Published in final edited form as:

J Aging Health. 2017 March ; 29(2): 206–221. doi:10.1177/0898264316635562.

Access to care and diabetes management among older American Indians with type 2 diabetes

Emily J. Nicklett, PhD, MSW,

Assistant Professor, University of Michigan School of Social Work, 1080 South University Avenue, Ann Arbor, MI 48109-1106, (734) 763-6282

Adam Omidpanah, MS,

Biostatistician, Center for Clinical Epidemiological Research, University of Washington

Ron Whitener, JD,

Director, Tribal Court Public Defense Clinic, Senior Law Lecturer and Executive Director, University of Washington School of Law

Barbara V. Howard, PhD, and

Senior Scientist, Medstar Health Research Institute, Professor, Department of Medicine, Georgetown University Hospital, 6495 New Hampshire Avenue, Suite 201, Hyattsville, MD 29783, (301) 560-7307

Spero M. Manson, PhD (Senior Author)

Distinguished Professor, Community & Behavioral Health, Centers for American Indian and Alaska Native Health, Colorado School of Public Health, University of Colorado Denver, Nighthorse Campbell Native Health Building, 13055 East 17th Avenue, Mailstop F800, Aurora, CO 80045, (303) 724-1444

Abstract

Objective—Examine the relationship between healthcare access and diabetes management among a geographically diverse sample of American Indians (AIs) age 50 and older with type 2 diabetes.

Method—We examined the relationship between access to care and diabetes management, as measured by HbA_{1c} values, using 1998–99 data from the Strong Heart Family Study. A series of bivariate and multivariate linear models examined the relationships between nine access-related variables and HbA_{1c} values.

Results—In bivariate analyses, out-of-pocket costs were inversely associated with lower HbA_{1c} levels. No other access-related characteristics were significantly associated with diabetes management in bivariate or in multivariate models.

Correspondence to: Emily J. Nicklett.

Human Subjects/Institutional Approvals:

Determination of “Not Regulated” Status [HUM00085558]

Discussion—Access-related barriers were not associated with worse diabetes management in multivariate analyses. The study concludes with implications for clinicians working with AI populations to enhance opportunities for diabetes management.

1. Introduction

In the United States, diabetes disproportionately affects American Indian (AI) communities. Diabetes-related complications remain a leading cause of death among AIs, who are over three times more likely to die from diabetes-related complications than are U.S. citizens overall (Indian Health Service, 2008).

American Indians confront disproportionately greater barriers to care than non-Hispanic whites, including greater difficulty accessing specialty care, appointment delays, and longer wait times (Call et al., 2006). These barriers to accessing care could partially explain differences in diabetes management between non-Hispanic whites and AIs (Centers for Disease Control and Prevention, 2011; Taylor & Kalt, 2005). American Indians are more likely to live in geographically remote regions with limited access to healthcare and to have limited access to public or private transportation (King et al., 2000). Rural AIs are more likely to be poor, less likely to receive care, and they typically carry a greater chronic disease burden than their suburban or urban AI counterparts (Baldwin et al., 2002; Call et al., 2006; Mueller et al., 1999; Probst et al. 2004). Across populations, greater distances to healthcare sites are associated with lower utilization of recommended treatments (Nemet & Bailey, 2000), higher disease burdens (Billi, Pai, & Spahlinger, 2007), and higher disease-specific mortality (Jones et al. 2008; Lamont et al. 2003). These differences are more pronounced among rural (Arcury et al., 2005; Nemet & Bailey, 2000) and socioeconomically disadvantaged groups (Arcury et al., 2005).

Effective management of type 2 diabetes often requires a range of self-care, routine care, and specialty care services (e.g., visits with dietitians, nurse educators, or exercise trainers). Barriers to accessing these health services could result in poorer diabetes management and its associated outcomes.

AI communities in the United States are culturally and historically diverse. AI communities face unique and substantial barriers to accessing health care. However, few studies have examined predictors of diabetes management in different AI communities (Baldwin et al., 2002; Centers for Disease Control and Prevention, 2011). Most research on diabetes management among AIs considers only one region or compares AIs in general to other racial or ethnic groups (e.g., O'Connell et al., 2012). In this paper, we examine whether or not healthcare access was associated with diabetes management among AIs representing three distinct U. S. regions. We pursued this line of inquiry within a framework developed by Penchansky and Thomas (1981), which considers availability, accessibility, accommodation, affordability, and acceptability of care as the key components of access.

2. Methods

Participants

We analyzed data from the Strong Heart Family Study (SHFS), part of the parent Strong Heart Study (SHS). The SHS is a large prospective epidemiological study of AI health. The SHS examines cardiovascular disease and its risk factors among extended families in 13 AI communities in Arizona, Oklahoma, and North and South Dakota (National Institutes of Health, 2001). The 1998–99 SHFS, which was conducted during Phase III of the SHS, includes data about barriers to accessing care not previously available in the SHS (National Institutes of Health, 2001). In addition to the original SHS cohort, the SHFS recruited approximately 30 large families comprising 900 individuals across all participating SHS regions (Connor, Kralewski & Hillson, 1994).

Older AIs with type 2 diabetes have unique service needs, yet they are often overlooked in the literature. To examine which, if any, barriers to care are associated with diabetes management among older AIs, the analytic sample was restricted to AI adults aged 50 and older. Of the 1,322 eligible participants in the SHFS, 795 participants were excluded because they did not have type 2 diabetes and an additional 395 participants were excluded because they were under the age of 50. The resulting analytic sample includes 292 SHFS participants aged 50 and older in three geographic regions (Arizona: $n=124$; Oklahoma: $n=105$; North/South Dakota: $n=63$). Diabetic status was defined according to American Diabetes Association (2003) criteria (Kahn, 2003).

Variables and Measurement

Dependent variable—We examine diabetes management using Hemoglobin A_{1c} (HbA_{1c}). HbA_{1c} is an indicator of short- and long-term diabetes management and is prognostic of adverse diabetes outcomes and blood glucose management (Sidorov et al., 2000; Williams et al., 2004). HbA_{1c} was measured by high-pressure liquid chromatography (National Institutes of Health, 2001). Glucose measures and tolerance tests were rigorously collected for the SHS and SHFS; the procedures are described elsewhere (Connor, Kralewski & Hillson, 1994).

Independent variables—Access to care was measured in terms of perceived barriers to receiving care (Nelson, 2002). Drawing upon previous literature that identified barriers to care among AIs (Call et al., 2006; Jervis, Jackson, & Manson, 2002), we examined the relationships between nine potential access barriers and diabetes management, including *accessibility* (travel time, transportation provider, and transportation costs), *availability* (hospital/clinic takes appointments, appointment scheduling lag), *accommodation* (hospital/clinic takes walk-ins, wait time for appointments and walk-ins), and *affordability* (out-of-pocket payments). Access variables were assessed using structured clinical interviews. The SHFS did not include measures of *appropriateness* of care, and thus we were unable to examine the potential of that variable to contribute to diabetes management, although we do recognize that cultural dissonance and language differences can impede care among older AI adults (Call et al. 2006; Jervis, Jackson, & Manson, 2002).

In descriptive analyses, the access-related variables were examined as nominal dichotomous variables (*transportation cost*, *appointments accepted at usual source of care*, *walk-ins accepted at usual source of care*, *out-of-pocket visit costs*), nominal categorical variables (*transportation provider*), and ordinal categorical variables (*travel time to usual source of care*, *typical advanced appointment booking*, *typical wait time for appointments*, and *typical wait time for walk-ins*). In bivariate and multivariate analyses, access-related variables were examined as nominal dichotomous variables (*self-transport to appointments*, *transportation cost*, *appointments accepted at usual source of care*, *hospital/clinic takes walk-ins*, *out-of-pocket visit costs*) and continuous variables.

Covariates—Descriptive analyses were conducted by *geographic region* (Arizona, Oklahoma, and North/South Dakota). We included geographic region as a covariate in these analyses to examine whether or not geographic differences influenced the relationship between diabetes management and access to care, as previous research suggested (Baldwin et al., 2002; Centers for Disease Control and Prevention, 2011; Indian Health Service, 2008; Mueller et al., 1999). We also examined socioeconomic characteristics, as previous studies have found a consistent relationship between poverty and barriers/lower utilization of care (Centers for Disease Control and Prevention, 2011; Taylor & Kalt, 2005). Accordingly, we controlled for household *income* (less than \$5,000, \$5,000 to less than 10,000, and \$10,000 and over), *education* (less than 8 years, 8–12 years, and 12 or more years), and *employment status* (whether or not participant is employed full-time). We also controlled for *sex* and *age*, as the need for care, barriers to seeking care, and the relationship between access to care and diabetes management might differ according to these socio-demographic characteristics.

Self-reported *duration of diabetes* was included as a covariate. Duration of diabetes is indicative of greater diabetes severity, which we anticipated to be negatively associated with diabetes management.

Data Analysis

Descriptive statistics (means and percentages) were conducted for HbA_{1c}, covariates, and for main effects by region (Arizona, Oklahoma, and North/South Dakota) and overall. We examined whether or not healthcare access is associated with diabetes management by conducting bivariate and multivariate linear regression analyses for each of the 9 access items (independent variables) and for HbA_{1c} (dependent variable).

To examine the relationships between access measures and diabetes management, we constructed a series of 9 bivariate statistical models, in which each of the 9 items (across the 4 domains of access) was regressed on HbA_{1c}. Next, we conducted a series of 9 multivariate statistical models, in which each of the 9 items was regressed on HbA_{1c}, controlling for site, age, sex, employment (full-time), education (ordinal, 0=less than 8 years of education, 1=8 years to less than 12 years, and 2=12 or more years of education), total annual household income (ordinal, 0=less than \$5,000 per year, 1=\$5,000 per year to less than \$10,000 per year, and 2=\$10,000 or more per year), and diabetes duration in years. Ordinal measures (*travel time to usual source of care*, *typical advanced appointment booking*, *typical wait time for appointments*, and *typical wait time for walk-ins*) were coded numerically according to

their ordinal levels in regression models, in order to provide a test of trend between categories and HbA_{1c} levels. The adequacy of possible trends was verified by subsequent tests for a larger categorical model and its corresponding test of heterogeneity.

To maintain sufficient statistical power, these results were not disaggregated by geographic region, although we did include geographic region as a control variable in multivariate models.

Heteroscedasticity-consistent standard errors were used to calculate robust confidence intervals and relax assumptions about the shape of the trend and corresponding residuals (Zeileis, 2004). R version 3.0.1 was used for data management and analyses (“The R Project for Statistical Computing,” n.d.). The value $p < 0.05$ was considered statistically significant.

3. Results

Descriptive Statistics: Outcome and Covariates

As shown in Table 1, mean HbA_{1c} values were fairly consistent across geographic regions (8.3 in Arizona and 8.4 in Oklahoma and in North/South Dakota). However, the distribution of HbA_{1c} levels was not consistent across regions; diabetes control (as measured by HbA_{1c}) was reached by 29% of participants in Arizona, 27% of participants in Oklahoma, and only 13% of participants in North/South Dakota. Overall, participants reported having diabetes for an average of 14.8 years (19.2 years in Arizona, 12.7 years in Oklahoma, 9.7 years in North/South Dakota). These differences were not attributable to age, as the mean age of participants (62.7 years) was fairly consistent across regions.

Descriptive Statistics: Barriers to Healthcare Access (Main Effects)

The majority of participants considered tribal or IHS facilities to be their “usual source of care” (91.1%), followed by private practitioners and facilities (4.4%), VA/medical facilities (2.1%), traditional healers (0.7%), and HMOs (0.7%).

Accessibility—As shown in Table 2, nearly half (49.5%) of participants traveled less than 15 minutes to their usual source of care, and only a small percentage (4.1%) traveled one hour or more. Travel time was shortest in the Arizona region. The majority of participants (59.2%) provided their own transportation to receive care. This trend was strongest in the North/South Dakota and Oklahoma regions (65.1% and 63.5%, respectively), but was still prevalent in Arizona (53.3%). Apart from self-transport, transportation provided by family members (27.7%) and community health representatives (9.3%) was most prevalent. Few participants rode with friends (2.1%) or paid drivers (1.7%). Relatively few participants (5.1%) reported that they had costs associated with transportation to their usual source of care; among those who did, trends were strongest in North/South Dakota (7.7%) and weakest in Oklahoma (3.4%).

Availability—Nearly all participants (98.3%) reported that their usual source of care accepted scheduled appointments, with 95.2% in North/South Dakota and 99.2% in Arizona. *Scheduling time for appointments* varied substantially across participants and regions. Relatively few participants (33.2%) in the Oklahoma region were able to schedule

appointments within 2 weeks. The majority of participants in the Arizona region could schedule appointments within 2 weeks (72.9%), and even more could do so in the North/South Dakota region (90.2%).

Accessibility—Walk-in appointments generally were available, but wait times were relatively long. Ninety-three percent of participants in the Oklahoma region reported that walk-in appointments typically were available at their usual source of care, compared to 81% of participants in the North/South Dakota region. As shown in Table 2, the average wait times generally were shorter for scheduled appointments compared to walk-ins; however, this trend also varies across participants and geographic regions.

Affordability—Only 11.9% of participants paid out-of-pocket visit costs, although this varied greatly by geographic region. In the Arizona region, fewer than 2% of participants reported paying out-of-pocket for visits at their usual source of care, compared to 9.6% in North/South Dakota and 18.4% in Arizona.

Bivariate Analyses

Bivariate analyses, displayed in Table 3, show that AIs reporting any out-of-pocket visit costs had on average 14% lower HbA_{1c} values compared to those reporting no out-of-pocket costs (95% CI: 0.12 – 1.61). None of the other eight access-related measures was significantly associated with HbA_{1c} values.

Multivariate Analyses

We fit nine multivariate models, treating each access variable separately as a regressor of interest on HbA_{1c}, controlling for duration of diabetes and age, sex, geographic region, household income, and employment status. As shown in Table 4, none of the access-related measures was statistically significantly associated with diabetes management.

In the multivariate models, none of the socioeconomic indicators significantly predicted diabetes management. In each of the nine models, longer duration of diabetes was statistically significantly associated with lower HbA_{1c}, with effects ranging from 0.05 to 0.07. Diabetes duration (in 1-year increments) was associated with a 0.06 difference in HbA_{1c} (95% CI: 0.04 – 0.08). Age also was significantly associated with HbA_{1c} in the models that investigated the relationship between HbA_{1c} and several *availability* and *accommodation* measures, including *typical advanced appointment booking required* and *typical wait time for walk-ins*.

4. Discussion

This is the first study to examine the relationship between diabetes management and access to care in a geographically diverse sample of older AIs. We examined associations between healthcare access (Penchansky & Thomas, 1981) and diabetes management in 13 AI communities in Arizona, Oklahoma, and North and South Dakota. Our findings concerned: (a) access to diabetes care among participants; and (b) the relationship between access to care and diabetes management in bivariate and multivariate analyses.

Access to Care

Previous literature suggested that AIs faced unique, heightened barriers to care (Call et al. 2006; Jervis, Jackson, & Manson, 2002). Consistent with these findings, our participants experienced the following challenges to accessing care:

- Less than half of participants lived within a fifteen-minute commute of their usual source of care;
- Nearly 40% relied on transportation from a friend, family member, community health representative, or paid driver;
- While most participants were able to make appointments at their usual source of care, these appointments often required scheduling several weeks in advance; and
- Wait times tended to be long for both appointments and walk-ins.

Bivariate and Multivariate Relationships

Few measured access-related barriers were associated with diabetes management in bivariate models. The expected negative associations between diabetes management barriers to health care access (accessibility, availability, and accommodation) were not statistically significant. In bivariate analyses, the measure of affordability (out-of-pocket costs) was actually associated with better diabetes management. This relationship may reflect self-selection bias, as cost remains a key barrier to healthcare in the United States (Lasser et al., 2006). Higher out-of-pocket costs were significantly positively associated with higher income categories, but were not associated with education or employment status. AIs with greater financial resources may be more likely to seek care without being deterred by copays. Participants paying more out-of-pocket costs are likely doing so because they are utilizing health services outside of reservation communities, and thus they may have better access to other health-promoting goods and services as well.

Despite noted barriers to accessing care, none of the examined factors related to accessibility, availability, accommodation, or affordability were significantly associated with diabetes management in multivariate models. These findings are consistent with the Harris (2000) study, which examined the relationship between healthcare access, utilization of diabetes-related medical care, and health outcomes among a diverse, population-based sample of Americans with type 2 diabetes. Participants had poorer health status and outcomes than expected, considering favorable rates of healthcare access and utilization, screening for complications, and treatment of diabetes-related complications (Harris, 2000).

Our study involves some limitations. The study population includes older AIs who participated in the Strong Heart Family Study, primarily AIs residing in rural areas. Therefore, the findings may be more relevant to AIs living in rural communities, rather than to those living in urban areas. The associations were examined using cross-sectional data; therefore, causal inferences cannot be made regarding relationships between access to care and diabetes management.

Limitations in availability of the data also presented several challenges. Analyses were subject to limitations of the secondary data, including sample size. Self-report of access-related measures (e.g., wait times, costs) may be influenced by recall bias. Inadequate reporting of access measures could relate to other underlying measures, such as health beliefs and optimism, which might in turn relate to diabetes management. Some of the pre-established categories in access measures (e.g., travel time, wait time) are not mutually exclusive. We were also unable to consider appropriateness of care, which is an important facet of healthcare access for older AI adults (Call, et al. 2006; Jervis, Jackson, & Manson, 2002). With regard to diabetes management, the field is moving beyond HbA_{1c} as an exclusive indicator of diabetes management (Nicklett & Liang, 2010). Reliance upon this single measure may have constrained our ability to observe the expected associations between access to care and participant status.

5. Conclusions and Clinical Implications

The diabetes diagnosis process can be challenging, particularly among patients with constrained personal or community financial resources (Nicklett & Damiano, 2014). In addition to new or changed interactions with the healthcare system, patients are introduced to new regimens that can be demanding and complex. Clinicians working with AI populations should continue to partner with patients, providers, and/or communities to identify potential barriers and facilitators to diabetes management. Through shared decision-making approaches, clinicians and patients deliberate and reach a consensus on therapeutic goals (World Health Organization, 2005), which enhances adherence and subsequent outcomes (Shah et al., 2010).

Clinicians should continue to support patients in identifying—as well as addressing—barriers to diabetes management. Many AI patients face structural or environmental barriers that constrain opportunities for patients to prevent them from achieving their therapeutic goals (Ershow, 2009; Giles-Corti & Donovan, 2002; Mitchell, 2012) such as lack of access to affordable diabetes-friendly foods (Hendrickson et al., 2006; O'Connell, Buchwald, & Duncan, 2011; Thompson et al., 2002) and limited opportunities for safe physical activity (Belza et al., 2004; Thompson et al., 2002). When individual and community-level resources are constrained, clinicians need to support patients and community members in overcoming such contextual and environmental barriers to diabetes management.

Diabetes outcomes have improved in AI communities incrementally since Congress enacted the Special Diabetes Program for Indians (SDPI) in 1997 (Wilson et al., 2005); however, AIs continue to be at heightened risk for diabetes and its complications (Indian Health Service, 2008). The findings of the present study suggested that improved access to care may be a necessary—but not sufficient—strategy for diabetes management among AIs. Additional strategies that consider social determinants of health are needed to improve diabetes outcomes in AI communities.

Acknowledgments

This research was supported by a grant from the Native Elder Research Center (NERC) through the Resource Center for Minority Aging Research from the National Institute on Aging (Grant #12164572) through the Native

Elder Research Center, jointly administered by the University of Washington and the University of Colorado Denver. Preparation of this manuscript was supported by the National Institute of Diabetes Digestive and Kidney Disease (1P30DK092923, SM Manson) and by the Claude D. Pepper Older Americans Independence Center's Research Career Development Core at the University of Michigan (5P30AG024824, N Alexander). Additional support was provided by the Washington University Center for Diabetes Translation Research (P30DK092950) from the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health. The authors would like to acknowledge Fawn Yeh, Jeff Henderson, Steve Schwartz, David Pratt, Tim McBride, and the two anonymous reviewers for their helpful suggestions. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Indian Health Service.

References

- Arcury TA, Gesler WM, Preisser JS, Sherman J, Spencer J, Perin J. The effects of geography and spatial behavior on health care utilization among the residents of a rural region. *Health Services Research*. 2005; 40(1):135–155. [PubMed: 15663706]
- Baldwin LM, Grossman DC, Casey S, Hollow W, Sugarman JR, Freeman WL, Hart LG. Perinatal and infant health among rural and urban American Indians/Alaska Natives. *American Journal of Public Health*. 2002; 92(9):1491–1497. [PubMed: 12197982]
- Belza B, Walwick J, Schwartz S, LoGerfo J, Shiu-Thornton S, Taylor M. Older adult perspectives on physical activity and exercise: Voices from multiple cultures. *Preventing Chronic Disease*. 2004; 1(4):A09.
- Billi JE, Pai CW, Spahlinger DA. The effect of distance to primary care physician on health care utilization and disease burden. *Health Care Management Review*. 2007; 32(1):22–29. [PubMed: 17245199]
- Call KT, McAlpine DD, Johnson PJ, Beebe TJ, McRae JA, Song Y. Barriers to care among American Indians in public health care programs. *Medical Care*. 2006; 44(6):595–600. [PubMed: 16708009]
- Centers for Disease Control and Prevention. National diabetes fact sheet: National estimates and general information on diabetes and prediabetes in the United States, 2011. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2011. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf
- Connor RA, Kralewski JE, Hillson SD. Measuring geographic access to health care in rural areas. *Medical Care Review*. 1994; 51(3):337–377. [PubMed: 10138051]
- Ershow AG. Environmental influences on development of type 2 diabetes and obesity: Challenges in personalizing prevention and management. *Journal of Diabetes Science and Technology*. 2009; 3(4):727–734. [PubMed: 20144320]
- Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. *Social Science & Medicine*. 2002; 54(12):1793–1812. [PubMed: 12113436]
- Harris MI. Health care and health status and outcomes for patients with type 2 diabetes. *Diabetes Care*. 2000; 23(6):754–758. [PubMed: 10840991]
- Hendrickson D, Smith C, Eikenberry N. Fruit and vegetable access in four low-income food deserts communities in Minnesota. *Agriculture and Human Values*. 2006; 23(3):371–383.
- Indian Health Service. Regional Differences in Indian Health, 2002–2003 Edition. Washington: U.S. Department of Health and Human Services: Office of Public Health Support: Division of Program Statistics; 2008. p. 1-122. Retrieved from http://www.ihs.gov/dps/files/RD_entirebook.pdf
- Jervis LL, Jackson MY, Manson SM. Need for, availability of, and barriers to the provision of long-term care services for older American Indians. *Journal of Cross-Cultural Gerontology*. 2002; 17(4):295–311. [PubMed: 14617961]
- Jones AP, Haynes R, Sauerzapf V, Crawford SM, Zhao H, Forman D. Travel times to health care and survival from cancers in Northern England. *European Journal of Cancer*. 2008; 44(2):269–274. [PubMed: 17888651]
- Kahn R. Follow-up report on the diagnosis of diabetes mellitus: The expert committee on the diagnosis and classifications of diabetes mellitus. *Diabetes Care*. 2003; 26(11):3160. [PubMed: 14578255]
- King AC, Castro C, Wilcox S, Eyler AA, Sallis JF, Brownson RC. Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of U.S. middle-aged and older-aged women. *Health Psychology*. 2000; 19(4):354–364. [PubMed: 10907654]

- Lamont EB, Hayreh D, Pickett KE, Dignam JJ, List MA, Stenson KM, ... Vokes EE. Is patient travel distance associated with survival on phase II clinical trials in oncology? *Journal of the National Cancer Institute*. 2003; 95(18):1370–1375. [PubMed: 13130112]
- Lasser KE, Himmelstein DU, Woolhandler S. Access to care, health status, and health disparities in the United States and Canada: Results of a cross-national population-based survey. *American Journal of Public Health*. 2006; 96(7):1300–1307. [PubMed: 16735628]
- Mitchell FM. Reframing diabetes in American Indian communities: A social determinants of health perspective. *Health & Social Work*. 2012; 37(2):71–79. [PubMed: 23029974]
- Mueller KJ, Ortega ST, Parker K, Patil K, Askenazi A. Health status and access to care among rural minorities. *Journal of Health Care for the Poor and Underserved*. 1999; 10(2):230–249. [PubMed: 10224828]
- National Institutes of Health. Strong Heart Study Data Book: A Report to American Indian Communities. 2001. NIH Publication No. 01-3285. Retrieved from https://www.nhlbi.nih.gov/resources/docs/shs_db.pdf
- Nelson A. Unequal treatment: confronting racial and ethnic disparities in health care. *Journal of the National Medical Association*. 2002; 94(8):666–668. [PubMed: 12152921]
- Nemet GF, Bailey AJ. Distance and health care utilization among the rural elderly. *Social Science & Medicine*. 2000; 50(9):1197–1208. [PubMed: 10728841]
- Nicklett EJ, Damiano SK. Too little, too late: Socioeconomic disparities in the experience of women living with diabetes. *Qualitative Social Work*. 2014; 13(3):372–388. [PubMed: 25364302]
- Nicklett EJ, Liang J. Diabetes-related support, regimen adherence, and health decline among older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2010; 65(3):390–399.
- O'Connell M, Buchwald DS, Duncan GE. Food access and cost in American Indian communities in Washington State. *Journal of the American Dietetic Association*. 2011; 111(9):1375–1379. [PubMed: 21872701]
- O'Connell JM, Wilson C, Manson SM, Acton KJ. The costs of treating American Indian adults with diabetes within the Indian Health Service. *American Journal of Public Health*. 2012; 102(2):301–308. [PubMed: 22390444]
- Penchansky R, Thomas JW. The concept of access: Definition and relationship to consumer satisfaction. *Medical Care*. 1981; 19(2):127–140. [PubMed: 7206846]
- Probst JC, Moore CG, Glover SH, Samuels ME. Person and place: The compounding effects of race/ethnicity and rurality on health. *American Journal of Public Health*. 2004; 94(10):1695–1703. [PubMed: 15451735]
- Shah ND, Mullan RJ, Breslin M, Yawn BP, Ting HH, Montori VM. Translating comparative effectiveness into practice: the case of diabetes medications. *Medical Care*. 2010; 48(6):S153–S158. [PubMed: 20473211]
- Sidorov J, Gabbay R, Harris R, Shull RD, Girolami S, Tomcavage J, ... Hughes R. Disease management for diabetes mellitus: impact on hemoglobin A1c. *The American Journal of Managed Care*. 2000; 6(11):1217–1226. [PubMed: 11185847]
- The R Project for Statistical Computing. n.d. Retrieved November 1, 2014, from <http://www.r-project.org/>
- Taylor, JB., Kalt, JP. American Indians on reservations: A databook of socioeconomic change between the 1990 and 2000 censuses. 2005. Retrieved from <http://hpaied.org/sites/default/files/publications/AmericanIndiansonReservationsADatabookofSocioeconomicChange.pdf>
- Thompson JL, Allen P, Cunningham-Sabo L, Yazzie DA, Curtis M, Davis SM. Environmental, policy, and cultural factors related to physical activity in sedentary American Indian women. *Women & Health*. 2002; 36(2):57–72.
- Williams JW, Katon W, Lin EHB, Nöel PH, Worchel J, Cornell J. ... IMPACT Investigators. The effectiveness of depression care management on diabetes-related outcomes in older patients. *Annals of Internal Medicine*. 2004; 140(12):1015–1024. [PubMed: 15197019]
- Wilson C, Gilliland S, Cullen T, Moore K, Roubideaux Y, Valdez L, Vanderwagen W, Acton K. Diabetes outcomes in the Indian Health System during the era of the Special Diabetes Program for

Indians and the Government Performance and Results Act. *American Journal of Public Health*. 2005; 95(9):1518–1522. [PubMed: 16051933]

World Health Organization. Preparing a health care workforce for the 21st century: the challenge of chronic conditions. 2005. Retrieved from http://www.who.int/chp/knowledge/publications/workforce_report/en/

Zeileis A. Econometric computing with HC and HAC covariance matrix estimators. *Journal of Statistical Software*. 2004; 11(10):1–17.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1

Sociodemographic and health measures by geographic region, The Strong Heart Family Study, 1998–1999.

Characteristics	Arizona (N = 124)	Oklahoma (N = 105)	Dakota (N = 63)	Total (N = 292)
HbA _{1c} ; mean (SD)	8.3 (2.0)	8.4 (2.0)	8.4 (2.0)	8.4 (2.0)
Diabetes control; n (%)	29 (27.9)	27 (28.7)	13 (23.2)	69 (27.2)
Age; mean (SD)	61.6 (7.4)	63.9 (7.7)	62.9 (7.6)	62.7 (7.6)
Age group; n (%)				
50 to 64	86 (69.4)	64 (61.0)	38 (60.3)	188 (64.4)
65 to 74	30 (24.2)	33 (31.4)	21 (33.3)	84 (28.8)
75 and older	8 (6.5)	8 (7.6)	4 (6.3)	20 (6.8)
Female; n (%)	94 (75.8)	71 (67.6)	40 (63.5)	205 (70.2)
Income; n (%)				
less than \$5,000	33 (34.7)	11 (22.0)	21 (37.5)	65 (32.3)
\$5,000 to less than \$10,000	27 (28.4)	14 (28.0)	13 (23.2)	54 (26.9)
\$10,000 or more	35 (36.8)	25 (50.0)	22 (39.3)	82 (40.8)
Education; n (%)				
Less than 8 years	76 (63.9)	40 (38.5)	23 (39.0)	139 (49.3)
8 years to less than 12 years	43 (36.1)	51 (49.0)	33 (55.9)	127 (45.0)
12 years or more	0 (0.0)	13 (12.5)	3 (5.1)	16 (5.7)
Employed full-time; n (%)	24 (20.0)	27 (26.0)	15 (25.4)	66 (23.3)
Diabetes duration (years); mean (SD)	19.2 (12.6)	12.7 (8.7)	9.7 (7.9)	14.8 (11.1)

Table 2

Access measures by geographic region, The Strong Heart Family Study, 1998–1999.

Region	Arizona (N = 124)	Oklahoma (N = 105)	Dakota (N = 63)	Total (N = 292)
Accessibility				
Travel time to usual source of care; n (%)				
Less than 15 minutes	74 (60.2)	36 (35.0)	33 (52.4)	143 (49.5)
15 to 30 minutes	33 (26.8)	36 (35.0)	9 (14.3)	78 (27.0)
31 to 45 minutes	13 (10.6)	19 (18.4)	10 (15.9)	42 (14.5)
45 to 60 minutes	3 (2.4)	7 (6.8)	7 (11.1)	17 (5.9)
1 to 2 hours	0 (0.0)	5 (4.9)	3 (4.8)	8 (2.8)
More than 2 hours	0 (0.0)	0 (0.0)	1 (1.6)	1 (0.3)
Transportation to care; n (%)				
Self	65 (53.3)	65 (62.5)	41 (65.1)	171 (59.2)
Family member	40 (32.8)	31 (29.8)	9 (14.3)	80 (27.7)
Friend	4 (3.3)	2 (1.9)	0 (0.0)	6 (2.1)
Community health representative	8 (6.6)	6 (5.8)	13 (20.6)	27 (9.3)
Paid driver	5 (4.1)	0 (0.0)	0 (0.0)	5 (1.7)
Transportation cost; mean (SD)	1.3 (3.5)	3.9 (3.4)	6.7 (7.7)	3.4 (5.1)
Availability				
Appointments at usual source of care; n (%)	121 (99.2)	103 (99.0)	60 (95.2)	284 (98.3)
Typical advanced appointment booking; n (%)				
2 days or less	32 (34.8)	5 (5.7)	23 (37.7)	60 (25.0)
3 days to 1 week	11 (12.0)	3 (3.4)	18 (29.5)	32 (13.3)
1 to 2 weeks	24 (26.1)	21 (24.1)	14 (23.0)	59 (24.6)
3 or 4 weeks	10 (10.9)	9 (10.3)	4 (6.6)	23 (9.6)
More than 4 weeks	15 (16.3)	49 (56.3)	2 (3.3)	66 (27.5)
Accommodation				
Walk-ins at usual source of care; n (%)	109 (89.3)	97 (93.3)	51 (81.0)	257 (88.9)
Typical wait time for appointments; n (%)				
Less than 15 minutes	34 (27.9)	14 (14.0)	7 (11.7)	55 (19.5)
15 to 30 minutes	44 (36.1)	16 (16.0)	17 (28.3)	77 (27.3)
31 to 45 minutes	11 (9.0)	8 (8.0)	7 (11.7)	26 (9.2)
45 to 60 minutes	11 (9.0)	20 (20.0)	9 (15.0)	40 (14.2)
1 to 2 hours	20 (16.4)	22 (22.0)	10 (16.7)	52 (18.4)
More than 2 hours	2 (1.6)	20 (20.0)	10 (16.7)	32 (11.3)
Typical wait time for walk-ins; n (%)				
Less than 15 minutes	19 (20.0)	8 (8.9)	8 (16.0)	35 (14.9)
15 to 30 minutes	21 (22.1)	6 (6.7)	7 (14.0)	34 (14.5)
31 to 45 minutes	8 (8.4)	8 (8.9)	3 (6.0)	19 (8.1)
45 to 60 minutes	9 (9.5)	14 (15.6)	10 (20.0)	33 (14.0)
1 to 2 hours	28 (29.5)	25 (27.8)	13 (26.0)	66 (28.1)
More than 2 hours	10 (10.5)	29 (32.2)	9 (18.0)	48 (20.4)

Region	Arizona (N = 124)	Oklahoma (N = 105)	Dakota (N = 63)	Total (N = 292)
Affordability				
Out-of-pocket visit costs; mean (SD)	0.3 (1.8)	2.8 (18.4)	1.5 (9.6)	1.5 (11.9)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3
Model-based associations between access-related barriers and diabetes control: Bivariate analyses.

Variables	Accessibility Model coefficient (SE), 95% CI	Availability Model coefficient (SE), 95% CI	Accommodation Model coefficient (SE), 95% CI	Affordability Model coefficient (SE), 95% CI
Accessibility				
Travel time to usual source of care	−0.05 (0.13) (−0.30, 0.19)			
Drive self to usual source of care	0.12 (0.25) (−0.37, 0.60)			
Transportation cost	0.18 (0.25) (−0.31, 0.66)			
Availability				
Appointments at usual source of care		0.98 (0.59) (−0.18, 2.15)		
Typical advanced appointment booking		0.12 (0.08) (−0.05, 0.28)		
Accommodation				
Walk-ins at usual source of care			0.05 (0.41) (−0.76, 0.86)	
Typical wait time for appointments			0.02 (0.07) (−0.12, 0.17)	
Typical wait time for walk-ins			0.00 (0.08) (−0.15, 0.14)	
Affordability				
Out-of-pocket visit costs				−0.86 (0.38) (−1.61, −0.11)

* p<0.05

Table 4

Model-based associations between access-related barriers and diabetes control: Multivariate analyses.

	Accessibility		Availability		Accommodation		Affordability	
	Model	coefficient (SE), 95% CI	Model	coefficient (SE), 95% CI	Model	coefficient (SE), 95% CI	Model	coefficient (SE), 95% CI
Accessibility								
Travel time to usual source of care		-0.06 (0.15) (-0.34, 0.23)						
Drive self to usual source of care		0.10 (0.35) (-0.59, 0.79)						
Transportation cost		0.02 (0.33) (-0.63, 0.67)						
Availability								
Appointments at usual source of care				0.30 (0.45) (-0.58, 1.18)				
Typical advanced appointment booking				0.07 (0.12) (-0.17, 0.31)				
Accommodation								
Walk-ins at usual source of care						-0.12 (0.48) (-1.06, 0.82)		
Typical wait time for appointments						-0.03 (0.10) (-0.24, 0.17)		
Typical wait time for walk-ins						-0.09 (0.12) (-0.31, 0.14)		
Affordability								
Out-of-pocket visit costs								-0.51 (0.40) (-1.29, 0.27)

Note: Multivariate models control for age, sex, geographic region, income group, education, employment, and duration of diabetes.