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Increasing Burden of Type 2 Diabetes in Navajo Youth: The SEARCH for Diabetes in Youth Study

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Abstract

Aim: SEARCH has recently reported that both prevalence and incidence of youth onset type 2 diabetes (YT2D) increased among most US race/ethnic groups in the early 2000s. This study reports on the incidence (2002–2013) and prevalence (2001, 2009) of YT2D in the Navajo Nation among youth age < 20 years from 2001 to 2013.

Methods: SEARCH sought to identify prevalent YT2D cases in 2001 (N=75) and 2009 (N=70) and all incident YT2D cases in three periods: 2002–05 (N=53), 2006–09 (N=68) and 2010–13 (N=90) in Navajo Nation. Denominators were based on the active Indian Health Service user population for eligible health care facilities. Prevalence (per 100,000) and period-specific incidence rates (per 100,000 person-years) were computed for youth age 10–19 years. Changes in prevalence were tested with a 2-sided skew-corrected inverted score test, while changes in incidence were tested with Poisson regression.

Results: YT2D prevalence was high but stable in 2001 and 2009, overall [146.6 (116.8, 184.0) vs 141.5 (112.0, 178.8), p=0.65) and in all subgroups. In contrast, incidence rates increased particularly between the second and third periods overall and in most subgroups by age and by sex.

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Conclusion(s): These data confirm the high burden of YT2D among Navajo youth and suggest an increasing risk in more recent years. However, recent improvements in obesity reduction in this population demonstrate optimism for potential reductions in YT2D in Navajo Nation.

Keywords

Diabetes; native youth; trends

Introduction

Youth diabetes is an important and worsening global health challenge (1, 2). Youth onset Type 2 Diabetes (YT2D) is mediated by social, environmental, and genetic factors – influences that affect not only the rates of diagnoses (incidence rates and prevalence), but also YT2D outcome severity (3). YT2D also disproportionately affects many indigenous populations around the world (4). Rates among indigenous populations, including American Indian (AI) populations in the United States (5, 6, 7), First Nations populations in Canada (8), and Australian Indigenous populations (9, 10, 11), have highlighted these groups as having a disproportionate risk. Rates of YT2D are almost uniformly higher in indigenous versus non-indigenous groups with variation across populations. For example, rates of YT2D in Australia varied from a six-fold difference (9) to more than twenty times the rate for indigenous youth compared to non-indigenous youth (31.1 vs. 1.4 per 100,000 person years; respectively) (10) whereas YT2D prevalence rates comparing AI versus non-Hispanic white youth in 2001 in the United States demonstrated a near nine-fold difference (1.74 vs. 0.19 per 1000 youth; respectively) (SEARCH, 2006).

Internationally, indigenous people have coped with rising rates of T2D for decades (4). Although rates of diabetes in international indigenous populations tend to show increasing trends, trends within and across AI youth remain understudied with the earlier literature on AI YT2D almost entirely characterized by research involving the Pima Indian community in Arizona (5, 6, 7). While members of the Pima tribe have the highest known rates of T2D in the world (5), less is known about evolving trends in incidence for other Native American youth. The foundational work with the Pima population followed by the start of the SEARCH for Diabetes in Youth study (SEARCH) (5) have begun to clarify heterogeneity in YT2D trends. AI youth aged 15–19 years had the greatest risk of YT2D of all racial/ethnic groups in the racially diverse SEARCH study, which includes youth across the United States of all race/ethnic backgrounds (5). In contrast and consistent with prior work, the rates of T1D in AI youth were the lowest of all SEARCH study racial/ethnic groups.

Diabetes in Navajo adults has been reported since the 1960s, with recent reports suggesting rates of T2D two to four times those of non-Hispanic white adult populations and rising over recent decades (12,13). Studies of diabetes prevalence or incidence in Navajo youth were unavailable until the SEARCH Study (5). SEARCH previously documented Navajo youth diabetes incidence rates for the period 2002–2005 (5). In this report, we extend that work and focus on changes in YT2D prevalence and incidence among Navajo youth from 2001 to 2013.

While the narrative of AI diabetes epidemiology is often disheartening, recent analyses have highlighted significant improvements and provided optimism. Among AI youth, overweight and obesity trends seem to have stabilized in the mid-2010s (14); however, the most severe categories of obesity have continued to accelerate (14). Given this context, it is unclear whether YT2D incidence and prevalence rates will plateau and decline or continue to accelerate.

Methods

Participants

The Navajo tribe has participated in the multi-center SEARCH for Diabetes in Youth study since its inception in 2001 as part of the Colorado SEARCH site (15). SEARCH activities within Navajo Nation are undertaken with Navajo Nation Human Research Review Board and Colorado Multiple Institutional Review Board oversight and approval. Indian Health Service (IHS) and tribally operated facility leadership also formally endorse SEARCH study work in compliance with the Health Insurance Portability and Accountability Act (5). The Navajo people who live on Navajo Nation land inhabit portions of what are now the states of Arizona, New Mexico, and Utah. SEARCH-Navajo specifically includes the sovereign Navajo reservation lands and immediately surrounding “border” regions (280 consistent communities throughout the study). As previously described (15), SEARCH-Navajo actively surveils IHS health system databases. The SEARCH-Navajo population under surveillance for this report included all Navajo Nation tribal members, as recognized by the Navajo Nation, under 20 years of age who were active health system users of tribally operated or IHS operated regional health facilities and who were living in one of 280 specific geographic communities within and very near the borders of the Navajo Nation. Surveillance for youth diabetes cases covered the years 2002 through 2013 for incidence, and 2001 and 2009 for prevalence calculations. Although SEARCH-Navajo is specific to the defined communities, the denominator represents the Navajo IHS health system user population, and as such is not specifically geographic (youth who are not IHS active users are excluded). We omitted YT2D cases under age 10 in the numerator and denominator of our estimates because we identified fewer than five cases of YT2D in youth under age 10 over the study period and could not generate meaningful estimates from those data. As such, YT2D denominators were limited to ages 10–19 years, an approach consistent with prior SEARCH analyses. This approach provided a yearly overall denominator ranging between 40,000 and 50,000 youth.

Navajo members qualify as SEARCH study cases if they received health care from either tribally operated or IHS operated facilities in the preceding three years, were diagnosed with diabetes < 20 years at an included facility, and live in one of the 280 recognized SEARCH-Navajo communities, as defined for the denominator. The most recent year with complete incident data is 2013.

Prevalence was calculated as the ratio of the number of existing YT2D cases (10–19 years old) in 2001 and 2009 divided by the number of IHS members in the same age range and geographic areas. Age- and sex-specific prevalence were estimated similarly by restricting the numerator and denominator to the appropriate age and sex subgroups. Confidence intervals (CI) around the estimates obtained for each prevalent year and changes in prevalence were tested with a 2-sided skew-corrected inverted score test (16, 17).

Average period-specific incidence rates (per 100,000 person-years) were calculated as the number of incident cases during each four-year period divided by the number of IHS members who were at risk of developing YT2D during each period. Changes in period-specific incidence estimates for the three periods 2002–2005, 2006–2009, and 2010–2013 were assessed by fitting Poisson regression using the number of incident cases in each period as the outcome, the midpoint of each period as the predictor and the total number of individuals who were at risk during each period as an offset. Diagnostic tests were performed and showed that the model assumptions were met.

Results

Table 1 shows overall YT2D prevalence counts in 2001 and 2009 and average incidence counts in the three periods, and by age and by sex. SEARCH ascertained prevalent cases of YT2D in 2001 (N=75) and 2009 (N=70) and incident cases of YT2D annually since 2002 (YT2D N=211) in youths 10–19 years of age. Table 2 shows YT2D prevalence (per 100,000) was high but stable in 2001 and 2009, overall [146.6 (116.8, 184.0) vs 141.5 (112.0, 178.8), p=0.65)] and in all subgroups. YT2D incidence significantly increased over the three periods from 2002–2005, 2006–2009, and 2010–2013 (p<0.001). Specifically, Table 2 shows significantly and progressively larger increases in YT2D incidence within the second (2006–2009) to third (2010–2013) surveillance periods (p=0.01). YT2D incidence increased the most among younger (p=0.001) and female Navajo youth (p<0.001) and particularly from the second to third surveillance periods (p=0.02; p=0.01, respectively). The overall average increase was 98.8% (95% CI: 41.7%, 179.1%) over the entire evaluation period.

Discussion

These data confirm the previously reported rates of YT2D among Navajo youth (5) and suggest an increasing risk over time. Upcoming 2017 prevalence data will be crucial to assessing whether prevalent cases have increased since 2009 mirroring the observed incidence increases. However, the disproportionate increases observed in younger Navajo youth and girls highlight key at-risk populations. This knowledge may inform the optimal design of prevention and intervention programs. For example, Tribal Turning Point (18) directs YT2D prevention towards pre-pubertal youth and Stopping GDM (19) focuses on reducing gestational diabetes (GDM) in females of reproductive age. Tanmas (20) recently published an analysis of diabetes risk among Pima youth and young adults, correlating degree of obesity severity and exposure to intrauterine GDM with YT2D risk. Higher severity of obesity class, and exposure to GDM each conferred marked increase in YT2D risk. Although GDM exposure and obesity severity are outside the scope of this study, these factors can guide future research on population and public health decision making when combined with SEARCH Navajo findings reported here.

Our report has some limitations. First, since our sample is limited to active users of the IHS health system, it is possible that these findings reflect IHS health system selection bias. Economic fluctuations and the emergence of the Affordable Care Act (ACA) coincide with our observed incidence increases. At present, it is impossible to determine the impact of these changes on IHS utilization. Second, our prevalence data stopped in 2009, while we observe an increase in incidence after 2010, suggesting a need to reassess prevalence in later years. Forthcoming SEARCH 2017 prevalence data may further elucidate key information about diabetes trends in Navajo youth, either reinforcing the consistency of findings over time or raising new questions. Lastly, SEARCH Navajo reported rates reflect provider diagnosed diabetes and do not reflect population diabetes screening.

Over the study period, both provider awareness of YT2D and changes in diagnostic approaches could have influenced our findings. Specifically, the American Diabetes Association (ADA) included hemoglobin A1c (HbA1c) as one of the accepted diagnostic tests for diabetes in 2010 (21). Prior to this time, clinicians relied on some combination of random blood glucose, fasting blood glucose, and oral glucose tolerance testing (OGTT). While these tests remain part of the clinical approach to diabetes screening and diagnosis, the addition of laboratory HbA1c has reduced perceived testing barriers. While there is some concern that HbA1c in children may have a lower sensitivity and yield fewer T2D cases (21), further analysis within other Southwest American Indian populations showed that HbA1c was predictive of future diabetes development (22). Trends in self-reported YT2D case presentation (2002–2010), specifically whether youth were identified due to having symptoms, as the result of a “checkup,” or due to community screenings, were previously evaluated by SEARCH (23). This analysis showed that fewer youth over time learned of their T2D due to symptoms, and more were identified during a “checkup.” This implies that changes in observed YT2D rates could well relate to and be influenced by changes in health seeking behaviors, changes in diagnostic approaches, or other factors. However, it is unclear whether this finding is true for all YT2D as subgroup analyses were not reported, meaning this trend may or may not be representative for Navajo youth over the same period. Nevertheless, it is not known whether changes in clinical approaches or modes of T2D diagnosis over the study period are resulting in more versus fewer YT2D cases identified..

Changing patterns of healthcare utilization could also impact these results. Medicaid expansion with the United States Federal Government’s passage of the Affordable Care Act (ACA), for example, could lead to more choice in healthcare facility selection and use, introducing bias if those who receive healthcare outside of study facilities are different from those who receive healthcare within Navajo Area Indian Health Services (NAIHS) facilities. Analyses of healthcare utilization changes over time in this specific NAIHS population are not presently available (24; 25).

Moreover, given the small number of cases contributing to these trends, any fluctuation could become influential. However, previous literature has identified lower than expected rates of undiagnosed or subclinical YT2D (3) and SEARCH case identification practices have remained consistent over time. It is likely that most, if not all, active NAIHS user population youth with diabetes would be consistently identified in this analysis.

Lastly, it is important to emphasize that these findings are specific to the SEARCH Navajo population. While it remains possible that other AI groups have experienced similar trends over time, this study does not offer insight into that question. Obesity trends reported by Bullock (14) revealed significant regional obesity severity differences across AI and Alaska Native (AN) geographic regions. For example, the Alaskan IHS youth user population had the lowest prevalence of class 2 or 3 obesity (8.9%), whereas Southwest Subregion 2 had the highest prevalence (15.6%). Of note, the SEARCH Navajo population resides within the Southwest Subregion 1 where the prevalence of class 2 or 3 obesity was 10.1%. Thus, since youth weight status varies significantly between IHS geographic regions, it is possible that AI YT2D rates may follow a similar geographic variance. Bullock et al (14) highlighted reasons for optimism, by showing that between 2006 and 2015 AI youth obesity rates may be stabilizing, and even decreasing amongst children ages 2 through 5. It will be of urgent importance to learn if YT2D rates will also stabilize and potentially improve in future years. Further research may help to answer this question. However, this provides hope for Navajo communities and youth that YT2D trends may likewise improve over time.

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Novelty Statement:

- Youth onset diabetes is a significant problem for Native youth, but the extent of the issue in Navajo youth is unclear.
- This study confirms the high burden of youth onset Type 2 Diabetes Mellitus (YT2D) among Navajo youth.
- Effective and sustainable programs aimed at primary prevention of YT2D in Navajo may help prevent future diabetes cases.

Table 1.

Numbers of Youth Onset Type 2 Diabetes Prevalent Cases, Incident Cases, and the Population at Risk

	Prevalent Cases		Incident Cases		
	2001	**2009**	**2002–2005**	**2006–2009**	**2010–2013**
All Cases/ Population at risk	75/50,461	70/49,458	53/201,887	68/195,233	90/174,151
Age (years)					
10–14	18/27,107	12/23,104	21/102,701	23/91,059	40/86,353
15–19	56/23,354	58/26,354	32/99,186	45/104,174	50/87,798
Sex					
Female	42/25,166	35/24,805	31/100,919	38/97,608	58/87,361
Male	32/25,295	35/24,653	22/100,968	30/97,625	32/86,790

The number of cases and the population at risk for the incident year time periods are the sum of the cases or population for each year in the time period, ignoring any overlap in the population from one year to the next.

Table 2:

Prevalence and Incidence of Youth Onset Type 2 Diabetes and 95% CI (per 100,000/year) among Navajo youth age 10–19 years

	Prevalence			Incidence					
	2001 Prevalence	**2009 Prevalence**	**P from 2001 to 2009**	**2002–2005 Incidence**	**2006–2009 Incidence**	**2010–2013 Incidence**	**P from 2002–2005 to 2006–2009**	**P from 2006–2009 to 2010–2013**	**Overall P**
All	146.6 (116.8, 184.0)	141.5 (112.0, 178.8)	0.65	26.3 (20.1,34.3)	34.8 (27.5,44.1)	51.7 (42.1,63.5)	0.12	0.01	**<0.0001**
Age (years)									
10–14	66.4 (42.0,104.9)	51.9 (29.7,90.8)	0.19	20.4 (13.4,31.3)	25.3 (16.8,37.9)	46.3 (34.0,63.1)	0.43	0.02	**0.001**
15–19	239.8 (184.7,311.2)	220.1 (170.3,284.4)	0.36	32.3 (22.9,45.5)	43.2 (32.3,57.8)	56.9 (43.2,75.1)	0.20	0.17	**0.01**
Sex									
Female	166.9 (123.5,225.5)	141.1 (101.5,196.2)	0.15	30.7 (21.6,43.6)	38.9 (28.4,53.4)	66.4 (51.4,85.8)	0.32	0.01	**0.0004**
Male	126.5 (89.6,178.5)	142.0 (102.1,197.4)	0.34	21.8 (14.4,33.0)	30.7 (21.5,43.9)	36.9 (26.1,52.0)	0.22	0.47	**0.05**