these changes, we hypothesize that the number of patients with GP and obesity, particularly in an inpatient setting, is expected to rise. These patients are at risk of being subjected to multiple inpatient procedures to determine their etiology, management, and nutritional support. However, despite the rising prevalence of GP, there are significant gaps in the related literature, including the characteristics of obese GP hospitalizations. Accordingly, we aimed to estimate and assess patient demographics and hospitalization characteristics of obese GP hospitalizations using the National Inpatient Sample (NIS). Further, we assessed the trends of hospitalizations, outcomes, and the burden of the disease on the US healthcare system in terms of resource utilizations and costs over the last decade. Additionally, these patients were compared with non-obese GP hospitalizations to highlight differences in patient demographics and outcomes.

Materials and methods

Design and data source

This study analysed the NIS database, one of the largest publicly available databases in the US, derived from billing data submitted by hospitals across the US to statewide data organizations. The NIS covers 97% of the US population and approximates a 20% stratified sample of discharges from US community hospitals [9]. The dataset is weighted to obtain national estimates [10]. The NIS database was coded using the International Classification of Diseases, Ninth and Tenth Revision, Clinical Modification/Procedure Coding System (ICD-9/10-CM/PCS) for the study period.

Study population

We included all adult (18 years or older) obese (BMI ≥30 kg/m^2) GP patients from 2007-2017 available in the NIS database. Non-obese GP hospitalizations were used as controls. Individuals aged 17 years or younger were excluded from the analysis.

Statistical analysis

The statistical analysis was conducted using SAS 9.4 (SAS Institute Inc., Cary, NC) to account for weights in the stratified survey design. The weights were considered in the statistical estimation process by incorporating variables for strata, cluster, and for weight to discharges in the NIS universe. Descriptive statistics were provided, and included mean values for age, length of hospital stay (LOS), and total hospital charge (THC), while other categorical variables were expressed as count (%). To test for the trend for proportions of binary variables in years, the Cochran-Armitage trend test was implemented. The trends for the averages of age, LOS and THC in years were examined using linear regression. In addition, the Rao-Scott chi-square test was performed for a comparative analysis between obese and non-obese GP hospitalizations. P-values ≤0.05 were considered statistically significant.

Ethical considerations

The NIS database lacks patient and hospital-specific identifiers. Hence, this study did not require Institutional Review Board (IRB) approval for analysis as per guidelines put forth by our institutional IRB for research on database studies.

Data availability statement

The NIS is one of the largest, publicly available, multi-ethnic inpatient databases in the US and can be accessed at: https://www.hcup-us.ahrq.gov.

Results

Trends in hospitalization for obese gastroparesis

From 2007-2017, there was an increase in obese GP hospitalizations from 2286 in 2007 to 47,265 in 2017 (P=0.0019) (Fig. 1). Of all GP hospitalizations, the proportion of obese GP hospitalizations had a rising trend, with an increase from 6.16% in 2007 to 17.96% in 2017 (P<0.001). The patients' mean age was 51.9 years (Table 1). Males had a rising trend in obese GP hospitalizations from 20.22% in 2007 to 25.64% in 2017 (P<0.001), whereas hospitalization for females declined from 79.78% in 2007 to 74.36% in 2017 (P<0.001). There was a declining trend in obese GP hospitalizations for Whites from 66.38% in 2007 to 58.81% in 2017 (P<0.001). Conversely, Blacks, Hispanics, and Asians showed a trend towards increasing obese GP hospitalizations (Table 1). Furthermore,

[a]Department of Internal Medicine, Central Michigan University College of Medicine, Saginaw, MI, USA (Dushyant S. Dahiya, Asim Kichloo); [b]Department of Gastroenterology and Hepatology, Parkview Cancer Institute, Fort Wayne, IN, USA (Abhilash Perisetti); [c]Division of Gastroenterology and Hepatology, Department of Medicine, Indiana University School of Medicine, Indianapolis, IN, USA (Mohammad Al-Haddad); [d]Department of Gastroenterology and Hepatology, University of Arkansas for Medical Sciences, Little Rock, AR, USA (Rahul Sharma, Sumant Inamdar); [e]Department of Statistics, Actuarial and Data Science, Central Michigan University College, Mt Pleasant, MI, USA (Chin-I Cheng)

the comorbidity burden for obese GP hospitalizations increased during the study period with a rising trend noted for individuals with a Charlson Comorbidity Index (CCI) score ≥3, suggestive of increased healthcare utilization.

From an endoscopic procedural characteristic standpoint, a declining trend in inpatient upper endoscopy, from 8.28% in 2007 to 5.36% in 2017 (P<0.001), was noted for obese GP hospitalizations. Additionally, there was a decreasing trend in obese GP hospitalizations with bariatric surgery status from 5.68% in 2007 to 2.55% in 2017 (P<0.001). Urban teaching, small- and medium-sized hospitals had an increasing trend in obese GP hospitalizations, while a decreasing trend was noted for large hospitals (Table 1).

Trends of outcomes for obese gastroparesis hospitalizations

We noted a rising trend in inpatient mortality, from 0.64% in 2007 to 1.10% in 2017 (P<0.001), for obese GP hospitalizations (Fig. 2). Additionally, inpatient mortality for both males and females increased during the study period. Whites and Blacks were observed to have a rising trend in inpatient mortality for obese GP hospitalizations (Table 2). Furthermore, the mean LOS increased from 4.64 days in 2007 to 6.05 days in 2017 (P=0.0029), while the mean THC increased from $22,306 in 2007 to $62,220 in 2017 (P<0.001). The rates of endoscopic jejunostomy also increased for obese GP hospitalizations to 0.28% by 2017 (Table 2).

Comparative analysis for obese and non-obese gastroparesis hospitalizations

Obese GP hospitalizations accounted for 13.75% of all GP hospitalizations in the US from 2007-2017. These patients were older (51.9 vs. 50.8 years, P<0.001) and predominantly female (76.11% vs. 64.36%, P<0.001) compared to the non-obese counterparts. Although Whites made up a majority of the study sample, obese GP hospitalizations had a higher proportion of

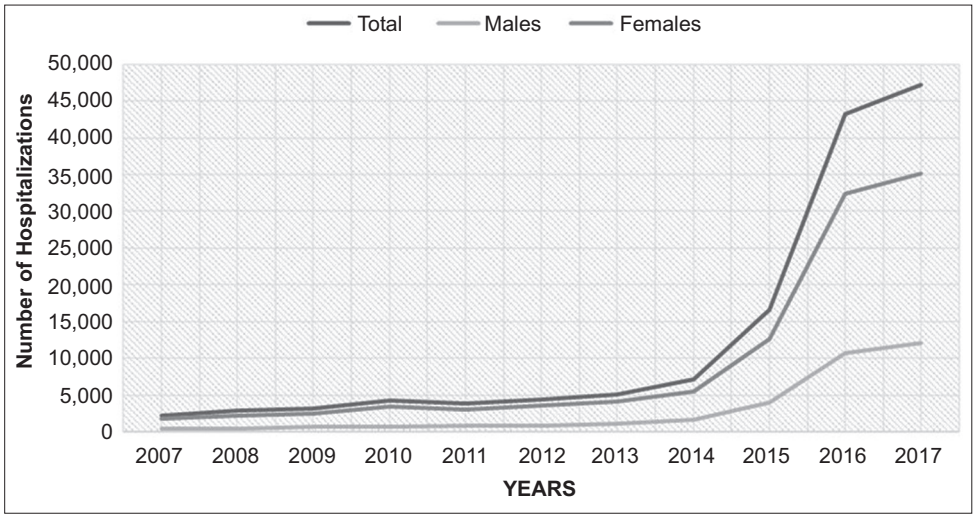

Figure 1 Hospitalizations for gastroparesis with obesity in the United States from 2007-2017, total and by sex

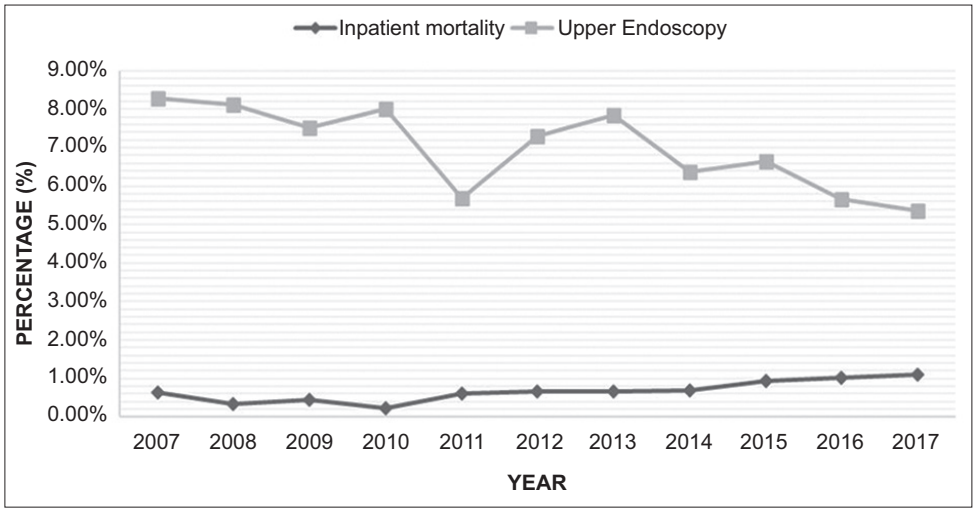

Figure 2 Trends in inpatient mortality and upper endoscopy for gastroparesis hospitalizations with obesity in the United States from 2007-2017

Table 1 Hospitalization characteristics of GP with obesity in the United States from 2007-2017

Variable	Years												Trend (P-value)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2007-2017 (Overall)	
Total number of hospitalizations	2,286	2,847	3,153	4,225	3,892	4,460	5,165	7,145	16,670	43,185	47,265	140,293	Increase (P=0.0019)
Proportion of hospitalizations for GP with obesity out of all GP hospitalizations (%)	6.16	6.33	7.20	8.99	8.11	9.47	10.14	11.33	14.08	16.82www-wwwww-wwww	17.96	13.75w	Increase (P<0.001)
Mean age (years)	47.63	48.12	49.12	47.98	48.76	48.38	49.06	49.40	51.73	52.97	53.33	51.93	Increase (P<0.001)
Age groups (years)													
18-34	526 (23.01%)	614 (21.55%)	566 (17.94%)	894 (21.15%)	749 (19.24%)	990 (22.20%)	1,115 (21.59%)	1,445 (20.22%)	2,445 (14.67%)	4,440 (10.28%)	4,480 (9.48%)	18,263 (13.02%)	Decrease (P<0.001)
34-49	741 (32.41%)	944 (33.15%)	1,080 (34.27%)	1,367 (32.36%)	1,379 (35.42%)	1,455 (32.62%)	1,590 (30.78%)	2,010 (28.13%)	5,015 (30.08%)	13,440 (31.12%)	14,260 (30.17%)	43,281 (30.85%)	Decrease (P<0.001)
50-64	670 (29.33%)	911 (31.99%)	989 (31.36%)	1,403 (33.20%)	1,079 (27.73%)	1,240 (27.80%)	1,430 (27.69%)	2,420 (33.87%)	5,645 (33.86%)	15,670 (36.29%)	18,010 (38.10%)	49,467 (35.26%)	Increase (P<0.001)
65-79	330 (14.43%)	298 (10.46%)	430 (13.63%)	495 (11.72%)	591 (15.18%)	645 (14.46%)	870 (16.84%)	1,105 (15.47%)	3,065 (18.39%)	8,410 (19.47%)	9,220 (19.51%)	25,458 (18.15%)	Increase (P<0.001)
≥80	19 (0.82%)	81 (2.86%)	89 (2.81%)	66 (1.56%)	95 (2.44%)	130 (2.91%)	160 (3.10%)	165 (2.31%)	500 (3.00%)	1,225 (2.84%)	1,295 (2.74%)	3,824 (2.73%)	Increase (P<0.001)
Gender													
Male	462 (20.22%)	509 (17.89%)	649 (20.58%)	727 (17.20%)	792 (20.34%)	880 (19.73%)	1,060 (20.52%)	1,635 (22.88%)	3,960 (23.77%)	10,710 (24.81%)	12,120 (25.64%)	33,504 (23.89%)	Increase (P<0.001)
Female	1,824 (79.78%)	2,338 (82.11%)	2,504 (79.42%)	3,498 (82.80%)	3,101 (79.66%)	3,580 (80.27%)	4,105 (79.48%)	5,510 (77.12%)	12,700 (76.23%)	32,455 (75.19%)	35,145 (74.36%)	106,759 (76.11%)	Decrease (P<0.001)
Race													
White	1,127 (66.38%)	1,565 (64.20%)	1,905 (69.81%)	2,663 (68.44%)	2,378 (66.80%)	2,650 (61.48%)	3,390 (67.46%)	4,500 (65.22%)	9,630 (59.87%)	25,050 (59.77%)	27,080 (58.81%)	81,938 (60.88%)	Decrease (P<0.001)
Black	355 (20.92%)	513 (21.07%)	543 (19.89%)	756 (19.43%)	797 (22.38%)	1,070 (24.83%)	1,010 (20.10%)	1,460 (21.16%)	4,035 (25.09%)	11,355 (27.09%)	12,410 (26.95%)	34,304 (25.49%)	Increase (P<0.001)
Hispanic	180 (10.60%)	260 (10.65%)	180 (6.58%)	311 (7.99%)	290 (8.15%)	360 (8.35%)	425 (8.46%)	710 (10.29%)	1,735 (10.79%)	4,150 (9.90%)	4,910 (10.66%)	13,510 (10.04%)	Increase (P<0.001)
Asian	< 11 (0.52%)	14 (0.58%)	29 (1.08%)	23 (0.60%)	< 11 (0.14%)	15 (0.35%)	45 (0.90%)	50 (0.72%)	185 (1.15%)	330 (0.79%)	355 (0.77%)	1,061 (0.79%)	Increase (P=0.0075)

(Contd...)

Table 1 *(Continued)*

Variable	Years												Trend (P-value)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2007-2017 (Overall)	
Native American	< 11 (0.53%)	24 (0.97%)	< 11 (0.21%)	33 (0.86%)	42 (1.19%)	65 (1.51%)	55 (1.09%)	50 (0.72%)	165 (1.03%)	335 (0.80%)	355 (0.77%)	1,139 (0.85%)	No trend (P=0.0768)
Other	18 (1.05%)	62 (2.53%)	66 (2.43%)	104 (2.68%)	48 (1.34%)	150 (3.48%)	100 (1.99%)	130 (1.88%)	335 (2.08%)	690 (1.65%)	935 (2.03%)	2,638 (1.96%)	Decrease (P=0.0013)
Charlson comorbidity index (CCI)													
CCI=0	793 (34.70%)	942 (33.10%)	897 (28.45%)	1,473 (34.86%)	972 (24.98%)	1,260 (28.25%)	1,555 (30.11%)	1,960 (27.43%)	2,410 (14.46%)	2,815 (6.52%)	2,735 (5.79%)	17,813 (12.70%)	Decrease (P<0.001)
CCI=1	651 (28.49%)	842 (29.57%)	889 (28.20%)	1,076 (25.46%)	1,018 (26.15%)	1,280 (28.70%)	1,355 (26.23%)	1,665 (23.30%)	2,480 (14.88%)	3,655 (8.46%)	3,075 (6.51%)	17,986 (12.82%)	Decrease (P<0.001)
CCI=2	464 (20.30%)	555 (19.51%)	573 (18.18%)	708 (16.77%)	765 (19.66%)	730 (16.37%)	815 (15.78%)	1,320 (18.47%)	2,345 (14.07%)	4,985 (11.54%)	4,775 (10.10%)	18,036 (12.86%)	Decrease (P<0.001)
CCI ≥ 3	377 (16.51%)	507 (17.82%)	794 (25.17%)	968 (22.91%)	1,137 (29.21%)	1,190 (26.68%)	1,440 (27.88%)	2,200 (30.79%)	9,435 (56.60%)	31,730 (73.47%)	36,680 (77.61%)	86,458 (61.63%)	Increase (P<0.001)
Hospital region													
Northeast	254 (11.09%)	245 (8.62%)	187 (5.94%)	314 (7.42%)	580 (14.90%)	415 (9.30%)	645 (12.49%)	695 (9.73%)	1,815 (10.89%)	5,700 (13.20%)	6,655 (14.08%)	17,505 (12.48%)	Increase (P<0.001)
Midwest	550 (24.08%)	497 (17.46%)	771 (24.46%)	740 (17.51%)	800 (20.56%)	1,100 (24.66%)	1,040 (20.14%)	1,690 (23.65%)	4,120 (24.72%)	10,830 (25.08%)	11,850 (25.07%)	33,989 (24.23%)	Increase (P<0.001)
South	990 (43.33%)	1,411 (49.55%)	1,535 (48.69%)	2,201 (52.09%)	1,647 (42.30%)	1,990 (44.62%)	2,440 (47.24%)	3,060 (42.83%)	7,565 (45.38%)	19,685 (45.58%)	21,150 (44.75%)	63,674 (45.39%)	Decrease (P<0.001)
West	491 (21.50%)	694 (24.37%)	659 (20.91%)	971 (22.98%)	866 (22.24%)	955 (21.41%)	1,040 (20.14%)	1,700 (23.79%)	3,170 (19.02%)	6,970 (16.14%)	7,610 (16.10%)	25,126 (17.91%)	Decrease (P<0.001)
Hospital size													
Small	325 (14.26%)	437 (15.41%)	365 (11.89%)	628 (15.13%)	508 (13.12%)	540 (12.11%)	610 (11.81%)	1,175 (16.45%)	2,940 (17.64%)	7,000 (16.21%)	8,300 (17.56%)	22,829 (16.29%)	Increase (P<0.001)
Medium	772 (33.83%)	740 (26.08%)	938 (30.51%)	1,140 (27.45%)	1,116 (28.84%)	1,170 (26.23%)	1,495 (28.94%)	2,160 (30.23%)	5,080 (30.47%)	12,645 (29.28%)	14,815 (31.34%)	42,071 (30.03%)	Increase (P<0.001)
Large	1,184 (51.91%)	1,660 (58.50%)	1,771 (57.60%)	2,385 (57.42%)	2,245 (58.04%)	2,750 (61.66%)	3,060 (59.25%)	3,810 (53.32%)	8,650 (51.89%)	23,540 (54.51%)	24,150 (51.09%)	75,206 (53.68%)	Decrease (P<0.001)

(Contd...)

Table 1 *(Continued)*

Variable	Years												Trend (P-value)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2007-2017 (Overall)	
Hospital location and teaching status													
Rural	318 (13.92%)	398 (14.04%)	395 (12.86%)	568 (13.67%)	583 (15.06%)	565 (12.67%)	675 (13.07%)	745 (10.43%)	1,065 (6.39%)	3,255 (7.54%)	3,345 (7.08%)	11,912 (8.50%)	Decrease (P<0.001)
Urban Nonteaching	1,097 (48.09%)	1,375 (48.46%)	1,448 (47.08%)	2,135 (51.40%)	1,608 (41.57%)	1,920 (43.05%)	2,105 (40.76%)	2,080 (29.11%)	4,590 (27.53%)	11,060 (25.61%)	10,065 (21.29%)	39,483 (28.18%)	Decrease (P<0.001)
Urban Teaching	867 (37.99%)	1,064 (37.50%)	1,232 (40.07%)	1,451 (34.93%)	1,678 (43.37%)	1,975 (44.28%)	2,385 (46.18%)	4,320 (60.46%)	11,015 (66.08%)	28,870 (66.85%)	33,855 (71.63%)	88,711 (63.32%)	Increase (P<0.001)
Expected primary payer													
Medicare	776 (34.01%)	785 (27.57%)	983 (31.34%)	1,335 (31.81%)	1,543 (39.70%)	1,715 (38.54%)	1,945 (37.73%)	2,610 (36.58%)	7,670 (46.05%)	22,905 (53.09%)	24,555 (52.01%)	66,823 (47.70%)	Increase (P<0.001)
Medicaid	336 (14.73%)	455 (15.97%)	501 (15.98%)	721 (17.17%)	695 (17.88%)	930 (20.90%)	970 (18.82%)	1,635 (22.92%)	3,590 (21.56%)	8,895 (20.62%)	9,870 (20.91%)	28,598 (20.41%)	Increase (P<0.001)
Private	920 (40.31%)	1,229 (43.18%)	1,333 (42.49%)	1,694 (40.35%)	1,302 (33.48%)	1,320 (29.66%)	1,635 (31.72%)	2,300 (32.24%)	4,320 (25.94%)	9,220 (21.37%)	10,480 (22.20%)	35,753 (25.52%)	Decrease (P<0.001)
Self-pay	174 (7.62%)	260 (9.14%)	214 (6.82%)	322 (7.66%)	183 (4.72%)	345 (7.75%)	360 (6.98%)	400 (5.61%)	660 (3.96%)	1,190 (2.76%)	1,460 (3.09%)	5,568 (3.97%)	Decrease (P<0.001)
Other	76 (3.32%)	118 (4.13%)	106 (3.36%)	126 (3.00%)	164 (4.22%)	140 (3.15%)	245 (4.75%)	190 (2.66%)	415 (2.49%)	935 (2.17%)	845 (1.79%)	3,359 (2.40%)	Decrease (P<0.001)
Median household income (quartile)													
1st (0-25th)	789 (35.13%)	797 (28.43%)	945 (30.57%)	1,364 (32.82%)	1,359 (35.60%)	1,630 (37.26%)	1,535 (30.37%)	2,375 (33.86%)	6,230 (37.90%)	16,570 (38.92%)	17,410 (37.34%)	51,003 (36.91%)	Increase (P<0.001)
2nd (26th-50th)	530 (23.62%)	684 (24.42%)	765 (24.74%)	1,071 (25.77%)	939 (24.61%)	1,150 (26.29%)	1,580 (31.26%)	2,155 (30.72%)	4,000 (24.33%)	11,115 (26.10%)	13,355 (28.65%)	37,345 (27.02%)	Increase (P<0.001)
3rd (51st-75th)	548 (24.40%)	694 (24.78%)	804 (26.02%)	1,005 (24.18%)	934 (24.46%)	930 (21.26%)	1,225 (24.23%)	1,445 (20.60%)	3,935 (23.94%)	9,395 (22.06%)	10,225 (21.93%)	31,140 (22.53%)	Decrease (P<0.001)
4th (76th-100th)	378 (16.85%)	627 (22.37%)	577 (18.67%)	716 (17.23%)	585 (15.33%)	665 (15.20%)	715 (14.14%)	1,040 (14.83%)	2,275 (13.84%)	5,500 (12.92%)	5,630 (12.08%)	18,709 (13.54%)	Decrease (P<0.001)
Upper endoscopy	189 (8.28%)	231 (8.11%)	237 (7.51%)	338 (8.00%)	221 (5.68%)	325 (7.29%)	405 (7.84%)	455 (6.37%)	1105 (6.63%)	2,445 (5.66%)	2535 (5.36%)	8,486 (6.05%)	Decrease (P<0.001)

(Contd...)

Table 1 *(Continued)*

Variable	Years												Trend (P-value)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2007-2017 (Overall)	
Bariatric surgery status	130 (5.68%)	264 (9.28%)	367 (11.65%)	478 (11.32%)	303 (7.78%)	355 (7.96%)	400 (7.74%)	535 (7.49%)	855 (5.13%)	1,105 (2.56%)	1,205 (2.55%)	5,997 (4.27%)	Decrease (P<0.001)
Disposition													
Discharge home	1,847 (81.03%)	2,383 (83.68%)	2,481 (78.70%)	3,391 (80.27%)	3,092 (79.62%)	3,605 (80.83%)	4,080 (78.99%)	5,570 (78.01%)	11,375 (68.28%)	27,275 (63.17%)	29,675 (62.82%)	94,774 (67.59%)	Decrease (P<0.001)
Transfer to short-term hospital	58 (2.53%)	26 (0.90%)	71 (2.25%)	74 (1.74%)	76 (1.97%)	95 (2.13%)	130 (2.52%)	135 (1.89%)	255 (1.53%)	755 (1.75%)	735 (1.56%)	2,409 (1.72%)	Decrease (P<0.001)
Transfer to another facility (includes Skilled Nursing Facility and Intermediate Care Facility)	118 (5.17%)	151 (5.30%)	237 (7.51%)	262 (6.20%)	307 (7.90%)	320 (7.17%)	325 (6.29%)	515 (7.21%)	2,120 (12.73%)	6,500 (15.06%)	7,190 (15.22%)	18,044 (12.87%)	Increase (P<0.001)
Home healthcare	209 (9.16%)	239 (8.38%)	297 (9.41%)	433 (10.26%)	333 (8.58%)	380 (8.52%)	520 (10.07%)	750 (10.50%)	2,425 (14.56%)	7,525 (17.43%)	8,295 (17.56%)	21,405 (15.26%)	Increase (P<0.001)
Discharge against medical advice	29 (1.27%)	35 (1.24%)	48 (1.53%)	51 (1.21%)	51 (1.32%)	30 (0.67%)	75 (1.45%)	120 (1.68%)	330 (1.98%)	680 (1.58%)	825 (1.75%)	2,274 (1.62%)	Increase (P<0.001)
Mortality	15 (0.64%)	< 11 (0.34%)	14 (0.45%)	< 11 (0.23%)	24 (0.61%)	30 (0.67%)	35 (0.68%)	50 (0.70%)	155 (0.93%)	435 (1.01%)	520 (1.10%)	1,297 (0.92%)	Increase (P<0.001)

GP, Gastroparesis

Table 2 Outcomes for hospitalization of gastroparesis with obesity from 2007-2017

Outcome	Years											2007-2017 (Overall)	Trend (P-value)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017		
Inpatient mortality (%)	0.64	0.34	0.45	0.23	0.61	0.67	0.68	0.70	0.93	1.01	1.10	1297 (0.92%)	Increase (P<0.001)
Inpatient mortality according to sex (%)													
Male	1.06	0	0	0	0	0.57	0.47	0	1.01	1.17	1.36	345 (1.03%)	Increase (P<0.001)
Female	0.54	0.41	0.56	0.28	0.77	0.70	0.73	0.91	0.91	0.96	1.01	952 (0.89%)	Increase (P<0.001)
Inpatient mortality according to race (%)													
White	0	0.30	0.74	0.36	0.41	0.94	0.59	0.67	0.99	1.00	1.20	783 (0.96%)	Increase (P<0.001)
Black	1.36	0	0	0	1.16	0	0	0.68	0.62	0.93	0.81	254 (0.74%)	Increase (P<0.001)
Hispanic	2.79	0	0	0	0	1.39	1.18	1.41	0.29	1.33	0.71	120 (0.89%)	No trend (P=0.3201)
Asian	0	0	0	0	1.2	0	0	0	0	4.55	2.82	30 2.82%)	No trend (P=0.3422)
Inpatient mortality according to age (%)													
18-34	0.96	0	0	0	0	0	0	0.69	0	0.45	0	35 (0.19%)	No trend (P=0.3605)
34-49	0.65	0	0.42	0.37	0	0.34	0.63	0.25	0.70	0.48	0.67	229 (0.53%)	Increase (P=0.001)
50-64	0	0.52	0	0	0.89	0.40	0.70	0.62	1.06	0.96	0.89	414 (0.84%)	Increase (P<0.001)
65-79	0	1.66	2.24	0.94	1.61	1.55	0.57	0.45	1.47	1.72	2.44	464 (1.82%)	Increase (P<0.001)
≥80	2.57	0	0	0	5.20	7.69	6.25	9.09	3.00	4.49	3.09	155 (4.05%)	No trend (P=0.1548)
Length of stay (days)	4.64	4.93	4.85	4.80	4.76	4.54	4.81	4.86	5.74	6.03	6.05	5.71	Increase (P=0.0029)
Total hospital charge (USD)	22,306	26,091	28,064	32,897	32,993	32,123	36,362	37,218	52,844	59,786	62,220	53,373	Increase (P<0.001)
Endoscopic jejunostomy (%)	0	0.16	0.29	0.31	0.13	0	0.19	0.21	0.21	0.29	0.28	347 (0.25%)	Increase (P<0.001)

Blacks (25.49% vs. 22%, P<0.001) compared to the non-obese cohort (Table 3). Furthermore, obese GP hospitalizations had higher rates of upper endoscopy (6.05 vs. 5.42%, P<0.001), mean LOS (5.71 vs. 5.32 days, P<0.001), and mean THC ($53,373 vs. $45,040, P<0.001) compared to the non-obese subgroup.

Discussion

This study evaluated the trends and outcomes of hospitalization among obese GP patients over the span of a decade. To our knowledge, this is the only study that evaluated the trends of obese GP hospitalizations and compared them to non-obese GP hospitalizations.

From 2007-2017, obese GP hospitalizations accounted for 13.75% of all GP hospitalizations in the US. We noted an increasing trend in total obese GP hospitalizations and in the proportion of obese GP hospitalizations during the study period. Males and non-Whites (Blacks, Hispanics, and Asians) were found to have a rising trend in hospitalizations. Although the overall rate of inpatient upper endoscopy decreased from 8.28% in 2007 to 5.36% in 2017, obese GP hospitalizations had higher upper endoscopy utilization. There was an

Table 3 Comparative analysis for obese and non-obese gastroparesis hospitalizations in the United States from 2007-2017

Variables	Gastroparesis hospitalizations with obesity	Gastroparesis hospitalizations without obesity	P-value
Proportion of all gastroparesis hospitalizations (%)	13.75	86.25	
Mean age (years)	51.9	50.8	<0.001
Sex (%)			<0.001
Male	23.89	35.64	
Female	76.11	64.36	
Race (%)			<0.001
White	60.88	63.18	
Black	25.49	22.00	
Hispanic	10.04	10.21	
Upper endoscopy (%)	6.05	5.42	<0.001
Length of stay (days)	5.71	5.32	<0.001
Total hospital charge (USD)	53,373	45,040	<0.001
Inpatient mortality (%)	0.92	1.33	<0.001

increasing trend in mean LOS and mean THC for obese GP hospitalizations. Furthermore, inpatient mortality for obese GP hospitalizations rose from 0.64% in 2007 to 1.1% in 2017 (P<0.001); however, obese GP hospitalizations had lower rates of inpatient mortality compared to the non-obese cohort.

GP is difficult to manage and leads to a poor quality of life. As the prevalence of obese GP patients continues to rise, it further complicates an already challenging situation and places an additional burden on the healthcare system. However, the current literature lacks data on the exact prevalence and impact of obesity in patients with GP as this association is fairly recent. A multicenter study involving 7 tertiary care centers in the US reported that 29% of patients with GP tended to be obese, while over a 48-week follow-up period 30% of the patients with GP had a ≥5% increase in body weight, thereby moving toward a higher BMI class [7]. Our study echoed similar findings as we report rising trends in both GP hospitalizations with obesity and in the proportion of obese GP hospitalizations out of all GP hospitalizations.

Prior studies have reported that patients in the 50-69 age group have the highest rates of diagnosis of GP amongst all age groups [11,12]. In our study, the mean age for obese GP hospitalizations was 51.9 years, compared to 50.8 years for the non-obese cohort. There was a rising trend in mean age for obese GP hospitalizations, signifying that it is increasingly present in older individuals, particularly those over 50 years of age (Table 1). Interestingly, we noted an increasing trend in obese GP hospitalizations for males while females showed a downtrend. This contradicts literature, which reports a higher prevalence of both GP and obesity in females compared to males [11-13]. The exact reason for this finding is unknown, but it may be partly attributable to poor dietary and lifestyle compliance in men leading to excessive weight gain and higher inpatient admissions.

Racial disparities were also evident in our study. We noted a declining trend in GP hospitalizations with obesity for Whites, whereas a rising trend was noted for Black, Hispanic, and Asian populations (Table 1). Furthermore, obese GP hospitalizations had a higher proportion of Blacks compared to the non-obese cohort (Table 3). These findings are consistent with prior studies that reported a higher likelihood of hospitalization for GP in ethnic minorities such as Blacks [14,15]. The primary reason for this trend is likely to be poor or delayed access to healthcare in these patient populations, leading to hospitalization for a condition that could be managed in an outpatient setting.

From a mortality perspective, a database study in 2012 reported an inpatient mortality of 1.5% for obese GP patients, with lower odds of inpatient mortality compared to non-obese gastroparetic patients [16]. In our study, inpatient mortality for GP hospitalizations with obesity increased from 0.64% in 2007 to 1.10% in 2017 with a rising trend noted for males, females, Whites and Blacks (Table 2). This consistent rise in mortality may be secondary to the complications associated with both GP and obesity. However, we noted lower rates of inpatient mortality for obese GP hospitalizations compared to the non-obese cohort. This is consistent with current literature and may partially be attributed to the "obesity paradox" which hypothesizes that the presence of obesity is protective against inpatient outcomes such as morality [17].

From an inpatient procedure standpoint, there was a decline in inpatient upper endoscopies for obese GP hospitalizations. This may be because the management of GP in an inpatient setting is focused primarily on correction of fluid and electrolyte abnormalities, nutritional support, strict glycemic control, dietary education, and prokinetic therapy [1,18,19]. Endoscopic procedures are usually not indicated for inpatients, and are mainly deferred to an outpatient setting. However, after a comparative analysis, obese GP hospitalizations had slightly higher rates of upper endoscopy utilization compared to the non-obese cohort. This may be due to the fact that obese patients may develop refractory GP, which, in turn, requires additional endoscopic intervention. Nonetheless, we advocate

for additional prospective studies to further investigate these findings.

We also noted a decreasing trend in inpatient admissions for obese GP hospitalizations with bariatric surgery status. This can be attributed partially to the fact that bariatric procedures are being increasingly performed on obese patients with excellent outcomes and may result in significant improvement in symptoms of GP [20-22]. Additionally, as obesity decreases after bariatric procedures, it may prevent the development of refractory GP which may in turn lead to decreased hospitalizations and a lower US healthcare burden.

It is well established that GP places a significant burden on the healthcare system. From 2006-2013, emergency department visits for GP increased from 12.9 to 27.3 per 100,000 ED visits, while the associated hospital charge for subsequent admissions after the ED visit increased from $286 million to $592 million [23]. In our study, for obese GP hospitalizations, there was a trend towards increasing mean THC and LOS over the study period. The mean THC increased by 178.9% and the mean LOS increased by 30.4% from 2007-2017. Additionally, compared to the non-obese GP cohort, obese GP hospitalizations had a higher mean THC and a longer mean LOS. Furthermore, we noted a trend towards rising rates of endoscopic jejunostomy (Table 2). The rising mean THC, LOS, and rates of endoscopic jejunostomy may be due to comorbidities and complications associated with obese GP hospitalizations at presentation, which often require additional interventions and a multidisciplinary team approach for management. From a hospital perspective, urban teaching hospitals had an increasing trend in obese GP hospitalizations. This may be due to their urban location, which represents a high population density, and easy availability of specialists at these centers, leading to higher inpatient admissions and transfers from other hospitals.

This study has several strengths and limitations. A key strength of this study is the study population, derived from one of the largest, multi-ethnic, publicly available databases in the US. The NIS consists of data on inpatient admissions from hospitals across the US. Therefore, the outcomes derived from this study are applicable to hospitalizations all over the US. The 11-year study period also allows us to establish meaningful trends. Additionally, through the study design, we focus on the biodemographic characteristics, outcomes, and associations of GP hospitalizations in obese patients, which adds substantial meaningful information to the current literature. In addition, a comparative analysis of the obese and non-obese cohort allows for extensive analysis and helps assess the magnitude of the disease entity.

However, we do acknowledge all the limitations associated with our study. The NIS database does not contain data on the severity of the disease, the methods used to establish diagnosis, or the hospital course. It also lacks extensive data on the treatment aspects of GP in obese patients. Furthermore, given the retrospective study design, all biases associated with retrospective studies are applicable to this study. Finally, NIS is an administrative database using ICD codes to store information; hence, the possibility of coding errors cannot be excluded. However, despite these limitations, the authors believe that the large sample size, unique methodology and comprehensive analysis technique help us better understand and fill the gaps in the current literature. This study aims to stimulate conversation and promote research on GP in obese individuals.

In conclusion, obese GP hospitalizations made up 13.75% of all GP hospitalizations in the US. Rising trends were noted in obese GP hospitalizations, from 2286 in 2007 to 47,265 in 2017, and in inpatient mortality, from 0.64% in 2007 to 1.10% in 2017. However, rates of upper endoscopy declined during the study period. The mean THC and LOS for obese GP hospitalizations increased by 178.9% and 30.4%, respectively, from 2007-2017. Compared to the non-obese cohort, higher rates of upper endoscopy utilization, inpatient mortality, mean LOS and mean THC were noted for obese GP hospitalizations. Further prospective studies are needed to confirm these findings.

Summary Box

What is already known:

- Gastroparesis (GP) affects the patient's quality of life and places a significant burden on the healthcare system
- The prevalence of obesity in patients with GP is on the rise because of the adoption of maladaptive dietary habits to cope with the symptoms of GP
- The presence of obesity in patients with GP further complicates an already challenging management

What the new findings are:

- Obese GP hospitalizations accounted for 13.75% of all GP hospitalizations in the United States
- There was an increasing trend in obese GP hospitalizations, from 2,286 in 2007 to 47,265 in 2017
- Rates of inpatient upper endoscopy for obese GP hospitalizations declined from 8.28% in 2007 to 5.36% in 2017
- Inpatient mortality increased from 0.64% in 2007 to 1.1% in 2017 for obese GP hospitalizations

References

1. Camilleri M, Parkman HP, Shafi MA, Abell TL, Gerson L; American College of Gastroenterology. Clinical guideline: management of gastroparesis. *Am J Gastroenterol* 2013;**108**:18-37.
2. Usai-Satta P, Bellini M, Morelli O, Geri F, Lai M, Bassotti G. Gastroparesis: new insights into an old disease. *World J Gastroenterol* 2020;**26**:2333-2348.
3. Kichloo A, Dahiya DS, Wani F, et al. Diabetic and non-diabetic gastroparesis: a retrospective comparative outcome study from the nationwide inpatient sample. *Gastroenterology Res* 2021;**14**:21-30.
4. Yu D, Ramsey FV, Norton WF, et al. The burdens, concerns,

and quality of life of patients with gastroparesis. *Dig Dis Sci* 2017;**62**:879-893.
5. Parkman HP. Idiopathic gastroparesis. *Gastroenterol Clin North Am* 2015;**44**:59-68.
6. Parkman HP, Yates KP, Hasler WL, et al; NIDDK Gastroparesis Clinical Research Consortium. Dietary intake and nutritional deficiencies in patients with diabetic or idiopathic gastroparesis. *Gastroenterology* 2011;**141**:486-498, 498.e1-e7.
7. Parkman HP, Van Natta M, Yamada G, et al. Body weight in patients with idiopathic gastroparesis. *Neurogastroenterol Motil* 2021;**33**:e13974.
8. Blumhagen J, Volckmann E. Managing Gastroparesis in the Setting of Obesity. In: Ibele A, Gould J. (eds) Gastroparesis. Springer, Cham; 2020.
9. Healthcare Cost and Utilization Project. Introduction to the HCUP National Inpatient Sample (NIS) [database online]. The National (nationwide) Inpatient Sample database documentation. Rockville, MD: Agency for Healthcare Research and Quality. Available from: https://www.hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2018.jsp [Accessed 1 March 2022].
10. Houchens R, Ross, D, Elixhauser A, Jiang J. Nationwide Inpatient Sample (NIS) Redesign Final Report 2014 [database online]. HCUP Methods Series Report # 2014-04 ONLINE. Rockville, MD: Agency for Healthcare Research and Quality. Available from: http://www.hcup-us.ahrq.gov/reports/methods/methods.jsp [Accessed 1 March 2022].
11. Jung HK, Choung RS, Locke GR 3rd, et al. The incidence, prevalence, and outcomes of patients with gastroparesis in Olmsted County, Minnesota, from 1996 to 2006. *Gastroenterology* 2009;**136**:1225-1233.
12. Syed AR, Wolfe MM, Calles-Escandon J. Epidemiology and diagnosis of gastroparesis in the United States: a population-based study. *J Clin Gastroenterol* 2020;**54**:50-54.
13. Wang YR, Fisher RS, Parkman HP. Gastroparesis-related hospitalizations in the United States: trends, characteristics, and outcomes, 1995-2004. *Am J Gastroenterol* 2008;**103**:313-322.
14. Garawi F, Devries K, Thorogood N, Uauy R. Global differences between women and men in the prevalence of obesity: is there an association with gender inequality? *Eur J Clin Nutr* 2014;**68**:1101-1106.
15. Parkman HP, Yamada G, Van Natta ML, et al. Ethnic, racial, and sex differences in etiology, symptoms, treatment, and symptom outcomes of patients with gastroparesis. *Clin Gastroenterol Hepatol* 2019;**17**:1489-1499.
16. Okeke F. Gastroparesis impacts mortality and resource utilization in patients admitted with obesity: a nationwide analysis. *Am J Gastroenterol* 2016;**111**:S255.
17. Shaka H, El-Amir Z, Wani F, Et al. The paradox: Ischemic cerebrovascular accidents and obesity – A retrospective Nationwide inpatient study. *Obes Med* 2021;**23**:100339.
18. Enweluzo C, Aziz F. Gastroparesis: a review of current and emerging treatment options. *Clin Exp Gastroenterol* 2013;**6**:161-165.
19. Waseem S, Moshiree B, Draganov PV. Gastroparesis: current diagnostic challenges and management considerations. *World J Gastroenterol* 2009;**15**:25-37.
20. Smith BR, Schauer P, Nguyen NT. Surgical approaches to the treatment of obesity: bariatric surgery. *Endocrinol Metab Clin North Am* 2008;**37**:943-964.
21. Papasavas PK, Ng JS, Stone AM, Ajayi OA, Muddasani KP, Tishler DS. Gastric bypass surgery as treatment of recalcitrant gastroparesis. *Surg Obes Relat Dis* 2014;**10**:795-799.
22. Chang SH, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA. The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003-2012. *JAMA Surg* 2014;**149**:275-287.
23. Hirsch W, Nee J, Ballou S, et al. Emergency department burden of gastroparesis in the United States, 2006 to 2013. *J Clin Gastroenterol* 2019;**53**:109-113.