Association between number of comorbid medical conditions and depression among individuals with diabetes; race and ethnic variations

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Abstract

Background: Medical and psychiatric comorbidities are commonly comorbid with diabetes. Race and ethnicity may, however, modify the link between medical and psychiatric comorbidities in individuals with diabetes. In this study we compared Non-Hispanic Whites, African Americans, and Caribbean Blacks with diabetes for the association between number of comorbid medical conditions and lifetime and 12-month major depressive disorder (MDD) in individuals with diabetes.

Methods: Data came from the National Survey of American Life (NSAL), 2001–2003. We included 603 patients with diabetes (75 non-Hispanic Whites, 396 African Americans, and 131 Caribbean Blacks). Number of comorbid medical conditions was the independent variable, lifetime and 12-month MDD were dependent variables, and age, gender, education, marital status, employment, and body mass index were covariates. Race- and ethnic-specific logistic regressions were used to determine race and ethnic differences in the associations between number of chronic medical conditions and lifetime and 12-month MDD, while the effect of all covariates were controlled.

Results: Number of chronic medical conditions was positively associated with lifetime MDD among non-Hispanic Whites (OR = 1.719, 95 % CI = 1.018 – 2.902) and African Americans (OR = 1.235, 95 % CI = 1.056 – 1.445) but not Caribbean Blacks (P > .05). Number of chronic medical conditions was also associated with 12-month MDD among non-Hispanic Whites (OR = 1.757, 95 % CI = 1.119 – 2.759) and African Americans (OR = 1.381, 95 % CI = 1.175 – 1.623) but not Caribbean Blacks (P > .05).

Conclusions: This study shows race- and ethnic- differences in the association between number of medical comorbidities and MDD among patients with diabetes. These findings invite researchers to study the mechanisms behind race- and ethnic- differences in vulnerability and resilience to the mental health effects of chronic medical conditions.

Introduction

With a trend which is increasing in many countries [1], diabetes currently affects about 350 million people worldwide [2]. With 465 billion dollars direct medical cost, diabetes is responsible for about 10 % of total healthcare expenditures in the United States [1].

Possibly due to its complications [3, 4] and also its effects on activities of daily living and well-being and social life [5–9], individuals with diabetes are at higher risk of depression [10, 11]. The prevalence rate of depression is three-times higher in people with type 1 diabetes and nearly twice as high in people with type 2 diabetes compared to controls [12]. Up to 75 % of adults with diabetes have at least one comorbid medical conditions [13]. High rates of depression and comorbid medical conditions are an essential aspect of diabetes, emphasizing the need for collaborative care for patients with diabetes [14].
Screening, diagnosis, and treatment of comorbid medical and psychiatric conditions - defined as coexisting chronic diseases [11]- should be considered as an essential part of patient care, quality assurance, and evaluation of response to treatment [15]. As most patients with index medical diseases such as diabetes also suffer from comorbid health conditions [15], studying the influence of comorbid conditions on health outcomes helps health care providers to better plan the follow up of patients’ health [16,17].

Number of chronic medical conditions is one of the commonly used measures of comorbidity in epidemiological and community-based studies [18–21]. In this approach, comorbidity is measured based on number, not type, of medical conditions [22–28]. Studies have shown that number of comorbid conditions is associated with low well-being [29–33], functional status, health related quality of life [34], and higher disability [34] and mortality [35]. Patients with diabetes and comorbid conditions are at higher risk of insulin resistance [13,36]. Unfortunately, the existing literature on the link between co-morbidity and health and well-being [37–51] does not provide information on this association among patients with diabetes.

Very few studies have tested if race and ethnicity interfere with the effects of medical comorbidities on the mental health of individuals with diabetes or other index diseases. Race and ethnicity determine social class and life experiences, personalities, identities, values, exposures, resources and assets. In this view, even if separate effects of risk and resilience factors are similar across groups, their additive and multiplicative effects may be different across subgroups [52–60]. This can be in part due to differential overlap of risk and protective factors, or different distribution of confounders and mediators. Race and ethnicity shape human’s identity, life experience, values, social power, and access to individual and environmental assets and resources that in turn determine distribution, vulnerability, and resilience of individuals to risk and protective factors [18,56]. In this view, race and ethnicity operate as contextual factors that modify resilience and vulnerability to the separate, additive, and multiplicative effects of risk and protective factors.

As race and ethnicity have shown to moderate the link between medical and psychiatric conditions [18,52–60] and in response to the gap of knowledge on race and ethnic differences in the associations between medical and psychiatric comorbidities among patients with diabetes, the current study compared non-Hispanic Whites, African Americans, and Caribbean Blacks with diabetes for the association between number of medical comorbidities and lifetime and 12-month major depressive disorder (MDD).

Methods
The current study used a cross sectional design. We borrowed data from the National Survey of American Life (NSAL), 2001–2003. The NSAL has been conducted as a part of the Collaborative Psychiatric Epidemiology Surveys (CPES). The study was funded by the National Institute of Mental Health (NIMH).

Ethics
The study protocol received approval by the Institutional Review Board of the University of Michigan. Participants received monetary compensation. Data was kept fully confidential, and all data were collected, restored, and analyzed in an anonymous fashion. All participants provided written consent.

Participants
The NSAL methodology, including sampling, process, and interviewer training, has been described elsewhere [61–63]. The NSAL used a national household probability sample of adults (18 years and older). African Americans were residents of large cities, other urban areas, or rural areas. Caribbean Blacks were sampled from large cities.

Race and ethnicity
African-American individuals were identified as Blacks who did not identify any ancestral tie in the Caribbean. Caribbean Blacks were composed of Blacks who self-identified as being of Caribbean ancestry. The non-Hispanic White population included all Caucasian adults except for those who reported Hispanic ancestry [64].

Enrollment to the NSAL
The NSAL survey population included US adults (age 18 and older) who were African Americans, Caribbean Blacks or Whites and resided in households located in the contiguous 48 states. The NSAL sample was restricted to adults who were able to complete the interview in English. Institutionalized individuals (e.g. including those in prisons, jails, nursing homes, and long-term medical or dependent care setting) were excluded [64].

Sampling
The NSAL applied a multi-stage sampling design. The ‘core’ sample for the NSAL was a national area probability sample from which African Americans and Whites were sampled. The sampling also included a special supplemental sample of households in areas of high Caribbean Black residential density. The design of the NSAL Core sample closely resembled the National Survey of Black Americans, 1979–80, which was designed to be optimal for drawing the African-American sample. The NSAL national area probability sample was selected independently of other CPES samples [64].
Interview
All interviews were conducted in English. For 86% of the respondents, data was collected through face-to-face computer-assisted interviews. Telephone interviews were used for collection of data of the remaining 14% of the participants. Interviews lasted 140 min on average. Response rate was 72.3% overall. The response rate was 70.7% for African Americans, 77.7% for Caribbean Blacks, and 69.7% for non-Hispanic Whites.

Measures
Socio-demographic characteristics
Demographic (age and gender) and socio-economic (marital status, and geographic region of the country) characteristics were control variables in this study. Marital status was operationalized as a three level categorical variable (Divorced/Separated/Widowed, Never Married, and Married) while country of origin was a four level variable (Northeast, Midwest, South, and West).

Number of comorbid medical comorbidities
Number of comorbid medical conditions was measured using self-reported history of doctor-diagnosed chronic medical conditions, from 13 medical conditions that could occur in addition to diabetes. Respondents were asked about the following conditions: Arthritis/rheumatism, peptic ulcers, cancer, hypertension, chronic liver disease, chronic kidney disease, stroke, asthma, other chronic lung diseases, atherosclerosis, sickle cell disease, heart disease and glaucoma. Self-reported history of doctor-diagnosed chronic medical conditions has been shown to be accurate [65].

Outcomes
A modified version of the World Mental Health (WHO) Composite International Diagnostic Interview (CIDI) was used to measure lifetime and 12-month MDD. The CIDI is a fully structured diagnostic interview that is designed to measure a wide range of DSM-IV based non-psychotic mental disorders. The CIDI has been used in the World Mental Health project [66]. The CIDI is used by trained lay interviewers to generate diagnoses of lifetime and recent DSM-IV-TR / ICD-10 disorders [67]. Clinical reappraisal studies have documented high concordance of CIDI diagnoses with diagnoses made by psychiatrists [68, 69]. Investigation of area under the receiver operating characteristic curve (AUC) has found excellent concordance between CIDI and the Structured Clinical Interview for DSM-IV diagnoses of MDD. Additionally, the prevalence differences between CIDI and Structured Clinical Interview for DSM-IV (SCID) are non-significant at the optimal CIDI diagnostic thresholds. Thus, CIDI operating characteristics are equivalent for MDE to those of the best alternative screening scales [70]. CIDI is also known to provide valid findings for Blacks and their ethnic groups [71–73].

Statistical analysis
To consider the NSAL’s multi-stage sample design, we used Stata 13.0 for data analysis. For all our analyses, we applied weights due to strata, clusters, and non-response. As a result, results are nationally representative. We used sub-population survey command for all our analyses. Race/ethnic-specific logistic regressions were applied for data analysis. We used number of comorbid medical conditions as the independent variable, demographic and socio-demographics as controls, and lifetime and 12-month MDD as outcomes. Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI) were reported. P-values less than 0.05 were considered statistically significant.

Results
Most NSAL participants in all ethnic groups were between 30 and 44 years of age. Almost half of NSAL participants in each ethnic group were women. While most non-Hispanic Whites and African Americans were born inside the US, most Caribbean Blacks were born outside the US. Although most non-Hispanic Whites and African Americans lived in the South, the Northeast represented most Caribbean Blacks (Table 1).

In summary, number of medical comorbidities was positively associated with lifetime MDD among non-Hispanic Whites (OR = 1.719, 95% CI = 1.018 – 2.902) and African Americans (OR = 1.235, 95% CI = 1.056–1.445) but not Caribbean Blacks (P > .05) with diabetes (Table 2). Number of medical comorbidities was associated with 12-month MDD among non-Hispanic Whites (OR = 1.757, 95% CI = 1.119 – 2.759) and African Americans (OR = 1.381, 95% CI = 1.175 – 1.623) but not Caribbean Blacks (P > .05) with diabetes (Table 3).

Discussion
The present study documented racial and ethnic variations in the association between number of medical comorbidities and MDD among individuals with diabetes. Our findings suggest that number of medical comorbidities is associated with higher odds of lifetime and 12-month MDD among non-Hispanic Whites and African Americans, but not Caribbean Blacks with diabetes. Although there is a well-established literature on the effect of medical comorbidities in diabetes and other index medical conditions [74, 75], very little is known about race and ethnic differences in these links [18, 52, 60].

Our finding regarding the positive association between number of medical comorbidities and MDD among non-Hispanic White and African American individuals with diabetes is in line with the findings from previous studies...
### Table 1 Demographic and Socio-economic Description of the NSAL participants based on race and ethnicity

| Demographic data | Race/ethnic subgroups | n (%) | n (%) | n (%) | n (%) | Total n (%) |
|------------------|-----------------------|-------|-------|-------|-------|-------------|
| Gender           |                       |       |       |       |       |             |
|                  | Men                   | 1271 (44.03) | 643 (50.87) | 372 (47.26) | 2286 (45.87) |             |
|                  | Women                 | 2299 (55.97) | 978 (49.13) | 519 (52.74) | 3796 (54.13) |             |
| Marital Status   |                       |       |       |       |       |             |
|                  | Married               | 960 (32.91) | 559 (37.56) | 383 (47.36) | 1902 (40.25) |             |
|                  | Partner               | 260 (8.74)  | 131 (12.58) | 44 (6.59)  | 435 (7.81)   |             |
|                  | Separated             | 286 (7.16)  | 128 (5.37)  | 37 (3.11)  | 451 (5.08)   |             |
|                  | Divorced              | 524 (11.75) | 178 (9.29)  | 147 (13.06) | 849 (12.31)  |             |
|                  | Widowed               | 353 (7.90)  | 78 (4.29)   | 103 (7.83) | 534 (7.74)   |             |
|                  | Never married         | 1170 (31.55) | 542 (30.92) | 173 (22.05) | 1885 (26.81) |             |
| Region           |                       |       |       |       |       |             |
|                  | Northeast             | 411 (15.69) | 1135 (55.69) | 107 (22.67) | 1653 (20.56) |             |
|                  | Midwest               | 595 (18.81) | 12 (4.05) | 83 (7.96) | 690 (12.91) |             |
|                  | South                 | 2330 (56.24) | 456 (29.11) | 609 (54.60) | 3955 (54.48) |             |
|                  | West                  | 234 (9.25)  | 18 (11.14) | 92 (14.76) | 344 (12.06)  |             |
|                  | Mean (SD)*            | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |             |
| Education        | 12.43 (2.23)          | 12.93 (1.00) | 13.32 (5.00) | 12.89 (2.65) |             |             |
| Age (Years)      | 42.33 (14.50)         | 40.28 (5.78) | 44.98 (31.11) | 43.57 (16.61) |             |             |
| Income ($ US)    | 36,846 (33,236)       | 47,017 (47,397) | 47,397 (47,397) | 42,455 (39,594) |             |             |

*Weights have been considered

There are also studies not showing any effects for comorbidities on patients’ outcomes [77, 78]. We also could not show an association between number of medical comorbidities and MDD among Caribbean Black individuals with diabetes. The remaining question is what psychosocial factors explain race and ethnic differences in the link between medical and mental health.

Some researchers believe that the effect of somatic comorbidity on well-being and health is independent of type of comorbidity, index disease, outcome, and population. Although medical comorbidities worsen a wide range of objective and subjective outcomes [19], our study suggests that these effects may vary across populations. Thus, although health care providers should take a holistic approach to the subjective well-being of patients with any index disease such as diabetes [19], such interventions can also benefit from tailoring based on race and ethnicity.

Medical comorbidities are rules rather than exceptions [19]. As comorbidities influence multiple aspects of subjective health, health care providers should pay special attention to the existing physical and mental comorbidities; such a comprehensive approach may improve physical and mental well-being of patients [51]. Physicians and other health care providers who deliver care to patients with diabetes should evaluate patients for other comorbid medical and mental conditions including MDD, however, the screening and management protocols that are tailored based on race and ethnicity may be superior in efficacy. In all groups, however, regardless of race and ethnicity, early detection and treatment of comorbid conditions should be considered as a universal goal.

Although it is not only the index medical condition but also comorbid conditions that impose risk to the well-being of patients, health care providers have a tendency to exclusively focus on the index disease. Any medical decision for a patient with diabetes should be made while taking into account all medical and psychiatric comorbid conditions. Unfortunately, less has been discussed about the importance of incorporating medical and psychiatric comorbidities in the process of care for racial and ethnic minority patients with chronic medical conditions such as diabetes [79, 80].

Comorbidity affects prognosis of medical conditions, and diabetes is not an exception [81–85]. Primary health care providers and also specialists should always be encouraged to consider all chronic medical and mental comorbidities in the process of decision-making regarding treatment choices [79, 80, 86]. The current study provides a better understanding of racial and ethnic differences in the effect of comorbid medical conditions on MDD of patients with diabetes, and this information will hopefully help with the medical decision-making related to the care of patients with diabetes [87].

Before any final conclusion, all limitations of the current study should be discussed. Due to the cross sectional nature of our study, causal association is implausible. The results do not suggest whether MDD is a risk factor for multiple comorbid conditions, or comorbid medical conditions cause MDD. The study did not sample U.S. residents who were not able to undergo an interview in English. Type of chronic comorbid conditions was not entered into the analysis, as well. This is particularly important because various chronic medical conditions may have different psychological correlates [88]. In addition, diabetes and also comorbid medical conditions were measured using self-reported data, which is subjected to measurement error (recall bias). Furthermore, the result of our study is generalizable to the community sample of adults with diabetes, not necessarily to a clinical sample of patients with diabetes. Finally, it was also unknown if comorbid conditions such
as heart disease or stroke were complications of diabetes or not. Future research should differentiate between medical comorbidities (such as hypertension, which are independent of the diabetes diagnosis) and medical complications associated with diabetes (e.g. micro-vascular or macro-vascular complications) which are secondary to diabetes. Due to the above limitations, the results should be interpreted with caution. More research is needed to better understand race and ethnic differences in the role of medical comorbidities in shaping psychological well-being of patients with diabetes and other conditions [18, 52, 60, 89, 90].

### Conclusion

Our findings suggest that among individuals with diabetes, race and ethnicity moderate the association between number of medical comorbidities and MDD. This information may help a wide range of health care providers such as endocrinologists, internists, psychiatrists and family physicians who are involved in providing health care for individuals with diabetes. Patients with diabetes should be screened for multiple comorbid medical conditions and MDD, regardless of their race and ethnicity, however, multiple comorbid medical conditions and MDD tend to cluster more strongly among non-Hispanic White and African Americans.

| Table 2 Association between number of medical comorbidities and lifetime major depressive disorder among non-Hispanic Whites, African Americans, and Caribbean Blacks with diabetes (Continued) |
|---------------------------------------------------------------|
| Number of Comorbid Medical Conditions                         |
| Caribbean Blacks                                              |
| Number of Comorbid Medical Conditions                         |
| 1.739 0.260 1.7 0.103 0.932 2.041                             |

| Table 2 Association between number of medical comorbidities and lifetime major depressive disorder among non-Hispanic Whites, African Americans, and Caribbean Blacks with diabetes (Continued) |
|---------------------------------------------------------------|
| Number of Comorbid Medical Conditions                         |
| African Americans                                             |
| Age 0.939 0.017 −3.41 0.002 0.904 0.975                      |
| Marital Status<b>                                              |
| Divorced/ Separated/ Widowed 2.076 1.007 1.51 0.143 0.770 5.597 |
| Non-Hispanic Whites                                           |
| Number of Comorbid Medical Conditions                         |
| 1.719 0.420 2.22 0.043 1.018 2.902                            |

### SE Standard error
CI Confidence interval
*Reference Group = Caribbean Blacks
bReference Group = Married
cReference Group = Northeast
Further research should explore why the link between number of medical comorbidities and MDD is weaker among individuals with diabetes who are from Caribbean Black descent.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
SA designed the conceptual model and carried out the analysis. MML drafted the manuscript. Both authors contributed to the revision. Both authors read and approved the final manuscript.

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Table 3 Association between number of medical comorbidity and Odds of 12-month major depressive disorder among non-Hispanic Whites, African Americans, and Caribbean Blacks with diabetes (Continued)

| Region | Odds ratio | SE | t | P | 95 % CI for odds ratio |
|--------|------------|----|---|---|-----------------------|
| Midwest | 0.434 | 0.398 | −0.1 | 0.370 | 0.066 | 2.833 |
| South  | 0.480 | 0.309 | −1.1 | 0.263 | 0.129 | 1.789 |

| Age | 0.991 | 0.019 | <0.001 | <0.001 | 0.875 | 0.951 |
| Race/Ethnicity | | | | | | |
| African American | | | | | | |
| Non-Latino White | | | | | | |
| Marital Status | | | | | | |
| Divorced/ Separated/ Widowed | 3.802 | 2.233 | 0.227 | 0.026 | 1.178 | 12.275 |
| Never Married | 2.449 | 1.577 | 1.16 | 0.252 | 0.554 | 9.120 |
| Region | | | | | | |
| Midwest | 0.232 | 0.220 | −1.5 | 0.128 | 0.035 | 1.542 |
| South | 0.297 | 0.178 | −2.02 | 0.047 | 0.090 | 0.984 |
| West | 0.102 | 0.090 | −2.59 | 0.012 | 0.018 | 0.591 |
| Number of Comorbid Medical Conditions | | | | | | |
| All | | | | | | |
| Age | 0.804 | 0.058 | −3.01 | 0.010 | 0.687 | 0.940 |
| Race/Ethnicity | | | | | | |
| African American | | | | | | |
| Non-Latino White | | | | | | |
| Marital Status | | | | | | |
| Divorced/ Separated/ Widowed | 16.478 | 26.468 | 1.74 | 0.105 | 0.513 | 529.636 |
| Never Married | 252.770 | 503.945 | 2.77 | 0.016 | 3.405 | 18761.970 |
| Region | | | | | | |
| Midwest | 1.000 | | | | | |
| South | 0.018 | 0.035 | −2.01 | 0.065 | 0.000 | 1.339 |
| West | 0.000 | 0.001 | −3.22 | 0.007 | 0.000 | 0.072 |
| Number of Comorbid Medical Conditions | | | | | | |
| African Americans | | | | | | |
| Age | 0.917 | 0.021 | −3.82 | 0.001 | 0.875 | 0.960 |
| Marital Status | | | | | | |
| Divorced/ Separated/ Widowed | 4.691 | 3.536 | 2.05 | 0.049 | 1.004 | 21.913 |
| Never Married | 1.329 | 1.140 | 0.33 | 0.743 | 0.230 | 7.681 |
| Region | | | | | | |
| Midwest | 0.434 | 0.398 | −0.91 | 0.370 | 0.066 | 2.833 |
| South | 0.480 | 0.309 | −1.14 | 0.263 | 0.129 | 1.789 |

American than Caribbean Black individuals with diabetes. Further research should explore why the link between number of medical comorbidities and MDD is weaker among individuals with diabetes who are from Caribbean Black descent.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
SA designed the conceptual model and carried out the analysis. MML drafted the manuscript. Both authors contributed to the revision. Both authors read and approved the final manuscript.
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