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Direct Social Support and Long-term Health Among Middle-Aged and Older Adults With Type 2 Diabetes Mellitus

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Objectives. This study examined whether or not direct social support is associated with long-term health among middle-aged and older adults with diabetes mellitus.

Method. Direct social support was assessed at baseline (2003) for 1,099 adults with type 2 diabetes mellitus from the Health and Retirement Study. Self-reported health status was examined at baseline and in 4 biennial survey waves (2003–2010). A series of ordinal logistic regression models examined whether or not the 7-item Diabetes Care Profile scale was associated with a subsequent change in health status over time. Additional analyses examined whether or not individual components of direct social support were associated with health status change.

Results. After adjusting for baseline covariates, greater direct social support as measured by the Diabetes Care Profile was associated with improved health outcomes over time; however, this trend was not significant ($p = .06$). The direct social support measures that were associated with improved health over follow-up were support for taking medicines (odds ratio [OR] = 1.22), physical activity (OR = 1.26), and going to health care providers (OR = 1.22; all $p < .05$).

Discussion. Interventions that specifically target improving specific aspects of diabetes social support may be more effective in improving long-term health than less targeted efforts.

Key Words: Diabetes—Regimen—Self-rated health—Social support.

SOCIAL support—or the provision of emotional and tangible assistance by family, friends, and other members of one's social network—is associated with better health and well-being among older adults (Berkman & Syme, 1979; House, Landis, & Umberson, 1998; Schulz et al., 2006; Uchino, 2004). Among older adults with chronic illness, social support is associated with better self-management, fewer hospital admissions, and better health-related quality of life (DiMatteo, 2004; Gallant, 2003; Lett et al., 2005; Luttik, Jaarsma, Moser, Sanderman, & van Veldhuisen, 2005). For diabetes mellitus in particular, a condition that often requires complex medical and self-care regimens to prevent disabling complications, evidence suggests that social support is particularly important for successful management (Gallant, 2003).

The extent to which social support improves disease management and the well-being of middle-aged and older adults with diabetes mellitus is driven by the relationships and patterns of interaction between those providing and those receiving support (noting that this relationship is often bidirectional). According to the social control perspective (Uchino, 2004; Umberson, 1987), social support affects health-related behavior directly and indirectly. Indirect mechanisms include an individual's moderation of their behavior due to improved mental health (e.g., renewed sense of optimism), social responsibility, or social obligation (e.g., guilt) to the support source. Direct mechanisms include tangible assistance or the direct provision of care. Umberson (1987) provides an example of indirect mechanisms of social control: "…an individual might remind his or her spouse to avoid using salt because of its effect on blood pressure…" (Umberson, 1987, p. 310). However, the effectiveness of direct mechanisms of social control on health has been relatively understudied (Uchino, 2004).

The prevalence of diabetes mellitus among older adults is high (27% among the 65+ population in 2010) and is projected to rapidly increase in the United States (Boyle, Thompson, Gregg, Barker, & Williamson, 2010; CDC, 2011). As older adults with diabetes mellitus experience significantly accelerated health decline over time (Blaum, Ofstedal, Langa, & Wray, 2003), social support that improves management could improve the overall health of people with diabetes mellitus. Accordingly, interest is growing in ways to enhance social support for this population (Rosland & Piette, 2010).

However, there are significant limitations to current evidence on the effect of social support on long-term health for people with diabetes mellitus. The majority of research on the effect of social support on diabetes mellitus outcomes

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has focused on whether or not support enhances the commitment to self-care and regimen adherence (Belgrave & Lewis, 1994; Gallant, 2003; Rosland et al., 2008; Tol et al., 2011). Although social support was found to be positively associated with better self-care practices in each of these studies, these better practices were not always associated with improved health outcomes (Ingram et al., 2007; Nicklett & Liang, 2010; Tol et al., 2011). The few prospective studies to date that specifically examine the relationship between social support and health outcomes of older adults with diabetes mellitus have had very short follow-up periods or are conducted on special population groups, limiting external validity. For example, Sacco, Malone, Morrison, Friedman, and Wells (2009) conducted a randomized controlled trial to examine how a telephone-administered social support intervention affected both health-promoting behaviors (diet and exercise) and health outcomes (HbA1c and BMI) among type 2 diabetics. Although greater levels of baseline social support were associated with improvements in self-management behaviors, there was no significant relationship found between social support and health outcomes in 6 months (Sacco et al., 2009). It might be necessary to examine the relationship between support and health status over a longer period of time for the benefits of support (through better self-management behaviors and other mechanisms) to be realized in improved health outcomes. Further, telephone-administered support might not capture the most meaningful sources of support that improves diabetes-related behaviors.

Ingram and colleagues (2007) conducted a quasiexperimental design of a community health worker intervention model among 70 participants from a community of farmworkers on the U.S.–Mexico border for a period of 12 months. Among other outcomes, Ingram and colleagues investigated the relationship between support from family and friends and clinical diabetes mellitus outcomes, such as HbA1c levels. Study participants reported increased support from family and friends after participating in the program, as well as improved HbA1c levels. Although individual aspects of support were not examined in the Ingram study and the effects were small, enrollment in a support group and having an advocate to engage in tangible assistance was predictive of decreased HbA1c levels in a 12-month period. In the Ingram study, support predicted improved diabetes outcomes; however, specific aspects of support related to diabetes care were not examined. Although the findings suggest that there is an important relationship between support and diabetes outcomes, the findings cannot be extrapolated to the general population due to the special population of study (farmworkers on the U.S.–Mexico border) and due to the nature of the study (community health worker intervention).

Nicklett and Liang (2010) explored the relationship between illness-related support, regimen adherence, and health outcomes. In this study, support measures, self-reported adherence, and self-rated health (SRH) were assessed at baseline. Change in SRH according to baseline measures of support and adherence was assessed during a 2-year period. Although a significant positive relationship was found between illness-related support and self-management behaviors, baseline illness-related support did not predict a change in health outcomes during a 2-year period, suggesting that support did not necessarily translate to improved or maintained SRH over the short term. It is possible that the 2-year follow-up period was not sufficiently long to capture the relationship.

Vastly different definitions and measures of social support in the literature also impose challenges on understanding the relationship between social support and health (Cohen & Syme, 1985; Uchino, 2004). The majority of studies have examined the relationship between general (or indirect) social engagement or social support and health, such as emotional or practical support in all aspects of the relationship. Fewer studies have examined the relationship between direct social support—or promotion of health-related activities—and subsequent health.

According to the social control perspective (Uchino, 2004; Umberson, 1987), both direct and indirect forms of social support influence health. However, evidence suggests that direct forms of support (i.e., tangible aspects of social support), particularly those aspects that promote adherence to a complex regimen of a chronic disease such as diabetes mellitus, are most strongly associated with healthy behaviors and outcomes than indirect or general social support (Ary, Toobert, Wilson, & Glasgow, 1986). This suggests that social support directed to improve regimen adherence ("direct social support") might be particularly protective against health decline. In addition, it may be more feasible to intervene in clinical settings to promote direct social support for specific health activities than to address the overall level of social engagement or social support of a patient. In order to better target efforts, research is needed that examines whether or not direct social support relates to subsequent health status among chronically ill populations. As few studies to date have examined the benefits of direct social support on health, relatively little is known about the longitudinal effects of direct social support among middle-aged and older adults with chronic illnesses such as diabetes mellitus.

Further understanding is also needed regarding which aspects of direct social support are associated with health status changes over time. The composite score of the 7-item Diabetes Care Profile is typically used to assess overall direct social support for people with diabetes mellitus (Fitzgerald et al., 1996, 1998). However, research is needed to examine whether or not composite values from the 7-item Diabetes Care Profile predict health status change. For example, Gallant (2003) found that there is more evidence that social support is successful at improving diet and physical activity adherence than other types of chronic illness regimen activities. In addition, adherence to some

health behaviors—such as taking medications and physical activity—may have more impact on health decline over time than others. The few studies that have attempted to assess the relationship between particular aspects of direct social support and health status relationship prospectively have had very short follow-up periods (Nicklett & Liang, 2010; Sacco et al., 2009).

To address these gaps in knowledge, this study examines two key research questions: (a) whether or not overall direct social support protects against health decline among middle-aged and older adults with type 2 diabetes mellitus during an 8-year period; (b) which particular kinds of direct social support, if any, are protective against health decline. We hypothesized that higher overall direct social support at baseline will decrease the odds of health decline over time. We also hypothesized that certain direct social support aspects, particularly those related to more difficult aspects of regimen adherence (support for keeping weight under control and following diet and exercise aspects of the regimen), will be more protective against health decline than others (support for foot care, testing blood sugar, and meeting with health care providers).

Method

Sample Design

Data for this study were obtained from the Health and Retirement Study (HRS). HRS is a national, longitudinal, population-based study that has tracked older individuals for nearly two decades (Heeringa & Connor, 1995). The HRS Diabetes Study (2003) is sponsored by the National Institute on Aging and was conducted by the University of Michigan.

We analyzed data from 1,099 individuals with type 2 diabetes mellitus who participated in the 2003 HRS Diabetes Supplement and in the general HRS survey from 2004 to 2010. Our study is restricted to older adults with type 2 diabetes. Type 1 diabetes is diagnosed earlier in life, and the critical window for direct social support to affect later health likely occurs at younger ages. In contrast, type 2 diabetes is often first diagnosed in middle and old age, at a time when direct social support for diabetes management can affect risk of later diabetes complications, health status, and mortality.

The mailed 2003 Diabetes Supplement was fielded to 2,381 individuals who had affirmed they had an unspecified kind of diabetes in the previous (2002) HRS round and who were not participating in any other HRS mail surveys that year. The mailed survey requested information on a variety of domains, including medications, comorbidities, and health care providers. Questionnaires were returned by 1,901 participants (nearly 80% response rate), of which 1,516 had type 2 diabetes mellitus (385 respondents were excluded because they reported having type 1 diabetes or that they were uncertain).

Analytic sample and weights.—Participants considered appropriate (fit the sampling criteria) for this analysis were aged 50 and older, had type 2 diabetes mellitus, survived through follow-up, and received support for at least one aspect of their diabetes regimen. Of the 1,516 eligible participants, 371 experience loss to follow-up due to mortality (24.5%). Although these participants are included in diagnostic analyses (Table 1), they were excluded from multivariate analyses. The remaining 1,145 participants were considered appropriate for this study. An additional 46 participants (4%) were excluded due to missing data on all social support measures or on key sociodemographic, health, and behavior variables. The resulting analytic sample size is 1,099 participants.

Weights were constructed by the HRS to adjust for the complex sampling design and nonresponse to generate unbiased estimates for the 2003 Diabetes Supplement respondents specifically.

Measures

Dependent variable.—SRH was assessed by the question, "Would you say your health is excellent, very good, good, fair, or poor?" This global categorical measure has been found to be highly concordant with clinical assessments, as well as a reliable predictor of mortality and health care utilization (Idler & Benyamini, 1997). SRH was recoded to 5 (*excellent*), 4 (*very good*), 3 (*good*), 2 (*fair*), and 1 (*poor*). To examine the relationship between direct social support and long-term SRH outcomes, our analysis tested the cumulative odds of reporting an increase in the SRH values (e.g., good vs. poor; excellent vs. good) over time. The cumulative odds of improved SRH measures were examined at baseline (2003) and during a 7-year follow-up (2004, 2006, 2008, and 2010). Dependent variable coefficients examine overall trends in SRH values over time. Coefficients greater than 1 suggest that SRH has improved during follow-up. Coefficients that are less than 1 suggest that SRH has declined over time. Finally, a coefficient of "1" indicates that SRH values were generally stable over follow-up.

Independent variables.—Following Fitzgerald and colleagues' (1996, 1998) Diabetes Care Profile, participants were asked the extent to which they agreed with the following statement in 2003: "I can count on my family or friends to help and support me a lot with… [regimen component]." The regimen included following a recommended eating plan, taking medicine, checking feet regularly for wounds or sores, engaging in regular physical activity, testing blood sugar, health care providers, and keeping one's weight under control. Response options were on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Some respondents indicated that certain aspects were not a part of their regimen (or the response was missing), which ranged from 4.4% (support for going to health care providers and keeping weight under control) to 6.7%

Table 1. Characteristics of Surviving and Nonsurviving Participants in the Health and Retirement Study and 2003 Diabetes Study at Baseline, Weighted Sample

Characteristic	Mean/% survivors (n = 1,099)	Mean/% nonsurvivors (n = 371)	t Value	p Value	Variable type
Self-rated Health Status (baseline)	2.79	2.39	−8.79	.013*	Ordinal (1–5)
Support for following meal plan	3.69	3.82	1.28	.33	Ordinal (1–5)
Support for taking medicine	3.93	4.11	3.24	.08†	Ordinal (1–5)
Support for taking care of feet	3.79	3.91	0.21	.85	Ordinal (1–5)
Support for getting enough physical activity	3.73	3.81	1.13	.38	Ordinal (1–5)
Support for testing blood sugar	3.84	3.96	0.77	.52	Ordinal (1–5)
Support for going to health care providers	4.03	4.14	2.15	.17	Ordinal (1–5)
Support for keeping weight under control	3.80	3.89	0.76	.53	Ordinal (1–5)
Sex (male)	46.40%	46.90%	1.44	.29	Binary (ref: Male)
Age (years)	67.33	73.30	3.45	.08†	Continuous
Race/Ethnicity					Categorical (ref: White)
Non-Hispanic White (White)	70.00%	73.05%	0.30	.79	Binary (ref.)
Non-Hispanic Black	16.85%	14.29%	−2.27	.15	Binary (ref.)
Hispanic/Latino	10.50%	10.78%	0.13	.91	Binary (ref.)
Other	2.69%	1.89%	0.48	.68	Binary (ref.)
Education					Categorical (ref: LTHS)
LTHS	26.86%	41.24%	1.67	.24	Binary (ref.)
High school or GED	36.51%	32.61%	−7.33	.018*	Binary (ref.)
Some college	20.39%	15.36%	0.63	.59	Binary (ref.)
College or more	16.24%	10.78%	−8.25	.014*	Binary (ref.)
Insulin use	20.63%	33.96%	3.05	.09†	Binary (ref.)
Comorbidities	2.17	2.83	4.41	.048*	Count
BMI	30.58	29.36	0.93	.45	Continuous
Functional difficulty	13.19%	36.93%	3.43	.08†	Binary (ref.)
Physical activity (once per week)	88.28%	66.31%	−3.50	.07†	Binary (ref.)
Drink alcohol	36.02%	23.19%	−3.41	.08†	Binary (ref.)
Currently smoke	9.19%	10.38%	0.80	.51	Binary (ref.)

Notes. Not all percentages add up to 100.00% due to rounding. LTHS = less than high school; GED = General Educational Development certificate or credential; BMI = body mass index.

*Indicates significant difference between survivors and nonsurvivors on the characteristic at $p < .05$.

†Indicates significant difference between survivors and nonsurvivors on the characteristic at $p < .10$.

(support for taking medicine). As direct social support variables are analyzed separately in most models, participants with missing values on some (but not others) are maintained in the overall sample of the study. As a result, sample sizes vary slightly in some multivariate models. The majority of participants (90%) provided responses for all aspects of direct social support. Of the participants who did not provide responses for each aspect of direct social support, most were missing data on multiple domains. As stated earlier, participants with missing data on all aspects were considered out of scope and therefore excluded from the study.

We developed a composite scale for direct social support modeled after the Diabetes Care Profile. This scale was calculated by summing the possible responses for the seven direct social support variables, consistent with the validated scale produced by Fitzgerald and colleagues (1996, 1998). Higher numbers represent greater overall direct social support. As the seven summed measures that comprised the scale each had a minimum score of 1, seven points were subtracted from the scale total to produce a range in the scale of 0–30. Seventy-nine (7.2%) respondents indicated that one or more of the seven analyzed regimen components was not part of their regimen (or did not respond) and did not receive a composite score.

Sociodemographic, health, and behavior covariates.—We included the following sociodemographic characteristics as covariates: sex, age, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic/Latino, and other), and educational status (less than high school, high school or General Educational Development certificate or credential [GED], some college, or college or more). We also controlled for baseline health measures to reduce potential confounding, including diabetes severity, comorbidity, functional ability, and body composition. Insulin use was used as a proxy for disease severity at baseline. Comorbidity was determined by the number of diagnosed chronic illnesses in addition to diabetes mellitus (including high blood pressure, cancer of any kind, lung disease, a heart condition, a stroke, emotional/psychiatric problems, or arthritis), ranging from 0 to 7 comorbidities. Body composition was measured as body mass index (BMI) at baseline. Functional limitations were assessed by the number of Instrumental Activities of Daily Living (IADLs) in which participants reported "some difficulty" completing independently. IADLs evaluate the

extent to which participants can engage in higher ordered skills, which are necessary for independent living (Gitlin et al., 2006). Due to the emphasis on independent living and the scale's relatively high variability, IADLs were selected as the most appropriate measure of baseline functional status in our sample of community-dwelling older adults. Measured IADL activities included using the phone, managing money, taking medications, shopping for groceries, and preparing hot meals at baseline. We also controlled for health behavior characteristics at baseline, including whether or not the participant engaged in physical activity at least once per week, consumed alcohol, and/or smoked at baseline. With the exception of insulin use, which was ascertained from the 2003 Diabetes Supplement, all baseline control variables were assessed in the 2004 HRS round.

Statistical Analysis

We first calculated descriptive statistics for each of the key variables. We also analyzed whether or not these values differ significantly between survivors and nonsurvivors in the sample. To examine our hypotheses, we used ordinal logistic regression (OLR) analyses to test whether or not baseline social support was associated with change in SRH longitudinally and across repeated measures.

To test our hypotheses, we conducted OLR analysis (also described as proportional odds analysis). This method was chosen due to the ordinal nature and repeated measure of the dependent variable from 1 (*poor*) to 5 (*excellent*). In the context of this study, the approach describes the cumulative odds of improved health from baseline through follow-up. This method takes the ordering of response categories into consideration when estimating how predictor variables relate to probabilities of a given response over time (Bender & Grouven, 1997). OLR calculates a single odds ratio (OR) for the association between a predictor variable (e.g., support from friends/family in following a recommended eating plan) and each combination of higher risk versus lower risk outcome categories over follow-up (e.g., excellent health vs. other categories; very good health vs. other categories; poor, fair, good, or very good health vs. excellent health).

Proportional odds assumptions were tested (and found to be met) by comparing the OLR model with multinomial logistic regression through a nested model approach (Stata Corporation, 2007). The key predictor and outcome variables were normally distributed. All analyses were conducted using Stata version 10.0 (College Station, TX). The OLR models were fitted with the Stata "ologit" command using weights to take the complex sampling design features into account (Clayton & Hills, 1993; Liu & Koirala, 2013).

We conducted a series of OLR analyses to examine our first hypothesis that baseline direct social support (measured as baseline values of the Diabetes Care Profile) is protective against long-term health decline (assessed through proportional odds of lower SRH values over repeated measures). In addition to the fully adjusted model, we included results for models that adjusted for different covariate domains to enable interpretation of how the inclusion of certain covariates influenced results. The analyses examined whether or not the Diabetes Care Profile scale predicted change in SRH, controlling for sociodemographic characteristics (Model 1), health characteristics (Model 2), and behavior characteristics (Model 3). Model 4 examines whether or not the Diabetes Care Profile scale predicts SRH change, adjusting for all sociodemographic, health, and behavior characteristics.

To examine our second hypothesis that some kinds of direct social support (such as keeping weight under control and following diet and exercise aspects of the regimen) are more protective against health decline than others, we tested each direct social support item separately with change in SRH as the outcome. The models tested the odds of improved health for each aspect of direct social support, adjusting for the sociodemographic, health, and behavior characteristics described earlier.

Results

Descriptive Statistics

A brief description of measures and baseline characteristics of participants are shown in Table 1. The weighted sample used for multivariate models (survivors, n = 1,099) had 46% men. Among survivors, the racial/ethnic composition of participants was non-Hispanic White (70%), non-Hispanic Black (17%), Hispanic/Latino (11%), and other/unspecified (2%). At baseline, about 37% participants reported having graduated from high school, 20% received some college, and 16% completed college or more. Approximately 27% had not completed high school at baseline. At baseline, the mean age of the sample was 67 years (range 50–96 years). Twenty-one percent of surviving participants took insulin. On average, participants had more than two additional comorbidities and a BMI of 30.58, which is considered obese. Approximately 13% of respondents reported some difficulty in IADLs. Most participants (88%) engaged in physical activity at least once per week, 36% drank alcohol, and 9% smoked.

Survivors were more likely to report better health at baseline than the 371 participants who died after 2003 (mean baseline SRH: 2.79 for survivors and 2.39 for nonsurvivors; p = .01). Survivors were more likely to have completed postsecondary education (16.24% vs. 10.78%, $p < .05$) and to have a high school degree as the highest level of education (36.51% vs. 32.61%, $p < .05$) relative to nonsurvivors. Survivors reported, on average, less comorbidity in addition to diabetes than nonsurvivors (2.17 vs. 2.83). There were no significant differences in the levels of direct social support between survivors and nonsurvivors. The groups also did not differ by sex, age, or race/ethnicity. Survivors and

nonsurvivors did not significantly differ in baseline measures of disease severity, functional status, or BMI. Finally, survival did not differ by physical activity, alcohol use, or smoking status. Therefore, by focusing on survivors, our sample overrepresents groups with higher baseline SRH, fewer comorbidities, and higher levels of education. (See Table 1 for additional comparisons of survivors and nonsurvivors).

The Diabetes Care Profile Scale

The Diabetes Care Profile scale was positively associated with health status over time; however, this relationship was only marginally significant after controlling for sociodemographic and health-related characteristics (OR = 1.03, $p = .06$). Therefore, participants who reported higher levels of direct social support as indicated by the Diabetes Care Profile tended to have lower odds of health decline, but the results were not significant at $p < .05$. The OR of the scale was stable across models (1.02–1.03), but only reached marginal significance when behavior characteristics were considered and in the full model. The results of these tests are shown in Table 2.

Individual Aspects of Direct Social Support

The ordinal multivariable logistic regression analyses adjusting for baseline sociodemographic and health characteristics (Table 3) demonstrate that some aspects of direct social support were significantly associated with change in health status, whereas others were not. As shown in Model 2, a one-unit increase in support for taking one's medicine predicted 22% higher odds of improvement in SRH over the data collection period ($p = .037$). Model 4 demonstrates that a one-increment increase of support for getting enough physical activity predicted 26% higher odds of health improvement ($p = .011$). Finally, as shown in Model 6, a one-unit increase in support for going to health care providers predicted 22% higher odds of health improvement within 7 years ($p = .043$). A one-unit increase in support for keeping one's weight under control was associated with 17% higher odds of health improvement; however, this was only marginally significant (at $p = .08$). The other measures—reported support from friends/family for following a meal plan, taking care of one's feet, and testing one's blood sugar—did not significantly predict change in SRH over time in multivariable models. We repeated analyses imputing missing data on all covariates using multiple imputations. As shown in Table 3, these results are fairly stable across models, a few notable differences in statistical significance across models (e.g., support for taking medicine is only a significant predictor in the fully adjusted model).

Discussion

In this sample of middle-aged and older adults with type 2 diabetes mellitus, reported baseline support from family and friends in taking medicine, getting enough physical activity, and going to health care providers was associated with subsequent improvements in SRH, controlling for baseline sociodemographic and health-related

Table 2. Ordinal Logistic Models for the Diabetes Care Profile Scale With SRH and Control Variables for a 7-Year Follow-up Period in Survivors, Weighted Sample

	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Characteristic	*N* = 1,081	*N* = 1,001	*N* = 1,008	*N* = 987
Diabetes Care Profile Scale	1.02 (−0.02, 0.05)	1.02 (1.00, 1.05)	1.03 (1.00, 1.06)†	1.03 (1.00, 1.06)†
Sex (ref: Male)	0.07 (−0.28, 0.42)			0.72 (0.49, 1.06)†
Age	0.01 (−0.01, 0.03)			1.02 (1.00, 1.04)
Race/ethnicity (ref: White)				
Non-Hispanic Black	0.02 (−0.37, 0.41)			1.08 (0.68, 1.73)
Hispanic/Latino	−0.14 (−0.77, 0.50)			0.71 (0.36, 1.39)
Other	−2.11 (−3.19, −1.03)**			0.15 (0.03, 0.70)*
Education (ref: LTHS)				
High school or GED	0.53 (0.12, 0.94)*			1.43 (0.93, 2.21)
Some college	0.31 (−0.20, 0.83)			1.11 (0.64, 1.94)
College or more	0.96 (0.29, 1.64)**			2.23 (1.09, 4.56)*
Insulin use (ref: Use)		0.93 (0.65, 1.34)		0.93 (0.63, 1.38)
Comorbidities		0.66 (0.58, 0.76)**		0.69 (0.60, 0.80)**
BMI		0.97 (0.94, 0.99)*		0.97 (0.95, 1.00)†
Functional difficulty		0.51 (0.36, 0.74)**		0.70 (0.46, 1.07)
Physical activity			3.03 (2.08, 4.41)	2.03 (1.31, 3.17)**
Alcohol consumption			2..18 (1.47, 3.22)**	1.77 (1.09, 2.87)*
Smoke			0.82 (0.48, 1.41)**	0.95 (0.51, 1.77)

Notes. The control variables in the four models are sociodemographic (Model 1), health (Model 2), behavior variables (Model 3), and the full model (Model 4). CI = confidence interval; OR = odds ratio; BMI = body mass index.; LTHS = less than high school; GED = General Educational Development certificate or credential; SRH = self-rated health.

*$p < .05$. **$p < .01$. †$p < .10$.

Table 3. Separate Multivariable Ordinal Logistic Models for Direct Social Support Components and Other Variables With SRH for a 7-Year Follow-up Period in Survivors, Weighted Sample

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Characteristic	*N* = 1,017	*N* = 1,035	*N* = 1,029	*N* = 1,022	*N* = 1,038	*N* = 1,034	*N* = 1,034
Support for following meal plan	1.14 (0.96, 1.37)	—	—	—	—	—	—
Support for taking medicine	—	1.22 (1.01, 1.48)*	—	—	—	—	—
Support for taking care of feet	—	—	1.15 (0.96, 1.38)	—	—	—	—
Support for getting enough physical activity	—	—	—	1.26 (1.06, 1.51)*	—	—	—
Support for testing blood sugar	—	—	—	—	1.12 (0.95, 1.32)	—	—
Support for going to health care providers	—	—	—	—	—	1.22 (1.01, 1.48)*	—
Support for keeping weight under control	—	—	—	—	—	—	1.17 (0.98, 1.38)†
Sex (ref: Male)	0.74 (0.50, 1.08)	0.73 (0.51, 1.06)†	0.72 (0.50, 1.04)†	0.69 (0.47, 0.99)*	0.72 (0.50, 1.03)†	0.75 (0.52, 1.07)	0.74 (0.51, 1.07)
Age	1.02 (0.99, 1.04)	1.02 (1.00, 1.04)†	1.02 (1.00, 1.04)†	1.01 (0.99, 1.04)	1.02 (1.00, 1.04)†	1.02 (1.00, 1.04)	1.02 (1.00, 1.04)
Race/ethnicity (ref: White)							
Non-Hispanic Black	1.06 (0.67, 1.68)	1.06 (0.68, 1.67)	1.06 (0.67, 1.66)	1.05 (0.66, 1.67)	1.06 (0.68, 1.68)	1.06 (0.67, 1.67)	1.06 (0.68, 1.67)
Hispanic/Latino	0.70 (0.37, 1.33)	0.70 (0.37, 1.33)	0.70 (0.36, 1.33)	0.69 (0.36, 1.32)	0.71 (0.37, 1.34)	0.74 (0.39, 1.41)	0.71 (0.38, 1.34)
Other	0.15 (0.03, 0.77)*	0.23 (0.06, 0.79)*	0.23 (0.06, 0.82)*	0.22 (0.06, 0.84)*	0.23 (0.06, 0.83)*	0.14 (0.03, 0.65)*	0.14 (0.28, 0.73)*
Education (ref: LTHS)							
High school or GED	1.37 (0.90, 2.10)	1.43 (0.94, 2.17)†	1.45 (0.95, 2.22)†	1.41 (0.93, 2.14)	1.46 (0.96, 2.22)†	1.38 (0.91, 2.09)	1.38 (0.91, 2.10)
Some college	1.08 (0.63, 1.87)	1.06 (0.62, 1.80)	1.09 (0.63, 1.88)	1.10 (0.63, 1.91)	1.07 (0.62, 1.83)	1.12 (0.65, 1.92)	1.08 (0.63, 1.86)
College or more	2.31 (1.17, 4.56)*	2.21 (1.13, 4.34)*	2.42 (1.23, 4.74)*	2.32 (1.15, 4.67)*	2.35 (1.21, 4.58)*	2.37 (1.22, 4.62)*	2.40 (1.23, 4.68)*
Insulin use (ref: Use)	0.98 (0.67, 1.44)	0.96 (0.65, 1.40)	0.96 (0.65, 1.41)	0.97 (0.66, 1.43)	0.96 (0.66, 1.41)	0.98 (0.67, 1.44)	0.98 (0.67, 1.43)
Comorbidities	0.69 (0.60, 0.80)**	0.68 (0.59, 0.78)**	0.68 (0.59, 0.78)**	0.68 (0.60, 0.79)**	0.68 (0.59, 0.78)**	0.68 (0.59, 0.78)**	0.69 (0.60, 0.79)**
BMI	0.97 (0.95, 1.00)*	0.98 (0.95, 1.00)†	0.98 (0.95, 1.00)†	0.98 (0.95, 1.00)†	0.97 (0.95, 3.17)*	0.97 (0.95, 1.00)†	0.98 (0.95, 1.00)†
Functional difficulty	0.67 (0.45, 1.02)†	0.68 (0.45, 1.03)†	0.68 (0.45, 1.13)†	0.67 (0.44, 1.02)†	0.68 (0.45, 1.02)†	0.68 (0.45, 1.03)†	0.67 (0.44, 1.01)†
Physical activity	2.08 (1.36, 3.17)**	2.14 (1.39, 3.30)**	2.12 (1.36, 3.28)**	2.02 (1.30, 3.13)**	2.07 (1.35, 3.17)**	2.09 (1.36, 3.21)**	2.05 (1.34, 3.13)**
Alcohol consumption	1.70 (1.06, 2.71)*	1.67 (1.05, 2.63)*	1.68 (1.05, 2.67)*	1.76 (1.10, 2.79)*	1.69 (1.07, 2.68)*	1.68 (1.06, 2.67)*	1.69 (1.07, 2.66)*
Smoke	1.01 (0.55, 1.85)	0.96 (0.53, 1.74)	0.97 (0.53, 1.75)	0.90 (0.50, 1.63)	0.93 (0.51, 1.71)	0.97 (0.53, 1.74)	0.98 (0.53, 1.79)

Notes. CI = confidence interval; OR = odds ratio; BMI = body mass index; LTHS = Less Than High School; GED = General Educational Development certificate or credential; SRH = self-rated health.
*$p < .05$. **$p < .01$. †$p < .10$.

characteristics. This provides evidence for the social control perspective's position that direct forms of social support influence health (Uchino, 2004; Umberson, 1987). These findings provided only partial evidence in favor of our first hypothesis. Although we did not find that support—as measured in the Diabetes Care Profile scale—predicted change in health status overall, some forms of direct social support (taking medications, engaging in physical activity, and seeing health care providers) were protective against health decline over time. These findings did not provide support for our second hypothesis that support for domains in which diabetics are typically more resistant to change (diet, physical activity, and keeping weight under control) will be the strongest predictors of health status change, with the exception of support for physical activity.

Our study added to prior research on the effects of baseline direct social support on subsequent health by following participants for 7 years, a significantly longer period than prior population-based prospective studies (Nicklett & Liang, 2010; Sacco et al., 2009). Unlike prior studies, we also examined individual direct social support measures and overall direct social support (compared with the study by Ingram et al., 2007). Overall, this study provides evidence that provides support to the study's alternative hypotheses.

There are several mechanisms through which direct social support could protect against health decline among middle-aged and older adults with type 2 diabetes. Direct social support for adherence tasks are associated with improved consistency and accuracy of regimen adherence (DiMatteo, 2004; Gallant, 2003). Adherence is associated with better diabetes control and health outcomes (Holahan & Holahan, 1987; Karter et al., 2004; Peirce, Frone, Russell, Cooper, & Mudar, 2000; Rhee et al., 2005; Rozenfeld, Hunt, Plauschinat, & Wong, 2008). By helping increase diabetic adults' self-efficacy, direct social support may also help prevent depression, as people with more social support tend to have fewer depressive symptoms, thus avoiding depression's detrimental effects on diabetes outcomes (Lustman et al., 2000).

In our study, direct support for taking medicine, getting enough physical activity, and going to appointments each predicted significantly higher odds of improvement in SRH, ranging from 22% to 26%. In contrast, direct support for the other regimen aspects (following a meal plan, taking care of one's feet, testing one's blood sugar, and keeping one's weight under control) did not predict improved SRH. Consistent with our results, previous research suggests that some regimen-related activities are more strongly associated with health outcomes than others. Specifically, studies have found that regimen adherence, physical activity, and going to health care provider appointments are positively associated with improved health outcomes among older and chronically ill adults (Karter et al., 2004; Penedo & Dahn, 2005; Vik, Maxwell, & Hogan, 2004). Evidence has been mixed regarding the effectiveness in the aspects of the regimen in promoting health for which we did not find a significant relationship between support and SRH (Blonde & Karter, 2005; Flegal, Kit, Orpana, & Graubard, 2013).

If direct social support for following a meal plan, taking care of one's feet, testing one's blood sugar, and keeping one's weight under control translated into improved adherence of these activities, relative health would likely improve among middle-aged and older adults with type 2 diabetes mellitus. It is possible that we did not find a significant relationship because support for these activities did not result in higher adherence to these activities. Another explanation is that for these aspects of the diabetes regimen, a longer follow-up period is necessary to observe the impact of social support on SRH. The examination of HbA1c levels as the outcome is more sensitive to change than SRH (Ingram et al., 2007).

These findings suggest that the overall Diabetes Care Profile scale is not the optimal screening tool for clinicians in identifying adults with diabetes mellitus who are at higher risk of health decline. There could be more benefit in identifying diabetic adults with lower levels of direct social support in the domains of taking medicine, getting physical activity, and going to health care provider appointments. Patients with lower levels of support in these areas are at higher risk of health decline and could therefore benefit from more intensive resources to manage diabetes mellitus and other health risks.

These findings also have several important clinical implications. This study specifically finds that support for improving adherence in taking medications, engaging in physical activity, and meeting with health care providers improves health- and diabetes-related outcomes among middle-aged and older adults. Therefore, engaging, informing, and involving patients' friends and family in these activities directly are tangible strategies for improving outcomes in these domains and for the health of diabetics more generally. To encourage support for improving appointment and medication adherence, health care practitioners should encourage diabetic patients to bring a "medical visit companion" (such as a family member or a friend) to appointments, nutrition classes, and other events that provide information pertinent to diabetes (Wolff & Roter, 2008). This would provide the friend or family member with knowledge and insight into the patients' illness and how it should be managed, thus making them better positioned and informed to provide tangible support to encourage diabetes self-management. As diabetes self-management typically takes place in the home or in the context of families, linkages between clinical settings, the home, and the community are particularly beneficial for enhancing adherence (Culos-Reed, Rejeski, McAuley, Ockene, & Roter, 2000). Social support for physical activity has previously been associated with improved health behaviors and outcomes (Eyler et al., 1999). In clinical encounters, health care providers should encourage patients to engage in exercise with friends or family to improve activity levels, accountability, and support levels for these activities.

Future research should investigate whether or not interventions that target patients with relatively high or relatively low levels of support are most effective. This will inform interventions crafted to increase direct social support or to provide more intense support from other sources, such as health professionals, community health workers, or peers, thus preventing the excess health decline seen in this observational study.

Our study has several important limitations. In our study, we included only those participants who survived to age 50 and those who survived the 7-year follow-up period. The survivors were more likely to have higher levels of education and were less likely to use insulin at baseline relative to those who died. Our analytic sample of survivors also reported higher baseline SRH than those who died during follow-up. Therefore, our results reflect the effects of direct social support on people with diabetes mellitus who are relatively healthy, and have higher education, at baseline. Future studies should examine the effect of social support on length of survival and on mortality.

The direct social support characteristics and health status are based entirely on self-reported data. SRH is a global measure of health and well-being. Although SRH is an appropriate measure for evaluating change over time, responses could vary across participants based on interpretation of the global SRH measure. Previous studies suggest that although some respondents evaluate specific health problems, others consider mental health, general physical functioning, and/or health behaviors (Krause & Jay, 1994; Singh-Manoux et al., 2006). Although SRH is evaluated over time, direct social support was only evaluated at baseline. It is possible that support could change in response to change in health status. Although previous research suggests that support is steady or increases over time among older adults (Lang & Carstensen, 1994; van Tilburg, 1998), little is known about how direct social support for diabetes-related tasks varies over time.

This analysis examines the relationship between support and changes in health status over time. The follow-up period should be sufficient to observe behavior change and the manifestation of those changes in improved health. Because we examined direct aspects of support (as opposed to indirect aspects such as emotional support), any benefits of direct social support should be realized over follow-up because they operate through tangible mechanisms, such as diabetes self-care. As measures of direct social support were only available at baseline, the probabilities of change in SRH were examined over follow-up. Future studies with repeated measures of support can contribute to this research by describing trajectories of support and subsequent health behaviors and outcomes.

Our study includes a community-based sample, and the extent to which these findings could be generalized in institutional settings is not clear. As with any epidemiological study, there may be unmeasured factors that may confound the relationship between direct social support and SRH. Strengths of this study include a population-based sample, a longitudinal analysis with a sufficient follow-up period to examine change, and the ability to adjust for many key covariates that can influence social support and health decline.

In conclusion, support from family or friends for taking medications, physical activity, and going to health care providers was protective against health decline in this national longitudinal sample of middle-aged and older adults with diabetes mellitus. Future research should examine whether and how intervening with friends and family who provide support to patients could further protect against health decline for patients with type 2 diabetes mellitus. Interventions that specifically target improving specific aspects of diabetes social support may be more effective in improving long-term health than less targeted efforts.

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E. J. Nicklett conceived of the study, performed all statistical analyses, wrote the paper, and revised the manuscript. M. E. M. Heisler helped plan the study and revise the manuscript. M. Spencer helped revise the manuscript. A.-M. Rosland helped plan the study and assisted with writing and revising the manuscript.

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