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BRIEF COMMUNICATION

Birth Defects and Genetic Disorders Among Arab Americans—Michigan, 1992–2003

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Abstract Birth defects and genetic disorders are leading causes of infant morbidity and mortality in many countries. Population-based data on birth defects among Arab-American children have not been documented previously. Michigan has the second largest Arab-American community in the United States after California. Using data from the Michigan Birth Defects Registry (MBDR), which includes information on parents' country of birth and ancestry, birth prevalences were estimated in offspring of Michigan women of Arab ancestry for 21 major categories of birth defects and 12 congenital endocrine, metabolic, and hereditary disorders. Compared with other non-Hispanic white children in Michigan, Arab-American children had similar or lower birth prevalences of the selected types of structural birth defects, with higher rates of certain hereditary blood disorders and three categories of metabolic disorders. These estimates are important for planning preconception and antenatal health care, genetic counseling, and clinical care for Arab Americans.

Keywords Birth defects · Arab-American children · Michigan Birth Defects Registry · Metabolic disorders · Hereditary blood disorders

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Introduction

Birth defects and genetic disorders, leading causes of infant morbidity and mortality in many countries, can vary by race and ethnicity [1, 2]. Hereditary and metabolic disorders are responsible for a substantial proportion of infant morbidity and mortality in Arab countries [3]. Population-based data on birth defects among Arab-American children have not been documented previously. Michigan has the second largest Arab-American community in the United States after California (200,000–300,000 persons of Arab ancestry) [4]. Births to women of Arab ancestry represent approximately 2.3% of total live births in Michigan every year and 2.4% of all birth defects ascertained by the Michigan Birth Defects Registry (MBDR) [5]. Michigan is one of the few states that make further classification for ethnic groups such as Arabs. The purpose of our study was to estimate the rates of major birth defects and congenital endocrine, metabolic and hereditary disorders among Arab-American children in Michigan.

Methods

Data from 1992 to 2003 were extracted from the MBDR and linked to birth certificate data provided by the Michigan Department of Community Health. The MBDR is a statewide, population-based surveillance system that ascertains diagnoses of birth defects and genetic disorders up to 2 years after delivery, with case reports received from hospitals, cytogenetics laboratories, and genetic counseling centers. These data are augmented by information from vital records, Medicaid claims, Children's Special Health Care Services enrollment, newborn screening results, and other sources. Twenty-one birth defects were selected for

analysis; national prevalence estimates of these defects have been reported recently [6]. In addition, rates were calculated for 12 categories of congenital endocrine, metabolic, and hereditary disorders that can be identified by newborn screening. The prevalences for children of U.S.- and foreign-born Arab mothers were compared with those for children of non-Hispanic, non-Arab white mothers in Michigan and for all non-Arab children born in Michigan during the study period. The data collection was granted an exemption as a public health surveillance activity with adequate confidentiality protections by the Institutional Review Board of the Michigan Department of Community Health.

Results

During the study period, there were 1,184,587 live births to non-Hispanic white mothers in Michigan. Of these, there were 36,830 live births to mothers of Arab ancestry (29,426 to foreign-born Arab mothers, 7,384 to U.S.-born Arab mothers and 20 to mothers of unknown place of birth). The MBDR received reports of 2,374 children of Arab ancestry with birth defects (1,932 children of foreign-born mothers and 442 of U.S.-born mothers). Table 1 describes the geographic ancestry or place of birth for this population that were self-reported by parents of children with birth defects. Of all mothers with Arab ancestry, 68.8% reported that the father also had Arab ancestry.

Table 2 presents birth defect prevalences per 10,000 live births and the rate ratios for 21 structural birth defects among Michigan Arab-American children versus all other children and non-Hispanic white children in Michigan. The prevalences ranged from 0.0 per 10,000 live births for encephalocele to 12.22 per 10,000 live births for Down syndrome in Arab Americans. For all other Michigan children and for non-Hispanic whites, the prevalence ranged from 0.96 and 0.94 per 10,000 live births for anencephalus to 11.21 and 11.84 per 10,000 live births for Down syndrome, respectively.

Table 1 Arab-Americans parents' place of birth or ancestry

Country	Mother's place of birth/ ancestry ($n = 2,374$)	Father's place of birth/ ancestry ($n = 2,296$)
Iraq	33.0%	27.8%
Lebanon	24.0%	20.9%
Yemen	8.0%	6.9%
Jordan	5.0%	4.2%
Syria	3.5%	2.7%
Saudi Arabia, Kuwait, Emirates	3.3%	2.3%
Israel, Jerusalem, West Bank	2.3%	2.6%
Egypt	1.9%	1.4%
Others	19.0%	31.2%

The following birth defects were more prevalent among Arab-American children compared with all non-Arab Michigan children and non-Hispanic white children, although the differences in rates were not statistically significant: anophthalmia/microphthalmia, esophageal atresia/tracheoesophageal fistula, lower limb reduction defects, Down syndrome, and trisomy 18. The other structural birth defects were generally lower in prevalence in Arab Americans than among non-Hispanic whites and all non-Arab Michigan births, but these differences were statistically significant only for two categories of defects (cleft lip with or without cleft palate, and the combined category for two abdominal wall defects: gastroschisis or omphalocele). The unadjusted prevalence ratios for occurrence of the 21 birth defects among Arab-American children versus children of other non-Hispanic white mothers ranged from 0.20 (gastroschisis/omphalocele) to 1.57 (reduction defect, lower limb).

Table 3 summarizes the prevalences of 12 categories of congenital endocrine, metabolic, and hereditary disorders per 10,000 live births and the prevalence ratios for the Arab-American children versus non-Hispanic whites and all non-Arab Michigan children. The prevalences for the following categories were significantly higher among children born to Arab mothers than among children of non-Hispanic white mothers and all other Michigan mothers: maple syrup urine disease and other branched-chain aminoacidopathies, medium chain acyl-CoA dehydrogenase deficiency and other specified metabolic disorders, organic acidemias and other acidoses, and glucose-6-phosphate dehydrogenase deficiency. The rates of thalassemia and sickle cell disease were also higher in Arab Americans than in other non-Hispanic whites, but the difference was only statistically significant for thalassemia. The prevalence of sickle cell disease among Arab Americans was significantly lower than among all non-Arab Michigan children, which includes births to black mothers.

Discussion

This study provides the first estimates of rates of leading major birth defects and congenital endocrine, metabolic, and hereditary disorders among Arab-American children in Michigan. The data highlight the increased prevalences of specific categories of genetic disorders among Arab Americans in Michigan. The occurrence of recessively inherited disorders is influenced by the frequency of carriers in the population, rates of children born to parents

Table 2 Birth prevalence of 21 selected major birth defects among Arab Americans versus all other children and non-Hispanic white children, Michigan 1992–2003

Diagnostic grouping	ICD9 code	Number of Arab-American children	Arab-American prevalence/ 10,000 live births	Number of all other children	Prevalence in all other children/ 10,000 live births*	Prevalence ratio for Arab Americans versus all others	95% confidence interval	Number of non-Hispanic white children	Non-Hispanic white prevalence/ 10,000 live births**	Prevalence ratio for Arab Americans versus non-Hispanic whites	95% confidence interval
Neural tube defects											
Anencephalus	740.0–740.1	3	0.81	154	0.96	0.85	0.27–2.65	111	0.94	0.87	0.27–2.73
Spina bifida	741.0, 741.9	12	3.26	648	4.04	0.80	0.45–1.42	492	4.15	0.78	0.44–1.38
Encephalocele	742.0	0	0.00	158	0.98	0.00		106	0.89	0.00	
Eye defects											
Anophthalmia or microphthalmia	743.0, 743.1	7	1.90	260	1.62	1.18	0.56–2.50	184	1.55	1.23	0.58–2.62
Cardiovascular defects											
Truncus arteriosis	745.0	2	0.54	187	1.17	0.45	0.11–1.82	154	1.30	0.41	0.10–1.65
Transposition of great arteries	745.1	10	2.72	727	4.53	0.59	0.32–1.11	568	4.79	0.56	0.30–1.04
Tetralogy of Fallot	745.2	13	3.53	840	5.23	0.67	0.39–1.16	635	5.36	0.65	0.38–1.13
Endocardial cushion defect	745.6	14	3.80	654	4.07	0.93	0.55–1.58	498	4.20	0.90	0.53–1.53
Hypoplastic left heart syndrome	746.7	7	1.90	594	3.70	0.51	0.24–1.07	454	3.83	0.49	0.23–1.03
Orofacial defects											
Cleft palate only	749.0	15	4.07	858	5.35	0.76	0.45–1.26	670	5.66	0.71	0.43–1.19
Cleft lip with or without cleft palate	749.1, 749.2	13	3.53	1,563	9.74	**0.36**	**0.21–0.62**	1,266	10.69	**0.32**	**0.19–0.56**
Gastrointestinal defects											
Esophageal atresia/tracheoesophageal fistula	750.3	16	4.34	575	3.58	1.22	0.74–2.00	453	3.82	1.14	0.69–1.88
Rectal and large intestinal atresia or stenosis	751.2	16	4.34	738	4.60	0.94	0.58–1.55	529	4.47	0.97	0.59–1.60
Musculoskeletal defects											
Reduction defect, upper limb	755.2	5	1.36	420	2.62	0.51	0.21–1.24	310	2.62	0.51	0.21–1.24
Reduction defect, lower limb	755.3	8	2.17	242	1.51	1.46	0.72–2.95	167	1.41	1.57	0.77–3.19
Gastroschisis or Omphalocele ***	756.7	3	0.81	725	4.52	**0.18**	**0.06–0.55**	479	4.04	**0.20**	**0.06–0.61**
Diaphragmatic hernia	756.6	11	2.99	484	3.02	0.99	0.54–1.80	364	3.07	0.97	0.53–1.77
Chromosomal defects											
Down syndrome (trisomy 21)	758.0	45	12.22	1,800	11.21	1.09	0.81–1.47	1,402	11.84	1.03	0.77–1.39

Table 2 continued

Diagnostic grouping	ICD9 code	Number of Arab-American children	Arab-American prevalence/ 10,000 live births	Number of all other children	Prevalence in all other children/ 10,000 live births*	Prevalence ratio for Arab Americans versus all others	95% confidence interval	Number of non-Hispanic white children	Non-Hispanic white prevalence/ 10,000 live births**	Prevalence ratio for Arab Americans versus non-Hispanic whites	95% confidence interval
Trisomy 13	758.1	3	0.81	168	1.05	0.77	0.25–2.42	117	0.99	0.82	0.26–2.58
Trisomy 18	758.2	6	1.63	225	1.40	1.17	0.52–2.62	150	1.27	1.30	0.57–2.94

*All other live births = 1,605,005

**Non-Hispanic white live births = 1,184,587

***Gastroschisis and Omphalocele are separate birth defects, but are shown here in the same row since both have the same ICD-9 code

from the same ethnic group, and the frequency of consanguinity (descent of both parents from the same immediate ancestor).

In Arab countries, carriers of glucose-6-phosphate dehydrogenase deficiency and hemoglobinopathies are known to be common, but the frequencies of inborn errors of metabolism are not well-defined. There is evidence from the MBDR data that the parents of children with birth defects and genetic disorders are usually both of Arab descent, although the data do not provide detail about ethnicity beyond the country of origin. The contribution of consanguinity to the rates reported from Michigan cannot be determined because the MBDR surveillance program does not collect that information. Hoodfar and Teebi [7] reported data from Montreal among the Middle Eastern families who were referred to a clinical genetics unit. They found that the consanguinity rate was 23.5% among Middle Eastern families versus 5% in the non-Middle Eastern comparison group. This estimate is still lower than rates of consanguinity in Arab countries, which range from 20% to 70% [2, 3] and partly account for the high prevalence of certain recessively inherited disorders in Arab communities.

The increased rates of certain metabolic disorders reported here, such as medium chain acyl-CoA dehydrogenase (MCAD) deficiency, were unexpected; MCAD deficiency has been reported to be rare in Arab families [8]. However, many Arab countries have only recently started hospital-based or regional newborn screening surveillance systems that include a limited number of metabolic disorders [8]. Newborn screening for MCAD deficiency and other disorders is now routine in Michigan, and analysis of screening data by race and ethnicity will be necessary to further examine the questions raised by these data.

Our findings of lower rates of certain defects in Arab American children that were statistically significant are intriguing, but replication and refinement of these findings will be necessary before counseling recommendations can be made. The prevalence of cleft lip with or without cleft palate among Arab American children was lower than that in Non-Hispanic white mothers in Michigan and the rates in many Arab countries. However, these rates have been variable, ranging from 5.0 per 10,000 live births in United Arab Emirates to 18.9 per 10,000 live births in Saudi Arabia [9, 10]. Many of the birth defects studies done in Arab countries are hospital-based, so it would be difficult to generalize or compare their results to our study. Similarly, it would be inappropriate to draw conclusions for counseling purposes regarding our gastroschisis and omphalocele findings, since they are distinctly different defects but both had the same ICD-9 code in the MBDR, a problem that has been noted in other birth defects registries [11].

These data have other limitations: the surveillance system uses passive case ascertainment with a limited

Table 3 Birth prevalence of 12 categories of congenital endocrine, metabolic, and hereditary disorders among Arab Americans versus all other children and non-Hispanic white children, Michigan, 1992–2003

Diagnostic grouping	ICD9 code	Number of Arab-American children	Arab-American prevalence/ 10,000 live births	Number of all other children	Prevalence in all other children/ 10,000 live births	Prevalence ratio for Arab Americans versus all others	95% confidence interval	Number of non-Hispanic white children	Non-Hispanic white prevalence/ 10,000 live births	Prevalence ratio for Arab Americans versus non-Hispanic whites	95% confidence interval
Congenital hypothyroidism	243	16	4.34	637	3.97	1.10	0.67–1.80	446	3.77	1.11	0.67–1.82
Congenital adrenal hyperplasia and other adrenogenital syndromes	255.2	7	1.90	250	1.56	1.23	0.58–2.60	173	1.46	1.31	0.62–2.80
Galactosemia	271.1	3	0.81	121	0.75	1.08	0.34–3.40	88	0.74	1.10	0.35–3.48
Phenylketonuria and hyperphenylalaninemias	270.1	6	1.63	218	1.36	1.21	0.54–2.71	175	1.48	1.11	0.49–2.50
Tyrosinemia and other specified aminoacidopathies/Waardenburg syndrome	270.2	3	0.81	106	0.66	1.24	0.39–3.91	66	0.56	1.48	0.47–4.73
Maple syrup urine disease and other branched-chain aminoacidopathies	270.3	4	1.09	41	0.26	**4.60**	**1.64–12.91**	32	0.27	**4.45**	**1.56–12.69**
Organic acidemias and other acidoses	276.2	9	2.44	150	0.93	**2.72**	**1.39–5.33**	115	0.97	**2.65**	**1.34–5.23**
Medium chain acyl-CoA dehydrogenase deficiency and other specified metabolic disorders	277.8	6	1.63	114	0.71	**2.37**	**1.04–5.38**	51	0.43	**5.70**	**2.43–13.37**
Cystic fibrosis	277.0	7	1.90	489	3.05	0.62	0.29–1.30	421	3.55	0.53	0.25–1.11
Glucose-6-phosphate dehydrogenase deficiency	282.2	8	2.17	54	0.34	**7.40**	**3.50–15.69**	12	0.10	**62.30**	**18.77–206.98**
Thalassemias including sickle-beta thalassemia	282.4	5	1.36	130	0.81	1.70	0.70–4.11	34	0.29	**5.37**	**2.08–13.88**
Sickle cell disease	282.6	5	1.36	770	4.80	**0.28**	**0.12–0.67**	92	0.78	1.79	0.73–4.41

ability to confirm diagnoses; rates of all conditions might be overestimated as some suspected diagnoses might be coded without confirmation; and self-reported parents' place of birth by mothers might underestimate the prevalence of these conditions among Arab Americans. During the study period, except for hemoglobinopathies, routine newborn screening in Michigan did not include any of the metabolic or hematologic conditions that were found to have significantly higher prevalences among Arab-American children. In the absence of universal screening and diagnostic confirmation during the study period, the magnitude of the rate ratios reported here might have been affected by clinical under recognition of these conditions in non-Arab children or coding practices that vary by ethnicity.

Conclusions

The data suggest the need for culturally sensitive prenatal care and genetic counseling in Arab populations in the United States, especially for carrier testing and consanguinity counseling, and for programs for Arab-American populations with a focus on cultural and social support measures undertaken by the family to manage pregnancy events and the possibility of having children with congenital and genetic disorders. Providers of medical services for Arab-American families should inquire about the presence and level of consanguinity, as well as being familiar with genetic disorders that are common in Arab communities such as sickle cell disease, thalassemia and glucose-6-phosphate dehydrogenase deficiency. These efforts are necessary to improve birth outcomes and provide reproductive options to Arab-American families. It is also important to understand ethnic differences in the prevalence of these disorders to provide appropriate clinical care and to interpret disparities in health care use and in child morbidity due to structural birth defects and other congenital conditions.

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