

## Walking Toward a New Me: The Impact of Prescribed Walking 10,000 Steps/Day on Physical and Psychological Well-Being

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**Purpose:** To determine whether individuals participating in a program designed to accumulate 10,000 steps/day demonstrate health, fitness and psychological benefits. **Methods:** Sedentary individuals (22 F, 7 M; age  $59.8 \pm 5.78$  yr) were randomly assigned into a walking (W,  $n = 14$ ) or control (C,  $n = 15$ ) group. Following baseline assessment, the W group was given a daily plan to reach 10,000 steps/day within 3 weeks and asked to maintain this level for 12 weeks; the C group was asked to maintain their current activity. Participants were evaluated for cardiovascular endurance, resting and postexercise HR, functional ability, cholesterol, psychological well-being, and exercise self-efficacy before and following the 15-week program. **Results:** Significant changes over time were noted between groups ( $G \times T$ ;  $P < .05$ ) with the W group demonstrating improvements in postexercise HR ( $-6.51\%$ ), total cholesterol (TC:  $-7.74\%$ ), and personal growth ( $2.53\%$ ). While not statistically significant, the W group also demonstrated improvements in 6 min walk distance ( $2.32\%$ ), total/HDL ratio ( $-10.09\%$ ), 8 foot up-and-go time ( $-3.35\%$ ), chair stands ( $6.17\%$ ), flexibility ( $128\%$ ), and environmental mastery ( $4.54\%$ ). **Conclusion:** A 15-week program aimed at accumulating 10,000 steps/day improves cardiovascular performance and personal growth and also positively influences many variables that are indicators of health, fitness and psychological well-being.

**Keywords:** physical activity, exercise, older adults, health, cholesterol

In the United States, the majority of adults do not engage in the recommended amount of physical activity of 30 minutes per day on most days of the week. National estimates suggest that at least 54% of adults in the U.S. are not active enough,<sup>1</sup> and 38% of the population over the age of 55 years is sedentary.<sup>2</sup> In addition, more adults are living to an older age, which suggests that they are living as physically inactive individuals for a longer period of time.

It is well recognized that a number of chronic health conditions can be prevented, improved, or managed with physical activity. Some of these conditions include obesity, hypertension, and diabetes. Approximately 80% of older adults have at least 1 chronic health condition, and 50% have 2.<sup>3</sup> Further, nearly 44% of those aged 75 and older have limited physical activity due to chronic conditions.<sup>4</sup> Therefore, it is logical to suggest that with the increasing number of older adults in the U.S., efforts to decrease the number who are sedentary may reduce the potential for developing chronic health conditions or permit for greater control of already existing health

issues. In 2001, the National Blueprint: Increasing Physical Activity among Adults Age 50 and Older suggested targeting individuals aged 50 and older as a means of improving both physical and psychological health.<sup>2</sup> For example, walking is associated with a reduction in cardiovascular disease hospitalizations in men and women aged 65 years and older.<sup>5</sup>

The accumulation of 10,000 steps/day has been suggested as way to prescribe physical activity for the general population and has received widespread attention in the popular press. Despite the limited documentation for this prescription, Tudor-Locke and Bassett<sup>6</sup> explain that there is general consistency between the recommendation of 10,000 steps/day and U.S. public health guidelines of accumulating 30 minutes of physical activity that is in addition to one's daily routine. Further, Wilde, Sidman and Corbin<sup>7</sup> concluded that 10,000 steps/day is a reasonable goal for physical activity in previously sedentary women (30–55 years). Whether the prescription of 10,000 steps/day is reasonable for other populations is unclear.

The accumulation of 10,000 steps/day has been shown to help one obtain health benefits (for an excellent overview, see Tudor-Locke and colleagues<sup>6,8</sup>). Body mass index and percent body fat have been shown to be lower in women who walked 10,000 steps/day than in others who walked less,<sup>9</sup> as well as in sedentary, overweight adults following 36 weeks of walking with 10,000 steps/day

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as the goal.<sup>10</sup> Another investigation indicated significant decreases in body mass index (BMI), waist girth and resting heart rate following a 12-week pedometer-based activity intervention,<sup>11</sup> while other walking interventions have demonstrated increases in  $\text{VO}_2$  peak and decreases in percent body fat in postmenopausal women.<sup>12</sup> Other research has suggested that individuals aged 50 and older who report habitual walking have a higher  $\text{VO}_2$  max and faster gait speed.<sup>13</sup>

In addition to the physical health benefits, increased physical activity has been found to be associated with subjective well-being, or hedonic well-being, which focuses on life satisfaction, increased positive affect, and/or decreased negative affect.<sup>14</sup> Physical activity has also been found to be associated with quality of life (QOL).<sup>15,16</sup> For example, walking interventions have been found to be related to decreased affect/mood,<sup>17</sup> increased exercise/mobility self-efficacy,<sup>18,19</sup> and improved quality of life.<sup>20,21</sup> However, little research has been done to examine the effects of physical activity, especially pedometer-based interventions, on psychological well-being, or eudaimonic well-being. Aristotle conceptualized eudaimonia as the dynamic process of developing one's potential. The term psychological well-being (PWB) has been used in previous physical activity research, but these studies have typically considered it synonymous with subjective well-being (SWB).<sup>15</sup> Although related, PWB and SWB are conceptually distinct.<sup>22,23</sup> Moreover, PWB and SWB are important components of quality of life, but widely-used measures of QOL (eg, SF-12/36, WHOQOL-BREF/100) do not assess PWB.<sup>15,16</sup> Measures of SWB typically assess how a person is feeling (eg, are you happy?), but these measures do not tap into aspects of PWB which aim to assess self-realization and human fulfillment. Therefore, a study on the effects of exercise on PWB would contribute to the existing literature on exercise and QOL.

Psychological well-being involves "striving toward excellence based on one's unique potential" or "construed as growth and human fulfillment, [which] is profoundly influenced by the surrounding context of people's lives . . . (p. 14)."<sup>24</sup> It is a multidimensional construct which includes perceptions of autonomy, personal growth, positive relationships, self-acceptance, purpose in life, and environmental mastery.<sup>24-26</sup> Research on PWB has

found that these factors change over time and are related to health-related biological variables. For example, personal growth and purpose in life, often considered the essence of eudaimonia, have been reported to decrease with increasing age and are related to lower salivary cortisol levels, lower inflammatory markers (ie, sIL-6r), and higher HDL cholesterol levels.<sup>24,27</sup> Despite the theoretical appeal and empirical evidence, to our knowledge, no studies have been conducted which examine the influence of a pedometer-based physical activity intervention on measures of physical and psychological well-being. Therefore, the purpose of this study was to establish whether individuals who attempt to accumulate 10,000 steps a day display positive health, fitness, and psychological benefits after a 15-week walking program.

## Methods

### Participants

Sedentary men and women age 50 to 70 years from a Midwest University campus and surrounding community were recruited through newspaper advertisements. Thirty adults (22 females, 8 males) volunteered to participate in the study. All volunteers received physician consent and provided informed consent before participation. Individuals were not eligible for the study if they were already accumulating 10,000 or more steps/day. One individual was excluded based on this criterion. This investigation was approved by the Institutional Review Board at the University.

Following the establishment of baseline walking levels, 29 sedentary individuals (22 females, 7 males) with an average age of  $59.8 \pm 5.78$  years were enrolled in this investigation. Volunteers were randomly assigned into either a walking (W;  $n = 14$ ; 11 females, 3 males) or a control (C;  $n = 15$ ; 11 females, 4 males) group. Two individuals from the W group discontinued participation in the study after weeks 2 and 12. The last recorded data for these 2 individuals were carried forward based on an intention-to-treat (ITT) principle. The data presented represent the 29 subjects who were enrolled in the investigation. Subject characteristics are shown in Table 1.

**Table 1 Subject Characteristics (M  $\pm$  SD)**

|              | Walking ( $n = 14$ ) <sup>a</sup> | Control ( $n = 15$ ) <sup>b</sup> | Total ( $n = 29$ ) <sup>c</sup> |
|--------------|-----------------------------------|-----------------------------------|---------------------------------|
| Age (yrs.)*  | 57.4 $\pm$ 6.52                   | 62.1 $\pm$ 3.99                   | 59.8 $\pm$ 5.78                 |
| Height (in.) | 66.4 $\pm$ 4.50                   | 64.8 $\pm$ 3.09                   | 65.6 $\pm$ 3.85                 |
| Weight (lb.) | 201.1 $\pm$ 40.77                 | 176.5 $\pm$ 28.91                 | 188.4 $\pm$ 36.70               |

\*  $P < .05$

<sup>a</sup> 11 females, 3 males.

<sup>b</sup> 11 females, 4 males.

<sup>c</sup> 22 females, 7 males.

## Measures

Volunteers were tested before the 1-week baseline assessment of walking levels (Pre) and following the 15-week intervention period (Post) for cardiovascular measures, cholesterol, functional ability, psychological well-being, and exercise self efficacy. Each test within these categories is described briefly below.

Cardiovascular measures included cardiovascular endurance, and pre and post exercise heart rate. Cardiovascular endurance, reported as distance, was estimated from a submaximal 6-minute walk test. Participants were instructed to cover as much distance as possible in the allotted time in a safe manner. Heart rate was measured before and immediately following the 6-minute walk using a Cardiosport First heart rate monitor (Deer Park, NY). The preexercise heart rate (HR) was taken following a seated, quiet rest period of at least 5 minutes.

Cholesterol measures included total cholesterol (TC), HDL levels, and the total cholesterol/HDL ratio. Fingertip blood was sampled upon arrival at the laboratory following an overnight (10 hour) fast. Analysis was completed utilizing a Cholestech Analyzer (Hayward, CA).

Functional ability was assessed utilizing some of the tests from the Senior Fitness Test.<sup>28</sup> A brief description for each test follows; for a full description see Rikli & Jones.<sup>28</sup> The tests used were the 8-foot-up-and-go test for agility and dynamic balance, the chair stands test for lower body strength, and the chair sit-and-reach test for lower body flexibility. For the 8-foot-up-and-go test, performance is measured as the time it takes someone to rise from a chair, walk around a cone placed 8 feet in front of the chair, and return to a seated position. The measure for the chair stands test is the number of complete times that an individual can move from a seated position to a full stand, and return to the seated position in 30 sec. During the chair sit-and-reach test, each person was asked to sit in a standard folding chair, extend 1 leg with the foot at a 90° angle, while the other leg was bent with the foot flat on the floor. Flexibility was measured as the distance that the individual could reach his or her hands toward the toe of the extended leg, with the fingers reaching even with the toe considered zero. A reach past the toes was scored as a positive value and a distance short of the toes was scored as negative. Flexibility was measured on both sides, and the score from the best side was recorded and analyzed.

Psychological well being was assessed using an instrument developed by Ryff.<sup>25</sup> This instrument includes 6 scales assessing the dimensions of psychological well-being: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. An abbreviated version of the instrument (9 items vs. 20 items per scale) was used due to the number of measures that have been included in this study, and the 9-item version is being used in a longitudinal study by Ryff (personal communication, August 30,

2004). Each item is rated on a 6-point Likert scale ranging from strongly agree (1) to strongly disagree (6) with negative items reversed scored. Each scale contains about the same number of positively and negatively worded items, and high scores indicate more positive self-ratings on the dimension being assessed. This instrument is a valid measure of psychological well-being and has been used in numerous studies of this construct.<sup>25-27</sup>

Exercise self-efficacy was measured using an instrument developed by McAuley.<sup>29</sup> This 8-item instrument assesses the participant's belief in his or her ability to continue exercising at a moderate intensity, 3 times a week, 40 or more minutes per session over the next 2 months. Items are rated on a percentage scale ranging from not at all confident (0%) to highly confident (100%). Scores were calculated by summing all ratings and then dividing by the total number of items. Evidence for the validity of this instrument has been reported in the literature and has been used successfully in many exercise-related studies.<sup>18,30</sup>

## Intervention

Following the pretest assessment, pedometers (New Lifestyles SW-401) were issued to all participants. Volunteers were instructed on how to wear the pedometer, as well as how to read and reset the step function. Each participant was asked to wear their pedometer throughout each day while following their normal routine and to record total steps each day for 1 week (7 days) on the recording sheet provided. Following this baseline assessment, subjects returned to the laboratory with their step log to verify eligibility for the study and to be randomized into either the W or the C group. Individuals were not eligible for the study if they were already recording 10,000 or more steps/day. One individual was excluded based on this criterion.

After subjects were randomized into the W or the C group, they were given a recording sheet and instructions specific to the group. All participants were asked to wear their pedometer throughout each day, and to record the steps each day from their pedometer. C volunteers were instructed to not change their usual level of activity. Volunteers in the W group were given an individualized walking plan to assist in progressively reaching the 10,000 step goal over a 3-week period. To do this, average steps/day was calculated from their baseline recording week. This value was then subtracted from 10,000 and divided by 3 to give a goal for a weekly increase. Each week, the individual was asked to increase his or her daily step total by this number, so that by the 3rd week the goal was 10,000 steps/day. W volunteers were then asked to maintain 10,000 steps/day for the next 12 weeks.

All participants reported daily step counts each week throughout the program (October through the following July) either by regular visits to the laboratory, e-mail, or fax. Walking sessions were offered to help individuals reach their daily step goal, though very few participants took advantage of this opportunity. In

addition, weekly updates were sent to the W subjects with encouraging phrases such as 'you are doing a great job,' 'we appreciate your effort,' 'keep up the good work.' If subjects were not consistently reaching their step goal (ie, 10,000 steps/day), individualized counseling and encouragement was provided in person, by phone or by e-mail communication.

## Statistical Analysis

All data are reported as mean  $\pm$  SD. Data were analyzed based on the ITT principle, with the last recorded data carried forward for missing values. A repeated measures analysis of variance was used to determine if there were significant changes over time or between groups. Independent *t* tests were performed comparing the 2 groups on the pretraining data. The W group was younger ( $P < .05$ ) and heavier ( $P = .07$ ). Based on this finding, age and weight were used in a Mahalanobis distance statistical procedure to identify potential outliers, and 1 outlier was identified in the W group. Data were analyzed with and without the outlier, and the results did not change substantially. Differences in statistical results for 2 variables (6-minute walk distance, post exercise HR) are noted in the results. However, given these minor differences in statistical results and the existence of outliers in the population, the statistical analysis is based on data from all participants. In addition, a percent (%) change was calculated for each variable for both groups (W and C). Finally, Pearson correlation coefficients were performed between post measures of physical and psychological well-being for the entire sample.

## Results

### Physical Function and Fitness

Participants in the W group increased their steps an average of 2163 steps/day at the end of the 15-week program. Steps in the C group increased an average of 388 steps/day over the same time period. Average steps/day for each group and percent changes are shown in 4-week intervals in Table 2.

Independent *t* tests indicated that there were no significant differences at baseline between groups for the following variables: 8-foot-up-and-go, chair stands,

chair sit-and-reach, 6-min walk, preexercise HR, postexercise HR, TC, HDL, or the TC/HDL ratio. Therefore, an analysis utilizing the baseline values as covariates was deemed not necessary.

Significant group by time interactions ( $P < .05$ ) were noted for post exercise HR, TC, and a trend for the 6-minute walk distance ( $P = .061$ ). Specifically, the W group demonstrated improvements in post exercise HR and TC while the C group declined on these measures. When the outlier was removed from the data, a significant group by time interactions ( $P < .05$ ) were noted for the 6-minute walk distance, TC, and a trend for post exercise HR ( $P = .08$ ). Pre and post measures for each variable, as well as percent change, are shown in Table 3.

As can be seen in Table 3, while not statistically significant, the W group also demonstrated improvements in TC/HDL ratio ( $-10.09\%$ ), 8-foot up-and-go time ( $-3.35\%$ ), number of chair stands ( $6.17\%$ ), and flexibility ( $128\%$ ). Declines or no change in numerous evaluation measures in the C group are also noted in Table 3.

### Psychological Well-Being and Exercise Self-Efficacy

Independent *t* tests indicated that there were no significant differences at pretest between groups for all measures of psychological well-being and exercise self-efficacy. A significant group by time interaction was found for personal growth ( $P < .05$ ). Specifically, the W group demonstrated improvements in personal growth while the C group declined in this measure. Trends for the time main effect were noted for self-acceptance ( $P = .07$ ) and exercise self-efficacy ( $P = .08$ ) with both groups reporting improvements in self-acceptance and a decline in exercise self-efficacy. Pre and post measures for each variable, as well as percent change, are shown in Table 4.

### Relationship Between Physical and Psychological Measures

Pearson correlation coefficients were calculated between measures of physical and psychological well-being at postintervention for the entire sample. The number of chair stands was found to correlate with purpose in life ( $r = .39$ ,  $P < .05$ ). No other relationships were statistically significant.

**Table 2** Average Steps per Day During Walking Program (M  $\pm$  SD)

|                     | Baseline          | Week 1                       | Week 5                       | Week 9                       | Week 15                      |
|---------------------|-------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| Walking (steps/day) | 5,795 $\pm$ 2,039 | 7,232 $\pm$ 2,113<br>(24.8%) | 8,575 $\pm$ 2,414<br>(48.0%) | 7,967 $\pm$ 2,784<br>(37.5%) | 7,958 $\pm$ 2,771<br>(37.3%) |
| Control (steps/day) | 5,912 $\pm$ 2,833 | 5,793 $\pm$ 2,640<br>(-2.0%) | 6,223 $\pm$ 2,350<br>(5.3%)  | 6,022 $\pm$ 2,911<br>(1.7%)  | 6,300 $\pm$ 2,638<br>(6.6%)  |

Note. Percentages shown are change from baseline.

**Table 3** Percent Change in Physical Function and Fitness Measures Pre/Post Walking Program (M  $\pm$  SD)

|                                 | Pre                | Post               | % change |
|---------------------------------|--------------------|--------------------|----------|
| 8 Foot Up and Go (sec.)         |                    |                    |          |
| Walking                         | 5.37 $\pm$ 0.90    | 5.19 $\pm$ 0.75    | -3.35    |
| Control                         | 5.53 $\pm$ 0.92    | 5.67 $\pm$ 0.82    | 2.53     |
| Chair stand (#)                 |                    |                    |          |
| Walking                         | 13.93 $\pm$ 1.90   | 14.79 $\pm$ 1.89   | 6.17     |
| Control                         | 13.93 $\pm$ 2.84   | 14.00 $\pm$ 2.17   | 0.50     |
| Flexibility (in.)               |                    |                    |          |
| Walking                         | 0.679 $\pm$ 4.64   | 1.55 $\pm$ 3.26    | 128.28   |
| Control                         | 0.617 $\pm$ 2.64   | 0.117 $\pm$ 2.93   | -81.04   |
| 6-minute walk (m)               |                    |                    |          |
| Walking                         | 577.29 $\pm$ 79.10 | 590.71 $\pm$ 71.55 | 2.32     |
| Control                         | 576.60 $\pm$ 79.80 | 556.80 $\pm$ 58.24 | -3.43    |
| Pre-exercise heart rate (bpm)   |                    |                    |          |
| Walking                         | 75.64 $\pm$ 14.57  | 71.21 $\pm$ 10.39  | -5.86    |
| Control                         | 71.60 $\pm$ 12.55  | 72.13 $\pm$ 14.18  | 0.74     |
| Post-exercise heart rate (bpm)* |                    |                    |          |
| Walking                         | 121.79 $\pm$ 21.50 | 113.86 $\pm$ 15.28 | -6.51    |
| Control                         | 111.53 $\pm$ 14.92 | 113.27 $\pm$ 17.47 | 1.56     |
| Total cholesterol (g/dl)*       |                    |                    |          |
| Walking                         | 225.21 $\pm$ 50.24 | 207.79 $\pm$ 53.07 | -7.74    |
| Control                         | 212.27 $\pm$ 27.78 | 232.67 $\pm$ 45.87 | 9.61     |
| HDL (g/dl)                      |                    |                    |          |
| Walking                         | 53.43 $\pm$ 16.84  | 51.36 $\pm$ 14.07  | -3.87    |
| Control                         | 49.87 $\pm$ 12.05  | 53.33 $\pm$ 15.70  | 6.94     |
| TC/HDL ratio                    |                    |                    |          |
| Walking                         | 4.66 $\pm$ 1.91    | 4.19 $\pm$ 1.10    | -10.09   |
| Control                         | 4.43 $\pm$ 0.93    | 4.64 $\pm$ 1.47    | 4.74     |

\*  $P < .05$ , Significant Group  $\times$  Time Interaction.

## Discussion

The results of this study clearly indicate that there are both physical and psychological benefits that occur following a 15-week walking program in which participants increased their walking by about 2200 steps/day, up to approximately 8000 steps/day. Fitness benefits include a decrease in postexercise HR and a trend toward a significant increase in 6-minute walking distance. A decrease in total cholesterol was also observed, which can be categorized as a health benefit. Psychological well-being also improved with a significant increase in perceptions of personal growth. Numerous other positive

adaptations that are important contributors to physical and psychological well-being, but were not statistically significant, were also observed.

It is important to note that the walking program prescribed for the participants was designed to have them accumulate at least 10,000 steps/day for 12 consecutive weeks, but that the average steps/day was nearer to 8,000, or an increase of approximately 2200 steps/day. Thus, our findings agree with others who demonstrated significant improvements in lipid profiles following 24 months where subjects increased their activity by 2000 to 3000 steps/day (to  $\sim$ 9000 steps/day).<sup>31</sup> While we can hypothesize that more substantial adaptations would occur if individuals

**Table 4** Percent Change in Psychological Well-Being and Exercise Self-Efficacy Measures Pre/Post Walking Program (M  $\pm$  SD)

|                        | Pre               | Post              | % change |
|------------------------|-------------------|-------------------|----------|
| Autonomy               |                   |                   |          |
| Walking                | 37.93 $\pm$ 6.83  | 39.07 $\pm$ 5.93  | 3.01     |
| Control                | 41.47 $\pm$ 5.88  | 42.27 $\pm$ 5.31  | 1.93     |
| Environmental mastery  |                   |                   |          |
| Walking                | 42.29 $\pm$ 6.17  | 44.21 $\pm$ 5.34  | 4.54     |
| Control                | 43.27 $\pm$ 5.95  | 42.73 $\pm$ 7.48  | -1.25    |
| Personal growth*       |                   |                   |          |
| Walking                | 45.00 $\pm$ 4.80  | 46.14 $\pm$ 5.70  | 2.53     |
| Control                | 45.33 $\pm$ 4.89  | 41.87 $\pm$ 4.47  | -7.63    |
| Positive relations     |                   |                   |          |
| Walking                | 45.57 $\pm$ 4.64  | 46.79 $\pm$ 4.63  | 2.68     |
| Control                | 45.93 $\pm$ 5.50  | 46.60 $\pm$ 6.82  | 1.46     |
| Purpose in life        |                   |                   |          |
| Walking                | 42.71 $\pm$ 7.47  | 43.21 $\pm$ 6.62  | 1.17     |
| Control                | 44.07 $\pm$ 5.48  | 42.27 $\pm$ 6.50  | -4.08    |
| Self-acceptance        |                   |                   |          |
| Walking                | 40.57 $\pm$ 8.47  | 42.29 $\pm$ 9.21  | 4.24     |
| Control                | 43.40 $\pm$ 5.93  | 44.67 $\pm$ 6.38  | 2.93     |
| Exercise self-efficacy |                   |                   |          |
| Walking                | 86.07 $\pm$ 16.60 | 77.41 $\pm$ 24.03 | -10.06   |
| Control                | 82.33 $\pm$ 13.85 | 74.42 $\pm$ 26.72 | -9.61    |

\*  $P < .05$ , Significant Group  $\times$  Time Interaction.

increased their activity level to a greater extent, ie, if they achieved and maintained the 10,000 step/day prescription, it should be noted that the participants in the walking group moved from the 'low active' category to the 'somewhat active' category, as described by Tudor-Locke and Bassett.<sup>6</sup> Further, the 'somewhat active' category (7500 to 10,000 steps/day) has been previously demonstrated as providing positive health benefits.<sup>11,32,33</sup> Therefore, it is very encouraging that relatively small changes in activity can have a positive impact. There were a number of variables that did not show significant improvements over the 15-week period, but improved, when presented as a percent change from baseline. These included changes in the fitness parameters of agility and dynamic balance (3.35%), lower body strength (6.17%), lower body flexibility (128%), and preexercise heart rate (-5.86%). In addition, changes in the health measures of total cholesterol (-7.74%) and the total cholesterol to HDL ratio (-10.09%) were observed. In general, percent

changes in the control group did not move in a positive manner. While the adaptations mentioned above were not statistically significant, it can be argued that the changes are clinically significant and are important contributors for improving health and fitness.

As indicated in the introduction, the number of individuals in the U.S. over the age of 65 continues to increase, and many of these individuals are physically inactive and have 1 or more chronic health conditions. Our results indicate that increasing physical activity by at least 2000 steps/day is a reasonable goal for individuals over the age of 50, and that this level of activity can be maintained for at least 12 weeks. Our findings are in agreement with Bravata et al,<sup>40</sup> who demonstrated through a meta-analysis that pedometer interventions in adults of 18 weeks yielded an average increase in steps of 2491/day and 26.9% over baseline. Investigations of longer durations are necessary, however, to further investigate the effectiveness of a pedometer program in older adults.

If the increase in physical activity is maintained, the positive health changes that have been observed, in our findings and others,<sup>5,9–13,33,40</sup> can have long-term benefits in terms of disease risk (eg, diabetes, obesity, metabolic syndrome) as well as help older adults remain independent. These positive physical effects can potentially improve quality of life and reduce health care costs.

For measures of psychological well-being, the change for environmental mastery (4.54%) and stabilization of purpose in life was notable for the walking group compared with the control group, and this finding is in addition to the significant change for personal growth mentioned previously. According to Ryff and colleagues' conceptualization of PWB, personal growth and purpose in life are most closely tied to Aristotle's concept of eudaimonia (ie, the dynamic process of developing one's potential), and these findings are unique to the literature. Other studies have examined the influence of walking on measures of SWB (eg, affect, quality of life) or *how you feel*, but no studies have reported the influence of a walking program on PWB or *how you feel about who you are*. Personal growth and purpose in life have been found to be correlated with biological variables.<sup>24,25</sup> Consequently, it is not surprising that sedentary individuals participating in a walking program and experiencing physical and psychological benefits would report an improvement in personal growth and a stabilization of purpose in life. The finding that environmental mastery positively changed following a walking program is consistent with previous research reporting a positive relationship between exercise and self-efficacy.<sup>30</sup> Environmental mastery and self-efficacy both involve perceptions of control and competence, but "the emphasis on finding or creating a surrounding context that suits one's personal needs and capacities is unique to environmental mastery" (p. 23).<sup>24</sup> Participants in the walking program improved on various measures of physical function and fitness, and this improvement was associated with increased beliefs in being able to accomplish everyday activities or tasks in his or her life.

Although nonsignificant positive changes were observed for other measures of psychological well-being, the differences between the comparison groups were minimal. This is consistent with previous research that has reported increased perception of autonomy, positive relations with others, and self-acceptance with increased age.<sup>24,25,27</sup> It is possible that longer participation in a walking or exercise program is required for differences between more and less active groups to be observed for these variables.

The decrease in exercise self-efficacy was an unexpected finding. Previous studies have supported the positive effects of exercise programs/ interventions on self-efficacy.<sup>30</sup> However, there is a potential explanation for this finding. In this sample of sedentary individuals, the pretest mean for exercise self-efficacy was very high and may be indicative of their inexperience with exercise. Participants reported about 84% confidence in adopting

and maintaining regular exercise whereas other studies with similar samples have reported values around 55% to 70%.<sup>18,34</sup> The walking group averaged about 8000 steps/day which is below the 10,000 steps/day goal of the walking program. Specifically, only 6 of the 14 participants (43%) in the walking program were able to achieve 10,000 steps/day by week 4, and 4 participants were able to maintain 10,000 steps/day for the remainder of the program. Three of the four participants who adhered either maintained or improved their exercise self-efficacy scores to 100% confidence whereas 75% of participants who did not meet the goal of 10,000 steps/day reported a decrease in exercise self-efficacy. In a study by Jones, Harris, Waller, and Coggins,<sup>35</sup> individuals who were low in physical fitness and well-being reported high levels of confidence (or self-efficacy) to maintain regular exercise, but this overconfidence coupled with failure to meet exercise goal expectations contributed to participant dropout.

In this study, most participants (12 of 14) completed the walking program despite the overall decrease in exercise self-efficacy, and this may be attributed to the characteristics of the program. Stimulus control strategies (eg, phone prompts; activity logs) have been found to be successful in changing physical activity patterns in older adults.<sup>36</sup> Moreover, the exercise self-efficacy scores were still relatively high after the walking program, and the lower scores at posttest may be reflective of a more accurate perception of their exercise capabilities. In support of this explanation, the correlation between pretest exercise self-efficacy and pretest physical activity levels was lower ( $r = .09$ ,  $P = .63$ ) than the correlation between posttest exercise self-efficacy and changes in physical activity (ie, posttest minus pretest step counts) over the 15 week study ( $r = .35$ ,  $P = .06$ ). Other studies have reported similar findings of higher correlations between post treatment self-efficacy scores and improved drinking status in alcoholics<sup>37,38</sup> and abstinence from cigarette smoking.<sup>39</sup>

Certainly it was disappointing that many of the participants did not maintain the 10,000 step/day goal across the final 12 weeks of the intervention. However, Bravata et al,<sup>40</sup> in a systematic review of the literature, also demonstrated that in pedometer intervention studies, users who were given a step goal increased their activity approximately 2000 steps/day, which was associated with a decrease in systolic blood pressure, an important health outcome.<sup>40</sup> Users who were given no step goal demonstrated no significant increases in physical activity. Short, self-paced walks have been found to improve affect, and this may lead to greater involvement and adherence to an exercise program.<sup>41</sup> Therefore, future studies should consider a more gradual increase in the number of steps/day and evaluate whether predetermined goals such as 10,000 steps/day compared with more individually-based goals are more conducive to physical and psychological well-being. In addition, this was a preliminary investigation with a relatively small sample size. Despite these limitations, participants in the experimental group still showed significant improvements in some measures of physical

and psychological well-being, and positive adaptations in numerous others. This provides excellent evidence that small changes in activity level utilizing walking as the exercise can result in positive health, fitness, and psychological benefits for individuals aged 50 to 70 years.

The National Blueprint: Increasing Physical Activity among Adults Age 50 and Older provides a suggestion to target individuals aged 50 and older for physical activity programs as a means of improving physical and psychological health.<sup>2</sup> This investigation provides solid evidence that a simple walking program is adequate to induce numerous physical and psychological benefits. As individuals adapt, additional walking, higher intensity training, and resistance training can be added as tolerated for additional benefits.

As individuals age, levels of functional ability often decline. Age-related declines may also be evident for psychological well-being (eg, personal growth). This investigation provides evidence that a small increase in activity level (~2000 steps/day) can help to increase or maintain measures of functional fitness and psychological well-being over a 15-week period, while no change in activity level may add to declining levels of function and well-being. Therefore, the prescription of a walking program as a first step to maintaining functional fitness and well-being is recommended. This is particularly important as walking limits few, is easily accessible for most individuals, and requires no expensive equipment as time, rather than steps, can be used as a target goal.

## Conclusion

A 15-week program aimed at accumulating 10,000 steps/day improves cardiovascular performance as measured by the 6-min walk test and postexercise heart rate and psychological well-being as measured by personal growth even though participants did not reach the 10,000 step goal. In addition, this program positively influenced a number of variables that are indicators of physical and psychological well-being. While not all improvements were statistically significant, most adaptations were directionally consistent with the hypotheses. These adaptations are potentially important contributors for improving health, fitness, and well-being. Therefore, walking programs should be suggested to adults aged 50 to 70 as means of increasing physical activity and improving levels of health, fitness, and well-being.

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