



International Journal of **EXERCISE SCIENCE**

Original Research

Simple Bodyweight Training Improves Cardiorespiratory Fitness with Minimal Time Commitment: A Contemporary Application of the 5BX Approach

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ABSTRACT

International Journal of Exercise Science 14(3): 93-100, 2021. Bodyweight training (BWT) is a style of interval exercise based on classic principles of physical education. Limited research, however, has examined the efficacy of BWT on cardiorespiratory fitness. This is especially true for simple BWT protocols that do not require extraordinarily high levels of effort. We examined the effect of a BWT protocol, modelled after the original “Five Basic Exercises” (5BX) plan, on peak oxygen uptake (VO_{2peak}) in healthy, inactive adults (20 ± 1 y; body mass index: 20 ± 5 kg/m²; mean \pm SD). Participants were randomized to a training group that performed 18 sessions over six weeks ($n=9$), or a non-training control group ($n = 10$). The 11-minute session involved five exercises (burpees, high knees, split squat jumps, high knees, squat jumps), each performed for 60-seconds at a self-selected “challenging” pace, interspersed with active recovery periods (walking). Mean intensity during training was $82 \pm 5\%$ of maximal heart rate, rating of perceived exertion was 14 ± 3 out of 20, and compliance was 100%. ANCOVA revealed a significant difference between groups after the intervention, such that VO_{2peak} was higher in the training group compared to control (34.2 ± 6.4 vs 30.3 ± 11.1 ml/kg/min; $p = 0.03$). Peak power output during the VO_{2peak} test was also higher after training compared to control (211 ± 43 vs 191 ± 50 W, $p = 0.004$). There were no changes in leg muscular endurance, handgrip strength or vertical jump height in either group. We conclude that simple BWT – requiring minimal time commitment and no specialized equipment – can enhance cardiorespiratory fitness in inactive adults. These findings have relevance for individuals seeking practical, time-efficient approaches to exercise.

KEY WORDS: Interval exercise, peak oxygen uptake, physical conditioning

INTRODUCTION

Physical inactivity remains prevalent despite strong evidence that cardiorespiratory fitness (CRF) is independently associated with mortality and disease risk (14). Common cited barriers to regular physical activity include a perceived lack of time, and access to appropriate equipment and facilities (28). The latter has been exacerbated by public health measures and behavioural changes in response to the novel coronavirus, and the challenge of maintaining metabolic health during a global pandemic (13). There is value in identifying simple, time-

efficient exercise strategies that increase CRF – as objectively measured by peak oxygen uptake (VO_{2peak}) – given that even a modest improvement in this parameter is associated with a reduction in mortality risk (7).

Vigorous intermittent exercise, including protocols broadly characterized as high intensity interval training (HIIT), can enhance markers of cardiometabolic health despite relatively low time commitment (2). Practical and feasible applications of HIIT include brief, vigorous intermittent stair climbing, which as has been shown to increase CRF without the need for specialized equipment (1, 9). Bodyweight training (BWT) is another popular variant of HIIT adopted by many practitioners (26), but limited research has examined the efficacy of simple BWT on CRF (8, 15, 22, 23). This is particularly true for submaximal protocols that do not require extraordinarily high levels of effort.

5BX – “Five Basic Exercises” – was a fitness plan developed over a half century ago by the Royal Canadian Air Force based on classic principles of physical education (21). It was initially intended for service members stationed in remote outposts, but has enduring relevance as a simple, practical approach to conditioning. The original 5BX plan required only 11 minutes per day, was not dependent on elaborate facilities or equipment, and could be appropriately scaled based on fitness level. Performing the 5BX plan for several months has been reported to improve submaximal indices of CRF and exercise tolerance (10), including in individuals with cardiovascular disease (19). The original 5BX plan included stretching, which places minimal stress on the cardiovascular system, and exercises such as sit-ups that are generally not recommended today.

The present study examined the effect of a contemporary BWT program on CRF in healthy, inactive adults. The intervention was modelled on the original 5BX plan, but modified to include calisthenics and bodyweight movements that are now commonly recommended for this style of training (12, 27). Brief bouts of vigorous exercise were interspersed with recovery periods, and the program required eleven minutes per session. We hypothesized that VO_{2peak} following the BWT intervention, which consisted of 18 sessions over six weeks, would be higher compared to a non-training control group.

METHODS

Participants

Twenty-two individuals were recruited from the McMaster University community. Participants were deemed healthy, based on completion of the Canadian Society of Exercise Physiology (CSEP) Get Active Questionnaire (GAQ) (4). Participants were inactive, based on self-report of accumulating < 150 minutes of moderate to vigorous weekly activity. Exclusion criteria included the diagnosis of a cardiometabolic disease or musculoskeletal condition that would contraindicate BWT. Participants were randomized in a counterbalanced manner to a training group or a non-training control group. The control group was invited to complete the training intervention after study completion. A sample size of 10 participants per group was estimated to detect a 1-metabolic equivalent (MET) difference in our primary outcome, VO_{2peak} , based on

means and standard deviations from previous studies in our lab, at an alpha level of 0.05 with 80% power. Three individuals withdrew for reasons unrelated to the study, leaving $n = 9$ individuals who completed the intervention (five males and four females; 20 ± 1 years, body mass index = 21 ± 5 kg/m², mean \pm SD) and $n = 10$ in the control group (one male and nine females, 19 ± 0 years, 21 ± 5 kg/m²). The experimental procedures were approved by the McMaster Research Ethics Board, and all participants provided written informed consent. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (18).

Protocol

Participants initially performed an incremental ramp test to exhaustion using an electronically-braked cycle ergometer (Excalibur Sport V 2.0, Lode, Groningen, The Netherlands) and metabolic cart (Quark CPET, COSMED, Chicago, IL, USA) to determine $\text{VO}_{2\text{peak}}$ and peak power (W_{peak}) as previously described (1,9). Participants subsequently returned to the laboratory to become familiarized with muscular fitness testing, and baseline testing was completed ~24-72 hours later. After a 2-minute walking warm-up, peak leg power was determined based on the best of three maximal jumps performed from a semi-squat position, and hand grip strength was determined using a dynamometer (Smedley Hand Dynamometer, Stoelting Co, Wood Dale, IL, USA), as detailed elsewhere (3). Muscular endurance was assessed using a wall sit test to volitional fatigue, involving an isometric squat with the knees flexed at 90 degrees, as confirmed by a goniometer (Baseline Plastic Goniometer 12-1000, Fabrication Enterprises, White Plains, NY).

Participants were randomized with a 1:1 allocation ratio using a concealed envelope after baseline testing. The training group returned to the lab to become familiarized with the nature of the exercises to be performed, and the 6 - 20 Borg rating of perceived exertion (RPE) scale. Training commenced 72 hours after the familiarization visit, and a total of three sessions were performed each week for six weeks. Each training session consisted of an 11-minute protocol that involved alternating bouts of vigorous exercise and light active recovery, in addition to a brief warm-up and cool-down. The specific protocol and order of exercises was:

Warm-up: 1-minute of jumping jacks;
Vigorous exercise: 1-minute of modified burpees without push-ups;
Recovery: 1-minute of walking in place;
Vigorous exercise: 1-minute of high knee running in place;
Recovery: 1-minute of walking in place;
Vigorous exercise: 1-minute of split squat jumps;
Recovery: 1-minute of walking in place;
Vigorous exercise: 1-minute of high knee running in place;
Recovery: 1-minute of walking in place;
Vigorous exercise: 1-minute of squat jumps;
Cool-down: 1-minute of walking in place.

For each bout of vigorous exercise, participants self-selected a relative intensity (i.e. effort level) based on instructions to choose a “challenging pace”, with the goal of completing as many repetitions as possible. All sessions were supervised by one of the investigators, but no additional direction or encouragement was provided. Heart rate (HR) was monitored continuously for subsequent analysis (Polar A300, Kempele, Finland) and RPE was recorded after each exercise bout. All participants completed all training sessions. Enjoyment was assessed using the Physical Activity Enjoyment Scale (11) immediately following the first and last training session. The post-training $\text{VO}_{2\text{peak}}$ test was conducted ~72 hours after the final training session, or 6 weeks after baseline testing in the control group, followed ~24 - 72 hours later by muscular fitness testing.

Statistical Analysis

All data are expressed as mean \pm SD ($n = 10$ for control, $n = 9$ for training). $\text{VO}_{2\text{peak}}$, W_{peak} , peak leg power, wall sit time, and grip strength data were analysed with analysis of covariance (ANCOVA), using baseline values as the covariate on IBM SPSS (IBM Corp., Version 25.0, Armonk, NY, USA) as previously described (9). This approach tests whether groups are different on the post-test while controlling for pre-test values (20). Cohen’s d was used to determine effect size from baseline to post testing within the training group. Enjoyment during the first and final sessions was compared with a two-tailed paired t -test. Significance was set at $p < 0.05$.

RESULTS

ANCOVA revealed a significant difference between groups after the intervention, such that $\text{VO}_{2\text{peak}}$ was higher in the training group compared to control (34.2 ± 6.4 vs 30.3 ± 11.1 ml/kg/min, $p = 0.03$, $d = 0.38$) (Figure 1). The mean increase from baseline in the intervention group was ~7% (2.1 ± 4.5 ml/kg/min), which corresponded to ~0.5 MET. W_{peak} was also higher after training compared to control (211 ± 43 vs 191 ± 50 W, $p = 0.004$, $d = 0.35$) (Figure 1). Grip strength, peak leg power, and wall sit time were not different between groups after the intervention. Mean exercise HR, averaged over all training sessions, was $82 \pm 5\%$ of maximum (165 ± 10 bpm) and RPE was 14 ± 3 . Enjoyment ratings tended to increase but were not different between the first and last session (98 ± 14 vs 86 ± 12 ; $p = 0.06$).

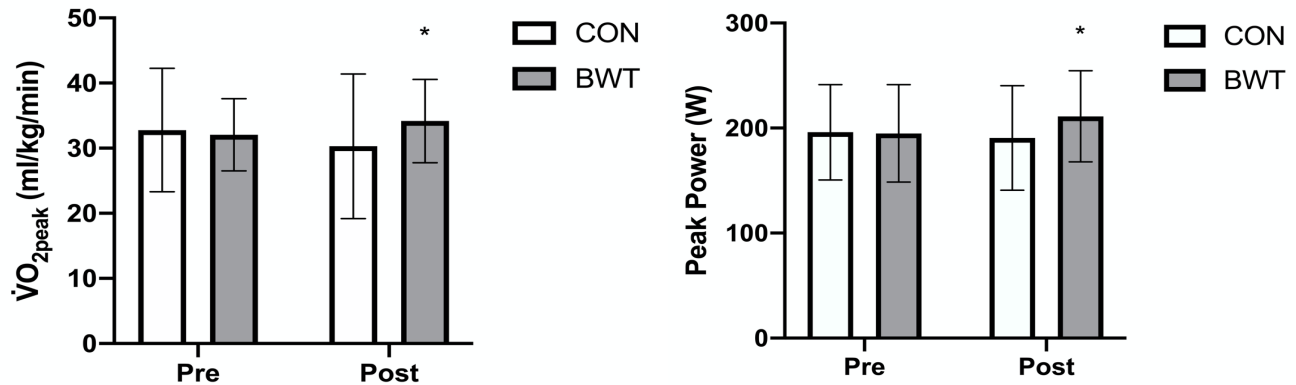


Figure 1. VO_{2peak} (left panel) and peak power (right panel) measured before (Pre) and after (Post) six weeks of bodyweight training (BWT) or an equivalent period without a prescribed exercise intervention (CON). Values are means ± SD. *p < 0.05 between groups.

DISCUSSION

The major novel finding of the present study was that VO_{2peak} was higher following a simple BWT program, as compared to a non-training control group, in previously inactive young adults. The 11-minute protocol was modelled on classic principles of physical education and the original 5BX plan. It involved basic exercises performed at a self-selected “challenging” pace, interspersed with active recovery periods, and was performed thrice weekly for six weeks.

HIIT has re-emerged in recent years as one of the most popular fitness trends worldwide, with “Tabata”-style training being one particularly well-known variant (26). This method is commonly practiced using bodyweight intervals that resemble traditional calisthenics, although the original study involved cycling bouts at a workload equivalent to ~170% of VO_{2max} (25). This specific protocol involves eight 20-second cycles of ‘all out’ effort interspersed with 10-seconds of rest, and requires an extraordinarily high level of motivation. BWT applied using a Tabata-style approach can increase CRF (15, 22), although there are equivocal data in this regard (8). The very intense nature of the efforts required, however, makes this type of training unsuited or unpalatable for some individuals. Other studies have demonstrated the potential for less intensive BWT – typically performed in conjunction with equipment-based exercises – to increase CRF (17), including in people at risk for cardiometabolic diseases (5).

The protocol in the present study did not precisely mimic the classic 5BX plan, but modelled some essential aspects: it involved basic exercises and only eleven minutes per session, was not dependent on elaborate facilities or equipment, and was scaled to individual fitness by having participants self-select their effort (i.e., a “challenging pace”). Despite the relatively training low time commitment, the protocol enhanced exercise tolerance, as evidenced by a higher VO_{2peak} and W_{peak} following the intervention, as compared to a non-training control group (Figure 1). The change in VO_{2peak} in the BWT group was less than the ~1 MET improvement reported in previous 6-week training studies that employed brief, intermittent exercise interventions including vigorous stairclimbing (1) and stationary cycling (6, 16). Nonetheless, even a modest

improvement in cardiorespiratory fitness is associated with a reduction in mortality risk and small changes may confer benefits to cardiometabolic health (7).

Considerable attention has recently been focused on the psychological responses to interval exercise. The emerging data support the viability of this type of activity as an alternative to traditional, moderate-intensity continuous exercise (24). High adherence to free-living HIIT in previously sedentary overweight and obese adults has been observed in conjunction with high levels of enjoyment (29). In the present study, enjoyment remained high at the end of the 6-week training period and not different compared to the start of the program. These data suggest that at least short-term BWT performed at a self-selected pace could be a sustainable exercise strategy in previously inactive individuals, but adherence to self-paced BWT warrants further study.

There are several limitations to the present work. The sample size was relatively small, and while participants were deemed inactive based on self-report of not meeting weekly physical activity guidelines, this varied between individuals. Diet and physical activity – aside from the prescribed exercise – was not specifically controlled or monitored over the course of the study, for example, through the use of food parcels or activity trackers. While this simulated “free living” conditions, potential changes in these factors may have contributed to measurement variability, or introduced confounding influences beyond the training intervention. Larger, longer and more sophisticated studies are warranted to more comprehensively assess the effect of simple BWT on health-related responses, as well as the underlying physiological mechanisms, and behavioural implications. A recent study compared twelve weeks of virtually-monitored, home-based BWT to moderate-intensity continuous training and a lab-based HIIT intervention. It did not include a non-exercise control group, but found the three protocols similarly increased CRF, whole-body insulin sensitivity, and skeletal muscle capillarization and mitochondrial density (23).

In summary, the present results suggest that CRF can be enhanced through simple bodyweight training that is modelled on classic principles of physical education, and the original 5BX plan. The 11-minute protocol employed in this study involved basic exercises performed at a self-selected “challenging” pace, and required no specialized equipment. These findings have relevance for individuals seeking practical, time-efficient approaches to exercise, a quest that is particularly challenging during a global pandemic.

ACKNOWLEDGEMENTS

This study was supported with funds from McMaster University and the Natural Sciences and Engineering Research Council (NSERC) to MJG. LRA held a NSERC Undergraduate Student Research Award.

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