



# Time Trends in Healthcare Utilization Due to Self-Reported Functional Diseases of the Stomach

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## Abstract

**Introduction** Cohort studies from referral centers suggest an increasing burden of functional gastric disorders, with frequent emergency room (ER) visits, hospitalizations, or absenteeism. We hypothesized that recruitment from tertiary care sites skews results and thus investigated the burden of these illnesses, using the population-based data of the Medical Expenditure Panel Survey (MEPS).

**Methods** Using MEPS data for the years 2000–2015, demographic, economic, healthcare-related, and quality-of-life indicators were extracted for adults reporting the diagnosis of functional gastric diseases to assess trends and to compare results with data from all adults surveyed.

**Results** Between 2000 and 2015,  $2.7 \pm 0.2\%$  of the adults surveyed reported a functional gastric illness. Within the period studied,  $28.8 \pm 2.8\%$  and  $17.9 \pm 1.6\%$  of this cohort reported ER visits or hospitalizations, respectively. Only a fraction of these persons attributed the ER visits ( $22.6 \pm 0.9\%$ ) or admissions ( $10.9 \pm 0.8\%$ ) to the functional gastric disorder. Rates remained stable during the period studied. Female sex, measures of physical function, comorbidities, and an income below the poverty line were predictors of healthcare utilization. While utilization was stable over time, annual costs increased by  $113.9 \pm 16.6\%$  during the study period, outpacing the inflation rate of 37.6%.

**Conclusions** Persons with functional gastric disorders have significant healthcare needs and face increasing costs of care, largely due to coexisting illnesses. While it is important to recognize this impact, the need for emergency care or hospitalizations remained stable and lower than reported for patients seen in tertiary referral centers, providing reassuring information for patients and providers.

**Keywords** Medical expenditure panel · Functional dyspepsia · Gastroparesis · Healthcare resource utilization

## Introduction

Functional dyspepsia and gastroparesis fall into the category of functional gastric disorders, which are common chronic conditions that involve the brain–gut axis and affect an estimated 5% of the general population [1, 2]. Impaired emptying, altered accommodation, changes in visceral sensation,

and abnormal processing of visceral sensory input all contribute to the development of dyspeptic symptoms [3–5]. While gastroparesis has typically been defined as being distinct from other forms of functional dyspepsia, recent data show a significant overlap in symptoms in cohorts with or without delayed gastric emptying [6–9]. Longitudinal studies are limited, but most cohort studies suggest a significant and ongoing impact on quality of life [10–12]. Consistent with these results, resource utilization remains high and hospitalization rates are reportedly increasing [12–15]. These results contrast with population-based studies, which show stable prevalence but shifting symptoms with less of a need for ongoing and expensive medical care [1, 2]. Recruitment of patient cohorts in tertiary referral centers may explain this apparent discrepancy, as referral bias skews data, which tend to be sicker, have a higher prevalence of coexisting illnesses, and often do not respond to treatments. We thus

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hypothesized that drawing from a representative sample of the US population will show less of an impact and provide a more realistic picture of healthcare resource utilization over time.

The Medical Expenditure Panel Survey collects detailed information about acute and chronic medical conditions, the associated healthcare resource utilization, key demographic and economic data, and quality-of-life indicators (<https://meps.ahrq.gov/mepsweb>). It polls a large cohort of individuals living in different areas of the USA to provide representative data on trends in health and health care. Diagnoses are self-reported and entered as three-digit number based on the International Classification of Diseases-Version 9 (ICD-9). We used the self-reported diagnosis of a functional disorder of the stomach (ICD-9 code 536) to examine time trends between the years 2000 and 2015.

## Methods

### Data Source

The Consolidated Household Component, the Medical Conditions file, and the Prescribed Medicine files of the Medical Expenditure Panel (MEP) are in the public domain and can be obtained through a Web site maintained by the Agency for Healthcare Research and Quality (<https://meps.ahrq.gov/mepsweb/>). To ensure privacy, they exclude all potential identifiers and only provide the limited three-digit version of the diagnostic codes. Using the code “disorders of function of the stomach” (ICD-9 code 536), we selected our target cohort for the years 2000–2015. The category includes achlorhydria (536.0), acute dilation of the stomach (536.1), persistent vomiting (536.2), gastroparesis (536.3), gastrostomy complications (536.4), dyspepsia (536.8), and unspecified functional gastric disorders (536.9). We obtained the Full Year Consolidated Data File, the Medical Conditions File, and the Prescribed Medicines File for these years. The files were uploaded into Stata (version 14.2; College Station, TX) and combined into master files for each of the years covered using the unique codes for specific individual within defined dwellings (*dupersid*). We excluded children (persons < 18 years of age at the end of the calendar year) as published cohort studies largely focus on adult patients.

### Data Extraction

Using cohorts defined by the year of participation, we extracted demographic information (age, sex, race, ethnicity, and marital status), economic information (income, poverty level as predefined by the survey, use of food stamps), data on insurance coverage for persons under the age of 65 years, healthcare use (office encounters, outpatient encounters in

hospital-affiliated clinics, emergency room (ER) visits, inpatient treatments, prescriptions filled), the related costs (expenses covered and self-pay) as well as ratings on functional limits (activity limitations, work limitations, social limitations), missed workdays due to illnesses, and the summary scores for the physical and mental sections of the Short Form 12 (SF12), a validated health status questionnaire [16]. Data on utilization were separated into two measures with all encounters and prescriptions as one and use attributed to the gastric problem as the second set of variables as defined within the data files. To determine trends of self-pay, we converted the annual out-of-pocket expenses for the previously mentioned services into percentages of total annual costs. The survey also collects information about specific diseases that are considered relevant for public health policies. The reported diagnoses of hypertension, arthritis, coronary artery disease, a prior stroke, emphysema, and asthma were entered and summed up as comorbidity burden. In addition, we abstracted information about prescriptions, reviewing all prescriptions to identify the use of proton pump inhibitors (PPIs), histamine-2 receptor antagonists (H2RA), metoclopramide, antiemetics (dronabinol; granisetron; meclizine; ondansetron; prochlorperazine; promethazine; scopolamine), and opioids. We extracted the body mass index (BMI) in kg/m<sup>2</sup> and separately identified persons with a BMI below 18.5 (underweight), over 30 (obese), and over 35 (morbidly obese) based on threshold definitions of the Centers of Disease Control ([https://www.cdc.gov/healthypeople/assessing/bmi/adult\\_bmi/index.html](https://www.cdc.gov/healthypeople/assessing/bmi/adult_bmi/index.html)).

### Data Analysis

Descriptive and analytic statistics were obtained using Stata. Unless stated otherwise, data are shown as mean with standard error (SE). For dichotomous variables, we used the Chi-square test to compare groups. Continuous variables were compared with the multivariate analysis with Bonferroni correction for multiple comparisons. To assess changes over time, we used the Cuzick’s test for trend. Demographic, economic, and health-related variables were entered into a Poisson regression to determine their relative role as indicators of higher resource utilization, defined by hospitalizations or ER visits. A  $P < 0.05$  was considered as significant difference. Probabilities above this threshold are labeled as nonsignificant (n.s.).

## Results

### Demographic Characteristics

During the period studied, a total of 10,699 persons ( $669 \pm 27$  per year) reported the diagnosis of a functional

gastric disorder, amounting to  $2.7 \pm 0.2\%$  of the adult respondents. There were no discernible trends over time (data not shown). The population was female predominant with Caucasian accounting for about two-thirds of the cohort and with a mean age around 50 years. One-quarter identified as Hispanic. The mean BMI was around 28 with  $2.4 \pm 0.1\%$  being underweight,  $32.2 \pm 0.5\%$  exceeding the threshold of obesity, and  $13.5 \pm 0.3\%$  having a BMI in the morbidly obese range (Table 1).

Looking at the economic background of respondents, the annual income rose from  $\$23,620 \pm 1226$  in 2000 to  $\$24,056 \pm 1028$  in 2015. While this change is significant (test for trend:  $z = 2.33$ ;  $P < 0.05$ ), this increase in less than 2% is clearly far below the inflation rate of 37.6% calculated based on the consumer price index (<https://www.usinflationcalculator.com>). As shown in Fig. 1, the fraction of persons falling below the poverty line did not differ between persons with functional gastric disorders and the entire cohort ( $X^2 = 0.94$ ; n.s.), while slightly more persons with functional gastric disorders received food stamps ( $16.6 \pm 0.4\%$  vs.  $15.8 \pm 0.1\%$ ;  $X^2 = 5.04$ ;  $P < 0.05$ ). Lack of medical insurance may function as another socioeconomic indicator. Considering the federally and state-funded programs for the poor and elderly, we narrowed the search to adults under the age of 65 years. As shown in Fig. 1, the fraction of uninsured persons with functional gastric diseases was significantly higher than reported for the entire cohort with a drop in 2014 ( $X^2 = 78.2$ ;  $P < 0.01$ ; test for trend:  $z = -2.5$ ;  $P < 0.05$ ), which coincided with the implementation of the Affordable Care Act (<https://www.kff.org/health-reform/issue-brief/assessing-aca-marketplace-enrollment/>). Persons with functional gastric disorders

had a higher burden or comorbid diseases that are routinely assessed as part of the survey (Table 2).

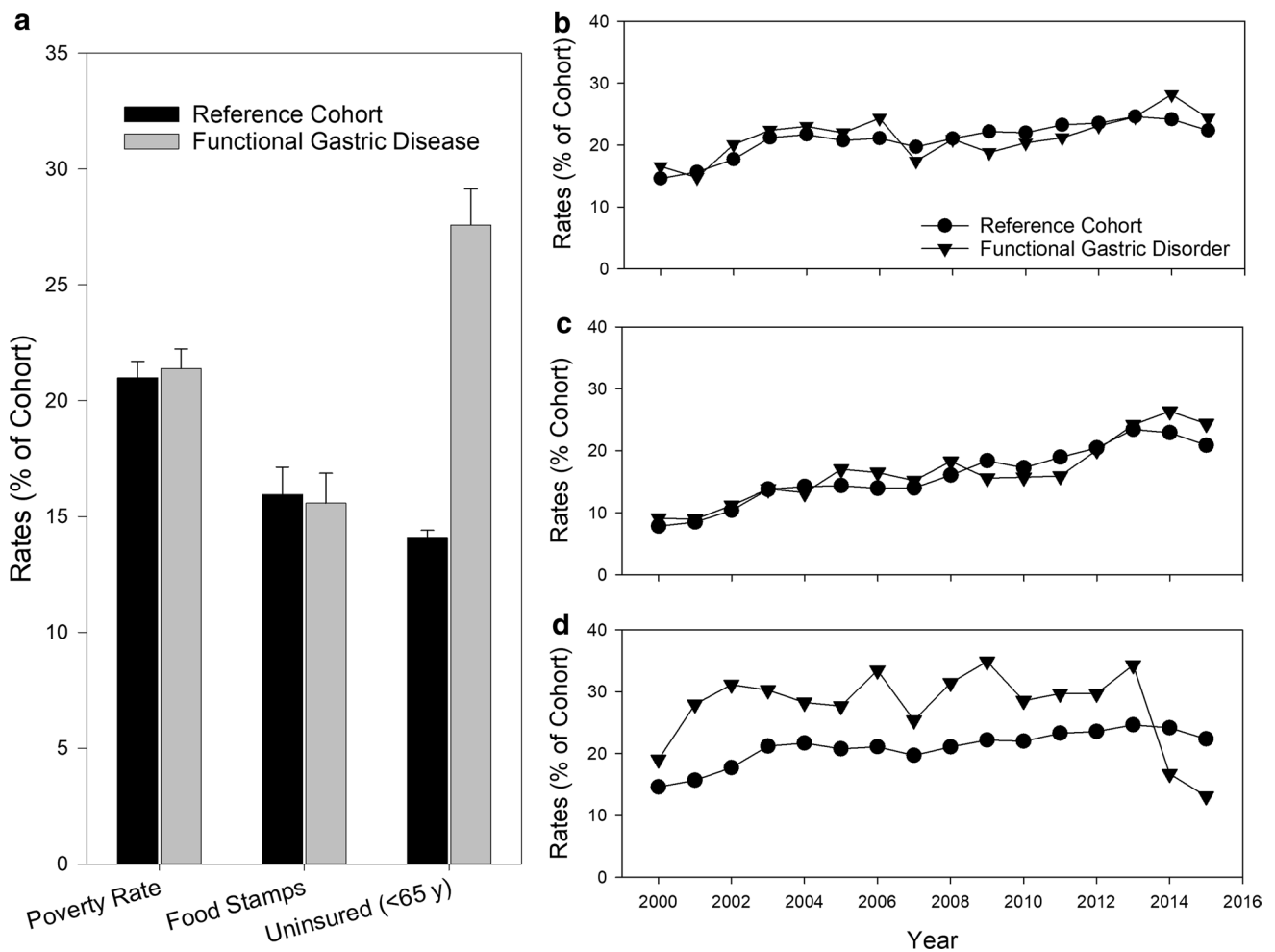
## Healthcare Utilization

Focusing on the relative number of persons using different healthcare services, the cohort with functional gastric disorders had significantly more encounters in the ambulatory care setting including ER visits (office visits:  $X^2 = 2110$ ;  $P < 0.001$ ; hospital-based outpatient visit:  $X^2 = 3171$ ;  $P < 0.001$ ; ER visits:  $X^2 = 27,697$ ;  $P < 0.001$ ), had more hospitalizations ( $X^2 = 1871$ ;  $P < 0.001$ ), and received more prescriptions ( $X^2 = 3888$ ;  $P < 0.001$ ) than the entire cohort (Fig. 2a). Focusing on the fraction of persons attributing utilization of different resources to the functional gastric disorders, only a fraction of the persons reported a relation to their stomach problems, with  $33.8 \pm 0.6\%$  for office visits,  $15.3 \pm 0.7\%$  for hospital-affiliated ambulatory care encounters,  $22.6 \pm 0.9\%$  for ER visits,  $10.9 \pm 0.8\%$  for hospitalizations, and  $66.8 \pm 0.8\%$  for prescriptions (Fig. 2a). The pattern largely remained stable during the period examined (Fig. 2b–f). The percentage of persons having office-based encounters declined between 2008 and 2013, before increasing again ( $z = -3.49$ ;  $P < 0.01$ ). Visits in hospital outpatient settings and the number of persons receiving prescription medications dropped slightly ( $z = -2.45$ ;  $P < 0.05$ ;  $z = -5.41$ ;  $P < 0.01$ ), while ER visits increased ( $z = 3.72$ ;  $P < 0.01$ ). The fraction of persons hospitalized was unchanged ( $z = -1.5$ ; n.s.). When quantifying healthcare resource utilization rather than simply separating users from nonusers, the relative impact of functional gastric disorders decreases with again only a fraction of the encounters or

**Table 1** Baseline demographic data on persons with self-reported functional gastric disorders

Variable	Persons with functional gastric disorder	Entire cohort	Statistic
Sample size	10,699	365,629	
Women <sup>a</sup>	$62.0 \pm 0.5\%$	$53.6 \pm 0.1\%$	$X^2 = 294.9$
Age <sup>a</sup>	$51.5 \pm 0.7$ years	$45.0 \pm 0.03$	$z = -69.0$
Body mass index (kg/m <sup>2</sup> ) <sup>a</sup>	$28.2 \pm 0.1$	$27.7 \pm 0.01$	$z = -50.5$
Underweight (BMI < 18.5) <sup>a</sup>	$2.4 \pm 0.1\%$	$1.9 \pm 0.1\%$	$X^2 = 3328$
Obese (BMI > 30)	$32.2 \pm 0.5\%$	$28.6 \pm 0.1\%$	
Morbidly obese (BMI > 35) <sup>a</sup>	$13.5 \pm 0.3\%$	$11.2 \pm 0.1\%$	
Married <sup>a</sup>	$49.6 \pm 0.5\%$	$51.8 \pm 0.1\%$	$X^2 = 20$
Race <sup>a</sup>	$74.3 \pm 0.4\%$	$63.8 \pm 0.1\%$	$X^2 = 71.8$
Caucasian	$16.7 \pm 0.4\%$	$18.3 \pm 0.1\%$	
Black	$6.1 \pm 0.2\%$	$8.9 \pm 0.1\%$	
Asian	$0.9 \pm 0.1\%$	$1.1 \pm 0.1\%$	
Native American	$1.9.1\%$	$6.5 \pm 0.1\%$	
Asian/Pacific Islander			
Hispanic	$25.4 \pm 0.4\%$	$25.2 \pm 0.1\%$	$X^2 = 0.2$

<sup>a</sup> $P < 0.01$



**Fig. 1** Economic indicators of the cohorts surveyed are expressed as percentage of the cohort below the poverty line, receiving food stamps, or being uninsured (restricted to adults under 65 years). **a** Average data for all participants during the period studied. The black bars represent the entire cohort, the gray bars show results for persons

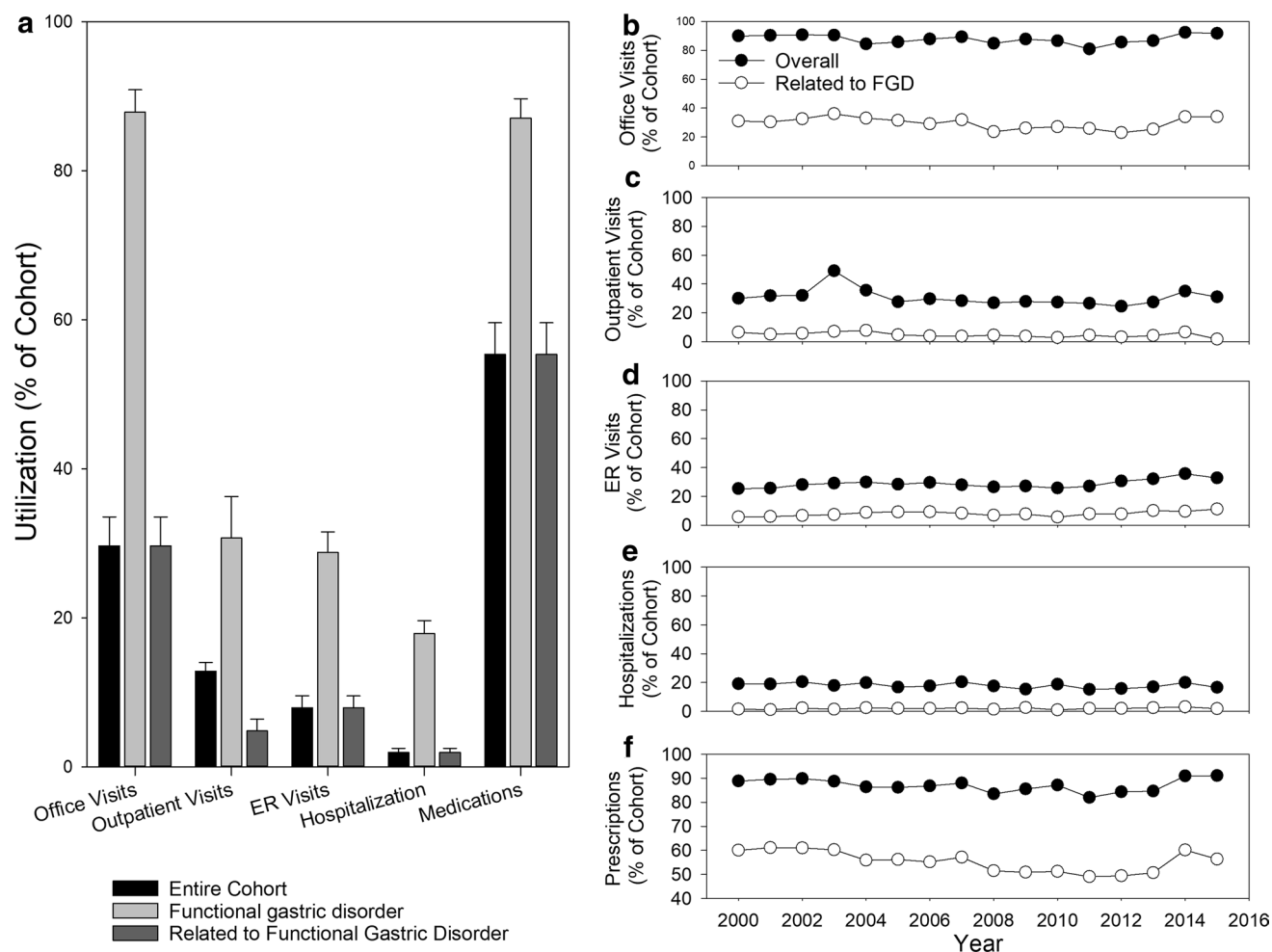
with functional stomach disorders. **b–d** Data over time (circles: entire cohort; triangles: persons with functional gastric disorders) for the fraction of persons falling below the poverty line (**b**), receiving food stamps (**c**), or being uninsured (**d**)

**Table 2** Comorbidity burden reported by persons with functional gastric

Condition	Reference cohort (%)	Cohort with functional gastric disorder (%)	X <sup>2</sup> and significance
Hypertension	23.9 ± 2.5	44.0 ± 5.6	10,930.8; P < 0.001
Diabetes mellitus	9.0 ± 1.3	16.5 ± 3.0	1777.6; P < 0.001
Coronary artery disease	4.2 ± 1.1	9.2 ± 1.9	1336.2; P < 0.001
Stroke	3.2 ± 0.6	7.2 ± 1.2	1166.6; P < 0.001
Arthritis	15.8 ± 2.0	38.8 ± 5.9	11,374.6; P < 0.001
Asthma	9.3 ± 0.2	13.3 ± 1.6	117.7; P < 0.001
Emphysema	1.7 ± 0.3	4.1 ± 1.0	716; P < 0.001

prescriptions being attributed to this diagnosis. As shown in Fig. 3a, functional gastric disorders accounted for only 6.7 ± 0.2% of the office visits, 5.3 ± 0.2% of encounters in hospital-affiliated ambulatory care centers, 20.3 ± 0.4%

of the ER visits, 8.4 ± 0.2% of the hospitalizations, and 3.5 ± 0.1% of annual prescriptions. Consistent with this observation, only a minority of persons received acid-suppressive medications, antiemetics, or metoclopramide, which



**Fig. 2** Healthcare utilization of the cohorts. **a** Averages for the entire period studied (black bar: entire cohort; light gray: cohort with functional gastric disorders; dark gray: utilization for functional gastric disorders; data given as percentages). The results were significantly different for all categories, when persons with functional gastric disorders were compared to the entire cohort of adult participants

are often employed to treat functional gastric disorders (Fig. 3b). As several studies of gastroparesis reported high rates of opioid use, we also identified persons with at least one opioid prescription during the year they participated in the survey. Numbers remained stable with  $5.6 \pm 1.0\%$  of the cohort having submitted a prescription for opioids to their pharmacy ( $X^2 = 17.6$ ; n.s.; Fig. 3b). Similarly, there were no significant changes in the use of acid-suppressive agents ( $X^2 = 24.9$ ), metoclopramide ( $X^2 = 26.8$ ), and antiemetics ( $X^2 = 38.9$ ).

### Cost of Care

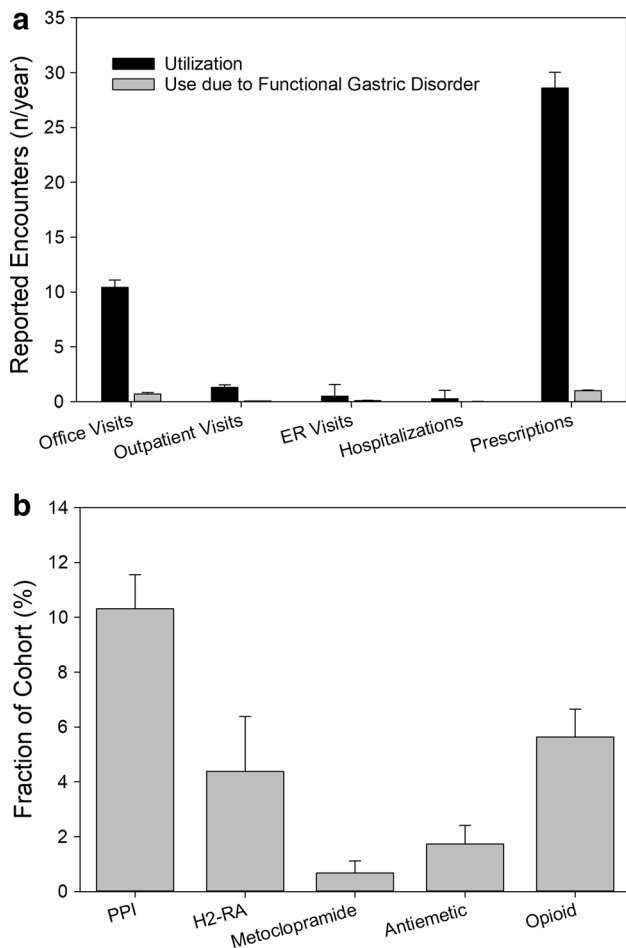
Consistent with the higher resource utilization, the annual expenses for healthcare services were higher for persons with functional gastric disorders compared with the entire cohort

( $P < 0.001$ ). **b–f** Annual data for office-based visits (**b**), outpatient visit in hospital-based centers (**c**), emergency room visits (**d**), hospitalizations (**e**), and drug prescriptions (**f**). Black symbols show utilization of services; white circles represent data limited to utilization for functional gastric disorders (FGD) in these cohorts

( $F = 85$ ;  $P < 0.001$ ; Fig. 4a). Between 2000 and 2015, expenditures rose from  $\$ 6072 \pm 524$  to  $\$ 12,985 \pm 1009$  ( $z = 8.75$ ;  $P < 0.001$ ). The rate of rise was comparable between the two groups ( $F = 3.5$ ; n.s.) and by far outpaced the rate of inflation derived from the consumer price index ( $F = 5.99$ ;  $P < 0.001$ ; Fig. 4b). Out-of-pocket expenses accounted for  $5.8 \pm 3.0\%$  of the total costs. While expenditures rose over time as described above, the self-pay remained stable and dropped after the changes in Medicare with the average fraction falling from  $7.4 \pm 1.2$  to  $4.5 \pm 1.0\%$  ( $z = -17.98$ ;  $P < 0.001$ ).

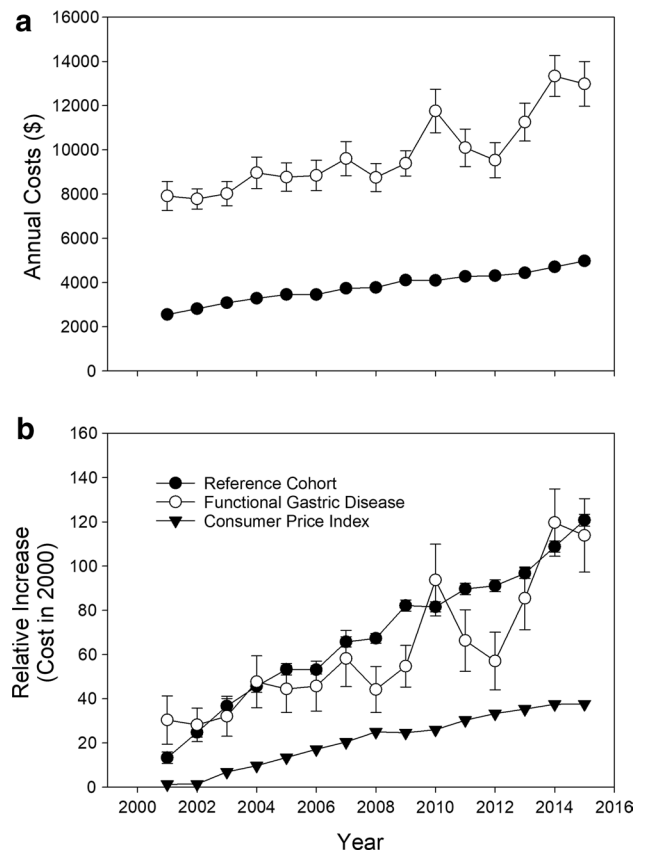
### Impact

To address the effects of illness on functional status, we analyzed global statements about perceived limitations, the need for help with activities of daily living, and the



**Fig. 3** Utilization of healthcare services and prescription medications in persons with functional gastric disorders. **a** The average number for office visits, hospital-based outpatient clinics, ER visits, hospitalizations, and prescriptions for all causes (black bars) and for management of the functional gastric disease (gray bars). **b** The average percentage of persons with prescriptions for proton pump inhibitors (PPIs), histamine-2 receptor antagonists (H2-RA), metoclopramide, antiemetics, and opioids

physical and mental components of the SF-12. As shown in Fig. 5a, about 6% of persons with functional gastric disorders required assistance for activities of daily living, with nearly one-quarter experiencing activity limitations or limitations in their work life. Thirteen percent reported a limiting impact on their social life. Compared to the entire cohort of respondents as reference group, these results point at a significant illness impact (difficulties with activities of daily living:  $X^2 = 1360$ ,  $P < 0.01$ ; activity limitations:  $X^2 = 4365$ ;  $P < 0.001$ ; limitations at work:  $X^2 = 2291$ ,  $P < 0.01$ ; social limitations:  $X^2 = 139,001$ ;  $P < 0.001$ ). When asked about absenteeism, 3510 respondents (32.8%) mentioned not being able to work on one or more days during the year, with rates remaining stable over time ( $z = 1.33$ ; n.s.). Consistent with these summarizing statements, the physical

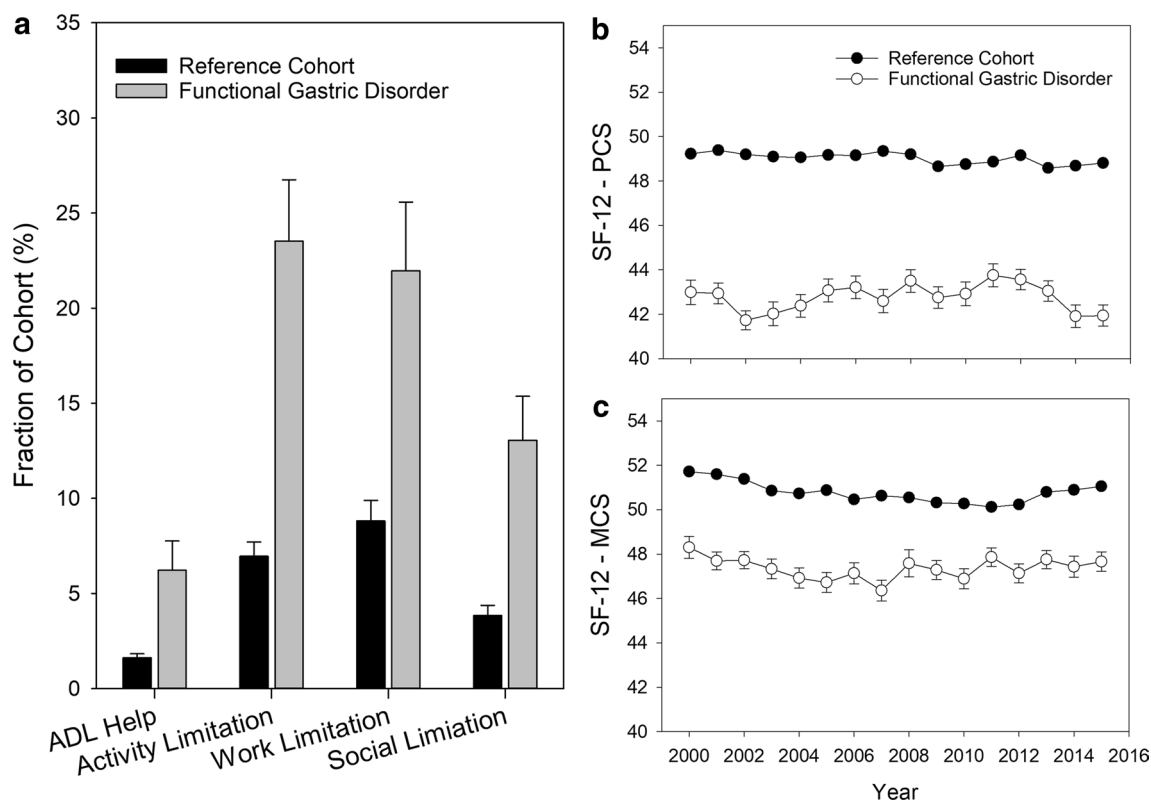


**Fig. 4** Annual changes in the cost of care for the time between 2000 and 2015. **a** The absolute cost of care without adjustment for inflation (black symbols: entire cohort surveyed; white symbols: persons with functional gastric disorders). The data are normalized to the level in 2000 as 100% to demonstrate the relative increase and compared to inflation rate derived from the consumer price index (black triangles)

(PCS:  $F = 3198.2$ ;  $P < 0.01$ ) and mental (MCS:  $F = 1135.4$ ;  $P < 0.01$ ) components of the SF-12 were significantly lower than expected for healthy individuals and seen in the entire cohort and remained stable over time (PCS:  $z = 0.67$ ; n.s.; MCS:  $z = -0.21$ ; n.s.; Fig. 5b, c).

**Predictors of Utilization**

To account for the many different variables with potential type 2 errors, we performed a Poisson regression, entering demographic, economic, and health-related variables. We focused on ER visits and hospitalizations as key variables, as prior studies showed their importance of drivers of health-care costs. Comorbidity burden, opioid prescriptions, and, to a limited degree, other outpatient encounters were associated with higher likelihoods of ER visits or admissions, while male sex, increasing age, better ratings of physical functioning, and living in poverty correlated with lower rates for these endpoints (Table 3).



**Fig. 5** Self-described function and quality of life of persons with functional gastric disorders. **a** The average fraction of persons requiring help for activities of daily living (ADL) or describing limitation for activities, work, or social lives (black bars: entire cohort surveyed; gray bars: persons with functional gastric disorders). The results of

the SF-12 are displayed for the physical (**b**) and mental (**c**) scores for the cohorts surveyed between 2000 and 2015 (black symbols: entire cohort; white symbols: persons with functional gastric disorders). Differences were significant with  $P < 0.001$  for all comparisons

## Discussion

Using data from a randomly chosen cohort of the general population, this study shows an impact of functional gastric disorders, as perceived limitations on activities, work, and social life are common and as healthcare utilization and costs are higher than experienced by most Americans. However, most of this indirect illness burden is due to comorbid conditions rather than the gastric disease. More importantly, the results do not show frequent ER visits or common and even increasing hospitalization rates, which stands in contrast to observational studies of patient cohorts seen in tertiary care centers and which should be reassuring information for patients and providers. Our data also identified opioid prescriptions a potential driver of healthcare resource utilization. This finding may be especially important as several studies showed a high prevalence of opioid use in their cohorts. Lastly, the cost of care rose significantly over time, by far outpacing inflation. However, this steep rise in healthcare costs mirrors results seen in the general population, highlighting the challenge of healthcare inflation the US faces.

Cohort studies report frequent and often expensive hospitalizations in persons with gastroparesis [12, 17–19]. Pasricha et al. [7] surveyed healthcare resource utilization in patients with chronic unexplained nausea and reported only slightly lower rates when compared to patients seen with gastroparesis. Cyclic vomiting syndrome as another functional gastric illness comes with high rates of emergency room visits and hospitalizations [20–22]. While the data structure of MEPS does not provide details required to differentiate between these disorders, ER visits and hospitalizations were substantially lower compared to published studies conducted in tertiary referral centers. Focusing on population-based studies, about 60–80% of persons with functional dyspepsia will seek medical advice and use medications to treat their illness [23–25]. Similarly, patients with dyspeptic symptoms who are seen by primary providers use more healthcare services than matched controls, with about half of these additional interventions addressing gastrointestinal issues [26]. This need for more medical care and interventions comes with direct costs due to healthcare expenditures. Consistent with our findings, this increase in costs is at least partly driven by a higher burden of comorbid

**Table 3** Potential predictors of emergency room visits and hospital admissions

Variable	Emergency room visits		Hospitalizations	
	IRR <sup>a</sup>	95% CI <sup>b</sup>	IRR <sup>a</sup>	95% CI <sup>b</sup>
<i>Demographics</i>				
Age	0.977	0.973–0.981	0.987	0.979–0.996
Male sex	1.199	1.042–1.379	0.952	0.716–1.265
Race	0.962	0.917–1.009	0.972	0.879–1.074
Hispanic	0.989	0.852–1.148	1.233	0.874–1.741
Body mass index	0.992	0.982–1.001	0.983	0.964–1.002
<i>Health and healthcare</i>				
Opioid use	1.829	1.487–2.250	1.886	1.244–2.859
Comorbidity burden	1.169	1.088–1.255	1.173	1.030–1.336
SF-12 physical component	0.982	0.976–0.989	0.970	0.958–0.983
SF-12 mental component	0.998	0.993–1.004	0.996	0.983–1.006
Office visits	1.002	1.000–1.006	1.007	1.009–1.012
Hospital-based clinic visits	1.004	0.995–1.012	1.012	1.003–1.021
Annual prescriptions	0.998	0.995–1.000	1.001	0.998–1.005
<i>Socioeconomics</i>				
Below the poverty line	0.625	0.541–0.722	0.725	0.534–0.984
Uninsured	0.982	0.976–0.989	0.791	0.482–1.300

Demographic data, variables related to health status, and economic situation were entered into a Poisson regression to determine the role as risks for ER visits and hospital admissions

<sup>a</sup>IRR Incidence rate ratio

<sup>b</sup>CI Confidence interval

conditions [27, 28]. This impact of comorbidities is not unique to functional gastric disorders but is generally seen in functional gastrointestinal disorders and could be related to healthcare-seeking behavior or the common coexistence of other illnesses ranging from migraines to fibromyalgia or anxiety and depression [23, 29–32]. Thus, our data fit into a pattern seen in studies that examined population-based survey responses [23, 24] or insurance claims data [27, 28], clearly showing an impact of these functional disorders but painting a less pessimistic picture than studies conducted in specialized centers.

Consistent with the higher resource utilization, the unadjusted annual healthcare expenditures for persons with functional gastric disorders were higher than reported for the entire cohort. During the period studied, the cost of care outpaced the rate of inflation based on the consumer price index. However, relative increments were similar across groups and fit into the known pattern of healthcare inflation in the USA [33, 34]. Despite the rapid increase in healthcare costs, out-of-pocket contributions did not follow this trend, largely due to changes in contributions for prescriptions, which accounted for 23.4 and 45.6% of self-pay in

non-elderly and elderly adults in 2003 [35]. This percentage fell slightly with the more widespread use of generics [36] and dropped further with implementation of Medicare Part D and the Accountable Care Act. The decrease in co-pays may not be representative for the burden of healthcare costs for other groups as biologicals and agents targeting specific signaling pathways are more commonly used [37]. These newer drugs do not only come with higher costs but often also require higher in out-of-pocket expenses [38–40].

The impact of functional gastric disorders goes beyond the use and cost of medical services. Nearly a quarter of the cohort reporting such a problem also described limitations on activities, often including work and social interactions. Survey responses in a population-based study suggest even higher numbers in persons meeting diagnostic criteria for functional dyspepsia; interestingly, the higher fraction of persons describing that daily activities were affected by their illness (61%) contrasted with a lower rate of absenteeism of 12.5%, which was about one-third of the persons surveyed in this study [24]. Differences in the definition or perception of activity limitations may contribute to these apparent discrepancies, as indicated by a cohort study of patients with gastroparesis, which reported such limitations in 67% but related not only missed work days but disability in 11% to this illness [41]. The latter number corresponds with the observation that less than 50% of a large patient group with gastroparesis seen in a specialized center were employed [42]. Thus, even if the apparently higher impact on productivity based on the skewed population seen in tertiary care centers represents the far end of the spectrum, the high prevalence of dyspeptic symptoms in the general population and its apparent effect on well-being and function likely generates significant indirect costs due to absenteeism and the resulting in loss of productivity [43].

Disease impact was also apparent of the quality-of-life measures obtained. The physical and mental sub-scores of the SF-12 were lower than the established reference values for healthy persons and the mean values of the entire cohort participating in the MEPS. Results fell within the range seen in a population-based study of persons meeting diagnostic criteria for functional dyspepsia [44]. Consistent with other findings, the quality-of-life scores are higher than reported in patient cohorts recruited in tertiary care centers [45, 46].

Looking at medication use, we noted relatively stable patterns with acid-suppressive agents being most commonly used. However, the results are lower than reported in population studies or insurance claims data that relied on symptom-based consensus criteria or a diagnosis made by a healthcare provider [47, 48]. As these agents are widely available as over-the-counter medication, we may only partially capture their role. Considering the role of nausea in functional gastric disorders, symptomatic treatment with antiemetics is frequently reported in patient



cohorts [13, 18] and may even be increasing [49], a pattern our data do not reflect. Several cohort studies suggest high rates of opioid use in patients with gastroparesis seen in tertiary care centers with number ranging between 25 and 41% [12, 18, 42]. The use of these agents does not only raise questions about their potential contribution to impaired stomach function and dyspeptic symptoms; these studies and our analysis also show a correlation with increased hospitalization rates. Yet, our data do not show an increasing use of prescription opioids, with stable rates of about 5% throughout the period studied, which are substantially lower than those reported in studies of patient groups seen in tertiary care. Interestingly, the findings also fall below findings representative for the US population, as Miller and Moriya determined that 13% of adults under 65 years of age received at least one opioid prescription in 2015 and 2016 [50] with an even higher number (19%) in person 65 years and older [51]. Thus, the overall use of prescription medication is not only lower than seen in the skewed patient populations seen in tertiary centers, but it also falls below numbers seen in some population-based investigations.

While this study provides important and interesting information about the impact of functional gastric diseases, it comes with several limitations. First, the diagnosis code is based on self-reported problems or illnesses rather than confirmed diagnoses or accepted consensus criteria. Second, the classification scheme is limited to the three-digit ICD-9 code, thus not allowing to differentiate between distinct disorders, such as gastroparesis and cyclical vomiting. Moreover, a fraction of these self-reported problems may well have been acute problems, thus differing from functional dyspepsia or gastroparesis, which are defined by chronicity. While the survey includes questions about disease onset and need for ongoing care, most of the responses were listed as “not available.” Nonetheless, there are parallels with other studies focusing on functional gastric illnesses, as we noted a clear female predominance and an age distribution that mirrors that seen in clinical cohorts [13, 18, 52]. Considering our interest in time trends in impact and management, we did not attempt to use matched controls to compare findings with respondents who reported functional gastric disorders. If we used reference data, we chose results obtained for the entire adult population covered by MEPS, which was younger with less comorbid conditions, showed less of a female predominance, and had a different racial distribution. Nonetheless, the comparison with a representative sample of American adults provides an important anchoring point for the interpretation of our data. Lastly, time trends described in this analysis represent data from independent cohorts that were chosen as MEPS participation for a single year and do not represent a longitudinal study of a defined and consistent cohort over time.

Overall, this study shows that persons with self-reported functional gastric disorders have an increased use of health-care resources, which is significantly affected by coexisting illnesses and comes with the direct burden of health-care cost and the indirect impact on quality of life, ability to function at home and at work. However, this impact is less than reported for patient cohorts seen in specialized centers and remained stable over time, thus contrasting with recent reports and providing some reassuring outlook for patients and providers.

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