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Social Support and Lifestyle vs. Medical Diabetes Self-Management in the Diabetes Study of Northern California (DISTANCE)

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Abstract

Background—In chronic illness self-care, social support may influence some health behaviors more than others.

Purpose—Examine the relationship between social support and seven individual chronic illness self-management behaviors including two healthy “lifestyle” behaviors (physical activity and diet) and five more highly-skilled and diabetes-specific (“medical”) behaviors (checking feet, oral medication adherence, insulin adherence, self-monitoring of blood glucose, and primary care appointment attendance).

Methods—Using cross-sectional administrative and survey data from 13,366 patients with type 2 diabetes, we specified Poisson regression models to estimate adjusted relative risks (ARR) of practicing each self-management behavior at higher vs lower levels of social support.

Results—Higher levels of emotional support and social network scores were significantly associated with lifestyle behaviors [healthful eating ARR (95%CI) 1.14 (1.08, 1.21) and 1.10 (1.05, 1.16), and physical activity 1.09 (1.01, 1.17) and 1.20 (1.12, 1.28)]. Both social support measures were also associated with checking feet [ARR 1.21 (1.12, 1.31) and 1.10 (1.02, 1.17)]. Neither measure was significantly associated with other medical behaviors.

Conclusions—Social support was associated with increased adherence to lifestyle self-management behaviors, but was not associated with increased medical self-management behaviors, other than foot self-examination.

Keywords

Social Support; Diabetes Mellitus; Self-Management

For people with diabetes, self-management is important for maintaining cardiometabolic control and avoiding complications. Diabetes self-management regimens are often complex and many patients fall short of self-care goals. Identifying factors that can help patients adhere to diabetes self-management regimens is important. One such factor that may have potent effects on diabetes self-management is social support, including emotional support or interactions with a social network of family members, friends, or peers.

Studies have shown positive associations between patients' perceived social support and self-reported adherence to chronic disease regimens[1], [2]. Greater perceived social support has also been associated with better chronic disease outcomes, including glycemic control among those with diabetes, and hospitalization risk and functional status among those with cardiac disease and rheumatoid arthritis[2]–[6]. In light of these encouraging findings, much attention is being focused on ways to harness social support to help patients with chronic disease improve their health via more effective self-management[7]–[14].

Many of the original studies evaluating social support's impact on self-management behaviors used a composite outcome measure that combined several individual behaviors into one summary self-management behavior score. However, it is possible that social support may impact each individual diabetes self-management behavior to a different extent, for several reasons. Some behaviors are more often done in a social setting, and supportive others may be more effective at influencing some behaviors more than others. In a 2003 systematic review of studies among adults with chronic conditions[1], Gallant found most of the studies that examined associations between social support and an individual self-management behavior examined the 'lifestyle behaviors' of healthful eating and physical activity. The review concluded that there was sparse and conflicting evidence about the associations between social support and more 'medical' self-management behaviors such as medication adherence or home monitoring (i.e. of glucose or blood pressure levels) that are more disease-specific and may require more technical skill. These behaviors are particularly important to examine, since medication adherence and self-monitoring play central roles in diabetes management. If social support impacts medical behaviors less, this could imply that different strategies are needed to impact those behaviors versus lifestyle behaviors.

Gallant's review included only one study that directly compared the associations between social support and multiple individual self-management behaviors in the same patient sample [15]; since then five additional studies have done so[16]–[20]. Unfortunately, patterns of associations between social support and individual behaviors were inconsistent in these newer studies, except for a positive association with healthful eating in each study (See Table 1 for a summary of these six studies' results). Five of the six studies were limited by small sample sizes ($N=89$ to 208), increasing the chances of false negative associations with individual behaviors. All of these studies relied on participant self-reports of self-management behavior.

The Diabetes Study of Northern California (DISTANCE) offers an unique opportunity to directly examine the pattern of associations between social support and specific diabetes self-management behaviors. This large study represents the experience of over 13,000 Kaiser Permanente patients with type 2 diabetes, thus greatly lowering the chance of false negative findings and affording the opportunity to examine separate behaviors (for example, adherence to oral medications vs. adherence to insulin). In addition, DISTANCE offers both subjective measures of diabetes self-management behaviors via survey data and objective behavior measures through linked health system administrative data, including medication adherence and adherence to primary care appointments, a behavior which has been previously linked to successful diabetes management[21], [22], but whose relationship to social support has not been explored to our knowledge. Using the DISTANCE survey and administrative data linkage, we examined whether the relationship between social support and diabetes regimen adherence differed across seven distinct lifestyle and medical self-management behaviors.

Methods

Data and Participants

DISTANCE was conducted among patients identified as having diabetes (identified using an algorithm based on administrative data)[23] who received care in Kaiser Permanente Northern California (KPNC), an integrated health care delivery system. Using an ethnically-stratified, random sample of adults with diabetes, aged 30–75, surveys were conducted in English, Spanish, Mandarin, Cantonese, and Tagalog from May 2005 to December 2006. There were 20,188 survey respondents (response rate 62%). Survey responses were then linked to laboratory, prescription, and health service utilization data. Further details of the survey rationale, design, and sampling procedure have been previously published[24], [25]; survey instrument available at <http://distancesurvey.org>). The institutional review boards at the Kaiser Foundation Research Institute and University of California, San Francisco approved this study.

For the current study, we excluded participants who responded to an optional short version of the DISTANCE survey that did not include questions on social support (n=2,393), those without KPNC membership or pharmacy benefits at any time in the year prior to the survey (n=699), those with Type 1 diabetes (n=806), based on a published algorithm[24], and those with a positive pregnancy test any time within 16 months prior to the survey (due to the possibility of changes in prescribed diabetes regimens related to pregnancy) (n=28).

Measures

Measures of Self-Management (Outcomes)—Participants self-reported their adherence to the diabetes lifestyle self-management tasks of healthful eating and physical activity. For healthful eating, respondents reporting that they “followed a healthful eating plan” at least 3.5 days per week (average score based on two questions about the past week and the past month) were classified as adherent[26]. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ)[27]. An IPAQ score equivalent to meeting the recommended level of activity in public health guidelines (30 minutes of

moderate-intensity activity on at least five days/week) (Department of Health and Human Services, 1996) or more was considered adherent.

Healthful eating and physical activity, which are recommended to everyone, were classified as “lifestyle” behaviors. Each participant’s adherence to five diabetes-related medical self-management tasks was also measured: checking feet, oral medication adherence, insulin adherence, self-monitoring of blood glucose (SMBG), and primary care appointment attendance. These 5 behaviors were classified as “medical” based on their increased importance to managing diabetes specifically and need for more specialized skill or knowledge to complete them. To measure foot checks, respondents were asked, “Do you (or does someone in your home) regularly check your feet, including between your toes, at least three days a week?” Those responding ‘yes’ were classified as adherent [26]. Respondents who reported bilateral lower extremity amputations were excluded from this measure. For measures of diabetes medication adherence, we excluded participants who did not have any diabetes medication utilization (i.e. those who managed diabetes through diet and exercise only) per administrative data. Oral diabetes medication adherence was measured both with a self-reported measure and an administrative measure. For self-report, participants were asked “on how many days out of the last seven days did you miss taking any of your recommended diabetes pills, even one pill[26]?” Those who reported missing medications on two or more days were classified as non-adherent. As an administrative measure of oral diabetes medication adherence, we used pharmacy dispensing data to estimate continuous medication gaps (CMG[28]) and classified participants as non-adherent if they lacked a pill supply for >20% of the time for prescribed oral hypoglycemic agents during the 12 months prior to the survey. The CMG measure for oral hypoglycemic agents has been validated against self-report data in DISTANCE[29]. For self-reported insulin adherence, respondents were asked, “if you are prescribed insulin, on how many days out of the last seven days did you miss an insulin injection?” Those who reported missing insulin on two or more days were classified as non-adherent. We did not calculate insulin adherence from administrative data, because insulin is often prescribed on a sliding scale, so frequency of use cannot be reliably determined based on dispensing data. We examined SMBG adherence among insulin users only, because there is no uniform guideline for the frequency of SMBG for those who use oral diabetes medications only. For a self-reported measure we used the survey item “On how many days out of the last seven days did you test your blood sugar[26]?” Participants were classified as adherent if they reported SMBG at least once every day in the last week. For an administrative measure of SMBG, we calculated the average number of strips used per day, by summing the total number of test strips dispensed by KPNC pharmacies during the year prior to the survey and dividing by 365. Adherence to daily SMBG was defined as an average of 0.75 strips per day. The determination of SMBG by test strip dispensing records has been previously validated in the DISTANCE population against self-report SMBG[30]. For an administrative measure of primary care appointment adherence, participants were classified as adherent when more than two-thirds of all scheduled (and not cancelled) primary care appointments were attended in the 12 months prior to the survey. This threshold has been associated with significantly greater risk factor control (glycemic, LDL and blood pressure)[21], [22].

Measures of Social Support (Exposures of Interest)—Emotional support was measured using responses to two previously validated questions[31] “I have someone I can turn to for support and understanding” and “I have someone I can really talk to.” Participants were classified as having high levels of emotional support if they “agreed” or “strongly agreed” to either question. The Social Network Index (SNI)[32] is a widely used measure of social ties, and higher SNI scores have been linked with a wide variety of positive health outcomes[33]–[36]. We computed the SNI score (range 0–4) according to previously published algorithm:[35] participants received 1 point for being married or ‘living as married’, 1 point for having three or more friends or relatives with whom they spend time at least once a month, 1 point for attending religious services once a month or more, and 1 point for participating in other groups or organizations once a month or more. We created three SNI categories according to variable distribution and conceptual interest: score 0–1 (i.e. one or less modes of social contact), 2, or 3–4. Alternate analyses maintaining the SNI as a 5-category variable had similar results. Because SNI measures the structure of the respondent’s social network, and emotional support reflects a function of that network, we did not consider these constructs similar enough to combine into one social support measure.

Analysis

We specified separate models estimating the relationship between each social support measure and each of nine measures of diabetes self-management behavior described above (i.e., self-report measures of healthful eating, physical activity, checking feet, oral diabetes medication adherence, insulin adherence, and SMBG among insulin users; and administrative measures of oral diabetes medication adherence, SMBG among insulin users, and primary care appointment attendance. Modified Poisson regression with a log link function and robust error variance was used to estimate the adjusted relative risk (RR)[37], [38] for each exposure. The DISTANCE study used a stratified random sampling design which over-sampled minority patients to provide adequate power for ethnic contrasts. To account for this design effect, we weighted analyses using expansion weights (reciprocal of the non-proportional sampling fractions for each ethnic group) in all multivariable models. While we had no reason to believe that the relationship between social support and self-management would be different among survey respondents versus non-respondents, we addressed survey non-response bias in the analysis using the Horvitz-Thompson approach[39]. We first fit a model predicting response to the DISTANCE survey and then created individual weights (reciprocal of the probability of response) that we used in all multivariable models. Between 22% and 28% of the study cohort was missing data on covariates needed for one or more of the models. For our main analyses we removed these participants (case wise deletion). So as not to violate assumptions of linearity in the multiplicative models, categorical variables were used instead of their continuous form.

Our goal was to evaluate the strength of the association between social support and health behaviors, and thus we also adjusted models for those covariates we considered potential confounders of the social support-health behavior association. Covariates included measures of respondent’s survey-reported socio-demographic characteristics (age, sex, education level, income level, race/ethnicity), health-related quality of life (self-reported SF8)[40], a

measure of chronic comorbidities (DxCg)[41]; diabetes severity (self-reported number of years with diabetes, and insulin use captured from KPNC pharmacy data)[29], and depressive symptoms (self-reported Patient Health Questionnaire-8 (PHQ-8)>10)[42]. Because depressive symptoms can also mediate the effect of social support on health behaviors[43, p. 2004], [44], we examined alternate models without a depressive symptoms variable; the results of those models were very similar to the models that included depressive symptoms, so we adjusted for depressive symptoms in the final models. For models of diabetes medication adherence, we also included the total number of ongoing prescriptions (with 30 days supply) and an indicator for whether the participant had been hospitalized in the last year. For models of appointment keeping, we included an indicator for whether the participant had been hospitalized in the last year and the number of scheduled appointments per year (both derived from administrative data). For models of diabetes medication adherence and SMBG, participants were included in either pair of models only if they had data for both the self-reported and administrative measures of outcomes. As a sensitivity analysis we analyzed models including all applicable respondents, with indicators for missing variables. The results for these models were similar to the models using case-wise deletion.

Finally, as an exploratory analysis, we evaluated whether patterns of associations between social support and self-management behaviors differed by key participant groups: men vs. women, age ≥ 65 years vs. < 65 years, and race/ethnicity group. For each key participant characteristic we evaluated each of the final 18 models with the addition of a social support measure*patient characteristic interaction term.

Results

Of the 13,366 patients with type 2 diabetes included in the analyses (Table 2), 51% were male, the average age was 59 years, and 75% were self-identified as being from a racial/ethnic minority group. Sixty-one percent had some college education. Twenty percent used insulin, 67% used oral hypoglycemic agents only, and 13% were not prescribed any diabetes medications.

Eighty-seven percent of respondents reported a high level of emotional social support, and 52% had a social network index score of 3 or 4 out of 4 (Table 2). Among the specific components of the social network index, 71% of respondents reported being married or living as married, 72% had regular contact with friends and relatives, 55% attended religious services regularly, and 49% attended groups regularly (data not shown in table). Increasing SNI was significantly correlated with higher emotional support were highly correlated in our data (chi square $p < 0.001$, see Supplemental Table 1 for details).

Adherence ranged from 60% for adequate physical activity to 90% for insulin adherence and 93% for adherence to primary care appointments (Table 3). Adherence to SMBG among insulin users was very similar when comparing self-reported (63% adherent) and administrative (65% adherent) measures. More participants were classified as adherent to oral diabetes medications by the self-report measure (90%) than by the administrative measure (67%).

Table 4 shows the associations between the social support measures and each self-management behavior, in models unadjusted and adjusted for potential confounders. In these models, both high emotional support and high SNI were significantly associated with greater self-reported adherence to lifestyle behaviors of healthful eating and physical activity. Specifically, high emotional support and highest level of SNI were associated with healthful eating [ARR 1.14 (95% CI: 1.08, 1.21) and 1.10 (1.05, 1.16)], physical activity [1.09 (1.01, 1.17) and 1.20 (1.12, 1.28)]. High emotional support and higher SNI were also significantly associated with higher adherence to the medical behavior of checking feet [ARR 1.21 (1.12, 1.31) and 1.10 (1.02, 1.17)]. In contrast, neither measure of support was significantly associated with the other medical self-management behaviors (i.e., oral diabetes medication adherence (measured via self-report or administrative data), insulin adherence, SMBG (self-report or administrative measure), or primary care appointment adherence) after adjustment. While the unadjusted model examining high emotional support and self-reported oral diabetes medication adherence was borderline significant (RR 1.04 (1.01, 1.07)), association was attenuated and not statistically significant after adjustment (ARR 1.03 (0.99, 1.07)). In the model of SNI with self-reported oral diabetes medication adherence, and all other unadjusted models, unadjusted results were consistent with adjusted results (See Supplemental Table 2 for full model results).

Finally, we noted no substantive or consistent differences in the association of social support and self-management behaviors across key patient subgroups of age, gender, and race/ethnicity (See Supplemental Table 3 for details).

Discussion

In this study of 13,366 racially and ethnically diverse patients with type 2 diabetes with uniform access to health care, we found that emotional support and social connectedness were significantly associated with increased adherence to recommended healthful eating regimen, physical activity levels, and checking feet daily, but not with adherence to oral diabetes medications, insulin, SMBG, or primary care appointment attendance. This study was unique in its ability to directly compare the relationship between social support and adherence to a wide array of self-management behaviors among a large, diverse population of people with diabetes and uniform access to healthcare.

This study benefits from the availability of administrative data for several important outcomes and covariates, and the inclusion in models of depressive symptoms and several other possible confounders of the relationship between social support and self-management. However, it should be noted that, while the emotional support and SNI measures we used are reasonable proxies for social support[44–45], we lacked measures of other types of social support. The Social Network Index reflects the participant's number of modes of social connections and not what functions those social ties are providing. Although overall SNI scores have been linked with a wide variety of positive health outcomes, the uniform weighting of each component of the index may poorly reflect the reality, e.g., being married likely carries very different significance to health behavior than regularly attending religious services. We also did not have data on diabetes-specific social support (e.g. help directed at specific diabetes management tasks such as SMBG or transport to medical appointments), in

contrast to Nicklett's study [16], which showed that diabetes-specific support was associated with adherence to all five diabetes management behaviors examined. However the SNI has been used as a proxy for functional social support, and has been associated with positive health outcomes, in many prior studies[31], [33], [34], [36], [46]. In this study, it is striking that the patterns of association between social network structure (SNI) and one of its presumed functions (emotional support) with individual diabetes self-management behaviors were so similar, and that SNI and emotional support levels were correlated with one another. This suggests that these two measures may be capturing one underlying social support construct, such as the perception that one has reliable social resources to draw on in times of stress or change that could be important to successful self-management behavior.

The pattern in the current study provides some evidence for a reduced importance of social support as patient's progress from "lifestyle" to more skilled "medical" behaviors. For example, this study was consistent with other recent smaller studies in finding social support related to healthful eating. In the case of physical activity, which had mixed results in past diabetes social support studies, our study found a clear signal of an association with social support. Checking feet and taking oral medications are activities that are more specific to diabetes, but require lower skill levels; these behaviors had mixed results (checking feet clearly associated with emotional support but only associated with SNI at the highest level, and taking oral medications trending toward a significant association with emotional support. Finally, there was no indication of association of social support with the most technically demanding medical self-management behaviors, insulin adherence or SMBG. These daily self-management behaviors require the most skill, and are most specific to diabetes.

If these cross-sectional associations reflect an effect of social support on self-management behavior, there are several possible explanations for the pattern seen. It is possible that social support matters more for activities that are typically done in social settings, such as eating and physical activity. Perhaps social ties to friends and organizations widen a patient's access to health information that is more relevant to the general population, such as information about healthful eating and physical activity. For checking feet and taking pills, support may be more likely to come from those with a more intimate relationship with the patient than those in the wider social network (reflecting a stronger association in our study from emotional support than SNI for these behaviors). Among the diabetes-specific self-management behaviors, family and friends may perceive some behaviors as more important than others. In addition, both people with diabetes and their supporters may feel more confident that the supporters have sufficient knowledge and skills to help with lifestyle and less skilled behaviors, than with more technically challenging medical behaviors, e.g., SMBG and insulin use. Finally, there may be essential factors beyond social support (such as financial resources or professional support) that people with diabetes need to achieve adherence for 'medical' behaviors, like financial means to purchase medications or test strips for SMBG. This may also be the case for attending appointments, which depends on several internal motivators and external facilitators (e.g., transportation) to be achieved successfully[47].

If social support does have a differential impact on specific health behaviors, this would have interesting implications for improving diabetes management. Although the relative risks of social support association with behavior adherence were modest, a 15% higher likelihood of adhering to healthful eating, 10% higher chance of adhering to physical activity guidelines, and 21% increased chance in checking feet regularly could, separately and collectively, have a substantial impact on the health and well-being of individuals with type 2 diabetes. Moreover, social support (e.g., having regular contact with or encouragement from family and friends) is relatively low cost and has many other potential benefits to multiple aspects of chronic illness care (such as reduction of co-morbid depressive symptoms). The impact on diabetes outcomes of encouraging patients with diabetes to strengthen their emotional closeness with others, or of expanding their supportive social networks (perhaps through health related activities like walking groups, healthy cooking classes, or diabetes support groups) is being investigated. It remains to be seen whether it would be more feasible to increase receipt of effective support by encouraging patients to expand their social ties, or by interventions that attempt to modify the behavior of existing supportive others (such as family members), in particular to help them become more effective at supporting 'medical' behaviors. In either case, research to identify and remedy barriers to supporters' influence on such important self-management behaviors as medication adherence and SMBG for insulin users could be helpful. Helpful approaches to increasing effective support of medical behaviors might include increasing supporters' knowledge about and skills in tracking, filling, and taking diabetes medications, in using SMBG, and how and when to encourage the patient to contact their health care provider when additional assistance is needed. It may be, however, that even with enhanced information and training, family and friends are not the most potent supporters of medical behaviors, and that professional care providers such as nurses, diabetes educators, or community health workers are more suited to the task.

This study has potential limitations that should be kept in mind when interpreting its results. Our main analyses included 18 multivariable models, so the possibility that one or more false positive findings arose by chance is increased. Since the analyses are cross-sectional, we cannot conclude there is a causal relationship between social support and health behaviors. In addition, it is possible that people who perceive greater social support are more susceptible to social desirability bias in reporting health behaviors, or that an unmeasured factor (e.g. a personality trait such as optimism) might lead patients to report both higher levels of social support and adherence. However, the SNI, which measures the number of modes of social connection, should be less susceptible to subjective judgment and bias, and there were no substantive differences in the associations between support and adherence, SMBG, and appointment keeping when comparing self-reported versus objectively assessed administrative outcomes. It should be noted that adherence to lifestyle behaviors is notoriously difficult to measure accurately,[48] so our self-reported measures may not reflect true differences in healthy eating and physical activity. Future studies of the association between social support and self-management behavior may be strengthened through more objective behavior measures of outcomes (such as pedometers). Another potential limitation is that two of the four measures of medical behaviors had a relatively small amount of variance (90% adherence to insulin and 93% adherence to primary care

appointments), which may have had a ‘ceiling’ effect on our ability to detect higher adherence with higher social support. In addition, rates of self-reported versus administrative adherence to oral medications differed significantly. However this is likely because self-reported adherence was based on the previous seven days, while the administrative data-based adherence measure integrated adherence over the previous year. Measurement errors in KPNC pharmacy data are unlikely, and the adherence measures used in this study have been previously validated[29]. Finally, the lack of data on social support across unsurveyed populations precludes evaluation of whether these results generalize to the remaining Kaiser population with diabetes or to the wider diabetes population. While levels of social support and self-management behaviors are likely to vary across populations, the association between social support and behaviors is likely more robust and generalizable. We have reported previously that basic associations found in the DISTANCE responders generalize to non-responders using data available for all Kaiser members, and that the Kaiser population is sociodemographically similar to other insured people in the surrounding geographic region [25]. Nonetheless, caution is needed when generalizing our findings to the wider population with diabetes.

In conclusion, we found that, in a large cohort of people with type 2 diabetes, high levels of social support were more clearly associated with adherence to ‘lifestyle’ behaviors such as healthful eating and physical activity than with ‘medical’ behaviors that are increasingly skilled and diabetes-specific, such as diabetes medication adherence and SMBG among insulin users. It will be important to determine whether social support can be increased or harnessed as a strategy for improving self-management for chronic conditions, and whether such strategies should focus on lifestyle aspects of self-management exclusively, or should attempt to remedy supporters’ barriers to influencing patients’ medical self-management behavior.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Previous Studies Directly Comparing Associations Between Social Support and Individual Self-Management Behaviors Among Adults with Diabetes.

	Healthful Eating	Physical Activity	Checking Feet	Medication Adherence	SMBG	Outpatient Appointment Adherence
Bailey et al 1997 (N=104)	+	+	--	×	×	--
Shaw et al 2006 (N=208)	+	×	+	--	×	--
Tang et al 2008 (N=89)	+	+	×	×	+	--
Rosland et al 2008 (N=164)	+	×	×	×	+	--
Rees et al 2010 (N=450)	+	+	×	--	×	--
Nicklett et al 2010 (N=1788)	+	+	+	+	+	--

+ = significant and positive association between increasing social support and increased adherence to behavior; × = no significant association between social support and the behavior; -- = association not tested; SMBG = self-monitored blood glucose

Table 2

Participant Characteristics and Social Support Indicators

	Mean (SD) or n (%)
All Participants	N = 13,366
Age	59 (10)
Male	6,839 (51%)
Race/Ethnicity	
African American	2,380 (18%)
Asian	1,571 (12%)
Caucasian	3,372 (25%)
Filipino	1,481 (11%)
Latino	2,415 (18%)
Multiracial	1,540 (12%)
Other/unknown	607 (5%)
Education	
No degree earned	1,840 (14%)
HS/GED	3,807 (29%)
Some college	3,390 (26%)
College grad	4,101 (32%)
Yearly Income	
< \$25K	2,173 (18.0%)
\$25K – \$49K	3,437 (29%)
\$50K – \$79K	3,079 (26%)
\$80K +	3,379 (28%)
Physical health status (PCS-8)*	45.8 (10.2)
DxCg Comorbidity Score**	4.6 (5.2)
Diabetes Duration (years)	
0–9	8,107 (61%)
10–19	3,758 (28%)
20+	1,440 (11%)
Diabetes Medication	
Insulin +/- oral medications	2,617 (20%)
Oral medications only	8,942 (67%)
No diabetes medications	1,807 (13%)
Depressive Symptoms	
None	7,354 (64%)

	Mean (SD) or n (%)
Mild	2,639 (23%)
Moderate to severe	1,517 (13%)
Drug copay \$30	3,400 (26%)
Office visit copay \$25	1,372 (10%)
Number of chronic prescriptions	4.9 (2.7)
Number of scheduled outpatient appointments	
< 10	6,998 (52%)
10–20	3,972 (30%)
>20	2,396 (18%)
Hospitalized in the last year	1,184 (9%)
High Emotional Support	11,560 (87%)
Social Network Index	
0	469 (4%)
1	1,986 (16%)
2	3,725 (29%)
3	4,151 (33%)
4	2,404 (19%)

Includes any participant included in at least one analytical model.

* The PCS-8 score increases with better physical health, with a score of 50 = the average score of the 1998 general U.S. population.

** The DxCG uses medical and prescription drug data to assign a risk score indicative of the relative risk of future medical resource consumption compared to the population average consumption. A higher DxCG generally indicates more comorbidities.

Table 3

Diabetes Self-Management Behavior Adherence

	Total N Available	n(%) Adherent*	
		Self-Report Measure	Administrative Data-Based Measure
Healthy Eating	12,788	9,243 (72.3%)	---
Adequate Physical Activity	13,259	8,003 (60.4%)	---
Checking Feet Regularly	13,270	8,376 (63.1%)	---
Diabetes Oral Medication Adherence	9,799	8,800 (89.8%)	6,554 (66.9%)
Insulin Adherence [∫]	2,447	2,213 (90.4%)	---
Daily SMBG among insulin users [∫]	2,596	1,641 (63.2%)	1,688 (65.0%)
Primary Care Appointment Adherence	11,191	---	10,450 (93.4%)

* Based on total N with data for that measure

[∫] Among insulin users only

Table 4

Modified Poisson Multiple Regression Model-Based Relative Risks of Diabetes Self-Management Behavior Adherence with Higher Social Support*

		Healthy Eating (s)	Adequate Physical Activity (s)	Checking Feet (s)	Diabetes Oral Medication Adherence (s)	Diabetes Oral Medication Adherence (a)	Insulin adherence (s)	Daily SMBG among insulin users (s)	Daily SMBG among insulin users (a)	Primary Care appointment adherence (a)
High Emotional Support	RR (95% CI)	1.19 (1.13, 1.25) [†]	1.16 (1.09, 1.24) [†]	1.25 (1.16, 1.33) [†]	1.04 (1.01, 1.07) [†]	1.00 (0.95, 1.06)	1.04 (0.99, 1.09)	1.12 (0.98, 1.27)	1.04 (0.93, 1.16)	1.01 (0.99, 1.03)
	ARR (95% CI)	1.14 (1.08, 1.21) [†]	1.09 (1.01, 1.17) [†]	1.21 (1.12, 1.31) [†]	1.03 (0.99, 1.07)	0.99 (0.93, 1.06)	1.03 (0.96, 1.10)	1.09 (0.95, 1.26)	1.03 (0.91, 1.18)	1.01 (0.99, 1.03)
Social Network Index	RR (95% CI)	---	---	---	---	---	---	---	---	---
	0–1 (ref)	---	---	---	---	---	---	---	---	---
	2	1.09 (1.04, 1.15) [†]	1.14 (1.07, 1.22) [†]	1.01 (0.95, 1.07)	1.00 (0.97, 1.03)	1.00 (0.95, 1.06)	1.01 (0.96, 1.06)	0.99 (0.87, 1.12)	0.99 (0.89, 1.10)	1.01 (0.99, 1.03)
	3–4	1.16 (1.11, 1.21) [†]	1.26 (1.19, 1.33) [†]	1.10 (1.04, 1.16) [†]	1.01 (0.99, 1.04)	1.00 (0.95, 1.06)	1.02 (0.98, 1.07)	1.08 (0.97, 1.20)	0.96 (0.87, 1.06)	1.01 (0.99, 1.03)
	ARR (95% CI)	---	---	---	---	---	---	---	---	---
	0–2 (ref)	---	---	---	---	---	---	---	---	---
	2	1.07 (1.02, 1.27) [†]	1.13 (1.05, 1.21) [†]	1.02 (0.95, 1.09)	0.98 (0.95, 1.02)	0.96 (0.91, 1.03)	0.99 (0.93, 1.05)	1.02 (0.89, 1.17)	1.03 (0.92, 1.16)	1.01 (0.99, 1.04)
	3–4	1.10 (1.05, 1.16) [†]	1.20 (1.12, 1.28) [†]	1.10 (1.03, 1.17) [†]	1.0 (0.97, 1.03)	0.98 (0.92, 1.03)	1.02 (0.96, 1.07)	1.08 (0.96, 1.23)	0.98 (0.88, 1.10)	1.02 (0.99, 1.03)

* Emotional Support and Social Network Index were examined in separate models.

All Adjusted Relative Risks (ARR) adjusted for: age, sex, race/ethnicity, education, income, physical component of SF8, DxcG comorbidity score, duration of diabetes, diabetes treatment, and depression. Medication adherence models also adjusted for: hospitalization in year prior to baseline, number of chronically used medications. Appointment adherence models also adjusted for hospitalization in year prior to baseline and total number of scheduled appointments.

† Among insulin users only (s) = self-reported, (a) = derived from administrative data

95% Confidence Interval does not cross 1