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Original Article

Psychosocial stress and changes in estimated glomerular filtration rate among adults with diabetes mellitus

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ABSTRACT

Background: Psychosocial stress has been hypothesized to impact renal changes, but this hypothesis has not been adequately tested. The aim of this study was to examine the relationship between psychosocial stress and estimated glomerular filtration rate (eGFR) and to examine other predictors of eGFR changes among persons with diabetes mellitus (DM).

Methods: Data from a survey conducted in 2005 by a major health maintenance organization located in the southeastern part of the United States, linked to patients' clinical and pharmacy records ($n = 575$) from 2005 to 2008, was used. Study participants were working adults aged 25–59 years, diagnosed with DM but without advanced microvascular or macrovascular complications. eGFR was estimated using the Modification of Diet in Renal Disease equation. A latent psychosocial stress variable was created from five psychosocial stress subscales. Using a growth factor model in a structural equation framework, we estimated the association between psychosocial stress and eGFR while controlling for important covariates.

Results: The psychosocial stress variable was not directly associated with eGFR in the final model. Factors found to be associated with changes in eGFR were age, race, insulin use, and mean arterial pressure.

Conclusion: Among fairly healthy DM patients, we did not find any evidence of a direct association between psychosocial stress and eGFR changes after controlling for important covariates. Predictors of eGFR change in our population included age, race, insulin use, and mean arterial pressure.

Introduction

Reduced renal function, which may progress to diabetic nephropathy (DN), is a major cause of mortality among diabetes mellitus (DM) patients [1,2]. An earlier study has demonstrated that mortality rate among type 1 DM patients without kidney disease approaches individuals free of the condition [3]. With an estimated quarter to a third of individuals with DM likely to

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develop DN [4–6], it is crucial to understand the predictors of renal decline to minimize their occurrence and ultimately, reduce chronic kidney disease among individuals with DM.

Among DM patients, tight glycemic control decreases the risk of decline of renal function and slows the progression of DN [7,8]. However, some DM patients with poor glycemic control never develop DN, whereas some with good glycemic control progress to DN [5]. Such occurrence indicates that factors other than glycemic control may be important for decline of renal function and subsequent progression to DN. One obvious candidate has been genetic factors because there is a strong familial risk for DN; however, there has been limited success in identifying specific genes that account for such predisposition among large DM population [9,10]. Other traditional risk factors influencing the initiation, sustenance, and progression of DN include high blood pressure and smoking [11–13]. For instance, hypertension is estimated to be present in ∼80% of patients with kidney diseases [14]. However, the variability in the onset and progression of DN has not been fully explained as a function of the group differences in the aforementioned traditional risk factors alone [5]. Some nontraditional risk factors proposed to influence the renal decline in the general population include psychosocial stress, oxidative stress, advanced glycation end-products, and activation of protein kinase C [15–17]. The relationship between psychosocial stress and decline of renal function among DM patients has not been adequately investigated, which is the reason for the current study.

Psychosocial stress has been suspected as a potential factor in decline of renal function because of its established relationship with glycemic control, hypertension, and smoking [18–21]. Another proposed link between psychosocial stress and decline of renal function is through the increased engagement in behaviors that increase the risk of renal damage such as alcohol abuse, smoking, and drug abuse [15,22–24]. Although higher levels of psychosocial stress have been associated with overall poor health, high blood pressure, poor glycemic control, and smoking [18,25–29], the direct association between psychosocial stress and decline in renal function has not been adequately examined.

The primary aim of the present study was therefore to examine the direct relationship between psychosocial stress and renal function over time among individuals with DM. Although factors including glycemic control, blood pressure, smoking, and other sociodemographic factors have been associated with decline of renal function, the course of estimated glomerular filtration rate (eGFR) among DM patients can be complex and heterogeneous and may be affected by multiple factors including existing comorbid conditions [30]. For instance, albuminuria was identified as the strongest predictor of eGFR decline among Caucasians with DM [31], whereas among Japanese with DM, higher glycemic levels were the strongest predictor [32]. Owing to the variability in eGFR trajectory among different populations, our secondary study aim was to explore other documented predictors of decline of renal function among our unique study population.

Methods

Study population

We used data from a survey conducted in 2005 by a major health management organization (HMO) in the southeastern part of the United States that collected information on health and healthy behaviors. Study participants were working adults who, at the time of the survey in 2005, met the following inclusion criteria: (1) age 25–59 years; (2) employed by one of the 100 largest private or public employer groups offering the HMO as an insurance option; (3) enrolled in the HMO; (4) subscriber within the enrolled family; and (5) diagnosed with DM but without any of the following complications from diabetes—microalbuminuria or macroalbuminuria, overt proteinuria, retinopathy, nephropathy, and/or neuropathy.

Only individuals who reported their race as African American (black) or Caucasian (white) were included in the present study because other racial/ethnic groups represented a very small proportion of the HMO enrollees. The Institutional Review Board of the HMO reviewed and approved the study protocol.

Data and measures

The survey instrument included items and scales that had previously been used in other studies and which had demonstrated reliability and validity [33,34]. The survey was conducted once during 2005. Participants' 4-year clinical and pharmacy records from 2005 to 2008 were linked to their 2005 survey data.

Dependent variable
The main dependent variable was eGFR. Using the serum creatinine, the annual eGFR was estimated using the Modification of Diet in Renal Diseases equation [35].

$$eGFR = 186 \times SCr^{-1.154} \times Age^{-0.203} \times [1.210 \; if \; black] \times [0.742 \; if \; female] \tag{1}$$

Main independent variable
The main independent variable was psychosocial stress, assessed from social settings (family and friends) and the work environment. Social stress was assessed by two 4-item subscales: one reflecting friend/family support and the other measuring friend/family strain. The instrument was adapted from the Midlife in the United States (MIDUS) study [33]. The MIDUS study scales for family and friends are identical except for the reference (e.g., "How much do members of your family really care about you?" and "How much do your friends really care about you?"); therefore, we combined the references to create a single measure of social climate (e.g., "How much do your friends and family members really care about you?"). Each subscale was averaged and scaled from 0 (most strained, least supportive) to 100 (least strained, most supportive). The work-related psychosocial stress was assessed using the following four subscales from the MIDUS study [33]: work decision authority (6 items), job demands (5 items), coworker support (2 items), and supervisor support (3 items). Each item was assessed using a 5-response Likert scale: "all of the time," "most of the time," "sometimes," "rarely," and "never." Each subscale was averaged and scaled from 0 (most strained, least supportive) to 100 (least strained, most supportive) by transforming each item response from 0 to 100 (and reverse coding where necessary).

Health-related covariates
Glycemic control was assessed using hemoglobin A1c (HbA1c) measures from participants' laboratory results from 2005 through 2008. Data on height, weight, systolic blood pressure, and diastolic blood pressure were obtained from medical records associated with participants' primary care