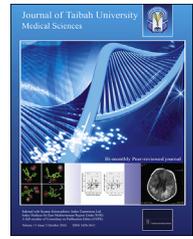




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Original Article

## Dumbbells and ankle-wrist weight training leads to changes in body composition and anthropometric parameters with potential cardiovascular disease risk reduction



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### المخلص

**أهداف البحث:** يُعد دعم النشاط البدني أحد الاستراتيجيات العالمية لخفض عبء أمراض القلب والأوعية الدموية. تهدف هذه الدراسة إلى تحديد ومقارنة أثر تمارين المقاومة الخفيفة باستخدام أثقال الدميل أو أوزان الكاحل والمعصم على معالم القياسات البشرية وتركيب الجسم، بين البالغين في مقاطعة "كلانتان" بدولة ماليزيا.

**طرق البحث:** أجري هذا البحث المجتمعي العشوائي بمقاطعة كلانتان بدولة ماليزيا من شهر مارس إلى شهر أغسطس ٢٠١٢م. تم تقسيم البالغين ممن زاد مؤشر كتلة الوزن لديهم عن ٢٣ كغم/م<sup>٢</sup> بشكل عشوائي إلى مجموعتين، أثقال الدميل (عدددهم ٦٩) وأوزان الكاحل والمعصم (عدددهم ٦٩). قامت مجموعة أثقال الدميل بتمارين جماعية منظمة ثلاث مرات أسبوعياً باستخدام زوج من الدميل، وزن كل منهما كيلوجرام واحد. وأعطيت مجموعة أوزان الكاحل والمعصم زوجاً من أوزان الكاحل، وزن كل منهما نصف كيلوجرام، وزوجاً من أوزان المعصم وزن كل منهما نصف كيلوجرام يتم ارتداؤها خلال الأنشطة اليومية ثلاثة أيام أسبوعياً، لمدة لا تقل عن عشرين دقيقة يومياً. تم قياس كل من مؤشر كتلة الجسم، ومحيط الخصر، ونسبة الخصر إلى الورك، ونسبة الدهون في الجسم ونسبة العضلات في الجسم ابتداءً، وبعد ستة أسابيع، وثلاثة أشهر وستة أشهر من بداية الدراسة.

**النتائج:** أكملت التجربة ٨٩ مشاركاً. كانت هناك انخفاضات ملموسة في مؤشر كتلة الجسم في الأسبوع السادس فقط لمجموعة أثقال الدميل. ولم تُلاحظ أي

تغيرات ذات قيمة في مؤشر كتلة الجسم بالنسبة لمجموعة أوزان الكاحل والمعصم. كما لوحظ تحسن ملموس في كل من محيط الخصر ونسبة الخصر، إلى الورك ونسبة الدهون في الجسم ونسبة العضلات في الجسم بعد ستة أسابيع، وثلاثة أشهر وستة أشهر مقارنة مع بداية الدراسة.

**الاستنتاجات:** أحدثت تمارين المقاومة باستخدام أثقال الدميل أو أوزان الكاحل والمعصم تحسناً ملموساً في عناصر معينة من مركبات الجسم ومعالم القياسات البشرية.

**الكلمات المفتاحية:** تمارين المقاومة الخفيفة؛ أثقال الدميل؛ أوزان الكاحل والمعصم؛ الخطورة على القلب والأوعية الدموية

### Abstract

**Objectives:** Promoting physical activity is a global strategy to reduce the burden of cardiovascular disease. This study aimed to determine and compare the effect of light resistance training using either dumbbells or ankle-wrist weights on the anthropometric parameters and body composition of adults in Kelantan, Malaysia.

**Methods:** This randomized community trial was conducted in Kelantan, Malaysia, from March through August 2012. Adults with a body mass index (BMI) of more than 23 kg/m<sup>2</sup> were randomized into dumbbell (N = 69) and ankle-wrist (N = 69) weight groups. Participants in the dumbbell group performed structured group exercises three times per week using a pair of one-kilogram dumbbells. Participants in the ankle-wrist weight group were given one pair of 500 gm ankle

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weights and one pair of 500 gm wrist weights to be worn during the activities of daily living three days per week for at least 20 min. BMI, waist circumference (WC), waist-to-hip ratio (WHR), body fat percentage (BF%) and skeletal muscle percentage (SM%) were measured at baseline, week 6, month 3 and month 6.

**Results:** Eighty-nine participants completed this study. There were significant reductions in BMI only at week six for the dumbbell group. No significant BMI changes were observed for the ankle-wrist weight group. Significant improvements of WC, WHR, BF%, and SM% were observed in both intervention groups from baseline at week 6, month 3, and month 6.

**Conclusion:** Resistance exercise using either dumbbells or ankle-wrist weights produced significant improvements in certain components of body composition and anthropometric parameters.

**Keywords:** Ankle-wrist weights; Cardiovascular risk; Dumbbells; Light resistance training

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## Introduction

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels that includes coronary heart disease, cerebrovascular disease, peripheral artery disease, rheumatic heart disease, congenital heart disease, deep vein thrombosis and pulmonary embolism.<sup>1,2</sup> In 2010, the number of deaths caused by CVDs was 18.1 million. By 2030 it is predicted that 55 million people will die because of NCDs, with 23.3 million annual deaths caused by CVDs (primarily heart disease and stroke).<sup>2</sup>

Obesity and overweight are defined as an abnormal or excessive accumulation of fat that presents health risks, specifically the risk of CVDs.<sup>3</sup> WHO defines overweight as a body mass index (BMI) of greater than or equal to 25; people with a BMI greater than or equal to 30 are considered obese.<sup>3</sup> In the Asian population, it has been observed that health risks increase below the BMI cut-off point of 25 kg/m<sup>2</sup>. For this reason, a lower cut-off point for overweight ( $\geq 23.0$  kg/m<sup>2</sup>) has been proposed for use in these populations.<sup>4</sup>

Physical inactivity or a lack of physical activity is one of the most important public health challenges in the 21st century; it might even be the most important.<sup>5</sup> It has been identified as the fourth-highest risk factor for global mortality (6% of all deaths globally) and was estimated to be the main cause of approximately 21–25% of breast and colon cancers, 27% of diabetes cases, and 30% of ischemic heart disease burden.<sup>6</sup>

The importance of resistance exercise in promoting health and preventing chronic diseases has become increasingly

recognized<sup>7,8</sup> because it has great potential not just to improve skeletal muscle strength, endurance, power, and neuromuscular function<sup>9</sup> but also to contribute to the prevention and management of atherosclerotic coronary heart disease, hypertension, diabetes, overweight, and obesity.<sup>10,11</sup> However, traditional resistance training using weight machines is resource intensive, potentially resulting in lower adherence.<sup>12</sup> To improve adherence, a simpler and easier method of resistance training should be an integral component of any training program that aims to reduce obesity, CVD risk and overall health, especially at the community level. Resistance training using lighter weights, such as light dumbbells, does not require many resources and has proven beneficial in improving overall health.<sup>13–15</sup> This study was conducted to compare the effect of light resistance training using dumbbells and ankle-wrist weights on body composition and anthropometric measurements.

## Materials and Methods

### Study design

This randomized community trial was conducted in Tumpat District, Kelantan (which is situated on the East Coast of Peninsular Malaysia), from March 2012 through August 2012. The calculation for the required sample size was performed using STATA software (sample size calculation of means with repeated measures), with a type I error of 5% and type II error of 20%. The sample size obtained was 66 participants per group (after 40% dropout), resulting in 132 participants overall. Participants aged 18 to 60 years old who volunteered to participate with a body mass index (BMI) equal to or greater than 23.0 kg/m<sup>2</sup> were included in this study. Those who were pregnant, who were on any weight management treatment/program, who had existing joint pain that restricted physical movements, or who had existing cardiac conditions (NYHA Functional capacity class II, III and IV) were excluded. All of the participants were randomized into two equal-sized groups using block randomization: a light resistance training group using dumbbells and a light resistance-training group using ankle-wrist weights. The randomization sequence was concealed using sealed envelopes.

### Light resistance training protocol

#### Dumbbell exercise

A dumbbell exercise was performed with a pair of commercially available lightweight (1 kg) soft dumbbells for at least 15 min per day, three days per week using a dumbbell exercise method invented by Professor Suzuki Masashige (Bull Inst. Health & Sport Science, University of Tsukuba).<sup>16</sup> Each exercise session was preceded by a five-minute stretching routine. The dumbbell exercise consisted of 12 movements that targeted both the upper and lower body large muscle groups. The 12 exercise movements were the standing shoulder press, bent dumbbell row, squat, upper body twist, butterfly, bent lateral raise, simultaneous curl, concentration curl, one hand draw up, kick back, front dumbbell raise, and triceps extension. Soft dumbbells were used, enabling participants to have a firm grasp on the

dumbbell. The participants performed 12 repetitions of each exercise, with two seconds of concentric and two seconds of eccentric movement in continuous motion, and with 15–30 s of rest between exercises. The total estimated time from stretching to the end of exercise was approximately 20 min.<sup>17</sup>

Group exercises led by an instructor were conducted for the first three months. During this supervised phase of intervention, exercise sessions were conducted five times per week in the community hall, and the participants were free to choose to attend any three sessions.<sup>18</sup>

#### Resistance training using ankle and wrist weights

Participants were given a pair of 0.5 kg ankle weights and pair of 0.5 kg wrist weights, for a total weight of 2 kg. They were instructed to wear them for at least 20 min per day three days per week during activities of daily living that involved movements of the upper and lower limbs, such as walking, performing house chores, or gardening. Participants were given notebooks to write the date and duration of their training.

#### Data collection

Waist circumference (WC) was measured using a non-elastic measuring tape 2.5 cm above the umbilicus and below the xiphoid process. Hip circumference was measured at the largest circumference around the buttocks above the gluteal fold (posterior extension). Waist to hip ratio (WHR) was calculated by dividing waist circumference by hip circumference. Height was measured using a non-elastic tape attached to a wall. The height was recorded in centimetres.<sup>19</sup> Body composition was determined through the bioelectrical impedance method using an Omron Karada Scan HBF-362<sup>®</sup> Body Composition Monitor, which gives information about weight, BMI, total body fat percentage (BF%), and skeletal muscle percentage (SM%).

#### Statistical analysis

Data entry and statistical analysis were performed using SPSS software version 18.0.<sup>20</sup> Analysis was begun with data exploration to check for both the normality of data and for any potential error in data entry. Repeated measures analysis of variance (RM ANOVA) was used to determine within-group changes of body composition and anthropometric parameter (from baseline to sixth week, third month, and sixth month), to compare overall differences between groups (between group differences regardless of time) and to compare differences between groups at each time level: at baseline, at the sixth week, at the third month, and at the sixth month (between-group differences with regard to time).

## Results

Initially, 136 participants were recruited to join the study. Eighty-nine participants aged between 25 and 56 years old completed this study, with 40 in the dumbbell group and 49 in the ankle-wrist group. There was no adverse event reported. Comparison of socio-demographic data and baseline characteristics for participants who completed this study

indicates that there were no significant differences between those two groups (Table 1).

In this study, there was a significant reduction in mean BMI in the dumbbell group at week 6 compared to the baseline (mean difference, MD = 0.23; 95% CI: 0.05, 0.42;  $p = 0.007$ ) and no significant changes in BMI for other time comparisons. For the ankle-wrist weight group there were no significant changes in mean BMI for all time comparisons. There were no significant differences in BMI between the two groups either regardless of time ( $F(1,87) = 0.17$ ,  $p = 0.678$ ) or with regard to time (Wilks' Lambda  $F(3,85) = 0.53$ ,  $p = 0.662$ ) (Figure 1).

Participants in the dumbbell group showed a significant reduction of WC from the baseline at week 6 (MD = 4.30; 95% CI: 2.42, 6.18;  $p < 0.001$ ), month 3 (MD = 4.26; 95% CI: 2.10, 6.42;  $p < 0.001$ ), and month 6 (MD = 3.85; 95% CI: 1.96, 5.74;  $p < 0.001$ ). Similarly, in the ankle-wrist weight group, there were significant reductions in WC from the baseline at week 6 (MD = 3.49; 95% CI: 2.50, 4.48;  $p < 0.001$ ), month 3 (MD = 3.31; 95% CI: 2.07, 4.55;  $p < 0.001$ ), and month 6 (MD = 3.37; 95% CI: 2.22, 4.51;  $p < 0.001$ ). Differences between groups both regardless of time and with regard to time revealed no significant differences ( $F(1,87) = 0.93$ ,  $p = 0.337$  and Wilks' Lambda  $F(3,85) = 0.991$ ,  $p = 0.401$ ) (Figure 2).

For WHR, the dumbbell group showed a significant reduction from baseline at week 6 (MD = 0.025; 95% CI: 0.006, 0.043;  $p < 0.004$ ), month 3 (MD = 0.022; 95% CI: 0.003, 0.041;  $p < 0.016$ ), and month 6 (MD = 0.018; 95% CI: 0.001, 0.037;  $p = 0.048$ ). Similarly, in the ankle-wrist weight group there were significant reductions in WHR from the baseline at week 6 (MD = 0.016; 95% CI: 0.006, 0.025;  $p < 0.001$ ), month 3 (MD = 0.011; 95% CI: 0.001, 0.022;

**Table 1: Sociodemographic comparison of participants in dumbbell and ankle-wrist weight groups.**

Variable	Group		Test statistics (df)	p-Value
	Dumbbell (n = 40)	Ankle-wrist weight (n = 49)		
Age (years)	37.98 (6.94)	40.10 (8.56)	-1.29 (87)	0.209 <sup>a</sup>
<b>Sex</b>				
Female	34 (85.0)	40 (81.6)	0.18 (1)	0.673 <sup>b</sup>
Male	6 (15.0)	9 (18.4)		
<b>Race</b>				
Malay	40 (100.0)	48 (98.0)	—	0.551 <sup>c</sup>
Siamese	0 (0.0)	1 (2.0)		
<b>Anthropometry</b>				
BMI (kg/m <sup>2</sup> )	27.89 (4.55)	28.21 (4.43)	-0.34 (87)	0.735 <sup>a</sup>
WC (cm)	86.68 (10.15)	88.31 (11.57)	-0.70 (87)	0.487 <sup>a</sup>
WHR	0.83 (0.08)	0.85 (0.07)	-1.27 (87)	0.209 <sup>a</sup>
BF (%)	34.89 (4.80)	34.69 (5.65)	0.18 (87)	0.861 <sup>a</sup>
SM (%)	24.21 (2.69)	24.02 (2.92)	0.30 (87)	0.764 <sup>a</sup>

Data were described as the mean (SD) for age, frequency (%) for sex and race.

Body mass index (BMI), waist circumference (WC), waist hip ratio (WHR), body fat percentage (BF%), skeletal muscle percentage (SM%).

<sup>a</sup> Independent sample t-test.

<sup>b</sup> Chi-square test.

<sup>c</sup> Fisher exact test.

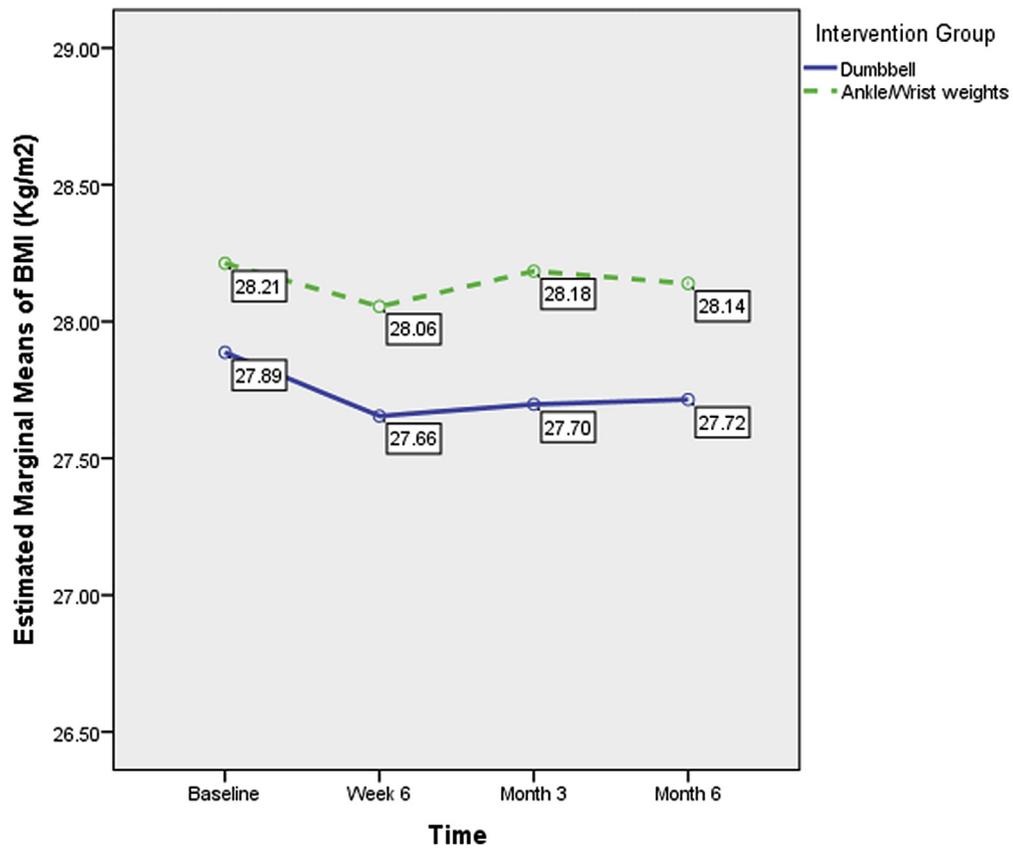


Figure 1: Profile plot showing the BMI changes over time for the dumbbell and ankle-wrist weight groups.

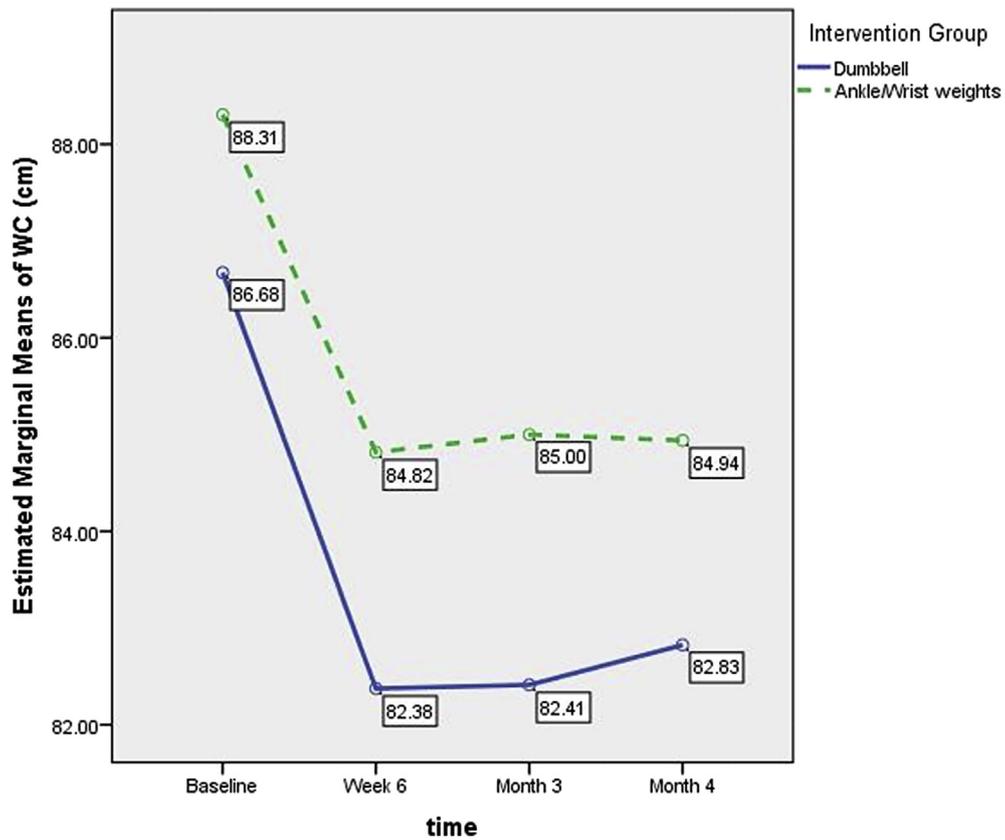


Figure 2: Profile plot showing the WC changes over time for the dumbbell and ankle-wrist weight groups.

$p = 0.035$ ), and month 6 (MD = 0.012; 95% CI: 0.002, 0.022;  $p = 0.008$ ). No significant difference was observed between the two groups either regardless of time ( $F(1,87) = 2.86$ ,  $p = 0.094$ ) or with regard to time (Wilks' Lambda  $F(3,85) = 1.69$ ,  $p = 0.175$ ) (Figure 3).

In the dumbbell group, there were significant reductions in BF% using time comparison for baseline versus week 6 (MD = 0.85; 95% CI: 0.40, 1.30;  $p < 0.001$ ), baseline versus month 3 (MD = 1.14; 95% CI: 0.60, 1.68;  $p < 0.001$ ), and baseline versus month 6 (MD = 1.04; 95% CI: 0.49, 1.58;  $p < 0.001$ ). In the ankle-wrist weight group, there were also improvements of BF% for similar time comparisons: baseline versus week 6 (MD = 0.79; 95% CI: 0.46, 1.12;  $p < 0.001$ ), baseline versus month 3 (MD = 1.20; 95% CI: 0.72, 1.69;  $p < 0.001$ ), and baseline versus month 6 (MD = 1.12; 95% CI: 0.69, 1.56;  $p < 0.001$ ). Between-group comparison both regardless of time and regarding time reveal no significant differences ( $F(1,87) = 0.36$ ,  $p = 0.849$  and Wilks' Lambda  $F(3,85) = 0.19$ ,  $p = 0.902$ ) (Figure 4).

In the dumbbell group, there were significant increases in SM% comparing baseline versus week 6 (MD = -0.43; 95% CI: -0.78, -0.08;  $p = 0.007$ ), baseline versus month 3 (MD = -0.66; 95% CI: -1.06, -0.27;  $p < 0.001$ ), and baseline versus month 6 (MD = -0.81; 95% CI: -1.23, -0.38;  $p < 0.001$ ). The ankle-wrist weight group showed significant increases in SM% using time comparison for baseline versus week 6 (MD = -0.46; 95% CI: -0.65, 0.28;  $p < 0.001$ ), baseline versus month 3 (MD = -0.82; 95% CI: -1.13, -0.51;  $p < 0.001$ ), and baseline versus month 6

(MD = -0.75; 95% CI: -1.11, -0.38;  $p < 0.001$ ). Similar to all other parameters, there was no significant difference in SM% between the two groups both regardless of time ( $F(1,87) = 0.06$ ,  $p = 0.808$ ) and with regard to time (Wilks' Lambda  $F(3,85) = 1.52$ ,  $p = 0.216$ ) (Figure 5).

## Discussion

The benefits of an active lifestyle with respect to avoiding chronic diseases have been widely recognized.<sup>21,22</sup> This study investigated a six-month course of resistance training using either a pair of lightweight dumbbells or lightweight ankle-wrist weights on anthropometric parameters and body composition.

BMI measurement is widely employed in epidemiological studies to predict obesity-related morbidity and mortality in adults. However, BMI does not distinguish between weight associated with muscle and weight associated with fat.<sup>23</sup> One surrogate for adiposity measurements is WC, which reflects central adiposity rather than general adiposity. Evidence for the importance of central adiposity compared to overall body fatness has been shown in many studies that have demonstrated a link between central adiposity and an increased risk of metabolic disturbance, morbidity, and mortality.<sup>24,25</sup> However, the use of WC has its own limitations because WC represents not only subcutaneous fat but also muscle, bone, blood vessels, nerves, and internal fat. In addition, people with large musculature may be misclassified as obese.<sup>26</sup> Despite this limitation, a

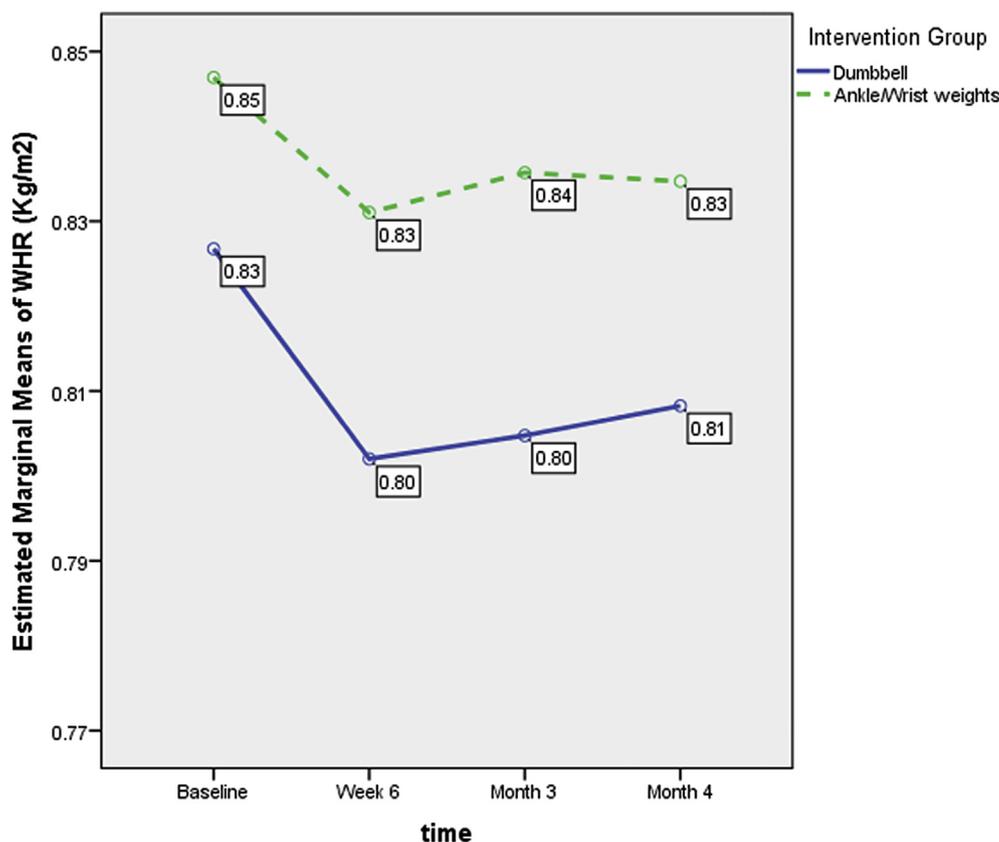


Figure 3: Profile plot showing the WHR changes over time for the dumbbell and ankle-wrist weight groups.

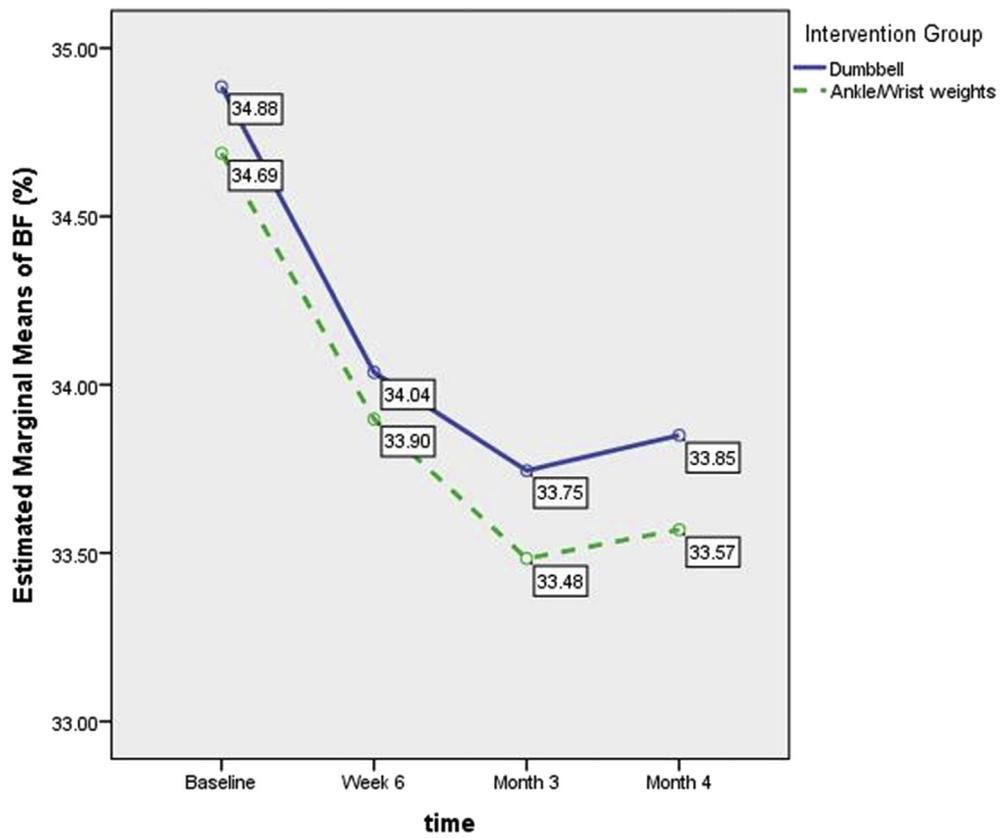


Figure 4: Profile plot showing the BF% changes over time for the dumbbell and ankle-wrist weight groups.

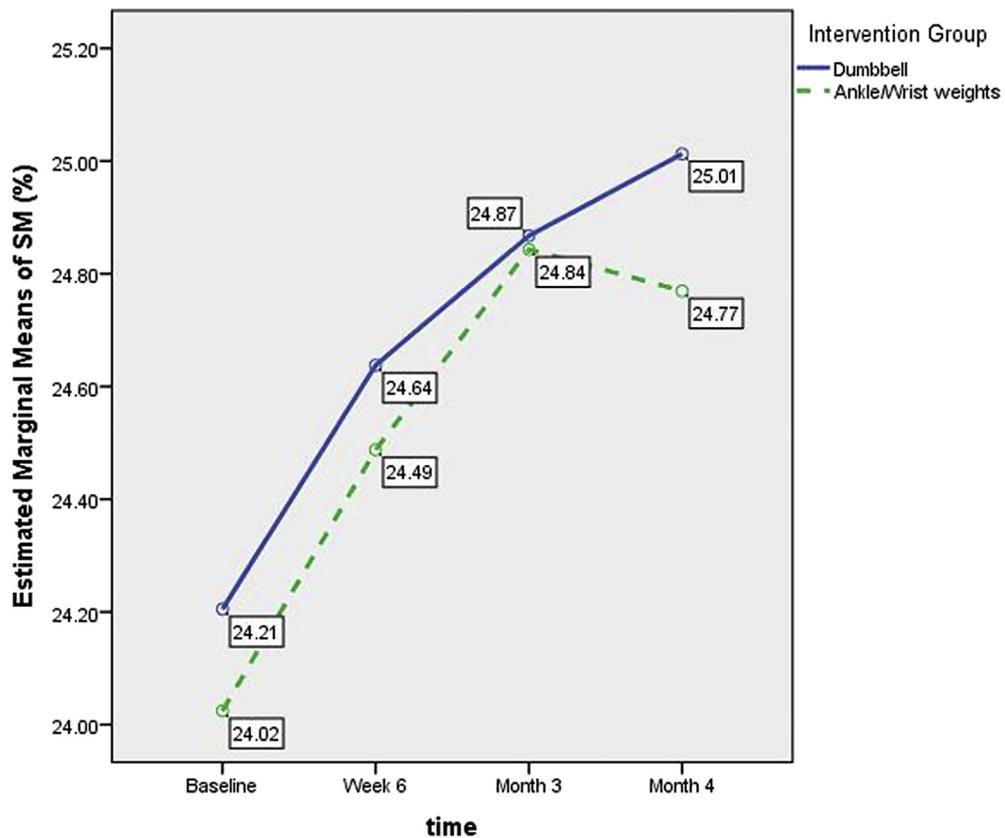


Figure 5: Profile plot showing the SM% changes over time for the dumbbell and ankle-wrist weight groups.

strong association between WC, visceral adipose tissue, and obesity-related health risk has been recognized by several epidemiological studies.<sup>27,28</sup>

WHR is also strongly associated with CVDs.<sup>29</sup> This finding was supported by a meta-analysis of 15 prospective studies involving 258,111 participants, suggesting that WHR was more strongly associated with CVDs than WC.<sup>30</sup> Because BMI, WC, and WHR are all used as surrogate measures of adiposity, it makes more sense to measure the level of adiposity by measuring the percentage of body fat. BF% has been suggested to be a better indicator of other obesity comorbidities, such as coronary heart disease risk. BF% has also been associated with both all-cause mortality and CVD mortality.<sup>31,32</sup>

In this study, a significant reduction in BMI occurred only in the dumbbell group at the sixth week. However, the changes could not be maintained beyond the initial six weeks. No significant change of BMI was observed in the ankle-wrist weight group. Significant reductions in WC, WHR, and BF% with a significant increase in SM% were observed at the sixth week, third month, and sixth month for both groups compared to baseline.

Regular endurance training improves body composition by decreasing fat mass and either increasing or maintaining fat-free mass. Fat-mass reduction caused by endurance training is associated with a reduction in body weight.<sup>33</sup> Conversely, resistance training is an efficacious and behaviourally feasible alternative to aerobic activities for weight control, even though body weight does not change as much because the loss of fat mass is often offset by a gain in muscle mass.

This study showed that neither method of light resistance training resulted in a significant BMI reduction. Inconsistent BMI results from previous studies also indicate that resistance training alone might not be able to produce a substantial reduction in weight.<sup>34,35</sup> Even though this study did not demonstrate a statistically significant reduction in BMI, it is still clinically important because any reduction in weight can increase a person's motivation to continue any program that aims to improve overall health.

A study conducted in Korea to determine the effect of progressive resistance training using elastic bands and one-to-three-kg ankle weights three times per week for twenty minutes showed no significant changes in WC after eight weeks. It has been suggested that a longer duration of progressive resistance training was necessary to produce a noticeable statistical change in WC.<sup>36</sup> However, in our study six weeks of resistance training did not produce a significant reduction in WC in either study group. The difference could be attributable to a larger WC at baseline (87.6 cm in our study compared to 76.7 cm in the Korean study).

Previous studies on the effect of resistance training on WHR did not produce consistent findings. A study among 15 elderly patients who performed combined aerobic exercise and moderate intensity resistance training resulted in a reduction of WHR after six months.<sup>37</sup> In contrast, a clinical study comparing the effect of resistance and aerobic exercise in 60 obese female adults showed no significant improvement in WHR for both groups after 12 weeks.<sup>38</sup>

Reductions of BF% were consistently observed in other resistance training studies. In a Korean study, the percentage of body fat decreased significantly after 12 weeks of progressive resistance training from 27.7% to 26.0%.<sup>36</sup> Similar

effects were observed in the resistance training study conducted in Turkey mentioned above, in which the percentage of body fat decreased significantly from 29.7% to 27.4% after eight weeks.<sup>34</sup>

Findings for SM% similar to those of this study have been observed in previous published studies. Compared with aerobic training, eight weeks of light resistance weight training has the ability to produce a larger gain in muscle mass.<sup>34</sup> A one-kilogram increase in muscle mass was observed in a 12-week progressive resistance training study using elastic bands with ankle weights.<sup>36</sup> Progressive resistance training—specifically, of the thigh—produced a significant (5.4%) increase in muscle mass among older healthy adults in as little as eight weeks.<sup>40</sup> Another progressive resistance training study among older adults conducted for a longer duration (six months) revealed a significant increase in total body lean mass and a significant (3%) increase in the muscle mass of the leg.<sup>39</sup>

#### *Limitations and recommendations*

In this study, only people who were interested and therefore more motivated to reduce weight participated. Motivation has been reported to play an important role in the success of behavioural changes because of its direct effect on adherence to the suggested program activity. Thus, implementation of a similar exercise program among the public might not result in a similar outcome compared to that observed in this study. Further study of the effect of light resistance training using similar or any other modalities is recommended, especially studies that explore the effect according to age, race, and gender.

#### **Conclusion**

A similar pattern of change in anthropometric parameters and body composition were observed between the two groups in this study, suggesting that an unstructured form of light resistance training using ankle-wrist weights have a similar potential to reduce CVDs risk as a structured method of light resistance training using dumbbells. Although there was no significant reduction in BMI, significant improvements in WC, WHR, BF%, and SM% were observed in both groups and could potentially reduce the risk of CVDs. However, a longer period of time is needed to observe a reduction in the incidence of CVDs in the population.

#### **Conflict of interest**

All of the authors declare that they do not have any competing interests.

#### **Authors' contributions**

All of the authors have contributed significantly to this article, including designing the study, collecting data, analysing data, interpreting data, and preparing and approving the final draft of the manuscript.

## Ethical approval

Ethical clearance was obtained from the Human Research Ethics Committee (HREC) of the Universiti Sains Malaysia (Ref: USM/KK/PPP/JEPeM [243.3.(15)]). All stages of this study adhere to the Declaration of Helsinki's principles. Verbal and written informed consent were obtained from all participants prior to this study and verbal consent was obtained again before each assessment and upon obtaining blood samples.

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