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Longitudinal Trends in the Prevalence of Diabetes Mellitus in an Urban Emergency Department

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Abstract

Objective—The objective of this study was to examine the longitudinal trends in diabetes mellitus (DM) in emergency department (ED) patients and evaluate the factors associated with those trends.

Methods—We conducted a retrospective analysis of all patients who presented to the ED from 2006 to 2011. The presence of DM, height, and weight were recorded prospectively. The study was conducted in the ED of an urban, academic hospital with an average yearly volume of approximately 62,000 patients. Inclusion criteria were age 16 years and older; presentation to the ED for any reason; and documentation of height, weight, and history of DM. Data were analyzed in 1-year blocks, then examined for trends using linear regression analysis. Data also were examined by obesity class: normal (body mass index [BMI] 20–24.9 kg/m²), overweight (BMI 25–29.9 kg/m²), obese (BMI 30–39.9 kg/m²), and extreme obesity (BMI >40 kg/m²).

Results—There was a statistically significant increase in the prevalence of type 2 DM during the study period. The percentage of type 2 DM for all patient visits increased progressively from 10.7% to 16.1% (r^2 0.97). Progressive increases in yearly type 2 DM prevalence were observed for all BMI classes. The rate of change in the increase of DM was related directly to the degree of obesity. For the normal weight category, the percentage of patients with DM increased 0.5%/year (r^2 0.92), overweight 0.7%/year (r^2 0.88), obesity 1.0%/year (r^2 0.90), and extreme obesity category 1.4%/year (r^2 0.94). Patient age increased slightly for all obesity groups, accounting for a 0.2% to 0.4%/year increase in the prevalence of DM in the population.

Conclusions—In this longitudinal analysis, we found an increase in the prevalence of patients with DM and an increase in ED visits by patients with DM. Our results indicate that these increases are influenced most significantly by the obesity level of the patient.

Keywords

diabetes mellitus; obesity; emergency department; body mass index

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Estimates are that diabetes mellitus (DM) affects more than 25 million people in the United States and ranks as the seventh leading cause of death. DM also is a major cause of heart disease and stroke, and is the leading cause of renal failure, blindness, and nontraumatic limb amputation in the United States. Estimated medical costs for DM care total more than \$116 billion.¹ Although the development of DM is multifactorial and complex, well-recognized and significant risk factors for the development of DM in adults are weight gain and obesity.^{2–10} With estimates of more than 78 million obese adults and 12.5 million obese adolescents and children in the United States,¹¹ the potential for a change in the prevalence of DM exists.

With estimates on the prevalence of DM based largely on telephone interviews, emergency department (ED) discharge diagnoses, and national survey data, the true prevalence of DM is difficult to measure. In addition, the Centers for Disease Control and Prevention estimates that based on hemoglobin A1c and fasting glucose levels, there are 7 million Americans with undiagnosed DM and another 79 million Americans (35% of the US population) with pre-DM or higher than normal fasting glucose and hemoglobin A1c levels but not high enough to meet diagnostic criteria for DM.¹ Because the ED remains a medical access point for many patients,¹² it may be a place to intercede using educational or other targeted interventions or screening programs. This is difficult to determine, however, without a good understanding of the true prevalence of DM or the factors that may affect this. The objective for this study was to examine the longitudinal trends in DM in adult ED patients and evaluate the factors associated with those trends.

Methods

Study Design

We conducted a retrospective analysis of all of the patients who presented to the adult ED for any reason from 2006 to 2011. The study was conducted in the adult ED of an urban, academic hospital in the southern United States with an average yearly volume of approximately 62,000 patients during the study period. Because our institution has a separate pediatric ED, the adult ED sees all patients aged 16 years and older. Data were obtained from a deidentified patient database and therefore was granted a waiver for consent from the institutional review board.

Patients were eligible for inclusion if they were 16 years of age or older, presented to the ED for any reason, had documented height and weight data, and had a documented history of DM. There were no additional exclusion criteria. Data on height, weight, and history of DM were entered prospectively into the electronic medical record at the time of the patient visit. A history of DM was obtained by patient self-reporting and/or documented history of DM. The electronic medical record required further specification of DM as type 2 DM or type 1 DM. Physicians were required to document DM status before chart completion. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared for each patient.

Data Analysis and Outcomes

Data were stratified by 1-year blocks and analyzed using linear regression analysis to examine for trends. Data were additionally stratified by BMI class. In keeping with the National Heart, Lung, and Blood Institute's terminology, we used the following classifications: normal weight (BMI 20–24.9 mg/kg²), overweight (BMI 25–29.9 mg/kg²), obese (BMI 30–34.9 mg/kg²), and extreme obesity (BMI >40 kg/m²).¹³ The data were analyzed in two ways: first, all patient visits to the ED were assessed; second, the visit information was analyzed by individual patient to account for the same patient presenting multiple times to the ED. As such, the first method provided information on all patient visits, whereas the second provided information on all patients during each 1-year period. Predictors for the regression analysis were determined a priori and included age, BMI, and DM, which were entered into the model. The data were then further analyzed for the prevalence of DM by race. Data were analyzed using Microsoft Access (Microsoft, Redmond, WA) and GraphPad Prism (GraphPad Software, La Jolla, CA).

The primary outcome of interest was the change in the overall prevalence of DM in the ED during the 6-year study period. Secondary outcomes were factors that influenced these trends, specifically BMI and age. Outcomes were determined a priori.

Results

There were 368,424 patient visits during the study period. Of these, 293,686 (80%) had the DM history question answered, 323,422 (88%) had height and weight information documented, and 260,942 (71%) patient visits had both items documented. The racial makeup of the patient population during the study period was 72.6% African American, 26.4% white, and 1% other. There was a strong positive trend overall showing an increasing prevalence of type 2 DM in patients presenting to the ED during the study period, although no changes in the percentage of type 1 DM were appreciated. The overall percentage of individual patients with type 2 DM increased from 8.4% to 12.5% (r^2 0.95) during the study period. When looking at all patient visits to the ED, where individual patients could be counted more than once if they presented multiple times to the ED, the percentage of patient visits in those with type 2 DM also increased progressively from 10.7% to 16.1% (r^2 0.97).

When stratified by year, progressive increases in type 2 DM prevalence were observed for all BMI classes, as shown in Figure 1; however, as shown in the results of the linear regression analysis, the rate of change in the prevalence of DM was directly related to the degree of obesity (Fig. 2). When evaluated by obesity class, the yearly increase in percentage of DM increased proportional to the degree of obesity. The percentage of patients with DM increased as follows: normal weight 0.5%/year (r^2 0.92; $P < 0.009$), overweight 0.7%/year (r^2 0.88; $P = 0.006$), obese 1.0%/year (r^2 0.90; $P = 0.004$), and extreme obesity 1.4%/year (r^2 0.94; $P < 0.002$; Fig. 2). The absolute change in the percentage of DM in those with extreme obesity ranged from 18.4% to 24.9% (Fig. 1).

Patient age did increase slightly in all obesity classes; however, when using age as a covariate in the prevalence of DM, increasing age accounted for only a 0.2% to 0.4%/year increase in the prevalence of DM in the population (Table 1). Also, overall rates of obesity

and extreme obesity increased slightly during the study period, as shown in Table 2. During the 6-year study period, the percentage of overweight patient visits did not change and the percentage of obese visits increased slightly (2.6% relative increase); however, a larger relative change was seen in the extreme obesity category (9.1%).

Because of the demographics of the ED population, data were analyzed only in African Americans and whites. Both African Americans and whites showed similar increases in the prevalence of DM and obesity and extreme obesity during the 6-year study period (Figs. 3 and 4). Extreme obesity increased by 24% in African Americans and 33% in whites. The difference in these increases was not statistically significant (Fig. 3); however, the prevalence of DM was 40% higher in African Americans compared with whites with normal weight or overweight, which was statistically significant. The prevalence of DM in those who were obese was 20% higher in African Americans, although this was not statistically significant, and the prevalence of DM in the extremely obese categories was the same (Fig. 5).

Discussion

In this analysis, we found a steady increase in the prevalence of type 2 DM in those patients presenting to the ED, which appears to be influenced by the obesity level of the patient and, to a much lesser extent, the patient's age. Although the increase in DM prevalence was seen in all weight classes, the impact of obesity on the increasing prevalence of DM was most notable in the extreme obesity category. When evaluated by race, both African Americans and whites experienced increases in the prevalence of DM during the study period. Normal-weight or overweight African Americans had a baseline higher prevalence of DM compared with whites in those same BMI categories. Interestingly, the prevalence of DM for those with extreme obesity was much higher regardless of race and was the same for African Americans and whites, suggesting that racial differences in the prevalence of DM are erased as individuals become more obese. With more than one-third of US adults classified as obese according to estimates,¹¹ it would be reasonable to expect that the prevalence of DM will continue to increase, as found in our results. In addition, during the study period, the overall rates of obese and extremely obese patients who presented to the ED also increased, with the largest relative increase in the extreme obesity category.

Our results are consistent with previous research, which has shown that both BMI and weight gain in adulthood are significant predictors for the development of DM.^{2,5,6,14} Kaneto et al¹⁴ further noted that long-term weight gain as a predictor of DM was independent of total weight, and that adult weight gain, even within the normal weight class, could increase the risk of developing DM. This is consistent with our findings; however, our sample population is much larger than that in their study (13,700), and their study took place in a country with a relatively low rate of obesity and extreme obesity.¹⁴

We found that the prevalence of DM in a patient population seeking care in the ED not only increased but also that the number of visits for patients with DM increased to an even greater degree, suggesting that patients with DM use the ED more than other patients without a history of DM. This increase in ED usage has the potential to adversely affect ED

operations, as well as patient outcomes and quality of care. Research has shown that ED crowding and longer ED wait times are associated with a higher risk of mortality, poorer achievement of quality of care metrics, and decreased levels of patient satisfaction.^{15–17} Also, although national data have suggested that the increase in overall obesity in the United States has leveled off,¹¹ our data from an ED population show that the rate of extreme obesity continues to rise. These findings have the potential for significant public health impact, both from a patient-centered quality-of-life standpoint and a health-systems, resource-utilization standpoint.

As the leading cause of blindness, renal failure, and limb amputation, DM's potential social impact on a patient's quality of life is substantial.¹ Patients with these complications frequently are left requiring assistance with many activities of daily living, which often necessitates costly living assistance. The psychological impact of such life-altering conditions also is significant. Research has shown that depression and anxiety are higher in patients with acquired blindness and that advanced vision loss leads to activity restrictions and further depression.^{18–21} Research also has shown that patients with lower-limb amputations are at higher risk for psychological distress, with increased rates of depression and anxiety.^{22–24} Similarly, Pollice et al reported that the effect of dialysis treatment on patients' quality of life and subsequent limitations in activities and increased level of disability contributed to increased risks of depression and anxiety.²⁵

If the prevalence of DM is increasing nationwide, as was found in our site-specific study, then the number of patients with these potential medical complications could increase as well, significantly affecting the healthcare system as a whole. Many of the complications previously discussed require costly, complicated medical procedures and management. Furthermore, as found in our study, the number of ED visits in patients with DM increased during the study period, suggesting increased resource utilization and total healthcare costs in patients with DM, although this was not examined directly.

This work highlights the importance of DM prevention and weight management. The medical, psychosocial, and financial effects of DM are impressive. We found that the prevalence of DM in our population continues to rise and that the rate of increase was proportional to the degree of obesity. With an increasing prevalence of DM noted in all BMI categories, however, an emphasis on regular health screenings, patient education regarding DM, and counseling on weight management in all weight classes could mitigate the increasing prevalence of DM. Although we did not study the impact of weight reduction directly, our work does suggest that even some weight loss or loss of weight gained may decrease the risk of developing DM. In addition, our results suggest that the prevalence of DM in the normal-weight and overweight African American population is significantly higher than the prevalence of DM in whites in the same weight categories, suggesting a high-risk group that could benefit from early health screenings and primary care referral.

Our study does have several limitations. First, this was a retrospective study, with the inherent limitations implied in such a methodology. Data on weight, height, and history of DM were entered prospectively. Coupled with limited inclusion criteria and a large sample size, we believe we captured a true representation of the population, further strengthening

our results. Second, this was a single-center study that took place in a state with a high prevalence of obesity (34%)²⁶; therefore, our results may not be generalizable to other regions with lower obesity rates. Our study population was 73% African American. According to national estimates, non-Hispanic black Americans had the highest age-adjusted rates of obesity,²⁶ which also could limit generalizability. Because we were attempting to include as broad a patient cross-section as possible, we did not examine comorbid conditions and race and focused only on BMI, age, and DM in the data analysis. Finally, in this analysis, the presence of DM was determined by documentation and patient reporting of a medical history of DM. As previously mentioned, research suggests that there is a high prevalence of undiagnosed DM in ED patients.²⁷ As such, a documented history of DM or self-reporting of DM may not be the ideal method for assessing the true prevalence of DM in the ED.

Conclusions

In this analysis, we found that the prevalence of DM in an ED population is increasing. Although the increasing prevalence of DM was found in all weight classes, the rate of increase was proportional to the degree of obesity. Further studies are needed to determine the etiology of this increase and possible interventions, such as targeted patient education, improved screening processes, and early referral to primary care, which could reduce the prevalence of DM in the ED.

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Key Points

- We found an increase in the prevalence of patients in the emergency department (ED) with adult-onset diabetes mellitus (DM) and an increase in ED visits by patients with DM.
- Although this increasing prevalence of DM was seen in all weight classes to some degree, the rate of change was proportional to the degree of obesity.
- The prevalence of DM in a patient population seeking care in the ED increased, but the number of visits for patients with DM increased to an even greater degree, suggesting that patients with DM use the ED more than other patients without a history of DM.
- In this ED population, the overall rates of obesity and extreme obesity increased during the study period, contrary to national reports that the rates of obesity and extreme obesity seem to be leveling off.

Fig. 1.
Diabetes mellitus by obesity class. DM, diabetes mellitus.

Fig. 2.
 Linear regression analysis: percentage of patients with diabetes mellitus per year. DM, diabetes mellitus.
 * P value < 0.05

Fig. 3.
Percentage of patients with extreme obesity (body mass index $>40 \text{ kg/m}^2$).

Fig. 4.
Percentage of patients with obesity (body mass index 30–34.9 mg/kg²).

Fig. 5.
Prevalence of diabetes mellitus by obesity category.
Abbreviations: DM: Diabetes Mellitus

Table 1

Patient age, in years

Year	NW	OW	Ob	Ext ob
2006	36.4	39.5	39.6	39.0
2007	36.0	39.6	40.0	39.5
2008	36.9	40.4	40.5	39.4
2009	37.0	40.9	40.7	39.9
2010	37.7	41.2	41.6	40.4
2011	37.8	41.5	41.4	39.9
<i>P</i>	0.009 ^a	0.001 ^a	0.002 ^a	0.035 ^a

Ext ob, extreme obesity; NW, normal weight; Ob, obese; OW, overweight.

^aStatistically significant.

Table 2

Overall percentages of obesity classes

Year	NW	OW	Ob	Ext ob
2006	28.6	32.2	22.8	8.8
2007	27.9	32.6	22.9	8.8
2008	28.2	32.2	22.5	9.1
2009	27.7	32.4	23.0	9.4
2010	28.0	32.2	22.9	9.7
2011	27.5	32.2	23.4	9.6
<i>P</i>	0.063	0.537	0.172	0.004 ^a

Ext ob, extreme obesity; NW, normal weight; Ob, obese; OW, overweight.

^aStatistically significant.