Serious Psychological Distress and Diabetes Management among American Indians and Alaska Natives

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Objective: Our study examined associations between serious psychological distress and blood glucose level (HbA1c) and body mass index (BMI) among American Indian and Alaska Native (AI/AN) participants in a cardiovascular disease prevention program.

Design: Using linear regression, we assessed the relationships between serious psychological distress and HbA1c and BMI at baseline and one year later.

Setting, Participants, and Intervention: AI/AN participants were aged ≥18 years, diagnosed with type 2 diabetes, and enrolled in the Special Diabetes Project for Indians Healthy Heart Project.

Main Outcome Measures: Outcomes were percentage of HbA1c and BMI, measured at enrollment and first annual exam. Both outcomes were continuous measures in all analyses.

Results: Serious psychological distress was associated at baseline with increased HbA1c in the unadjusted and adjusted models (adjusted b=.17%, P<0.01). Serious psychological distress also was associated at baseline with increased BMI (.635 kg/m^2, P=.01) and at one year with increased BMI (0.174 kg/m^2, P= .01) in the unadjusted model. After adjustment for demographic and health characteristics, these relationships were no longer significant.

Conclusions: Cross-sectional baseline findings are consistent with existing literature. One-year findings suggest need for further inquiry into mediators of psychological distress and examination of additional diabetes-specific health outcomes. Additional years of observation may be needed to disentangle relationships between serious psychological distress and BMI. (*Ethn Dis*. 2015;25[2]:145–151)

Key Words: American Indian, Alaska Native, Diabetes, Serious Psychological Distress

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Introduction

Diabetes is an emerging pandemic,[1] affecting 25.8 million adults in the United States. It increases the risk of complications that compromise quality of life,[2,3] including co-occurring illnesses such as cardiovascular and kidney diseases.[4] The presence of diabetes substantially increases the cost of health care, with expenditures 2.3 times higher than when absent.[5] American Indians and Alaska Natives (AI/ANs) are twice as likely to have diabetes as non-Hispanic Whites.[6] Treating diabetes among AI/ANs consumes nearly one-third of all Indian Health Service medical resources.[7] Hence, the successful management of diabetes promises to enhance well-being and to save increasingly scarce health care dollars.

Serious psychological distress plays an important role among these challenges.[8] It contributes to poorer diabetes self-management, unsuccessful glycemic control, lack of treatment adherence, and increased severity of diabetes over time.[9–13] Diabetics who experience serious psychological distress underutilize health care services and are less likely to fill a prescription.[14,15] Depression is associated with poorer diabetes treatment outcomes and increased mortality.[16–18] Past studies also have reported associations between serious psychological distress and higher BMI,[19–21] which plays an important role in managing diabetes. In general, there is a reciprocal link between depression and weight: younger individuals who are depressed gain weight, and older individuals who are obese are more likely to experience depression.[22–24]

In 1997, the US Congress established the Special Diabetes Project for Indians (SDPI) to address high rates of diabetes among AI/ANs. Over the ensuing decades, participant health status and lifestyle have improved substantially.[25] Our study explores the associations between serious psychological distress and two outcomes – HbA1c and BMI – found in participants in the SDPI's Healthy Heart Project (HHP), which focuses specifically on reducing cardiovascular disease risk among AI/ANs who suffer from diabetes. Program data were used to test for associations between serious psychological distress and HbA1c and BMI and to examine

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Our study explores the associations between serious psychological distress and two outcomes – HbA1c and BMI – found in participants in the Special Diabetes Project for Indians Healthy Heart Project

the effect of changes in level of distress between baseline and one year on these outcomes.

METHODS

Setting and Sample

We examined data from the SDPI HHP, an intensive case-management program intended to reduce participants' risk of cardiovascular disease. Participants were AI/AN, aged ≥18 years, and diagnosed with type 2 diabetes. Individuals were excluded if pregnant, receiving dialysis for end-stage renal disease, undergoing cancer treatment, experiencing alcohol/substance abuse problems, or suffering from any other condition that, according to a provider's judgment, would affect participation. Authorized by local institutional review boards (IRBs) or the National Indian Health Service IRB (for sites without local review boards), participating programs identified eligible individuals through electronic medical records or local diabetes registries. Some programs also recruited participants through community events (eg, diabetes screenings, health fairs) and clinic-based activities (eg, advertisements in local clinics, provider referrals). The formal evaluation period, from which these data were drawn, yielded 3,039 participants from 30 sites across the United States. They were assessed at enrollment and followed annually for three years. More details about SDPI HHP can be found elsewhere.[26] Our current analyses focus on data collected between enrollment and the first annual exam.

Dependent Variables

The outcomes of interest were HbA1c and BMI, calculated from measured height and weight. Both were assessed at enrollment (baseline) and the first annual exam (one year) and were treated as continuous measures in all analyses.

Independent Variables

Serious Psychological Distress at Baseline

Serious psychological distress was measured using the Kessler-6, which was developed for use in the redesigned U.S. National Health Interview Survey to discriminate cases of serious mental illness from non-cases; it has excellent internal consistency and reliability,[27,28] and has performed well among AI/AN populations.[29] The Kessler-6 included the following questions: During the past 30 days, about how often did you feel: 1) nervous, 2) hopeless, 3) restless or fidgety, 4) so depressed that nothing could cheer you up, 5) that everything was an effort, and 6) worthless? Response options ranged from "None of the time" to "All of the time" and were coded 1 to 5. Responses to these six items were averaged to calculate a summary Kessler-6 score. A higher score indicated higher distress. This average score was used as a continuous variable in all analyses.

Change in Serious Psychological Distress

We calculated change in serious psychological distress between baseline and one year by subtracting baseline values from one-year values. We then categorized change in serious psychological distress into three categories: no change in distress, decreased distress, and increased distress. No change in distress was defined as the interquartile range (−.333 to .327), decreased distress corresponded to the lowest quartile (−3.333 to −.334), and increased distress corresponded to the highest quartile (.328 to 3.167).

Sociodemographic Covariates at Baseline

Age, sex, and educational attainment were measured at enrollment. Educational attainment was operationalized as two categories: less than high school and high school graduate or beyond.

Health Covariates at Baseline

Health covariates measured at study enrollment included comorbid health conditions, alcohol use, physical activity, current smoking status, and current use of depression or anxiety medication. Comorbid health conditions were identified using a self-administered comorbidity questionnaire.[30] These conditions included heart disease, high blood pressure, lung disease, ulcer or stomach disease, kidney disease, liver disease, anemia or other blood disease, cancer, depression, osteoarthritis or degenerative arthritis, rheumatoid arthritis, and back pain. We subsequently converted the comorbidity score into quartiles to reduce outlier effects. The Alcohol Use Disorders Identification Test (AUDIT) was employed to assess alcohol use; it included 10 questions about alcohol use over the past year. Two sample AUDIT questions are: 1) How often do you have a drink containing alcohol? and 2) How often during the last year have you had a feeling of guilt or remorse after drinking? The total score ranged from 0 to 40; due to a right-skewed distribution, our analyses included an indicator for scores ≥ 8.[31] Physical activity was measured as frequency in minutes per week in the month prior to enrollment. Responses were categorized into four levels: 1) 0 minutes, 2) 1–89 minutes, 3) 90–149 minutes, and 4) ≥ 150 minutes. Smoking status was assessed as either "current smoker" or "never/former smoker." Medication use for depression or anxiety was indicated for participants who reported taking medication prescribed to address any depression or anxiety disorders.

Analysis

We executed a two-part analysis. In the first phase, we determined the cross-sectional relationship between serious psychological distress and the outcomes of interest. In the second phase, we assessed relationships between change in serious psychological distress and these same outcomes after one year of intervention. Baseline variables were

Table 1. SDPI HHP baseline participant characteristics according to baseline serious psychological distress quartile

Characteristic	Distress Quartile[a]			
	1	2	3	4
Demographic				
Age, mean years (SE)	57.6 (.7)	55.0 (.6)	52.9 (.9)	51.4 (.6)
Female, %	59	68	65	71
High school graduate, %	79	84	80	75
Health				
Comorbidity[b], mean score (SE)	3.4 (.1)	3.8 (.2)	4.2 (.2)	5.6 (.3)
AUDIT, mean score (SE)	1.2 (.2)	1.8 (.2)	2.2 (.3)	2.8 (.4)
Physical activity, mean minutes/week (SE)	112 (11)	110 (10)	118 (11)	121 (15)
Current smoker, %	17	19	21	26
Current depression medication use, %	13	17	22	41

[a] 1st quartile = (1.00–1.17), 2nd = (1.18–1.66), 3rd = (1.67–2.17), 4th = (2.18–5.00).
[b] Comorbid conditions include heart disease, high blood pressure, lung disease, ulcer or stomach disease, kidney disease, liver disease, anemia or other blood disease, cancer, depression, arthritis, and back pain.

described using means and standard errors for continuous variables and proportions for categorical variables. We used linear regression to determine cross-sectional association between baseline serious psychological distress and baseline HbA1c. The dependent variable was baseline HbA1c; independent variables included baseline serious psychological distress and sociodemographic as well as health covariates. We first fit a separate unadjusted model for each independent variable. Our next model included all independent variables to adjust simultaneously for covariates chosen *a priori* based on the literature.

We also used linear regression to assess the association between change in serious psychological distress between baseline and one year and HbA1c measured at one year. This analysis was performed using a similar procedure to that described above for the cross-sectional analysis. The dependent variable was one-year HbA1c; the independent variable of interest was change in serious psychological distress. Change in distress was included in the model using dummy variables with no change as the referent group. Our first models examined each independent variable separately, but included a term for baseline HbA1c, so results were independent of the baseline outcome value. A final model was fit that included all independent variables to simultaneously adjust for selected covariates.

The same approach then was used to examine the associations between serious psychological distress and BMI. We followed the same procedures as described above for HbA1c, except that baseline BMI was the dependent variable for the cross-sectional analysis and one-year BMI served as the dependent variable for change in serious psychological distress.

Missing data were handled using multiple imputation and inverse probability weighting.[32] Multiple imputation was used to estimate missing baseline data. Sequential regression multivariate imputation was used to generate 20 imputed data sets in IVEware.[33] Data from the first annual exam were missing for 948 participants (31%). We used inverse probability weighting to reduce potential bias caused by attrition. Weights were estimated via logistic regression to predict probability that each participant would return for the first annual exam. Model predictors were based on previous SDPI HHP analyses that examined participant- and site-level factors associated with one-year retention.[26] The inverse of the predicted probability of retention was used to reweight the data to account for participants who did not participate in the first annual exam.

All regression models used the sandwich variance estimator to account for correlation among participants at the same site. Results are presented as regression coefficients with standard errors. Regression coefficients are interpreted as the change in the outcome measure (HbA1c or BMI) for a 1-unit change in the indicated independent variable. Analyses were performed using Stata 12.[34] The Stata prefix mi:procedure was used for all analyses to accommodate multiple imputed data sets; .05 was considered the threshold for significance.

RESULTS

Baseline Characteristics

Baseline participant characteristics according to quartiles of serious psychological distress are presented in Table 1. Mean age of participants tended to decrease as serious psychological distress increased; mean age ranged from 57.6 years in the lowest serious psychological distress quartile to 51.4 years in the highest distress quartile. The majority of our sample was female and had completed high school. The proportion of female participants increased in higher serious psychological distress quartiles, while there was no apparent association between education and distress levels. Mean values for the comorbidity score (range = 3.4–5.6), alcohol use scale (range = 1.2–2.8), and amount of weekly physical activity (range = 112–121 minutes/week) tended to increase with each distress quartile. Similarly, prevalence of current smoking (range = 17%–26%) and depression medication use (range = 13%–41%) increased in higher distress quartiles.

Table 2. Unadjusted and adjusted regression coefficients for association between serious psychological distress and HbA1c (baseline)

Independent Variable at Baseline	Dependent Variable: Hemoglobin A1c at Baseline	
	Unadjusted Coefficient[a] (SE)	Adjusted Coefficient[a] (SE)
Exposure of interest		
Serious psychological distress	.192[c] (.054)	.170[c] (.046)
Covariates		
Age	−.036[d] (.002)	−.035[d] (.003)
Male sex	.162 (.096)	.165 (.089)
High school graduate	−.178 (.116)	−.253[b] (.103)
Comorbidity score	−.192[c] (.055)	−.083 (.053)
AUDIT score	.562[d] (.136)	.085 (.133)
Physical activity	−.105[b] (.043)	−.134[c] (.037)
Current smoker	.202[b] (.094)	−.037 (.098)
Current depression medication use	−.338[c] (.098)	−.350[d] (.075)
Body mass index	.000 (.006)	−.014[b] (.006)

[a] Coefficient interpreted as change in hemoglobin A1c for 1-unit change in independent variable;
[b] $P<.05$.
[c] $P<.01$.
[d] $P<.001$.

Serious Psychological Distress and Hemoglobin A1c

The cross-sectional analysis at baseline between serious psychological distress and HbA1c showed that, unadjusted for covariates, a 1-unit increase in baseline serious psychological distress was associated with an increase of .192% in baseline HbA1c. Also, among unadjusted covariates, age, comorbidity score, physical activity, and current depression medication use were associated with a decrease in baseline HbA1c. AUDIT score and being a current smoker were associated with an increase in baseline HbA1c. As shown in Table 2, the association between serious psychological distress and HbA1c remained significant after adjustment for covariates. Increased age, physical activity, and BMI as well as completion of high school and current use of depression/anxiety medication were significantly associated with decreased baseline HbA1c in the adjusted model.

Table 3 illustrates the linear regression coefficients for the association between change in serious psychological distress (between baseline and one year) and HbA1c at one year. We found no relationship between change in serious psychological distress and HbA1c at one year. However, a 1-unit increase in age was associated with a slight decrease in HbA1c at one year in both models. Also, as one would anticipate, a 1-unit increase in baseline HbA1c was associated with an increase in one-year HbA1c.

Table 3. Unadjusted and adjusted regression coefficients for association between change in serious psychological distress and hemoglobin A1c at one year

Independent Variable	Dependent Variable: Hemoglobin A1c at One Year	
	Unadjusted Coefficient[a] (SE)	Adjusted Coefficient[a] (SE)
Exposure of interest – change in serious psychological distress between baseline and one-year[b]		
No change	Ref	Ref
Decrease	.027 (.087)	.015 (.087)
Increase	.120 (.105)	.094 (.104)
Covariates at baseline		
Age	−.008[c] (.003)	−.010[c] (.004)
Male sex	−.169 (.083)	−.144 (.090)
High school graduate	−.015 (.082)	−.049 (.087)
Comorbidity score	−.055 (.031)	−.044 (.035)
AUDIT score	−.000 (.198)	−.045 (.208)
Physical activity	−.025 (.031)	−.026 (.035)
Current smoker	−.045 (.104)	−.111 (.100)
Current depression medication use	.130 (.072)	.136 (.082)
Body mass index	−.004 (.005)	−.008 (.006)
Hemoglobin A1c level	.520[d] (.037)	.510[d] (.038)

[a] Coefficient interpreted as change in hemoglobin A1c for 1-unit change in independent variable, unadjusted model adjusts for baseline hemoglobin A1c only.
[b] No change: 25th–50th percentile, Decrease: ≤25th percentile, Increase: ≥75th percentile.
[c] $P<.05$.
[d] $P<.001$.

Serious Psychological Distress and BMI

The cross-sectional analysis at baseline between serious psychological distress and BMI showed that, unadjusted for covariates, a 1-unit increase in baseline serious psychological distress was associated with a .635 kg/m^2 increase in BMI. Also in the unadjusted model, age, being male, and physical activity were associated with a decrease in baseline BMI. High school graduate status, comorbidity score, and current depression medication use were associated with an increase in baseline BMI. As shown in Table 4, after adjustment for covariates, the magnitude of the association between serious psychological distress and BMI was reduced and no longer significant. Increased age,

Table 4. Unadjusted and adjusted regression coefficients for association between serious psychological distress and BMI at baseline

Independent Variable at Baseline	Dependent Variable: Body Mass Index at Baseline	
	Unadjusted Coefficient[a] (SE)	Adjusted Coefficient[a] (SE)
Exposure of interest		
Serious psychological distress	.635[c] (.208)	−.135 (.179)
Covariates		
Age	−.175[d] (.297)	−.230[d] (.016)
Male sex	−1.568[d] (.297)	−.894[c] (.265)
High school graduate	1.804[d] (.431)	1.038[b] (.398)
Comorbidity score	.924[d] (.187)	1.428[d] (.189)
AUDIT score	−.395 (.494)	−1.554[c] (.481)
Physical activity	−1.014[d] (.139)	−.957[d] (.109)
Current smoker	−1.326[c] (.392)	−2.206[d] (.398)
Current depression medication use	1.126[c] (.366)	.036 (.299)
Hemoglobin A1c level	−.002 (.095)	−.211[b] (.085)

[a] Coefficient interpreted as change in body mass index for 1-unit change in independent variable.
[b] $P<.05$.
[c] $P<.01$.
[d] $P<.001$.

AUDIT score, physical activity, and HbA1c as well as being male and a current smoker were significantly associated with decreased baseline BMI in the adjusted model. Completion of high school and a higher comorbidity score were significantly associated with increased baseline BMI.

Table 5 presents the results of the linear regression examining the association between change in serious psychological distress (between baseline and one year) and BMI at one year. We found no relationship between change in serious psychological distress and BMI at one year. Across both the unadjusted and adjusted models, a 1-unit increase in either baseline BMI or baseline HbA1c was associated with increased BMI at one year.

Table 5. Unadjusted and adjusted regression coefficients for association between change in serious psychological distress and BMI at one year

Independent Variable	Dependent Variable: Body Mass Index at One Year	
	Unadjusted Coefficient[a] (SE)	Adjusted Coefficient[a] (SE)
Exposure of interest – change in serious psychological distress between baseline and one year[b]		
No change	Ref	Ref
Decrease	−.080 (.141)	−.161 (.152)
Increase	.172 (.134)	.112 (.137)
Covariates at baseline		
Age	−.010 (.007)	−.006 (.007)
Male sex	−.052 (.087)	.039 (.100)
High school graduate	−.325 (.164)	−.317 (.163)
Comorbidity score	.004 (.052)	.021 (.054)
AUDIT score	.417 (.232)	.256 (.227)
Physical activity	−.000 (.051)	.016 (.051)
Current smoker	.266 (.146)	.167 (.159)
Current depression medication use	.180 (.118)	.182 (.124)
Body mass index	.964[c] (.010)	.962[c] (.010)
Hemoglobin A1c level	.125[c] (.029)	.112[c] (.028)

[a] Coefficient interpreted as change in body mass index for 1-unit change in independent variable, unadjusted model adjusts for baseline BMI only.
[b] No change: 25th–50th percentile, Decrease: ≤25th percentile, Increase: ≥75th percentile.
[c] $P<.001$.

DISCUSSION

This study contributes to recently emerging interest in the relationship between serious psychological distress and two common indicators of diabetes treatment outcomes, namely, HbA1c and BMI. Our initial unadjusted baseline associations between serious psychological distress and these two outcomes pointed toward the significance of serious psychological distress in diabetes management; however, the statistical significance of serious psychological distress was not sustained throughout these analyses. The cross-sectional baseline findings supported our initial expectation that increased levels of serious psychological distress are associated with increased levels of both HbA1c and BMI. However, the relationship of change in serious psychological distress between baseline and one year and these outcomes dropped below statistical significance. A longer follow-up was not possible in this study due to substantial participant attrition in later years; however, it may be needed to better examine this potential association.

We observed a strong relationship between serious psychological distress and HbA1c in the cross-sectional baseline analysis but no relationship at one year. Upon entering SDPI HHP, participants who experienced higher serious psychological distress also were likely to have higher HbA1c levels. The strong relationship between increasing baseline serious psychological distress and increasing baseline HbA1c among

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enrollees is consistent with previous observations of an association between serious psychological distress and blood glucose levels[9,10] and between mental disorders and level of HbA1c.[35,36] However, change in serious psychological distress was not significantly associated with HbA1c and was not statistically significant at one year. It is possible that the intensive case-management process may have mitigated participants' levels of serious psychological distress at entry. This could explain our negative findings of proximal, rather than distal, serious psychological distress impacts on HbA1c. These findings do not support a temporal relationship between serious psychological distress and HbA1c, but do not preclude the possible influence of serious psychological distress on diabetes management. Williams et al,[37] for example, found that serious psychological distress was associated with fewer foot checks but not with HbA1c checks. Li et al[10] also noted that social position (ie, low socioeconomic status) weakened the relationship between serious psychological distress and diabetes treatment outcomes. Unfortunately, our study was unable to explore these additional pathways of the possible impact of serious psychological distress. Yet, the initial unadjusted findings suggest that these and other potential mechanisms for serious psychological distress may be important to diabetes management goals.

Our cross-sectional analyses revealed an initial, unadjusted association between serious psychological distress and BMI at baseline. Higher serious psychological distress was associated with a higher BMI, but the magnitude of this association was attenuated and no longer significant in the adjusted model. This observation suggests both the importance of serious psychological distress, as well as mediating effects of the covariates in managing BMI. Change in serious psychological distress and one-year BMI were unrelated in our analyses. A previous five-year observational study tested the reciprocal relationship between depression and obesity and found that obesity was associated with increased risk of depression.[23] Our study only examined one year of intervention. Additional time may be required to reveal an association between serious psychological distress and BMI.

Though the baseline results suggest relationships between serious psychological distress and HbA1c and BMI, these relationships were no longer statistically significant after one year of participation in the SDPI HHP. The SDPI HHP substantially increased contact with a health care provider through intensive case management and diabetes education. Doing so may have tempered the relationship between serious psychological distress and HbA1c and BMI.

Our study has several limitations. Although it included a large number of AI/ANs, it is neither tribally nor nationally representative. Hence, the findings only are generalizable to SDPI HHP participants. Nevertheless, given the rapid diffusion of this initiative to other tribal communities, the results promise to inform a widening audience. The individuals who enrolled in the program may have self-selected in some unknown manner that affects risk, severity, and duration of distress and therefore its association with HbA1c and BMI. Finally, 31% of participants did not return for the one-year assessment. Loss to follow up and uncertain status one year later may have constrained our ability to adequately estimate the associations of interest, despite having used inverse probability weighting to correct for such bias. Yet this study drew upon a large number of AI/ANs with diabetes who represent a diverse array of tribes, settings, organizations, and locales not found elsewhere in studies of this nature.

CONCLUSION

Our study was one of the first to examine the role of serious psychological distress in diabetes management among AI/ANs who are diagnosed with diabetes. Overall, the results are consistent with previous findings of a cross-sectional relationship between serious psychological distress and HbA1c and BMI. The one-year findings did not bear out our assumptions about the likely longitudinal relationships among these. Future lines of inquiry should consider the possibly mediating effects of the nature and extent of case management, which varied among SDPI HHP participants, as well as longer periods of observation. We also recommend broadening the focus beyond such outcomes as HbA1c and BMI, to include quality of life and related indicators of well-being. Understanding the roles of these and related factors in managing diabetes promises to inform intervention with AI/ANs specifically and the population at large who suffer from this chronic, debilitating disease.

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