Journal of Aging and Physical Activity, 2003, **11**, 488-502

Health Benefits of Cobblestone-Mat Walking: Preliminary Findings

Fuzhong Li, Peter Harmer, Nicole L. Wilson, and K. John Fisher

This study examined the effect of cobblestone-mat walking on older adults. Community-dwelling older adults ($N = 40$) were randomized into either an 8-week cobblestone-mat walking activity ($n = 22$) or a control group ($n = 18$). Cobblestone-mat walking entailed three 45-min sessions per week. Primary outcomes included SF-12 (mental, physical), instrumental activities of daily living (IADLs), psychophysical well-being, daytime sleepiness, and pain. Secondary outcomes included resting blood pressure and perceived control of falls. The walkers experienced significantly improved ($p < .04$) SF-12 scores, IADLs, and psychophysical well-being and significantly reduced ($p < .01$) daytime sleepiness and pain. They also reported significantly ($p < .05$) improved perceptions of control over falls. A significant between-groups difference in resting diastolic blood pressure was observed ($p < .05$), with reductions in the walkers. A significant within-group reduction ($p < .05$) in systolic blood pressure was observed in the walkers only. The data indicate that 8 weeks of cobblestone-mat walking can significantly improve health-related outcomes in older adults.■

Key Words: older adults, ■

The U.S. population is rapidly aging (U.S. Census Bureau, 2000), and declining physical function and frailty pose psychological and physical health risks, which are an increasing public health problem. Efforts to maintain or improve functional independence and reduce chronic disease conditions resulting from the aging process have thus become an important public health mission. Exercise is one preventive health behavior that is receiving greater attention because of mounting evidence that it improves health status and functional performance among older adults (King, Rejeski, & Buchner, 1998; Mazzeo et al., 1998). Unfortunately, optimal modalities for physical activity in older adults are not well established. For older adults, many conventional exercise programs (e.g., aerobic exercise, weight/resistance training) are unappealing, overly challenging, labor intensive (requiring close supervision of workouts), or inconvenient (requiring access to facilities). Thus, there is a need to develop simple, convenient, and readily accessible exercise

---

Li, Wilson, and Fisher are with the Oregon Research Institute, 1715 Franklin Blvd., Eugene, OR 97403. Harmer is with the Dept. of Exercise Science, Willamette University, Salem, OR 97301.

programs that will reduce health problems and improve the quality of life of the aging population.

This study explored a new exercise method, cobblestone-mat walking, and examined its health-related benefits. In this activity, people walk barefoot on a fixed mat that has a smooth, yet undulated, cobblestone-like surface. The activity is rooted in traditional Chinese holistic medicine (Veith, 1949), which underpins other forms of Chinese health-related activities such as Tai Chi (China National Sports Council, 1983; Wu, 2002; Yan & Downing, 1998), Qi Gong, and acupuncture/acupressure/massage (Chang, 1995; Ehling, 2001; Tse, 1995; Wanning, 1993; Yu, 2001). Specifically, from the perspective of Chinese medicine and principles of reflexology, the uneven surfaces of the cobblestones stimulate and regulate acupoints located on the soles of the feet. As in reflexology therapy or zone therapy, these acupoints relate to specific internal organs (e.g., kidneys, spleen) and promote balancing life energy (*chi*) through the body's meridian system (i.e., specific energy pathways in the body). Cobblestone-mat walking resembles acupressure and massage therapies that rely on manual techniques (i.e., manual motions of kneading, pushing, rubbing, and pressing) to stimulate the meridians and acupoints to vitalize *chi* to keep *yin* and *yang* in balance, resulting in improved mental and physical well-being (Wanning).

Although there is considerable anecdotal evidence indicating the health benefits of this activity (e.g., pain relief, sleep enhancement, improved physical and mental well-being), no controlled research has been undertaken to evaluate its claimed benefits and assess its efficacy. Using portable mats that replicate cobblestone-like paths found in China, this study was designed to explore the health-related benefits of a cobblestone-mat walking program for the elderly. The study had two main objectives. The first was to determine whether cobblestone-mat walking could be administered in a community setting using an elderly population. This involved two feasibility-related issues. First, because the activity is a uniquely Asian form of physical activity, it was necessary to examine the acceptability of this activity in Western society. Second, because individuals walk on varying surfaces of simulated stones, it was necessary to evaluate issues related to the safety of the activity and assess any adverse reactions to the training (e.g., foot discomfort, pain).

The second objective of the study was to evaluate the efficacy of cobblestone-mat walking as a physical activity to improve selected health-related outcomes. Anecdotal evidence of positive outcomes of cobblestone walking led the investigators to speculate on the potential influence of cobblestone-mat walking on selected health benefits. The a priori hypothesis was that the cobblestone-mat walking would improve health outcomes. A secondary hypothesis was that the activity would improve a sense of control over falls and reduce resting blood pressure.

Methods

PARTICIPANTS

Participants were recruited in Portland, OR, between July and September 2002. Recruitment occurred via community-wide promotion including direct mailings and newspaper advertisements, as well as word of mouth. Inclusion criteria for the study were being 60 years of age or older, not participating in regular physical activity (i.e., in the previous 2 months, no more than 90 min of structured group exercise per week), being an independent ambulator able to walk without the use of aids, having no progressive or debilitating conditions that would limit participation in moderate-intensity exercise, having a physician's approval for participation, and having no severe foot or ankle problems. The study protocol was approved by the Oregon Research Institute's institutional review board.

A total of 169 individuals responded to the study promotion. Of these, 20 individuals declined before being screened. The remaining 149 individuals were contacted by telephone for preliminary screening. After this screening, 96 individuals were deemed ineligible. Of the 53 eligible individuals, 5 declined, leaving a total of 48 individuals randomized to either the experimental group ($n = 24$) or the control group ($n = 24$). Two individuals did not receive the intervention (one declined and the other did not attend any classes), and 6 individuals declined in the control condition, leaving a total of 40 participants in the study ($n = 22$ in experimental, $n = 18$ in control). Figure 1 displays a flowchart describing the participant recruitment and intervention process.

STUDY DESIGN

The study involved a randomized, controlled, nonblinded, 8-week trial with participants randomized to one of two study conditions: cobblestone-mat walking or attention control. Cobblestone-mat walking entailed three 45-min sessions per week for 8 weeks. Reasons for this short training schedule were based on anecdotal reports from long-time walking individuals and consultations with health experts in China and the realities of a restricted budget. Both primary and secondary outcomes were assessed at baseline and at study termination. Thus, a two-way (Group × Time) repeated-measures design was used. Because of the preliminary nature of this study, an exit interview was conducted at study termination with those in the intervention group in order to obtain qualitative data regarding the exercise activity and study design.

RANDOMIZATION PROCEDURE

Before enrollment of the first study participant, a research statistician not working on the study used a computer program to generate random numbers for group assignment. After baseline assessments, study participants were randomly assigned to the mat-walking group or the attention-control group in a 1:1 ratio. The principal investigators were blinded to the assignment.

INTERVENTION PROTOCOL

Mat-Walking Group. Participants randomly assigned to the intervention condition were provided with an 8-week stone-stepping program (three 45-min sessions per week) in which they were trained to walk on portable mats imported from China. The mats were made of synthetic material (6 ft long and 1.5 ft wide) that replicated actual cobblestone paths found in China. These mats featured varying levels of undulation and were placed on padded underlay. An example of a mat used in this study is shown in Figure 2 (more detailed information on walking

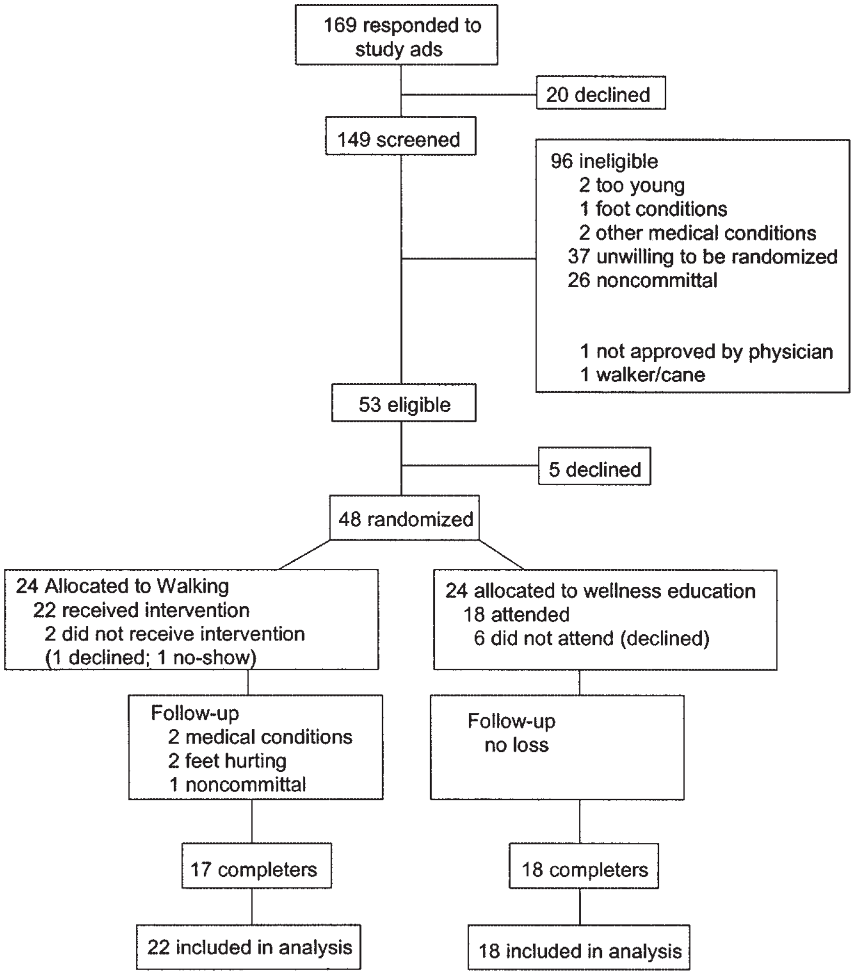

Figure 1. A flowchart describing the participant recruitment and intervention process.

paths using mats and real cobblestone can be found at http://healthyaging.ori.org). An initial orientation session was conducted to introduce participants to this new exercise experience and to explain the training protocol. Participants were then given the opportunity to experiment with walking on the mats. Each session consisted of a self-administered foot massage, warm-up, walking on the mat, and cool-down exercises. The activity was accompanied by background music and/or trivia questions.

The core training protocol consisted of timed intervals of walking on the mats. The total time spent on mat walking per session varied from 12 min initially and

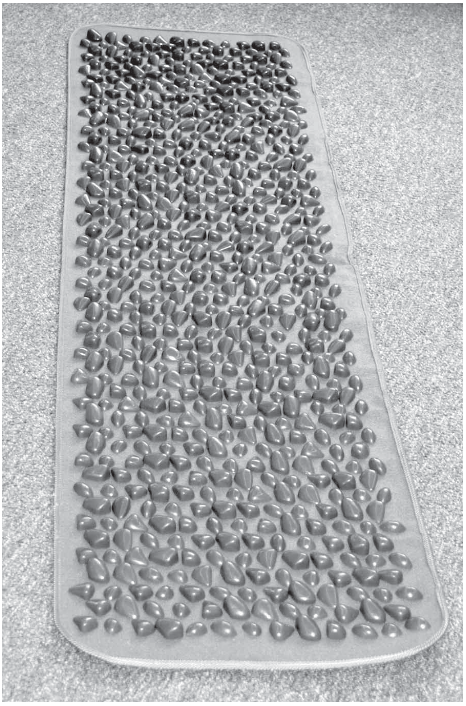

Figure 2. Example of a cobblestone mat (made of plastic that imitates the shape of natural cobblestone rocks) used in this study.

progressed to a maximum of 25 min per session over the 8-week period. In each training session, participants performed multiple sets of two to five repetitions of timed walks, with actual on-the-mat walking time for each repetition ranging from 1 to 5 min. The number of repetitions was gradually decreased over the 8 weeks as the actual walking time on the cobblestone mats increased.

To allow participants to gradually become accustomed to walking on the mats, four different mat formations were arranged on the floor. Participants began the walking protocol by experimenting on individual mats and were encouraged to get used to the sensation of mat walking and to develop their ability to walk on the mats for longer periods of time. Next, the mats were placed in a pinwheel formation in which the mats radiated from the center of a circle outward, much like spokes on a wheel. Participants walked in a circular path across the mats in a formation such that approximately every other step was on a mat. "Dashed-line" was the third mat formation. In this layout, the mats were arranged end to end in a large rectangular track, allowing 18–24 in. between mats. This allowed participants to walk the length of a mat and then have one or two steps on a smooth surface before continuing to the next mat. The final arrangement involved mats in a "circled" formation, in which the mats were placed end to end in a large rectangular track with no space between

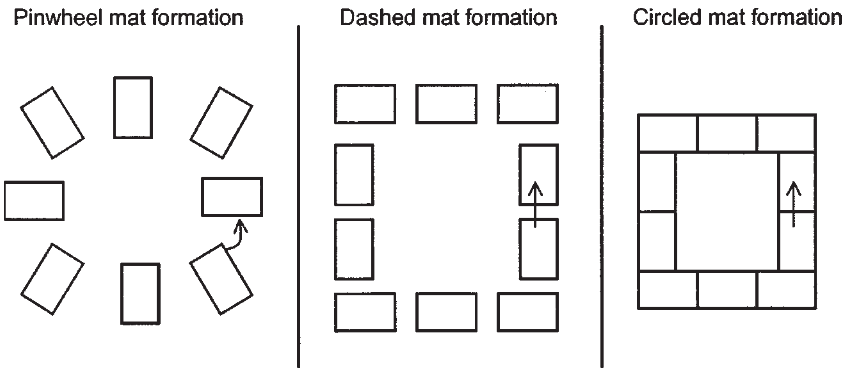

Figure 3. Layout of training formations used in this study.

them, creating a continuous walkway. Participants progressed over time from one formation to the next until the circled formation was reached during Session 7, at which point they continued to walk on the circled formation for the duration of the intervention. The layouts of training formations are provided in Figure 3. The cobblestone training protocol used in this study is available on request (the manual is also available at http://healthyaging.ori.org).

Frequent breaks of up to 1 min were allowed between intervals of mat walking. As a complementary activity to mat walking, a foot-rolling activity was provided between sets, in which participants sat in chairs rolling their feet on wooden rollers. The rollers consisted of four or five cylindrical, grooved pieces of wood that rotated on axles as the rollers glided over the soles of the feet. The foot rollers were intended to provide soothing relief to the feet between mat-walking sessions. Each participant was also given with a pair of cotton socks to be worn while walking on the mats to reduce discomfort, as well as for sanitary purposes. Drinking water was available, and participants were encouraged to drink during breaks in their mat-walking activities. Three or four research assistants were present to provide training instructions, supervision, and encouragement.

Control Group. Participants in the control condition served as attention controls. They were instructed to continue their usual physical activities and were also invited to four meetings to meet one another, enjoy a light meal and social interaction, tour a local Chinese garden, attend a focus-group discussion on senior health and physical activity, and listen to an educational talk on alternative medicine. These participants were provided with an identical 8-week cobblestone-mat walking program at the end of the study.

PRIMARY OUTCOME MEASURES

Primary outcomes in this study included health-related quality-of-life indicators involving the SF-12 (mental and physical; Ware, Kosinski, & Keller, 1995), an adapted version of instrumental activities of daily living (IADLs; Mihalko &

McAuley, 1996), psychophysical well-being (Myers et al., 1999), daytime sleepiness (Johns, 1991), and pain (Wewers & Low, 1990).

SF-12 Mental and Physical Summary Scales. The SF-12 contains 12 items reflecting what respondents are able to do functionally, how they feel, and how they evaluate their health status. Two scores, referred to as the mental- and physical-health summary scores, were calculated. Each subscale was transformed into a scale ranging from 0 to 100, with higher scores indicating better mental and physical health. Cronbach's alphas (α) reliability for the mental and physical subscales were satisfactory (α = .78, .79, respectively, at pretest; α = .80, .83, respectively, at posttest).

IADL. The IADL (2)■ assessed basic self-care activities including the following functions: bathing, dressing, getting up from and sitting down on a chair, reaching, carrying items, and walking. Participants are asked to rate the extent to which they could successfully perform 20 basic ADLs on a 7-point Likert scale. The items were averaged, with higher scores indicating better physical functioning. The reliability for the scale was high (α = .96 at pretest, .94 at posttest).

Psychophysical Well-Being. The 10-item Vitality Plus Scale (Myers et al., 1999), which assesses accumulated benefits resulting from exercise (e.g., sleep, energy, feeling relaxed), was used as a measure of psychophysical well-being. Scores on the scale range from 10 to 50, with higher scores indicating greater well-being resulting from exercise. The reliability for the scale was satisfactory (α = .84 at pretest, .81 at posttest).

Daytime Sleepiness. The Epworth Sleepiness Scale (Johns, 1991) was used to assess daytime sleepiness. The scale contained eight items designed to measure sleep propensity. Participants were asked to rate on a scale of 0 to 3 how likely they would be to doze off or fall asleep in eight situations, based on their recent lifestyle and regular daily routine. Higher scores indicated high daytime sleepiness. The reliability for the scale was adequate (α = .70 at pretest, .71 at posttest).

Pain. A visual analog scale was used to measure pain. Participants were asked to put a mark across a horizontal line (0–100 mm) at a position that indicated how they felt at the time in relation to two indicators: *no pain* (0) and *pain as bad as can be* (100). The distance was measured from *no pain* to the participant's mark. Lower values represented lower levels of pain.

SECONDARY OUTCOME MEASURES

Control Over Falls. A measure of perception of control over falls was used (Tennstedt, Lawrence, & Kasten, 2001). The measure has four items that focus on control over the environment and one's own mobility and ability to do things to prevent falls and reduce the fear of falling. The response format used a 5-point Likert-type scale ranging from *strongly disagree* (1) to *strongly agree* (5), with *unsure* (3) being the midpoint of the scale. Item scores were averaged to form a summary score, with higher scores indicating more perceived control. The reliability for the scale was good (α = .76 at pretest, .88 at posttest).

Resting Blood Pressure. A trained and experienced research assistant used an aneroid sphygmomanometer to measure resting systolic and diastolic blood pressures.

EXIT INTERVIEW

At the completion of the intervention, we asked for participants' reactions to the training protocol. Specifically, we asked questions related to enjoyment of the activity, perceived benefits of the activity, perceived risk of injury, sense of well-being, likelihood of continuing the activity, and willingness to recommend the activity to relatives or friends.

STATISTICAL ANALYSIS

A two-way repeated-measures analysis of variance (ANOVA) was used to assess changes during the 8-week training period in the outcomes of interest. The alpha level for all tests was set at .05 using a two-tailed test of significance. Statistical analysis of the data was performed using the Statistical Package for the Social Sciences software (Norusis, 1994). Analyses were completed on a modified intent-to-treat principle, with participants who participated in the study analyzed ($N = 40$). Of 5 intervention participants who had dropped out the study, 4 provided the follow-up data. Incomplete data from the 1 remaining dropout were handled through the last observation carried-forward method (Peduzzi, Henderson, Hartigan, & Lavori, 2002).

Because of the exploratory nature of this study, 40 study participants (20 in each condition) were anticipated to be included; this was judged to be adequate to answer the major study questions. Power calculations were based on this number that provided 80% power at alpha = .05 to detect differences between the control and intervention groups' mean change scores of 5 points on SF-12 (a 5-point between-groups difference is considered practically meaningful; Ware, Snow, Kosinski, & Gandek, 1993), a 10% improvement in IADL scores for the intervention condition compared with the attention-control condition, and a mean between-interventions difference of 5 mm Hg in blood pressure (Young, Appel, Jee, & Miller, 1999). No subgroup analyses (e.g., gender, age) were planned or examined. When appropriate, effect size, computed as the mean difference between the mat-walking- and control-group changes divided by the pooled standard deviation, is presented.

Results

Participants ranged in age from 60 to 88 years (mean = 72.6, $SD = 6.9$). As shown in Table 1, the study groups were comparable on demographic measures of age, gender, race, education, household income, weight, and height. There were also no significant differences in the outcome variables between subjects assigned to intervention and the control group at study entry. Table 2 presents means and standard deviations of various health indicators for participants in the experimental and control groups at pretest and posttest.

COMPLIANCE

Class compliance rates over the 8-week period (24 sessions) were calculated for all participants ($n = 22$; Figure 1). Median compliance was 21 sessions, ranging from 2 to 24 sessions. A total of 79% of the participants ($n = 18$) attended 15 or more

Table 1 Demographics of the Study Sample (*N* = 40)

Demographic	Walking (*n* = 22)	Control (*n* = 18)	*p*
Age (years)	72 ± 6.4	73.3 ± 7.3	.57
Female, *n* (%)	18 (82)	13 (72)	.47
White ethnicity, *n* (%)	19 (86)	17 (94)	.28
High school education or higher, *n* (%)	21 (95)	17 (94)	.88
Household income below $35,000, *n* (%)	12 (55)	14 (77)	.13
Health status,[a] *M* ± *SD*	2.55 ± 1.0	2.44 ± 1.1	.76
Weight (lb), *M* ± *SD*	167.3 ± 44.5	169.8 ± 34.4	.85
Height (in.), *M* ± *SD*	64.5 ± 4.4	64.7 ± 3.1	.89
Body mass index (kg/m^2)	28.02 ± 5.45	28.59 ± 5.51	.74

[a]This is measured on a 5-point Likert scale with 1 = *poor* and 5 = *excellent*.

sessions. Five participants dropped out of the study; reasons included other commitments (*n* = 1), poor medical conditions (*n* = 2), and foot pain (*n* = 2). The overall dropout rate for the 8-week study was 23%.

CHANGE IN SF-12 MENTAL AND PHYSICAL SCORES

Univariate ANOVA results for the group-by-time interaction indicated significant differences for the two SF-12 scores (see Table 2). Results indicated that, compared with the controls, participants in the mat-walking group showed significant improvements in the mental ($p < .01$) and physical ($p < .04$) summary scores of the SF-12. The effect sizes (*d*) on the mental and physical outcomes were considered moderate to large (*d* = .56, .71, respectively).

CHANGE IN INSTRUMENTAL ACTIVITIES OF DAILY LIVING

A significant group-by-time interaction ($p < .03$) was observed for IADLs. Intervention participants reported increased levels of self-reported IADLs compared with the controls over the 8-week intervention period. A moderate effect size was observed for this outcome (*d* = .56).

CHANGE IN PSYCHOPHYSICAL WELL-BEING

A significant group-by-time interaction ($p < .03$) was observed for the Vitality Plus Scale scores. Intervention participants reported improved perceptions of psychophysical well-being compared with the controls. A relatively large effect size was observed for this outcome (*d* = .81).

Table 2 Primary and Secondary Measurements for the Intervention (n = 22) and Control (n = 18) Groups at Pretest and Posttest, $M \pm SD$

	Preintervention		Postintervention		
	Walking	Control	Walking	Control	*p*
Primary measures					
SF-12 mental (range 0–100)	68.25 ± 26.13	66.96 ± 29.67	76.46 ± 21.08	62.35 ± 27.98	.01
SF-12 physical (range 0–100)	56.17 ± 32.34	57.14 ± 31.28	72.96 ± 15.59	56.21 ± 29.46	.04
IADL (range 1–7)	5.97 ± .97	6.04 ± 1.22	6.33 ± .60	5.88 ± .94	.03
psychophysical well-being (range 10–50)	34.91 ± 6.77	34.39 ± 6.85	37.46 ± 2.91	32.83 ± 7.60	.03
daily sleepiness (range 0–16)	10.38 ± 3.63	9.39 ± 3.84	8.14 ± 3.75	10.22 ± 4.10	.006
pain (ranging 1–10)	3.37 ± 3.06	3.37 ± 2.49	1.40 ± 1.13	3.27 ± 2.93	.05
Secondary measures					
control over falling (range 1–5)	4.30 ± .56	4.39 ± .49	4.64 ± .38	4.16 ±.70.05	
systolic blood pressure (mm Hg)	133.64 ± 9.68	132.17 ± 13.62	125.64 ± 14.16	131.22 ± 8.30	.08
diastolic blood pressure (mm Hg)	81.50 ± 9.41	81.22 ± 8.59	75.64 ± 8.46	80.39 ± 9.22	.05

CHANGE IN DAYTIME SLEEPINESS

Participants in the experimental condition in comparison with the controls experienced significantly reduced daytime sleepiness ($p < .006$) as indicated by scores on the Epworth Sleepiness Scale. A moderate effect size was observed for this outcome ($d = .51$).

CHANGE IN PAIN

A significant ANOVA group-by-time interaction ($p < .05$) was observed for the pain measure. Participants in the mat-walking condition reported overall reduced pain scores compared with those in the attention control condition. A large effect size was observed for this outcome ($d = .85$).

CHANGE IN PERCEPTION OF CONTROL OVER FALLS

Mat-walking participants reported significant improvement ($p < .05$) in their ability to control falling compared with the control participants. A large effect size was observed for this outcome ($d = .85$).

CHANGE IN RESTING BLOOD PRESSURE

A between-groups difference was found only for diastolic blood pressure ($p < .05$). Mat-walking participants were shown to have reduced diastolic pressure over the 8 wk of training compared with those in the control. The between-groups mean difference in diastolic pressure at posttest was 4.75 mm Hg. Although there was no statistically significant change in systolic blood pressure ($p = .08$) between the two groups, there was a significant within-group pre-to-post change in systolic blood pressure ($p < .05$) for the experimental group only, indicating reduced systolic blood pressure for the walking participants over the 8-week training. The mean change for systolic blood pressure during the 8-week intervention period for the mat-walking group was 8.0 mm Hg ($p < .009$). No within-group change in systolic blood pressure was observed for the control group ($p = .72$).

EXIT INTERVIEW

Participants reported that they enjoyed the activity (90%, $n = 18$), felt benefits from participation (85%, $n = 17$), and experienced a positive effect on their sense of well-being (65%, $n = 13$). Most participants (95%, $n = 19$) felt that there was no risk of injury from mat walking and believed that they would continue the activity if it were available (75%, $n = 15$). A total of 90% of participants ($n = 18$) indicated that they would recommend the activity to relatives or friends.

ADVERSE EFFECTS

Training safety was closely monitored throughout intervention. No falls were observed by the staff or reported by the participants. Adverse effects related to walking were observed for 1 individual, who had a bruise on the ball of her foot and subsequently dropped out of the study (at Week 2). One individual had an edema resulting from a secondary kidney disorder and dropped out of the study (at Week 2). One reported foot pain without any injury and dropped out after two class sessions. Three participants reported that the balls of their feet were very tender at one point during the early stage of the intervention. To ease their discomfort, these participants walked on the mats less often for a couple of sessions, and then resumed all activities.

Discussion

This study was the first to investigate the effects of cobblestone-mat walking, a new physical activity for older adults. Although exploratory in nature and limited in scope, the study provided preliminary evidence in terms of gauging the appeal of the new activity in a community setting, the low risk of injury from the activity, the level of interest in it, and physicians' willingness to allow patients to enter the study (only 1 person was not approved because of a blood disorder and would not have been approved to participate in any type of exercise). From the study's exit interview, it was shown that participants in the mat-walking group expressed satisfaction with and continued interest in the activity.

Beyond the feasibility questions, results from the study showed improvements in both the primary and secondary outcomes from cobblestone-mat walking, providing support for our overall hypothesis that participants would show improvements on selected health-related outcomes. Over the 8-week walking program, participants experienced significant improvements in health status (as shown in SF-12 mental and physical scores), IADLs, and psychophysical well-being and significant reductions in daytime sleepiness and pain. Participants also reported significant improvement in perceptions of control over falls. A significant change in resting blood pressure was observed. The pre–post effect sizes observed in the outcome variables showed adequate effects, indicating meaningful changes in outcomes resulting from the brief exposure to the mat-walking intervention.

The magnitude of change in most of the intervention outcomes seems to be pronounced and somewhat surprising given the short duration of the study. There are at least two possible reasons that might substantiate these findings. First, the study sample was recruited from a physically inactive population; that is, per our protocol, participants were not involved in regular or structured exercise at the study onset. Using physically inactive older adults might have potentiated more improvement in health outcomes and accentuated the impact of the activity on the outcome measures. Second, the novel nature of this foot-stimulation activity (i.e., applying pressure to acupoints on the soles of the feet) might have contributed to the magnitude of our observed multiple outcome measures. Although the actual mechanisms that influence the changes remain to be investigated through future trials, the results of this study have provided initial scientific support for the claimed health benefits of cobblestone walking, which have previously been anecdotal.

The training protocol of 45 min per walking session (including both warm-up and cool-down exercises) is considered appropriate given the nature of this activity (i.e., walking on an uneven surface). This is a typical session length in most studies of this type. For example, a pilot study using a pre–post design showed that a 40-min low-impact walk session using the artificial bamboo-stepping technique called *aotake* (Hayakawa, Takada, & Tanaka, 2001[redacted]; Isono & Hayakawa, 2000) elicited significant changes in self-reported negative mood states (tension, anger, fatigue, depression, and confusion). Thus, together with limited findings in this area, it seems reasonable to tentatively conclude that cobblestone-mat walking has beneficial effects.

From a practical perspective, mat walking is potentially a much simpler exercise program than many similar exercise modalities (e.g., Tai Chi, StairMaster, exercise bike, treadmill) in terms of program implementation and costs, provided that cobblestone facilities are available for public use and that no training is required on using the facilities. In recent years, cobblestone walking has been widely disseminated in public parks and residential areas in China as an “age-appropriate” physical activity suitable for most seniors. For portable mats such as those used in this study, the activity has the advantages of not being limited by weather, space, or time constraints. It is also a relatively safe activity, provided that individuals have no severe foot or ankle problems. Therefore, given the initial effectiveness of the activity reflected in this study, it appears that mat walking can be promoted as a simple, stand-alone physical activity. With the use of mats, the activity can be carried out either outdoors (e.g., parks) or indoors (e.g., at home). In this regard, it is recommended that practitioners follow the training protocol established in this study (available at http://healthyaging.ori.org) and preferably walk once a day on a regular basis.

A more conventional method, outdoor-based walking (as done in China and Japan), uses courses that are constructed of a combination of cobblestones cemented in a patchwork pattern of tracks, with varying textures from smooth on the outside track to least smooth on the innermost track (see sample pictures taken from China at http://healthyaging.ori.org). This has the advantage of greater stimulation because of the use of real stones but has the disadvantages of the need for open space and course construction and limitations by the weather. Given the simplicity of cobblestone-mat walking, it might also be considered as part of an integrated (multifaceted) exercise intervention aimed at improving health status and overall quality of life. In terms of cost, the mats that we used were relatively inexpensive (about $15 per mat, approximately 6 ft long and 1.5 ft wide). Thus, even when compared with Tai Chi, a well-established stand-alone, “low-tech” (Blair & Garcia, 1996), inexpensive exercise modality with demonstrated health benefits (Li et al., 2001), we argue that cobblestone-mat walking is more accessible in terms of requiring no special technique or skills to achieve health benefits.

Although promising, these data represent only preliminary support for cobblestone-mat walking as a potential means of improving health-related outcomes in the elderly and provide initial justification for the development of an efficacy trial. Therefore, several limitations with regard to the design of the study should be noted. First, because of the exploratory nature of the study, a small sample size was used. The sample size was not an arbitrary decision; rather, it was based on an assumed degree of effectiveness of the activity and a careful analysis of power on selected key outcomes of interest. Second, for reasons of cost containment and budget limitations for this pilot study, we decided to use self-reported health measures including physical functioning. We acknowledge the limitations of self-report measures (physical functioning in particular), which rely on respondents’ memories and subjective judgment. Future investigators should consider using objective physical-health measures (e.g., performance-based functional tests) that might not only confirm the current findings but also more rigorously examine the effects of cobblestone walking. Third, the lack of a compatible (exercise) control condition is a major limitation. It is possible that the participants in the mat-walking group anticipated certain health benefits (i.e., expectancy effects), resulting in a threat to internal validity. Ideally, one would use a control group that involved traditional walking, using the same duration, intensity, and frequency of exercise to determine whether cobblestone walking is better than standard walking or other forms of exercise. Future studies should incorporate this design to enable researchers to more rigorously examine the health benefits of this novel activity for older adults.

In summary, the results of this study have provided initial understanding of the potential benefits of cobblestone-mat walking and are sufficiently provocative to warrant further investigation. A large-scale clinical trial to determine whether longer, more frequent, or more intensive training would result in improved clinical measures of functional ability should be undertaken.

Acknowledgments

Preparation in this manuscript was supported in part by Grant No. AG18394 from the National Institute on Aging.

The authors would like to thank Kim Olson-Charles, Mandy Green, Shane Bishop, and Jennifer Hileman for their assistance in supervising and monitoring the study trial and data collection. We also thank the volunteers who participated in the study. The authors acknowledge editorial assistance from Ron Renchler.

References

Blair, S.N., & Garcia, M.E. (1996). Get up and move: A call to action for older men and women. *Journal of the American Geriatrics Society,* **44**, 599-600.

Chang, Y.S. (1995). *Acupressure massaging to keep healthy*. Taipei: Yuan-ChiTzai.

China National Sports Council. (1983). *Tai qi chuan exercise*. Beijing: People's Sport.

Ehling, D. (2001). Oriental medicine: An introduction. *Alternative Therapies in Heath and Medicine,* **7**, 71-82.

Hayakawa, Y., Takada, K., & Tanaka, K. (2001). Effects of bamboo stepping exercise on mood state. *Medicine and Science in Sports and Exercise,* **33**(5), S76.

Isono, K., & Hayakawa, Y. (2000). Aotake: A modified stepping exercise program for Japanese older adults. *Journal of Aging and Physical Activity,* **8**, 175-177.

Johns, M.W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep,* **14**, 540-545.

King, A.C., Rejeski, W.J., & Buchner, D.M. (1998). Physical activity interventions targeting older adults: A critical review and recommendations. *American Journal of Preventive Medicine,* **15**, 316-333.

Li, F., Harmer, P., McAuley, E., Duncan, T.E., Duncan, S.C., Chaumeton, N.R., & Fisher, J. (2001). An evaluation of the effects of Tai Chi exercise on physical function among older persons: A randomized controlled trial. *Annals of Behavioral Medicine,* **2**, 89-101.

Mazzeo, R.S., Cavangh, P., Evans, W.J., Fiatarone, M., Hagberg, J., McAuley, E., & Startzell, J. (1998). ACSM position stand on exercise and physical activity for older adults. *Medicine and Science in Sports and Exercise*, **30**, 992-1008.

Mihalko, S.L., & McAuley, E. (1996). Strength training effects on subjective well-being and physical function in the elderly. *Journal of Aging and Physical Activity,* **4**, 56-68.

Myers, A.M., Malott, O.W., Gray, E., Tudor-Locke, C., Ecclestone, N.A., O'Brien Cousins, S., & Petrella, R. (1999). Measuring accumulated health-related benefits of exercise participation for older adults: The Vitality Plus Scale. *Journal of Gerontology: Medical Science,* **54**, M456-M466.

Norusis, M.J. (1994). *SPSS for Windows: Base system user's guide* (release 10.0). Chicago: SPSS.

Peduzzi, P., Henderson, W., Hartigan, P., & Lavori, P. (2002). Analysis of randomized controlled trials. *Epidemiological Reviews,* **24**, 26-38.

Tennstedt, S.L., Lawrence, R.H., & Kasten, L. (2001). An intervention to reduce fear of falling and enhance activity: Who is most likely to benefit? *Educational Gerontology,* **27**, 227-240.

Tse, M. (1995). *Qi Gong for health and vitality*. New York: St. Martin's Griffin.

U.S. Census Bureau, 1900–1980, 1980 census of population, general population characteristics, United States summary (PC80-1-B1); 1990, 1990 census of population, general population characteristics, United States summary (CP-1-1); and 2000–2050, population projections of the United States by age, sex, race, Hispanic origin, and nativity: 1999 to 2100. Retrieved from http://www.census.gov/population/www/projections/natproj.html, April 16, 2003.

Veith, I. (1949). *Huang Ti Nei Ching Su Wen. The Yellow Emperor's classic of internal medicine*. Berkeley: University of California Press.

Wanning, T. (1993). Healing and the mind/body arts: Massage, acupuncture, yoga, t'ai chi, and Feldenkrais. *American Association of Occupational Health & Nursing Journal,* **41**, 349-351.

Ware, J.E., Kosinski, M., & Keller, S.D. (1995). *SF-12: How to score the SF-12 physical and mental health summary scales* (2nd ed.). Boston: The Health Institute, New England Medical Center.

Ware, J.E., Snow, K.K., Kosinski, M., & Gandek, B. (1993). *SF-36 Health Survey manual and interpretation guide*. Boston: The Health Institute, New England Medical Center.

Wewers, M., & Low, N. (1990). A critical review of visual analogue scales in the measurement of clinical phenomena. *Research in Nursing and Health,* **13**, 227-236.

Wu, G. (2002). Evaluation of the effectiveness of Tai Chi for improving balance and preventing falls in the older population—A review. *Journal of the American Geriatrics Society,* **50**, 746-754.

Yan, J.H., & Downing, J.H. (1998). Tai Chi: An alternative exercise form for seniors. *Journal of Aging and Physical Activity,* **6**, 350-362.

Young, D.R., Appel, L.J., Jee, S., & Miller, E.R. (1999). The effects of aerobic exercise and T'ai Chi on blood pressure in older people: Results of a randomized trial. *Journal of the American Geriatrics Society,* **47**, 277-284.

Yu, G. (2001). *Healthy massage*. Beijing: Beijing Scientific Technology.