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Ethnicity and gestational diabetes in New York City, 1995–2003

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Objective To characterise the patterns of occurrence of gestational diabetes among a wide range of ethnic groups that reside in New York City.

Design Birth records and hospital discharge data were linked to more accurately assess the risk of gestational diabetes by ethnicity, compare risk in US-born to foreign-born women, and assess time trends.

Setting New York City.

Population All singleton live births occurring between 1995 and 2003.

Methods Multivariable binomial regression analysis of ethnicity and gestational diabetes, yielding adjusted risk ratios with non-Hispanic white women as the referent.

Main outcome measure Diagnosis of gestational diabetes on birth certificate or in hospital discharge.

Results Adjusted relative risks (aRRs) were modestly elevated for African-Americans and sub-Saharan Africans and somewhat higher (<2.0) for non-Hispanic Caribbeans, Hispanic Caribbeans, Central Americans, and South Americans. The aRR was 4.7 (95% CI = 4.6–4.9) for South Central Asians (with an absolute gestational diabetes risk of 14.3%), 2.8 (95% CI = 2.7–3.0) among South-East Asian and Pacific Islanders, and 2.3 (95% CI = 2.2–2.4) among East Asians. Among South Central Asians, the greatest risks were found for women from Bangladesh (aRR = 7.1, 95% CI = 6.8–7.3). Foreign-born women consistently had higher risk than US-born women. Risk for gestational diabetes increased over time among South Central Asians, some Hispanic groups, and African-Americans.

Conclusions Risk of gestational diabetes appears to vary markedly among ethnic groups, subject to potential artefacts associated with screening and diagnosis. These differences would have direct implications for health care and may suggest aetiologic hypotheses.

Keywords Ethnicity, gestational diabetes.

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Introduction

The increasing ethnic diversity of the US population has influenced patterns of reproductive health. In the USA, in 2004, only 56% of live births were to non-Hispanic white women, with 23% to Hispanic women, 14% to non-Hispanic black women, and 6% to Asians.[1] Ethnicity is an indicator of many potential influences on health, including socioeconomic position and discrimination, lifestyle factors, such as diet and physical activity, medical care access and utilisation, and genetic heritage based on geographic origin. A number of important epidemiological discoveries regarding the origins of cardiovascular disease and cancer have been generated by seeking the causes of ethnic variation in disease risk.[2–5]

Increased risk of low birthweight and preterm birth among African-Americans[6,7] and the relatively favourable birth outcomes of Mexican-Americans despite their economic disadvantage[8,9] are among the few established links between ethnicity and reproductive health outcomes. Extending the scope of interest in ethnicity and reproductive health to include gestational diabetes has promise, given the strong influence of obesity on risk[10,11] and known ethnic variation in the prevalence of obesity.[12] Based on data from the Pregnancy Nutrition Surveillance System, a network that includes

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Table 1. Risk of gestational diabetes by ethnicity: absolute, unadjusted, and adjusted risk ratios, New York City, 1995–2003 (n = 951, 920)

Ethnic groups	Number of cases	Risk (%)	Unadjusted		Adjusted	
			Risk ratio	95% CI	Risk ratio*	95% CI
Non-Hispanic white	9846	3.6	1.0		1.0	
African-American	6387	4.3	1.2	1.2–1.2	1.2	1.2–1.3
North Africa	398	7.2	2.0	1.8–2.2	1.8	1.6–2.0
Egypt	199	5.9	1.7	1.4–1.9	1.4	1.2–1.6
Morocco	128	9.3	2.6	2.2–3.1	2.2	1.8–2.6
Other North Africa**	64	9.3	2.6	2.1–3.3	2.2	1.7–2.8
Sub-Saharan Africa	1018	5.9	1.6	1.5–1.7	1.3	1.2–1.4
Gambia	50	4.1	1.1	0.9–1.5	1.2	0.9–1.6
Ghana	210	6.9	1.9	1.7–2.2	1.3	1.2–1.5
Guinea	76	5.2	1.5	1.2–1.8	1.4	1.1–1.7
Ivory Coast	51	4.8	1.3	1.0–1.8	1.2	0.9–1.5
Mali	51	4.6	1.3	1.0–1.7	1.2	0.9–1.6
Nigeria	221	6.4	1.8	1.6–2.0	1.2	1.1–1.4
Senegal	90	6.5	1.8	1.5–2.2	1.4	1.2–1.7
Other West Africa***	87	6.3	1.7	1.4–2.1	1.5	1.2–1.8
Central/East/Southern Africa****	182	5.6	1.6	1.3–1.8	1.3	1.2–1.5
East Asia	3512	6.2	1.7	1.7–1.8	2.3	2.2–2.4
China	2801	6.6	1.9	1.8–1.9	2.3	2.2–2.4
Hong Kong	115	9.9	2.7	2.3–3.3	2.8	2.3–3.3
Japan	89	3.0	0.8	0.7–1.0	1.0	0.8–1.3
Korea	265	3.3	0.9	0.8–1.1	1.2	1.1–1.3
Taiwan	87	7.7	2.1	1.7–2.6	2.4	2.0–3.0
Other East Asia*****	155	13.7	3.8	3.3–4.4	4.1	3.5–4.8
South-East Asia and Pacific Islands	1027	8.6	2.4	2.3–2.6	2.8	2.7–3.0
Malaysia	73	9.3	2.6	2.1–3.2	2.5	2.0–3.2
Philippines	706	9.0	2.5	2.3–2.7	2.6	2.4–2.8
Vietnam	153	8.4	2.3	2.0–2.7	2.9	2.5–3.4
Other South-East Asia******	95	6.6	1.8	1.5–2.2	2.2	1.8–2.7
South Central Asia	4758	14.3	4.0	3.9–4.1	4.7	4.6–4.9
Afghanistan	102	8.4	2.3	1.9–2.8	2.8	2.3–3.3
Bangladesh	1606	21.2	5.9	5.6–6.2	7.1	6.8–7.3
India	1602	11.7	3.3	3.1–3.4	3.7	3.5–3.9
Iran	67	4.6	1.3	1.0–1.6	1.3	1.0–1.7
Pakistan	1263	16.2	4.5	4.3–4.8	4.6	4.3–4.8
Other South Central Asia*******	118	7.7	2.2	1.8–2.6	2.3	1.9–2.8
Non-Hispanic Caribbean	5038	6.9	1.9	1.9–2.0	1.6	1.6–1.7
Antigua and Barbuda	110	7.8	2.2	1.8–2.6	1.7	1.4–2.1
Barbados	174	7.5	2.1	1.8–2.4	1.7	1.5–2.0
Grenada	208	8.3	2.3	2.0–2.6	1.7	1.5–2.0
Haiti	1066	6.9	1.9	1.8–2.0	1.4	1.3–1.5
Jamaica	1617	6.2	1.7	1.7–1.8	1.4	1.4–1.5
St Lucia	69	6.3	1.7	1.4–2.2	1.4	1.1–1.8
St Vincent	136	8.2	2.3	2.0–2.7	1.7	1.5–2.1
Trinidad and Tobago	1077	9.0	2.5	2.4–2.7	2.2	2.1–2.4
Virgin Islands	24	3.7	1.0	0.7–1.5	1.1	0.7–1.6
Other non-Hispanic Caribbean********	557	5.9	1.6	1.5–1.8	1.4	1.3–1.5
Hispanic Caribbean	8767	4.9	1.4	1.3–1.4	1.6	1.6–1.7
Cuba	124	4.8	1.3	1.1–1.6	1.2	1.0–1.4
Dominican Republic	3954	4.8	1.3	1.3–1.4	1.5	1.5–1.6
Puerto Rico	4689	5.0	1.4	1.3–1.4	1.6	1.6–1.7
Mexico	2780	6.3	1.8	1.7–1.8	2.6	2.5–2.7

(*continued*)

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Table 1. (*Continued*)

Ethnic groups	Number of cases	Risk (%)	Unadjusted		Adjusted	
			Risk ratio	95% CI	Risk ratio*	95% CI
Central American	1133	4.9	1.4	1.3–1.5	1.5	1.4–1.5
Belize	53	5.4	1.3	1.0–1.7	1.3	1.0–1.7
El Salvador	334	5.5	1.5	1.4–1.7	1.7	1.5–1.9
Guatemala	192	4.4	1.5	1.3–1.7	1.7	1.5–2.0
Honduras	329	4.6	1.3	1.1–1.4	1.3	1.2–1.4
Nicaragua	49	4.1	1.1	0.9–1.5	1.2	0.9–1.6
Panama	124	4.8	1.2	1.0–1.5	1.2	1.0–1.4
Other Central America*********	47	5.0	1.4	1.1–1.8	1.3	1.0–1.7
South America	4189	6.6	1.9	1.8–1.9	2.0	1.9–2.1
Argentina	54	3.6	1.0	0.8–1.3	1.1	0.9–1.5
Brazil	79	4.5	1.3	1.0–1.6	1.3	1.0–1.6
Colombia	666	6.1	1.7	1.6–1.9	1.7	1.6–1.9
Ecuador	913	4.3	1.2	1.1–1.3	1.4	1.3–1.5
Guyana	2130	10.8	3.0	2.9–3.1	3.0	2.9–3.1
Peru	152	3.9	1.1	0.9–1.3	1.0	0.9–1.2
Venezuela	61	4.4	1.2	1.0–1.6	1.4	1.1–1.8
Other South America**********	131	4.8	1.3	1.1–1.6	1.3	1.1–1.5
Other Hispanic	533	3.6	1.0	0.9–1.1	1.3	1.2–1.4
Native American	15	3.9	1.1	0.7–1.8	1.2	0.7–1.9
Other ethnicity	301	4.6	1.3	1.1–1.4	1.3	1.1–1.4

*Adjusted for maternal age, maternal education, maternal pre-pregnancy weight, parity, and smoking during pregnancy.
**Algeria, Libya, Sudan, and Tunisia.
***Benin, Burkina Faso, Cape Verde, Guinea-Bissau, Liberia, Mauritania, Niger, Sierra Leone, Togo.
****Somali Republic, South Africa, Swaziland, Tanzania, Uganda, Zaire, Zambia, Zimbabwe.
*****Macao, Mongolia, Singapore.
******Brunei, Guam, Indonesia, Laos, Mariana Islands, Marshall Islands, New Guinea, Papua New Guinea, Samoa, American, Samoa, Western, Solomon Islands, Thailand, Truk Islands.
*******Burma, Kazakhstan, Kyrgyzstan, Nepal, Sri Lanka, Tajikistan, Turkmenistan.
********Aruba, Bahamas, Bermuda, Cayman Islands, Curacao, Dominica, Guadalupe, Martinique, Montserrat.
*********Costa Rica, 'Other Central America'.
**********Bolivia, Chile, French Guiana, Paraguay, Suriname, Uruguay, 'Other South America'.

approximately 700 000 women from 22 states, the prevalence of pre-pregnancy overweight and obesity in 2003 was 41.2% among non-Hispanic white women, 49.7% among non-Hispanic black women, 41.4% among Hispanic women, and 26.1% among Asian/Pacific Islanders (http://www.cdc.gov/pednss). Ethnic variation in diabetes prevalence beyond what can be accounted for by obesity[13] also encourages a closer look at ethnic variation in gestational diabetes.

Short-term consequences of gestational diabetes include increased rates of fetal macrosomia,[14–16] caesarean section,[14,16,17] birth defects,[18] neonatal hypoglycaemia,[19] and hyperbilirubinaemia.[20] Long-term consequences may include later development of type II diabetes and impaired glucose tolerance for the mother[21,22] and childhood obesity.[23,24] By linking birth records for New York City, where ethnic diversity is substantial, with hospital discharge data, we were able to examine the risk of diagnosed gestational diabetes in relation to ethnicity.

Methods

Data from the New York City Department of Health and Mental Hygiene on live births during the period 1995–2003 were made available, with information on mother's demographic characteristics (age, race/ethnicity, and education), smoking, pre-pregnancy weight, pregnancy complications (including a checkbox for gestational diabetes), and parity. The information on ethnicity for this analysis included the US Census indication of race as white women, black women, American Indian, or one of ten different categories of Asian or Pacific Islander. In addition, maternal ethnic ancestry and maternal country of birth were available. Because for most women, ethnic ancestry was listed as the name of a country, ethnic categories were created for every country with 1000 or more births during the period 1995–2003. For those women who listed their ethnic ancestry as Hispanic, Spanish, Arab, Muslim, Hindu, Kurd, or Sikh, their country of birth was

used to place them in an ethnic category; those who listed their ethnic ancestry as Hispanic but were US born were placed in a separate category. A category of non-Hispanic white women was created from all persons who reported their race as 'White' and their ethnic ancestry as American, European, Australian, Hebrew, or Jewish, as well as those who reported their ethnic ancestry as Arab and were not previously categorised based on their country of birth as described above. These countries were then collapsed into geographic regions for analysis,[25] with the following major groups: North African, sub-Saharan African, East Asian, South-East Asian and Pacific Islanders, South Central Asian, non-Hispanic Caribbean, Hispanic Caribbean, Mexican, Central American, South American, other US-born Hispanic, Native American, and others.

To improve the identification of gestational diabetes,[26] birth records were linked to hospital discharge data from the Statewide Planning and Research Cooperative System (SPARCS) by the New York State Department of Health. Starting with the 1 173 053 births from vital records for the period 1995–2003, 1 084 882 (92.5%) hospital discharge records were successfully linked to births, with 88 171 lost due to missing personal information used in the matching algorithm. Birth records of infants of multiple gestations were considerably less likely to be successfully matched to a hospital discharge record; therefore, the analysis is restricted to singleton births. Of 1 133 020 singleton births from vital records for the years 1995–2003, 1 067 356 (94.2%) were successfully linked to a hospital discharge record. The proportion of singleton births successfully linked was 95.1% for non-Hispanic white women, 95.1% for non-Hispanic black women, 94.4% for Hispanics, 93.4% for Asians, and 92.5% for women of other ethnicity.

The key item from the SPARCS data used for this analysis was the indication of gestational diabetes among the discharge diagnosis codes (ICD-9 648.81-648.82). Following earlier research on the optimum algorithm for combining these data resources based on a study in California,[26] we considered women who had an indication of gestational diabetes on either the birth certificate or the hospital discharge data (or both) as gestational diabetes cases and those who had no indication on either source as free from gestational diabetes. Of the 49 920 women identified in total, 7404 (14.8%) women were noted on the birth records only, 16 225 (32.5%) were noted on the hospital discharge data only, and 25 788 (51.7%) were noted on both.

An indicator of pregestational diabetes was derived from the birth certificate and the SPARCS data using the same algorithm described above for gestational diabetes (ICD-9 25000-25082, 36201, 64801-64802). Because by definition, gestational diabetes is any degree of glucose intolerance that is *first recognised during pregnancy*, women previously diagnosed with pregestational diabetes are not at risk of gestational diabetes and are excluded from the analyses (n = 6542, 0.6%). Women with missing information on ethnicity were also excluded (n = 9840).

We considered variables available from the birth records as potential confounders, including maternal age (≤25, 26–30, 31–35, 36–40, and ≥41 years), maternal education (≤8, 9–12, 13–16, and ≥17 years), pre-pregnancy weight divided into quintiles (<53.5, 53.5 to <58.5, 58.5 to 64.0, 64.0 to 74.4, and ≥74.4 kg), tobacco use during pregnancy (yes/no), and parity (0, 1, and ≥2). Because of the large study size, we included all variables in the models rather than restricting to those covariates that acted as confounders.

Relative risks were calculated for each group relative to non-Hispanic white women, and adjusted relative risks (aRRs) were derived from multivariable binomial regression models using log link controlling for the covariates, as applied by others.[27] Women for whom information was missing on any of the covariates (n = 102 423) were excluded from estimates of relative risk. (Relative risks were recalculated including 102 423 women with missing data on covariates and the results did not differ.) Next, the relative risk for foreign-born mothers compared with US-born mothers within each regional ethnic group was calculated. Relative risks were also calculated for select country-specific ethnic groups with a sufficient number of US-born women (n = 500). The aRRs were calculated for each group using the method described above. Time trends in the risk of gestational diabetes in the 9-year period from 1995 to 2003 were analysed by Poisson regression models[28] for each major ethnic group using separate models. Year was included as a linear term and the log of the yearly population at risk was included as an offset term. The average annual percentage change (AAPC) of the number of events was defined as AAPC = $(e^{\beta} - 1)$ 100 and a 95% CI was calculated. The AAPC was then calculated separately for each regional ethnic category.

Results

The overall risk of gestational diabetes based on either birth certificates or hospital discharge data was 5.2%; hospital discharge data alone identified 4.4% of women as cases, birth certificates alone identified 3.7%, and the two sources were concordant in identifying 2.7%. Focusing on the cases identified by either source as the most complete (Table 1), non-Hispanic white women had the lowest risk among all major ethnic groups considered, with 3.6% of pregnancies affected by gestational diabetes. Using this group as the referent, aRRs were modestly elevated (aRRs ≤ 1.5) for African-Americans, sub-Saharan Africans, and Native Americans. The aRRs were 1.5–2.0 for non-Hispanic Caribbeans, Hispanic Caribbeans, Central Americans, and South Americans. Asians showed notably higher risks, with an aRR of 4.7 (95% CI = 4.6–4.9) among South Central Asians (an absolute gestational diabetes

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risk of 14.3%), an aRR of 2.8 (95% CI = 2.7–3.0) among South-East Asian and Pacific Islanders, and an aRR of 2.3 (95% CI = 2.2–2.4) among East Asians. All of these estimates are highly precise based on the large number of births in all major ethnic groups.

There was variation, as expected, within regions, particularly in Asia. Among East Asian women, those from Japan and Korea were very similar in risk to non-Hispanic white women, whereas all others from that region had two-fold or greater aRRs. Among South Central Asians, the most extremely elevated risks were found for women from Bangladesh (aRR = 7.1, 95% CI = 6.8–7.3), Pakistan (aRR = 4.6, 95% CI = 4.3–4.8), and India (aRR = 3.7, 95% CI = 3.5–3.9). All other groups in that region except Iranians still had aRRs well above 2.0.

Among women from Caribbean countries, there was general consistency with the exception of more notably elevated risks in Trinidad and Tobago (aRR = 2.2, 95% CI = 2.1–2.4) and lower risk among women from the Virgin Islands (aRR = 1.1, 95% CI = 0.7–1.6) and Cuba (aRR = 1.2, 95% CI = 1.0–1.4). Mexican women had higher risk than those from Central and South America (aRR = 2.6, 95% CI = 2.5–2.7), with elevations also found for women from Guyana to a much greater extent than for others from South America (aRR = 3.0, 95% CI = 2.9–3.1). An absence of increase was seen among women from Argentina or Peru.

The overall profile shows marked variation by ethnicity with little impact from adjustment for potential confounders, including age and pre-pregnancy weight. The degree of consistency within region is notable, with the few exceptions noted above. At an even broader level, the pattern of slightly increased risk for African-Americans, more notably increased risk for Latinas, and markedly increased risk for Asians is clear, but with substantial within-group variation, particularly among the regions and countries of Asia. Alternate case definitions using hospital discharge or birth certificates alone or requiring both to be positive yielded very similar patterns across ethnic groups (data not shown). For example, the relative risk reported here for South Central Asians of 4.0 was 4.3 for hospital discharge diagnoses alone, 4.0 for birth certificate data alone, and 4.1 for those identified on both sources. Only for very small groups (e.g. Native Americans), did the relative risks differ materially across diagnostic approaches.

Comparison of gestational diabetes risk among women who were born outside the USA to those of the same ancestry born within the USA (limited to those countries with a large enough number of US-born women for analysis) provides a rather consistent pattern of elevated risks for foreign-born women (Table 2). Focusing on the aRRs, given the strong confounding by maternal age associated with the US-born women being older on average, markedly greater risk for foreign-born women (aRR ≥ 2.0) was found for North African and South Central Asian women. Foreign-born women had aRRs of 1.5 to <2.0 compared with US-born women among those from sub-Saharan Africa, South-East Asia, and South America, and aRRs of <1.5 among women from East Asia and the Caribbean and Central America, where a number of countries (Jamaica, Cuba, and all of Central America) showed no difference between nativity groups.

The temporal patterns of gestational diabetes risk over the 9-year period, examined solely for the major geographic regions due to limited precision for individual countries, showed an overall modest increase of 1.1% per year (Figure 1). There was variation across regions, but no clear pattern. Modest declines were found for non-Hispanic white women and East and South-East Asians, with little change for those from the Caribbean and Central or South America. Increases were found for African-Americans (relative increase of 1.7% per year), South Central Asians (2.2% per year), Mexicans (4.0% per year), and other US-born Hispanics (2.7% per year) (Figure 1).

Discussion

Gestational diabetes is a frequently diagnosed complication of pregnancy, particularly among Asian women, and most markedly among women from South Central Asia for whom the risk also seems to be rising over time. Nonetheless, the more modestly elevated risk among Latin American women is also of concern, given the size of this population. Independent of any aetiologic significance, these patterns help to establish screening priorities to focus on the highest risk groups.

The reasons for differences among ethnic groups are varied, including genetic variation based on geographic origin (unlikely for countries that share ancestry), lifestyle and cultural factors in those countries (e.g. resulting from different religious and dietary traditions), and selective immigration (with timing and reasons for emigration differing even for countries geographically proximal to one another). Assuming for the moment that these patterns of gestational diabetes are valid (discussed in more detail below), the data suggest that some influential but unidentified social, behavioural, or biological characteristics are more prevalent among high-risk ethnic groups. Given the lack of direct data, proposed explanations are conjectural, but the modest increases in risk among African-American and Latina populations may well be due to increased body weight or lower levels of physical activity as suggested by national studies of body mass index (BMI) and physical activity by ethnicity.[12,29] While we were able to control for the reported pre-pregnancy weight included in the birth certificate data, the very strong association between BMI and gestational diabetes, with relative risks of 8 or more between extreme groups,[10,11,30] leaves much room for residual confounding with adjustment for a measure that is likely limited in accuracy and fails to take height into account.

Table 2. Risk of gestational diabetes by nativity among ethnic groups: absolute, unadjusted, and adjusted risk ratios, New York City, 1995–2003

Ethnic groups	*n*	% gestational diabetes	Risk ratio for foreign born versus US born			
			Unadjusted		Adjusted	
			Risk ratio	95% CI	Risk ratio*	95% CI
North Africa						
US born	234	1.7	1.0			
Foreign born	5177	7.5	4.4	1.6–11.6	2.7	1.0–7.1
Sub-Saharan Africa						
US born	287	3.1	1.0			
Foreign born	17038	5.9	1.9	1.0–3.6	1.6	0.8–3.1
East Asia						
US born	3272	5.6	1.0			
Foreign born	53121	6.3	1.1	1.0–1.3	1.2	1.1–1.4
China						
US born	2459	6.4	1.0			
Foreign born	39600	6.7	1.0	0.9–1.2	1.3	1.1–1.5
South-East Asia and Pacific Islands						
US born	697	4.3	1.0			
Foreign born	11228	8.9	2.1	1.4–2.9	1.8	1.2–2.5
Philippines						
US born	588	4.1	1.0			
Foreign born	7270	9.4	2.3	1.5–3.4	1.9	1.2–2.8
South Central Asia						
US born	850	6.8	1.0			
Foreign born	32385	14.5	2.1	1.7–2.7	1.9	1.5–2.5
India						
US born	555	7.2	1.0			
Foreign born	13087	11.9	1.6	1.2–2.2	1.7	1.2–2.2
Non-Hispanic Caribbean						
US born	3709	3.4	1.0			
Foreign born	68671	7.1	2.1	1.8–2.5	1.4	1.2–1.6
Jamaica						
US born	1026	3.9	1.0			
Foreign born	24864	6.3	1.6	1.2–2.2	1.1	0.8–1.5
Haiti						
US born	1240	2.8	1.0			
Foreign born	14270	7.2	2.6	1.8–3.6	1.5	1.1–2.2
Hispanic Caribbean						
US born	84746	4.4	1.0			
Island or foreign born	94242	5.3	1.2	1.2–1.3	1.1	1.0–1.1
Puerto Rico						
US born	71199	4.7	1.0			
Island or foreign born	22449	6.1	1.3	1.2–1.4	1.2	1.1–1.2
Dominican Republic						
US born	11978	3.1	1.0			
Foreign born	70724	5.1	1.7	1.5–1.8	1.2	1.1–1.4
Cuba						
US born	1569	4.0	1.0			
Foreign born	1031	6.0	1.5	1.1–2.1	1.1	0.8–1.6
Mexico						
US born	1478	4.0	1.0			
Foreign born	42766	6.4	1.6	1.2–2.1	1.5	1.2–1.9

(*continued*)

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Table 2. (*Continued*)

Ethnic groups	*n*	% gestational diabetes	Risk ratio for foreign born versus US born			
			Unadjusted		Adjusted	
			Risk ratio	95% CI	Risk ratio*	95% CI
Central America						
US born	2273	3.4	1.0			
Foreign born	20693	5.1	1.5	1.2–1.9	1.1	0.9–1.4
Honduras						
US born	634	3.3	1.0			
Foreign born	6559	4.7	1.4	0.9–2.2	1.1	0.7–1.7
Panama						
US born	608	4.3	1.0			
Foreign born	2303	4.4	1.0	0.7–1.6	0.8	0.5–1.2
South America						
US born	5442	3.1	1.0			
Foreign born	58114	7.0	2.3	1.9–2.6	1.7	1.5–2.0
Ecuador						
US born	2269	2.8	1.0			
Foreign born	19220	4.4	1.6	1.2–2.1	1.1	0.9–1.5
Colombia						
US born	1463	3.4	1.0			
Foreign born	9420	6.6	1.9	1.4–2.6	1.4	1.0–1.8

*Adjusted for maternal age, maternal education, maternal pre-pregnancy weight, parity, and smoking during pregnancy.

The fact that adjustment for pre-pregnancy weight, even if a crude proxy for BMI, did not reduce relative risks at all for most groups calls into question the possibility that there is substantial residual confounding.[31] The magnitude of increase found for Asian populations and their overall lower prevalence of obesity suggest that other explanations must be driving the patterns, perhaps genetic or unmeasured lifestyle factors.

The general patterns reported here are broadly similar to those found in previous studies that relied on birth certificates[32] or were from smaller, more highly selected clinic or hospital populations.[10,33–35] The small increased risk among African-Americans is commonly, but not universally, seen,[10,11,32,33,35] as is a modest increase among Latinas.[10,32,33,35] A more pronounced increased risk among Asians[10,11,33,35–37]and some supportive evidence for an even more strongly increased risk among South Central compared with East and South-East Asians have been noted previously,[30,32,38] perhaps as a result of greater prevalence of obesity in the former group.[8] The tendency for risk of gestational diabetes to be lower among mothers born in the USA is counter to the patterns found for preterm birth and fetal growth restriction among foreign versus US-born Mexican-Americans.[8]

Given our reliance on birth records and hospital discharge summaries, the potential for incomplete assessment to affect patterns across groups warrants consideration. Screening is recommended but not necessarily applied universally across all clinical settings, cutpoints for screening and diagnosis differ, and women may not all be screened or followed for diagnosis depending on their compliance with prenatal care, even if screened and diagnosed accurately.[39] There is wide variation in the perceived specificity of the diagnosis among clinicians and researchers, some viewing the spectrum of glucose tolerance as part of normal biological variation rather than seeing high values as a disease to be treated.

Birth certificate data are subject to incomplete or inaccurate recording, resulting in grossly incomplete documentation of pregnancy complications.[40] However, if identified, it would be considered clinically important to document the occurrence of gestational diabetes and note it in the medical record. In contrast to some other pregnancy complications, such as pre-eclampsia or placenta praevia, although different cutpoints are applied in different settings,[39] the algorithms for diagnosing gestational diabetes are straightforward based on standard values for an oral glucose tolerance test.

Screening with a glucose challenge test is quite common and universal in many clinical settings in the USA, and if positive, follow up is essentially complete subject to the woman's continuation in prenatal care. While there are no systematically collected survey data on completeness of screening applicable to our population,[39] practice guidelines in the USA call for universal screening. While 98.3% of the women

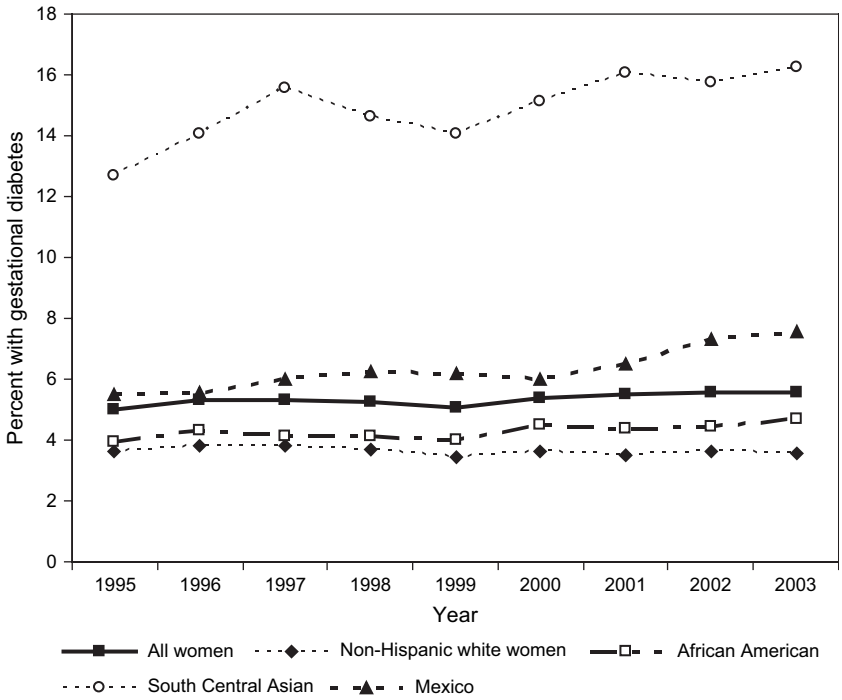

Figure 1. Temporal trends in risk of gestational diabetes by ethnicity, New York City, 1995–2003.

in the population received prenatal care, the proportions were slightly lower among African-Americans (96.8%), other Hispanics (97.4%), and Native Americans (97.3%), potentially causing underascertainment. The cutpoint for proceeding from the glucose challenge test to the oral glucose tolerance test is 135 or 140 mg/dl, adding additional variability into the case ascertainment process. Women with pre-existing diabetes may be misidentified as cases of gestational diabetes, but the proportion is likely to be small, given the limited prevalence of type II diabetes in reproductive age women and our efforts to exclude identified cases of pregestational diabetes from the analysis.

Identifying cases as those who are positive on birth certificates or hospital discharge diagnoses has been found to be optimal using complete medical record review as the gold standard.[26,41] Combining positive reports on birth certificates and hospital discharge diagnoses enhances completeness of ascertainment;[26] yet, the sizable discrepancies between notation of gestational diabetes on the birth records compared with hospital discharge diagnosis raise concerns with whether even their combination is truly complete. To the extent that intensity of medical scrutiny and notation of the presence of gestational diabetes is incomplete, there is the potential for differential completeness over time and across ethnic groups. However, it seems unlikely that the intensity of care or quality of medical records favours immigrant women relative to non-Hispanic white women. Furthermore, the patterns found for the case definition that includes women identified as cases from either source yielded results that were similar to those found when we varied the case definition to include those identified from the two sources considered alone or concordant positive reports across the two sources.

The key question for this study is not whether there are missed cases or overdiagnoses of individuals, which is certain to occur, but rather whether these errors are large and systematically related to ethnicity, creating artefactual patterns across those groups. While it seems unlikely to fully account for the markedly different patterns among Asian-Americans compared with non-Hispanic white women, for example, the more subtle differences among subgroups of Latinas may well reflect such subtleties in care, diagnosis, treatment, and recording. More socio-economically deprived ethnic groups might be less likely to receive prenatal care and receive recommended screening and treatment, which would tend to understate their risk (in contrast to the elevated risks reported relative to non-Hispanic white women). However, prenatal care providers serving primarily ethnic minorities may be aware of the increased risk and be more thorough in screening and documentation or set lower cutpoints, creating artefactual increases in their reported risk. In addition, time trends are subject to shifting diagnostic thoroughness and criteria, with the general trend towards more increased emphasis on the need for screening and diagnosis, and more liberal criteria for defining gestational diabetes, likely to create artefactual increases in apparent risk over time.

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In addition to the lack of detailed information on BMI or other potential mediators of the patterns of risk that were identified, we lacked detailed information on ethnicity or acculturation such as duration of time since immigration to the USA for foreign-born women or language preferences. Clinical characteristics of the gestational diabetes itself were also unavailable, including actual scores on glucose tolerance tests or information on the course of the disease through pregnancy. However, as noted above, we have some basis for confidence in the completeness of diagnoses from combining birth certificate and hospital discharge data[26,40,41] and were able to analyse refined subgroups, given the sizable number of women from other parts of the world residing in New York City. The precision of risk estimates, even for individual countries, is notable.

Conclusions

We have documented a potentially important pattern of ethnic variation in a common pregnancy complication. While there are questions about the validity of the patterns reported and the exact meaning of the ethnic patterns of risk that seem to be present, these data encourage intensive research to interpret the aetiologic implications and to consider more fully the merits of ethnicity-specific screening guidelines.

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Contribution to authorship

All authors contributed to the conception and design of the study, the analysis and interpretation, critical revision of the manuscript, and the statistical analysis. D.A.S. and T.M.J. completed the initial draft of the manuscript and the acquisition of the data.

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