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Neighbourhood food environment and gestational diabetes in New York City

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Summary

The association between neighbourhood characteristics and gestational diabetes has not been examined previously. We investigated the relationship between the number of healthy food outlets (supermarkets; fruit/vegetable and natural food stores), and unhealthy food outlets (fast food; pizza; bodegas; bakeries; convenience, candy/nut and meat stores) in census tract of residence, and gestational diabetes in New York City. Gestational diabetes, census tract and individual-level covariates were ascertained from linked birth-hospital data for 210 926 singleton births from 2001 to 2002 and linked to commercial data on retail food outlets. Adjusted odds ratios (aOR) were estimated using a multilevel logistic model.

No association between food environment measures and gestational diabetes was found, with aORs ranging from 0.95 to 1.04. However, an increased odds of pre-pregnancy weight >200 lbs for women living in a given neighbourhood with no healthy food outlets [aOR = 1.14, 95% CI 1.07, 1.21] or only one healthy food place [aOR = 1.10, 95% CI 1.04, 1.18] relative to two or more healthy food outlets was found. Due to probable misclassification of neighbourhood food environment and pre-pregnancy obesity results are likely to be biased towards the null. Future research, including validity studies, on the neighbourhood food environment, obesity during pregnancy and gestational diabetes is warranted.

Keywords

gestational diabetes; maternal obesity; healthy food outlets

Introduction

Gestational diabetes mellitus is a common pregnancy complication for which there is a growing public health concern. Defined as glucose intolerance that appears or is first recognised during pregnancy, gestational diabetes affects an estimated 4% of all pregnancies in the US and can result in serious complications to both the mother and the infant.[1] Known risk factors for gestational diabetes include pre-pregnancy obesity, advanced maternal age, physical inactivity, low socio-economic status and family risk of gestational diabetes.[2,3] Pre-pregnancy diet may also be associated with gestational diabetes.[4–7]

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The fact that gestational diabetes has important behavioural risk factors as well as ethnic and socioeconomic disparities suggests that there may be important contextual determinants to elucidate, yet gestational diabetes is largely absent from the substantial body of literature relating neighbourhood characteristics to pregnancy health. One neighbourhood characteristic that may be of particular importance to gestational diabetes is the neighbourhood food environment. Previous research has shown an association between living in a neighbourhood with fewer supermarkets and lower fruit and vegetable intake,[8] poorer diet during pregnancy,[9] higher BMI [body mass index (kg/m^2)][10,11] and higher risk of obesity.[11] In addition, lower availability of healthy foods has been associated with a low-quality dietary pattern.[12] The importance of obesity in the aetiology of gestational diabetes, and the potential effect of dietary composition, makes it a relevant pregnancy outcome to examine in relation to food environment. We hypothesised that a poor food environment, characterised by a low number of healthy food outlets or high number of unhealthy food outlets, is associated with an increased risk of gestational diabetes. We examined this question using cross-sectional population-based data from New York City.

Methods

Data sources

New York City birth data for 247 323 singleton live-births were matched to the hospital record associated with the delivery.[13] These data were then linked by census tract of residence to the 2001 Dun & Bradstreet retail food database and to socio-economic variables from the 2000 US census.

We excluded 1536 births to women with an indication of pregestational diabetes, as by definition they were not at risk for onset of diabetes during pregnancy. We additionally excluded 11 816 births (4.9%) with missing data on census tract, and 17 819 births (7.4%) whose mother's residence was outside of New York City, leaving a total of 210 926 births in 2156 census tracts for analysis.

Neighbourhood-level measures

Census tract was used as a proxy for neighbourhood, consistent with previous research.[8,10,14–17] We also used a second larger definition of neighbourhood defined as the census tract of residence plus all adjacent census tracts (ArcView 9.1).

Neighbourhood food measures were created by replicating measures used in a study of food environment and obesity in New York City.[11] Food outlets were categorised as 'healthy' (supermarkets, fruit and vegetable stores, and natural food stores) and 'unhealthy' (fast food, pizza, convenience stores, bodegas, bakeries, candy and nut stores, and meat stores), and tabulated by census tract. We additionally tabulated the number of supermarkets and fast food outlets separately to be consistent with previous literature. Neighbourhood-level potential confounders included a neighbourhood deprivation index[17] and the percent-age of an area that is used for commercial purposes. As it is plausible that the opening of retail food outlets is associated with the socio-economic status of a neighbourhood, and thus the prevalence of obesity and gestational diabetes, we considered neighbourhood deprivation a potential confounder.

Individual-level measures

We classified women as having gestational diabetes by combining information from the birth and hospital discharge records.[13] From the birth certificate we identified those with a diagnosis of gestational diabetes, and from the hospital discharge record those for whom any of the 18 diagnosis codes associated with delivery were International Classification of

Diseases (ICD)-9 code 648.81–648.82.[18] We then considered women who had gestational diabetes indicated in either source to be a case based on a validity study of the best algorithm for combining these data resources previously conducted in Washington.[18]

Individual level covariates including parity, pre-pregnancy weight, race/ethnicity, maternal education, maternal age and Medicaid status were obtained from the birth certificate. There was no information on maternal height with which to calculate BMI (kg/m^2), so we used maternal weight >200 lbs as a proxy for obesity.[19]

Statistical analysis

Univariable distributions of the number of retail food outlets per neighbourhood were examined to determine categories for analyses. In order to account for the clustering of births within census tracts, a logistic multilevel generalised linear model with a random intercept term was used to calculate odds ratios (OR) for each food environment variable in relation to the dichotomous outcome of gestational diabetes.[20] Covariates were selected as potential confounders due to their potential association with either food environment or gestational diabetes (Table 1). We intentionally did not control for pre-pregnancy weight as we hypothesised that it is on the causal pathway between food environment and gestational diabetes. We also reran all models additionally controlling for the other food environment measures.

Interaction terms for maternal education, employment status, race/ethnicity and each food environment variable were tested for statistical significance using added-last *F*-tests calculated by PROC GLIMMIX. The models for all food environment measures were repeated using the larger definition of neighbourhood based on clusters of census tracts. All models were estimated using PROC GLIMMIX in SAS 9.1.3.

Results

The overall risk of gestational diabetes for the years 2001–02 was 5.5%. In unadjusted analyses, there was an increased odds of gestational diabetes among women living in a given neighbourhood with no healthy food outlets [OR = 1.10, 95% confidence interval (CI) 1.03, 1.17], and among women living in a given neighbourhood with only one healthy food place [OR = 1.08, 95% CI 1.01, 1.06] relative to those living in a given neighbourhood with two or more; however, this increase was attenuated after adjusting for borough of residence (Table 1).

After adjusting for both group-level and individual-level covariates, adjusted ORs related to the number of both healthy outlets and unhealthy outlets were small in magnitude, varying from 0.95 to 1.04, and were not statistically significant (Table 1). Using the larger definition of food neighbourhood produced nearly identical results (data not shown). Results for number of supermarkets and fast food outlets considered in isolation were similar, and there was no evidence of effect modification for the other food environment variables by maternal education, employment status or race/ethnicity (data not shown).

In a *post hoc* analysis, we created a model relating the food environment variables to the outcome maternal pre-pregnancy weight >200 lbs. There was an increased odds of pre-pregnancy obesity for women living in a given neighbourhood with no healthy food outlets [aOR = 1.14, 95% CI 1.07, 1.21] or only one healthy food place [aOR = 1.10, 95% CI 1.04, 1.18] relative to two or more healthy food outlets, while there was no association between unhealthy food outlets and pre-pregnancy obesity (Table 2).

Discussion

This research builds on previous research on neighbourhood characteristics and pregnancy outcomes by examining a specific feature of the neighbourhood environment in relation to gestational diabetes, an important complication that has received little attention in the neighbourhood effects literature. Despite the fact that obesity is a strong risk factor for gestational diabetes, we found a significant association between healthy food outlets and a crude measure of obesity but not gestational diabetes. It is possible that as gestational diabetes is a more contingent outcome than the intermediary factor of obesity, the true magnitude of the association is weaker and thus more likely to appear null by way of attenuation due to measurement error of either the food environment or gestational diabetes. Indeed, in unadjusted analyses relating living in a given neighbourhood with no healthy food outlets and gestational diabetes, we found a significant, albeit weak, association [OR = 1.10, 95% CI 1.03, 1.17] that was attenuated only by addition of borough of residence.

Our *post hoc* analysis of pre-pregnancy obesity was limited by our measure of obesity. Lack of information on maternal height probably resulted in misclassification and biased the measure of association towards the null, and it is likely that the true association between neighbourhood food environment and pre-pregnancy obesity is of greater magnitude. Thus, these findings present an important avenue for future research.

There are also some limitations to the measurement of neighbourhood food environment, including the definition of neighbourhood and what constitutes a healthy or unhealthy food environment. We used the census tract as a proxy for neighbourhood. There is some evidence that a census tract boundary provides greater homogeneity in food environment than larger census tract clusters.[21] Indeed, we found no difference in our results when we used a cluster of census tracts to define neighbourhood boundaries. Based on these results, it is unlikely that the null findings of the main hypothesis were the result of the choice of neighbourhood boundary. However, it is plausible that regardless of neighbourhood boundaries, women may shop outside of their neighbourhoods for healthy foods. This could partially explain the null results presented here, although this alternative explanation may be limited to women who have the resources to shop outside their neighbourhood.

Secondary commercial data allow enumeration of food outlets in a large urban area such as New York City. However, a complete portrait of the food environment that can be obtained by primary data collection also incorporates other aspects of the availability, accessibility, affordability and quality of food.[22] Our inability to take these differences into account in our measures may have resulted in non-differential misclassification of the food environment, and must be considered as an alternative explanation of our overall null results.

One unique strength of this study was the ability to use ICD-9 codes for the hospital discharge record for delivery and birth certificate data to ascertain gestational diabetes. Previous research on neighbourhood characteristics and pregnancy outcomes has largely been limited to birthweight and preterm birth[23–35] partially due to the availability of these measures in birth data. This unique population-based data source made it possible to examine a pregnancy outcome previously neglected in the neighbourhood effects literature.

This study did not detect an association between the number of healthy or unhealthy retail food outlets in the neighbourhood and gestational diabetes. An association between the lack of healthy food outlets and pre-pregnancy weight >200 lbs was found, while there was no such association for unhealthy food outlets. Inferences from these results are limited by potential misclassification of neighbourhood food environment and pre-pregnancy obesity, which are expected to bias results towards the null. Research regarding the validity of neighbourhood food environment measures among pregnant women is warranted. In addition, future research should examine the availability of healthy food in relation to pre-pregnancy obesity and diet during pregnancy.

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Table 1

Unadjusted (OR) and adjusted odds ratios (aOR) for neighbourhood food characteristics and gestational diabetes, New York City, 2001–02 (*n* = 210 926)

Neighbourhood food characteristic	OR [95% CI]	aOR[a] [95% CI]	aOR[bc] [95% CI]
Number of healthy food places			
0	1.10 [1.03, 1.17]	1.01 [0.95, 1.07]	1.02 [0.97, 1.08]
1	1.08 [1.01, 1.06]	1.04 [0.97, 1.11]	1.04 [0.98, 1.11]
2 or more	1.00 Reference	1.00 Reference	1.00 Reference
Number of unhealthy food places			
0–1	1.00 Reference	1.00 Reference	1.00 Reference
2–3	0.95 [0.87, 1.03]	0.97 [0.90, 1.06]	0.97 [0.90, 1.04]
4–7	0.97 [0.89, 1.05]	0.99 [0.92, 1.07]	0.97 [0.90, 1.04]
8 or more	0.92 [0.85, 1.00]	1.00 [0.93, 1.08]	0.95 [0.89, 1.02]

[a]Adjusted for neighbourhood deprivation, percentage commercial space, borough.

[b]Additionally adjusted for maternal education (<12 years, 12 years, >12 years), maternal age, parity (0, 1, ≥2), Medicaid status (yes/no), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian and Pacific Islander, other); estimates for each food characteristic mutually adjusted for the other.

[c]*n* = 207 645 observations for adjusted ORs due to exclusion of women with missing data on covariates from multivariable models.

Table 2

Adjusted odds ratios (aOR) for neighbourhood food characteristics and pre-pregnancy weight >200 lbs, New York City, 2001–02 (*n* = 207 645)

Neighbourhood food characteristic	aOR[a]	[95% CI]
Number of healthy food places		
0	1.14	[1.07, 1.21]
1	1.10	[1.04, 1.18]
2 or more	1.00	Reference
Number of unhealthy food places		
0–1	1.00	Reference
2–3	1.00	[0.93, 1.08]
4–7	1.00	[0.94, 1.08]
8 or more	0.88	[0.81, 0.94]

[a]Adjusted for neighbourhood deprivation, percentage commercial space, borough, maternal education (<12 years, 12 years, >12 years), maternal age, parity (0, 1, ≥2), Medicaid status (yes/no), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Asian and Pacific Islander, other).