ORIGINAL ARTICLE

TRENDS in
Sport Sciences
2021; 28(**4**): 281-289
ISSN 2299-9590
DOI: 10.23829/TSS.2021.28.4-5

Effects of low, medium and high intensity walking on sleep quality and psychological well-being of the elderly women with cognitive impaired

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Abstract
Introduction. The rapid growth of aging population, in recent years is the result of a process known as the demographic transition. Cognitive disorders such as dementia and delirium, common problems in older adults, are influenced by deteriorating quality and quantity of sleep and psychological well-being and depression. Aim of Study. The purpose of the present research was to investigate the effectiveness of low, medium and high-intensity walking in the quality of sleep and psychological well-being of elderly women suffering from cognitive impairment. Material and Methods. A pre-test and post-test quasi-experimental research design was selected for the study. The sample consisted of 80 elderly women in the age range of 60-75 years who were randomized into four experimental groups. Exercise intensity was evaluated and controlled by pedometers. In the pre-test and post-test stages, all subjects completed the Pittsburg Sleep Quality Index and the psychological well-being scale. The data analysis was conducted using inferential statistical tests such as repeated measures ANOVA and Bonferroni post-hoc tests. Results. In the pre-test stage (prior to the intervention), the results showed no significant differences between the control and experimental groups in terms of well-being, sleep quality and their subcomponents (P > 0.05). In the post-test stage (after the intervention), the results indicated significant differences between control and experimental groups in terms of well-being and sleep quality (P < 0.05). The Bonferroni post-hoc test showed that low, moderate, and high-intensity group had higher scores in sleep quality and well-being compared to the control group (P < 0.05). Conclusions. The results showed that low, moderate, and high-intensity walking has a positive and significant effect on well-being and sleep quality of women with cognitive impairments. Thus, based on these findings, walking is recommended as a useful and health promoting method to improve sleep quality and the well-being of women with cognitive impairments.

KEYWORDS: walking, well-being, elderly women, pedometer, sleep quality.

Received: 16 April 2021
Accepted: 20 May 2021

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Introduction

The rapid growth of the aging population, as opposed to the general population, in recent years has been the result of a process known as demographic transition. According to the World Health Organization (WHO), the number of people over 60 years of age, which was 590 million in 2000, is expected to surpass 1.2 billion in 2025. The vast majority of these people (70%) live in the developing countries [2]. According to the demographic forecasts, if the current trend of population growth persists, the population of people over 60 years of age (9.2% of the total population) would have surpassed the total population of children under 5 years of age (8.5% of the total population) by 2020 [4, 6]. Lack of autonomy and independence, as well as inability to perform daily activities, lead to the deterioration and loss of cognitive function in elderly people. The cognitive status depends on the systematic functioning of different brain systems. The aging process undermines the performance of those systems, which triggers cognitive problems. The severity of this disorder varies greatly and may include a wide range of elderly people. Cognitive disorders such as dementia and delirium, being common problems in older adults, are influenced by the deteriorating quality and quantity of sleep and psychological well-being as well as depression [3, 30].

Research shows that the increasing prevalence of cognitive impairments in the elderly gives rise to another old age-related problem, sleep disturbances, which has a significant impact on mental and physical problems of the elderly. Sleeping is a key element in the circadian rhythm, which is associated with physical and mental rejuvenation. Epidemiological studies suggest that more than 57% of the elderly report sleeping problems and only 12% are satisfied with their sleep [2, 9]. More than 40% of older adults report poor sleep quality [7]. Although the time spent in bed increases as we age, the real sleep duration decreases. Moreover, the length of deep sleep stages (stages 3 and 4 of non-REM sleep), as the main factor in sleep quality, is reduced. At the age of 70 the delta phase of sleep makes up less than 10% of the total sleep duration, as opposed to 25-50% in adolescents and young adults. However, despite the importance of this issue, scant attention has been paid to sleep research. Insomnia is a common sleep disorder in older adults. Studies show that sleep disorders in elderly people may lead to depression, falls, cognitive disorders, concentration problems, irritability, poor quality of life, dementia, fatigue, mood instability, anxiety and poor mental health [16].

A review of literature suggests that most elderly people take hypnotic drugs to deal with problems associated with the perceived sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep sufficiency and poor daily performance [12, 31]. An important point that needs to be stressed here is that hypnotic agents are effective for short-term use and should not be prescribed for long periods of time [18]. Thus, it seems that the best way to improve sleep quality is to identify a method to reduce adverse physical and mental symptoms in the elderly.

Non-pharmacological treatments take effect more slowly than hypnotic drugs do, but they are more durable and display fewer side effects such as addiction. Gerontologists have introduced regular physical activity as a method increasingly recognized as a way of initiating and maintaining good sleep by providing calmness and increasing core body temperature. It is presumed that sleep and physical activity are separate behaviors controlled by separate physiological mechanisms, but there is ample evidence that demonstrate a clinical relationship between sleep and physical activity [4, 6]. Based on some studies, decreased sleep duration in older adults can be associated with reduced physical activity and prolonged inactivity. Research results reported significant improvement in the quality and quantity of sleep in older adults after moderate-volume aerobic exercise (e.g. walking) [23, 24].

King et al. determined the effect of a 16-week aerobic exercise program including walking and running on the quality and quantity of sleep in older adults, reporting that this exercise increased sleep duration in participants by 42 min. However, their results did not reflect a dramatic change in the quality of sleep [15]. In another study, Oda reported significant improvement in sleep quality of the subjects after 6-month exercise, but they found no significant changes in stage 3 of non-REM sleep [4]. Similarly, Oda did not observe a significant alteration in the quality and quantity of sleep in the elderly following water exercise [22]. The quality of sleep is a major factor in promoting physical and cognitive functioning of elderly people, but it is impossible to effectively address problems of elderly people without focusing on different aspects of their mental health. Therefore, researchers and practitioners seek to improve all aspects of mental health in different age groups, considering psychological well-being as a major aspect of the elderly life.

As people age, the level of their psychological well-being decreases due to their diminishing independence and physical abilities. Researchers argue that a factor that may affect psychological well-being in the elderly is connected with exercise and physical activity [29]. Findings of two other studies have shown that participation in aerobic exercise programs improves psychological well-being in the elderly [5, 25]. Bustamante et al. reported that older adults with higher levels of physical activity have more favorable levels of psychological well-being [8]. In a systematic review, Shams et al. reported that only limited studies have firmly concluded that physical activity exerts a permanent positive effect on the psychological well-being of the elderly. Therefore, they suggested that a regular program of low to moderate-volume physical activity may have a greater effect on improving people's psychological functioning as opposed to a vigorous aerobic activity or non-aerobic activity. Despite inconsistent findings concerning the effects of varying intensities of physical activity on sleep quality and psychological well-being of the elderly, scientific evidence shows that the ability and motivation to engage in aerobic activities such as cycling, swimming, and running, decreases with age [31]. Despite the obvious physiological benefits of exercise and physical activity for the public, most people assume that regular daily physical activity with low, moderate, and high volume - determined based on the metabolic and physiological parameters of workout volume (e.g. lactate threshold, maximal oxygen consumption, etc.) – is difficult and unusual [20]. In other words, continuous regulation of every session of physical activity based on the percentage of maximum heart rate, heart rate reserve, baseline heart rate, maximum oxygen consumption and lactate threshold, as well as the mathematical assessment of activity volume is difficult for ordinary people in general and for the elderly in particular. It is while the evaluation of a physical activity program including its duration, volume and number of sessions per week is a major concern of experts and researchers [14, 33]. It seems that a convenient way to adjust the volume of an exercise program that is easy to understand is to apply the customary and valid style of counting steps, which has received growing attention in Japan and the European countries as a way of measuring the volume of physical activity. Additionally, studies show that as we age, we develop a tendency to prefer walking as a common form of aerobic activity, mainly because it is practicable in various conditions and environments. Walking is an exhilarating form of physical activity that is generally accepted by the public and commonly practiced during leisure time and daily activities and its execution is driven by pleasure, promotion of performance of bodily systems, and rehabilitation.

Therefore, the present study attempted to determine the volume level of physical activity in the elderly based on step counts per day using valid and reliable pedometer devices. The purpose of pedometers is twofold. Firstly, it can be easily used to determine the volume of physical activity in older adults. Secondly, they do not need to be worried about determining the volume of their daily physical activities, as this goal could be achieved with little costs. Since most interventional studies have only considered the effectiveness of one volume level of aerobic exercise on sleep quality and psychological well-being and they provided inconsistent results regarding the effects of physical activity on sleep quality and psychological well-being of the elderly, this study was conducted to compare the effectiveness of low, moderate, and high levels of physical activity for sleep quality and psychological well-being of the elderly with cognitive impairments.

Material and Methods

This was a quasi-experimental study with pre-test – post-test design. The population included elderly women attending the municipality neighborhood houses, senior centers, parks, gardens and recreational centers at district 1 of Tehran. After a general invitation for elderly women to participate in the study, 200 women willing to do so were selected using a convenience sampling method. Then, based on the exclusion and inclusion criteria 80 elderly females aged 60-75 were selected and randomized into four groups: three experimental groups with low, moderate, and high levels of physical activity and a control inactive group. The exclusion criteria included a history of asthma, respiratory and cardiovascular disease, disabilities or use of mobility aid devices such as crutches and wheelchairs, a history of cerebrovascular accidents, serious skull damage, a history of anesthesia, motor disorders, and unwillingness to continue the study. The main inclusion criterion was a basic level of physical activity. All of the above criteria and factors were controlled using the demographic questionnaire (Figure 1).

The main study instruments included a demographic questionnaire, the Mini–Mental State Examination (MMSE), psychological well-being questionnaire, the Pittsburgh sleep quality index and a pedometer. The validity of the demographic questionnaire was confirmed by experts. MMSE developed by Folstein in 1975 is one of the tools commonly used to assess the cognitive status. The questionnaire consists of several dimensions including orientation, registration, memory, attention, calculation, recent memory, language and visuospatial abilities. Each person is awarded a score of 1 to 30 with scores greater than 25 indicating lack of cognitive impairment, 20-25 indicating possible cognitive damage, and less than 20 denoting a definitive detection of cognitive disorders. The validity and reliability of the questionnaires were measured several times. The validity of the instrument used to evaluate the cognitive status of the elderly has already been assessed in psychiatry textbooks [10]. The internal consistency of the questionnaire was measured based on Cronbach's alpha (0.81) and its sensitivity and specificity in the cut-off point of 22 were 90% and 93.5%, respectively.

The psychological well-being questionnaire is an 84-item scale with 6 components of environmental mastery, independence, positive relations with others, personal growth, purposefulness and self-acceptance.

Each component consists of 14 items that are scored on a 6-point Likert scale (from "strongly disagree" to "strongly agree"). Ryff et al. reported a test–retest reliability of 0.82 for the questionnaire and 0.70 to 0.78 for its components. The test–retest reliability of the Iranian version of the questionnaire was also measured at 0.82. The PSQI is a questionnaire that measures self-reported sleep habits over the past 4 weeks. It is a global measure with 7 components: perceived sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep sufficiency and the use of sleep medication. The score for each component is in the range of 0 to 3, with high scores indicating poorer sleep quality. A score of 5 (i.e. poor sleep) yielded a diagnostic sensitivity and specificity of 89.6% and 86.5%, respectively. The internal consistency of the scale was confirmed with Cronbach's alpha (α = 0.83), and test–retest reliability of 0.85 in this study [2]. In their research on seniors aged 60 and above in Iran, Ahmadi et al. reported a reliability of 0.87 using the Kappa coefficient [2]. A portable pedometer (OMRONHJ_113) with less than 1.5% error was used to measure daily steps.

This small device using a sensitive accelerometer measures the number of an individual's steps and the distance a person travels. Ultimately, based on the initial information (such as weight and the length of steps) given to the device, it measures one's status of physical activity and the amount of calories burned. McNamara et al. measured the concurrent validity of the pedometer with an accelerometer and its convergent validity with

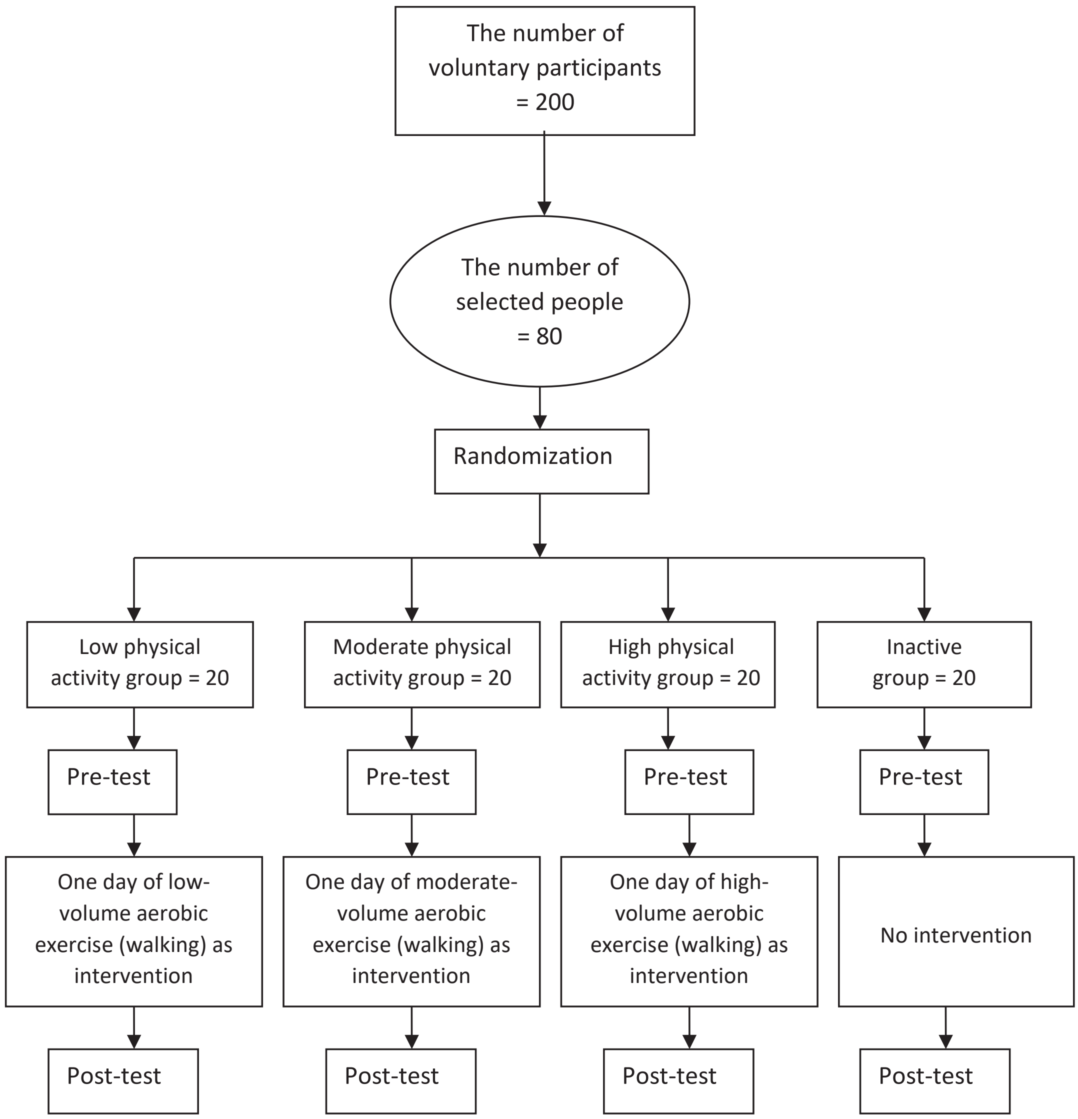

Figure 1. Data sampling and research method

a heartbeat meter using the Pearson coefficient (0.55--0.99) [19]. These researchers reported a convergent reliability correlation coefficient of 0.88 for the pedometer at the maximum oxygen consumption. McNamara et al. in a study entitled "The correlation between the results obtained from a pedometer and the international physical activity questionnaire (IPAQ)" reported that the pedometer had acceptable validity and reliability [19]. Before the study the cognitive performance of the subjects was assessed using the MMSE test and the elderly women with cognitive impairment were included in the present study. After screening the participants based on the study criteria, they filled out the pre-test questionnaires (which concerned low, moderate, and high volume physical activity) including the Pittsburgh sleep quality index (PSQI) and the psychological well-being scale. Afterwards, the subjects learned how to use the pedometer and record its data. The participants were the elderly with low levels of physical activity. In other words, their activity level at the baseline (the two-week period, during which their level of physical activity was determined) was less than the physical activity level recommended by the WHO for a healthy life (less than 5,000 steps per day). Based on these inclusion criteria all the elderly participating in the study were identical in terms of the basic level of physical activity.

To determine the basic level of physical activity in the subjects the elderly were requested to wear the device on their waist all day long for two weeks [33]. They were also requested to record the number of their daily steps in the specific form. After selecting 80 elderly people with low levels of physical activity, they were randomized into four groups (each group consisting of 20 elderly women). According to Gilson et al. and Tudor-Locke et al., more than 12,500 steps per day indicate a very high level of physical activity, between 10,000-12,499 steps indicate a high level of physical activity, between 7,500-9999 steps denote a moderate level of physical activity, between 5,000-7,499 steps denote a low level of physical activity and less than 5,000 steps per day is considered as inactivity [11, 32]. The four levels of physical activity (high, moderate, low, and non-active) were selected as the intervention levels for the elderly in the four groups. After the completion of the pre-intervention phase the subjects entered the intervention phase. Exercise protocols included 6 weeks (3 sessions per week and a total of 18 sessions) of physical activity in the form of walking and counting steps using a pedometer (step counters). In the experimental groups the volume of physical activity (the number of steps taken per hour) was measured with the use of pedometers worn around the waist of the subjects at 5-8 p.m.

A day after the completion of the study protocols participants in the four groups filled out the post-test questionnaires including the psychological well-being scale and the Pittsburgh sleep quality index. The data were analyzed using ANOVA, repeated measure ANOVA and the Bonferroni post-hoc test. The results of the Shapiro–Wilk test showed normal distribution of the data ($P > 0.05$). Levene's test also confirmed the homogeneity of the variable variance in the four groups ($P > 0.05$). The results of Levene's test exhibited homogeneity between the variances in the experimental groups ($P > 0.05$). The mean sleep quality of older adults with cognitive impairment in the experimental groups with low, moderate, and high levels of physical activity in the pre-test and the post-test phases is presented in Table 1.

Table 1. Mean of sleep quality in pre-test and post-test phases

Variable	Low volume of physical activity		Moderate volume of physical activity		High volume of physical activity		Inactive	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Sleep quality	12.1	5.67	10.90	5.37	5.37	11.75	11.20	10.75

The repeated measure ANOVA in the four experimental groups during the pre-test and post-test phases showed that the test stages (pre-test – post-test) had a significant effect and the mean sleep quality of subjects in the post-test phase was significantly higher than that of the pre-test phase ($P < 0.05$). The group main effect was also significant, so that the subjects in the inactive group had poorer sleep quality than those in the other groups ($P < 0.05$). The interactive effect of the inactive group at different tests was also significant (Table 2).

Table 2. Results of repeated measure ANOVA to compare sleep quality in pre- and post-test stages

	Sum of squares	df	Mean squares	F	P-value
Main effect of test stage	726.75	1 and 76	726.750	147.47	0.001
Mean effect of group	79.68	3 and 76	26.56	13.44	0.001
Interactive effect	215.21	3 and 76	71.74	14.55	0.001

The results of the Bonferroni post-hoc tests to evaluate post-intervention paired differences showed that the subjects (elderly women) with cognitive problems in the high, moderate and low level activity groups reported higher sleep quality than those in the inactive group (Figure 2).

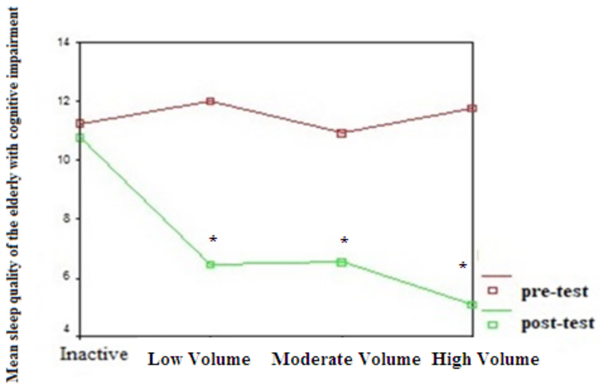

Figure 2. A comparison of sleep quality in pre-test and post-test phases

The pre- and post-test mean scores of psychological well-being for the older adults in the intervention groups (high, moderate, and low physical activity volume) and the inactive group are presented in Table 3.

The results of repeated measure ANOVA showed that the main effect of the test stages (pre-test – post-test) was significant and the mean score of post-intervention psychological well-being was significantly higher than that of the pre-intervention stage ($P < 0.05$). The main group effect was also significant so that the subjects in the inactive group had lower psychological well-being than the other groups ($P < 0.05$). The interactive effect of the group at test stages was significant (Table 4).

The results of paired comparison test using Bonferroni post-hoc test showed that after the intervention, the subjects in high and medium level activity groups had better psychological well-being than the other two groups (Figure 3).

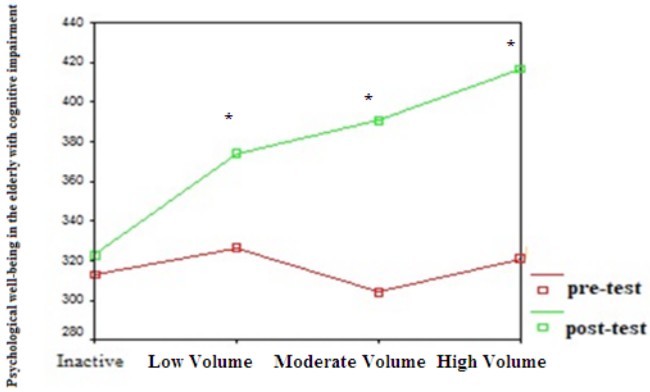

Figure 3. Comparison of psychological well-being before and after the intervention

Discussion

This study aimed to determine the effects of aerobic walking exercise with high, moderate and low level volumes on the psychological well-being and sleep quality in older adults with cognitive impairment. The results showed that different levels of walking activity have varying effects on cognitive disorders and sleep quality in older adults. Hence, the subjects in the high volume physical activity group experienced greater sleep quality than those in the inactive group. Also the subjects in the moderate volume physical activity group showed better sleep quality than those in the low volume physical activity and the inactive groups. Studies reported that aerobic activity plays an important role

Table 3. Scores of psychological well-being among older adults

Variable	Low volume of physical activity		Moderate volume of physical activity		High volume of physical activity		Inactive	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Psychological well-being	326.50	374.20	304.01	390.60	321.35	416.30	312.90	322.80

Table 4. The result of repeated measures ANOVA to compare the psychological well-being of the subjects in the four groups at pre-test and post-test

	Sum of square	df	Mean square	F	P-value
Main effect of test stage	143041.60	1 and 76	120.08	143041.60	0.001
Mean effect of group	26651.56	3 and 76	8883.85	12.84	0.001
Interactive effect	45851.95	3 and 76	15283.98	12.92	0.001

in the autonomic control of the cardiovascular system. It can improve the control of parasympathetic nerves and decreases the control of sympathetic nerves in the cardiovascular system. Therefore, it induces a positive effect on the physiological mechanisms of sleep, such as improved sleep quality and duration of sleep [26].

A variety of theories and models related to the mechanism underlying the effect of aerobic activity on the quality of sleep have been proposed. According to the thermo-regulating theory, during slow wave sleep the core body temperature drops and the number of awakenings rises [1, 13]. Aerobic activity can also increase melatonin secretion. Melatonin is a hormone secreted from the pineal gland, a small gland in the cerebrum that helps the body to regulate the sleep-wake cycle. Melatonin can result in elevated core body temperature and therefore increase duration of sleep [12, 26]. The restoration theory of sleep suggests that anabolic activities (reactions that provoke growth and development) are heightened during sleep and catabolic activities increase during the day.

In order to restore and maintain the balance of energy and maintain appropriate body conditions, the amount of energy depleted due to bodily activities during daytime should be restored at rest. For this reason the body needs to sleep [24]. According to the restoration theory of sleep, sleeping is essential for revitalizing and restoring the physiological processes that keep the body and mind healthy [3, 24]. Akbari Kamrani et al. also developed the body energy maintenance theory, according to which aerobic activity may produce desirable changes in the circadian rhythm and increase the level of adenosine. Improved physical fitness in the elderly through exercise and physical activity may increase delta wave during non-REM stages 3 and 4, and therefore enhance the quality of sleep [2, 4].

Wang et al. (2014) reported that maintaining mobility and physical activity diminishes daytime drowsiness and improves sleep quality in the elderly. Sustained performance of daily activities such as bathing or eating is more effective in improving sleep quality than other important activities such as shopping, using public transport and making doctor appointments. The disparity of results with those of our study may be due to the differences in the study population, age range, divergent study design, cultural differences, type of aerobic exercise and its duration and volume as well as different tools and instruments. Our results also manifested significant differences between psychological well-being of the elderly women in the four groups. The scores for the psychological well-being of the subjects in high and moderate volume physical activity groups were significantly higher than those in the low volume physical activity and inactive groups [35].

In general, it could be concluded that human well-being relies on dealing with daily problems and experiences gained through these encounters. These experiences can affect one's thoughts and attitudes regarding various aspects of life. The results of this study showed that the adoption of an active lifestyle as a new experience in old age could have a positive effect on the psychological well-being of the elderly. Reid et al. argued that the effect of moderate and high levels of physical activity on improving psychological well-being in the elderly could be attributed to the nature of sport in terms of its attractiveness, as well as the social effects of exercise on people's cultures, which could be crucial to forging positive relationships with others [26].

Physical activity and sports also curb anti-social and ageist behaviors. Researchers also stated that physical activity in the elderly diminishes activity limitations, fosters independence, improves the performance of tasks and promotes a happy and successful life, which leads to the increased quality of life, and psychological well-being. Therefore, it can be construed that old people with low levels of psychological well-being can partially alleviate internal personality conflicts and achieve enhanced mental and social growth by engaging in physical activities as a favorable environmental experience. As shown by the results of other studies and our research, physical activity, sports and entertainment leads to a happy and satisfying life for senior citizens. Entertainment and recreational activities strengthen their self-confidence, while with improved physical, psychological and social dimensions the elderly can save themselves from the vicious circle of aging [26, 33, 34, 35].

A review of 25 studies suggested that moderate exercise is effective in alleviating tension, depression, confusion and psychological well-being, whereas high volume physical activity is less effective in this regard [31]. In turn, Wang et al. reported that a session of aerobic exercise with 60% maximal aerobic power on a stationary bicycle causes fatigue and reduces vitality and psychological well-being. Researchers reported that a 30-min session of aerobic activity with moderate volume, as opposed to high volume exercise, can further improve components of psychological well-being in people with severe clinical depression. Research shows that mental, psychological and physical fatigue may explain the ineffectiveness of high volume physical activity in improving mental psychological well-being in older adults [35].

Conclusions

The results of the present study suggested that walking and an active lifestyle leads to a significant improvement in psychological well-being and sleep quality in elderly women with cognitive disorders. Therefore, adopting an active lifestyle can be a desirable alternative to sleep and sedative medications prescribed in conventional treatments, which can pave the way for enhancing the quality of life and active participation of older adults in the community.

Given the rising elderly population, the physical, mental and social welfare of the elderly should be given priority in order to promote their health and prevent or reduce old age-related diseases. These results of this study can have implications for practitioners in the fields of medicine, psychology, sport psychology and other social disciplines as well as the staff of elderly health care centers.

One of the limitations of this study resulted from its restriction to the female Iranian elderly and a lack of review of studies of non-Iranian elderly and male elderly. Other limitations include failure to control other variables such as the level of education, personality and working background of the elderly women, which can influence the results. Future research is recommended to control these variables.

Conflict of Interests

The authors declare no conflict of interest.

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