Maternal Race–Ethnicity, Immigrant Status, Country of Birth, and the Odds of a Child With Autism

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Abstract
The risk of autism spectrum disorder varies by maternal race–ethnicity, immigration status, and birth region. In this retrospective cohort study, Western Australian state registries and a study population of 134 204 mothers enabled us to examine the odds of autism spectrum disorder with intellectual disability in children born from 1994 to 2005 by the aforementioned characteristics. We adjusted for maternal age, parity, socioeconomic status, and birth year. Indigenous women were 50% less likely to have a child with autism spectrum disorder with intellectual disability than Caucasian, nonimmigrant women. Overall, immigrant women were 40% less likely to have a child with autism spectrum disorder with intellectual disability than nonimmigrant women. However, Black women from East Africa had more than 3.5 times the odds of autism spectrum disorder with intellectual disability in their children than Caucasian nonimmigrant women. Research is implicated on risk and protective factors for autism spectrum disorder with intellectual disability in the children of immigrant women.

Autism spectrum disorder is a lifelong neurodevelopmental disorder characterized by deficits in social communication and interaction and by restricted and repetitive behaviors, interests, or activities. These deficits originate in early childhood and impact everyday functioning.[1] About 30% to 50% of persons with autism spectrum disorder have comorbid intellectual disability,[2,3] defined as having an IQ of less than 70 and impairments in adaptive functioning occurring before age 18 years.[1]

In some countries, the prevalence of diagnosed autism spectrum disorder is lower among children of women from minority ethnic groups. For example, children of Indigenous women in Australia[4] and Canada[5] have a lower prevalence of diagnosed autism spectrum disorder than the children of Caucasian women. In the United States, children born to Hispanic and Black women have lower prevalence of diagnosed autism spectrum disorder than children born to Caucasian women.[3] Additionally, some studies indicate the proportionate distribution of autism spectrum disorder with (vs without) intellectual disability is higher in the children of Hispanic, Asian, or Black women

than the children of Caucasian women.[6-8] Other studies[4,9-14] have suggested that the prevalence of autism spectrum disorder, and especially autism spectrum disorder with intellectual disability,[4,13] is higher among the children of immigrant than nonimmigrant women. In contrast, a United States population-based study reported that children born to immigrant Hispanic women had significantly lower rates of diagnosed autism spectrum

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disorder than children of nonimmigrant Hispanic or Caucasian women.[15]

Currently, it is not clear whether the association between maternal immigration status and the risk of having a child with autism spectrum disorder is primarily related to maternal race–ethnicity, immigrant status, or associated factors, such as the region of birth, the income status of the mother's native country, the distance from the native country,[16] maternal stress,[17,18] nutrition,[19] or other exposures of the mother. Although most studies have not separately examined race–ethnicity and immigration status, a few studies have shown that the prevalence of autism spectrum disorder among immigrant women can vary according to race–ethnicity and region of birth. For example, children born in Sweden[16] and the United States[20] to Black women from East Africa had higher rates of autism spectrum disorder with intellectual disability compared to children of native-born women. Likewise, children born in Western Australia and Malmö Sweden whose mothers were born in East Asia[4] had higher autism spectrum disorder prevalence rates than children born in the same countries to nonimmigrant women.[21]

The estimated prevalence of autism spectrum disorder is increasing,[22-24] and in Australia and other Western countries, the rate of immigration is also increasing. In Australia, the immigrant racial–ethnic composition[25,26] is changing over time, and so year of birth should be considered in the analyses of prevalence differences according to race–ethnicity/immigration status.[10,11,13,14] Therefore, while controlling for birth-year group and other demographic factors, we compared the prevalence of autism spectrum disorder with and without intellectual disability among children in Western Australia within subgroups defined by:

1. race–ethnicity,
2. immigrant status, and
3. region of birth for mothers of Asian race–ethnicity born in Asia and Black mothers born in East Africa.

Apart from providing insight into risk factors for autism spectrum disorder, differences in the prevalence of autism spectrum disorder among racial–ethnic groups might point to differences in ascertainment and thereby identify the need for enhanced screening in some population subgroups.

Data and Methods

Study Population and Data Collection

Our study population consisted of all women with a live-born child in Western Australia between 1994 and 2005 (inclusive). Our data were extracted from the Midwives Notification System,[27] which provided birth dates, data to inform measures of maternal race–ethnicity, parity and socioeconomic status, and the Western Australia Birth Register[27] which provided us with the maternal country of birth. Our third data source was the Intellectual Disability Exploring Answers Database[28] which receives diagnostic information on children with autism spectrum disorder or intellectual disability from the state government organization, the Disability Services Commission,[29] and the Western Australia

Department of Education. Diagnoses of autism spectrum disorder and intellectual disability were made by clinicians or psychologists using criteria from the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) and *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition, Text Revision). The Intellectual Disability Exploring Answers Database provided records of children born between 1994 and 2005 (inclusive) and diagnosed with autism spectrum disorder, with and without intellectual disability, before 2011. An IQ test was performed in all cases unless the child obviously did not have intellectual disability or the child was unable to be assessed. For children within the latter group, an estimate was made on whether the child was vulnerable to intellectual disability. Linkage of the aforementioned data sets was enabled by the use of an encrypted alphanumeric code, which was created for each mother by personnel from Western Australia's *Data Linkage Branch*.[27]

Maternal Groups

For women with at least one child identified with autism spectrum disorder, the index child was the eldest child with autism spectrum disorder born during the study period. Women in all comparison groups had no child identified with autism spectrum disorder, and the index child was the first-born child during the collection period. Case mothers were grouped into the case groups, *autism spectrum disorder with intellectual disability* and *autism spectrum disorder without intellectual disability*, according to the disability of their index child.

Explanatory Variables

Researchers have previously demonstrated that socioeconomic status, maternal age, and parity are associated with autism spectrum disorder.[4] The prevalence of autism spectrum disorder[30] and the pattern of immigration to Western Australia from different regions[25] have varied over time. Consequently, we included a binary measure of grouped birth year of the index child with the groups of 1994 to 1999 and 2000 to 2005. We derived our measure of maternal socioeconomic status from an *Index of Relative Socioeconomic Disadvantage*[31] and quartile boundaries from the original data set to define "low" pertaining to the lowest quartile, "medium" to the two inner quartiles, and "high" to the top quartile. We calculated maternal age at the index birth and defined a variable with the levels of 20 to 30 years, 31 to 40 years, and >40 years. Parity at the index birth was defined by 0 previous children, 1 previous child, 2 to 3 previous children, and >3 previous children. We did not include births after 2005, as a five-year period was needed for children with autism spectrum disorder without intellectual disability to have the opportunity to be diagnosed.

Variables Defining Maternal Groups

Race–ethnicity. We classified maternal race–ethnicity as Caucasian, Asian, Black, Indian, Maori or Polynesian, and Indigenous (Figure 1). In this article, Asian describes women identified
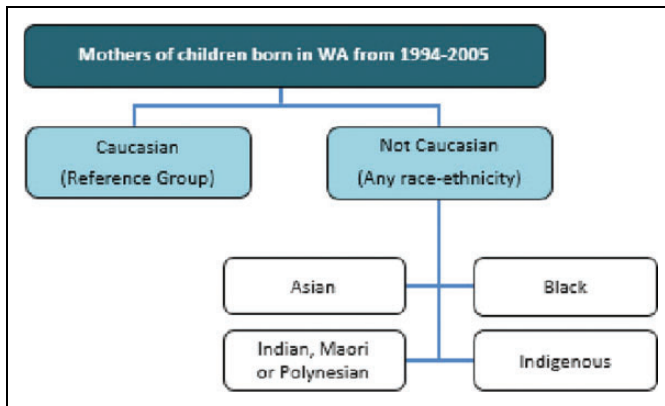
Figure 1. Comparison groups assessed in analyses according to race–ethnicity, independent of immigration status.

as being of Asian race–ethnicity and not women from Asia who can be of other race–ethnicities as well. The Indigenous group included all women who self-identified as an Australian Aboriginal or Torres Strait Islander.

Immigration status and region of birth. A binary variable indicated maternal immigration status. Women who were born in an Australian state or mainland territory were categorized as nonimmigrant and all others as immigrant. We further divided the remainder of the world into the six regions of Central Asia, South Asia, Other Asia, East Africa, Other Africa, and Other regions. We chose these regions because we wanted to explore the odds of having a child identified with autism spectrum disorder in women of Asian race–ethnicity from Central Asia and South Asia and in Black women from East Africa, as other researchers had noted higher odds of autism spectrum disorder in children of women from these regions (Supplementary Table 1). We also grouped Asian and Black immigrant women according to their birth region (Figure 2).

Analyses

We used multinomial logistic regression where the dependent variable was the autism spectrum disorder case group. As stated earlier, both autism spectrum disorder and intellectual disability are based on a child receiving a diagnosis. The independent variables were one or more of maternal race–ethnicity, immigration status, and region of birth. We included covariates for maternal age, parity, socioeconomic status, and index birth year in the final model and report the unadjusted and adjusted odds ratios. We did not assess maternal groups with less than six observations due to the unreliability of these results.[32] In case groups of size from six to nine, we calculated only the unadjusted odds ratios (or relative prevalence odds), as these groups were too small for the calculation of meaningful adjusted odds ratios.[33] Since socioeconomic status is positively correlated with the prevalence of diagnosed autism spectrum disorder,[4] we examined socioeconomic status in case groups where small numbers prevented us from calculating adjusted odds ratios. We tested the distribution of socioeconomic status in each of

these groups compared to the comparator group using a χ^2 test. In addition, we also tested proportions relating the demographic characteristics of parity and age to maternal groups using a χ^2 test.

Results

Our study sample included 134 204 mothers, of whom 1028 had a child with autism spectrum disorder with intellectual disability and 347 had a child diagnosed with autism spectrum disorder without intellectual disability. Compared to mothers aged 20 to 29 years, mothers of children diagnosed with either autism spectrum disorder with intellectual disability or autism spectrum disorder without intellectual disability were less likely to be younger than 20 years ($P < .00005$ and P value $= .0107$), while mothers of children with autism spectrum disorder with intellectual disability were more likely to be 40 years or more ($P < .00005$) and mothers of children with autism spectrum disorder without intellectual disability were not ($P = .0914$). Further, mothers of children diagnosed with either autism spectrum disorder with intellectual disability or autism spectrum disorder without intellectual disability were more likely to have had a previous child ($P < .00005$ and $P < .00005$; Table 1). The distribution of socioeconomic status was similar within all maternal groups. The majority (90.2%) of children with autism spectrum disorder without intellectual disability were born from 1994 to 1999 (Table 1) and compared to the number born in 2000 to 2005, the difference is highly significant ($P < .00005$). This is likely due to the fact that, on average, higher functioning children with autism spectrum disorder without intellectual disability are diagnosed more than four years later than children with autism spectrum disorder with intellectual disability.[34] At the end of the diagnostic period in 2010, the children in the second-year group were from five to ten years old, which means that many were less than 7.2 years, the average age of children receiving a diagnosis of Asperger syndrome, a form of autism spectrum disorder without intellectual disability.[34]

The number of children diagnosed with autism spectrum disorder with intellectual disability or autism spectrum disorder without intellectual disability from Indian, Maori, or Polynesian mothers was too small for meaningful analysis (N < 6). Hence, these mothers will not be further referenced. Similarly, the numbers of children diagnosed with autism spectrum disorder without intellectual disability in mothers of Asian, Black, and Indigenous race–ethnicities were too small for analysis (N < 6), and these subgroups will not be further referenced (Table 2).
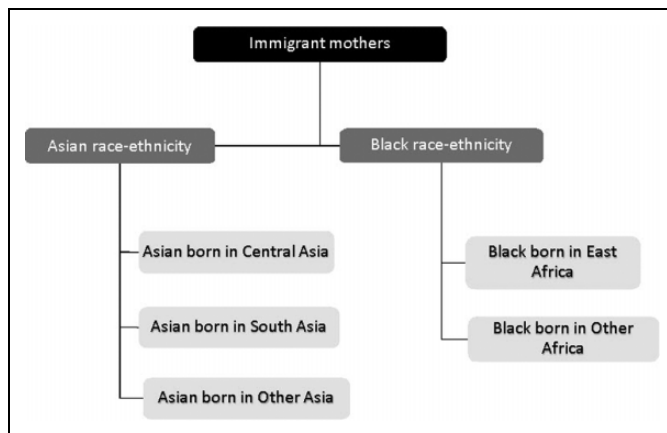
Race–Ethnicity

The odds of having a child identified with autism spectrum disorder with intellectual disability were similar among women of Asian race–ethnicity and Caucasian women, unadjusted odds ratio 1.09 (95% confidence interval: 0.8-1.4); adjustment for demographic factors reduced the odds ratio slightly, 0.77 (95% confidence interval: 0.6-1.02). Black women were about 50% more likely to have a child diagnosed with autism

Table 1. Demographic Characteristics of the Study Population According to ASD Status.

	No ASD (Comparator)	ASD With ID	ASD Without ID	Total
Maternal age at the index birth				
Less than 20 years	11 226 (8.5%)	38 (3.7%)	12 (3.5%)	11 276 (8.4%)
20-29 years	67 079 (50.5%)	426 (41.4%)	154 (44.4%)	67 659 (50.4%)
30-39 years	51 394 (38.7%)	530 (51.6%)	169 (48.7%)	52 093 (38.8%)
40 years or more	3130 (2.4%)	34 (3.3%)	12 (3.5%)	3176 (2.4%)
Parity at the index birth				
0 previous child	113 794 (85.7%)	480 (46.7%)	183 (52.7%)	114 457 (85.3%)
1 previous child	11 696 (8.8%)	345 (33.6%)	105 (30.3%)	12 146 (9.1%)
2-3 previous children	6448 (4.9%)	175 (17.0%)	52 (15.0%)	6675 (5.0%)
>3 previous children	891 (0.7%)	28 (2.7%)	7 (2.0%)	926 (0.7%)
Maternal SES at the index birth[a]				
Low	27 746 (20.9%)	255 (22.8%)	72 (20.8%)	28 073 (20.9%)
Medium	67 112 (50.5%)	519 (50.5%)	178 (51.3%)	67 809 (50.5%)
High	34 974 (26.3%)	232 (22.6%)	88 (25.4%)	35 294 (26.3%)
Missing	2997 (2.3%)	22 (2.1%)	9 (2.6%)	3028 (2.3%)
Index birth-year group				
1994-1999	65 460 (49.3%)	452 (44.0%)	313 (90.2%)	66 225 (49.4%)
2000-2005	67 369 (50.7%)	576 (56.0%)	34 (9.8%)	67 979 (50.6%)
Total	132 829	1028	347	134 204

Abbreviations: ASD, autism spectrum disorder; ID, intellectual disability; SES, socioeconomic status.
[a]We derived our measure of maternal SES from an *Index of Relative Socioeconomic Disadvantage* (Australian Bureau of Statistics[31]) and quartile boundaries from the original data set to define "low" pertaining to the lowest quartile, "medium" to the 2 inner quartiles, and "high" to the top quartile.

Figure 2. Categorization of mothers according to race–ethnicity and birthplace of interest.

spectrum disorder with intellectual disability than Caucasian women, although the difference was not statistically significant, odds ratio = 1.48 (0.7-3.1). For Indigenous women, the odds of having a child diagnosed with autism spectrum disorder with intellectual disability were about half the odds for Caucasian women both before, odds ratio = 0.54 (95% confidence interval: 0.4-0.8), and after adjustment, adjusted odds ratio = 0.52 (95% confidence interval: 0.3-0.8; Table 3).

Immigrant Status

After adjustment for demographic factors and compared to nonimmigrant women, immigrant women were less likely to have a child diagnosed with either autism spectrum disorder with intellectual disability or autism spectrum disorder without intellectual disability, adjusted odds ratios 0.64 (95% confidence interval: 0.6-0.7) and 0.62 (95% confidence interval: 0.5-0.8), respectively.

Groups of Special Interest

Overall, the children of immigrant women from other Asia had a lower prevalence of diagnosed autism spectrum disorder with intellectual disability ($P = .46$), and the children of immigrant women from East Africa had a higher prevalence of diagnosed autism spectrum disorder with intellectual disability than the referent group (children of Caucasian, nonimmigrant women; Table 4), although neither differences were significant. Prior to adjustment and compared to Caucasian nonimmigrant women, women of Asian race–ethnicity from Central Asia and from South Asia each had about a 30% increased odds of having a child diagnosed with autism spectrum disorder with intellectual disability, odds ratios 1.28 (95% confidence interval: 0.8-2.0) and 1.37 (95% confidence interval: 0.9-2.0), respectively (Table 5). After adjustment for demographic factors, these odds ratios were reduced, adjusted odds ratios 0.83 (95% confidence interval: 0.5-1.3) and 0.83 (95% confidence interval: 0.6-1.2), respectively. Women of Asian race–ethnicity from other parts of Asia had less than half the odds of having a child identified with autism spectrum disorder with intellectual disability, odds ratio 0.44 (95% confidence interval: 0.2-0.98), $P < .05$; due to small case numbers (N < 10), we did not perform adjusted analyses for this group. Black women from East Africa had more than three-fold higher odds of having a child identified with autism spectrum disorder with intellectual disability, odds

Table 2. ASD by Race–Ethnicity and Immigration Status.

Characteristic		No ASD (Comparator)	ASD With ID	ASD Without ID	Total
Race–ethnicity					
Caucasian		118 524 (89.2%)	937 (91.2%)	340 (98.0%)	119 801 (89.3%)
Asian		6517 (4.9%)	56 (5.5%)	5 (1.4%)	6578 (4.9%)
Black		594 (0.5%)	7 (0.7%)	0 (0.0%)	601 (0.5%)
Indian, Maori, or Polynesian		1826 (1.4%)	5 (0.5%)	0 (0.0%)	1831 (1.4%)
Indigenous		5368 (4.0%)	23 (2.2%)	2 (0.6%)	5393 (4.0%)
Immigration status					
Nonimmigrant		96 717 (72.8%)	752 (73.2%)	262 (75.5%)	97 731 (72.8%)
Immigrant		36 112 (27.2%)	276 (26.9%)	85 (24.5%)	36 473 (27.2%)
Race–ethnicity and immigration status					
Caucasian	Nonimmigrant	90 959 (76.7%)	725 (77.4%)	260 (76.5%)	91 944 (76.7%)
	Immigrant	27 565 (23.3%)	212 (22.6%)	80 (23.5%)	27 857 (23.3%)
Asian	Nonimmigrant	287 (4.4%)	2 (3.6%)	0 (0.0%)	289 (4.4%)
	Immigrant	6230 (95.6%)	54 (96.4%)	5 (100%)	6289 (95.6%)
Black	Nonimmigrant	18 (3.0%)	0 (0.0%)	0 (NA)	18 (3.0%)
	Immigrant	576 (97.0%)	7 (100%)	0 (NA)	583 (97%)
Indian, Maori, or Polynesian	Nonimmigrant	165 (9.0%)	2 (40%)	0 (NA)	167 (9.1%)
	Immigrant	1661 (91.0%)	3 (60%)	0 (NA)	1664 (90.9%)
Indigenous	Nonimmigrant	5260 (97.9%)	23 (100%)	2 (100%)	5285 (98.0%)
	Immigrant	108 (2.0%)	0 (0.0%)	0 (0.0%)	108 (2.0%)
Total		132 829 (100%)	1028 (100%)	347 (100%)	134 204 (100%)

Abbreviations: ASD, autism spectrum disorder; ID, intellectual disability; NA, percentage not able to be calculated.

Table 3. The Odds of Having a Child With ASD With ID in Women by Race–Ethnicity.

	ASD With ID	
Race–Ethnicity	Unadjusted OR (95% CI)	Adjusted OR[a] (95% CI)
Caucasian	1	1
Asian	1.09 (0.8-1.4)	0.77 (0.6-1.02)
Black	1.48 (0.7-3.1)	[b]
Indigenous	0.54 (0.4-0.8)[c]	0.52 (0.3-0.8)[c]

Abbreviations: ASD, autism spectrum disorder; CI, confidence interval; ID, intellectual disability; OR, odds ratio.
[a]Covariates were maternal age, parity, socioeconomic status, and birth-year group.
[b]Numbers were too small (N < 10) to produce reliable adjusted ORs.
[c]$P < .005$.

ratio 3.57 (1.7-7.6), $P < .005$; small case numbers also precluded adjusted analyses for this group. Indigenous women had about half the odds of having a child with autism spectrum disorder with intellectual disability, adjusted odds ratio 0.51 (0.3-0.8), $P < .005$.

Although small case numbers prevented us from performing adjusted analyses, we compared the socioeconomic status of immigrant women from both Other Asia and East Africa to nonimmigrant Caucasian women. Differences were significant between groups ($P < .0005$). Women of Asian race–ethnicity from Other Asia had a higher proportion of high socioeconomic status than nonimmigrant Caucasian women ($P = .0012$), and Black women from East Africa had a higher proportion of low socioeconomic status than nonimmigrant Caucasian women ($P = .0022$; Table 6).

Table 4. Numbers of Select Immigrant Groups.[a]

	Comparator Group			
Racial–Ethnic Groups of Interest	No ASD	ASD With ID	ASD Without ID	Total
Caucasian nonimmigrant women	27 565 (99.0%)	212 (0.8%)	80 (0.3%)	27 857 (100%)
Asian from Central Asia	1763 (98.9%)	18 (1.0%)	1 (0.1%)	1782 (100%)
Asian from South Asia	2746 (98.9%)	30 (1.1%)	1 (0%)	2777 (100%)
Asian from other Asia	1721 (99.5%)	6 (0.4%)	3 (0.2%)	1730 100%
Black from East Africa	246 (97.2%)	7 (2.8%)	0 (0.0%)	253 (100%)
Black from other Africa	330 (100%)	0 (0.0%)	0 (0.0%)	330 (100%)

Abbreviations: ASD, autism spectrum disorder; ID, intellectual disability.
[a]Shaded cells contain numbers that are too small for analysis.

Table 5. Odds Ratios for Having a Child With ASD With ID in Select Immigrant Groups.

	ASD With ID	
Racial–Ethnic Group	Unadjusted OR (95% CI)	Adjusted OR[a] (95% CI)
Caucasian nonimmigrant women	1	1
Asian from Central Asia	1.28 (0.8-2.0)	0.83 (0.5-1.3)
Asian from South Asia	1.37 (0.9-2.0)	0.83 (0.6-1.2)
Asian from Other Asia	0.44 (0.2-0.98)[b]	c
Black from East Africa	3.57 (1.7-7.6)[d]	c
Indigenous women	0.54 (0.4-0.8)[d]	0.51 (0.3-0.8)[d]

Abbreviations: ASD, autism spectrum disorder; CI, confidence interval; ID, intellectual disability; OR, odds ratio.
[a] Covariates were maternal age, parity, socioeconomic status, and birth year group.
[b] $P < .05$.
[c] Numbers were too small (N < 10) to produce reliable adjusted ORs.
[d] $P < .005$.

Table 6. SES Distribution by Maternal Region of Birth and Race–Ethnicity.

SES at Time of Index Birth[a]	Asian From Other Asia	Black From East Africa	Nonimmigrant Caucasian
Low	276 (16.0%)	85 (33.6%)	18 560 (20.2%)
Medium	894 (51.7%)	138 (54.6%)	47 791 (52.0%)
High	547 (31.6%)	28 (11.1%)	23 417 (25.5%)
Missing	13 (0.8%)	2 (0.8%)	2176 (2.4%)
Total	1730 (100%)	253 (100%)	91 944 (100%)

Abbreviation: SES, socioeconomic status.
[a] We derived our measure of maternal SES from an *Index of Relative Socioeconomic Disadvantage* (Australian Bureau of Statistics[31]) and quartile boundaries from the original data-set to define "low" pertaining to the lowest quartile, "medium" to the 2 inner quartiles, and "high" to the top quartile.

Discussion

We found that children born to Indigenous mothers were about half as likely to receive a diagnosis of autism spectrum disorder with or without intellectual disability as children born to Caucasian mothers. Children born to immigrant mothers overall were about 40% less likely to receive a diagnosis of autism spectrum disorder with or without intellectual disability. However, there were notable differences among children of immigrant mothers. Children born to Asian women from other Asia were less than half as likely to receive a diagnosis of autism spectrum disorder with intellectual disability, and children born to Black women from East Africa were more than 3.5 times as likely to have a child diagnosed with autism spectrum disorder with intellectual disability.

Others have shown that older mothers are more likely to have a child with autism spectrum disorder and less likely to be of young age. For example, Leonard et al[4] showed that compared to mothers aged 25 to 29 years, mothers younger than 20 years were less likely to have a child with autism spectrum disorder with intellectual disability, and mothers older than 39 years were more likely to have a child with autism spectrum disorder with intellectual disability. We found similar associations of a decreased likelihood of autism spectrum disorder with intellectual disability in mothers younger than 20 years and an increased likelihood in mothers more than 39 years. However, Leonard et al[4] found no significant association with age in mothers of children with autism spectrum disorder without intellectual disability. In contrast, we found that compared to mothers of 20 to 29 years, mothers of children with autism spectrum disorder without intellectual disability were less likely to be less than 20 years (P value = .107) but not more likely to be 40 years or more (P value = .0914). We suggest that our failure to find an association with mothers aged 40 years or older is due to the smaller number of mothers in this group and that due to the later age of diagnosis of autism spectrum disorder without intellectual disability, some of their children were not diagnosed before the deadline of January 1, 2011. The lower likelihood of autism spectrum disorder in the children of younger mothers might be due to underascertainment in this group. Due to our definition of the *index child* as the eldest child in comparator mothers and the eldest child with a disability in case mothers, we needed to adjust for parity in models but could not assess true parity differences for these children.

Indigenous women had about half the odds of a child diagnosed with autism spectrum disorder with intellectual disability. This is similar to the odds ratios described by others.[4,5] As in the United States,[35-37] this might be due to poorer access to health care and consequent underascertainment of autism spectrum disorder. In Western Australia, many Indigenous people live in remote areas,[38] where diagnosis is difficult to obtain. Moreover, there can be less motivation to seek a diagnosis since few services are available.

Children born to Black immigrant mothers have a higher prevalence of diagnosed autism spectrum disorder with intellectual disability than the referent group, nonimmigrant Caucasian mothers. These findings are in line with those of researchers in Sweden and the United States.[16,20] We further subdivided this group of immigrants and found that all cases of autism spectrum disorder identified in Black immigrant mothers were from mothers born in East Africa, with four born in Ethiopia and one each from Eritrea, Kenya, and Somalia, which are adjacent counties found within a localized region of East Africa and termed the *Horn of Africa*. Furthermore, all autism spectrum disorder diagnoses in the children of Black mothers were of autism spectrum disorder with intellectual disability, and these women were the only Black women from Africa to have a child with autism spectrum disorder. Additionally, in contrast to the Asian women who migrated from other Asia, the socioeconomic status of Black women who migrated from East Africa was lower than Caucasian nonimmigrant women. Thus, while the healthy immigrant effect might have explained the low diagnosed autism spectrum disorder prevalence in children born to Asian women who had migrated from Other Asia, it is unlikely that it was a driving force among this select group of women who migrated from East Africa.

To date, all studies exploring autism spectrum disorder in children of Black women from Africa have had the limitation of small numbers.[16,20] We were faced with similar difficulties. For example, due to small numbers, we were unable to perform adjusted regression analyses for either of the two immigrant groups with autism spectrum disorder prevalence rates that differed significantly from the referent group.

The lack of data has resulted in an inability of researchers to conduct studies to assess proposed mechanisms that might explain the higher prevalence of autism spectrum disorder with intellectual disability in Black immigrant mothers from East Africa. We raise three hypotheses and suggest that each, to some degree, can be affecting the prevalence of autism spectrum disorder. First, there can be an ascertainment effect with Black mothers more likely to get early diagnoses for their children. This could occur if in close-knit communities, diagnoses in a few families might influence other families to have a child with apparent development delays assessed in order to get needed services. Second, the severity of symptoms might be affecting the likelihood of diagnosis. In other words, almost all of the autism spectrum disorder in the children of Black mothers could be due to intellectual disability being the driving force of the children getting comprehensive developmental assessments. Finally, cultural factors might affect the accuracy of specific diagnostic tests for autism spectrum disorder, since cultural norms and expectations influence eye contact, language, and socialization in young children.[34]

In Black women from East Africa, it is difficult to identify unique environmental risk factors that would not be operating in many other African populations, although some have been proposed, such as nutritional factors and vitamin D deficiency. The latter hypothesis is supported by the fact that both male and female immigrants from Horn of Africa to Australia were deficient in vitamin D.[39] Prenatal stress has been associated with autism spectrum disorder.[40] Hence, another hypothesis is that the stress associated with lifestyle changes, which might be exacerbated in Black immigrant women from East Africa where many have had negative extremes, such as war, famine, and consequent refugee status,[41] has resulted in increased rates of autism spectrum disorder. Furthermore, in Australia, women from East Africa are reported to be the victims of increased domestic violence.[41,42] Stress is associated with the increased risk of a child with autism spectrum disorder.[43,44] A plausible mechanism is alteration in a woman's cortisol profile due to stress and that changes the fetal environment.[45]

Strength and Limitations

Our study was enabled by the availability of population-based data on children with autism spectrum disorder or intellectual disability. Important variables, such as race–ethnicity and birth dates, were collected by midwives in conjunction with the mothers, and immigration status was provided by the Birth Registry. This reduced bias and enhanced the accuracy of our results. Another strength is our separation of Asian race–ethnicity from the trait of *being born in Asia*.

Nonetheless, one study limitation is the likelihood of some incorrect categorizations of ethnicity. Moreover, the numbers of mothers of some ethnicities were small. This, combined with the small number of children with autism spectrum disorder, limited the groups available for analysis. The number of children with a diagnosis of autism spectrum disorder without intellectual disability was especially small; it is very likely that this group is incomplete, since younger children might not yet have been assessed for either autism spectrum disorder or intellectual disability and those children with milder symptoms of autism spectrum disorder without intellectual disability might not be recognized as such before they have entered school. This greatly limited our ability to assess autism spectrum disorder without intellectual disability. Overall, only 25% of children identified as having autism spectrum disorder were classified as autism spectrum disorder without intellectual disability, and the proportion among non-Caucasian groups was markedly lower.

Conclusion

Our comprehensive assessment of the Western Australia population revealed three groups of children whose prevalence of diagnosed autism spectrum disorder , particularly autism spectrum disorder with intellectual disability, diverged from the referent group—Caucasian children with nonimmigrant Caucasian mothers. Children born to Indigenous women had significantly lower prevalence of diagnosed autism spectrum disorder than the referent group, possibly associated with low socioeconomic status and poor access to diagnostic services. Children of women of Asian race–ethnicity who migrated from parts of other Asia also had significantly lower prevalence of diagnosed autism spectrum disorder; however, the underlying reason is likely different from that for children born to Indigenous women. These Asian immigrant women were of higher than average socioeconomic status, suggesting the possibility of a healthy immigrant effect. Finally, the high prevalence of diagnosed autism spectrum disorder in children born to Black women from East Africa is in line with a few other small studies. However, neither our study nor previous studies could explore the possible underlying reasons. We hypothesize that at least some of this difference could be the result of various factors leading to higher ascertainment of autism spectrum disorder in this group of children; however, we cannot rule out the possibility of some biological risk factor, such as nutrition or stress. Further study is needed to disentangle possible ascertainment versus biologic reasons for the disparities we observed. Such study will present challenges, given the need to aggregate data across many years and possibly combine data from multiple locations in order to have sufficient numbers to study children within immigrant subgroups. Nonetheless, in light of the improved outcomes of early intervention,[46] improved methods of ascertainment and access to services, particularly for Indigenous children, are indicated.

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