# Reducing the Health Risks of Diabetes

## How Self-determination Theory May Help Improve Medication Adherence and Quality of Life

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### Purpose

The purpose of this study is to apply the self-determination theory (SDT) model of health behavior to predict medication adherence, quality of life, and physiological outcomes among patients with diabetes.

### Methods

Patients with diabetes (N = 2973) receiving care from an integrated health care delivery system in 2003 and 2004 were identified from automated databases and invited to participate in this study. In 2005, patients responded to a mixed telephone-and-mail survey assessing perceived autonomy support from health care providers, autonomous self-regulation for medication use, perceived competence for diabetes self-management, medication adherence, and quality of life. In 2006, pharmacy claims data were used to indicate medication adherence, and patients' non–high-density lipoprotein (HDL) cholesterol, A1C, and glucose levels were assessed.

### Results

The SDT model of health behavior provided adequate fit to the data. As hypothesized, perceived autonomy support from health care providers related positively to autonomous self-regulation for medication use, which in turn related positively to perceived competence for diabetes self-management. Perceived competence then related positively to quality of life and medication adherence,

and the latter construct related negatively to non-HDL cholesterol, A1C, and glucose levels.

## Conclusions

Health care providers' support for patients' autonomy and competence around medication use and diabetes self-management related positively to medication adherence, quality of life, and physiological outcomes among patients with diabetes.

Approximately one-third of Americans born after the year 2000 are projected to develop type 2 diabetes.[1] People with diabetes have shortened life expectancy due largely to macrovascular disease. Importantly, antihyperglycemic and lipid-lowering medications appear to reduce this risk.[2,3] In practice, however, medication adherence is poor, which undermines efforts to improve the health of patients with diabetes.[4] Simply stated, medication adherence refers to the percentage of medication that patients take as directed. The reasons for nonadherence to medication regimens are complex and involve an interaction among patients, health care providers, and the broader social environment regarding medication use.[5,6]

Self-determination theory (SDT)[7] posits that humans are oriented toward physical and psychological health. Furthermore, people are more likely to adopt healthy behaviors, or to change unhealthy ones, when their basic psychological needs for autonomy, competence, and relatedness are supported. Of central importance to the initiation and maintenance of healthy behaviors (eg, taking medication as directed to improve glucose control for patients with diabetes) or to the termination of unhealthy ones (eg, stopping smoking) are the concepts of autonomous self-regulation and perceived competence for healthy behavior engagement. People feel autonomous when they regulate their behavior volitionally (ie, with the experiences of choice and reflective self-endorsement), whereas people feel controlled when they experience pressure or coercion to act in particular ways. For example, patients with diabetes would feel autonomous if they took medication as directed because doing so was personally important to them rather than because of pressure from either health care providers or spouses. People feel competent when they are capable and effective in achieving desired outcomes. Importantly, past research using SDT has shown that when people feel autonomous, they are more likely to feel competent to attain important outcomes.[8-10] Thus, patients are more likely to develop the skills necessary to manage their health once they volitionally endorse those behaviors.

According to SDT, autonomy support facilitates patients' autonomous self-regulation and perceived competence for healthy behavior engagement. Applied to the domain of medication adherence, when clinicians support patients' willingness and perceived ability to use medication effectively, patients are more likely to take medication as directed. Autonomy-supportive behaviors include clinicians' acknowledging patients' perspectives, providing choice and a meaningful rationale for healthy behavior engagement (eg, taking medication as directed to control blood glucose to prevent blindness and kidney failure), supporting patients' self-initiation of change, and providing relevant information concerning the behavior. Thus, patients' perceptions of the health care climate might influence their healthy behavior engagement by facilitating autonomous self-regulation and perceived competence, thereby promoting improved medication adherence and physiological outcomes.

Much less is known about the relations of autonomous self-regulation and perceived competence to patients' quality of life. One clinical trial found that changes in perceived autonomy support and competence related positively to the quality of life of patients with diabetes,[11] but that trial did not assess autonomous self-regulation. Thus, further exploration of the associations between the SDT model of health behavior and quality of life is needed.

The present study aimed to contribute to an understanding of medication adherence among patients with diabetes by applying the SDT model of health behavior[9,10,12,13] to predict medication adherence, quality of life, and physiological outcomes among patients with diabetes. Previous research based on SDT has revealed associations among medication adherence, autonomy support, autonomous self-regulation, and perceived competence in primary care[14] and treatment of both HIV[12] and tobacco dependence,[13] thus supporting the SDT model of health behavior. The present study is the first to examine the relations of the SDT model of health behavior to quality of life, medication adherence, and physiological outcomes (namely, non–high-density lipoprotein [HDL] cholesterol, A1C, and glucose levels) among patients with diabetes.

### Hypotheses

Four hypotheses were tested, which were based on the SDT model of health behavior. (1) First, it was hypothesized that perceived autonomy support from health care providers would relate positively to patients' autonomous self-regulation for medication use. (2) Second, it was hypothesized that autonomous self-regulation would relate positively to patients' perceived competence for diabetes self-management. (3) Third, it was hypothesized that perceived competence would relate positively to both quality of life and medication adherence. (4) Fourth, it was hypothesized that medication adherence would relate positively to improved clinical outcomes (namely, non–HDL cholesterol, A1C, and glucose levels).

## Method

### Study Setting

This study occurred in the context of a large, nonprofit, mixed-model health maintenance organization (HMO) in southeastern Michigan that provided patient care by members of a large, multispecialty, salaried medical group. The total patient population at the time of this study was approximately 270 000, with more than 13 000 patients having a diagnosis of diabetes mellitus. The medical group's institutional review board approved all aspects of this study, including the assurance that the protocol was compliant with HIPAA requirements.

### Study Inclusion and Exclusion Criteria

Patients were identified through automated databases as having met the following criteria: (1) at least 18 years of age in 2003, (2) 2 or more dispensings for an oral antihyperglycemic medication and 2 or more dispensings for a lipid-lowering medication in 2003 and 2004, (3) active enrollment in the HMO with prescription drug coverage in 2003 and 2004, and (4) 1 or more laboratory tests for glycosylated hemoglobin (A1C) and 1 or more non–HDL cholesterol measurements in 2003 and 2004. Patients were excluded for any of the following reasons: (1) they were institutionalized in a long-term care facility for more than 3 months in either 2003 or 2004, (2) they did not have prescription drug coverage through the HMO, or (3) they were previously contacted for participation in focus groups as part of the larger study.

### Study Participants and Data Collection Procedures

Patients with diabetes mellitus (N = 3063) who met the study's eligibility criteria were identified. Ninety of those patients (1) denied having either diabetes or hypercholesterolemia, (2) denied receiving antidiabetic or lipid-lowering medications, or (3) could not be interviewed due to cognitive impairment or death. A mixed telephone-and-mail survey[15] was administered to 2973 eligible patients during the latter half of 2005. Patients received an introductory letter describing the study, an informed consent form, a baseline questionnaire, and a $1 incentive. A second survey was mailed 4 weeks later to those who did not return the first survey, and reminder post cards were sent 2 weeks after each full mailing. Research staff called those who did not complete the mailed survey and conducted telephone-based interviews. If verbal consent was obtained, the interviewer completed the survey instrument using computer-aided telephone interviewing. Patients who completed the interview by phone received a $20 incentive.

### Data Collection Measures

***Perceived autonomy support.*** The modified Health-Care Climate Questionnaire[8,10] assessed patients' perceptions of the autonomy supportiveness of the health care setting (6 items; eg, My health care provider listens to how I would like to do things regarding my health). Responses were made on a 7-point Likert-type scale, ranging from 1 (*not at all true*) to 7 (*very true*).

***Autonomous self-regulation for medication use.*** The Treatment Self-regulation Questionnaire[10,16] presented patients with the stem, "The reason I would take my diabetes and cholesterol medications exactly as prescribed is . . . ." Patients rated preselected responses that assessed autonomous reasons for taking medications for diabetes and/or cholesterol (6 items; eg, Because I have carefully thought about it and believe it is very important for many aspects of my life). Responses were made on a 7-point Likert-type scale, ranging from 1 (*not at all true*) to 7 (very *true*).

***Perceived competence for diabetes self-management.*** The Perceived Competence Scale[10] assessed patients' experiences of feeling able to manage their diabetes successfully (4 items; eg, I am able to meet the challenge of taking my diabetes and cholesterol medications). Responses were made on a 7-point Likert-type scale, ranging from 1 (*not at all true*) to 7 (*very true*).

***Quality of life.*** The Short-Form 12 Health Survey, version 2 (SF-12v2)[17] assessed general mental and physical health. This scale has been validated and is used as a measure of health-related quality of life. An aggregate quality-of-life scale was computed by averaging the mental and physical health subscales.

***Adherence information.*** Medication adherence was measured using a combination of (1) 2 claims-based reports from the health care system (ie, 1 for antidiabetic medication and 1 for lipid-lowering medication) and (2) 2 self-report measures of medication use by patients (ie, 1 for antidiabetic medication and 1 for lipid-lowering medication). Claims-based medication adherence was measured as 1 minus the continuous, multiple-interval measure of medication gaps (CMG) multiplied by 100, in which the CMG is the ratio of the sum of the therapeutic gaps divided by the total days of observation.[18] Separate variables were created for antidiabetic and lipid-lowering medications. Because some patients were taking more than 1 antidiabetic or lipid-lowering medication, the CMGs for all drugs within the antidiabetic and lipid-lowering classes were averaged to create a composite CMG for each of those 2 drug categories. Medication adherence was then calculated from the CMG values as described above. Medication adherence values ranged from 0 to 100, which represent the percentage of days the patient took medications as prescribed during the study period. Medication adherence was calculated using the HMO's pharmaceutical claims data for the period of January 1, 2006, to December 31, 2006. Patients' self-reported adherence to antidiabetic and lipid-lowering medications was assessed using 2 survey items, which asked, "What percentage of the time over the past 6 months did you take your prescribed diabetes (or cholesterol) medication?" Responses were recorded on a visual analog scale, ranging from 0% to 100%.[19]

***Glycemic and lipid control.*** Laboratory values were available electronically for the period of January 1, 2006, to December 31, 2006. Glycemic control was modeled as a latent variable indicated by the z-scored averages of both A1C and glucose levels during the study period. Lipid tests were averaged over the study period to form a measure of non–HDL cholesterol.

## Data Analysis

Preliminary analyses involved 2 steps. First, the means, standard deviations, observed ranges, and Cronbach alphas for each variable in the hypothesized structural model were calculated. Second, Pearson correlations among all variables in the hypothesized structural model were calculated.

Primary analyses were conducted using structural equation modeling (SEM) with observed and latent variables in AMOS 7.0. SEM is a data-analytic method that can be used to model latent (ie, error free) constructs from observed (ie, measured) variables. SEM allows the researcher to test both individual relations (ie, paths) between 2 variables and a simultaneous set of relations among multiple variables. SEM assesses both the statistical significance of specified paths and the overall goodness of fit of the hypothesized model.

Primary analyses involved 2 steps. First, the measurement model was tested to assess the goodness of fit of the hypothesized model to the data. Adequate model fit is indicated by incremental fit index (IFI), comparative fit index (CFI), and Tucker-Lewis index (TLI) values greater than 0.90 and root mean square error of approximation (RMSEA) values less than 0.08.[20] Second, the structural model was tested to examine the hypothesized relations among the variables in the model. Model estimation was performed using full information maximum likelihood, which is both more consistent and efficient than pairwise or listwise deletion with handling missing data.[21]

The hypothesized model included 5 observed variables (ie, self-reported autonomy support, autonomous self-regulation for medication use, perceived competence for diabetes self-management, and quality of life, as well as physiologically assessed non–HDL cholesterol) and 2 latent constructs. It was expected that pharmaceutical claims-based reports and self-reports of adherence to both antidiabetic and lipid-lowering medications would load positively onto a latent construct termed *medication adherence* and that z-scored A1C and glucose levels would load positively onto a latent construct termed *glycemic control*. The authors examined a model with

Table 1

Sample Characteristics: For the Entire Sample and by Respondent Status

| Sample Characteristic | All (N = 2973) | Respondents (n = 2038) | Nonrespondents (n = 935) |
|---|---|---|---|
| Age in years, mean ± SD | 64.3 ± 10.5 | 64.6 ± 9.9 | 63.5 ± 11.5[a] |
| Female gender, % | 45.3 | 47.2 | 41.3[a] |
| Race, % | | | |
| White | 56.9 | 59.8 | 50.9[a] |
| African American | 38.4 | 36.5 | 42.5[a] |
| Other | 4.7 | 3.8 | 6.6[a] |
| Income, mean ± SD, $ | 41 644 ± 5126.7 | 43 620 ± 85 981.9 | 37 575 ± 111 565.9 |
| Non–high density lipoprotein cholesterol, mean ± SD, mg/dL | 117.8 ± 37.2 | 116.8 ± 37.9 | 120.2 ± 35.5[a] |
| Charlson comorbidity score | 3.6 ± 2.7 | 3.6 ± 2.8 | 3.5 ± 2.7 |
| Prevalence of nonadherence, %[b] | | | |
| Statins | 33.1 | 30.3 | 38.9[a] |
| Any lipid-lowering medication | 34.4 | 32.0 | 39.4[a] |

[a]$P < .05$ by *t* test, $\chi^2$, or Wilcoxon test, depending on the variable under study, to examine differences between respondents and nonrespondents.
[b]Nonadherence was defined as (1 – CMG)% < 80%, where CMG is the continuous, multiple-interval measure of medication gaps.

direct paths from perceived autonomy support to autonomous self-regulation for medication use, autonomous self-regulation to perceived competence for diabetes self-management, perceived competence to both quality of life and medication adherence, and medication adherence to both glycemic control and non–HDL cholesterol. The model also included several correlated errors that were hypothesized because of similarities in theoretical content and measurement. First, the authors controlled for the shared error variance among the self-report variables (ie, autonomy support, autonomous self-regulation for medication use, perceived competence for diabetes self-management, quality of life, self-reported antidiabetic medication adherence, and self-reported lipid-lowering medication adherence) in the model because some of those variables were conceptually similar and all were measured concurrently using the same method. Second, the authors controlled for the shared error variance between the adherence variables and their associated physiological outcomes, as justified by the similarity in measurement of the 2 assessments of medication adherence and their expected associations with outcomes. Finally, the authors controlled for the shared error variance between non–HDL cholesterol and the latent construct glycemic control because both clinical outcomes were assessed similarly.

## Results

Of the 2973 eligible patients, survey information was available from 2038 (68.6%). Nonrespondents were more likely (1) to be male, (2) to be of nonwhite race/ethnicity, (3) to have lower medication adherence, and (4) to have worse glycemic and lipid control, relative to respondents (see Table 1). Table 2 presents means, standard deviations, intercorrelations, and Cronbach alphas for the observed variables used in the hypothesized model. Analyses revealed that the SDT variables were modestly correlated with quality of life, glycemic control, and non–HDL cholesterol. Furthermore, both claims-based and self-reported antidiabetic and lipid-lowering medication adherence variables were correlated with glycemic control and non–HDL cholesterol.

### Primary Analyses

***Testing the measurement model.*** A confirmatory factor analysis (CFA) on the observed (ie, measured) variables and latent (ie, error free) constructs was performed

Table 2

**Associations Among Observed Variables Used to Assess the Structural Relations Among Perceived Autonomy Support, Autonomous Self-regulation for Medication Use, Perceived Competence for Diabetes Self-management, Quality of Life, Medication Adherence, Glycemic Control, and Non–High-Density Lipoprotein (HDL) Cholesterol**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | M | SD | α |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Patients' perceived autonomy support from health care providers | — | | | | | | | | | | 5.57 | 1.45 | .95 |
| 2. Autonomous self-regulation for medication use | .42[a] | — | | | | | | | | | 5.73 | 0.91 | .88 |
| 3. Perceived competence for diabetes self-management | .23[a] | .37[a] | — | | | | | | | | 5.36 | 1.48 | .95 |
| 4. Quality of life | .20[a] | .19[a] | .35[a] | — | | | | | | | 45.32 | 8.42 | .85 |
| 5. Pharmacy-reported antidiabetic medication | .04 | .04 | .03 | .07[a] | — | | | | | | 0.16 | 0.17 | — |
| 6. Pharmacy-reported lipid-lowering medication | .04[b] | .04 | .04 | .07[b] | .36[a] | — | | | | | 0.11 | 0.15 | — |
| 7. Self-reported antidiabetic medication | .10[a] | .20[a] | .19[a] | .11[a] | .20[a] | .13[a] | — | | | | 0.93 | 0.25 | — |
| 8. Self-reported lipid-lowering medication | .12[a] | .16[a] | .16[a] | .11[a] | .16[a] | .17[a] | .47[a] | — | | | 0.91 | 0.29 | — |
| 9. Glycosylated hemoglobin | –.05[b] | –.12[a] | –.16[a] | –.06[b] | –.16[a] | –.10[a] | –.10[a] | –.08[a] | — | | 7.85 | 1.45 | — |
| 10. Glucose | –.07[a] | –.12[a] | –.13[a] | –.06[b] | –.09[b] | –.03 | –.08[a] | .07[a] | . 62[a] | — | 148.77 | 2.49 | — |
| 11. Non-HDL | –.04 | –.09[a] | –.04 | –.03 | –.15[a] | –.19[a] | –.14[a] | –.24[a] | .21[a] | .16[a] | 117.75 | 37.22 | — |

Abbreviation: Sample sizes ranged from 1783 to 2646, depending on the completeness of data. The glycemic control variables (ie, A1C and glucose levels) were used as z-scores in the model; however, means and standard deviations are presented for the raw variables, whereas correlations are presented for the z-scored variables.

[a] $P < .01$.

[b] $P < .05$.

on a model with the covariances specified above. The CFA yielded acceptable fit of the model, $\chi^2(21) = 85.9$, $P < .001$; $\chi^2/df = 4.09$; IFI = 0.98; CFI = 0.98; TLI = 0.94; RMSEA = 0.03. The 4 factor loadings on the latent construct medication adherence were significant (all $P$s < .05) and ranged in magnitude from 0.29 to 0.76 (mean $\lambda$ = 0.54). The 2 factor loadings on the latent construct glycemic control were significant (both $P$s < .001) and were 0.89 and 0.70 for A1C and glucose levels, respectively. The covariances between (1) autonomous self-regulation for medication use and quality of life, (2) quality of life and self-reported antidiabetic medication adherence, (3) self-reported antidiabetic medication adherence and A1C, (4) self-reported antidiabetic medication adherence and

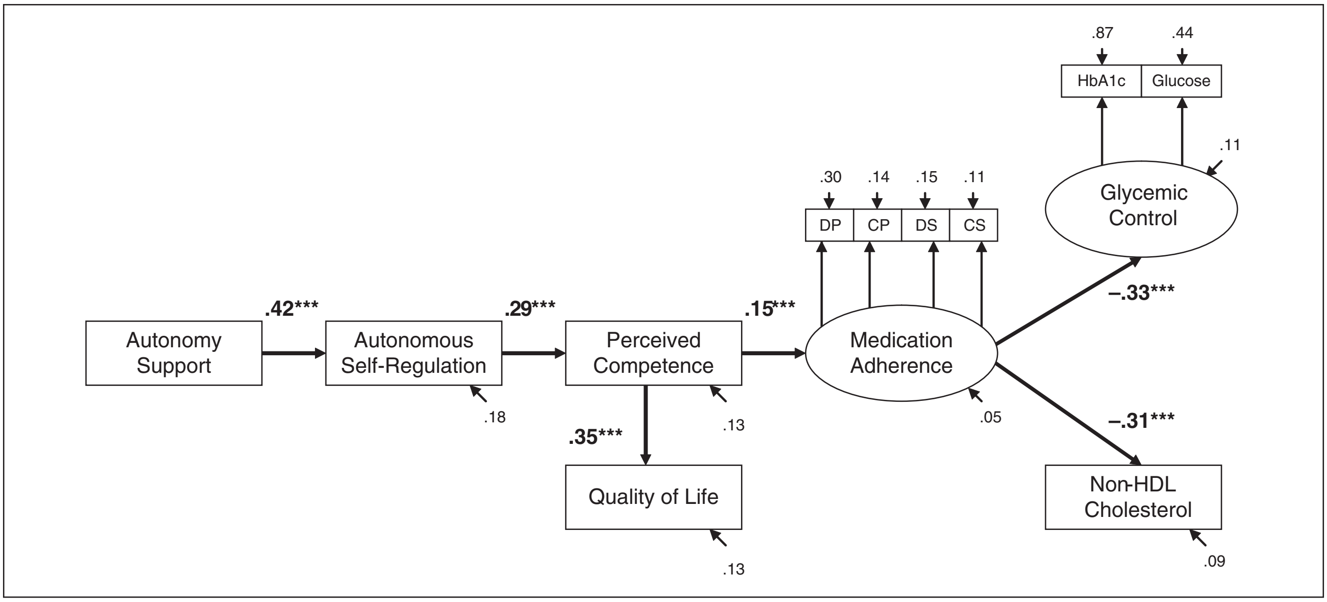


**Figure 1.** The structural equation model, with parameter estimates, examining the structural relations among the self-determination theory model of health behavior, quality of life, medication adherence, and physiological outcomes among patients with diabetes. Latent variables were used to represent "medication adherence" and "glycemic control," and the path coefficients are standardized estimates. Each squared multiple correlation ($R^2$) value represents the proportion of variance in an endogenous variable that is explained by the predictors of that particular endogenous variable. The covariances (specified in the text) between the residual variances were omitted from the figure for clarity. DP, pharmacy-reported antidiabetic medication; CP, pharmacy-reported lipid-lowering medication; DS, self-reported antidiabetic medication; CS, self-reported lipid-lowering medication; HbA1c, glycosylated hemoglobin. ***$P < .001$.

glucose, (5) self-reported antidiabetic medication adherence and claims-based antidiabetic medication adherence, (6) claims-based antidiabetic medication adherence and A1C, (7) claims-based antidiabetic medication adherence and glucose, and (8) A1C and glucose were not significant and thus were not included in the model used to test the fit of the structural model.

***Testing the structural model.*** Covariances were included in this model between the error terms that were significant in the measurement model. The structural model yielded acceptable fit to the data, $\chi^2(28) = 94.4$, $P < .0001$; $\chi^2/df = 3.37$; IFI = 0.98; CFI = 0.98; TLI = 0.96; RMSEA = 0.03. The results for the structural model appear in Figure 1. Perceived autonomy support related positively to autonomous self-regulation for medication use ($\beta = .42$, $P < .001$), autonomous self-regulation related positively to perceived competence for diabetes self-management ($\beta = .29$, $P < .001$), perceived competence related positively to both quality of life ($\beta = .35$, $P < .001$) and medication adherence ($\beta = .15$, $P < .001$), and medication adherence related negatively to both non–HDL cholesterol ($\beta = -.31$, $P < .001$) and glycemic control ($\beta = -.33$, $P < .001$). Thus, all hypothesized relations were significant and in the anticipated direction.

## Discussion

The present study was designed to apply the SDT model of health behavior to predict medication adherence, quality of life, and physiological outcomes among patients with diabetes. These relations may be considered confirmatory because they were hypothesized a priori and most have been reported in previous research.[12,14] However, the hypothesized associations between perceived competence for diabetes self-management and both quality of life and medication adherence have not been reported previously. The present results support those hypothesized relations and suggest that the SDT model of health behavior provides a useful framework for understanding both quality of life and medication adherence among patients with diabetes. Thus, these findings suggest that clinicians who support patients' autonomous self-regulation for medication use and perceived competence for diabetes self-management may facilitate patients' quality of life, medication adherence, and improved physiological outcomes.

These results are consistent with a growing body of literature linking motivational constructs to both quality of life and physiological indicators of health. Future research is needed to develop and test clinical interventions that support patients' autonomous self-regulation and perceived competence to determine whether those constructs promote quality of life, medication adherence, and glycemic and lipid control. Interestingly, the National Council on Patient Information and Education[4] indicated that patients who do not experience improved quality of life are less likely to adhere to treatment regimens. The present study provided new evidence suggesting that patients' motivation (ie, autonomous self-regulation and perceived competence) may represent important links between the health care climate, quality of life, medication adherence, and diabetes outcomes.[4]

The current findings build on the work of 2 previous longitudinal studies[9,10] showing that perceived competence relates to improved glycemic control. Together, these studies suggest that clinicians who elicit patients' perspectives, provide choice and a clear rationale for medication use, support patients' self-initiation, and help patients build diabetes self-management skills may support patients' autonomy, competence, quality of life, and medication adherence. On a practical level, the results of this study suggest that prescribers (ie, pharmacists, physicians, physician assistants, nurse practitioners) may facilitate patients' medication adherence if they elicit patients' thoughts and feelings about medication use, discuss alternative medications and treatment options, describe possible benefits and side effects of medication use, minimize use of controlling language, and clearly ask patients whether they are willing to take medication before writing or filling a prescription. Currently, the authors are conducting randomized clinical trials to examine the effects of such behaviors on patients' autonomous self-regulation, perceived competence, medication adherence, and quality of life. Importantly, autonomy-supportive interventions are consistent with American Diabetes Association guidelines[22] for promoting successful diabetes self-management.

Several limitations deserve mention. First, all data were collected over a fairly narrow period of time, which precludes a definitive statement on directionality among the hypothesized relations. However, the directionality of the hypothesized model was supported by the assessment of the psychological variables in 2005 and the outcomes in 2006, as well as by past applications of the SDT model to other health-related behaviors (eg, tobacco abstinence).[13] Nevertheless, longitudinal, randomized clinical trials are needed to demonstrate that SDT-based clinical interventions are effective. A second limitation is that the present study did not test the specific behaviors that facilitate autonomous self-regulation. Thus, it is important to examine which behaviors of health care providers are perceived as autonomy supportive and promote autonomous self-regulation, perceived competence, quality of life, and physiological health. Finally, because patients who never filled a prescription or who never obtained an A1C and fasting lipid profile were not included in this study, the observed ranges of the motivation variables were likely restricted, as those patients who were least motivated to receive care were not part of the sample. As a result, the strength of the parameter estimates in the model may have been attenuated. Other methodologies are needed to study how elements of the SDT model of health behavior relate to all patients' decisions to adhere to medication regimens. The authors suggest that all patients with a diagnosis of diabetes, whose physician recommended or wrote a medication prescription, be asked to provide data on motivation-relevant constructs.

In conclusion, this study found that both autonomous self-regulation and perceived competence—core elements in the SDT model of health behavior—were associated with quality of life, adherence to antidiabetic and lipid-lowering medications, and both glycemic and lipid control among patients with diabetes. These results suggest that specific strategies to improve autonomous self-regulation and perceived competence, as well as other aspects of the SDT model, may help improve medication adherence and quality of life and thus important diabetes-related health outcomes.

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