



Published in final edited form as:

J Immigr Minor Health. 2012 December ; 14(6): 949–958. doi:10.1007/s10903-012-9617-3.

Migration status in relation to clinical characteristics and barriers to care among youth with diabetes in the US

Lindsay M. Jaacks¹, Reena Oza-Frank², Ralph D'Agostino Jr.³, Lawrence M. Dolan⁴, Dana Dabelea⁵, Jean M. Lawrence⁶, Catherine Pihoker⁷, M. Rebecca O'Connor⁷, Barbara Linder⁸, Giuseppina Imperatore⁹, Michael Seid⁴, K.M. Venkat Narayan¹⁰, and Elizabeth J. Mayer-Davis^{1,11,12}

¹Department of Nutrition, The University of North Carolina, Chapel Hill, NC

²Research Institute at Nationwide Children's Hospital and Department of Pediatrics, The Ohio State University, Columbus, OH

³Department of Biostatistics, Wake Forest University School of Medicine, Winston-Salem, NC

⁴Cincinnati Children's Hospital Medical Center, Cincinnati, OH

⁵Department of Epidemiology, The University of Colorado, Denver

⁶Department of Research & Evaluation, Kaiser Permanente Southern California, Pasadena, CA

⁷Seattle Children's Hospital, Seattle, WA

⁸NIDDK, National Institutes of Health, Bethesda, MD

⁹Center for Disease Control and Prevention, Atlanta, GA

¹⁰Hubert Department of Global Health, Emory University, Atlanta, GA

¹¹Department of Medicine, The University of North Carolina, Chapel Hill, NC

Abstract

Migration status and the accompanying diversity in culture, foods and family norms, may be an important consideration for practitioners providing individualized care to treat and prevent complications among youth with diabetes. Approximately 20% of youth in the US have 1 foreign-born parent. However, the proportion and characteristics of youth with diabetes and 1 foreign-born parent have yet to be described. Study participants (n = 3,086) were from SEARCH for Diabetes in Youth, a prospective multi-center study in the US. Primary outcomes of interest included HbA1c, body mass index and barriers to care. Multivariable analyses were carried out using logistic regression and analysis of covariance. Approximately 17% of participants with type 1 diabetes (T1D) and 22% with type 2 diabetes (T2D) had 1 foreign-born parent. Youth with T1D and 1 foreign-born parent were less likely to have poor glycemic control [adjusted odds

¹²Corresponding author: Elizabeth J. Mayer-Davis, 2211 McGavran-Greenberg Hall, 135 Dauer Drive, Campus Box 7461, Chapel Hill, NC 27599, 919-966-1991 (telephone), 919-843-2011 (fax), mayerdav@email.unc.edu.

CONFLICT OF INTEREST

LM Jaacks, R Oza-Frank, R D'Agostino, Jr., LM Dolan, D Dabelea, JM Lawrence, C Pihoker, MR O'Connor, B Linder, G Imperatore, M Seid, K MV Narayan, and EJ Mayer-Davis have no conflicts of interest to disclose.

ratio (OR) (95% confidence interval): 0.70 (0.53, 0.94)]. Among youth with T2D, those with 1 foreign-born parent had lower odds of obesity [adjusted OR (95% CI): 0.35 (0.17, 0.70)]. This is the first study to estimate the proportion and characteristics of youth with diabetes exposed to migration in the US. Research into potential mechanisms underlying the observed protective effects is warranted.

Keywords

diabetes; youth; migration; US

BACKGROUND

Diabetes is a unique chronic condition in that it requires rigorous and individualized ongoing treatment provided by a multidisciplinary healthcare team to maintain quality of life and prevent poor glycemia, cardiovascular disease and other complications. Providing effective individualized care relies on the consideration of individual-level factors, such as knowledge, attitudes and beliefs, as well as the socio-cultural environment in which a patient lives. The fact that poor glycaemic control and cardiovascular disease risk factors are common among youth with diabetes in the US (1, 2) suggests that gaps remain in our understanding of the determinants of and prevention of these adverse health outcomes. Additional investigation of factors potentially associated with these clinical characteristics is needed in order to address these gaps. Research has supported associations of parental educational attainment, family structure and race/ethnicity (1) with glycaemic control and it is plausible that other demographic factors, such as migration status, may also be important considerations for improving treatment and prevention efforts.

Migration to the US has been increasing since 1945 (3) with the current immigrant population estimated to be 38.5 million or 12% of the total population (4). According to the 2009 US Census, approximately 20% of youth (< 18 years) have at least one foreign-born parent (5). However, the proportion of youth with diabetes who have at least one foreign-born parent is unknown. Furthermore, the demographic, socioeconomic and clinical characteristics of this subpopulation in the US have yet to be described.

Current evidence suggests that the impact of migration status on glycaemic control and self-management among youth with diabetes may differ in Europe and the US. Hsin et al. (6) found that among Hispanic youth with type 1 diabetes, those who migrated to the US more recently had better adherence measured using the Diabetes Self-Management Profile (7). In Italy, two cross-sectional studies reported that children of immigrants born in Italy have a younger age of type 1 diabetes diagnosis than children of immigrants born in their countries of origin or Italian children (8, 9). Children of immigrants (those born outside of Italy and those born in their country of origin, combined) were also more likely to have higher glycosylated hemoglobin A1c (A1C) than Italian patients (9). In France, a cross-sectional study of youth with type 1 diabetes found that youth with immigrant mothers had higher A1C and lower adherence to diet and insulin recommendations and that immigrant mothers had lower levels of diabetes knowledge relative to native French mothers (10).

SEARCH for Diabetes in Youth includes one of few cohorts with information on migration status concurrent with clinical characteristics and barriers to care among youth with diabetes in the US. These data provide a unique opportunity to explore the proportion and characteristics of youth with diabetes and at least one foreign-born parent. The objectives of this study were to: 1) determine the proportion of SEARCH participants with at least one foreign-born parent and the distribution of demographic and socioeconomic characteristics and 2) determine if having at least one foreign-born parent is associated with glycemic control, cardiovascular disease risk factors and barriers to care.

METHODS

Study Sample

SEARCH for Diabetes in Youth is a prospective cohort of youth with diabetes across six sites in the US: South Carolina, Ohio, Colorado, California, Washington and Hawaii. The study protocol was approved by Institutional Review Boards at each site and details of the methods have been published previously (11). Briefly, all prevalent cases of diabetes were identified in 2001 and incident cases were identified in subsequent years with estimated case ascertainment greater than 90% (12, 13). All ascertained cases were asked to complete a brief initial survey and after completion, were invited to a baseline visit during which anthropometric data and blood samples were collected. Participants in the 2002–2005 incident cohorts were also asked to attend periodic follow-up visits, on average, 12, 24 and 60 months after the baseline visit.

Initially, SEARCH did not query youth or parent migration status. In 2007, questions regarding migration were added to surveys that were administered to the 2001 prevalent cohort and the 2002–2005, and 2008 incident cohorts. Migration questions were consistent among the surveys and included whether the participant or either parent had migrated to the US, and if so, when they migrated and where they migrated from. SEARCH did not query the legal status of individuals that reported being born outside the US.

As a consequence of the SEARCH protocol, only baseline data were available for the 2001 prevalent and 2008 incident cohorts and follow-up visit data were additionally available for the 2002–2005 incident cohorts. In the event that data were available for more than one follow-up visit, the most recent visit was selected with the objective of increasing generalizability by including the most contemporary data and a diverse sample of disease durations. All outcome variables are therefore from a single visit.

A total of 3,191 youth diagnosed with type 1 or type 2 diabetes by a health care provider before the age of 20 years completed the survey containing the migration questions. Of these, 57 had missing data and 37 responded “Don’t know” to at least one of the three questions relating to migration, and thus were excluded from the present analysis. Additionally, 11 participants were born outside the US yet had US-born parents, possibly indicating that they were adopted. Due to potential differences in exposure, this subgroup of participants was excluded, leaving 3,086 participants in the final analysis.

Measures

Participants were categorized as exposed to migration if they had at least one parent that reported being born outside of the US. Self-reported country of origin was categorized into six macro geographical regions according to the United Nations' 2008 Demographic Yearbook: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania (14). Parental duration of residency in the US was calculated as the period beginning with the self-reported year of migration to the US and ending with the year of the baseline visit or most recent follow-up visit. For participants with two foreign-born parents, the parental duration in the US was calculated as the mean of the two parents' durations.

Participant age was calculated as the period beginning with date of birth and ending with the date of the baseline visit or most recent follow-up visit. Diabetes duration was calculated as the period from the date of diabetes diagnosis to the date of the baseline visit or most recent follow-up visit. Self-reported demographic and socioeconomic variables assessed included gender, race/ethnicity based on 2000 US Census classification (15) [non-Hispanic white, Hispanic (regardless of race), Asian/Pacific Islander, non-Hispanic black, Other (including Native American)], highest level of parental educational attainment (high school, some college or a degree), family structure (two-parent household, single-parent household, other household structure), estimated total annual household income (<\$24,999, \$25,000–\$49,999, \$50,000–\$74,999, \$75,000). Health insurance coverage was categorized as a binary variable (private, other) where other included participants reporting none (n = 32 for type 1 diabetes; n = 19 for type 2 diabetes), Medicaid/Medicare (n = 202 for type 1 diabetes; n = 46 for type 2 diabetes), and other (n = 20 for type 1 diabetes; n = 6 for type 2 diabetes). Proportions for health insurance coverage excluded the California and Hawaii SEARCH sites because these were healthcare plan sites and therefore all participants from these sites would be classified as having private insurance.

Barriers to care were assessed at follow-up visits via questionnaire items adapted from the Consumer Assessment of Healthcare Providers and Systems survey Supplemental Item Set for Children with Chronic Conditions (16). The seven barriers assessed included: not having a personal doctor (regular doctor), problems getting care (access to care), costs of care, problems getting medications/supplies, problems receiving care that takes into account personal and family context (contextual care), problems communicating with providers, and problems getting needed information. Barriers were identified as being absent or present based on operationalization schemes published previously (17).

Glycemic control was assessed using A1C measured in whole blood with automated non-porous ion-exchange high-performance liquid chromatography (Tosoh Bioscience, Montgomeryville, Pennsylvania) and was analyzed as a continuous outcome and as a binary outcome defined as A1C \geq 9.5% (poor glycemic control) versus < 9.5 (1).

Cardiovascular disease risk factors assessed included body mass index (BMI, kg/m²), BMI z-score, obesity (BMI \geq 95th percentile for age and sex), waist circumference (cm), systolic blood pressure (SBP, mmHg), diastolic blood pressure (DBP, mmHg), hypertension (SBP or DBP \geq 95th percentile for age, gender, and height), low-density lipoprotein (LDL, mg/dL) cholesterol, high-density lipoprotein (HDL, mg/dL) cholesterol, triglycerides (mg/dL), and

family history of diabetes (mother or father with diabetes). Methods used for anthropometric measures and clinical characteristics have been published previously (11). Quality of life was assessed using the Pediatric Quality of Life Inventory Generic Module (PedsQL) total score ranging from 0 to 100 with higher scores indicating better health-related quality of life. Frequency of self blood glucose monitoring (< 1 time per day, 1–2 times per day, 3 times per day, 4 times per day) was self-reported.

Analysis

All analyses were stratified by diabetes type. Chi-square tests were used to compare categorical outcomes and F tests (ANOVA) were used to compare continuous outcomes across migration status strata. A Fisher's Exact Test was used to compare categorical outcomes when cell sizes were less than or equal to 5. Test assumptions, including homogeneity of variances, were met.

Race/ethnicity was assessed as a potential effect measure modifier using a Breslow-Day test for homogeneity of the stratum-specific odds ratios at an alpha level of 0.10 to account for small sample sizes and consequently lower power for stratified estimates. Race/ethnicity stratum-specific estimates could not be derived for participants with type 2 diabetes due to small cell sizes. In the absence of effect measure modification, race/ethnicity was treated as a potential confounder and a single effect estimate was presented. Additional potential confounders were identified using a directed acyclic graph (18): diabetes duration, SEARCH site, parental education, and household income. A change-in-estimate approach with a 10% change taken to be an indication of confounding was used to determine the final adjustment set for a given outcome.

Multiple logistic regression analysis for binary outcomes and analysis of covariance (ANCOVA; generalized linear models) for continuous outcomes were used to assess the effect of migration status on A1C, obesity, BMI z-score, and barriers to care after adjustment for confounders. All statistical analyses were conducted using SAS 9.2 (SAS Institute, Cary, North Carolina). Statistical significance was considered for $P < 0.05$.

RESULTS

Of the 3,086 youth included in the present analysis, 16.9% ($n = 450$) of those with type 1 diabetes and 22.0% ($n = 92$) of those with type 2 diabetes had at least one foreign-born parent. Due to limitations in sample size, participants with one (type 1 diabetes, $n = 249$; type 2 diabetes, $n = 20$) or both (type 1 diabetes, $n = 201$; type 2 diabetes, $n = 72$) parents born outside the US were combined. Within this group, 53 of the participants with type 1 diabetes and 24 of those with type 2 diabetes were themselves born outside the US.

Duration of parental residency in the US ranged from 4 to 54 years among participants with type 1 diabetes and 4 to 45 years among those with type 2 diabetes. The majority of parents born outside the US migrated from Latin America and the Caribbean (Table I). The proportion of males with type 2 diabetes was lower among participants with US-born parents: 36.7% compared to 48.9% among those with at least one foreign-born parent. Parents of participants with type 1 diabetes who migrated to the US were less likely to have

some college or a degree than those born in the US and had lower household incomes. Participants with type 2 diabetes and at least one foreign-born parent were significantly more likely to live in a two-parent household and a trend towards lower parental education in this group approached significance.

Participants with type 1 diabetes and at least one foreign-born parent had a lower total PedsQL score, on average, than those with US-born parents (Table I). No statistically significant differences in frequency of blood glucose monitoring were observed between migration strata among participants with type 1 diabetes or participants with type 2 diabetes.

Information on barriers to care was available for the subsample with a follow-up visit (n = 1,496). In the unadjusted analysis, among participants with type 1 diabetes, having a regular doctor and receiving contextual care differed by parental migration status: participants with at least one foreign-born parent were more likely to experience these barriers (Table II). However, these differences were no longer statistically significant after adjustment for race/ethnicity and SEARCH site: adjusted odds ratios (OR) (95% confidence intervals (CI)) for not having a regular doctor: 1.10 (0.72, 1.67); not receiving contextual care: 1.14 (0.76, 1.72) (Table III). Among participants with type 2 diabetes, only access to care varied by parental migration status in the unadjusted analysis: those with US-born parents reported this barrier more frequently.

A total of 2,896 participants had glycemic control and cardiovascular disease risk factor data. Among participants with type 1 diabetes, there was no statistical evidence for heterogeneity across race/ethnicity strata (homogeneity test $p = 0.62$ for poor glycemic control and $p = 0.13$ for obesity). Race/ethnicity (non-Hispanic white versus all other) was therefore assessed as a potential confounder in all remaining multivariable models. Participants with type 1 diabetes and at least one foreign-born parent were significantly less likely to have poor glycemic control than participants with US-born parents [adjusted OR (95% CI): 0.70 (0.53, 0.94); Table IV]. Results based on A1C data analyzed continuously were similar [adjusted mean \pm SD A1C among participants with US-born parents: 8.53 ± 0.04 ; participants with at least one foreign-born parent: 8.17 ± 0.10 ; $p = 0.001$].

Obesity was not significantly associated with migration status among participants with type 1 diabetes [adjusted OR (95% CI): 0.79 (0.55, 1.12); Table IV] and an association was also not found when BMI z-scores were analyzed continuously [adjusted mean \pm SD BMI z-scores among participants with US-born parents: 0.62 ± 0.02 ; participants with at least one foreign-born parent: 0.55 ± 0.06 ; $p = 0.3$].

Glycemic control was not significantly associated with migration status among participants with type 2 diabetes [adjusted OR (95% CI): 0.65 (0.29, 1.45); Table IV] and results were again consistent when A1C was analyzed continuously [adjusted mean \pm SD A1C among participants with US-born parents: 8.29 ± 0.19 ; participants with at least one foreign-born parent: 7.89 ± 0.44 ; $p = 0.4$].

Participants with type 2 diabetes that had at least one parent born outside the US were significantly less likely to be obese relative to participants with US-born parents [adjusted OR (95% CI): 0.35 (0.17, 0.70); Table IV]. The direction of this association was consistent

when BMI z-scores were analyzed continuously, but was no longer statistically significant after adjustment [adjusted mean \pm SD BMI z-scores among participants with US-born parents: 1.97 ± 0.08 ; participants with at least one foreign-born parent: 1.73 ± 0.18 ; $p = 0.2$].

The following sensitivity analyses were performed and resulted in similar effect estimates as the combined results above: 1) baseline data for all participants (compared to most-recent visit data), 2) stratifying participants into the following three exposure categories: US-born parents, one foreign-born parent, both parents foreign-born, and 3) stratifying participants into the following three exposure categories: US-born parents, at least one foreign-born parent with duration in the US \geq median, at least one foreign-born parent with duration in the US $<$ median (data not shown).

DISCUSSION

The present analysis is one of few studies to examine health-related aspects of youth with diabetes who are children of immigrants to the US. Approximately 17% of participants with type 1 diabetes and 22% with type 2 diabetes had at least one foreign-born parent; similar estimates to those reported for the general population of youth (< 18 years) in the US (5). This study contributes to the growing documentation of the “healthy immigrant effect” (19). Participants with type 1 diabetes and at least one foreign-born parent had better glycemic control than those with US-born parents. Participants with type 2 diabetes and at least one foreign-born parent were less likely to be obese than their counterparts with US-born parents. Systematic reviews suggest that these comparatively better health outcomes may deteriorate over time as immigrants acculturate and acquire their host country’s rates of disease risk factors and disease (20–22). Here we have identified a potential early intervention target associated with better glycemic control and weight status.

Youth with type 1 diabetes who had at least one foreign-born parent were less likely to have poor glycemic control and had a lower mean A1C than youth with US-born parents. A similar magnitude and direction of effect was also observed among youth with type 2 diabetes, though the association was not statistically significant. Results of adjusted barriers to care analysis among participants with type 1 diabetes suggested that children of immigrants in this sample did not have significantly higher odds of reporting the barriers of having a regular doctor, access and cost of care, getting medications and information, or communicating with practitioners, perhaps explaining why we did not observe detrimental effects. The apparent protective effect may stem from better adherence to clinical recommendations among Hispanic youth (6), who made up nearly 50% of participants with at least one foreign-born parent in this sample. Better adherence in this group may be the result of cultural values, such as respect of elders and more reverent treatment of healthcare workers, observed previously in both Hispanic and Asian populations (6, 23). Additionally, offspring of immigrants may have greater family involvement and support (24), which have been associated with improved adherence in youth with diabetes (25). In this sample, participants with at least one foreign-born parent were more likely to live in a two-parent household. Family structure, serving as a proxy for family support, may be a mediating pathway through which parent migration status improves glycemic control among youth with diabetes.

Among participants with type 2 diabetes, those with at least one parent born outside the US were less likely to be obese relative to their counterparts with US-born parents. This difference may be explained by the large proportion of immigrants from Asia, Latin America and the Caribbean in this sample. In groups migrating from these regions, type 2 diabetes has been shown to occur at a lower BMI than in other populations (20, 26), perhaps due to the interaction of a genetic predisposition and exposure to a Western diet (27, 28). Compared to genetically similar adults in their villages of origin in India, UK migrants were found to have higher total energy intakes, fat intakes and IGF-1 levels, independent of BMI (29). A clinical implication of this result may be the need for type 2 diabetes screening at lower BMIs in patients with foreign-born parents.

Additionally, though speculative, these results may indicate that in this sample of immigrant families there is greater adherence to traditional, healthier foods. Previous studies in Latino youth have revealed an association between lower levels of acculturation and lower dietary intakes of energy, fat, and saturated fat (30) and studies in Asian adolescents have reported higher levels of vegetable consumption and lower levels of soda consumption relative to white adolescents (31). Further research on family support, dietary intake, and acculturation is needed to improve our understanding of the observed protective effects.

There were several limitations to the present analysis. For participants with type 1 diabetes, our sample sizes within racial/ethnic strata were small, particularly for Asian/Pacific Islanders, thus limiting our power to detect differences across racial/ethnic strata. Furthermore, though sensitivity analyses did not indicate substantial differences between strata of participants with one versus both parents born outside the US, small sample sizes limited the interpretability of these results. There was therefore the potential for heterogeneity within the group of participants with at least one foreign-born parent. The total sample size for youth with type 2 diabetes was also small. However, to our knowledge, this is the first analysis to present these data on children of immigrants with type 2 diabetes in the US and therefore it provides insight into this unexplored subgroup. Over 37% of participants with type 1 diabetes and 55% of those with type 2 diabetes and at least one foreign-born parent came from the California SEARCH site. Although confounding by SEARCH site was assessed, this disproportion may have introduced selection bias in that California has one of the largest immigrant populations in the US (32) and living in immigrant enclaves has been associated with improved health behaviors (33). Although ascertainment for SEARCH is high (12, 13), selection bias in the form of “the healthy volunteer effect” may have influenced the results: participants with at least one foreign-born parent that participated in this study may reflect a healthier group of individuals exposed to migration relative to the general US population. Finally, the only measures of acculturation investigated in this analysis were generational status and duration of residence in the US. More sophisticated scales of acculturation, such as “A Short Acculturation Scale for Hispanics,” which has been adapted for use in other cultures (34), could provide further insight into additional aspects that we were not able to explore, such as linguistic acculturation and ethnicity of neighborhoods, schools, and close friends.

Diabetes is a unique condition in that it requires tailored and multidisciplinary ongoing care. Parent migration status may be an important factor for health care teams to consider when

providing individualized care to youth with diabetes. The large proportion of participants with foreign-born parents reported here supports the need for further investigation of diabetes care in this understudied population.

Acknowledgments

The SEARCH for Diabetes in Youth Study is indebted to the many youth and their families, and their health care providers, whose participation made this study possible.

Grant Support: SEARCH for Diabetes in Youth is funded by the Centers for Disease Control and Prevention (PA numbers 00097, DP-05-069, and DP-10-001) and supported by the National Institute of Diabetes and Digestive and Kidney Diseases.

Site Contract Numbers: Kaiser Permanente Southern California (U48/CCU919219, U01 DP000246, and U18DP002714), University of Colorado Denver (U48/CCU819241-3, U01 DP000247, and U18DP000247-06A1), Kuakini Medical Center (U58CCU919256 and U01 DP000245), Children's Hospital Medical Center (Cincinnati) (U48/CCU519239, U01 DP000248, and U18DP002709), University of North Carolina at Chapel Hill (U48/CCU419249, U01 DP000254, and U18DP002708-01), University of Washington School of Medicine (U58/CCU019235-4, U01 DP000244, and U18DP002710-01), Wake Forest University School of Medicine (U48/CCU919219, U01 DP000250, and 200-2010-35171).

The authors wish to acknowledge the involvement of General Clinical Research Centers (GCRC) at the South Carolina Clinical & Translational Research (SCTR) Institute, at the Medical University of South Carolina (NIH/NCRR Grant number UL1RR029882); Children's Hospital and Regional Medical Center (Grant Number M01RR00037); Colorado Pediatric General Clinical Research Center (Grant Number M01 RR00069) and the Barbara Davis Center at the University of Colorado at Denver (DERC NIH P30 DK57516); and the Institutional Clinical and Translational Science Award (CTSA), NIH/NCRR at the University of Cincinnati (Grant Number IUL1RR026314-01).

The contents of this paper are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention and the National Institute of Diabetes and Digestive and Kidney Diseases.

REFERENCES

- Petitti DB, Klingensmith GJ, Bell RA, Andrews JS, Dabelea D, Imperatore G, et al. Glycemic control in youth with diabetes: The SEARCH for Diabetes in Youth Study. *J Pediatr.* 2009; 155(5): 668–672. [PubMed: 19643434]
- Mayer-Davis EJ, Ma B, Lawson A, D'Agostino RB Jr, Liese AD, Bell RA, et al. Cardiovascular disease risk factors in youth with type 1 and type 2 diabetes: Implications of a factor analysis of clustering. *Metab Syndr Relat Disord.* 2009; 7(2):89–95. [PubMed: 18847385]
- Monger R. US legal permanent residents: 2009. Office of Immigration Statistics, US Department of Homeland Security. Annual Flow Report. 2010
- US Census Bureau. The 2009 American Community Survey. Washington DC: US Census Bureau; 2010.
- US Census Bureau. Current Population Survey. 2010. Annual Social and Economic Supplement. 2009
- Hsin O, La Greca AM, Valenzuela J, Moine CT, Delamater A. Adherence and glycemic control among hispanic youth with type 1 diabetes: Role of family involvement and acculturation. *Journal of Pediatric Psychology.* 2010; 35(2):156–166. [PubMed: 19491214]
- Harris MA, Wysocki T, Sadler M, Wilkinson K, Harvey LM, Buckloh LM, et al. Validation of a structured interview for the assessment of diabetes self-management. *Diabetes Care.* 2000; 23(9): 1301–1304. [PubMed: 10977022]
- Cadario F, Vercellotti A, Trada M, Zaffaroni M, Rapa A, Jafusco D, et al. Younger age at diagnosis of type 1 diabetes mellitus in children of immigrated families born in Italy. *J Endocrinol Invest.* 2004; 27(10):913–918. [PubMed: 15762037]

9. Banin P, Rimondi F, De Togni A, Cantoni S, Chiari G, Iughetti L, et al. Type 1 diabetes in children and adolescents of immigrated families in Emilia-Romagna (Italy). *Acta Biomed.* 2010; 81(1):35–39. [PubMed: 20857851]
10. Tubiana-Rufi N, Moret L, Czernichow P, Chwalow J. Risk factors for poor glycemic control in diabetic children in France. *Diabetes Care.* 1995; 18(11):1479–1482. [PubMed: 8722073]
11. SEARCH for Diabetes in Youth Study Group. SEARCH for Diabetes in Youth: A multicenter study of the prevalence, incidence and classification of diabetes mellitus in youth. *Control Clin Trials.* 2004; 25(5):458–471. [PubMed: 15465616]
12. Liese AD, D'Agostino RB, Hamman RF, Kilgo PD, Lawrence JM, et al. SEARCH for Diabetes in Youth Study Group. The burden of diabetes mellitus among US youth: Prevalence estimates from the SEARCH for Diabetes in Youth Study. *Pediatrics.* 2006; 118(4):1510–1518. [PubMed: 17015542]
13. Dabelea D, Bell RA, D'Agostino RB, Imperatore G, Johansen JM, et al. SEARCH for Diabetes in Youth Study Group. Incidence of diabetes in youth in the United States. *JAMA.* 2007; 297(24):2716–2724. [PubMed: 17595272]
14. Demographic Yearbook. 2008. United Nations.
15. US Census Bureau. United States Census 2000. Washington, DC: US Department of Census; 2000. OMB no. 0607-0856.
16. Consumer assessment of healthcare providers and systems (CAHPS) (tm) 2.0 questionnaires [Internet]. 1998. Available from: <http://www.ahrq.gov/qual/cahps/cahpques.htm>.
17. Seid M, Waitzfelder B, Dabelea D, Dolan L, Imperatore G, Linder B, et al. Prevalence of barriers to health care in the US youth with diabetes: The SEARCH for Diabetes in Youth Study. *Diabetes.* 2009; 58(Suppl. 1):A271–A272.
18. Greenland S, Pearl J, Robins JM. Causal diagrams for epidemiologic research. *Epidemiology.* 1999; 10(1):37–48. [PubMed: 9888278]
19. Flores G, Brotanek J. The healthy immigrant effect: A greater understanding might help us improve the health of all children. *Arch Pediatr Adolesc Med.* 2005; 159(3):295–297. [PubMed: 15753277]
20. Oza-Frank R, Narayan KMV. Overweight and diabetes prevalence among US immigrants. *Am J Public Health.* 2010; 100(4):661–668. [PubMed: 19608956]
21. Oza-Frank R, Stephenson R, Narayan KM. Diabetes prevalence by length of residence among US immigrants. *J Immigr Minor Health.* 2011; 13(1):1–8. [PubMed: 19688263]
22. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. *Can J Public Health.* 2004; 95(3):114–121.
23. Ingersoll-Dayton B, Saengtienchai C. Respect for the elderly in Asia: Stability and change. *Int J Aging Hum Dev.* 1999; 48(2):113–130. [PubMed: 10376957]
24. Hernandez DJ. Demographic change and the life circumstances of immigrant families. *The Future of Children.* 2004; 14:16–47.
25. Grey M, Boland EA, Yu C, Sullivan-Bolyai S, Tamborlane WV. Personal and family factors associated with quality of life in adolescents with diabetes. *Diabetes Care.* 1998; 21(6):909–914. [PubMed: 9614606]
26. Creatoro MI, Moineddin R, Booth G, Manuel DH, DesMeules M, McDermott S, et al. Age- and sex-related prevalence of diabetes mellitus among immigrants to Ontario, Canada. *CMAJ.* 2010; 182(8):781–789. [PubMed: 20403889]
27. Ferreira SR, Lerario DD, Gimeno SG, Sanudo A, Franco LJ. Japanese-Brazilian Diabetes Study Group. Obesity and central adiposity in Japanese immigrants: Role of the western dietary pattern. *J Epidemiol.* 2002; 12(6):431–438. [PubMed: 12462278]
28. Ostbye T, Welby TJ, Prior IA, Salmond CE, Stokes YM. Type 2 (non-insulin-dependent) diabetes mellitus, migration and westernisation: The Tokelau Island Migrant Study. *Diabetologia.* 1989; 32(8):585–590. [PubMed: 2777000]
29. Heald AH, Sharma R, Anderson SG, Vyas A, Siddals K, Patel J, et al. Dietary intake and the insulin-like growth factor system: Effects of migration in two related populations in India and Britain with markedly different dietary intake. *Public Health Nutr.* 2005; 8(6):620–627. [PubMed: 16236191]

30. Mazur RE, Marquis GS, Jensen HH. Diet and food insufficiency among Hispanic youths: Acculturation and socioeconomic factors in the Third National Health and Nutrition Examination Survey. *Am J Clin Nutr.* 2003; 78(6):1120–1127. [PubMed: 14668273]
31. Allen ML, Elliott MN, Morales LS, Diamant AL, Hambarsoomian K, Schuster MA. Adolescent participation in preventive health behaviors, physical activity, and nutrition: Differences across immigrant generations for Asians and Latinos compared with whites. *Am J Public Health.* 2007; 97(2):337–343. [PubMed: 17138919]
32. Legal immigration to California in 2002. Sacramento, CA: 2003. State of California, Department of Finance.
33. Osypuk TL, Diez Roux AV, Hadley C, Kandula NR. Are immigrant enclaves healthy places to live? The multi-ethnic study of atherosclerosis. *Soc Sci Med.* 2009; 69(1):110–120. [PubMed: 19427731]
34. Cruz FAD, Padilla GV, Agustin EO. Adapting a measure of acculturation for cross-cultural research. *J Transcultural Nursing.* 2000; 11(3):191–198.

TABLE I

Demographic, socioeconomic and clinical characteristics of participants by diabetes type and parent migration status.^{a, b}

	Type 1 Diabetes		Type 2 Diabetes		P-value ^c
	US-born Parents (n = 2,217)	1 Foreign-born Parent (n = 450)	US-born Parents (n = 327)	1 Foreign-born Parent (n = 92)	
DEMOGRAPHIC CHARACTERISTICS					
Parent Duration in US ^d (years)	N/A	25.5 ± 11.2	N/A	24.5 ± 10.8	N/A
Parent Region of Origin					
Latin America & Caribbean		48.3 (213)		70.0 (63)	
North America		5.7 (25)		0.0 (0)	
Europe	N/A	20.2 (89)	N/A	1.1 (1)	N/A
Oceania		1.6 (7)		6.7 (6)	
Asia		19.3 (85)		20.0 (18)	
Africa		5.0 (22)		2.2 (2)	
Age at Visit ^e					
2–9 years	25.7 (535)	28.0 (117)	0.3 (1)	3.7 (3)	N/A
10 years	74.3 (1,549)	72.0 (301)	99.7 (302)	96.3 (79)	
Age at Diagnosis (years)	8.7 ± 4.4	8.3 ± 4.5	13.8 ± 2.7	14.3 ± 2.9	0.2
Male	50.8 (1,126)	48.2 (217)	36.7 (120)	48.9 (45)	0.03
Race/Ethnicity					
Non-Hispanic White	72.1 (1,599)	27.1 (122)	21.1 (69)	1.1 (1)	
Hispanic	10.5 (232)	49.6 (223)	13.8 (45)	69.6 (64)	
Asian/Pacific Islander	3.1 (68)	15.3 (69)	3.7 (12)	27.2 (25)	<0.0001
Non-Hispanic Black	13.3 (295)	6.9 (31)	45.0 (147)	2.2 (2)	
Other	1.0 (23)	1.1 (5)	16.5 (54)	0.0 (0)	
SOCIOECONOMIC CHARACTERISTICS					
Parent Highest Level of Education					
High School	17.9 (391)	30.0 (131)	46.7 (146)	58.8 (50)	0.05
Some college or a degree	82.1 (1,797)	70.0 (306)	53.4 (167)	41.2 (35)	
Family Structure					

	Type 1 Diabetes		Type 2 Diabetes		P-value ^c
	US-born Parents (n = 2,091)	1 Foreign-born Parent (n = 420)	US-born Parents (n = 303)	1 Foreign-born Parent (n = 82)	
CLINICAL CHARACTERISTICS					
PedsQL Score	81.9 ± 12.4	79.3 ± 13.7	76.9 ± 15.1	79.9 ± 10.5	0.2
Frequency of Glucose Monitoring					
< 1 time per day	2.0 (30)	3.3 (10)	26.6 (49)	28.6 (12)	
1–2 times per day	10.0 (149)	9.9 (30)	37.5 (69)	42.9 (18)	0.7
3 times per day	14.5 (216)	15.9 (48)	16.9 (31)	16.7 (7)	
4 times per day	73.5 (1,094)	70.9 (214)	19.0 (35)	11.9 (5)	
Glycemic Control					
A1C (%)	8.47 ± 1.79	8.45 ± 1.78	8.37 ± 2.84	8.13 ± 2.70	0.5
A1C 9.5%	22.7 (429)	24.2 (93)	33.9 (94)	31.7 (25)	0.7
Cardiovascular Disease Risk Factors					
Family History of Diabetes ^f					
BMI (kg/m ²)	13.4 (199)	14.5 (46)	58.1 (125)	46.0 (23)	0.1
BMI-z	21.6 ± 5.8	21.7 ± 5.8	35.5 ± 8.5	32.5 ± 9.9	0.007
Obese ^g	0.59 ± 0.99	0.67 ± 0.97	1.96 ± 1.24	1.67 ± 1.06	0.06
Waist Circumference (cm)	12.9 (260)	15.3 (62)	76.0 (219)	59.8 (49)	0.01
Systolic Blood Pressure (mmHg)	75.8 ± 16.5	75.4 ± 15.4	113.1 ± 21.2	108.4 ± 26.5	0.1
Diastolic Blood Pressure (mmHg)	103.6 ± 11.7	103.6 ± 12.3	117.5 ± 12.5	114.4 ± 11.7	0.05
Hypertensive ^h	66.1 ± 10.1	66.0 ± 10.2	73.2 ± 9.9	72.4 ± 10.1	0.5
LDL Cholesterol (mg/dl)	5.2 (103)	5.2 (21)	13.6 (39)	9.9 (8)	0.4
	94.9 ± 28.8	95.0 ± 25.1	105.3 ± 34.3	98.9 ± 31.4	0.1
Two-parent household	70.3 (1,544)	72.3 (323)	37.7 (122)	63.3 (57)	
Single-parent household	26.6 (585)	23.0 (103)	51.2 (166)	28.9 (26)	<0.0001
Other household structure	3.1 (68)	4.7 (21)	11.1 (36)	7.8 (7)	
Estimated Total Annual Household Income					
< \$24,999	13.9 (274)	17.1 (66)	51.2 (132)	43.6 (24)	
\$25,000–\$49,999	20.8 (410)	26.2 (101)	24.8 (64)	21.8 (12)	0.5
\$50,000–\$74,999	19.7 (387)	19.7 (76)	12.8 (33)	18.2 (10)	
\$75,000	45.6 (897)	36.9 (142)	11.2 (29)	16.4 (9)	

HDL Cholesterol (mg/dl)	56.8 ± 14.2	56.3 ± 14.0	0.5	42.1 ± 11.3	42.0 ± 12.8	0.9
Triglycerides (mg/dl)	83.5 ± 90.3	83.8 ± 64.0	0.96	178.6 ± 292.4	197.7 ± 169.7	0.6

^a Sample sizes vary for clinical characteristics due to 190 participants in the 2008 incident cohort that completed the initial survey but did not attend the baseline visit. Unrounded percents sum to 100.

^b Values presented as mean ± SD or % (n).

^c Chi-square test for categorical outcomes; F test for continuous outcomes. Fisher's Exact test for categorical outcomes with cell sizes less than or equal to 5.

^d Calculated using self-reported year of migration and the year of the baseline visit or most recent follow-up visit.

^e Calculated using self-reported date of birth and the date of the baseline visit or most recent follow-up visit.

^f Mother or father with diagnosed diabetes.

^g BMI 95th percentile for age and sex.

^h SBP or DBP 95th percentile for age, gender, and height.

TABLE II

Barriers to care by diabetes type and parent migration status.^{a, b}

	Type 1 Diabetes			Type 2 Diabetes		
	US-born Parents (n = 1,142)	1 Foreign-born Parent (n = 183)	P-value ^c	US-born Parents (n = 133)	1 Foreign-born Parent (n = 38)	P-value ^c
Insurance Coverage^d						
Private	78.4 (793)	69.5 (82)	0.03	39.3 (42)	33.3 (3)	0.7
Other ^e	21.6 (218)	30.5 (36)		60.8 (65)	66.7 (6)	
Barriers to Care						
Regular Doctor	16.5 (188)	23.1 (42)	0.03	40.2 (53)	43.2 (16)	0.7
Access to Care	15.5 (177)	16.9 (31)	0.6	28.0 (37)	10.8 (4)	0.03
Cost of Care	50.4 (572)	48.1 (88)	0.6	43.9 (58)	29.7 (11)	0.1
Medication	33.4 (372)	29.6 (50)	0.3	32.1 (35)	21.9 (7)	0.3
Contextual Care	24.2 (213)	33.1 (49)	0.02	36.0 (18)	60.0 (6)	0.2
Communication	50.8 (578)	53.0 (97)	0.6	53.0 (70)	41.7 (15)	0.2
Getting Information	49.5 (275)	56.8 (50)	0.2	33.3 (10)	42.9 (3)	0.7

^a Sample sizes may vary slightly due to missing data. Unrounded percents sum to 100.

^b Values presented as % (n).

^c Chi-square test for categorical outcomes; F test for continuous outcomes. Fisher's Exact test for categorical outcomes with cell sizes less than or equal to 5.

^d Proportions excluding California and Hawaii SEARCH sites because these sites were healthcare plan sites and therefore all participants from these sites would be coded as having private insurance.

^e Includes none (n = 32 for type 1 diabetes; n = 19 for type 2 diabetes), Medicaid/Medicare (n = 202 for type 1 diabetes; n = 46 for type 2 diabetes), and other (n = 20 for type 1 diabetes; n = 6 for type 2 diabetes).

TABLE III

Odds ratios (95% confidence intervals) for logistic regression models predicting barriers to care among participants with type 1 diabetes in the 2002–2005 incident cohorts. Participants with US-born parents were the referent group.

	Regular Doctor	Access to Care	Cost of Care	Medication	Contextual Care	Communication	Getting Information
<i>Unadjusted</i>	1.51 (1.04, 2.21)	1.11 (0.73, 1.69)	0.91 (0.67, 1.25)	0.84 (0.59, 1.19)	1.55 (1.07, 2.26)	1.09 (0.80, 1.50)	1.34 (0.85, 2.12)
<i>Adjusted race/ethnicity and SEARCH site^a</i>	1.10 (0.72, 1.67)	0.97 (0.62, 1.54)	0.98 (0.69, 1.38)	0.80 (0.55, 1.17)	1.14 (0.76, 1.72)	1.17 (0.83, 1.65)	1.16 (0.71, 1.89)

^aFinal adjustment set for barriers to care outcome in type 1 diabetes stratum given 10% change-in-estimate criteria.

TABLE IV

Odds ratios (95% confidence intervals) for binary logistic regression models predicting poor glycaemic control (A1C $\geq 9.5\%$) or obesity (BMI $\geq 95^{\text{th}}$ percentile for age and sex) by diabetes type. Participants with US-born parents were the referent group.

	Type 1 Diabetes (n = 2,511)	Type 2 Diabetes (n = 385)
Poor Glycaemic Control (A1C $\geq 9.5\%$)		
Unadjusted	1.08 (0.84, 1.40)	0.90 (0.53, 1.54)
Adjusted race/ethnicity ^a	0.73 (0.55, 0.96)	0.77 (0.45, 1.33)
Adjusted diabetes duration ^b	1.06 (0.82, 1.38)	0.99 (0.57, 1.71)
Adjusted SEARCH site ^c	0.96 (0.74, 1.27)	0.68 (0.36, 1.30)
Adjusted parental education ^d	1.01 (0.78, 1.32)	0.94 (0.54, 1.62)
Adjusted household income ^e	1.10 (0.83, 1.46)	1.16 (0.60, 2.24)
Adjusted race/ethnicity and SEARCH site ^f	0.70 (0.53, 0.94)	
Adjusted race/ethnicity, SEARCH site, and household income ^g		0.65 (0.29, 1.45)
Obesity (BMI $\geq 95^{\text{th}}$ percentile for age and sex)		
Unadjusted	1.22 (0.90, 1.65)	0.57 (0.34, 0.95)
Adjusted race/ethnicity ^a	0.87 (0.63, 1.20)	0.60 (0.36, 1.01)
Adjusted diabetes duration ^b	1.23 (0.91, 1.65)	0.48 (0.28, 0.81)
Adjusted SEARCH site ^c	1.16 (0.84, 1.60)	0.47 (0.28, 0.80)
Adjusted parental education ^d	1.05 (0.77, 1.44)	0.67 (0.36, 1.24)
Adjusted household income ^e	1.09 (0.78, 1.51)	0.47 (0.25, 0.88)
Adjusted race/ethnicity, parental education, and household income ^h	0.79 (0.55, 1.12)	
Adjusted diabetes duration, parental education, and household income ⁱ		0.35 (0.17, 0.70)

^aNon-Hispanic white versus all other race/ethnicities. Coded as a binary variable.

^bContinuous.

^cSouth Carolina, Ohio, California, Colorado, Washington, Hawaii. Coded using indicator variables with Colorado as the referent.

^dLess than or equivalent to high school versus some college or degree. Coded as a binary variable.

^eLess than \$24,999, \$25,000–\$49,999, \$50,000–\$74,999, \$75,000. Coded using indicator variables with \$75,000 as the referent.

^fFinal adjustment set for outcome of poor glycaemic control and A1C in type 1 diabetes stratum given 10% change-in-estimate criteria.

^gFinal adjustment set for outcome of poor glycaemic control and A1C in type 2 diabetes stratum given 10% change-in-estimate criteria.

^hFinal adjustment set for outcome of obesity and BMI z-scores in type 1 diabetes stratum given 10% change-in-estimate criteria.

ⁱFinal adjustment set for outcome of obesity and BMI z-scores in type 2 diabetes stratum given 10% change-in-estimate criteria.