DIABETES AND COVID-19 HOSPITALIZATIONS REPORT

August 2022

Abstract

This report is to describe the relationship between diabetes and COVID-19 inpatient hospitalizations in Connecticut and compare this relationship to that of non-diabetes and COVID-19 inpatient hospitalizations.

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Suggested citation: Poulin, S.M. (2022) Diabetes and COVID-19 Hospitalizations Report. Hartford, CT: Connecticut Department of Public Health.

This report was completed by the Connecticut Department of Public Health and supported by a cooperative agreement with the Centers for Disease Control and Prevention's Improving the Health of Americans Through Prevention and Management of Diabetes, Heart Disease, and Stroke (DP18-1815).

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Acknowledgements

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The author is grateful for the data, technical assistance, and/or critical review of the text provided by Justin Peng, Jennifer Behuniak, and Amy Mirizzi. These individuals are Connecticut Department of Public Health staff.

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Introduction

Diabetes is characterized by blood glucose levels that are above normal because the body does not make enough insulin, the body does not use insulin as well as it should, or both (CPSTF, n.d.). High blood sugar can lead to serious health problems that may be disabling or life-threatening. Health complications of diabetes include kidney disease, lower-extremity amputations, heart disease, and vision loss (CDC, April 2021). Furthermore, data and information collected throughout the Coronavirus Disease 2019 (COVID-19) pandemic indicate that diabetes (types 1 and 2) increases a person's risk of severe outcomes of COVID-19 (CDC, October 2021). These severe outcomes include acute respiratory distress, organ damage, and death (Li, Lv, Li, Change, & Lu, 2021).

The Diabetes and COVID-19 Hospitalizations Report is a publication of the Connecticut Department of Public Health. The main objective of this report is to describe the relationship between diabetes and COVID-19 inpatient hospitalizations in Connecticut and compare this relationship to that of non-diabetes and COVID-19 inpatient hospitalizations. The secondary objective is to detail which population subgroups are disproportionately impacted by diabetes and COVID-19. This information may be used by the Connecticut Department of Public Health and its partners to support activities that help adults with diabetes manage the condition, specifically during the pandemic.

Methods

The Connecticut Inpatient Hospitalization and Emergency Department dataset contains the number of inpatient discharges and emergency department visits in Connecticut. Each record in the dataset is a hospital discharge and not an unduplicated patient. In other words, one patient may be in the dataset multiple times if they were hospitalized multiple times. Therefore, throughout this report, numbers, percentages, and odds ratios are associated with inpatient discharges and not individual patients. Also, this analysis is limited to inpatient hospital discharges among Connecticut residents with admissions from April 1, 2020, to December 31, 2020.

Hospitalizations with diabetes as any diagnosis are defined as inpatient discharges with International Classification of Diseases (ICD)-10 Clinical Modification (CM) codes E10-E13 in any of the 15 diagnosis fields. Throughout this document inpatient discharges with diabetes as any diagnosis are referred to as diabetes hospitalizations. Hospitalizations with COVID-19 as any diagnosis are defined as inpatient discharges with ICD-10 CM code U07.1 in any of the 15 diagnosis fields. Inpatient discharges with COVID-19 as any diagnosis are referred to as COVID-19 hospitalizations or diagnoses.

Throughout this report, all racial groupings (e.g., Black or African American, White, Asian) exclude persons of Hispanic ethnicity. A Hispanic or Latino/a ethnicity category is included in text and tables reflecting data separate from race categories. Therefore, the modifier “Non-Hispanic or Latino/a” is assumed. Hospital discharges among adults who identify as Pacific Islander, American Indian or Alaskan Native, other race, or multiracial are grouped into a Non-Hispanic Other category due to small numbers of hospitalizations among these residents.

Also, throughout this document, only male and female gender categories are reported. Inpatient hospital discharge data only include the 2 gender categories. Gender is self-reported.

Additionally, data and statistics are presented by primary payer source. Primary payer source is the classification of the type of coverage expected for the patient visit. Data are categorized as public, private, self-pay or uninsured, and "other" payer. Public payers include Medicaid, Medicare, Medicare Advantage, Tricare, Title V, and other federal programs. Private payers include commercial health insurance, workers compensation, Blue Cross, health maintenance organization (HMO), and preferred provider organization (PPO). Self-pay or uninsured includes hospital discharges in which the patients are self-pay or have no medical insurance. "Other" payer includes payer sources categorized as other and discharges that are "no charge"

Unadjusted odds ratios are presented in this report. PROC Logistic (SAS Enterprise Guide version 7.15 HF8) produces odds ratios with Wald 95% Confidence intervals and p-values. The odds ratios represent the odds, or likelihood, that a hospitalization (diabetes or non-diabetes) will have a COVID-19 diagnosis. For each demographic category, the reference group is typically the group with the lowest percentage of COVID-19 hospitalizations. The confidence intervals and p-values are used to determine the statistical significance of the odds ratio. An odds ratio is considered statistically significant if the confidence interval does not contain one. Also, a p-value of less than 0.05 indicates statistical significance.

Multivariable logistic regression produces the odds of COVID-19 hospitalizations predicted by the presence of multiple demographic characteristics (PROC Logistic, SAS Enterprise Guide version 7.15 HF8). For this analysis, backward stepwise regression approach is used with age, gender, race and ethnicity, and payer included in the full logistic regression model. In the final logistic regression model, age and race and ethnicity are included to control for confounding factors. The reason for including age is that the odds of hospitalization increase with age. One reason for including race and ethnicity is that the unadjusted COVID-19 odds ratios vary by race and ethnicity. Both race and ethnicity and age are included in the model because each racial and ethnic group has a different age distribution (e.g., the White populations group tends to be older than the other groups); therefore, it is important to control for age to decrease its effects on the odds ratios for the racial and ethnic groups.

Gender and payer are not in the final multivariable logistic regression model based on backward elimination findings. Backward elimination means that variables are removed from the model one-by-one to determine the statistical effect on the regression model. When the gender and payer variables are each removed from the full logistic regression model (i.e., the model with gender, race and ethnicity, age, and payer as predictors), the likelihood ratio changes by less than 10%. This means that removing the gender and payer variables does not have a statistically significant impact on the model.

Disproportionate impact is the ratio of the percent of an outcome among a subpopulation group to the total percent of that subpopulation in the dataset. To determine if a subpopulation is disproportionately impacted:

- For each demographic subgroup, the ratio is obtained by taking the percentage of diabetes hospitalizations that also have COVID-19 diagnoses for the subgroup and divide it by the percentage of all hospitalizations that occurred for the subgroup.
- If the resulting proportionality index is greater than one, then the subgroup is considered disproportionately impacted.

Finally, population attributable risk represents the potential reduction in COVID-19 hospitalizations in the overall population if diabetes hospitalizations were prevented or avoided. For this analysis, population attributable risk is calculated by:

- Dividing the total COVID-19 hospitalizations by total hospitalizations (i.e., incidence in total population);
- Subtracting from that, COVID-19 hospitalizations among non-diabetes hospitalizations divided by non-diabetes hospitalizations (i.e., incidence in nonexposed group); and
- Divide the result by the incidence in the total population and multiply by 100.

Results

Description of the Dataset

(Refer to Table 1)

The dataset has 225,304 inpatient hospital discharges among Connecticut residents from April 1, 2020 to December 31, 2020, of which 53,044 are diabetes hospitalizations (23.5%) and 172,260 are non-diabetes hospitalizations (76.5%). Diabetes and non-diabetes hospitalizations vary by patient characteristic. Compared with non-diabetes hospitalizations, diabetes hospitalizations are more likely to be among older patients, men, Black and Hispanic patients, and patients with public insurance.

Table 1. Description of the dataset, by Diabetes Status, Connecticut[a]

	Diabetes Status		
Characteristic	Yes (N = 53,044)[b]	No (N = 172,260)[b]	p[c]
Age (years)	66.1 ± 15.6	54.8 ± 23.6	<0.001
Sex			<0.001
Female	46.9%	57.6%	
Male	53.1%	42.4%	
Race and Ethnicity			<0.001
White	61.1%	67.8%	
Black	17.6%	12.0%	
Hispanic	16.8%	14.0%	
Asian	1.2%	1.6%	
Other	2.1%	2.5%	
Missing	1.2%	2.2%	
Primary Payer			<0.001
Private	16.0%	28.8%	
Public	82.1%	68.7%	
Self-Pay/Uninsured	1.6%	2.3%	
Other	0.3%	0.3%	

[a] Table values are mean ± standard deviation for continuous variables and n (column %) for categorical variables.

[b] Numbers may not sum to total due to missing data, and percentages may not sum to 100% due to rounding.

[c] P-value is for **T-test** (comparing means of continuous variables) or chi-squared (**χ2) test** (categorical variables).

Unadjusted Associations

(Refer to Table 2)

Almost 11% of diabetes hospitalizations have a COVID-19 diagnosis. Among these hospitalizations, the likelihood of a COVID-19 hospitalization increases with age. Among diabetes hospitalizations, men and women have similar odds of COVID-19 hospitalization. Diabetes hospitalizations among White residents have the lowest odds of COVID-19 hospitalization compared with other racial and ethnic groups. Furthermore, diabetes hospitalizations among those with self-pay or no insurance and other payer are more likely to have a COVID-19 hospitalization compared to those with private payers. In contrast, diabetes hospitalizations among those with public insurance are less likely to have a COVID-19 hospitalization compared to those with private payers.

Almost 7% of non-diabetes hospitalizations have a COVID-19 diagnosis. Similar to diabetes hospitalizations, the likelihood of a COVID-19 hospitalization increases with age among non-diabetes hospitalizations. Also, among non-diabetes hospitalizations, men are more likely than women to have a COVID-19 diagnosis. Non-diabetes hospitalizations among White residents have lower odds of COVID-19 hospitalization compared with Black and Hispanic and resident of other races and similar odds to Asian residents and those with missing race and ethnicity. Moreover, non-diabetes hospitalizations among those with private insurance are least likely to also have a COVID-19 diagnosis compared to hospitalizations with other types of primary payers.

Table 2. Unadjusted Associations between Patient Demographics and COVID-19 Hospitalizations, by Diabetes Status, Connecticut

	Diabetes (n = 53,044)			Non-Diabetes (n = 172,260)		
	N[a]	% COVID-19 Hospitalization	OR (95% CI)	N[a]	% COVID-19 Hospitalization	OR (95% CI)
Demographic Factors						
Age (years)						
0-17	232	3.9%	Reference	8,916	1.9%	Reference
18-39	3,072	7.3%	1.94 (0.98, 3.82)	45,987	3.2%	1.68 (1.43, 1.97)
40-64	19,555	10.5%	2.90 (1.49, 5.64)	49,781	7.8%	4.29 (3.67, 5.00)
65-79	19,399	11.0%	3.05 (1.56, 5.94)	37,648	8.7%	4.84 (4.15, 5.65)
80+	10,786	12.5%	3.54 (1.81, 6.90)	29,928	10.8%	6.13 (5.25, 7.16)
Sex						
Female	24,894	10.9%	Reference	99,275	6.0%	Reference
Male	28,147	10.8%	1.00 (0.94, 1.05)	72,981	8.3%	1.40 (1.35, 1.46)
Race and Ethnicity						
White	32,390	8.3%	Reference	116,705	5.9%	Reference
Black	9,354	14.3%	1.84 (1.72, 1.98)	20,613	8.8%	1.53 (1.45, 1.62)
Hispanic	8,920	15.7%	2.07 (1.93, 2.22)	24,125	10.6%	1.88 (1.79, 1.97)
Asian	636	16.7%	2.21 (1.79, 2.74)	2,733	6.3%	1.07 (0.92, 1.25)
Other	1,113	13.4%	1.71 (1.43, 2.04)	4,283	7.0%	1.18 (1.05, 1.34)
Missing	631	12.7%	1.61 (1.27, 2.04)	3,801	5.8%	0.98 (0.85, 1.12)
Primary Payer						
Private	8,492	11.8%	Reference	49,563	5.4%	Reference
Public	43,567	10.5%	0.88 (0.82, 0.95)	118,266	7.5%	1.43 (1.37, 1.50)
Self-Pay/Uninsured	822	15.0%	1.32 (1.08, 1.62)	3,895	9.8%	1.93 (1.72, 2.16)
Other	158	26.0%	2.63 (1.83, 3.77)	518	18.3%	3.97 (3.17, 4.98)

[a] Numbers may not sum to total due to missing data.

OR = Odds Ratio; CI = Confidence Interval

Multivariable Logistic Regression Results

(Refer to Table 3)

Table 3 summarizes the results of the multivariable logistic regression for diabetes and non-diabetes hospitalizations. The odds of a COVID-19 diagnosis among diabetes hospitalizations do not change significantly when age and race and ethnicity are included in the model. One reason may be that diabetes hospitalizations tend to be among mainly older residents and, therefore, age does not have a great impact on the model.

In contrast, the odds of COVID-19 diagnosis among non-diabetes hospitalizations increases for all racial and ethnic groups when adjusted for age. In fact, among non-diabetes hospitalizations, the odds of a COVID-19 diagnoses for Asian residents and residents with missing race or ethnicity compared with White residents reached statistical significance. Also, the odds ratios of COVID-19 diagnosis among non-diabetes hospitalizations of residents 65-70 years old increased about 58% and the odds ratio for residents 80+ years old increased almost 70% with race and ethnicity included in the model. These increases may be due to the more varied age distribution of non-diabetes hospitalizations in general and among the racial and ethnic subgroups.

Table 3. Multivariable logistic regression model of factors associated with COVID-19 hospitalizations, by diabetes status

	Diabetes (n = 53,036)	Non-Diabetes (n = 172,238)
	OR (95% CI)	OR (95% CI)
Demographic Factors		
Age (years)		
0-17	Reference	Reference
18-39	1.88 (0.95, 3.71)	1.80 (1.53, 2.11)
40-64	3.14 (1.61, 6.12)	5.52 (4.72, 6.45)
65-79	3.79 (1.94, 7.40)	7.64 (6.53, 8.95)
80+	4.74 (2.43, 9.26)	10.40 (8.88, 12.17)
Race and Ethnicity		
White	Reference	Reference
Black	2.03 (1.89, 2.19)	2.20 (2.08, 2.32)
Hispanic	2.33 (2.17, 2.50)	3.30 (3.13, 3.48)
Asian	2.32 (1.88, 2.88)	1.75 (1.49, 2.05)
Other	1.81 (1.52, 2.16)	1.80 (1.59, 2.03)
Missing	1.69 (1.33, 2.15)	1.51 (1.31, 1.73)

Disproportionate Impact

(Refer to Table 4)

Where odds ratios compare one subgroup of a demographic category to a reference subgroup, disproportionate impact expresses if the percentage of diabetes with COVID-19 hospitalizations among a subgroup is different from that subgroup's representation in the dataset. The subgroups that have a higher percentage of diabetes with COVID-19 hospitalizations than overall hospitalizations are older adults, men, Black, Hispanic, and Asian residents, residents of "other" races, and hospitalizations with private, self-pay or uninsured, or other as the primary payer.

Table 4. Disproportionate Impact of Diabetes with COVID-19 Hospitalizations, Connecticut

	All Inpatient Hospitalizations (n = 225,304)[a]	Diabetes with COVID-19 Hospitalizations (n=5,757)[a]	Proportionality Index
	% of all hospitalizations	% of Diabetes with COVID-19	
Demographic Factors			
Age (years)			
0-17	4.1%	0.2%	0.04
18-39	21.8%	3.9%	0.18
40-64	30.8%	35.6%	1.16
65-79	25.3%	37.0%	1.46
80+	18.1%	23.4%	1.30
Gender			
Female	55.1%	47.1%	0.85
Male	44.9%	52.9%	1.18
Race and Ethnicity			
White	66.2%	46.6%	0.70
Black	13.3%	23.2%	1.74
Hispanic	14.7%	24.4%	1.66
Asian	1.5%	1.8%	1.23
Other	2.4%	2.6%	1.08
Missing	2.0%	1.4%	0.71
Primary Payer			
Private	71.8%	79.8%	1.11
Public	25.8%	17.4%	0.67
Self-Pay/Uninsured	2.1%	2.1%	1.02
Other	0.3%	0.7%	2.37

[a]Numbers may not sum to total due to missing data, and percentages may not sum to 100% due to rounding.

Limitations

This analysis has some limitations. First, the results of this analysis cannot be used to establish a causal relationship between diabetes and COVID-19. These results describe the distribution of and relationship between diabetes and non-diabetes hospitalizations and COVID-19 hospitalizations among Connecticut residents but not the causes of the relationships. Second, inpatient hospital data from 2020 may only provide information on patients who were very ill because elective surgeries were canceled and people were practicing social distancing including not seeking medical care, unless necessary. Third, the analysis uses ICD-10-CM codes instead of laboratory testing results. But this disease identification is often used to describe diabetes morbidity. Lastly, some population groups only have small numbers of patients, thereby increasing the possibility of information bias.

Preventing Diabetes Hospitalizations

The results of this analysis show that diabetes hospitalizations have a higher percentage of COVID-19 diagnosis compared with non-diabetes hospitalizations. Population attributable risk calculations estimate that eliminating all diabetes hospitalizations may have reduced COVID-19 hospitalizations by approximately 11.7%, or about 2,000 hospitalizations during the time period of April 1, 2020 to December 31, 2020.

Diabetes hospitalizations can be avoided by reducing the occurrence of diabetes complications. To decrease these complications, people with diabetes should:

- Visit a health care provider regularly to establish a target blood sugar range and keep blood sugar levels as close to that range as possible,
- Stop smoking or not start,
- Follow a healthy diet,
- Participate in regular physical activity,
- Maintain a healthy weight,
- Manage blood pressure and blood cholesterol levels, and
- Manage stress (CDC, May 2021).

Routine healthcare is important to the proper management of diabetes. Infrequent or inadequate healthcare may lead to an increase in diabetes complications, including susceptibility to and hospitalizations from COVID-19. Adults with diabetes may have delayed receiving routine healthcare during the COVID-19 pandemic. The literature suggests several reasons for the delay. For example, a study conducted in the United States suggests that about one-third of adults with diabetes may have delayed or avoided routine medical care in the previous 3 months because of COVID-19-related concerns (Czeisler, et al., 2021). Other studies suggest that there was limited access to healthcare providers due to staffing shortages and an overwhelmed healthcare system (Mohseni, et al., 2021).

Connecticut inpatient hospital discharge data suggests that among diabetes hospitalizations, adults with payers other than public and private insurers were at increased risk for COVID-19 hospitalizations. One explanation could be that the increase in unemployment during the pandemic resulted in the loss of health insurance for many people. A lack of health insurance is associated with decreased rates of routine healthcare (Woolhandler & D, 2020; Fox, Choi, Lanthorn, & Croke, 2022; Fedewa, et al., 2021).

Community Health Workers are effective in promoting and improving diabetes management specifically in groups facing health disparities related to race and ethnicity or socioeconomic standings. According to the Community Guide, there is strong evidence that diabetes interventions utilizing Community Health Workers are associated with improved glycemic control, particularly among adults with type 2 diabetes (Community Preventive Services Task Force, 2017). The effectiveness of Community Health Workers is due to their standing as trusted members of the community who are knowledgeable of the healthcare system. As trusted members of the community, Community Health Workers can address misinformation and fear. Also, being familiar with the community allows Community Health Workers to serve as a link for patients between social and community services and the healthcare system, thus addressing health equity and decreasing health disparities (Peretz, Islan, & Matiz, 2020). Having access to Community Health Workers can help to reduce the barriers and delays in receiving healthcare among patients with diabetes.

Conclusion

Diabetes hospitalizations are associated with an increased risk of COVID-19 hospitalizations. Diabetes preventive care practices, such as receiving routine healthcare, controlling blood sugar, and participating in physical activity are known to decrease the risk of diabetes complications including hospitalizations. Community Health Workers play an important role in reducing disparities in diabetes preventive care among groups most at risk for diabetes and COVID-19 hospitalizations. Along with Community Health Workers, the state and local health departments, healthcare systems, communities, and individuals can collaborate to promote diabetes preventive care practices as well as COVID-19 vaccinations and prevention strategies.

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