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Effects of 8-week kettlebell training on body composition, muscle strength, pulmonary function, and chronic low-grade inflammation in elderly women with sarcopenia

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ABSTRACT

Objectives: To examine the effect of kettlebell training on body composition, muscle strength, pulmonary function, and chronic low-grade inflammatory markers among elderly people with sarcopenia.
Design: Randomized controlled trial.
Setting: Community center and research center.
Participants: A total of 33 elderly women with sarcopenia (aged 65–75 years) were recruited.
Intervention: The participants were randomly assigned to a kettlebell training (KT) group or a control (CON) group. The KT group received an 8-week training intervention involving 60-min sessions twice a week, whereas the CON group members continued their daily lifestyles without participating in any exercise training. Four weeks of detraining were organized to observe the retention effect of the training program on the KT group.
Measurements: The participants' body composition, muscle strength, pulmonary function, and chronic low-grade inflammatory markers were measured and analyzed before training (at Week 0, W0), after 8 weeks of training (at Week 8, W8), and after 4 weeks of detraining (at Week 12, W12).
Results: In the KT group, appendicular skeletal muscle mass (ASM) and the sarcopenia index measured at W8 and W12 were significantly higher than those at W0(p = .004; p = .005). At W8 and W12, the sarcopenia index was significantly higher in the KT group than the CON group(p = .020; p = .019). In the CON group, the skeletal muscle mass levels measured at W8 and W12 were significantly lower than that at W0(p = .029; p = .005), and the ASM and the sarcopenia index measured at W8 were significantly lower than those at W0(p = .037; p = .036). Additionally, the measured left handgrip strength(p = .006), back strength(p = .011; p = .018), and peak expiratory flow (PEF) (p = .008; p = .006) were significantly higher in the KT group than the CON group at W8 and W12. At W8, the measured right handgrip strength was significantly higher in the KT group than the CON group(p = .043). In the KT group, the back strength and PEF levels measured at W8 and W12 were significantly higher than those at W0(p = .000; p = .004), and the left and right handgrip strength levels at W8 were significantly higher than those at W0(p = .004; p = .013). By contrast, in the CON group, the left(p = .004; p = .006)and right(p = .002; p = .004)handgrip strength levels and PEF(p = .018; p = .012) measured at W8 and W12 were significantly lower than those at W0. Moreover, compared with the high-sensitivity C-reactive protein (hs-CRP) levels measured at W0, those measured at W8 and W12 were significantly lower in the KT group(p = .006; p = .013)but significantly higher in the CON group(p = .005; p = .009). There was no significant difference in hs-CRP, IL-6, TNF-α between the KT and CON group.
Conclusion: For elderly people with sarcopenia, participating in kettlebell training significantly increases the sarcopenia index, grip strength, back strength, and PEF. In addition, the retention effect of the training program continued after 4 weeks of detraining.

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1. Introduction

Sarcopenia refers to the loss of skeletal muscle mass (SMM) and degeneration of muscle strength associated with aging among older people, even with unchanging body weight (Hairi et al., 2010; Cruz-Jentoft et al., 2010a; Johnson et al., 2013). However, studies have not specifically indicated whether sarcopenia should be regarded as a disease. For example, Cruz-Jentoft et al. (2010b) suggested that although sarcopenia cannot be considered a disease, it is an indicator of geriatric syndrome. From a long-term perspective, studies on sarcopenia have indicated that human skeletal muscle declines by 3%–10% per decade starting at the age of 25 years (Short et al., 2005). Moreover, human functional capacity decreases by 1%–2% starting at the age of 50 years and by 3% after the age of 60 years on a yearly basis (Toran et al., 2012); these symptoms lead to limited mobility and reduced quality of life (Morley et al., 2011). When studying the potential mechanisms underlying sarcopenia, the European Working Group on Sarcopenia in Older People presented a report suggesting that the onset and progression of sarcopenia are associated with multiple interactive mechanisms including protein synthesis, proteolysis, neuromuscular integrity, and muscle fat content (Cruz-Jentoft et al., 2010a).

Recent studies have asserted a close relationship between chronic low-grade inflammation (CLGI) and sarcopenia (Beyer et al., 2012), demonstrating that an increase in proinflammatory cytokines (clinically referred to as CLGI) is observable even in the circulatory systems of healthy aged individuals (Michaud et al., 2013; Guarner and Rubio-Ruiz, 2015). Aging has been confirmed to increase proinflammatory markers in the blood and to induce a chronic low-grade inflammatory state harmful to health (Michaud et al., 2013); this thus indirectly changes the immune system in older people, thereby resulting in immunosenescence (Poland et al., 2014). Clinical studies have also found that for older people, an increase in plasma levels of interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), C-reactive protein (CRP), and other proinflammatory cytokines is directly linked to an increased risk of morbidity and mortality (Michaud et al., 2013; Woods et al., 2014). Notably, a clear loss of SMM and muscle strength was detected among older individuals experiencing CLGI (Thomas, 2010).

Examining the relationship between the loss of SMM and chronic proinflammatory cytokines, Cesari et al. (2005) indicated that CRP and IL-6 are positively associated with total fat mass and negatively associated with appendicular lean mass. Other studies have confirmed that high levels of IL-6, CRP, and TNF-α are related to low muscle mass (Schaap et al., 2006; Alemán et al., 2011) and lead to a decline in muscle strength (Schaap et al., 2006); a study also demonstrated that increased plasma levels of TNF-α are associated with declining grip strength and knee extensor strength (Schaap et al., 2009). By conducting a cross-sectional study on men and women aged 70–79 years, Visser et al. (2002) found that higher plasma levels of IL-6 and TNF-α are associated with lower muscle mass and lower muscle strength; they also revealed that even well-functioning older people cannot avoid increased plasma levels of proinflammatory cytokines and the loss of muscle mass and muscle strength caused by aging.

Exercise improves physiological status and quality of life among older people. Taaffe (2006) regarded resistance weight training as an effective measure for enhancing the health of older people with sarcopenia. For older people, resistance training of moderate intensity was confirmed as helpful for increasing muscle size and strength (Burton and Sumukadas, 2010). Among the various types of weight training, kettlebell training is dynamic and involves full-body exercise. This training method is beneficial to increasing muscle power, muscle strength, core strength, and aerobic capacity, as well as to the development of functional capacity. Compared with conventional barbell or dumbbell weight training, kettlebell training involves more complex movements and variations and is widely applied in exclusive athletic training programs. Falatic et al. (2015) also confirmed that participating in kettlebell training 3 days a week for 4 consecutive weeks increases maximal oxygen consumption by approximately 6%; other studies have demonstrated that engaging in kettlebell training in other frequencies improves individuals' abilities in vertical jump tasks (Otto III et al., 2012), bench pressing, clean and jerk tasks (Manocchia et al., 2013), and squats (Otto III et al., 2012), in addition to improving their core strength and dynamic balance capacity (Jay et al., 2013). However, studies have rarely focused on applying kettlebell training in the design of related training programs for older people. We hypothesized that 8 weeks of kettlebell training would increase skeletal muscle mass, sarcopenia index, muscle strength performance, pulmonary function and thereby reduce levels of the chronic proinflammatory cytokines high-sensitivity CRP, IL-6, and TNF-α.

2. Methodology

This study recruited community-dwelling elderly citizens aged 65–75 years, and a total of 33 women with sarcopenia were selected as the final participants. Recruitment was announced by posters indicating the following inclusion criteria: (a) 65–75 years of age, (2) exhibiting signs of sarcopenia, and (c) agreeing to fully participate in the study program. The exclusion criteria were as follows: (a) being diagnosed as having immediate disease(s), (b) currently showing signs of infection, (c) having received vaccination within the past 4 weeks, (d) engaging in excessive alcohol or drug consumption, (e) currently receiving cancer treatment, (f) receiving chronic disease medication on a long-term basis, and (g) currently receiving medication that affects the immune system (e.g., steroidal and nonsteroidal antiinflammatory drugs). After understanding the research purpose, methodology, related rights of research participants, and potential risks, the participants were requested to provide written informed consent and fill out their basic personal information as well as a health status questionnaire. This study program was approved by the Institutional Review Board at Taoyuan General Hospital under the Ministry of Health and Welfare, Taiwan.

2.1. Study design

The duration of the study program was 12 weeks. The selected elderly female participants with sarcopenia were randomly divided into two groups: a kettlebell training (KT) group and a control (CON) group. During the program, all participants maintained their normal daily living schedules and diets. After 8 weeks of exercise training, both groups were subjected to a consecutive 4 weeks of detraining; this entailed them continuing their original daily schedules and diets and stopping all training and exercise tasks. Measured items included body composition (body weight, SMM, body fat mass [BFM], appendicular skeletal muscle mass [ASM], visceral fat area [VFA], and sarcopenia index), muscle strength performance (grip strength and back strength), pulmonary function (peak expiratory flow [PEF] and forced vital capacity [FVC]), and chronic proinflammatory cytokine concentration (i.e., high-sensitivity CRP, IL-6, and TNF-α). These items were measured at three time points, namely before training (at Week 0, W0), after training (at Week 8, W8), and after 4 weeks of detraining (at Week 12, W12), using the same measurement steps, procedures, equipment, and personnel employed. The sample size was estimated using the data from the baseline. Based on the possible effect size of 1 for the difference in some variables between the groups, alpha level of 0.05, and a power $(1 - \beta)$ of 0.80, it was estimated that at least a total of 15 participants were necessary.

2.2. Measurements

2.2.1. Training program for KT

For KT, qualified trainers were recruited to initiate a series of training courses in a community center, where kettlebell weight training with 60%–70% of 1 repetition maximum (RM) was conducted twice a week for 8 weeks. Aiming for full-body major muscle groups,