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Stress, depression and medication nonadherence in diabetes: test of the exacerbating and buffering effects of family support

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Abstract

Stressors and depressive symptoms have been associated with medication nonadherence among adults with type 2 diabetes (T2DM). We tested whether these associations were exacerbated by obstructive family behaviors or buffered by supportive family behaviors in a sample of 192 adults with T2DM and low socioeconomic status using unadjusted and adjusted regression models. We found support for the exacerbating hypothesis. Stressors and nonadherence were only associated at higher levels of obstructive family behaviors (adjusted interaction OR=1.12, $p=.002$). Similarly, depressive symptoms and nonadherence were only associated at higher levels of obstructive family behaviors (adjusted interaction OR=3.31, $p=.002$). When participants reported few obstructive family behaviors, neither stressors nor depressive symptoms were associated with nonadherence. We did not find support for the buffering hypothesis; stressors and depressive symptoms were associated with nonadherence regardless of supportive family behaviors. Nonadherent patients experiencing stressors and/or major depressive symptoms may benefit from interventions that reduce obstructive family behaviors.

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Conflict of Interests: Lindsay Satterwhite Mayberry declares that she has no conflict of interest. Leonard E. Egede declares that he has no conflict of interest. Julie A. Wagner declares that she has no conflict of interest. Chandra Y. Osborn declares that she has no conflict of interest. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000(5). Informed consent was obtained from all patients for being included in the study.

Keywords

Stress/stressors; depression; family support; social support; medication adherence; diabetes

Introduction

Approximately one-third of adults with type 2 diabetes mellitus (T2DM) are nonadherent to their diabetes medications (Cramer et al., 2008; Ho et al., 2006). Although optimal performance of all self-care behaviors is important, medication nonadherence is both common (Cramer et al., 2008; Ho et al., 2006; Kim et al., 2010) and by itself a strong, independent predictor of poor glycemic control (Egede et al., 2011; Heisler et al., 2007; Kim et al., 2010; Ngo-Metzger et al., 2012), hospitalizations (Ho et al., 2006; Hong & Kang, 2011), premature death (Egede et al., 2013; Ho et al., 2006; Hong & Kang, 2011), and higher healthcare costs (Egede et al., 2012; Salas et al., 2009). Racial/ethnic minorities are less adherent to diabetes medications than non-Hispanic Whites (Egede et al., 2011; Heisler et al., 2007; Kim et al., 2010; Osborn et al., 2011), and disparities in diabetes medication adherence have helped to explain disparities in glycemic control (Egede et al., 2011; Heisler et al., 2007).

Stressors and depressive symptoms are related (Fisher et al., 2001; Naranjo et al., 2011) but independent (Osborn et al., 2014) predictors of medication nonadherence (Billimek & Sorkin, 2012a, 2012b; DiMatteo et al., 2000; Gonzalez et al., 2007; Ngo-Metzger et al., 2012; Osborn et al., 2014) which disproportionately affect minorities and socioeconomically disadvantaged patients (Fisher et al., 2001; Jeon et al., 2009; Jiang et al., 2008; Mendenhall et al., 2012; Spencer et al., 2006). However, not all patients who experience these overlapping vulnerabilities are suboptimally adherent. Whether experiencing more stressors or depressive symptoms leads to less diabetes medication adherence may depend on the quantity and quality of a patient's social support. The *exacerbating model* of social support (Rook, 1998) posits the deleterious effects of stressors on outcomes will be stronger among persons experiencing more harmful behaviors from their social network than among persons experiencing little or none of these harmful behaviors. To our knowledge, no studies have examined the exacerbating hypothesis for any outcome in T2DM. The *buffering model* of social support (Cohen & Wills, 1985) posits that stressors have deleterious effects on outcomes among persons with little or no support, but no effect or a lesser effect among persons with high support. Several studies have examined whether support buffers adults with T2DM against the development of psychological distress or depression (Baek et al., 2014; Beekman et al., 1997; Littlefield et al., 1990; Thomas et al., 2007), yet few have examined buffering effects on diabetes management (Glasgow & Toobert, 1988; Griffith et al., 1990). Egede and Osborn (Egede & Osborn, 2010; Osborn & Egede, 2012) previously reported the absence of social support partially explains the association between depressive symptoms and diabetes medication nonadherence (i.e., mediation analysis). Moderation analysis, as proposed by the exacerbating and buffering models, suggests that the relationship between the predictor and the outcome vary based on the value of the moderator. To our knowledge, no studies have explored the buffering model with regards to diabetes medication adherence.

Although general social support is associated with more adherence to medications (DiMatteo, 2004), family members may be particularly well-suited to assist patients with diabetes medication adherence by reminding the patient to take medications as scheduled throughout their daily routine, ordering/picking up prescription refills, or helping the patient problem-solve when a side effect or hypoglycemic event occurs (Mayberry & Osborn, 2012). Such diabetes-specific supportive family behaviors are associated with more adherence to diabetes medications among adults with T2DM (Mayberry & Osborn, 2014). However, family interactions with the diabetic patient may not always be positive. Family members may also perform harmful behaviors (Carter-Edwards et al., 2004; Glasgow & Toobert, 1988; Henry et al., 2013; Mayberry & Osborn, 2012; Rosland et al., 2010), which are associated with patients being less adherent to diabetes medications (Mayberry & Osborn, 2012, 2014). These harmful or “obstructive” family behaviors include sabotaging behaviors (e.g., questioning the need for prescribed medications) (Carter-Edwards et al., 2004) and nagging or arguing about nonadherence (Carter-Edwards et al., 2004; Henry et al., 2013; Mayberry & Osborn, 2012; Rosland et al., 2010; Stephens et al., 2013).

Objective—We tested the moderation hypotheses that the associations between stressors/depressive symptoms and nonadherence would be stronger in the context of more obstructive family behaviors (exacerbating hypothesis) and weaker in the context of more supportive family behaviors (buffering hypothesis).

Methods

Study Design

We used data collected as part of a larger cross-sectional study of modifiable determinants of medication adherence (Mayberry et al., 2013). Eligible participants were English- or Spanish-speaking adults (≥ 18 years old) diagnosed with T2DM and self-administering prescribed medications (oral agents and/or insulin) who did not have a sensory/cognitive impairment that prohibited participation (Mayberry et al., 2013). The larger study enrolled 314 participants consecutively as they arrived for a clinic appointment at a Federally Qualified Health Center in Nashville, TN over a 2.5 year period. Of the 588 patients with T2DM who arrived for a clinic appointment during the enrollment period, 377 were eligible and 314 enrolled (83.3% of those eligible) (Mayberry et al., 2013). The participants who enrolled in the final study year (n=192) completed measures assessing family behaviors and stressors as part of the regular study protocol and were included in these analyses. Eligible and interested participants were taken to a private clinic room before and/or after their appointment to complete informed consent and an interviewer-administered survey. The interview protocol was translated to Spanish using the forward-backward technique (Behling & Law, 2000) by licensed translators. Participants were compensated \$20. The Vanderbilt University Institutional Review Board approved all study procedures prior to enrollment.

Measures

Predictors—Stressors were assessed with the Tool for Assessing Patients’ Stressors (TAPS) (Rothberg et al., 2011; Welch et al., 2011). Each of the 20 TAPS items assesses a stressor commonly reported by socioeconomically disadvantaged patient populations.

Participants are asked “In the past year (12 months), have any of the following family issues been stressful for you?” with 1=yes and 0=no as response options. Example items include “lack of affordable local transport for my family or myself” and “living in an unsafe neighborhood.” The TAPS score is calculated by summing the “yes” responses across items for a possible range of 0–20 (Osborn et al., 2014). Although the checklist nature of the TAPS precludes examination of internal consistency reliability, the stressors most commonly reported on the TAPS have been similar across samples of patients from FQHCs (Rothberg et al., 2011; Welch et al., 2011). This instrument was developed based on extensive input from healthcare providers and diabetes educators who treat patients at FQHCs (Osborn et al., 2014), enhancing its content and face validity.

Depressive symptoms were assessed with the validated Patient Health Questionnaire-9 (PHQ-9) (Kroenke et al., 2001) which assesses the frequency of depressive symptoms according to DSM-IV criteria on a scale from 0=not at all to 3=nearly every day. The PHQ-9 yields a continuous severity score from 0 to 27. In our sample, the PHQ-9 had internal consistency reliability of $\alpha=0.87$. PHQ-9 scores ≥ 10 coincide with a depression diagnosis from structured clinical interviews with 88% sensitivity and 88% specificity in general patient populations (Kroenke et al., 2001). Following the PHQ-9 developers’ recommendations, we categorized participants’ depressive symptoms as <5 none, 5–9 mild, ≥ 10 moderate to severe symptoms (Kroenke et al., 2001). Although 10 is the optimal threshold above which symptoms likely reflect depression in general populations (Kroenke et al., 2001), several studies (Anderson et al., 2001; Twist et al., 2013; van Steenbergen-Weijenburg et al., 2010) report the optimal cutoff point for correspondence with depression diagnosis from a clinical interview was higher among adults with diabetes. Twist et al. (2013) identified 12 as the optimal cutoff among adults with T2DM, reporting sensitivity of 86.9% and specificity of 80.3%. Therefore, we also categorized participants’ depressive symptoms as <5 none, 5–11 mild, ≥ 12 moderate to severe symptoms for sensitivity analyses.

Moderators—Supportive and obstructive family behaviors were assessed with the Diabetes Family Behavior Checklist-II (DFBC-II) (Glasgow & Toobert, 1988; Schafer et al., 1986). The 16-item DFBC-II asks respondents how often their family members have performed diabetes-specific behaviors in the last month on a scale from 1=never to 5=at least once a day. Supportive behaviors include “exercise with you” or “eat at the same time that you do,” whereas obstructive behaviors include “criticize you for not exercising regularly” or “eat foods that are not part of your diabetic diet.” We averaged the 9 supportive items and 7 nonsupportive items to create two subscales ranging from 1–5, with higher scores indicating more supportive or obstructive behaviors, respectively (Glasgow & Toobert, 1988). The DFBC-II also has a 2-item medication-specific subscale, which is calculated by subtracting the obstructive item score from the supportive item score for a possible range of –4 to 4 (Glasgow & Toobert, 1988; Schafer et al., 1986). In this sample, internal reliability (Cronbach’s α) was 0.85 for the supportive subscale and 0.78 for the obstructive subscale. Among adults with type 1 diabetes mellitus, Schafer et al. (1986) reported test-retest reliability ratings over a six-month period of 0.84 and 0.69 for the supportive and obstructive subscales, respectively, and correlations with family-member report ranged from 0.27 ($p<.10$) to 0.68 ($p<.001$), respectively (Schafer et al., 1986).

Outcome—Diabetes medication nonadherence was assessed with the Adherence to Refills and Medications for Diabetes (ARMS-D) (Mayberry et al., 2013). Items assess respondents' adherence to taking and refilling diabetes medications (e.g., "How often do you...forget to take your diabetes medicine(s)?" or "...run out of your diabetes medicine(s)?""). Response options range from 1=none of the time to 4=all of the time and are summed to produce a score ranging from 11 to 44 with higher scores indicating more nonadherence. The ARMS was originally designed to assess adherence to all medications and was validated against objective measures of refill adherence ($r=0.32$, $p<.01$ with retrospective six-month refill adherence) in a relatively similar sample to ours (i.e., predominantly African American, inner-city sample with a chronic disease) (Kripalani et al., 2009). The diabetes-specific ARMS-D correlates well with commonly used measures of diabetes medication adherence (all correlations >0.45 , $p<.001$) and predicts glycemic control (0.25 , $p<.001$) (Mayberry et al., 2013). In this sample, internal consistency reliability was $\alpha=0.85$.

Covariates—We collected self-reported age, gender, race, ethnicity, income, education, insurance status, and diabetes duration (time since diabetes diagnosis in years and months). The number and type of diabetes medication(s) were abstracted from participants' medical records.

Analyses

We used Stata 12 for analyses. First, we used Spearman's rank correlation coefficients (ρ) to examine bivariate associations between variables of interest. Next, we conducted a series of regression models with interaction terms using proportional odds/ordinal logistic regression. This approach treats the outcome as a series of ordinal variables (Harrell, 2001) and provides freedom from distributional assumptions for handling outcome data with floor or ceiling effects (e.g., 23% of our participants reported perfect adherence on the ARMS-D) (Harrell, 2001). We used an approximate likelihood-ratio test to confirm our data satisfied the proportional odds assumption that each probability curve has the same coefficient (Wolfe & Gould, 1998).

We conducted separate regression models with an interaction term between each predictor (i.e., stressors and depressive symptoms) and each type of family behavior (i.e., supportive, obstructive, and medication-specific support). We examined depressive symptoms continuously, to maximize our power to detect interactions, and categorically, to determine if interactions were consistent across different levels of depressive symptoms. We present results using the most common cutoff for PHQ-9 scores (≥ 10), but conducted sensitivity analyses with the higher cutoff suggested for use among adults with T2DM (≥ 12). Continuous variables were mean-centered to create interaction terms. For each interaction term with the supportive or obstructive subscales, we conducted a partially adjusted model and a fully adjusted model. To accommodate suppressor effects (Conger, 1974; Velicer, 1978) between supportive and obstructive family behaviors identified previously (Mayberry & Osborn, 2014), each partially adjusted model included the main effects, interaction term, and both types of family behaviors (e.g., obstructive family behaviors is a covariate in the model assessing the stress X supportive family behavior interaction). For each interaction term with the medication-specific subscale, we conducted an unadjusted model and a fully

adjusted model. Each fully adjusted model included a priori covariates (i.e., age, gender, race, ethnicity, income, education, insurance status, diabetes duration, and insulin status). We then further adjusted for depressive symptoms in the models assessing interactions with stressors to ensure identified effects could be attributed to stressors and not to the association between stressors and depressive symptoms. Significant interaction effects are graphically depicted using post-hoc probing methods (Holmbeck, 2002). Results are presented as odds ratios (OR) or adjusted odds ratios (AOR) which are nonlinear, and graphed as log-odds, which are linear.

Results

The sample was racially/ethnically diverse (56% African American and 10% Hispanic) and socioeconomically disadvantaged (76% had incomes less than \$20,000; 47% uninsured; 30% had less than a high school degree; see Table 1). Obstructive family behaviors were associated with more stressors ($p=.20$, $p=.005$) and more depressive symptoms ($p=.18$, $p=.01$). Supportive family behaviors, and, separately, the medication-specific subscale, were not associated with stressors or depressive symptoms. Both stressors ($p=.29$, $p<.001$) and depressive symptoms ($p=.23$, $p=.001$) were associated with nonadherence.

We found consistent support for the exacerbating hypothesis. The associations between stressors and nonadherence and depressive symptoms (continuous) and nonadherence were stronger as obstructive family behaviors increased (Table 2). The interaction with stressors remained significant after further adjusting for depressive symptoms (AOR=1.12, $p=.002$, not in Table). Post-hoc probing revealed a threshold of obstructive family behaviors over which stressors were associated with nonadherence. As shown in Figure 1, there was a significant association between experiencing more stressors and nonadherence among participants experiencing the sample mean or more of obstructive family behaviors (at +1 and +2 standard deviations), but not among participants experiencing less than the sample mean of obstructive family behaviors (at -1 and -2 standard deviations). Using the categorical measure of depressive symptoms, we found there was only an exacerbating effect among those with moderate to severe (but not among those with none or mild) depressive symptoms (Table 2). Therefore, we compared those with moderate to severe symptoms to all other participants for post-hoc probing. As shown in Figure 2, a similar threshold effect appears in this pattern of results; having moderate to severe depressive symptoms was only associated with nonadherence among participants experiencing the sample mean or more of obstructive family behaviors (at +1 and +2 standard deviations), but not among those experiencing less than the sample mean of obstructive family behaviors (at -1 and -2 standard deviations). Findings were consistent when using the higher cutoff of 12 to indicate moderate to severe depressive symptoms.

We did not find support for the buffering hypothesis. Results from fully adjusted analyses are presented. Neither supportive family behaviors (interaction AOR=1.06, $p=.07$) nor medication-specific support (interaction AOR=1.01, $p=.76$) moderated the association between stressors and nonadherence. Neither supportive family behaviors (interaction AOR=1.02, $p=.22$) nor medication-specific support (interaction AOR=1.02, $p=.16$) moderated the association between depressive symptoms (continuous) and nonadherence.

However, among participants with major depressive symptoms there was a significant interaction in the opposite-than-hypothesized direction for both supportive family behaviors (interaction AOR=2.07, $p=.03$) and medication-specific support (interaction AOR=1.59, $p=.04$). These AORs were >1.0 , indicating that having moderate to severe depressive symptoms was more strongly associated with nonadherence in the context of more support.

Discussion

In a racially diverse and socioeconomically disadvantaged sample of adults with T2DM, we found support for the hypothesis that obstructive family behaviors exacerbated the associations between both stressors and depressive symptoms and diabetes medication nonadherence. Neither stressors nor depressive symptoms were associated with nonadherence for patients with relatively low obstructive family behaviors, but both were increasingly associated with nonadherence at higher rates of obstructive family behaviors. Furthermore, the exacerbating effect for stressors was maintained after adjusting for depressive symptoms, suggesting a unique effect specific to stressors. Substantively, these results suggest patients may be able to maintain optimal medication adherence in the face of stressors and/or depressive symptoms as long as their family members do not sabotage, nag, or argue about self-care, although reverse causality is also plausible. For example, family members may be more inclined to sabotage, nag, or argue about self-care with family members who are nonadherent. To our knowledge, this study is the first to test the exacerbating model of social support (Rook, 1998) for any outcome in diabetes or medication nonadherence in any disease context.

We did not find support for the hypothesis that supportive family behaviors or medication-specific family support buffered associations between stressors or depressive symptoms and diabetes medication nonadherence (Cohen & Wills, 1985). On the contrary, we found evidence that the association between having moderate to severe depressive symptoms and nonadherence was *stronger* in the context of more supportive behaviors. This unexpected finding cannot be attributed to the positive association between supportive and obstructive family behaviors (Mayberry & Osborn, 2012, 2014) because analyses adjusted for obstructive family behaviors. Similar unexpected results have been reported by studies exploring social support as a moderator of the associations between health literacy and health status (Lee et al., 2009) between health literacy and medication adherence (Johnson et al., 2010) in general patient populations. We hypothesize that our unexpected finding may be attributable to (a) our cross-sectional design and/or (b) our use of measures of received support, instead of perceived support. Family members may become more supportive of patients' self-care once they become aware the patient is experiencing elevated depressive symptoms and/or is nonadherent. Such reverse-causality cannot be examined with our cross-sectional design. In general, consistent evidence for the buffering hypothesis has been documented by studies using measures of satisfaction with support (i.e., perceived support), rather than measures of actual support behaviors (i.e., received support) (Cohen & Wills, 1985; Thoits, 2011), such as the DFBC-II supportive subscale. Received support, but not perceived support, may be confounded with need (Thoits, 2011). In diabetes, Griffith et al. (Griffith et al., 1990) found evidence supporting the buffering hypothesis when examining the association between stress and glycemic control using a measure of perceived support,

and studies (Egede & Osborn, 2010; Osborn & Egede, 2012) identifying social support as a mechanism explaining the association between depressive symptoms and nonadherence also measured perceived support.

In addition to using cross-sectional data and measuring received support, there are other study limitations to note. We sampled from a single clinic and results may not generalize to other patient populations. Although we had a relatively small sample size, our sample was larger than most studies exploring the buffering hypothesis in diabetes (Baek et al., 2014; Glasgow & Toobert, 1988; Griffith et al., 1990; Littlefield et al., 1990). Our lack of support for the buffering hypothesis cannot be attributed to reduced power to detect interactions because nonsignificant interactions were in the opposite-than-hypothesized direction, suggesting we would find further evidence against the buffering hypothesis with a larger sample. We also used a single self-reported measure of medication adherence. There is no perfect method to assess medication adherence (Farmer, 1999; Hansen et al., 2009). Self-report is the most practical, but is subject to recall and reporting bias, and may overestimate adherence (Liu et al., 2001), whereas prescription refills assess medication quantity, but not dosing (Choo et al., 1999; Steiner & Prochazka, 1997). Electronic devices attempt to capture dosing, and are often considered the gold standard for measuring adherence, but may not precisely capture when or how much medication was ingested, are often impractical and expensive (Choo et al., 1999; Farmer, 1999), and may underestimate adherence (Liu et al., 2001). Self-report measures of adherence in T2DM have been demonstrated to be sufficiently accurate and comparable to other types of measures (Gonzalez et al., 2013; Krapek et al., 2004). Nonetheless, our use of a single measure presents limitations, as does our use of self-report measures of depressive symptoms (instead of a clinical interview) and family behaviors. Because we are the first to test or find support for the exacerbating hypothesis, future studies should examine this hypothesis with multiple measures of medication adherence (Liu et al., 2001).

Conclusion

The extant evidence suggests support buffers the individual against developing depressive symptoms or experiencing distress in the context of chronic disease (Baek et al., 2014; Beekman et al., 1997; Littlefield et al., 1990; Thomas et al., 2007) but, per our findings, support might not buffer the detrimental effects of stressors or depressive symptoms on adherence. Additional work is needed to understand these relationships, longitudinally, and in other patient populations. It may be that adult patients who experience numerous stressors and/or increased depressive symptoms are able to maintain adherence in the absence of the additional strains presented by family members who are sabotaging or nagging/arguing with them. Alternatively, family members may resort to nagging and arguing out of frustration after attempts to support the patient's adherence are ineffective, especially if the patient is managing depressive symptoms alongside their diabetes. Furthermore, family members of patients who experience numerous life stressors may also be coping with numerous stressors and may not have the energy or psychological resources to identify appropriate supportive behaviors and thus resort to nagging or arguing about adherence. Regardless, our findings suggest patients experiencing numerous life stressors and/or depressive symptoms may benefit from developing skills to talk with their family members about replacing nagging/

arguing behaviors with welcomed supportive behaviors (e.g., ordering/picking up prescription refills, carrying extra medication doses for the patient), and how to tell family members when their support attempts are not perceived as helpful. Interventions seeking to improve adherence among patients who experience numerous life stressors and/or major depressive symptoms should seek to reduce family members' diabetes-specific sabotaging and nagging/arguing behaviors.

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Figure 1. Adjusted effects of having high stressors on nonadherence to diabetes medications at different levels of obstructive family behaviors (the moderator)

resents the simple slopes and significance values for the effect of having + 1 SD on the TAPS (versus -1 SD on the TAPS) on the log-odds of nonadherence at different values of obstructive family behaviors relative to the sample mean. The values on the y axis have no substantive meaning in the interpretation of log-odds; the simple slopes depict changes in the log-odds of more nonadherence and are interpreted relative to zero (i.e., no association) and to each other. Adjusted for supportive family behaviors and covariates (age, race, ethnicity, education, insurance status, diabetes duration, and insulin status). SD=standard deviation; TAPS=Tool Assessing Patients' Stressors.

Figure 2. Adjusted effects of having a PHQ-9 score ≥ 10 on nonadherence to diabetes medications at different levels of obstructive family behaviors (the moderator)

Presents the simple slopes and significance values for the effect of having a PHQ-9 ≥ 10 (versus PHQ-9 < 10) on the log-odds of nonadherence at different values of obstructive family behaviors relative to the sample mean. The values on the y axis have no substantive meaning in the interpretation of log-odds; the simple slopes depict changes in the log-odds of more nonadherence and are interpreted relative to zero (i.e., no association) and to each another. Adjusted for supportive family behaviors and covariates (age, race, ethnicity, education, insurance status, diabetes duration, and insulin status). PHQ-9 = Personal Health Questionnaire-9; SD=standard deviation.

Table 1

Participant characteristics.

<i>N</i> = 192	Mean ± SD or n (%)
COVARIATES	
Age, years	51.6 ± 10.9
Gender	
Male	57 (29.7)
Female	135 (70.3)
Race	
White	65 (33.9)
African American/Black	107 (55.7)
Other	20 (10.4)
Hispanic ethnicity	19 (10.0)
Education, years	12.0 ± 3.0
Income	
<\$10,000	78 (43.6)
\$10,000 – \$14,999	49 (27.4)
\$15,000 – \$19,999	27 (15.0)
\$20,000	25 (14.0)
Insurance status	
Uninsured	90 (46.9)
Public Insurance	87 (45.3)
Private Insurance	15 (7.8)
Diabetes duration, years	7.7 ± 7.2
Prescribed insulin	90 (46.9)
PREDICTORS	
Stressors (TAPS)	4.8 ± 3.9
Depressive Symptoms (PHQ-9)	8.4 ± 6.6
<5 (None)	67 (34.9)
5–9 (Mild)	62 (32.3)
10 (Moderate to Severe) ^a	63 (32.8)
MODERATORS	
Supportive Family Behaviors (DFBC-II)	2.4 ± 1.0
Medication-Specific Subscale (DFBC-II)	1.2 ± 1.6
Obstructive Family Behaviors (DFBC-II)	2.1 ± 0.9
OUTCOME	
Medication Adherence (ARMS-D)	15.6 ± 4.9

ARMS-D = Adherence to Refills and Medications Scale for Diabetes; DFBC-II = Diabetes Family Behavior Checklist-II; PHQ-9 = Personal Health Questionnaire-9; SD = standard deviation; TAPS = Tool for Assessing Patients' Stressors

^a 12 (Moderate to Severe) n=46 (24.0%)

Table 2

Proportional odds/ordinal logistic regression analyses testing the exacerbating hypothesis: Odds ratios for moderation effects of obstructive family behaviors on the associations between stressors and diabetes medication nonadherence, and between depressive symptoms and diabetes medication nonadherence.

Outcome: Nonadherence		Stressors		Depressive Symptoms (PHQ-9)			
		TAPS X		Continuous X		Mild ^d X	
		Obstructive Family Behaviors	Obstructive Family Behaviors	Obstructive Family Behaviors	Obstructive Family Behaviors	Obstructive Family Behaviors	Moderate-Severe ^d X
		AOR	p value	AOR	p value	AOR	p value
Partially adjusted		1.10	.007	1.03	.08	1.42	.35
Fully adjusted		1.12	.002	1.05	.02	1.56	.24
						2.43	.02
						3.31	.002

^a Categorical PHQ-9; reference = none (PHQ-9 score<5)

Partially adjusted models include main effects, interaction terms, and supportive family behaviors. Fully adjusted models are further adjusted for age, gender, race, ethnicity, education, income, insurance status, diabetes duration, and insulin status (all as depicted in Table 1). AOR = adjusted odds ratio; PHQ-9 = Personal Health Questionnaire-9; TAPS = Tool for Assessing Patients' Stressors. Note: Results were consistent when using the cutoff of PHQ-9 12 to categorize participants with moderate-severe depressive symptoms: partially adjusted OR = 3.12, $p=.004$, fully adjusted OR = 4.35, $p<.001$.