FEATURE ARTICLE

Diabetes Distress, Daily Functioning, and A1C in Older Black Individuals With Diabetes and Mild Cognitive Impairment

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OBJECTIVE | The purpose of the cross-sectional study was to identify associations of diabetes distress, physical functioning, and cognition with A1C in older Black individuals with diabetes and mild cognitive impairment.

METHODS | The investigators analyzed previously collected data from 101 older Black individuals with diabetes and mild cognitive impairment. Participants were administered surveys at baseline to assess diabetes distress, physical functioning, and cognitive functioning and had A1C testing.

RESULTS | The mean age of participants was 68.4 years, and 62% were women. Participants with higher A1C showed worse self-reported daily functioning ($r = -0.28$, $P < 0.01$). Three of four diabetes distress factors were positively correlated with A1C: emotional ($r = 0.28$, $P < 0.01$), regimen-related ($r = 0.33$, $P < 0.01$), and interpersonal distress ($r = 0.27$, $P < 0.01$). In a multivariate regression with A1C as the dependent variable, only regimen-related diabetes distress ($\beta = 0.32$, $P = 0.008$) and self-reported daily functioning ($\beta = -0.33$, $P = 0.019$) were significant.

CONCLUSION | Regimen-related diabetes distress and self-reported daily functioning were found to compromise glycemic control in Black individuals with mild cognitive impairment and diabetes. This finding suggests that diabetes interventions should be multifaceted to improve glycemic control in the high-risk population of Black individuals with diabetes.

In people with diabetes, poor glycemic control increases the risk of microvascular and macrovascular complications, from cardiovascular and renal risks to impaired cognition (1,2). Mild cognitive impairment (MCI) is considered a symptomatic pre-dementia stage of impaired cognition that often involves deficits in memory and executive functioning that do not substantially interfere with activities of daily living (3). MCI occurs in ~10–20% of the population >65 years of age (4), and one study has shown MCI to be more prevalent among Black individuals, at 23% (5). Some studies have shown that cognitive impairment compromises the ability to self-manage diabetes by reducing medication adherence and increasing psychological distress related to managing diabetes (6,7).

Older Black individuals tend to have worse glycemic control than White individuals, in addition to higher rates of comorbid diseases such as cardiovascular disease, hypertension, and stroke. One factor that may contribute to these health disparities is that Black individuals experience disproportionately higher rates of psychosocial stress (7). Simons et al. (8) showed that the "weathering hypothesis," which posits that Black individuals experience high rates of illness as a physiological response to discrimination and structural oppression, leads to a chronic inflammatory state that begins early in life and persists into adulthood. Chronic stress can also lead to worse mental health (e.g., depression). Black individuals tend to have more persistent depression than White individuals, as well as higher rates of diabetes-related emotional distress (9). These higher rates of mental health comorbidities among Black individuals with diabetes is well documented, but whether it is associated with worse glycemic control in older Black individuals with MCI is uncertain.

In this cross-sectional study of older Black patients with both MCI and diabetes, we evaluated interrelationships among glycemic control and diabetes-related distress, depressive symptoms, cognition, medical comorbidity, and physical functioning to identify possible unique

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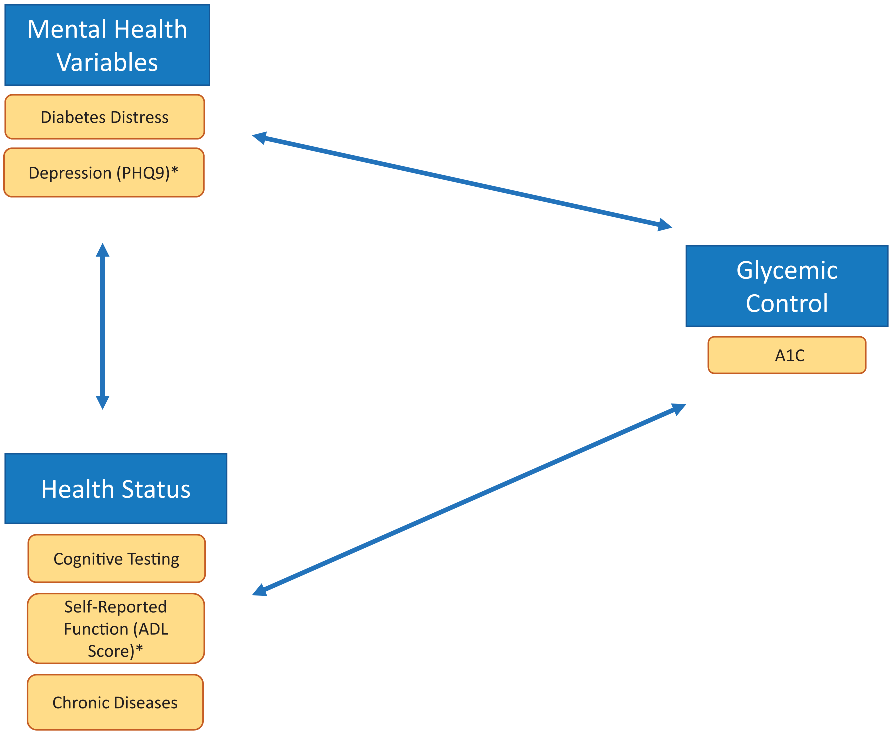

FIGURE 1 Proposed interrelationships between glycemic control, psychosocial variables, and health status. The figure illustrates the hypothesis that both mental health factors (e.g., depression and distress) and health status (e.g., chronic disease, daily functioning, and cognition) contribute to glycemic control. Poor glycemic control, in turn, contributes to worsening mental and physical health outcomes, creating a feedback loop. ADL, Activities of Daily Living-Prevention Instrument.

associations of these variables in this high-risk population (Figure 1).

Research Design and Methods

Participants were 101 Black individuals ≥60 years of age with concomitant type 2 diabetes and MCI, with <80% daily adherence to diabetes medications (as measured by electronic medicine bottle readings) and hemoglobin A1C (A1C) ≥7.5%. Participants were recruited from primary care practices at Thomas Jefferson University from 2015 to 2017. Institutional review board approval was obtained for this study, and all participants provided written informed consent.

The data presented were collected as a part of a 12-month randomized clinical trial testing the efficacy of two education-based interventions to improve diabetes self-management. That trial was designed to test the efficacy of an occupational therapist intervention to improve glycemic control in a select population that is at particularly high risk for worsening glycemic control and subsequent diabetes-related complications, namely older Blacks with an A1C ≥7.5% and mild memory problems. Half of the randomized participants received a behavioral intervention led by an occupational therapist to facilitate diabetes self-management behaviors (experimental group). The other half were paired with a race-concordant community health worker to receive basic diabetes education and support (control group). Data were collected on health outcomes and psychosocial and cognitive measures at baseline, 6 months, and 12 months. Only baseline data (collected before randomization) were analyzed in the current study.

Study Measures

Race-concordant community health workers conducted in-home assessments to obtain the following data.

Demographic Characteristics

Age, sex, marital status, years of education, and literacy, which was defined as reading level measured using the Reading Recognition Subtest of the Wide Range Achievement Test, v. 3 (10). At baseline, the examiner obtained height and weight to calculate BMI. A measure of financial burden was taken, for which the examiner asked participants, "How hard is it for you to pay for the very basics like food, housing, medical care, and heating?" Responses ranged from 1 = "no difficulty at all" to 4 = "very difficult."

Health Status and Cognitive Measures

Participants' number of chronic medical diagnoses and A1C were recorded at baseline. The Activities of Daily Living–Prevention Instrument (ADL-PI) was used to assess self-reported difficulty completing 15 daily functioning activities (e.g., handling money and shopping). Responses ranged from "no difficulty" to "does not do this activity" (11).

The National Alzheimer's Coordinating Center's Uniform Data Set neuropsychological test battery was used to assess cognition and includes the Mini-Mental Status Examination (MMSE); Wechsler Logical Memory tests, immediate and delay; Digit Span tests, forward and backward; Digit Symbol Substitution test; Trail-Making tests A and B; Category Fluency test; and Boston Naming test (12).

Mental Health Variables

The 17-item Diabetes Distress Scale (DDS) was used to assess four domains of diabetes-related emotional distress: emotional burden (e.g., "feeling overwhelmed by the demands of living with diabetes"), physician-related distress (e.g., "feeling that my doctor doesn't take my concerns seriously enough"), regimen-related distress (e.g., "feeling that I am not sticking closely enough to a good meal plan"), and interpersonal distress (e.g., "feeling that my friends/family don't appreciate how difficult living with diabetes is"). Items were rated from 1 = "no problem" to 6 = "serious problem." The four subscales are internally consistent (Cronbach's α ranged from 0.88 to 0.93) (6).

The Patient Health Questionnaire-9 (PHQ-9) was used to assess the level of depressive symptoms. Scores range from 0 to 27, with higher scores indicating more severe depressive symptoms. PHQ-9 scores have a sensitivity and specificity of 88% for major depressive disorder (as diagnosed via clinical interview) (13).

Statistical Methods

Continuous data were summarized using means and SDs and categorical variables using numbers and percentages. We then computed Pearson correlations to examine bivariate relationships between A1C and demographic characteristics, diabetes distress, number of health conditions, physical functioning, and cognitive functioning.

To examine the multivariate relationships among variables of interest, we performed a hierarchical linear regression in which the dependent variable was A1C. The following variables were entered sequentially, as follows:

- Step 1: age, education, sex, literacy score, and number of health conditions. This step controlled for demographic/background characteristics.
- Step 2: diabetes distress (emotional burden), diabetes distress (physician-related), diabetes distress (regimen-related), diabetes distress (interpersonal distress), and depression. This grouping was selected as the second step because mental health, specifically distress, was a primary interest in our study.

TABLE 1 Baseline Demographic and Clinical Characteristics of the Sample (N = 101)

Demographic	
Female sex	63 (62)
Education, years	12.28 ± 2.11
Age, years	68.44 ± 6.38
Literacy[a]	23.99 ± 7.54
BMI, kg/m^2	33.55 ± 6.68
Financial burden[b]	2.47 ± 1.07
Health status and cognition	
A1C, %	9.33 ± 1.57
Chronic medical conditions	5.58 ± 2.32
ADL-PI score[c]	34.91 ± 7.57
Trail-Making A score[d]	67.48 ± 32.38
Trail-Making B score[e]	217.75 ± 80.55
Logical Memory immediate score[f]	8.58 ± 2.94
Logical Memory delayed score[g]	6.31 ± 3.18
Digit Symbol Substitution score[h]	32.98 ± 13.45
MMSE score[i]	25.42 ± 2.59
Mental health	
DDS–emotional score[j]	2.95 ± 1.60
DDS–regimen-related score[k]	3.44 ± 0.73
DDS–interpersonal score[l]	2.38 ± 1.60
DDS–physician-related score[m]	1.65 ± 1.08
PHQ-9 score[n]	7.68 ± 6.17

Data are *n* (%) or mean ± SD. [a]The lower and upper bounds of the range are 0 and 42, with higher score indicating higher literacy. [b]The lower and upper bounds of the range are 1 and 4, with higher score indicating greater financial difficulties. [c]The lower and upper bounds of the range are 0 and 65, with higher score indicating better functioning. [d]The lower and upper bounds of the range are 0 and 150, with incomplete tasks scored as 150; higher scores indicate worse performance. [e]The lower and upper bounds of the range are 0 and 300, with incomplete tasks scored as 300; higher scores indicate worse performance. [f]The number of correct story elements recalled ranges from 0 to 25, with higher scores indicating better memory. [g]The number of correct story elements recalled after a 20-minute delay ranges from 0 to 25, with higher scores indicating better memory. [h]The number of symbols correct for the Digit Symbol test, with higher scores indicating better functioning. [i]The lower and upper bounds of the range are 0 and 30, with higher scores indicating better global cognitive functioning. [j]The lower and upper bounds of the range are 5 and 30, with higher scores reflecting greater feelings of burden. [k]The lower and upper bounds of the range are 5 and 30, with higher scores reflecting greater levels of regimen-related distress. [l]The lower and upper bounds of the range are 3 and 28, with higher scores reflecting greater levels of interpersonal distress. [m]The lower and upper bounds of the range are 4 and 24, with higher scores reflecting greater levels of physician-related distress. [n]The lower and upper bounds of the range are 0 and 27, with higher scores indicating more severe depression.

- Step 3: Trail-Making test A, Trail-Making test B, Digit Symbol Substitution test, Logical Memory immediate test, Logical Memory delayed test, and MMSE.
- Step 4: ADL-PI score.

The groupings in steps 3 and 4 were selected as the final steps in the regression to determine whether the relationships between distress and glycemic control were upheld after considering the effects of cognition and physical functioning.

Data were analyzed using SPSS, v. 27, statistical software.

Results

The sample was comprised of 101 Black individuals with diabetes and MCI. The mean age was 68.4 ± 6.4 years and 63 participants (62%) were women. The mean A1C was 9.33 ± 1.59, and the average number of comorbid chronic medical conditions was 5.6 ± 2.3 (Table 1).

Correlations are presented in Table 2. In terms of demographic variables, only age was significantly correlated with A1C ($r = -0.21$, $P < 0.05$), such that younger age was associated with higher A1C. In terms of general health, the number of chronic medical conditions was not significantly correlated with A1C, but self-reported functioning was negatively correlated such that participants with higher A1C had worse daily functioning ($r = -0.28$, $P < 0.01$). Three of the four diabetes distress factors were positively correlated with A1C: emotional distress ($r = 0.28$, $P < 0.01$), regimen-related ($r = 0.33$, $P < 0.01$), and interpersonal ($r = 0.27$, $P < 0.01$). None of the remaining variables, including cognitive test scores, were significantly correlated with A1C.

A linear regression analysis (Table 3) with A1C as the dependent variable was conducted, and the following independent variables were entered as blocks:

- Block 1: age, education, sex, literacy score, BMI, financial burden, and number of health conditions
- Block 2: diabetes distress (emotional burden) score, diabetes distress (physician-related) score, diabetes distress (regimen-related) score, diabetes distress (interpersonal) score, and depression (PHQ-9) score
- Block 3: Trail-Making A score, Trail-Making B score, Digit Symbol Substitution score, Logical Memory immediate score, Logical Memory delayed score, MMSE score
- Block 4: ADL-PI, self-reported functioning score

No variables were significant in the first step. The second step, in which the four diabetes distress variables and depression were added to the model, yielded a significant contribution to the model ($r = 0.47$, $P = 0.04$). Only regimen-related diabetes distress was significant ($\beta = 0.69$, $P = 0.008$). Neuropsychological test scores were added in the third step, and this block did not significantly increase multiple r. In our final step, we added self-reported functioning, which significantly contributed to the model ($\beta = -0.07$, $P = 0.019$).

TABLE 2 Correlations Between A1C Level and Demographic and Clinical Characteristics ($N = 101$)

	A1C
Demographics	
Sex	0.18
Education, years completed	−0.07
Age, years	−0.21*
Literacy score	−0.15
BMI	0.01
Financial burden	0.09
Health status and cognition	
Number of chronic medical conditions	0.12
ADL-PI score	−0.28†
Trail-Making A score	−0.10
Trail-Making B score	−0.05
Logical Memory immediate score	−0.03
Logical Memory delayed score	−0.05
Digit Symbol Substitution score	−0.01
MMSE score	0.02
Mental health	
DDS–emotional score	0.28†
DDS–regimen-related score	0.33†
DDS–interpersonal score	0.27†
DDS–physician-related score	0.06
PHQ-9 score	0.18

*$P < 0.05$. †$P < 0.01$.

Discussion

Our study population comprised 101 older Black individuals with MCI and poorly controlled diabetes who had, on average, 5.6 chronic medical conditions. We found that age; emotional, interpersonal, and regimen-related diabetes distress; and self-reported daily functioning significantly correlated with A1C. The unique characteristics of this sample limit the generalizability of this study, but we

TABLE 3 Multivariate Linear Regression Analysis With A1C Level as the Dependent Variable

	Standardized β (95% CI)	*P*
Sex	0.12 (−0.09 to 0.34)	0.248
Education	0.12 (−0.15 to 0.38)	0.376
Age*	−0.15 (−0.41 to 0.10)	0.235
Literacy	−0.11 (−0.42 to 0.20)	0.471
BMI	−0.11 (−0.33 to 0.11)	0.331
Financial burden	−0.10 (−0.34 to 0.14)	0.418
Number of health conditions	−0.02 (−0.26 to 0.23)	0.902
DDS–emotional burden score	−0.01 (−0.33 to 0.32)	0.997
DDS–physician-related score	−0.02 (−0.20 to 0.25)	0.827
DDS–regimen-related score	0.32 (0.09 to 0.56)	**0.008**
DDS–interpersonal score	0.19 (−0.08 to 0.45)	0.174
PHQ-9 score	−0.12 (−0.38 to 0.15)	0.388
Trail-Making A score	−0.13 (−0.40 to 0.14)	0.348
Trail-Making B score	−0.10 (−0.38 to 0.18)	0.493
Digit Symbol Substitution score	−0.14 (−0.45 to 0.17)	0.362
Logical Memory immediate score	−0.08 (−0.27 to 0.43)	0.660
Logical Memory delayed score	−0.07 (−0.42 to 0.27)	0.673
MMSE score	0.17 (−0.11 to 0.46)	0.232
ADL-PI self-reported functioning score	−0.33 (−0.61 to −0.06)	**0.019**

Only the final step in the linear regression (Model 4) is included. Bold type indicates statistical significance ($P < 0.05$). *Age did not significantly contribute to model due to the constrained range of age, given that all subjects were within the age range of 60–85 years.

nevertheless identified previously unreported associations among these variables in this high-risk population.

The multivariate model revealed that regimen-related diabetes distress and self-reported functioning were independently associated with A1C (Table 3). No cognitive test scores were significantly associated with A1C, likely because the range of scores was constrained to the lower end, given that all participants had MCI. The age range was also constrained, and age was no longer significant once the effects of diabetes distress were considered.

Three of four diabetes distress variables were significantly associated with A1C at the bivariate level, but only regimen-related distress emerged as independently associated at the multivariate level, with greater regimen-distress associated with lower A1C. This finding is significant in this sample, given that our participants were cognitively impaired. Cognitive impairment has been shown to make adherence to a healthy lifestyle and prescribed medications particularly frustrating (14). In a prior study, diabetes distress was shown to be comparatively higher in Black individuals than in White individuals with diabetes, and greater diabetes distress correlated with worse diabetes self-management (15). However, a limitation of our study is that we did not measure what aspects of diabetes regimens (e.g., diet, medication management, glucose monitoring, and exercise) differentially contributed to regimen distress. This issue will be important to clarify, given that another mixed-methods exploratory study by Hood et al. (16) found that many Black individuals with diabetes report being overwhelmed by their medication regimens. Feeling overwhelmed may be exacerbated when these patients have a high number of comorbidities, including mental/psychological disorders and cognitive impairment. Mental health disorders (e.g., depression, anxiety, and diabetes distress) that tend to be more persistent among Black individuals have been shown in other research to adversely affect diabetes self-management and A1C (9,17). Therefore, mental health should continue to be addressed in diabetes interventions aimed at older Black patients with comorbid health conditions.

Self-reported functioning also made a significant contribution to the linear regression model independent of the number of chronic health conditions. Prior studies have shown that a higher number of comorbidities (including diabetes and physical and mental conditions) is a significant risk factor for diabetes distress (17). However, our investigation shows that self-reported functioning was not driven by any particular health factor because the number of health conditions, presence of cognitive impairment, and mental health factors were all controlled for in the hierarchical regression. This is a significant finding given the high number of comorbidities and MCI characterized in our sample population. Therefore, we found self-reported functioning to be a valuable general indicator for managing diabetes in the face of comorbidities. Our study shows that difficulty with physical functioning translates to greater difficulty managing diabetes and potentially increases diabetes distress, which could explain the significant association with poor glycemic control.

Initially, we sought to determine whether MCI characterized by performance on multiple cognitive tests was associated with poor glycemic control. Interestingly, we did not find a significant relationship. This finding suggests that, among patients who already have impaired cognition (i.e., MCI), poor glycemic control cannot solely be attributed to cognitive deficits. Other factors such as psychosocial and overall daily functioning also appear to play a significant role in patients' struggles with MCI. Previous studies have shown MCI to be associated with worse glycemic control in older patients (18,19). However, because all participants in this study had poor cognitive functioning at baseline, the lack of variability in the cognitive testing scores may have reduced our ability to detect an association between MCI and A1C. Future research may benefit from including subjects with a wider range of neurocognitive functioning.

There were several limitations to this study. First, it was a cross-sectional study, which precludes making any causal inferences. Second, generalizability is uncertain given that all participants chose to enroll in a clinical trial. Third, all participants had poor glycemic control, an eligibility criterion that constrained the range of A1C levels. The strengths of this study include its large sample and the comprehensive clinical and mental health assessments of an underrepresented minority population.

The main finding of this study is that regimen-related diabetes distress and self-reported daily functioning appear to be significantly associated with glycemic control in older Black individuals with MCI and diabetes. Prior data suggest that health professionals may fail to recognize or may even disregard signs of declining mental or cognitive health when treating multisystemic metabolic disorders such as diabetes (17). In patients with diabetes and MCI, it should not be assumed that cognitive deficits alone account for poor glycemic control. Because diabetes presents with numerous physical and psychological manifestations that are detrimental to health, future diabetes interventions must be multifaceted and holistic. Culturally appropriate educational techniques such as story-telling and peer-led support groups have been shown to be particularly effective in treating Black individuals with diabetes (15). Improvement in diabetes distress was also found to directly improve A1C, medication adherence, and self-efficacy among middle-aged African American women with diabetes (20). Our investigation suggests that greater focus on improving mental health and physical functioning in older patients may be a valuable component for diabetes practitioners in the future, especially for Black patients who suffer disproportionately from physical comorbidities and diabetes distress.

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DUALITY OF INTEREST

No potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

N.R.B. analyzed data and wrote the manuscript. R.J.C. collected and analyzed data and edited the manuscript. B.W.R. collected data and edited the manuscript. B.W.R. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of data analysis.

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