Self-monitoring of Physical Activity

Effects on Self-efficacy and Behavior in People With Type 2 Diabetes

Purpose

The purpose of this study was to test the effect of keeping daily activity records on physical activity levels and self-efficacy for physical activity in adults with type 2 diabetes, and to examine the feasibility and acceptability of this intervention from the perspective of the participants.

Methods

This intervention study included 58 individuals with type 2 diabetes aged 40 to 65 years. Participants were randomly assigned: individuals in the intervention group kept daily activity records for 6 weeks, mailed to the researcher every 2 weeks. Data collection was completed at the beginning of the study and 6 weeks later, using the habitual physical activity index and the self-efficacy for exercise scale. Participants in the intervention group also completed the perceived feasibility checklist.

Results

The intervention resulted in enhanced self-efficacy. Physical activity improved in both the intervention and control groups. Activity recording was judged to be acceptable and feasible.

Conclusions

Daily activity recording can be used as part of a program to increase physical activity self-efficacy levels. Focused interactions between health care providers and patients

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may be enough to motivate people to higher levels of physical activity. The relationship between self-efficacy and behavior is complex and should be the subject of further research.

Lack of adequate physical activity is a contributing factor in the rising prevalence of type 2 diabetes. Higher levels of physical activity, even of moderate intensity, are associated with a substantial reduction in risk. Although physical activity is a recommended treatment of diabetes, levels in adults with type 2 diabetes are low. In one study, 31% of the people with diabetes surveyed reported no regular physical activity, and an additional 38% reported less than recommended levels.

Physical inactivity in people with type 2 diabetes has been found to be a significant predictor of higher overall mortality. Numerous studies show that metabolic parameters can be improved through increased levels of physical activity.

Recommendations abound for the development of interventions that aim to increase the level of physical activity of adults and thereby reduce diabetes-related risks. The challenge, however, is to help individuals with well-ingrained habitual patterns create healthy lifestyle modifications. Interventions that encourage self-responsibility and promote self-efficacy could enhance attempts to change health habits. Self-monitoring activities, such as keeping logs or journals, provide cues to enact desired behavior yet are simple to administer, low in cost, and require minimal time from the health care professional.

Theoretical Framework

Social cognitive theory provides one approach to understanding human action and was the guiding framework for this study. The theory is based on the idea that behavior is influenced by a transaction between behavior, cognitive thoughts, and environmental stimuli. Perceived self-efficacy describes the belief a person has about his or her personal capabilities to accomplish a task and is commonly thought of as a person’s confidence regarding the behavior. Efficacy beliefs affect what people will try, motivating them to choose skills with which they believe they will be successful. According to the theory, self-efficacy beliefs are influenced by 4 main sources: enactive attainment, vicarious experience, social persuasion, and physiological/emotional states. Enactive attainment is based on a person’s actual past performance, giving an authentic measure of a person’s capability that can encourage further attempts. Vicarious experience comes from the confidence gained by seeing other people judged to be similar to self perform the behavior. Social persuasion encourages action through verbal reinforcement of the ability to succeed. Positive subjective states, whether physical or emotional, can increase the likelihood of repeated action.

Review of the Literature

The current guidelines for exercise recommend at least 30 minutes of moderate physical activity on most days of the week. Moderate activity holds fewer risks than vigorous activity, may be more acceptable to sedentary individuals, and has been shown to have positive effects for people with diabetes. There is also evidence that multiple short bouts of physical activity lasting 10 minutes or more accumulated to 30 minutes per day resulted in similar improvements in cardiorespiratory fitness as longer bouts.

Many barriers to obtaining adequate physical activity have been identified, including lack of time, lack of role models, and bad weather, especially in northern climates. Perceived barriers and benefits are influential determinants of exercise behavior. Self-efficacy research focuses on confidence in one’s ability to meet activity goals, despite barriers. Multiple studies have found support for self-efficacy as a significant correlate of exercise behavior across varying populations.

Longitudinal designs in experimental-type research have also found self-efficacy to be a strong predictor of adherence to exercise goals following an intervention. The relationship of baseline self-efficacy to postintervention physical activity levels has found wide support. Multivariate techniques have further demonstrated the direct role of self-efficacy in explaining variations in behavior. There have been exceptions to the strong positive relationship purported to exist between self-efficacy and physical activity. In some studies, self-efficacy was a weak predictor of physical activity change. There have also been reports that self-efficacy decreased when an
activity program was started and that self-efficacy was predictive during the initiation phase of an exercise program but not during maintenance.

Although only roughly 25% to 28% of individuals with diabetes reported receiving specific guidelines for exercise from their physicians, research has shown that recommendations and individual counseling can provide an impetus for exercise behavior. People who received professional advice to modify physical activity levels were more likely to meet activity recommendations. Successful counseling sessions may be as short as 1 hour and can include generic rather than individualized information. Individual counseling by nurses has also been found to have positive effects on physical activity.

Strategies that encourage self-management, empowerment, and self-motivation have enjoyed success in improving metabolic parameters. Home-based programs have been found to enlist better adherence with exercise prescriptions than programs that required the participant to attend a class and do so at a cost savings. Ongoing self-monitoring has been found to be an effective moderator of change in exercise behavior. The act of keeping a daily record requires conscious thought about activity levels and serves as a reminder to exercise. In a study of healthy, working women, keeping activity records was found to have a significantly large effect on improving physical activity levels; however, no benefit to self-efficacy was found.

A self-monitoring intervention could influence self-efficacy primarily through two avenues. First, activity recording provides an individual with information about his or her actual behavior and may increase self-efficacy through focusing on enactive attainment. A visual documentation of performance is created, highlighting progress and needs. Second, activity recording creates an opportunity for social persuasion, allowing the health care professional to reinforce the client’s effort and to discuss how activity fits into daily life. The document also may provide self-persuasion. The use of activity records as a means to improve physical activity levels has not been tested in a clinical setting with people with diabetes. The purpose of this study was to test the effect of keeping daily activity records on physical activity levels and self-efficacy for physical activity in adults with type 2 diabetes, and to examine the feasibility and acceptability of this intervention from the perspective of the participants.

There were 3 research questions addressed in the study: (1) Is there a difference in the outcome of physical activity levels between individuals who performed the 6-week self-monitoring intervention of keeping activity records and those who did not, after controlling for initial physical activity levels? (2) Is there a difference in the outcome of self-efficacy for physical activity between individuals who performed the 6-week self-monitoring intervention of keeping activity records and those who did not, after controlling for initial self-efficacy levels? and (3) What is the perceived feasibility and acceptability of keeping activity records?

Method

Sample

Inclusion criteria required participants to be English speaking, aged 40 to 65 years, with self-reported type 2 diabetes, and under a physician’s care. People were excluded if they had restrictions that prohibited them from engaging in 30 minutes of low- to moderate-intensity physical activity on most days of the week, did not have the cognitive ability to keep simple activity records, or could not give informed consent to participate. Recruitment was through local primary care offices, the office of a certified diabetes educator, a diabetes support group, and advertisements. Fifty-eight people completed the initial data collection. Three participants did not complete the second data collection, leaving 27 people in the control group (14 women and 13 men), and 28 in the intervention group (14 women and 14 men; total N = 55). The sample ranged in age from 39 to 67 years, with a mean age of 53 years. The time since diagnosis with diabetes ranged from 1 month to 10 years, with a mean of 78 months. Sixty-six percent were married, and 34% were single. Yearly household income ranged from $6700 to more than $200 000, with a median income of $50 000. Three individuals had less than a high school degree, and 4 held doctoral degrees; the mean number of years of education was 15. All were Caucasian, residing in midsized towns in northern New York State. This region is mostly rural, with snowy, cold winters. The local hospital offers only sporadic diabetes education programs; there is no coordinated center for diabetes care.
Procedures

Participants were randomly assigned to intervention (kept activity records) or control (no records) groups, blocked by gender to ensure near equal numbers of men and women in each group. Interviews took place in the participant’s home, the researcher’s office in a university setting, or another location chosen by the participant. At the initial interview, subjects signed an informed consent form approved by appropriate institutional review boards. Demographic information was gathered, and the client was weighed. Moderate physical activity was defined for the participant as “activities that use large muscle groups and are at least equivalent to brisk walking,” and the researcher reviewed a list of examples that represented moderate amounts of activity. The study questionnaires were administered in random order. The researcher explained how to keep daily activity records on the calendar supplied to participants in the intervention group. Codes were provided that reflected moderate activities most likely to be performed by people with type 2 diabetes, and participants were instructed to create codes if needed. For each day, participants were asked to note the activity code, the duration of the activity in minutes, and a rating of intensity as slow, moderate, or brisk for any activity performed for 10 minutes or more (see Figure 1). They were instructed to send the records to the researcher every 2 weeks, using self-addressed, stamped envelopes. This initial meeting lasted between 30 minutes and 1 hour. After approximately 6 weeks, another meeting occurred, lasting about 15 to 30 minutes. Subjects again completed questionnaires about physical activity and self-efficacy for physical activity. Participants in the intervention group also completed an instrument to measure perceptions regarding the acceptability and feasibility of keeping daily activity records. In lieu of a stipend, individuals were given a pedometer, valued at $15.

Measures

Physical activity was defined conceptually to include both planned activity designed to exercise large muscles and movement of the body performed as part of daily living. The Habitual Physical Activity Index (HPAI) was

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Activity Codes
- WALK = walking, treadmill
- SW = swimming
- JOG = jogging
- EX = calisthenics, aerobics
- STEPS = climbing stairs
- LG = lawn, garden
- DAN = dance
- STR = stretching exercises
- CC = child care
- YOG = yoga
- HH = household
- LIFT = lift moderate weight
- ROW = rowing machine
- SPORT = (specify)
- OTHER = (specify)

Intensity Codes
- SL = Slow
- MOD = Moderate
- BR = Brisk, vigorous

Figure 1. Physical activity records.
used at both pretest and posttest to measure physical activity. The HPAI was chosen as it was designed to assess habitual patterns of light-, moderate-, and higher intensity activities. The original HPAI had 3 subscales, occupational, leisure, and sport; however, after factor analysis with a sample from the United States, it was modified to include only 2 subscales, occupational and leisure. It was also adjusted to be more sensitive to activities traditionally performed by women through the addition of a household/family care subscale. The HPAI, in its various forms, has shown adequate reliability. Burns and Froman’s 2-index scale resulted in $\alpha$ coefficients of .84 and .78 and 2-week test-retest stability estimates of .89 and .92 for the occupational and leisure indexes, respectively. Evaluation of the added household/family care subscale revealed a 1-month test-retest reliability of .79 to .91. Validity has also been supported with significant comparisons between index scores and corresponding activities in an activity log, as well as between index scores and an objective measure of physical activity using an accelerometer. This study used 3 indexes: (1) household/family care, (2) occupational, and (3) leisure, for a total of 30 items. The indexes were summed to create a total score. Possible total scores ranged from 3 to 15, with a higher score indicating higher levels of physical activity. Baseline internal consistency of the occupational and leisure subscales in the present study was acceptable at $\alpha = .84$ and .78, respectively. The household/family care subscale was only $\alpha = .54$. Result for the total scale was $\alpha = .76$.

Physical activity-specific self-efficacy was measured using the 9-item Self-efficacy for Exercise (SEE) scale, developed by previous modification of the Self-efficacy Barriers to Exercise scale. The original scale was found to have $\alpha$ coefficients of .90 and .84. The SEE also demonstrated internal consistency, with an $\alpha$ coefficient of .92, and validity by finding a significant correlation between scores on the SEE and exercise behavior ($r = 0.56, P < .05$). For this study, the SEE was modified to reflect current activity recommendations by changing the stem from “How confident are you right now that you could exercise 3 times per week for 20 minutes if . . .?” to “How confident are you right now that you could exercise for 30 minutes on most days of the week if . . . ?” One item of the SEE was also modified from the degree of confidence “if you felt pain when exercising” to “if you felt minor muscle aches when exercising” to prevent awarding higher points to a person who would inappropriately exercise through pain that may indicate a serious risk. The scoring was collapsed from a 10-point response format to a 5-point format to make it simpler and to be consistent with other instruments in the study. The total score was the mean of the 9 items, making potential scores range from 1 to 5, with higher scores indicating a higher level of self-efficacy. A high degree of internal consistency was demonstrated at baseline by an $\alpha$ score of .91.

The Perceived Feasibility Checklist was developed specifically for use in this study. The 9 items addressed understandability and usability of the records, time requirements to complete the records, influence the records had on motivation, and possible benefits the records may have conferred. Two nurses with experience with people making lifestyle changes were consulted regarding the content. The checklist was pilot tested for clarity and readability prior to use, with minor alterations made. The checklist used a 5-point Likert-type response format. Scores on each item were averaged to create a total score ranging from 1 to 5, with higher scores reflecting a more positive attitude toward the activity records. Initial reliability was supported with $\alpha = .81$. The instrument also included an open-ended item that gave the participants the opportunity to provide additional information.

### Data Analysis

The data were analyzed using SPSS, version 11.5. Descriptive statistics for the demographic variables of age, gender, length of time with diabetes, income, educational level, and marital status were examined, with no significant differences between groups. Weight at baseline, however, was significantly different between the groups (control group mean = 235 lb, intervention group mean = 206 lb, $t = 2.79, df = 56, P = .01$) and was considered as a covariate in later analyses. Study variables of physical activity and self-efficacy were found to be normally distributed. Physical activity and self-efficacy for physical activity at baseline (see Table 1) did not significantly differ between groups as confirmed by independent-samples $t$ test ($t = 0.52, df = 56, P = .60$, and $t = -.72, df = 56, P = .48$, respectively).

The effect of keeping daily physical activity records was addressed through the use of analysis of covariance (ANCOVA). The 2 dependent variables were physical
activity and self-efficacy as measured at the end of the 6-week period, and the independent variable was the intervention. The dependent variables were uncorrelated to each other ($r = 0.23, P = .10$), allowing each to be analyzed separately. Pretest physical activity and pretest self-efficacy were correlated with the respective dependent variables but were uncorrelated with each other, therefore becoming appropriate covariates (see Table 2). Initial weight was also included as a covariate to account for individual differences between groups. To assess the effect of time on each group, repeated-measures ANCOVA was performed for each of the dependent variables.

**Results**

Pearson product–moment correlations were performed to look for confounding variables. Income was positively related to education ($r = 0.55, P = .000$), and the number of months since being diagnosed with diabetes was negatively related to income ($r = -0.27, P = .04$). There was no relationship between any of the demographic variables and physical activity or self-efficacy.

A 1-way between-subjects ANCOVA was calculated with each of the dependent variables of posttest physical activity and posttest self-efficacy, the independent variable of group status, the covariates of weight, and the respective pretest values. Physical activity was not significantly different between the intervention and the control group at the study conclusion, $F(1, 51) = 0.06, P = .81$. The covariate of weight did not exert a significant effect on differences in physical activity, $F(1, 51) = 0.79, P = .38$, while pretest physical activity did, $F(1, 51) = 76.01, P = .00$. On examination of the outcome of self-efficacy, there was, however, a significant difference between groups, $F(1, 51) = 7.23, P = .01$, with the intervention group (mean = 3.69, SD = 0.91) showing greater self-efficacy than the control group (mean = 3.23, SD = 1.00). Both pretest self-efficacy and weight were related to posttest self-efficacy, $F(1, 51) = 84.58, P = .00$, and $F(1, 51) = 5.93, P = .02$.

Repeated-measures ANCOVA revealed that physical activity was significantly increased from the beginning of the study to the end in both the intervention group, $F(1, 27) = 17.04, P = .00$, and the control group, $F(1, 27) = 7.98, P = .01$. There was not a significant change in self-efficacy scores in either the intervention or control group, $F(1, 27) = 1.04, P = .32$, and $F(1, 26) = 1.04, P = .32$, respectively. The changes undergone by each group were in the opposite direction, with an increase in self-efficacy in the intervention group and a decrease in the control group (see Table 1).

Participants in the intervention group were assessed regarding the feasibility and acceptability of keeping activity records. Descriptive data related to the individual items of the Perceived Feasibility Checklist are reported in Table 3. The results indicated that the participants felt generally positive about the intervention. They noted that the records helped them to think about their activity and motivated them to follow activity recommendations. The structure provided enough codes to describe commonly performed activities, and the documentation was easy to understand. Participants stated that the intervention was beneficial and was not exceptionally time-consuming. The total scores ranged from...
2.22 to 4.89, with a mean score of 3.76 (SD = 0.67). Written comments concurred that the records helped reveal developing patterns of predictable activity and that continuation of self-monitoring could help in working toward activity goals.

Discussion

The lack of difference between groups in regard to physical activity at the end of the study could be explained in a number of ways. Since both groups improved their physical activity, it seems likely that people who agreed to participate may have been interested in physical activity and its effect on health to start with. It also may indicate that just by being in the study, people in both groups may have perceived near equal levels of verbal persuasion. There was only limited additional contact between the researcher and individuals in the intervention group. It is likely that to be successful, the intervention must provide stronger incentives, ongoing support, and problem-solving assistance. More frequent interaction between participant and professional using mail and telephone contact has been shown to improve functional capacity.\(^{23}\) Many participants in this study were disappointed to learn that the research protocol did not provide more structure of a prescriptive nature. The similar increase in physical activity in both groups may reflect that there are benefits to enacting a simple, face-to-face meeting focused solely on physical activity, even without formal record keeping. Discussion of physical activity with a professional provides a cue to action that may be an impetus in itself for initiation of behavior change. Professionals need to evaluate the messages they send. One individual stated that his physician had not told him any specifics about exercise; therefore, even though he knows physical activity is beneficial, he has only made minor exercise changes. He further stated that if given a specific exercise recommendation, he would follow it, “absolutely.” More research must test whether interactions with health care providers, as well as with peers, either one-on-one or in a group, can be adapted to encourage behavior change.

Analysis revealed that the intervention of keeping activity records did enhance feelings of self-efficacy. Although physical activity significantly increased in both groups over time, self-efficacy dropped in the control group but increased in the intervention group. This is in line with the work of researchers who have found that self-efficacy can be improved through interventions directed by professionals.\(^{22}\) Some researchers, however, have disagreed. Speck and Looney\(^ {21}\) found that their 12-week intervention of activity recording and pedometer-assisted monitoring did not encourage self-efficacy, noting a drop in self-efficacy in the intervention group, even with an increase in physical activity. They speculated that perceived self-efficacy becomes lower when people begin a behavior and are faced with actual barriers.\(^ {21}\) This was not evident in the current study. Perhaps the shortened time frame may not have provided adequate opportunity for participants to encounter barriers, avoiding a negative effect on self-efficacy. Other researchers have found that self-efficacy is not strongly related to behavior change before it has begun but takes on a more potent role as modifications in lifestyle are attempted.\(^ {22}\) Previous cross-sectional research seems to have established a positive relationship between self-efficacy and behavior\(^ {17,18}\); however, in this study, the relationship appears to be more complex. Self-efficacy was not consistently related to physical activity. Changes in self-efficacy did not consistently mirror differences in physical activity. Because lifestyle change takes time to develop, enhancing self-efficacy

### Table 3

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
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<tr>
<td>Easy to understand</td>
<td>4.05</td>
<td>0.58</td>
</tr>
<tr>
<td>Time-consuming (before reverse coding)</td>
<td>2.07</td>
<td>1.12</td>
</tr>
<tr>
<td>Think about activity</td>
<td>4.21</td>
<td>1.07</td>
</tr>
<tr>
<td>Motivated to follow recommendations</td>
<td>3.75</td>
<td>1.14</td>
</tr>
<tr>
<td>Enough codes</td>
<td>4.14</td>
<td>0.65</td>
</tr>
<tr>
<td>Do more to have something to write</td>
<td>3.32</td>
<td>1.12</td>
</tr>
<tr>
<td>Talked about records with family/friends</td>
<td>2.75</td>
<td>1.21</td>
</tr>
<tr>
<td>Records helped to talk to health professional</td>
<td>3.29</td>
<td>1.27</td>
</tr>
<tr>
<td>Keeping records was beneficial</td>
<td>3.96</td>
<td>1.07</td>
</tr>
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Scores range from 1 to 5. Higher scores note more positive ratings.
could have long-range, beneficial effects. Although the effects may not be immediate, improved self-efficacy could boost confidence toward later enactment. Interventions directed at enhancing self-efficacy seem especially important for individuals who are overweight.

In light of results that did not reflect a clear link between self-efficacy and behavior, the role of measurement error must be considered. Although overall, the HPAI was adequate, poor reliability of the household/family care subscale requires research into its psychometric properties, including revision of items and subsequent factor analysis. The social desirability of physical activity requires considering the role of potential bias. It is unclear whether self-report data accurately portray physical activity or whether participants did not want to appear sedentary. While the use of objective indicators such as pedometers or accelerometers could help, these devices are not without problems. The SEE as a measure of self-efficacy was also open to error. In administering the scale, it seemed difficult for participants to make the distinction between hypothetical ability and actual intention. Some participants commented that they had high confidence that none of these constraints “would” hold them back from getting 30 minutes of physical activity on most days of the week but also related that they did not have any real plans for engaging in that much activity. The disparity between what a person can do and what a person will do is not made clear in this scale and was interpreted uniquely by participants. The SEE seemed more a measure of perceived barriers than of intention for planned enactment. The change in scoring format from a 10-point to a 5-point scale may also have contributed to a low sensitivity to change. Further refinement of measurement techniques is needed.

Based on results, the use of self-monitoring of physical activity should be encouraged as a tool to increase self-efficacy and potentially long-term changes in behavior. To be successful, health care professionals must attend to the effort the person has made. Frustration has been expressed in previous research in that much activity. The disparity between what a person can do and what a person will do is not made clear in this scale and was interpreted uniquely by participants. The SEE seemed more a measure of perceived barriers than of intention for planned enactment. The change in scoring format from a 10-point to a 5-point scale may also have contributed to a low sensitivity to change. Further refinement of measurement techniques is needed.

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