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GENDER DIFFERENCE IN CLINICAL CONDITIONS AMONG HOSPITALIZED ADULTS WITH MYOTONIC DYSTROPHY

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Abstract

Introduction: In this study we examined gender differences in adult hospitalizations with myotonic dystrophy (DM).

Methods: From the Nationwide Inpatient Sample (NIS) 2010–2014, we identified 1,891 adult hospitalizations with a DM diagnosis and constructed a comparison group of hospitalizations without DM using propensity score matching. We calculated relative risk by gender for 44 clinical diagnoses that each accounted for at least 5% of DM hospitalizations.

Results: Hospitalizations with DM were longer (4.8 vs. 4.1 days, $P < 0.0001$) and more costly ($13,241 vs. $11,458, $P < 0.0001$) than those without DM. More than half (25 of 44) of the conditions co-occurring with DM hospitalizations did not differ in their relative risks by gender. For those that differed by gender, only 5 were specific to DM, compared with hospitalizations without DM.

Discussion: Our findings highlight the importance of comprehensive and coordinated care for DM rather than gender-oriented care in the inpatient setting.

Keywords

co-occurring conditions; DM; gender differences; hospitalizations; matching

Myotonic dystrophy types 1 (DM1) and 2 (DM2) together are the most prevalent muscular dystrophies, with a pooled prevalence of 8.3 per 100,000.[1] Both have multisystem manifestations that may affect cognition, cardiac function, pulmonary function, the endocrine system, and the gastrointestinal system.[2,3]

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Recent studies reported gender differences in clinical manifestations of DM. Using registry data and a survey of French DM1 patients, researchers reported a higher percentage of males with more severe muscular disability, myotonia, muscle weakness, cardiac involvement, respiratory involvement, developmental abnormalities, and cognitive impairment. Females more frequently had cataracts, dysphagia, digestive tract dysfunction defined as either constipation or diarrhea, incontinence, thyroid dysfunction, and obesity.[4] Another study using patient-reported data and medical records in a U.S. national registry of patients with DM1 and DM2 showed that females with DM1 were at greater risk than males for constipation and gallbladder problems.[5] In a retrospective study conducted on 307 patients with genetically confirmed DM2, the authors found that cataract and thyroid diseases occurred more frequently in women.[6] However, there has been no national study in the U.S. on gender differences in multisystem manifestations of DM using inpatient data.

We analyzed conditions recorded as discharge diagnoses among hospitalized adult patients with and without DM using a U.S. national inpatient database. Our aims were to: (1) identify conditions that were more likely to be recorded in hospitalizations among adult patients with DM as compared with hospitalizations without DM; (2) describe gender differences in the relative risk of these conditions; and (3) determine whether any gender differences were unique to DM or if the gender differences were also observed in comparable hospitalizations among adult patients without DM.

METHODS

Data Sources and Study Population.

This was a retrospective study using data over a 5-year period (from 2010 through 2014) from the Nationwide Inpatient Sample (NIS) database maintained by the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCUP). The NIS is the largest publicly available, all-payer inpatient health care database in the U.S. The NIS contains clinical and nonclinical data for each hospital stay, such as primary diagnoses, patient demographic characteristics, hospital characteristics, total charges, and length of stay.[7] The NIS is a sample of discharges from the state inpatient databases. Before the year 2012, the NIS contained all discharge data from a sample of hospitals each year, which represented a 20% stratified sample of U.S. community hospitals. Starting in 2012, the NIS used a redesigned sampling method to sample discharge records from all hospitals participating in the HCUP.[7] To increase the number of observations of rare outcomes, we included data before and after 2012.

There were 37,312,324 hospital discharge records from 2010 through 2014 in the NIS database. We excluded records with any of the following characteristics: age at admission younger than 18 years; pregnant; hospitalized during childbirth and puerperium; death while in the hospital; or transfer from another hospital. We also excluded records with missing information on any of the following variables: length of stay; total charges; age; sex; race; insurance type; hospital region; hospital bed size; and rural/urban location and teaching status of the hospital.

Case Identification and Costs.

We used the *International Classification of Diseases, ninth revision* (ICD-9) diagnosis codes to identify patients with DM (ICD-9 code: 359.21). This code includes both DM1 and DM2. We used the hospital-level cost-to-charge ratio files to convert the total charges to costs[8] and we adjusted the annual charges to 2014 dollars based on the consumer price indices of the Bureau of Labor Statistics.[9]

Matching.

We matched, one-to-one, the group of hospitalizations among adult patients with DM with a group of hospitalizations among adult patients without DM, using propensity scores. Propensity score matching is a statistical technique designed to reduce bias due to confounding.[10,11] The propensity scores were estimated through logistic regression by modeling the presence of DM diagnosis as a function of key patient and hospital characteristics, including age, sex, insurance type, race/ethnicity, hospital region, hospital bed size, and rural/urban location and teaching status of the hospital. Each hospitalization of an adult patient with DM was matched with a hospitalization of an adult patient without DM with the closest propensity score on the logit scale. If there were multiple matches, one was randomly chosen. The matching ensured that both groups of hospitalizations had comparable demographic, insurance, and hospital characteristics.

Clinical Classifications Software Diagnosis Codes.

The AHRQ's Clinical Classifications Software (CCS) is a tool for categorizing ICD-9 diagnosis and procedure codes into clinically meaningful categories.[12] We used single-level CCS diagnosis codes, which grouped more than 14,000 ICD-9 diagnosis codes into over 200 clinical categories.[12] The NIS data included up to 30 discharge diagnoses per hospitalization and we investigated all diagnosis codes listed, including both principal and secondary diagnoses. Based on CCS diagnosis codes, we selected 44 codes, each with a percentage of hospitalizations greater than or equal to 5% of all hospitalizations among adult patients with DM.

Statistical Analysis.

We used unweighted observations in our analysis. The first level of analysis was an overall comparison of hospitalizations with a DM diagnosis and those without a DM diagnosis in the NIS. We performed simple logistic regression model to assess the associations between DM status and demographic or hospital characteristics. We evaluated the associations between DM and length of stay or total charges using nonparametric Wilcoxon's rank sum tests.

We then used the MatchIt package[13] in R software version 3.3.3 (R Foundation for Statistical Computing, Vienna, Austria) to perform propensity score matching analyses. Finally, based on the matched sample of hospitalizations with and without DM, we calculated relative risks and their corresponding 95% confidence intervals for each CCS category to determine which CCS categories were significantly associated with DM and which CCS categories significantly differed by gender.

We used SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina) to conduct all statistical analyses, except for propensity score matching. We considered results as statistically significant when a two-tailed test yielded $P < 0.05$ or when a 95% confidence interval did not include 1.

RESULTS

After applying our exclusion criteria, 18,717,906 (50.2%) adult hospitalization records remained in our study sample. Among these, we identified 1,891 hospitalizations among adult patients with DM and 18,716,015 hospitalizations among adult patients without DM.

The characteristics of adult hospitalizations by whether DM was recorded as a discharge diagnosis were shown in Table 1. Compared with adult hospitalizations among patients without DM, a higher percentage of adult hospitalizations among patients with DM were white and insured by Medicaid. There were no statistically significant differences in the year of admission and hospital bed size between adult hospitalizations with and without DM diagnosis. The mean length of stay (4.8 vs. 4.1 days) and total costs ($13,241 vs. $11,458 in 2014 dollars) were higher for adult hospitalizations among patients with DM. A total of 1,891 hospitalizations without DM were successfully matched to 1,891 hospitalizations with DM based on the similarity of their propensity scores, indicating comparable demographic and hospital characteristics.

The relative risk for each of the 44 clinical conditions accounting for 5% or more of the hospitalizations among adult patients with DM were shown in Figure 1 (for exact numbers refer to Table S1 in the Supplementary Material online). Twenty-five conditions were more likely to be recorded as discharge diagnoses on hospitalizations among adult patients with DM, as indicated by a relative risk significantly greater than 1, in comparison to hospitalizations among adult patients without DM. For example, hospitalizations among adult patients with DM were more than 4 times as likely to having co-occurring conduction disorders recorded as hospitalizations among adult patients without DM. Twelve conditions were equally likely to be recorded as discharge diagnoses in hospitalizations among adult patients with and without DM, such as diabetes mellitus without complications. Eight clinical conditions were more likely to be discharge diagnoses for hospitalizations among adult patients without DM, such as essential hypertension.

Gender differences for the selected 44 clinical conditions by DM status among these 3,782 matched adult hospitalizations were shown in Figures 2 and 3 (for exact numbers refer to Table S2 online). Compared with hospitalizations among adult male patients with DM, hospitalizations among adult female patients with DM were more likely to have 11 conditions recorded as discharge diagnoses, such as thyroid disorders. Conversely, when compared with hospitalizations among adult female patients with DM, hospitalizations among adult male patients with DM were more likely to have 8 conditions recorded as discharge diagnoses, such as conduction disorders.

For more than half of the 44 examined discharge diagnoses, there were no significant gender differences among hospitalized adult patients with and without DM. Of the discharge

diagnoses that adult female patients with DM are more likely to have than their male counterparts, only 3 did not have elevated risks in hospitalizations among female patients without DM. These included nonspecific chest pain, bacterial infection (unspecified site), and complications of surgical procedures or medical care. Of the discharge diagnoses that adult male patients with DM were more likely to have than their female counterparts, only 2 were specific to DM: intestinal obstruction without hernia and other upper respiratory disease.

DISCUSSION

The high rate of Medicaid usage reflected the overall morbidity among DM patients. The differences in length of stay and total costs in adults with or without DM reflected the overall severity of DM; patients with DM were more likely to have longer and more expensive hospitalizations than patients without DM. Investigation of the conditions co-occurring with DM hospitalizations revealed the multisystem nature of the condition, including cardiac, respiratory, and gastrointestinal dysfunctions. These findings were consistent with previous findings such as those reported for a Utah population.[14]

We found some conditions for which the gender differences in hospitalizations in adult patients with DM were larger compared with the gender differences observed in hospitalizations in adult patients without DM. For example, nonspecific chest pain was more often a discharge diagnosis among adult female DM patients than among adult male DM patients. In comparison, there was no significant gender difference in discharge diagnosis of chest pain among adult patients without DM. Such differences may indicate gender-oriented care management. However, in more than half of the co-occurring conditions, the relative risks did not differ by gender. For the most part, the gender differences observed among adult patients with DM were also observed among hospitalized adult patients without DM. Thus, the results highlight the importance of comprehensive and coordinated care for DM rather than gender-oriented care management in the inpatient setting. Previous studies mainly focused on clinic outpatient care and found gender differences in some conditions in clinically confirmed DM1 or DM2 cases.[4–6] Our study focused on the inpatient setting and used a different case identification strategy via ICD-9 codes. Thus, our results were not directly comparable to those from the earlier studies.

This study has limitations. We relied on ICD-9 codes to identify DM (code 359.21). This DM code does not distinguish DM1 and DM2, thus limiting our ability to investigate gender differences separately by type of DM. Second, some states in the NIS did not report all of their diagnosis codes. It is possible that some conditions were underreported if their ICD-9 codes were not recorded. In addition, women were found to have more “nonspecific chest pain.” This illustrates the limited usefulness of ICD diagnosis codes, as this is a symptom more than a diagnosis. Continued outpatient work-up may have demonstrated occult cardiac arrhythmias as a cause, among others. Third, we focused on conditions that accounted for at least 5% of hospitalizations among adult DM patients for sample size considerations; thus, we excluded infrequent conditions, such as cancer.[15,16] Studies have shown that malignancies are more common in the DM population with gender-specific forms of malignancies. Fourth, the analysis was based on hospitalization data, so we were unable to

examine gender differences in clinical conditions treated in outpatient settings, such as obesity. Fifth, 1 patient could contribute to multiple hospitalizations in the data set. Therefore, the gender differences in hospitalizations and rehospitalizations could not be distinguished. Last, we excluded hospital transfer or hospitalizations resulting in death. We excluded transfer patients to better capture the complete hospitalization care. Deaths were excluded because hospitalizations resulting in death may have differed from those for regular hospital care. However, a French study demonstrated higher mortality in men with DM1.[4] Future studies could investigate whether mortality and causes for mortality differ by gender among patients with DM.

In conclusion, using a national U.S. hospitalization database, we found that hospitalizations in adult patients with DM were significantly longer and more costly than hospitalizations in adult patients without DM. Among the extensive list of multisystem co-occurring conditions for hospitalized adult patients with DM, the relative risks for more than half of these conditions did not differ by gender. Most discharge diagnoses that differed by gender among adult patients with DM also showed a gender difference among comparable adult patients without DM.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Abbreviations:

AHRQ	Agency for Healthcare Research and Quality
CCS	Clinical Classifications Software
DM	myotonic dystrophy
HCUP	Healthcare Cost and Utilization Project
ICD-9	International Classification of Diseases, ninth revision
NIS	Nationwide Inpatient Sample

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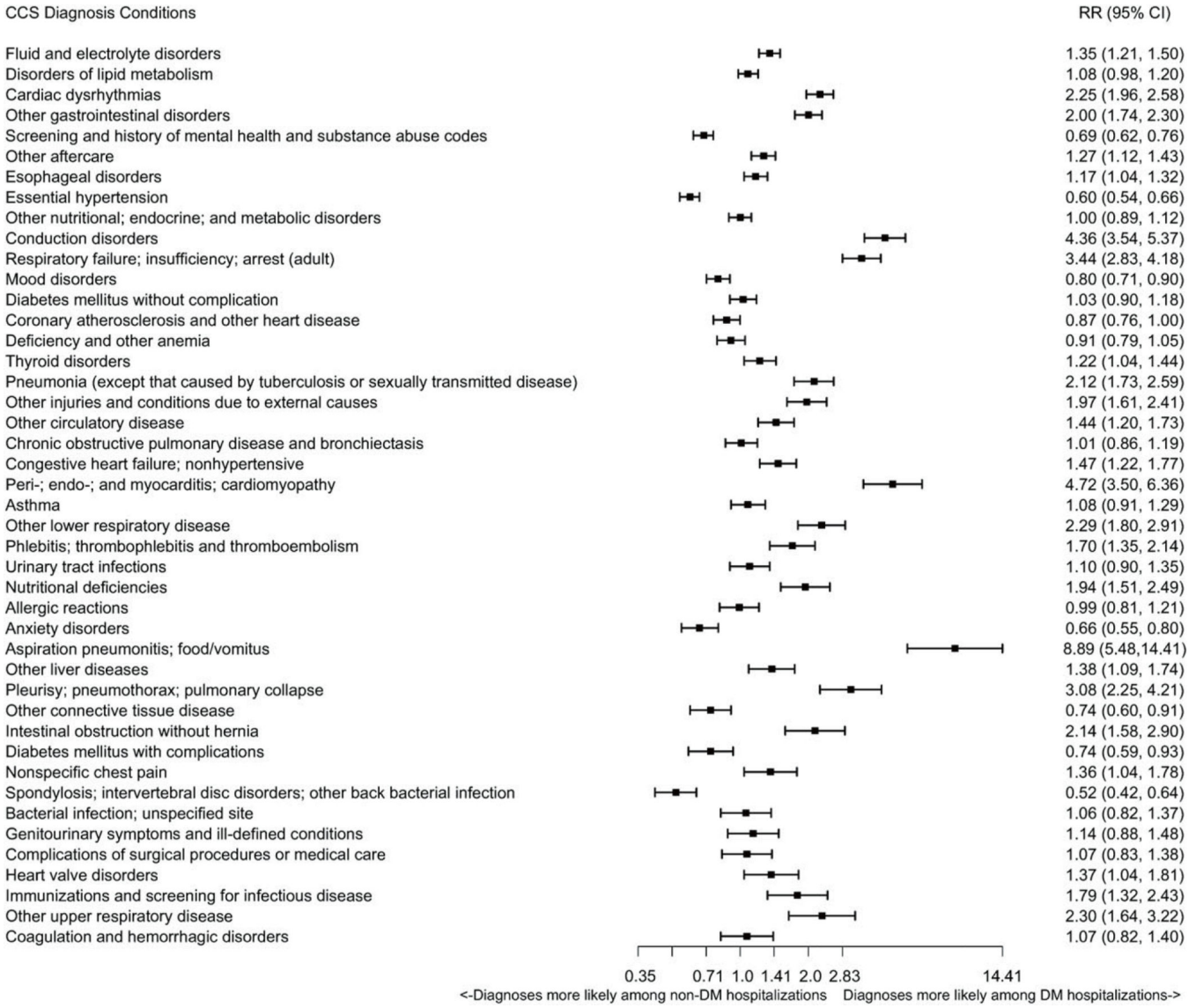

FIGURE 1.

Relative risk of comorbidities among adult hospitalizations with or without DM.

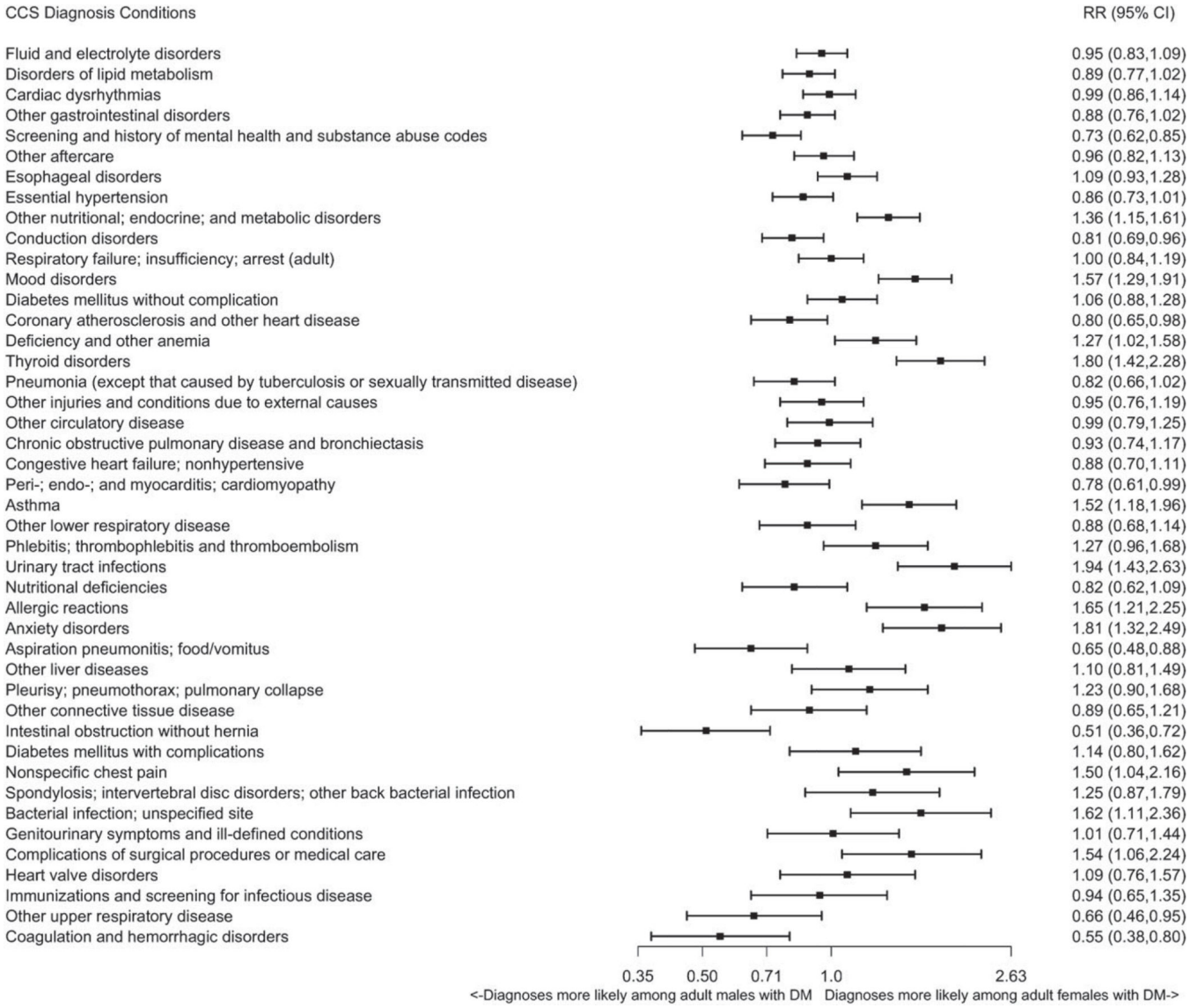

FIGURE 2.

Relative risk of comorbidities among adult hospitalizations with DM: male vs. female.

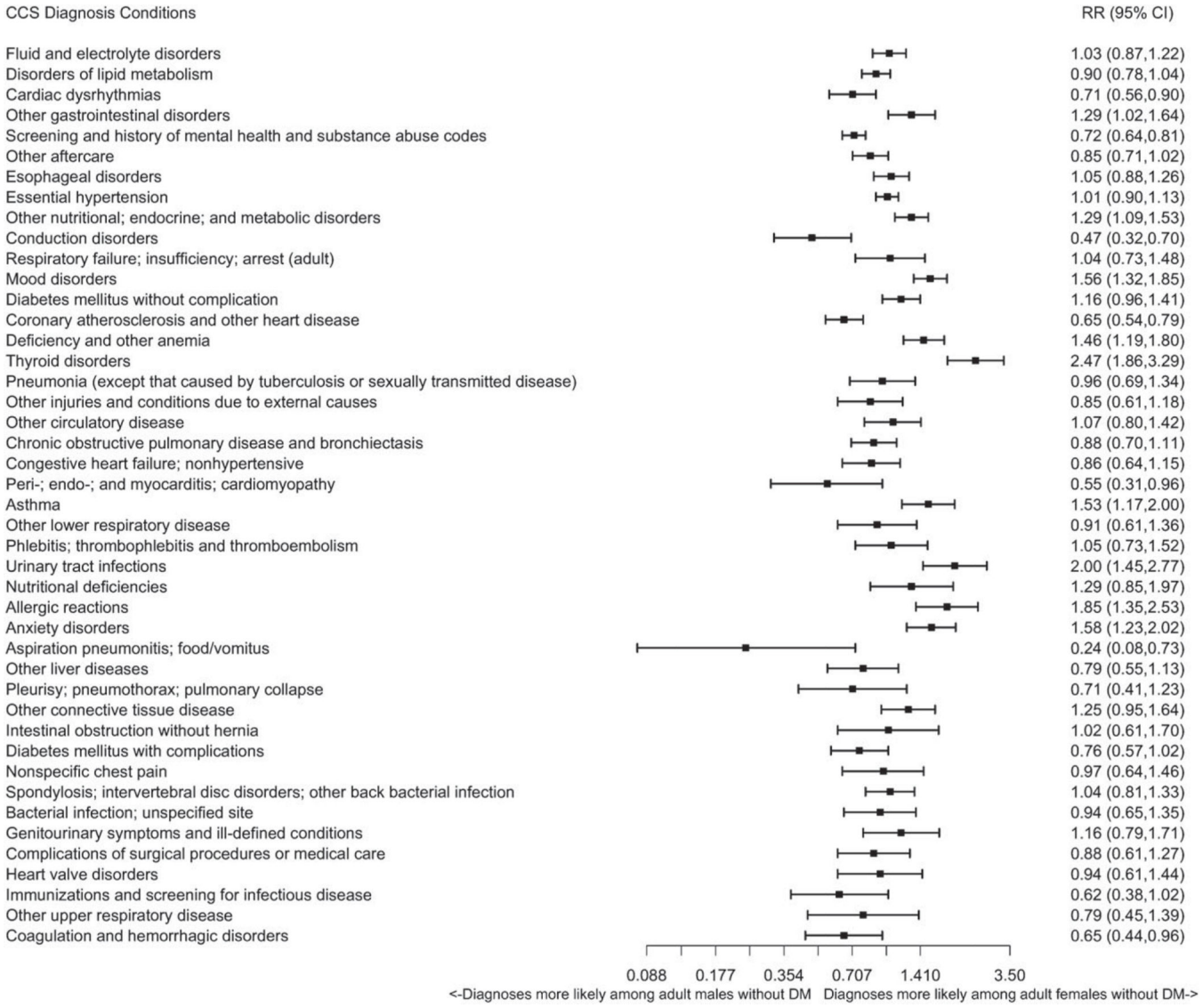

FIGURE 3.

Relative risk of comorbidities among adult hospitalizations without DM: male vs. female.

Table 1.

Characteristics of hospitalizations among adult patients with or without DM, NIS, years 2010–2014.

Variables*	Whether DM was recorded as a discharge diagnosis		Odds ratio (95% confidence interval)	*P*-value
	No (*n* = 18,716,015)	Yes (*n* = 1,891)		
Age at admission				
18–30 years	1,520,307 (8.1%)	195 (10.3%)	2.53 (2.14–2.99)	<0.0001
31–40 years	1,704,057 (9.1%)	245 (13.0%)	2.84 (2.43–3.31)	<0.0001
41–50 years	2,711,173 (14.5%)	514 (27.2%)	3.74 (3.30–4.25)	<0.0001
51–60 years	3,761,289 (20.1%)	480 (25.4%)	2.52 (2.22–2.86)	<0.0001
61+ years (reference level)	9,019,189 (48.2%)	457 (24.2%)		
Insurance type				
Medicaid	2,465,201 (13.2%)	380 (20.1%)	3.08 (2.37–4.00)	<0.0001
Medicare	8,574,689 (45.8%)	873 (46.2%)	2.03 (1.58–2.61)	<0.0001
Private	5,486,620 (29.3%)	516 (27.3%)	1.88 (1.45–2.43)	<0.0001
Other	892,162 (4.8%)	57 (3.0%)	1.28 (0.89–1.82)	0.1806
Uninsured (reference level)	1,297,343 (6.9%)	65 (3.4%)		
Sex				
Male	8,914,180 (47.6%)	858 (45.4%)	0.91 (0.83–1.00)	0.0496
Female (reference level)	9,801,835 (52.4%)	1,033 (54.6%)		
Race				
African American	2,730,821 (14.6%)	116 (6.1%)	0.36 (0.30–0.44)	<0.0001
Hispanic	1,714,911 (9.2%)	105 (5.6%)	0.52 (0.43–0.64)	<0.0001
Other	2,283,907 (12.2%)	266 (14.1%)	0.99 (0.87–1.13)	0.9321
White (reference level)	11,986,376 (64.0%)	1,404 (74.3%)		
Region of hospital				
Northeast	3,370,574 (18.0%)	412 (21.8%)	1.36 (1.17–1.58)	<0.0001
Midwest	4,238,877 (22.7%)	596 (31.5%)	1.56 (1.36–1.79)	<0.0001
South	7,750,857 (41.4%)	581 (30.7%)	0.83 (0.73–0.96)	0.01
West (reference level)	3,355,707 (17.9%)	302 (16.0%)		
Location/teaching status of hospital				
Rural	2,117,973 (11.3%)	257 (13.6%)	1.12 (0.98–1.28)	0.1107

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Variables*	Whether DM was recorded as a discharge diagnosis		Odds ratio (95% confidence interval)	*P*-value
	No (*n* = 18,716,015)	Yes (*n* = 1,891)		
Urban nonteaching	7,240,053 (38.7%)	618 (32.7%)	0.79 (0.71–0.87)	<0.0001
Urban teaching (reference level)	9,357,989 (50.0%)	1,016 (53.7%)		

* Data presented as frequency (percent). Odds ratios, 95% confidence intervals, and *P*-values were from simple logistic regression models.