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RESEARCH ARTICLE

Neighborhood Environment and Poor Maternal Glycemic Control—Associated Complications of Gestational Diabetes Mellitus

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Introduction: Risk of complications due to gestational diabetes mellitus is increasing in the U.S., particularly among individuals from racial minorities. Research has focused largely on clinical interventions to prevent complications, rarely on individuals' residential environments. This retrospective cohort study aims to examine the association between individuals' neighborhoods and complications of gestational diabetes mellitus.

Methods: Demographic and clinical data were extracted from electronic health records and linked to American Community Survey data from the U.S. Census Bureau for 2,047 individuals who had 2,164 deliveries in 2014–2018. Data were analyzed in 2021–2022 using Wilcoxon rank sum test and chi-square test for bivariate analyses and logistic regression for analysis of independent effects. All census tract–based variables used in the model were dichotomized at the median.

Results: Bivariate analysis showed that the average percentage of adults earning <\$35,000 was higher in neighborhoods where individuals with complications were living than in neighborhoods where individuals without complications were living (30.40%±12.05 vs 28.94%±11.71, p=0.0145). Individuals who lived in areas with ≥8.9% of residents aged >25 years with less than high school diploma had a higher likelihood of complications than those who lived in areas with <8.9% of such residents (33.43% vs 29.02%, p=0.0272). Individuals who lived in neighborhoods that had ≥1.8% of households receiving public assistance were more likely to have complications than those who lived in areas where <1.8% of households received public assistance (33.33% vs 28.97%, p=0.0287). Logistic regression revealed that the odds of deliveries with complications were 44% higher for individuals with obesity (OR=1.44; 95% CI=1.17, 1.77), 35% greater for individuals residing in neighborhoods with higher percentages of households living below the poverty level (OR=1.35; 95% CI=1.09, 1.66), and 28% lower for individuals from neighborhoods where a higher percentage of households had no vehicles available for transportation to work (OR=0.72; 95% CI=0.59, 0.89).

Conclusions: Clinical interventions in concert with environmental changes could contribute to preventing maternal and neonatal complications of gestational diabetes mellitus.

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INTRODUCTION

Gestational diabetes mellitus (GDM) is a common pregnancy-related condition[1,2] that in 2017 affected 8.4% of U.S. women.[3] It is associated with several maternal and infant complications, some of them due to poor maternal glycemic control.[4] In an international study of hyperglycemia and adverse pregnancy outcomes, investigators found significant associations between maternal glycemic levels and complications, such as preeclampsia, macrosomia, and intensive neonatal care. In addition, the risk of complications intensified with progressive elevation in maternal glucose concentrations.[5] Subsequent and more recent trials provide additional evidence of the correlation between poor maternal glycemic control and adverse consequences for the adult and infant.[6−8]

Given the pivotal role of hyperglycemia in the adverse effects of GDM, the focus of clinical intervention has been on managing maternal glycemic concentrations within prescribed levels[4,9] through several behavioral modification measures of self-management, such as diet, exercise, and self-monitoring of blood glucose (SMBG) levels.[4,9−12] When glycemic control cannot be reached through diet and exercise, then pharmacological therapy, primarily insulin, is used.[13,14]

The results of clinical interventions in reducing maternal and neonatal complications have been promising. In the Australian Carbohydrate Intolerance Study in Pregnant Women, individuals in the treatment group who received care from a medical team, personalized dietary plan, training in SMBG, and insulin treatment had significantly fewer adverse outcomes, including infant death, than individuals in the control group who received customary care.[15] In an investigation of the treatment of mild gestational diabetes, individuals who were treated with diet, SMBG tests, and insulin therapy had significantly fewer complications than individuals who were treated routinely.[16] Similarly, in a study of Chinese adults with GDM, those who received customized dietary and exercise intervention along with insulin had infants of smaller birthweight and rarer cases of macrosomia than those in the standard care group.[17]

The success of clinical efforts in achieving glycemic control and reducing complications demonstrated in RCTs have not been replicated in many individuals with GDM who live outside the controlled environment. The rate of several perinatal complications associated with GDM pregnancies is increasing in the U.S. and more so among individuals from racial minorities than among White individuals. For example, among individuals with GDM, the rate of preeclampsia rose significantly from 109.2 cases in 2014 to 140.7 cases per 1,000 live births in 2020. Although the rate of macrosomia declined, a significant increase was observed in neonatal intensive care unit admissions from 107.2 in 2014 to 114.4 per 1,000 live births in 2020.[18]

The focus of biomedical research has been on finding clinical interventions to prevent adverse outcomes of GDM. However, the salience of environmental conditions in influencing reproductive health outcomes is being recognized.[19] Research on the environmental correlates of GDM has been limited. Most emphasize the influence of neighborhood structures on the risk or prevalence of GDM,[20,21] rarely on the complications of GDM. The purpose of this study is to examine the association between individuals' neighborhood conditions and complications of GDM resulting from poor maternal glycemic control.

METHODS

Study Population

The research was based on a study population of 2,071 individuals with GDM aged 18−51 years who had 2,188 singleton live GDM deliveries between January 1, 2014 and December 31, 2018 at ChristianaCare Hospital, a large healthcare facility in northern Delaware. Individuals were identified as having GDM on the basis of ICD-10 codes (O24.419) in medical records. Individuals with pre-existing Type 1 or Type 2 diabetes were excluded. The authors used results from the American Community Survey on the basis of census tracts to identify neighborhood conditions.[22] The unit of analysis was GDM delivery. Approval for the protection of human subjects was obtained from the Internal Review Boards of ChristianaCare Health Services, Inc. and Delaware State University.

Measures

Data on mothers' demographic characteristics, medical encounters, and maternal and infant complications were extracted from electronic health records. American Community Survey data were downloaded from the U.S. Bureau of the Census[22] using the Python programming language and the Census Bureau's Application Programming Interface and linked to the electronic health records information for each delivery. The validity of the data set was checked by replicating the results for a patient or groups of patients using independent data extraction procedures and comparing the results. Errors in the source data from operational systems are assumed to be the usual random and nonsystemic errors found in any record-keeping system that is dependent on manual data entry.

The outcome variable, complications that are partly or mostly related to poor maternal glycemic control, was a composite measure constructed by summing the number of maternal and infant complications associated with delivery. It included preeclampsia, macrosomia, hypoglycemia, neonatal intensive care unit admission, hemorrhage, and stillbirth. Because actual glucose or HbA1C values were unavailable, the composite outcome was created on the basis of the known association with poor glycemic control. It was then converted into a dichotomous variable with the response choices of 1=with complications if the individual had a delivery with 1 or more of the above maternal or infant complications and 0=without complications if neither the individual nor the infant had any of the complications. For a more detailed measure, complications were further subdivided into maternal complications, infant complications, and both maternal and infant complications. However, owing to the small sample size of each subgroup, analyses were pursued with the dichotomous variable.

Control variables, individual's age in years at the time of delivery and individual's race, were self-reported. Authors used the Elixhauser International Classification of Diseases codes–based algorithm to define obesity.[23] The independent variables were the individual's neighborhood characteristics. *Neighborhood* was defined as the census tract in which the individual lived at the time of delivery. Census tract–based characteristics were used as proxy measures for the neighborhood variables because census tract was the smallest geographic unit for which measures were available from the U.S. Bureau of the Census. Data extracted from the American Community Survey included individual's neighborhood characteristics, such as median income; percentages of households below the poverty level; percentages of White, Black, or other than White or Black neighborhood residents; percentage of households who live in crowded housing; earners aged >16 years earning under $35000; households headed by a female; residents aged >25 years with less than high school diploma; households with no vehicle available for transport to work; households receiving public assistance; households where residence is rented rather than owned; males aged >16 years who are unemployed; overall unemployment rate; residents who are Latino; and residents who are foreign born.

Statistical Analysis

Because several census tract–based variables were highly skewed (skewness: 0.40–3.47; Kurtosis: −0.15 to 15.71), all census tract–based variables used in the model were dichotomized at the median. Average and SDs were used to describe continuous variables. Individual's demographic and neighborhood characteristics were compared according to the presence or absence of complications using Wilcoxon rank sum test for continuous variables and chi-square statistic for categorical variables. Statistical significance was reached at p=0.05. Neighborhood characteristics were assessed for multicollinearity using variance inflation factor (VIF). Logistic regression was used to assess the independent effect of the neighborhood characteristics on complications and the backward elimination procedure to select the variables in the final model. Data were analyzed in 2021–2022 using SAS, Version 9.4 (SAS Institute, Carey, NC).

RESULTS

From the sample of 2,188 deliveries, 21 cases were excluded because the residential addresses of the individuals at the time of delivery needed to identify the census tracts were unavailable, and 3 were excluded owing to missing values for race. The process reduced the number of individuals in the study to 2,047, and the final analytical data set consisted of 2,164 deliveries, as illustrated in Figure 1.

Of the 2,047 individuals included in the study population, 94.4% had 1 delivery, 5.4% had 2 deliveries, and 0.14% had 3 deliveries. The mean age of the 2,047 adults was 31.91±5.26 years, 50.61% were White, 20.81% were Black, 15.63% were Asian, and 0.24% were Native American.

Table 1 shows individuals' characteristics of the 2,164 deliveries in the study overall and according to the

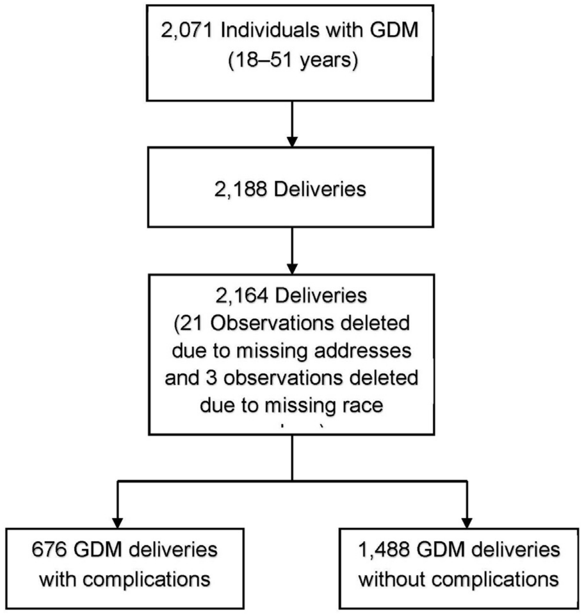

Figure 1. Study population of individuals with GDM.
GDM, gestational diabetes mellitus.

presence or absence of complications related to poor maternal glycemic control. Of the 2,164 deliveries, 676 (31.24%) were associated with complications, of which 132 (19.53%) were maternal, 443 (65.53%) were infant, and 101 (14.94%) were both maternal and infant. The mean age of all individuals in the sample at the time of delivery was 31.99 years. There was no significant difference in the mean age of mothers with and without complications. Of the deliveries, 51.16% of individuals with GDM were White, 20.19% were Black, 15.62% (n=338) were Asian, 0.23% (n=5) were American Indian, and 12.80% (n=277) were of other racial groups. Owing to their small number, Asian and American Indian individuals were included in the other category as shown in Table 1. As high as 74.28% (n=205) of individuals from the other group identified their ethnicity as Hispanic or Latino.

The association between race and complications was statistically significant (p=0.0009), with Black individuals most likely to have complications (37.76%), followed by White individuals (31.07%). In addition, adults who were obese were more likely to have complications than those who were not obese (37.93% vs 28.62%, p=0.0001).

Among the neighborhood characteristics, individuals with GDM who resided in neighborhoods with ≥5.7% of households below the poverty level were more likely to develop complications than individuals from neighborhoods with <5.7% of households below the poverty level (33.64% vs 28.77%, p=0.0146). The average percentage of adults earning <$35,000 was higher in neighborhoods where individuals with complications were living than in neighborhoods where individuals without complications were living (30.40%±12.05 vs 28.94%±11.71, p=0.0145)

Participants who lived in areas with ≥8.9% of residents aged >25 years with less than high school diploma had a higher likelihood of complications than those who lived in areas with <8.9% of such residents (33.43% vs 29.02%, p=0.0272). Likewise, participants who lived in neighborhoods that had ≥1.8% of households receiving public assistance were more likely to have complications than those who lived in areas where <1.8% of households received public assistance (33.33% vs 28.97%, p=0.0287).

Table 2 displays the results from the final logistic regression model using the backward elimination procedure after controlling for age. As the risk of adverse pregnancy outcomes increases with maternal age,[24] age can be an important biological determinant of GDM complications. Consequently, age was forced in the regression model. Rank-order correlation and VIF showed a high negative correlation between the percentage of people who are Black in the individual's home census tract and the percentage of people who are White in individual's home census tract (r= −0.95; p<0.0001; VIF=25). Hence, the percentage of people who are White in individual's home census tract was dropped from the analysis.

Three of the study participants' residential neighborhood characteristics, percentage of earners aged >16 years earning under $35,000, individuals aged >25 years with less than high school diploma, and households receiving public assistance, were not significant after adjusting for other risk factors, even though they were significantly different in the bivariate analyses. Another neighborhood feature, the percentage of households with no vehicle available for transport to work, emerged as significant when controlling for the effect of the other predictors.

After controlling for other variables in the model, race was not a significant predictor of complications. However, obesity was independently associated with complications. All else being equal, the odds of having deliveries with complications were 44% higher for individuals who were obese than for those who were not (OR=1.44; 95% CI=1.17, 1.77). Regarding neighborhood characteristics, holding all other variables in the model constant, the odds of having deliveries with complications were 35% higher for individuals who lived in neighborhoods where 5.7% or higher percentage of households were below the poverty level than for women living in neighborhoods where <5.7% of households were below the poverty level (OR=1.35; 95% CI=1.09, 1.66). Availability of vehicles for transportation to work had a negative association with complications. Controlling for the effect of all other variables in the model, the odds of complications were 28% lower for residents of neighborhoods where 3.6% or higher percentage of households had no vehicles available for transportation to work than for residents of neighborhoods where <3.6% of households had no vehicles available for transportation to work (OR=0.72; 95% CI=0.59, 0.89).

DISCUSSION

Although biomedical research to date has identified some of the risk factors for the complications of GDM, the focus of this study was on the contributions of environmental factors. Results of the bivariate analyses and the finding that individuals with GDM are 35% more likely to experience deliveries with complications if they lived in neighborhoods with more households below the poverty level than if they lived in neighborhoods with fewer households below the poverty level are consistent with several reports that link poverty with poor health.[21,25,26] Explanations for adverse diabetes outcomes in poor neighborhoods include lack of access to medical services, unstable housing, unsafe environment,

Table 1. Characteristics of Individuals in the Study for 2,164 Deliveries

Characteristics	Overall N=2,164	With complications[a] *n*=676 (31.24%)	Without complications[a] *n*=1,488 (68.76%)	*p*-value
Age, year, mean (SD)	31.99 (5.22)	31.90 (5.32)	32.03 (5.17)	0.5280[b]
Racial identification				
White, *n* (%)	1,107 (51.16)	344 (31.07)	763 (68.93)	
Black, *n* (%)	437 (20.19)	165 (37.76)	272 (62.24)	
Other, *n* (%)	620 (28.65)	167 (26.94)	453 (73.06)	0.0009[c]
Obesity, *n* (%)				
No	1555 (71.86)	445 (28.62)	1110 (71.38)	
Yes	609 (28.14)	231 (37.93)	378 (62.07)	0.0001[c]
Median income in individual's neighborhood				
Mean (SD)	67,710 (22,945)	66,105 (22,134)	68,439 (23,275)	0.0730[b]
<$63004, *n* (%)	1,081 (49.95)	347 (32.10)	734 (67.90)	0.3877[c]
≥$63004, *n* (%)	1,083 (50.05)	329 (30.38)	754 (69.62)	
Percentage of households below the poverty level in individual's neighborhood				
Mean (SD)	7.98 (7.88)	8.36 (8.24)	7.80 (7.71)	0.0797[b]
<5.7%, *n* (%)	1,067 (49.31)	307 (28.77)	760 (71.23)	
≥5.7%, *n* (%)	1,097 (50.69)	369 (33.64)	728 (66.36)	0.0146[c]
Percentage of people who are Black in individual's neighborhood				
Mean (SD)	24.93 (18.34)	25.32 (18.58)	24.75 (18.23)	0.4438[b]
<22.1%, *n* (%)	1,073 (49.58)	322 (30.01)	751 (69.99)	
≥22.1%, *n* (%)	1,091 (50.42)	354 (32.45)	737 (67.55)	0.2211[c]
Percentage of people who are White in individual's neighborhood				
Mean (SD)	64.22 (19.22)	63.96 (19.65)	64.34 (19.03)	0.6875[b]
<66.8%, *n* (%)	1,068 (49.35)	340 (31.84)	728 (68.16)	
≥66.8%, *n* (%)	1,096 (50.65)	336 (30.66)	760 (69.34)	0.5543[c]
Percentage of people who are other than White or Black in individual's neighborhood				
Mean (SD)	10.86 (5.36)	10.73 (5.61)	10.91 (5.24)	0.2764[b]
<10.3%, *n* (%)	1,067 (49.31)	325 (30.46)	742 (69.54)	0.4405[c]
≥10.3%, *n* (%)	1,097 (50.69)	351 (32.00)	746 (68.00)	
Percent of households who live in crowded housing in individual's neighborhood				
Mean (SD)	1.124 (1.559)	1.099 (1.487)	1.136 (1.592)	0.9322[b]
<0.5%, *n* (%)	1,025 (47.37)	318 (31.02)	707 (68.98)	0.8385[c]
≥0.5%, *n* (%)	1,139(52.63)	358 (31.43)	781 (68.57)	

(*continued on next page*)

Table 1. Characteristics of Individuals in the Study for 2,164 Deliveries (*continued*)

Characteristics	Overall N=2,164	With complications[a] *n*=676 (31.24%)	Without complications[a] *n*=1,488 (68.76%)	*p*-value
Percentage of earners aged >16 years earning <$35,000 in individual's neighborhood				
Mean (SD)	29.39 (11.84)	30.40 (12.05)	28.94 (11.71)	0.0145[b]
<28.3%, *n* (%)	1,067 (49.31)	314 (29.43)	753 (70.57)	0.0732[c]
≥28.3%, *n* (%)	1,097 (50.69)	362 (33.00)	735 (67.00)	
Percentage of households headed by a female in individual's neighborhood				
Mean (SD)	14.15 (10.20)	14.62 (10.57)	13.94 (10.02)	0.1129[b]
<11.5%, *n* (%)	1,077 (49.77)	326 (30.27)	751 (69.73)	0.3329[c]
≥11.5%, *n* (%)	1,087 (50.23)	350 (32.20)	737 (67.80)	
Percentage of residents aged >25 years with less than high school diploma in individual's neighborhood				
Mean (SD)	10.31 (6.68)	10.84 (7.01)	10.08 (6.51)	0.0204[b]
<8.9%, *n* (%)	1,075 (49.68)	312 (29.02)	763 (70.98)	0.0272[c]
≥8.9%, *n* (%)	1,089 (50.32)	364 (33.43)	725 (66.57)	
Percentage of households with no vehicle available for transportation to work in individual's neighborhood				
Mean (SD)	5.71 (7.32)	5.66 (7.61)	5.73 (7.19)	0.5153[b]
<3.6%, *n* (%)	1,081 (49.95)	354 (32.75)	727 (67.25)	0.1302[c]
≥3.6%, *n* (%)	1,083 (50.05)	322 (29.73)	761 (70.27)	
Percentage of households receiving public assistance in individual's neighborhood				
Mean (SD)	2.36 (1.88)	2.48 (1.92)	2.30 (1.86)	0.0198[b]
<1.8%, *n* (%)	1,039 (48.01)	301 (28.97)	738 (71.03)	0.0287[c]
≥1.8%, *n* (%)	1,125 (51.99)	375 (33.33)	750 (66.67)	
Percentage of households where residence is rented rather than owned in individual's neighborhood				
Mean (SD)	31.79 (18.13)	31.53 (17.71)	31.91 (18.32)	0.7790[b]
<30%, *n* (%)	1,080 (49.91)	342 (31.67)	738 (68.33)	0.6679[c]
≥30%, *n* (%)	1,084 (50.09)	334 (30.81)	750 (69.19)	
Percentage of males aged >16 years who are unemployed in individual's neighborhood				
Mean (SD)	5.84 (3.31)	5.75 (3.31)	5.88 (3.31)	0.4545[b]
<5.2%, *n* (%)	1,082 (50.0)	338 (31.24)	744 (68.76)	1.000[c]
≥5.2%, *n* (%)	1,082 (50.0)	338 (31.24)	744 (68.76)	
Overall unemployment rate in individual's neighborhood				
Mean (SD)	7.47 (3.59)	7.65 (3.76)	7.39 (3.51)	0.1310[b]
<6.9%, *n* (%)	1,068 (49.35)	318 (29.78)	750 (70.22)	0.1471[c]
≥6.9%, *n* (%)	1,096 (50.65)	358 (32.66)	738 (67.34)	

(*continued on next page*)

Table 1. Characteristics of Individuals in the Study for 2,164 Deliveries (*continued*)

Characteristics	Overall N=2,164	With complications[a] *n*=676 (31.24%)	Without complications[a] *n*=1,488 (68.76%)	*p*-value
Percentage of residents who are Latino in the individual's neighborhood				
Mean (SD)	10.54 (8.65)	10.93 (9.05)	10.36 (8.45)	0.1565[b]
<8%, *n* (%)	1,076 (49.72)	317 (29.46)	759 (70.54)	0.0760[c]
≥8%, *n* (%)	1,088 (50.28)	359 (33.00)	729 (67.00)	
Percentage of residents who are foreign born in individual's neighborhood				
Mean (SD)	11.52 (5.83)	11.46 (6.00)	11.54(5.75)	0.6069[b]
<10.5%, *n* (%)	1,078 (49.82)	343 (31.82)	735 (68.18)	0.5621[c]
≥10.5%, *n* (%)	1,086 (50.18)	333 (30.66)	753 (69.34)	

[a]The percentages are presented as row percentages.
[b]Age and neighborhood characteristics: difference in means between with and without complications was assessed using Wilcoxon rank sum test.
[c]Race and neighborhood characteristics: difference in frequencies between with and without complications was assessed using chi-square test.

Table 2. Characteristics Independently Associated With Complications

Variable	OR	95% CI
Age	0.99	0.98, 1.01
Racial identification		
Asian and American Indian and other versus White (ref)	0.87	0.70, 1.09
Black versus White (ref)	1.26	0.99, 1.60
Obesity, yes versus no (ref)	1.44	1.17, 1.77
Percentage of households below the poverty level in individual's neighborhood, ≥5.7% versus <5.7% (ref)	1.35	1.09, 1.66
Percentage of households with no vehicle available for transport to work in individual's neighborhood, ≥3.6% versus <3.6% (ref)	0.72	0.59, 0.89

sedentary lifestyle, poor food choices, unavailability of healthy food outlets such as supermarket chains and grocery stores within convenient distance, as well as quick access to inexpensive processed food.[4,20,27–31]

In addition, people living in poverty are in a constant state of stress. The struggle to make decisions with limited income, the anxiety about running out of money before the end of the month, the fear of being evicted from the place of residence, and utilities being disconnected can lead to severe stress. For individuals with GDM, it can be compounded by the stress of being diagnosed with GDM.[32] Studies of wealth-building behavior in low-income populations show that stress induced by living in poverty changes individual behaviors.[33] Experiments indicate that poverty affects the ability to make decisions because the stress of functioning within a limited budget reduces the human cognitive resources needed to make logical decisions and control impulses.[34,35] Thus, in addition to the structural limitations of an impoverished neighborhood, such as unavailability of healthy food outlets and supermarkets, the severe stress of poverty, which in itself can lead to hyperglycemia, can make it difficult for low-income individuals with GDM to comply with the regimen of clinical intervention needed to prevent complications.

Researchers[34] contend that given the cognitive overload experienced by impoverished individuals, reminders can help. In part, this may explain the success of study participants in achieving glycemic control. In 2 exercise experiments with individuals who had GDM, subjects' compliance with the exercise protocol was monitored through weekly phone calls and weekly to biweekly visits to the clinic.[11,12] Haushofer and Fehr assert that besides income, material assistance can also help in reducing poverty-related stress.[33] Individual Development Account is a program designed to help low-income individuals build assets. Section 8 Housing Choice Voucher program enables people to obtain stable housing through rental assistance, and the federal home energy assistance program aids with utility bills. Information about the programs and assistance in participating in the programs could be provided to low-income individuals during their medical visits.

The association between the unavailability of vehicles for transportation to work and the lower likelihood of complications was surprising because the authors expected a positive association between the 2 variables. One explanation could be the possibility of an anomaly in the data; the other could be the link between mode of transportation, risk of weight gain, and diabetes.

In an analysis of the U.S. state–level data, investigators found that traveling to work by car increased the number of residents in the state who were overweight, whereas using public transportation or walking to work reduced the number of overweight residents.[36] A review of the literature showed that the risk of diabetes declined with the walkability of a neighborhood, particularly in low-income areas.[37] Researchers in urban design, regional planning, and transportation have identified the structural features that can be built to make neighborhoods walkable.[38] In a Canadian study, the investigators estimated a surge of 25% in pedestrian commute to work for every unit of development in the walkability of a neighborhood.[39] Moreover, because walking or using the public transit system for commuting to work, shopping, or running errands is necessary for daily living, individuals with GDM may be compelled to exercise without setting aside time for it, being motivated, or being convinced about its benefits. In addition, because walking and using the public transit system out of necessity is likely to continue even after delivery, it could reduce the high risk of postpartum diabetes. However, because this study is based on data at the census tract level and not at the individual level, the authors cannot ascertain that individuals who do not have complications live in a household where there is no vehicle available. Consequently, additional studies are needed to verify the association between the availability of vehicle for transportation to work and complications of GDM.

Limitations

Some of the limitations are as follows: small number of cases, individuals were not differentiated by the number of GDM deliveries and by the type of complications; access to individual's daily point-of-care glucose values was unavailable; the neighborhood characteristics were based on census tract data, not on information directly related to the individuals; and generalizability of the results is limited because the data are from a single healthcare system serving largely urban and suburban areas.

CONCLUSIONS

Although studies have examined the association between environmental factors and prevalence or risk of diabetes, this is one of the few that focused on GDM complications and more specifically on poor maternal glycemic control–related complications. In addition, although investigators have assessed the impact of clinical interventions on reducing adverse outcomes in controlled settings, this research measured the influence of environmental conditions in natural settings. Findings suggest that clinical interventions in concert with environmental changes can contribute to reducing the risk of complications associated with poor maternal glycemic control.

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Declaration of interest: none.

CREDIT AUTHOR STATEMENT

Leela V. Thomas: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing – original draft, Writing –

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