

Social Support and Social-ecological Resources as Mediators of Lifestyle Intervention Effects for Type 2 Diabetes

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Abstract

A study was conducted to determine if an intervention could change social support and social-ecological resources of post-menopausal women diagnosed with type 2 diabetes, and if those changes mediated the intervention's effects on health behaviors and outcomes. Women ($N = 279$) were randomly assigned to receive a comprehensive 6-month Mediterranean Lifestyle Program (MLP) or usual care from their physicians (UC). MLP was successful in changing social embeddedness and social-ecological resources, but not a measure of perceived support. Changes in social-ecological resources mediated intervention effects on fat consumption, exercise and glycemic control. The experimental manipulation of mediators and the demonstrated mediation effects support the conclusion that social-ecological resources can contribute to improvements in healthful lifestyles for women with type 2 diabetes.

Keywords

- *intervention*
- *mediation*
- *social support*
- *type 2 diabetes*

INDIVIDUALS who have been diagnosed with type 2 diabetes have compelling reasons to adopt lifestyle changes that promote the control of blood glucose levels, improve quality of life and prevent diabetes complications such as heart disease, blindness and amputations. Nevertheless, making lifestyle changes can be a daunting challenge for even the most well-intentioned and well-informed patients. There are, no doubt, individuals who are successful in adopting more healthful lifestyles through autonomous efforts that appear to be self-directed. For many others, lifestyle changes occur in a social context of friends, family members, health professionals, community agents and social environmental settings that contribute to the behavior change process.

There is a massive literature on the connections between health and social resources, much of it tied to the concept of social support (Uchino, 2004). Many studies use correlational designs and are limited by the well-known constraints of such methods. However, there is an impressive accumulation of experimental research on diverse social support interventions directed at a broad array of health and mental health problem areas (Hogan, Linden, & Najarian, 2002). In the most extensive review of social support interventions, Hogan et al. (2002) analyzed the findings from 100 studies that evaluated the effects of social support interventions for smoking, obesity, cancer, heart disease, HIV infection, alcoholism, irritable bowel syndrome and other disorders; not one of the studies was concerned with type 2 diabetes. The reviewers observed that over 80 percent of the studies reported some beneficial effects of support intervention. Despite that positive feature, the research in general suffered from several serious limitations. The most serious limitation was the pervasive failure of researchers to determine if social support interventions actually changed dimensions of social support. Hogan et al. wrote:

Far and away, the most salient problem is that *most* of the studies examining efficacy of support interventions failed to include a measure of social support. This is particularly striking because investigators usually posit that improved support is their hypothesized reason for otherwise observed benefits.

Hence, underlying models cannot be tested. (2002, p. 425, emphasis in original)

This same observation was made in earlier reviews that considered more circumscribed support interventions (Barrera & Prelow, 2000; Bogat, Sullivan, & Grober, 1993).

The failure to determine if support interventions are successful in changing social support is a costly missed opportunity to inform both practice and theory. In essence, it is a missed opportunity to demonstrate that social support mediates the effects of an intervention on health behaviors and outcomes. Chen (1990) drew a useful distinction between action theory and conceptual theory components of a mediational model (MacKinnon, Taborga, & Morgan-Lopez, 2002). In a support intervention outcome study, investigators have the opportunity to address the action theory question, 'Was the intervention successful in changing social resource variables?' The action theory phase helps intervention designers determine if intervention activities were successful in altering those conditions that were hypothesized to change health outcomes. Failure to alter mediators might suggest modification or additions to the intervention to achieve the desired effects on social resources. The conceptual theory question is, 'Do changes in social resources account for changes in health outcomes?' This phase tests the theoretical assertion that social resources affect health-promoting behaviors and health outcomes. Although numerous correlational studies have found relations between social resources and health, there is still value in demonstrating that the experimental manipulation of social resources results in changes in health behaviors and outcomes.

The review by Hogan et al. (2002) discussed another important limitation of research on support interventions. They noted that simply including any measure of support within the design of a support intervention outcome study was not sufficient because there are numerous measures of support that assess distinct support concepts (Barrera, 1986). Hogan et al. advocated for the reasoned selection of social support measures that fit the implicit concepts underlying the intervention research hypotheses. One popular conceptual distinction contrasts structural and functional measures of

social resources (Cohen & Wills, 1985; DiMatteo, 2004). Structural measures include quantitative indicators of the extensiveness of a person's social ties such as marital status, network size and membership in community organizations. Functional measures assess the functions of social support such as emotional, instrumental, informational, companionship and validation support (Wills & Shinar, 2000). Functional measures include measures of perceived support that assess individuals' appraisals of support availability or adequacy (Cohen, 1988).

These distinctions are meaningful because measures of the concepts fit different theoretical models and show different relations to psychological distress and health. In the present study, prominent measures of structural and perceived support were included to determine if they could account for changes in health. Can healthful behaviors be accounted for by social embeddedness that is reflected in diverse social ties with organizations and informal relationships? Do people engage in healthful behaviors because they perceive that others care about them and their well-being?

Cohen (1988) described mechanisms that could account for the relation between social support and health: (a) suppression of negative affect; (b) enhanced immune system functioning; and (c) promotion of healthful lifestyles. In the present study, the focus is the hypothesized mechanism that links social resources to the promotion of healthful lifestyles, particularly lifestyles that include good nutrition and regular physical activity. Changes in eating habits and physical activity are difficult to achieve, yet there is some evidence that social support, particularly from family members, is related to healthful diet and exercise behaviors (Fitzgibbon, Stolley, Avellone, Sugerman, & Chavez, 1996; Glasgow & Toobert, 1988; Pham, Fortin, & Thibaudeau, 1996; Sallis & Nader, 1988).

Even a construct as broad as social support is typically limited to resources provided in personal relationships with family members, friends and acquaintances. Glasgow and his colleagues described a social-ecological approach to chronic disease management that incorporated some aspects of social support that are received from typical sources, but that also included forms of support from the broader community such as neighborhoods, worksites

and community organizations (Glasgow, Strycker, Toobert, & Eakin, 2000). In research to establish the validity of a scale to assess this broader construct, the Chronic Illness Resources Survey (CIRS), they found that it was related concurrently with measures of healthful eating and positive mental health and was related prospectively (four months later) to illness management and positive mental health. Furthermore, the CIRS was related to those validity indicators whereas more traditional measures of social support were not. Those results and other indications of the CIRS' reliability and validity suggested that there was value in understanding how social-ecological resources might affect the course of chronic illness management.

The present study

The Mediterranean Lifestyle Program is an experimental evaluation of an intervention for post-menopausal women who were diagnosed with type 2 diabetes. The randomized intervention trial compared a comprehensive lifestyle intervention to the usual diabetes care that women received from their regular physicians. The comprehensive intervention included procedures for improving eating, physical activity and stress management, but it also emphasized cohesion among participants and the mobilization of social resources to change lifestyle behaviors. Two previous reports established that the Mediterranean Lifestyle Program was more successful than usual medical care in changing eating practices, physical activity, stress management and biological measures of improved health (Toobert et al., 2003; Toobert, Strycker, Glasgow, Barrera, & Angell, 2005). The purpose of the present study was to determine if intervention effects were mediated by changes in social support and social-ecological resources (see Fig. 1). Because of the comprehensive aspects of the lifestyle intervention, the hypothesis was that all support and social-ecological variables would be affected by the intervention and that they would partially mediate the intervention's effects on health behaviors. Partial mediation was predicted because there were components of the intervention that were designed to change diet and physical activity outcomes directly

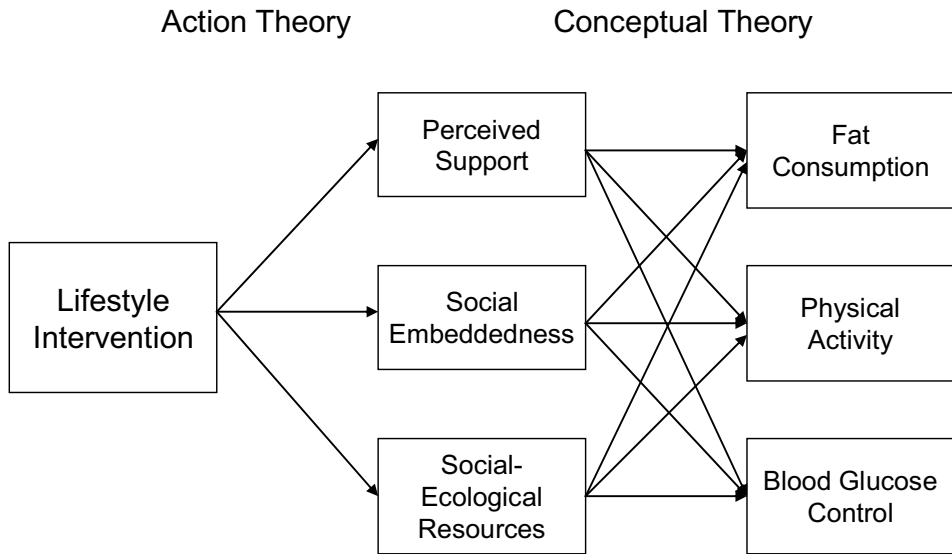


Figure 1. A conceptual model of social resource variables as mediators of the lifestyle intervention's effects on fat consumption, physical activity and blood glucose control.

rather than being mediated through social resources.

Method

Participants

Participants were 279 post-menopausal women with type 2 diabetes who received their medical care from participating primary care clinics. A participant was included if she was post-menopausal, diagnosed with type 2 diabetes for at least 6 months, lived independently (e.g. not in an institution), had a telephone, was able to read English, was not developmentally disabled and lived within 30 miles of the intervention site. Women were excluded if they were older than 75 or planned to move from the area within the study's time span of 2 years.

Rather than conducting this research with just those patients who would respond to an advertisement for supplemental treatment, we sought to reach a population of patients who were not actively seeking such treatment on their own. Eligible patients were sent a letter from their primary care physicians, followed by a telephone call inviting them to participate. Seventy percent of the physician practices that were approached to participate took part.

Participating and non-participating practices did not differ on the three variables that were available for comparisons: percentage of female physicians, type of medical specialty and independence of practice. Fifty-one percent of the women who were eligible, agreed to participate. Study participants ($N = 279$) were compared to those who declined participation in the study, but who provided some information during telephone screening ($n = 217$) (reported in Toobert, Strycker, Glasgow, & Bagdade, 2002). Those comparisons indicated no statistically significant differences in self-reported age, body mass index (BMI), age diagnosed with diabetes, type of diabetes medication used or smoking status. Relative to non-participants, participants had been diagnosed with diabetes for fewer years (8.5 vs 10.2, $p = .027$) and reported taking diabetes medications for fewer years (4.9 vs 6.7, $p = .006$).

All participants signed detailed informed consent statements prior to participation. Research procedures were reviewed and approved by an institutional review board. Participants agreed to participate in the study before they knew their assignment to conditions. Participants received no external incentives.

Design

A total of 116 participants were randomized to usual physician care (UC) and 163 to the Mediterranean Lifestyle Program (MLP). In assignment to experimental conditions, participants were stratified on: (a) physician practice; (b) smoking status; and (c) type of diabetes medication. Participants were assessed prior to the beginning of treatment and again six months following the initial assessment. More participants were assigned to the MLP condition to accommodate an 18-month extension of the study that further divided the MLP condition into two groups to compare long-term maintenance strategies.

Intervention

The six-month intervention began with a three-day retreat during which women were taught all program components. Retreats were followed by weekly meetings consisting of an hour each of physical activity, stress management, a Mediterranean diet potluck and support groups. Participants received manuals that detailed each aspect of MLP.

Dietary practices A registered dietician taught participants the Mediterranean alpha-linolenic acid-rich diet (de Lorgeril et al., 1994). The dietician individualized carbohydrate and fat requirements to optimize blood glucose and lipid concentrations within the parameters of the MLP. The diet recommended more bread; more root vegetables, green vegetables, and legumes; more fish; less red meat, replaced by poultry; no day without fruit; and avoidance of butter and cream, to be replaced by olive/canola oil products.

Physical activity Participants were advised to build up to one hour of moderate aerobic activity per day, at least three days per week. An exercise physiologist led exercise sessions at the weekly meetings.

Stress management Participants were instructed in yoga, progressive deep relaxation, meditation and directed or receptive imagery (Ornish, 1990; Toobert, Strycker, & Glasgow, 1998). Participants were asked to practice the techniques for at least one hour per day and were provided videotapes for use at home.

Support groups One professional who had at least master's level training and one peer leader (e.g. woman of similar age who had personal or family experience with diabetes) led each support group. Professional and peer leaders received extensive training in the supportive-expressive group therapy model used with the chronically and terminally ill (Spiegel & Classen, 2000). All leaders were supervised weekly.

Supportive-expressive therapy is designed to help patients express and explore both positive and negative illness-related affect, personalize their illness experience, move toward active coping with illness-related problems and encourage group support for illness problems and solutions. By creating the conditions for active coping and open discussion of support mobilization beyond the immediate group, the support intervention held the potential to broadly impact both social support and use of social-ecological resources.

Measures

Demographic and background variables Participants reported their age, family income and use of hormone replacement therapies. Family income was assessed using a 9-point scale where each scale point referred to a \$10,000 interval (1 = \$0 to \$9999, 9 = \$80,000 and more).

Social resources The 19-item MOS Social Support Survey (MOS) is a measure of perceived availability of functional support (Sherbourne & Stewart, 1991). The MOS instructions asked participants, 'How often is each of the following kinds of support available to you if you need it?' Items assessed five dimensions of social resources: emotional, informational, tangible, positive social interaction and affection. Participants rated the perceived availability of each item on a five-point scale that ranged from 'none of the time' to 'all of the time'. The scale was created and validated for use in the Medical Outcomes Study of chronic disease conducted by the Rand Corporation. In the present study, it had an internal consistency reliability of .96.

The Social Network Index is a structural measure of social integration that assessed social network diversity (Cohen, Doyle, Skoner,

Rabin, & Gwaltney, 1997). One point was given for the presence of each of 12 social relationships with whom a participant had contact at least once every two weeks (e.g. a spouse, child, parent, co-worker, religious organization member). Thus, scores reflected not only the existence of social relationships, but also frequency of contact with them. The Social Network Index has been used extensively including its use in the well-known study of social support and the common cold (Cohen et al., 1997). Internal consistency reliability was not an appropriate indicator of reliability for this measure because there was no a priori reason to expect that the presence of one type of a relationship (e.g. having a spouse) would be associated with having another type of relationship (e.g. a co-worker). The 6-month test-retest reliability for the UC control group was .42.

The brief Chronic Illness Resource Survey (CIRS) measured an individual's frequency of using resources from more proximal support (e.g. support from family and friends) to more distal factors (e.g. support from health care team, work and neighborhood or community) (Glasgow et al., 2000; Glasgow, Toobert, Barrera, & Strycker, 2005). The present study used a 22-item version. Participants rated their frequency of resource use on 5-point scales that ranged from 'not at all' to 'a great deal'. Previous research showed that the CIRS has good concurrent validity, internal consistency reliability ($d = .90$), and 1-month test-retest stability ($r = .83$) (Glasgow et al., 2000). In the present study, the CIRS showed an internal consistency reliability of .82.

Dietary fat Percentage of calories from fat was assessed with the Food Frequency Questionnaire (FFQ) developed at the Fred Hutchinson Cancer Center for the Women's Health Initiative (Patterson et al., 1999). This FFQ has been validated with 4-day food records and 24-hour dietary recalls (average correlation $r = .5$). The psychometric properties of this instrument have been reported in several studies (e.g. Kristal, Curry, Shattuck, Feng, & Li, 2000; Kristal, Shattuck, & Henry, 1990).

Physical activity The CHAMPS is a self-administered instrument developed for sedentary populations and tested primarily among

older adults. It consists of 41 items with frequency of activity assessed in times per week and duration classified using 6 categories ranging from 'less than 1 hour per week' to '9 or more hours per week'. Physical activity indices derived from the CHAMPS included caloric expenditure per week in all activities, which was used as the outcome measure. The CHAMPS has adequate test-retest reliability and has been demonstrated to be responsive to intervention effects (Harada, Chiu, King, & Stewart, 2001; Stewart et al., 2001).

Hemoglobin A_{1c} (HbA_{1c}) HbA_{1c} is a measure of a person's average blood glucose level over the past two- to three-month period. HbA_{1c} was assayed with ion exchange high-performance liquid chromatography using the BioRad Variant II Instrument and conducted at Oregon Medical Laboratories (OML) in Eugene, Oregon.

Results

Participant characteristics

Table 1 presents the baseline characteristics of women assigned to UC and MLP.

Because there was a condition difference on participants receiving hormone replacement therapy (59.3% in MLP vs 46.6% in UC, $p = .037$), receipt of hormone replacement therapy (no = 0, yes = 1) was used as a covariate in all subsequent analyses.

Attrition Six-month post-test data were collected on 245 (88%) of participants. A higher percentage of MLP participants (26 of 163, or 16%) did not complete the 6-month assessment than UC participants (8 of 116, or 7%), $\chi^2(1) = 5.19, p = .023$. Nevertheless, for participants who completed the 6-month assessment, there were no significant pre-treatment differences on any of the background, social resource or outcome measures. All participants who completed baseline and 6-month post-test assessments were included in the analyses.

Effects of the intervention on social support and social-ecological resource variables The first step in the mediation analyses was to determine if the intervention effected change in the three social resource variables (see Baron &

Table 1. Baseline characteristics of participants by treatment condition

Characteristic	Mean (SD) or Percent	
	Usual Care (n = 116)	MLP (n = 163)
Age	60.7 (7.8)	61.2 (8.1)
Income intervals	3.6 (2.1)	3.9 (2.2)
Hormone replacement therapy ^a	46.6%	59.3%
CIRS	2.7 (0.6)	2.7 (0.6)
MOS	3.9 (0.9)	4.0 (0.9)
Social Network Index	5.8 (2.0)	5.9 (2.4)
% fat calories (FFQ)	38.1 (9.3)	38.6 (9.0)
Caloric expenditure per week (CHAMPS)	3388.1 (3103.3)	3030.4 (2748.2)
HbA _{1c}	7.6 (1.6)	7.4 (1.3)

^a Two groups were significantly different, $p = .037$

Kenny, 1986). One regression model was estimated for each social resource variable. Age, income, hormone replacement therapy (no = 0, yes = 1), and intervention condition (UC = 0, MLP = 1) were the independent variables. Pre–post-change scores on social resource variables were the dependent variables. Lord's (1956) cautions about the unreliability of difference scores under certain conditions are still treated by some as a total condemnation of difference scores as appropriate estimates of change. However, over 20 years ago Rogosa and his colleagues demonstrated convincingly that difference scores are, in fact, highly reliable when there are individual differences in true change (e.g. Rogosa, 1988; Rogosa & Willett, 1983). They explained that only under the extreme and unlikely situation that all individuals grow at the same rate (i.e. no individual differences in change) are difference scores unreliable. For studies with two assessment periods, change scores are unbiased estimates of true change (Rogosa, 1988).

Regression analyses showed a significant intervention effect on pre–post-changes in the CIRS, $F(1, 231) = 11.45$, $\Delta R^2 = .05$, $p < .001$ and the Social Network Index, $F(1, 232) = 7.51$, $\Delta R^2 = .03$, $p < .01$, in the predicted direction, but not for the MOS, $F(1, 231) = 0.92$, NS. Because the intervention did not change MOS scores, they were not considered further in the mediation analyses.

Effects of the intervention on the outcome variables

One regression model was estimated

for each outcome. As in the regression models described earlier, the independent variables were age, income, hormone replacement therapy and intervention condition. Pre–post-changes on the physical activity (CHAMPS), percentage of calories from fat (FFQ), and HbA_{1c} were the dependent variables. As shown in Table 2, there were significant treatment effects on all of dependent variables.

Mediation effects for the CIRS and the Social Network Index Table 2 also shows the effects when pre–post-change on the CIRS was introduced into the last set of regression models. Pre–post-change on the CIRS was significantly related to change in all three dependent variables after accounting for the effects of age, income, hormone replacement therapy and intervention condition. Change in the CIRS accounted for 4–5 percent of the variance in outcome variable changes. The mediated effect was tested for significance (MacKinnon & Dwyer, 1993; Preacher & Leonardelli, 2001). Those tests showed that the CIRS significantly mediated the interventions effects on physical activity change ($z = 2.37$, $p = .02$), fat consumption change ($z = -2.35$, $p = .02$) and HbA_{1c} change ($z = -2.24$, $p = .02$). The percentages of the total effect that were attributable to the mediated effect were 23.13 percent for physical activity change, 12.74 percent for fat consumption change and 25.08 percent for HbA_{1c} change (see Fig. 2).

Similar analyses were conducted to determine if changes in the Social Network Index mediated

Table 2. Regressions without and with pre-post-changes in social resource variable (CIRS)

	Caloric expenditure (CHAMPS)						% calories from fat (FFQ)						HbA _{1c}						
	Without mediator			With mediator			Without mediator			With mediator			Without mediator			With mediator			
	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE	
Age	-10.89	29.76	-14.91	29.12	.000	.001	.000	.000	.001	.000	.001	-.004	.007	-.003	.007	-.003	.007		
Income	-61.65	106.24	-94.83	104.31	-.002	.002	-.002	.002	-.001	-.001	.002	.010	.026	.019	.026	.019	.026		
HRT	771.31	452.04	792.84	441.88	.004	.010	.004	.010	.003	.003	.010	.126	.112	.116	.110	.116	.110		
Treatment	1375.38**	436.62	1056.93*	437.26	-.053**	.010	-.046**	.010	-.046**	.010	-.046**	-.299**	.109	-.224*	.110	-.224*	.110		
CIRS	-	-	1407.72**	420.90	-	-	-	-	-.030**	.009	-.030**	-	-	-.317**	.106	-.317**	.106		
Total	.06	3.67**	.11	5.31**	.12	8.02**	.12	8.02**	.16	.16	8.69**	.04	2.37	.08	3.75**	.08	3.75**		
d.f.		4,218		5,217		4,229		4,229			5,228		4,224		5,223		5,223		

p* < .05, *p* < .01

intervention effects. Change in the Social Network Index was significantly related to change in physical activity scores even after accounting for the effects of age, income, hormone replacement therapy and the intervention condition, $F(1, 217) = 8.40, \Delta R^2 = .04, p = .004$. Change in the Social Network Index also was a significant mediator of the intervention's effect on changes in physical activity scores ($z = 1.99, p < .05$). The mediated effect accounted for 15.39 percent of the total effect (see Fig. 3). Change in the Social Network Index did not mediate the intervention effects on fat consumption or HbA_{1c}.

Discussion

The goal of this study was to evaluate social resources as mediators of the effects of a comprehensive lifestyle intervention on the health of women with type 2 diabetes. Results showed that changes in the social-ecological resources assessed by the CIRS mediated intervention effects on all of the outcome criteria—caloric expenditure per week from all physical activity, percentage of calories from fat and HbA_{1c}. Changes in the extensiveness of social ties (the Social Network Index) mediated the intervention's effect on physical activity. Surprisingly, the measure of perceived availability of social support (MOS) was not affected by the intervention and did not show mediation effects.

When Chen's (1990) framework for evaluating interventions is applied to these findings, it is apparent from the action theory analysis that the comprehensive MLP intervention was effective in increasing participants' reported use of social-ecological resources and their contacts with network ties. For over 20 weeks, MLP participants met with other support group members and trained leaders to help participants express feelings, to mobilize active coping with illness-related problems and to encourage group support around illness problems and solutions. It is conceivable that the groups were responsible for the changes observed in the social-ecological resources assessed by the CIRS as well as the changes assessed by the Social Network Index. Although it would be tempting to attribute changes in social resources solely to the social support group component

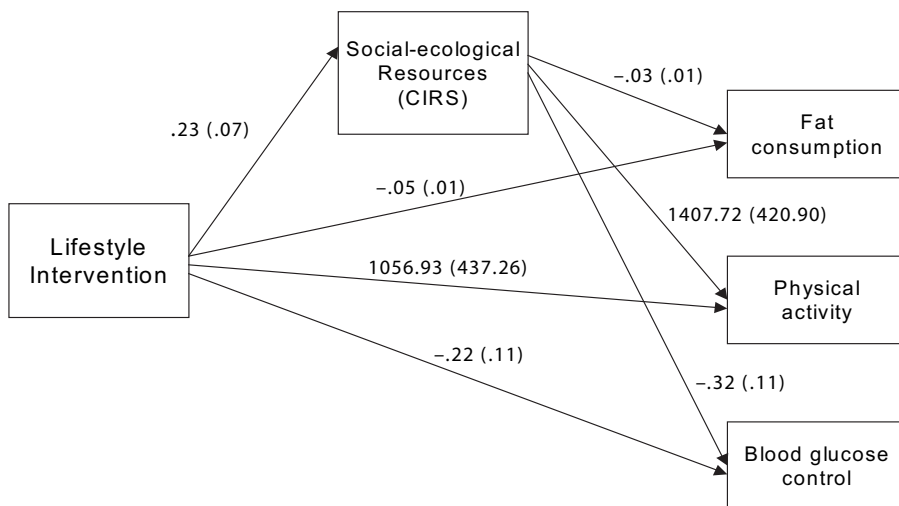


Figure 2. Social-ecological resources as a mediator of the lifestyle intervention’s effects on fat consumption, physical activity and blood glucose control. Numbers shown are statistically significant unstandardized regression coefficients (standard errors in parentheses). Separate regression models were estimated for each dependent variable.

of the MLP intervention, the study was not designed to evaluate each intervention component independently. It would have been premature (and very costly) to design a study to evaluate the four individual components of MLP before establishing that the comprehensive intervention affected the mediators and outcomes. This study was successful in the critical action theory demonstration that the comprehensive intervention led to changes in social resources.

The findings also were consistent with the underlying conceptual theory. Changes in the CIRS mediated intervention effects on all outcomes; changes in the Social Network Index mediated effects on physical activity. The effects involving the CIRS were particularly remarkable because of their consistency across the diet, exercise and biological outcome variables. The CIRS’ sensitivity to outcome effects should not be surprising because it was developed specifically for those who are challenged with chronic

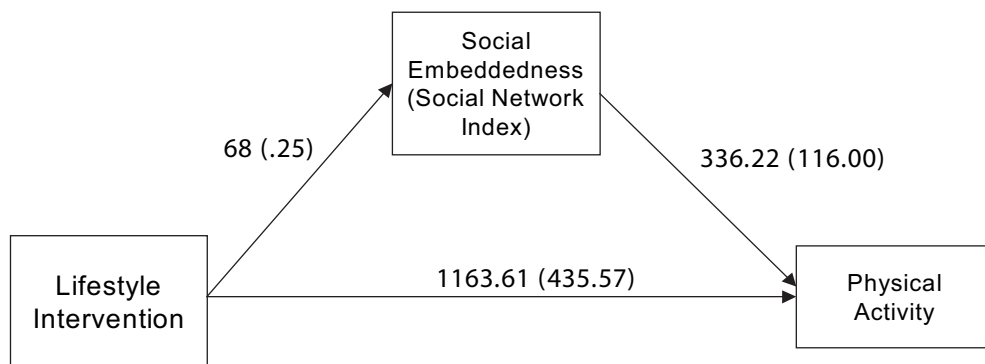


Figure 3. Social embeddedness as a mediator of the lifestyle intervention’s effects on physical activity. Numbers shown are statistically significant unstandardized regression coefficients (standard errors in parentheses).

illnesses (Glasgow et al., 2000). As a result, the social-ecological resources assessed by the CIRS (e.g. 'Have you walked or done other exercise activities with neighbors?') were tied to illness self-management more closely than measures of general social support. Although the Social Network Index items do not make specific reference to coping with illness, that measure has shown sensitivity to illness-related factors in previous research (Cohen et al., 1997; Hamrick, Cohen, & Rodriguez, 2002). Because the Social Network Index assesses relationships that were contacted at least once every two weeks, the intervention might have created change in that measure by increasing the frequency of contacts with existing social relationships.

It was surprising that the intervention did not alter perceived social support, which precluded the possibility of mediation effects for that construct. One possible explanation for the lack of an intervention effect on perceived social support is that the intervention simply did not have the elements to change participants' appraisals of support availability. Although that remains a possibility, it seems unlikely that the intervention could change the diversity of social network ties and the use of social-ecological resources without changing perceptions of social support. A more plausible explanation is that the MOS measure of perceived social support (Sherbourne & Stewart, 1991) was not sensitive to intervention effects. The MOS was not designed or validated as an intervention outcome measure. In fact, in its initial evaluation it showed rather high temporal stability (.78) over a 1-year interval (Sherbourne & Stewart, 1991). Even an Internet-mediated virtual support intervention was able to alter the perceived availability of social support, but that study used a social support measure designed specifically to be sensitive to the types of support that could be exchanged in a virtual support group (Barrera, Glasgow, McKay, Boles, & Feil, 2002). It is possible that the intervention could have been strengthened to exert a larger effect on perceived social support, but it is also possible that another measure of perceived social support would have detected changes caused by the MLP intervention.

The present study had several strengths. First, it was an experimental manipulation of support

and social ecological resources that allowed for tests of mediation. Despite some notable exceptions in laboratory research (Uchino, 2004) and controlled trials (Miller, Trost, & Brown, 2002), there has been a heavy reliance on correlational data for establishing empirical links between social support and health outcomes. For example, all of the studies in the meta-analysis by DiMatteo (2004) on social support and adherence to medical treatment were correlational. Experiments in the form of intervention outcome research have special value because they evaluate the efficacy of systematic efforts to improve health outcomes while at the same time allowing for tests of theoretical mechanisms underlying change in those outcomes. Also, consistent with the recommendations of Hogan et al. (2002), this study used multiple measures of distinct support and social resource constructs that were plausible factors for changing health outcomes. An additional strength was the inclusion of glycosylated hemoglobin as an outcome measure that supplemented self-reports of diet and exercise practices.

There also were limitations to the research. The current study was restricted to just postmenopausal women with type 2 diabetes. Although the participants were highly representative of patients from the local community (Toobert et al., 2002), this sample (like all samples) had obvious constraints. The success of the intervention trial suggests that it would be worthwhile to expand the external validity of this study with more diverse samples in other communities. Six months is a short interval for assessing lifestyle changes. On-going longitudinal assessments will determine how well participants maintain changes in social resources and health behaviors. It is important to acknowledge some common limitations to the conclusions that can be drawn from the mediational analyses (Holland, 1988). The statistically significant relation of the intervention to the mediator represents a causal relation because the intervention was randomly assigned to participants. However, the relation of the mediators to the outcome might not reflect a causal relation because participants were not randomized to levels of the mediator. It is possible, though not likely, that the outcome variables might be the intervening variable and the mediator might be the outcome. Mediated effects might also differ

for subgroups of participants. Mediation processes at later times might differ from the six-month effects that were analyzed here. Additional waves of data from this project will address these limitations and further elucidate the mediators of this intervention.

Future research should continue to develop and evaluate methods for creating new social support resources and mobilizing existing resources. Variations in the structure and the content of support groups can influence how effective the interventions are in improving health and might interact with specific characteristics of the participants (Helgeson, Cohen, Schulz, & Yasko, 2000; Helgeson & Gottlieb, 2000). In the present study the intervention affected social-ecological resources that went beyond traditional components of social support. Future research on the MLP and on community-based programs should explore how participants use intervention components to change the ways they access social-ecological resources. Such research strategies might include qualitative as well as quantitative approaches.

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