Original Research

Can Resistance Training Contribute to the Aerobic Components of the Physical Activity Guidelines?

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ABSTRACT

International Journal of Exercise Science 7(4) : 278-285, 2014. To evaluate if resistance training can reach Moderate to Vigorous Intensity (MVI) and contribute to the aerobic component of the international physical activity guidelines. Sixteen participants aged between 20 and 35 were recruited. Heart rate was recorded by heart rate monitor during a resistance training program. Based on maximal heart rate, time spent at MVI (55-69% of maximal heart rate) was calculated. Participants displayed a HR equal or above MVI for 51.5% ± 21.7% of time. When stratifying by lower and upper body sessions, that proportion was median (25-75th); 75.0% (32.5%-89.2%) and 45.8% (30.0%-66.8%) respectively. Body mass ($r=.68$; $p<.01$), body mass index ($r=.54$; $p=.03$), and leg press strength ($r=.59$; p=02) were positively associated with time spent at MVI. Assuming 10-minute bouts of aerobic exercise are not needed to achieve health benefits, it is possible to reach MVI with resistance training. Emphasis on the importance of performing resistance training should be done to reach the aerobic component of the physical activity guidelines and optimize health benefits. This provides an alternative option to those who may have difficulty or be unable to reach the required aerobic intensity by traditional aerobic exercises.

KEY WORDS: Exercise physiology, health, endurance activity, strength training, exercise intensity

INTRODUCTION

In 2010, the World Health Organization (WHO) released new Physical Activity Guidelines (PAG) stating that to optimize health benefits, adults 18 to 64 years old should participate in at least 150 minutes of moderate- to vigorous-intensity (MVI) aerobic physical activity, in bouts of 10 minutes or more in addition to two days of resistance training (21). Despite these recommendations, a recent study showed that only 15.4% of adults are meeting these guidelines when measured with accelerometers (4). Thus it is mandatory to find solutions that will increase the proportion of people meeting the PAG (e.g., improve understanding of what activities are reaching MVI).

It has recently been suggested that bouts of physical activity shorter than 10 minutes could also be associated to beneficial health outcomes, such as improvements in insulin sensitivity (10,19), reduced systolic blood pressure (19), increased fat oxidation (15,19) and improved cardiorespiratory fitness levels (10,13,15,19), as long as they repeatedly achieve MVI. These findings are likely the result of new technologies (e.g., accelerometers) that permit the evaluation of the impact of short bouts of activities spent at MVI (10). This suggests that exercises not typically considered as beneficial under the PAG because of their shorter duration, repeated 'bursts' of MVI exercise could become potential alternatives for successfully reaching the PAG. The inclusion of a wider variety of exercise options may result in enhanced exercise participation and adherence rates. This could be particularly beneficial for the 14.3% of the population who have a disability or mobility issues (8), such as individuals who are obese or older adults (9,11,17), as engagement in typical aerobic exercises may be limited. The inclusion of resistance training is already a key part of many national and international agencies recommendations (7,20,21). Therefore, it is rational to verify whether or not resistance training could supply the increases in heart rate needed to contribute to culminating the minimum mark of 150 minutes of what has historically been referred to as aerobic-based activities at MVI.

The objective of this study was to investigate whether resistance training activities are capable of getting young, active adults to reach MVI activity level, as deemed by increases in heart rate. Our hypothesis was that resistance training would increase heart rate to the minimum required intensity suggested by the PAG and potentially be proposed to contribute to the recommended 150 minutes of MVI activity.

METHODS

Participants

Thirty-nine participants participated in a nine week resistance training program, of which the main goals were to increase muscular strength and improve body composition. Of the original sample, those willing to wear a heart rate monitor for at least two individual sessions during the 9-week study were included in this secondary study. Thus, we had a final total of 16 participants. The goal of this study was to determine whether the resistance training protocol was capable of eliciting a heart rate response in young, active adults high enough to be considered within the MVI activity level. There was no statistical difference observed in terms of gender, age, or baseline body mass index (BMI) between the participants who accepted to participate in this secondary study when compared to those who did not ($p > 0.05$). All data to characterize the sample in the secondary study were collected at baseline. All study protocols were approved by the University of Manitoba Biomedical Research Ethics Board.

Inclusion criteria were: age of 18 years or above, self-reported completion of regular resistance training throughout the past two years, and free of orthopedic injuries. All subjects gave their written informed consent to participate. General characteristics of the participants are outlined in Table 1.

Table 1. General Characteristics.

	N = 16
Age (years)	27.96 ± 4.53
Gender (men)	5 (31.2%)
Body mass (kg)	67.11 ± 11.76
Body mass index (kg/m^2)	24.34 ± 3.63
Fat free mass (kg)	45.90 ± 11.31
Percent fat mass (%)	28.18 ± 11.91
Handgrip strength (kg)	58.03 ± 23.76

Data are presented as mean ± SD or N (%)

Protocol

Before the initiation of the training protocol, various measures were collected to describe the sample. Body composition (i.e., fat mass, lean body mass, and bone mass) measurements were performed using Dual energy X-ray absorptiometry (DXA, GE Prodigy Lunar Radiation Corp, Madison, WI). Body mass was measured to the nearest 0.1 kg on a calibrated scale (SECA, Hambourg, Germany), and height was obtained with a standard stadiometer (Takei, Tokyo, Japan). BMI was calculated using body mass (kg) divided by height squared (m^2). Handgrip strength was measured with a standard dynamometer (Preston, Jackson, MI, USA) according to standard procedures (3).

In order to individualize the exercise sessions, a Certified Personal Trainer for the study assessed the one repetition maximal (1-RM) lift using a submaximal testing protocol for each exercise of the program as described in detail elsewhere (12). Briefly, after a short warm-up, the trainer identified a weight that could potentially be lifted by the participant for one-to-ten repetitions using proper technique. If more than 10 repetitions were completed, more weight was added and the process repeated until a maximum of 10 repetitions could be performed. A rest period of two minutes was given between attempts, and a maximum of three attempts were permitted. Then, using a converting table, the maximum weight was multiplied by the corresponding percentage, and 1-RM was identified. For example, if the maximal load was 110lb and the participant performed seven repetitions (corresponding to .83 on the table); the estimated 1-RM was 133lb.

Upon arrival, participants underwent a five minute warm up on an ergocycle. Every week participants completed four exercise sessions consisting of two upper body and two lower body sessions alternatively, all under individual supervision from a Certified Personal Trainer. Participants performed three sets of each exercise for 12, 10, and 8 repetitions, with the exception of abdominal crunches which were completed until failure. Participants were required to lift 80% of their 1-RM for each exercise. The resting period between sets was 90 to 120 seconds as recommended by the American College of Sports Medicine (1) to target hypertrophy; the rest period was monitored by the trainer. Upper body weight training sessions consisted of the bench press, lat pull-down, shoulder press, bicep curl and triceps pushdown. Lower body weight training sessions consisted of leg press, leg extension, leg curls, calf raises and abdominal crunches. The duration of each session was intended to be a maximum of 45 minutes.

Before each workout, those who volunteered to participate in the secondary study were provided a heart rate monitor (Polar Accurex Plus Woodbury, NY) to wear in order to record their heart rate throughout the duration of the resistance training time, including the resting period between sets and exercises. The device periodically saved each participant's heart rate in 15-second intervals for analysis. The recorded data was then downloaded and used to determine how much time each participant spent at MVI [≥55% of age-predicted maximum heart rate (18)].

Statistical Analysis

Data management and statistical analyses were performed using SPSS version 18.0 (SPSS Inc, Chicago, IL). Normality of variables was tested by the Shapiro Wilk test. Results are reported as mean ± standard deviation (SD), for normally distributed variables. Median (25th-75th percentiles) was used to report descriptive variables not normally distributed, and N (%) was used for categorical variables. Wilcoxon Signed Ranks Test was used to compare the proportion of time spent at MVI between lower body sessions and upper body sessions. Finally, Spearman correlations were performed to evaluate if any variables were associated with the time spent in MVI during the resistance training program. Significance was accepted at $p \leq 0.05$.

RESULTS

Table 2 describes resistance training variables. A mean of 4.1 ± 2.7 sessions during the entire nine-week exercise program were recorded in our sample, while participants spent an average of 37.5 ± 4.5 minutes in each resistance training session. Moreover, participants spent 51.5% ± 21.7% of their time exercising at MVI. When taking part in a lower body resistance training session, participants spent a median (25-75th percentile) of 75.0% (32.5% – 89.2%) of their time in a MVI, in comparison to a median of 45.8% (30.0%–66.8%) of the time during upper resistance training session. However the difference in the proportion of time spent in MVI did not reach statistical significance (p= 0.07).

Table 2. Resistance Training Characteristics.

	N=16
Bench press 1-RM (kg)	48.9 ± 24.1
Leg press 1-RM (kg)	194.5 ± 92.0
Bench press 1-RM (kg)	48.9 ± 24.1
Total number of recorded sessions	4.1 ± 2.7
Mean time per session (min)	37.5 ± 4.5
Total % time at MVI	51.5 ± 21.7
Lower body session % MVI time	75.0 (32.5 – 89.2)
Upper body session % MVI time	45.8 (30.0 – 66.8)

Data presented as Mean ± SD, median (25-75th percentile), or N (%). 1-RM: One repetition maximal; MVI: Moderate- to Vigorous-intensity

The goal of reporting associations between characteristics of participants and MVI was to identify who would be more likely to increase heart rate to a level that reaches MVI while doing resistance training. Both body mass (r= .68 p=<0.01) and BMI (r= 0.54 p= 0.03) were positively associated with the percentage of time a participant spent at a MVI (Table 3), however, fat mass and fat free mass were not associated with the outcome. In terms of strength, both handgrip strength (r= 0.57 p= 0.03) and leg press 1-RM (r= 0.59 p= 0.02) were positively associated with the percentage of time spent at MVI, but bench press 1-RM was not. Neither leg press nor bench press relative to body mass was significantly correlated to time spent at MVI.

Table 3. Association between Characteristics and Time spent at Moderate- to Vigorous-Intensity.

	N=16 **R (p-value)**
Age	-0.23 (.38)
Gender	-0.22 (.41)
Body mass	0.68* (.01)
Body mass index	0.54* (.03)
Fat free mass	0.43 (.10)
Percent fat mass	-0.01 (.97)
Handgrip strength	0.57* (.03)
Bench press 1-RM	0.30 (.26)
Leg press 1-RM	0.59* (.02)
Relative bench press	-0.01 (.98)
Relative leg press	0.19 (.48)

* P < 0.05 Spearman's correlation. 1-RM: repetition maximal

DISCUSSION

The main objective of this study was to investigate the possibility of reaching moderate- to vigorous-intensity (i.e., MVI) physical activity levels in accordance with the PAG while performing resistance training. Recent research has displayed that the requirement of 10-minute bouts may not be necessary for individuals to achieve health benefits from exercise (10), similar to those achieved while participating in extended aerobic exercise (13,15,19). The novel finding of our study suggests that it is possible to reach MVI with resistance training, based on recorded heart rate. Our results suggest that approximately 50% of the time spent doing resistance training reaches MVI. A secondary finding is that resistance training appears to vary according to the type of workout completed, as we observed a greater proportion of individuals were capable of reaching the guideline cut-offs when performing lower-body resistance exercise. Moreover, our study identified some of the potential variables (e.g., body mass, BMI, leg press) that could be associated with the proportion of time spent at MVI while doing resistance training.

In this study, about half of the resistance training time was spent at MVI. This is impressive as the original study designed a resistance training protocol aimed at increasing muscle mass for the whole body. Therefore the load was high, repetitions were moderate and resting period between sets was relatively long, as is recommended (1,16). Decreasing the resting period could lead to a greater proportion of the resistance training session in MVI (6). In addition, since lower body sessions were found to increase MVI time (40.8% more) when compared to upper body sessions, it can be hypothesized that future programs focusing on lower body exercise could increase the proportion of time spent at MVI. Finally, even though the direct effect that individual exercises had on intensity was not recorded, it is logical to hypothesize that exercises including small muscle groups such as the biceps and triceps would lead to a smaller increase in heart rate, as others have reported different exercise intensities for small and large muscle mass exercises (6). Thus, a program more directly focused on large muscle groups could result in a larger proportion of time spent at MVI.

In total, approximately 50% of the current program was spent at MVI. Through manipulations to the parameters of the program, one could even potentially increase that proportion. This would then allow resistance training to contribute even more to the aerobic component of the PAG. Nonetheless, the current program if achieved three times a week would lead to approximately 60 minutes of aerobic MVI out of the 150 recommended.

Variables were found to be in association with the time spent at MVI during the recorded resistance training sessions. First, leg muscle strength but not chest muscle strength was associated with MVI time. This suggests that lower body strength and lower body exercise would have a greater impact on aerobic intensity levels in comparison to upper body, as was proposed by others (6). Handgrip strength was also positively correlated with MVI. It has previously been shown that handgrip strength is associated with overall fitness level (2). Thus it is believed that greater handgrip strength would result in an increased ability to maintain a higher intensity level. Both body mass and BMI were positively correlated with the percentage of time spent at MVI. In other words, within this sample the greater ones' weight, the greater the likelihood they could reach MVI while resistance training. It is possible that this is caused by the increased effort and requirements placed on the body when performing exercises at an increased weight during weight bearing activities (5). It is therefore possible that for overweight or obese individuals, resistance training may provide an even greater alternative to reach the PAG, as absolute strength is greater in obese compared to non-obese (14). However, in this sample only one participant had a BMI above 30 kg/m^2, which could explain the absence of association when muscle strength was considered relative to body weight.

Despite the fact that our results are innovative and intriguing, limitations are present in our study that must be highlighted. The low number of participants included makes it difficult to come to any definite conclusions. There is also a selection bias that could explain our result. Participants that agreed to take part in this study may have different individual characteristics (e.g. internal motivation) in comparison to individuals who choose not to take part to the study. Also, as there was only a mean of 4.1 sessions when participants wore the heart rate monitor throughout the 9-week study, it is possible that time spent at MVI was different during the study as participants got stronger and more familiarized with the exercise protocol. Finally, it must be mentioned that oxygen consumption measures instead of heart rate for determining exercise intensity would have been preferable.

With the potential acceptation that 10 consecutive minutes for each bout of MVI physical activities are not required to have a significant impact on physical activity related benefits, various alternative exercise methods become available to reach the guidelines. Our study suggests that it is possible for active individuals between the ages of 20 and 35 years to increase heart rate enough with resistance training to reach MVI. This suggests that resistance training could provide an alternative option to those who may have difficulty partaking in aerobic exercise at the required intensity levels recommended by the PAG to obtain desired health benefits. However, further research to support this claim is needed.

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