REVIEW ARTICLE

Beneficial Effects of Taekwondo Poomsae Training on the Elderly: A Literature Review

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Abstract

Aging is a phenomenon that causes adverse physiological changes. A major factor for older adults aged over 65 is lack of physical activity or exercise, which delay and prevent chronic disorders. Numerous studies have shown that martial arts may be an efficient approach to reduce the risk of chronic illnesses in the elderly population. However, there are few evidence-based reviews of the physiological changes resulting from Taekwondo poomsae training in the elderly. This review aimed to collect and report information regarding the various effects of poomsae training on older adults. A search of online literature was conducted for peer-reviewed articles. Of the total 144 articles, the 15 selected were relevant to the review. The results of this review found poomsae training’s efficacy on obesity, bone quality, balance, walking ability, overall physical fitness, and cognition in older adults. We conclude that poomsae training can result in positive physiological changes in older adults.

KEYWORDS

older adults, chronic disorders, physiological changes

Introduction

Aging is an inevitable phenomenon that leads to adverse physiological changes in older adults aged over 65, because they have lower resistance against stresses than young or middle-aged adults (9). In addition, they are more susceptible to chronic disorders compared with other age groups (12). One of the major factors for chronic disorders in older adults is lack of physical activity or exercise (2). Physical inactivity or non-exercise is attributed to a sedentary lifestyle in the elderly. A low physical performance and energy expenditure lifestyle can cause a decline in cardiovascular fitness, muscle mass, and strength in older adults, which increases the risk of morbidities such as obesity, metabolic syndrome, osteoporosis, and dementia (2). Ultimately, these factors can negatively impact the elderly (23).

Since age-associated chronic disorders have been regarded as a fundamental personal or community issue in human society (12), physical activity or exercise in older adults plays an important role in improving their health and preventing various chronic disorders (21). In particular, numerous studies have shown that martial arts may be an effective approach in reducing the risk of chronic illnesses in the elderly population (29).

Rogers et al. (29) reported the various effects of Tai Chi training on older adults, which include improved balance ability for preventing falls and enhanced physical performances such as walking, flexibility, strength, and power. In addition, cardiovascular function can also be improved. Tai Chi training prevents hypertension in the elderly by increasing the maximal oxygen ability and decreasing blood pressure (29).

However, there are few evidence-based studies on the effect of Taekwondo poomsae training in the elderly. This may be because the majority of articles on Taekwondo are the result of studies on sparring competitors or other age populations. Therefore, the purpose of this review was to collect and report the various effects of poomsae training on older adults.

Characteristics of Taekwondo Poomsae

Maximal heart rate (HR max) or maximal oxygen uptake (VO₂ max) during exercise is an assessment or index of cardiorespiratory (cardiovascular) fitness (10). As cited by Goosey-Tolfrey and Tolfrey (10),
American College of Sports Medicine (ACSM) guidelines state aerobic exercise should be performed within 60~90% HR max and 50~85% VO\textsubscript{2} max for improving cardiovascular fitness. A poomsae is a series of fundamental Taekwondo attack and defense techniques performed in a prescribed pattern, requiring the movement of lower extremities and arms by shifting weight (35). The intensity of poomsae is approximately 87% of HR max with a mean of 174 beats/min. On the other hand, Taekwondo basic drill training is 74% of HR max with a mean of 148 beats/min, and Taekwondo kick drills is 91% of HR max with a mean of 182 beats/min (18). Poomsae training intensity is between that of basic drills and kicking training. Therefore, poomsae may be regarded as an appropriate aerobic type exercise to improve cardiovascular fitness (18). The intensity of poomsae in older adults per se has not been measured and consequently should be the focus of future studies.

Methods

A computer literature search of Korean Studies Information Service System (KISS), Research Information Sharing Service (RISS), and Pubmed was performed for peer-reviewed articles using the following keywords: “Taekwondo,” “poomsae,” “older,” “elderly” or and “senior.” Korean and English articles were selected in this review. Since this review focused only on the beneficial effects of poomsae, studies on poomsae training and another conventional training method (e.g., aerobic or resistance exercise) were excluded. Articles were considered relevant if they included a quasi-experimental study with a control group, poomsae intervention, and dependent variables.

A total of 24 articles were found in RISS using the aforementioned keywords. Five of the 24 articles were excluded, because they did not focus the age group of this review. We further excluded 7 articles that were not about poomsae. The remaining 12 articles were relevant to poomsae and the age group.

A search of Google Scholar using the above keywords revealed 120 articles. Of those articles, 12 were excluded because of duplication, and 88 articles were excluded because they were irrelevant to this review. In addition, 17 were not academic research articles, but other forms of materials such as advertisements or books and were thus excluded as well. Therefore, 3 articles were selected using this search engine.

In addition, all the articles found using KISS overlapped with those of the search results from RISS. In PubMed, 35 articles were found after a search of “Taekwondo” and “elderly.” However, there were no articles relevant to the focus of this review, since 20 articles were not related to Taekwondo and 15 articles were irrelevant to the age group and poomsae.

Overall, we selected a total of 15 articles based on the results of the online search engines. The articles were categorized according to subtopics related to poomsae training and the health of elderly people resulting from specific physiological changes. We found that 7 articles were related to prevention of obesity and metabolic disease, 1 article was related to loss of bone quality, 5 articles were related to gait and balance ability, and 2 articles were related to dementia. Physical functions and health fitness were described in those subtopics.

Figure 1. Summary of the diagram of the searched articles according to the online search engine.
RISS: Research Information Sharing Service
Results and Discussion

In relation to our findings, we used five subtopics to describe the main effect of poomsae training on older adults. The first part of each subtopic described the appropriate biological mechanism. The second part described the efficiency of poomsae training, in which we compared the physiological characteristics of the training/experimental group and control group.

Obesity

Aging leads to physical inactivity, resulting in loss of muscle mass and strength as well as excessive increase in fatty tissues (26). Accumulation of excessive fat in older adults increases the prevalence of obesity and has negative consequences; i.e., metabolic syndrome (26). Therefore, it is important for the elderly to reduce and prevent obesity and metabolic syndrome.

Two studies reported that lean body mass was increased and body weight and body fat percentage were decreased from approximately 33% to 29% through 12 weeks of poomsae training (17, 33). Although body fat percentage did not meet the criteria for normal levels, which range from 18 to 28%, the decreased amount was near normal levels (6). In comparison with the control group, decreases in waist circumference from 87.64 cm to 85.93 cm (15), systolic blood pressure (SBP) from 136 mmHg to 127 mmHg, and diastolic blood pressure (DBP) from 90 mmHg to 80 mmHg were reported (17). In addition, an increase in high-density lipoprotein cholesterol (HDL-C) level from 50 mg/dL to 58 mg/dL (approximately 16%) was observed. Despite the abnormal levels of SBP and DBP, poomsae training reduced these to normal levels (17). Interestingly, apolipoprotein A1 (ApoA-I) levels were found to increase from 133 mg/dL to 145 mg/dL; in addition, decreases in triglyceride (TG) from 192 mg/dL to 177 mg/dL, total cholesterol (TC) from 211 mg/dL to 188 mg/dL, low-density lipoprotein cholesterol (LDL-C) from 142 mg/dL to 120 mg/dL, apolipoprotein B (Apo B) from 191 mg/dL to 182 mg/dL, and glucose level from approximately 108 mg/dL to 97 mg/dL were observed, which decreased to below normal levels (11, 17, 33). ApoA-I and Apo B are important indicators of HDL-C and LDL-C formation, respectively (27). In cases where TG levels were previously higher than normal, subjects’ TG levels were reduced to 177 mg/dL through poomsae training. One study hypothesized that if poomsae training of the experimental group was conducted for a longer period, subjects’ TG levels would have possibly been reduced more (32). In addition, fasting glucose levels were decreased successfully to normal levels through poomsae training (11, 17, 32).

Some studies also aimed to investigate the improvements of other blood parameters in relation to obesity and other chronic diseases. For example, in addition to cholesterol, C-reactive protein (CRP) and N-terminal pro-brain-type natriuretic peptide (NT-proBNP) are risk factors for obesity-induced cardiovascular disease (38). NT-proBNP level is also strongly associated with a higher risk of insulin resistance in obesity (38). CRP levels in particular are related to cardiovascular disease (31). In comparison with one control group, CRP and NT-proBNP levels were significantly decreased from 2.38 mg/dL to 1.94 mg/dL and 296 mg/dL to 278 mg/dL, respectively, through 12 weeks of poomsae training (33). We thus hypothesize that 12 weeks of poomsae training for elderly people could contribute to health improvements and prevent obesity-induced cardiovascular disease.

Adiponectin is a type of protein produced and secreted by adipocytes, and it plays an important role in improving insulin resistance and preventing obesity (24). Cho (6) reported a significant increase in adiponectin levels from 7.96 μg/mL to 9.18 μg/mL due to 12 weeks of poomsae training, whereas no change was observed in the control group.

Bone quality

Older adults are more likely to have osteopenia or osteoporosis because of decreases in bone mineral density (BMD) and bone mineral content (BMC) (8). Deficits in vitamin D, which commonly occur in older adults, contribute to excessive parathyroid hormone (PTH) secretion, altering free calcium release from the bone into the bloodstream (36). This mechanism plays an important role in reducing the absorptive function of calcium in the bone and is one of the major causes of osteoporosis (25). Kang et al. (13) evaluated the effects of 12 weeks of poomsae training on older adults aged 65 and over. The participants were divided into an experimental group (13 subjects) and a control group (9 subjects). Results of 25-hydroxy vitamin D tests (25(OH)D; a test to measure vitamin D in the body) showed that subjects’ vitamin D levels decreased from 14.78 ng/mL to 13.51 ng/mL. Likewise, subjects’ estradiol levels decreased from 11.95 pg/mL to 9.18 pg/mL due to 12 weeks of poomsae training, whereas no change was observed in the control group.

Furthermore, PTH levels increased significantly from 39.25 pg/mL to 49.38 pg/mL, or approximately 25.8%.
However, whole body BMD did not significantly change after 12 weeks of training. The authors indicated that 12 weeks of poomsae training for elderly people was insufficient for beneficial changes in bone-related variables. Therefore, they suggested that the duration and frequency of poomsae training and various scientifically validated kinetic components should be considered in further studies on bone quality (13).

Kohrt et al. (16) reported that weight-bearing physical activity or high-intensity loading exercise can increase BMD and other parameters. However, it is difficult for older adults to drastically increase bone quality after only a short or acute period of exercise (16). Allison et al. (1) reported that 12 months of high-impact weight-bearing exercise resulted in an increase in the BMD and BMC of the lower femoral neck in older adults, and the rate of change in both BMC and BMD of the femoral neck was increased by approximately 2% in the experimental group as compared with the control group.

Based upon the above findings, we also suggest that other variables such as insulin-like growth factor-1 (IGF-1) or sex steroid hormones in the blood of older adults following poomsae training should be examined. These factors might have a relationship with BMD in elderly people (19), and could be affected by poomsae training.

Balance and walking ability

Decline of balance and walking ability is one of the major causes of falls and injury in the elderly (30). Body sway variables such as in the mediolateral and anteroposterior directions have been measured using a force plate to determine balance ability (20). Lower values of body sway variables indicated that the participants in one Taekwondo study have greater balance ability (20). Poomsae training was previously examined in several studies for its potential to improve posture stability and gait control ability in older adults (14, 35, 40).

Shin et al. (35) studied the effects of poomsae on 16 older adult women. The experimental group performed poomsae for 60 min, 3 days per week for 12 weeks. After intervention, the center of pressure mediolateral range, anteroposterior and mediolateral distances, anteroposterior standard deviation, mean velocity, and 95% confidence ellipse area of the experimental group were smaller than those of the control group (35).

Chi et al. (5) examined the effect of aquatic exercise using poomsae on the stability of elderly women. In the study, 23 older women were divided into an experimental group (n = 12) and control group (n = 11). After 12 weeks of intervention, the experimental group showed significantly lower body sway in the anteroposterior and mediolateral directions (5).

Yoem et al. (40) randomly assigned 30 elderly females into two intervention groups (poomsae training and walking) and one control group. After 12 weeks of intervention, the mediolateral root-mean-square distance, mediolateral velocity, average velocity, and 95% confidence ellipse area of the intervention groups were significantly smaller than those of the control group. However, mediolateral root-mean-square distance and mediolateral velocity values of the walking group were higher than those of the training group, whereas average velocity and 95% confidence ellipse area values of the training group were higher than those of the walking group (40).

Cromwell et al. (7) randomly assigned 13 women and 7 men (average age 73.8 years) into a training and control group. Multidirectional Reach Test (MDRT) (back, right, left), absolute distance, Timed Up and Go (TUG) (seconds), normalized walking velocity (m/s), and gait stability ratio (GSR) were significantly improved in the training group compared with those in the control group. Moreover, Park and Kim (14) showed poomsae training produces considerable improvements in balance test for elderly people; i.e., Berg’s balance scale and stride length of both lower extremities. However, maximal oscillations (mm/s) and oscillation distance (mm) were significantly decreased (14).

Physical fitness

Physical fitness is the capability and energy to perform daily activities without fatigue. Physical fitness includes cardiorespiratory power, skeletal muscle power, strength, endurance, agility, balance, and flexibility. In particular, older adults experience a decline in cardiovascular fitness, which associated with a high risk of cardiovascular mortality (37). Therefore, improvement in cardiovascular function is important for older adults, and maximal oxygen uptake is the gold standard for determining cardiovascular fitness (37). It has been reported that peak VO2 max of overweight older women was significantly increased in the experimental group compared with in the control and walking group (17, 32, 33).

Muscular strength is defined as the capacity of generating force against the external resistance (39). Chi et al. reported that the muscle strength of isokinetic knee extension and flexion in women with a mean age of 70 was augmented significantly on both lower extremities.
by over 10 N·m through aquatic exercise (5). However, some studies show that grip strength in both hands was increased only slightly or not affected at all by poomsae training, and one control group even demonstrated a decline in grip strength (21, 22).

Another study reported that the push-up frequency of its experimental group was significantly increased through Taekwondo training for 12 weeks (17). However, Moon et al. reported that push-up frequency did not change in the Taekwondo intervention group of their study (22). Typically, push-up tests indicate upper body muscle strength and endurance (17). Nevertheless, subjects’ showed inconsistent push-up test results between different poomsae studies (17, 22).

Flexibility is defined as the capacity of attaining a range of motion (2). Variables such as sit-and-reach and sitting trunk flexion (cm) are measured to determine flexibility. Kwon et al. reported that obese older women who trained in Taekwondo had significant increases in sit-and-reach tests (17).

Cognition

Decline of cognitive function is the most common chronic disease in elderly people. As older adults age, β-amyloid protein accumulates in the cerebrum, forming neurotic plaques, leading to the development of dementia due to the death of brain cells in older adults (3).

Homocysteine and dehydroepiandrosterone (DHEA) concentration associated with increased cerebral hemorrhage is one of the major factors for dementia (4). In particular, DHEA level indicates the secretion of steroid hormones from the adrenal cortex and has been shown to decrease with age; therefore, it is typically used as an index for detecting physiological cognitive impairment or Alzheimer’s disease (28). In addition, one epidemiological study revealed that most patients with Alzheimer’s disease had vascular disorders, and homocysteine is one of the major factors for vascular disease in dementia (4).

Shin et al. have shown that poomsae training for 12 weeks significantly reduced β-amyloid levels from 11.44 pg/mL to 9.96 pg/mL. On the other hand, the β-amyloid levels were increased from 10.65 pg/mL to 11.63 pg/mL in the control group. DHEA levels were significantly increased from 41.03 mg/dL to 47.0 mg/dL in the experimental group, whereas it was decreased in the control group (22, 34).

Moon et al. reported frail elderly people aged over 70 years old (classified on the Fried’s Frailty Scale) who performed poomsae for 40 min, 3 times per week for 12 weeks resulted in a significant decrease in homocysteine level, and their Mini Mental State Examination (MMSE) score was increased to normal levels (22).

Another study related to the effects of poomsae, Taekwondo aerobics, and weight-lifting training on older adults showed that subjects’ DHEA level was highest in weight-lifting training, followed by Taekwondo aerobics and poomsae. Their DHEA level was significantly increased in all of these interventions (15).

Conclusion

As mentioned above, it is necessary for older adults to overcome the physiological deterioration caused by aging. Most previous studies of Taekwondo have focused on describing its effects on Taekwondo athletes or younger populations. This review focused on the effects of poomsae training on older adults. Our findings indicate the efficacy of poomsae training on obesity, bone quality, balance, walking ability, physical fitness, and cognition in older adults. Following this review, we concluded that poomsae training can result in positive physiological changes in older adults. However, these studies were limited to a few clinical factors. Therefore, it is important to focus on the potentially diverse effects of poomsae training on the elderly in future research.

Furthermore, muscle mass, strength, and power are strongly correlated with daily activities, and their loss in older adults can result in a decline in daily performance. However, the studies reviewed focused on aerobic fitness changes in the poomsae training of older adults. Therefore, we suggest future poomsae research focus on identifying improvements in muscle mass, strength, and power in elderly people.

Limitations and suggestions for future research

There were a number of limitations in this review. First, the articles we collected had insufficient sample sizes, which do not reflect the entire actual population. Therefore, we propose that future studies should recruit more participants in their samples. Second, this review was limited to the language of each article. A number of studies were written in Korean, and only a few were written in English. Inclusion of experimental articles in other languages would better convey the findings and enhance the quality of poomsae studies involving older adults. Moreover, results based on studies written in various languages will be more convincing for the general population. Third, aging is associated with more varied physiological changes than what are described.
above. Consequently, this review was limited in that it addressed only five clinical factors. It is therefore necessary for clinical studies on elderly people and poomsae to be more diverse in their methodology.

Acknowledgements

This work was supported by the National Research Foundation of Korea (NRF): funding was provided by the Ministry of Science, ICT and Future Planning (NRF-2013M3A9B6046417), the Ministry of Education (NRF-2014R1A1A2058645), and the Institute on Aging, Seoul National University.

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