Title: A COMPARISON OF BLOOD PRESSURE REDUCTIONS FOLLOWING 12-WEEKS OF ISOMETRIC EXERCISE TRAINING EITHER IN THE LABORATORY OR AT HOME

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Abstract

PURPOSE: Isometric exercise training (IET) induced reductions in resting blood pressure (RBP) have been achieved in laboratory environments, but data in support of IET outside the lab is scarce. The aim of this study was to compare 12-weeks of home-based (HOM) IET with laboratory-based, face-to-face (LAB) IET in hypertensive adults. METHODS: 22 hypertensive participants (24-60 years) were randomized to three conditions; HOM, LAB or control (CON). IET involved isometric handgrip training (4 x 2-minutes at 30% maximum voluntary contraction, 3 days per week). RBP was measured every 6-weeks (0, 6 and 12 weeks) during training and 6-weeks post-training (18 weeks). RESULTS: Clinically meaningful, but not statistically significant reductions RBP were observed following 12 weeks of LAB IET (SBP -9.1±4.1; DBP -2.8±2.1 P>0.05), which was sustained for 6 weeks of detraining (SBP -8.2±2.9; DBP -4±2.9, P>0.05). RBP was reduced in the HOM group after 12 weeks of training (SBP -9.7±3.4; DBP -2.2±2.0 P>0.05) which was sustained for an additional 6 weeks of detraining (SBP -5.5±3.4; DBP -4.6±1.8, P>0.05). CONCLUSIONS**:** Unsupervised home-based IET programs present an exciting opportunity for community-based strategies to combat hypertension but additional work is needed if IET is to be employed routinely outside the laboratory.

Keywords: Blood pressure, hypertension, isometric exercise, home exercise

Disclosure: The authors declare no conflict of interest.

Introduction

Hypertension (HTN) affects approximately 46% (103 million adults) of the US adult population ≥ 20 years of age [1, 2]. Less than half of hypertensive adults (46%) have their blood pressure (BP) controlled regardless of race/ethnicity or gender [1]; thus, interventions to decrease BP are critical to reduce the public health impact of HTN. Current projections estimate a total direct cost of HTN of $220 billion by the year 2035 [1, 3, 4], emphasizing the economic burden of one of the most modifiable risk factors for cardiovascular disease.

Exercise training is generally accepted as an intervention strategy to promote reductions in cardiovascular risk factors, like high blood pressure [5, 6]. Over the past two decades, isometric exercise training (IET), has become established as effective at inducing substantial reductions in resting blood pressure (RBP) in a short period of time [7-12]. Furthermore, typical IET investigations employ either handgrip or double-leg exercise protocols, with participants and investigators meeting in the laboratory for periods of three to ten weeks [7-9, 11, 13, 14].

Albeit effective, time and travel requirements for participants as well as time spent by researchers have been significant, which is impractical for implementing IET at the population level, especially for extended periods of time (>10-weeks). Even when a short duration exercise program like IET is administered, travel requirements, access to specialized equipment, and associated costs may outweigh the perceived potential benefits (e.g. RBP reduction) of the intervention [15-20]. Several investigations have used programmable and fully-automated handgrip dynamometers with integrated tracking and guiding software that can cost in excess of $500.00 USD per unit [21-23] and may not be covered by the participant's insurance provider. Others have reported reductions in RBP using cheaper spring loaded models [10, 24]. Our research group uses a cost-effective simple handgrip dynamometer that provides real time measurable and quantifiable feedback at an approximate cost of ~$25.00-$30.00 USD per unit, potentially eliciting similarly observed reductions in RBP compared to other isometric handgrip investigations [7,10-12, 21, 25-30].

The health benefits of lowering RBP are substantial and research has shown these positive effects are likely to be the result of compliance with regular exercise participation [31-36]. Moderate-to-high intensity aerobic, resistance, or combination training (a mix of both) of approximately 150 min/week is recommended to enhance blood pressure management, along with other risk factors for cardiopulmonary and metabolic disease [37]. When compared to traditional exercise programming, IET requires low-to-moderate levels of exertion and approximately 15 minutes per day, 3 days per week, to achieve significant reductions in RBP according to recent meta-analyses [6, 38].

Aerobic and resistance exercise programs have been shown to elicit improvements in BP control over periods of several weeks [39, 40] when completed in a monitored environment. A recent emphasis has been placed upon integrating successful exercise interventions into a home-based setting, to combat the barriers associated with supervised exercise programs [41-45]. Data on the RBP-lowering effects of home-based aerobic and resistance programs in populations of hypertensive individuals are limited [32-34, 36, 42]. Furthermore, only two home-based IET studies have been published [21, 46], one of which used handgrip exercise [21].

Despite recent findings supporting the benefits of IET, the efficacy of home-based, unsupervised IET programs is largely unknown. No direct comparisons between home-based (i.e. conducted outside a supervised laboratory environment) IET and laboratory-based IET (i.e. supervised training in the lab) exist. Therefore, such a comparison (home-based versus laboratory-based IET) is necessary to better understand the potential for this simple intervention to be implemented at the population level. Furthermore, published evidence supports the use of web-based materials to implement exercise interventions for the treatment and management of chronic disease, to reach a wider audience and further combat barriers associated with exercise [47]. No previous studies have explored the translation of an isometric exercise intervention into a user-friendly, time and cost-effective format, using a web-based video platform. This format could provide useful additional support for IET as a convenient method for managing HTN. Therefore, the purpose of this study was to determine whether home-based IET elicits significant and sustained reductions in RBP among adult hypertensives, as compared to a well-established laboratory-based IET protocol.

Methods

Participants

The University of North Carolina at Charlotte institutional review board approved all protocols and procedures of this investigation prior to study enrollment. 22 hypertensive or pre-hypertensive participants (Age: 49.71 ± 2.26; BMI: 31.25 ± 1.31 kg/m^2 ; RBP:137.4/87.4 mmHg) were recruited to participate (Table 1). Inclusion criteria for participation in the study were: faculty/staff member or graduate student status, between the ages of 21 and 60yrs, RBP measured between 130/81 and 160/100mmHg and/or those individuals currently prescribed medication to manage hypertension, for a period of at least 6-months at the time of enrollment. Participants possessed no contraindications to performing maximal isometric handgrip contractions and were able to understand the informed consent and other procedures relating to the performing of IET. Individuals presenting with physical limitations to completing IET or uncontrolled HTN, outside of these inclusion parameters, were excluded from the study.

Participants who met these criteria attended an orientation session where they provided written informed consent and completed baseline assessments (described below). Participants were then randomized to one of three study groups; laboratory-based (LAB) IET, home-based (HOM) IET (with instructional web-based video), and a control (CON) condition.

Procedures

IET instructional videos

Two members of the research team, a Certified Clinical Exercise Physiologist with experience administering IET protocols and the other a Certified Health Education Specialist with public health intervention expertise, created the instructional IET videos. Video extras included a group of diverse graduate students from the University's Department of Kinesiology, all with experience at completing IET procedures. Instructional videos were filmed in the University's Home Simulation lab, in order to mimic a similar environment to that in which participants were to engage in the training program. A still image captured from the videos may be found in Figure 1.

Two instructional videos were used for the home-based IET. Video 1 included a short (<5 minutes) segment about the benefits of IET on blood pressure and what participants should expect to experience during IET sessions, which was designed for participants to watch just once during their initial exercise session. The second video was a step-by-step, timed instructional video guiding participants through the IET protocol. Participants were encouraged to watch the second video each time they completed a "home-based" IET session. The videos were accessed through a private YouTube link, which only the research team and participants could view. Videos were used to provide exercise participants with visual and auditory feedback along with an on-screen timer, to ensure completion of the protocol. During an orientation session, all participants received detailed instructions from research team members on the use of their equipment and what to expect from a typical IET session, before leaving the laboratory**.**

Isometric Exercise Training (IET)

The LAB group participated in a group (~4 participants per session) exercise program, led by a member of the research team, three days per week for 12 weeks, followed by 6 weeks of monitored detraining. The HOM group completed the same IET program, alone in a location of their choice (e.g. home), following the instructional training video and recorded their performance in a participant pack provided (see Fig. 2). The CON group did not participate in IET during the 18-week study period, but were given the opportunity to participate at the end of 18-weeks (delayed treatment group).

Prior to each IET session, intervention participants completed an maximal voluntary contraction (MVC, 3 x 5 sec) test to determine exercise workload. Exercise participants completed IET using their dominant hand only. They undertook IET three times per week for 12 weeks, using a handgrip dynamometer provided at the start of the study (Camry, City Industry, California). Each session comprised 4 x 2 minute contractions, at 30% MVC, with 1 minute rest periods between contractions. Each training session was separated by at least 24 hours. All IET sessions were completed at the same time of day (within 1-2hrs) as the first exercise session.

Research team members evaluated each LAB participant throughout the exercise session to ensure they achieved and maintained the appropriate exercise intensity. HOM participants self-reported their performance during each exercise session, using the participant-tracking pack (Fig. 2). CON participants were asked to maintain their usual daily activities and not to change their current or ongoing physical activity outside the study. Both HOM and CON participants received weekly email communications from the research team members to inquire about changes in medications, illness and diet that may have occurred during each of the 6-week testing periods (6, 12 and 18 weeks) between laboratory visits. No additional communication between investigators and HOM participants took place.

Data Collection

Resting Blood Pressure Assessments

Investigators measured RBP and heart rate (HR) for all participants at baseline and every 6 weeks thereafter, in the laboratory, following standard procedures [48, 49]. An automated BP sphygmomanometer (American Diagnostic Corporation, Adview® 9000 Hauppauge, NY) was used to measure RBP and HR. Friz et al. [50] confirmed the accuracy of the Adview 9000 for clinical use and showed that it met requirements for 'A' grade classification for measurement of both SBP and DBP. Baseline RBP data was recorded from all participants over two days, separated by a minimum of 48 hours. In the event that the resting measures were 10 mmHg different between days, a third day of measurements was completed. All subsequent RBP assessments during the study were completed at the same time of day (within 1-2 hours) of baseline RBP assessments, to account for circadian variation.

Every 6-weeks a BP cuff was placed on the non-dominant arm of all participants regardless of study group. Participants rested quietly for 15-minutes in a darkened, temperature-controlled room (in the seated position with the arm at heart level). During data collection sessions, RBP was measured twice, each separated by 5 minutes. An average of the two measures was used for analysis at each time point and recorded accordingly. If measures one and two were ≥10 mmHg different from one another, a third measurement was recorded. If RBP was confirmed to be ≥10 mm Hg following the third measurement, participants were asked to return for follow-up testing 24 hours later to confirm measures. Prior to each data collection visit, participants were asked to consume only water (2 hours prior), abstain from caffeine and alcohol (12 hours prior) and to refrain from participation in vigorous exercise (24 hours prior).

Self-Care Behaviors Influencing RBP

The Hypertension Self-Care Activity Level Effects scale (H-SCALE) [51, 52] was used to assess participants' levels of engagement in self-care behaviors known to influence RBP. The measure is comprised of 6 subscales, each designed to measure one HTN-related self-care behavior: Medication Adherence, Diet, Physical Activity, Weight Management, Alcohol, and Smoking. These 6 H-SCALE subscales together contain 31 items assessing frequency of performing self-care behaviors over the past week and the degree to which participants engage in weight management practices. Sample items include, "How many of the past 7 days did you eat more than one serving of vegetables?," "How many of the past 7 days did you engage in weight lifting or strength training (other than what you do around the house or as part of your work)?," and "How many of the past 7 days did you smoke a cigarette or cigar, even just one puff?" The measure has been validated among a sample of predominately female, predominately Black patients with HTN [52]. The scale showed acceptable reliability in the present sample; Cronbach's alpha values were at or above .70 for each subscale containing more than 3 items at all time points.

The Medication Adherence, Diet, Physical Activity, and Smoking subscale scores are computed by summing the responses (number of days out of the past 7 that participants engaged in the behavior) for each item. The Weight Management subscale also uses a summed score; however, items assess agreement with weight management behaviors over the past 30 days. Response options range from strongly disagree (1) to strongly agree (5) on a Likert-type scale. The Alcohol subscale is scored by multiplying the reported number of drinks consumed per day by the reported number of days per week that alcohol is consumed, indicating the total number of alcoholic drinks consumed per week. All participants completed this self-report measure on paper during their data collection visits at baseline (week 0), 6, 12, and 18 weeks.

Statistical analysis

All blood pressure data were analyzed using SAS statistical software (SAS Institute Inc., Cary, NC) and GraphPad Prism Software (GraphPad Software Inc., La Jolla, CA). Data are reported as mean and standard error of the mean (SEM). All baseline RBP measures were assessed for differences between groups using a one-way analysis of variance (ANOVA). Comparisons between group means for SBP and DBP and HR were analyzed at baseline (before training) and over the course of 12 weeks of the training and detraining (18-weeks) using two-way repeated measures analysis of variance (ANOVA). P values <0.05 were considered statistically significant for differences between groups. From data that produced significant results, the Bonferroni post-hoc test was used to show significant differences between means.

Individual participant analyses were further completed using a general linear model. Regression coefficients were calculated and analyzed at each time point (baseline, 6-weeks, 12-weeks, and 18-weeks). Furthermore, recent evidence suggests that pre-training SBP level may be related to handgrip IET effectiveness, meaning that the higher baseline SBP, the greater the reduction in SBP observed [53]. Secondary analyses were conducted based upon a baseline blood pressure of ≥130 or 81 to test for and address such an association.

HTN self-care behavior data were analyzed using IBM SPSS Statistics version 23 (IBM Corporation, Armank, NY). Subscale scores were summed and paired t-tests were computed to assess differences in mean subscale scores across each time point for each study group.

Results

Effects of 12 weeks of isometric handgrip training on resting blood pressure

There were no significant differences in RBP between groups at baseline (Table 2). Furthermore, no significant differences in mean RBP reductions were found between groups (e.g. CON versus HOM or LAB) at any time point (see Fig. 3). While not significant between groups, greater reductions within groups were observed at week 12 in the LAB group (-9.1±4.1 mmHg, Fig. 4 and 6) and in the HOM group (-9.7±3.4 mmHg, Fig. 4 and 6). Changes in DBP were not significant for either LAB (-2.8±2.2 mmHg) or HOM (-2.2±2.0 mmHg) groups after the training period. Secondary analyses in LAB participants with a RBP ≥130 or 81 mmHg exhibited more considerable reductions in SBP at 6 and 12 weeks (-9.1±5 and -13.1±4 mmHg, Fig. 5 and 7) after training. In HOM participants with a RBP of ≥130 or 81 mmHg, reductions in SBP were also observed upon completion of the training (week 12; -11±4 mmHg, Fig. 5 and 7). Surprisingly, the greatest reductions in DBP were observed at 12-weeks, in the CON group only (-7.7 ± 1.2 mmHg). However, changes did not persist during the detraining period. Individual weekly (baseline –week 18) participant SBP trend lines can be found in Fig. 8, indicating non-uniform responsiveness to IET.

Effects of 12-weeks of isometric handgrip exercise on resting blood pressure maintenance during 6-weeks of detraining

Reductions in SBP were observed and sustained below baseline RBP, after 6-weeks of detraining (Fig. 3). In the LAB group and HOM group, SBP was 8.2±2.9 mmHg and 5.5±3.4 mmHg lower than baseline respectively at week 18. Furthermore, while not significant, DBP was lower than week 12 compared to baseline measurements in both LAB (-4.0±2.9 mmHg) and HOM groups (-4.6±1.8 mmHg). In participants with a baseline RBP of ≥130 or 81 mmHg a lower SBP was also maintained for 6 weeks after cessation of training in the LAB (-9.05±6 mmHg) and HOM (-5.1±3.7 mmHg) groups. Neither SBP (0.61±2.3 mmHg) nor DBP (+0.96 ± 1.1 mmHg) was lower than baseline between 12 and 18 weeks in CON participants.

Compliance and Adherence to Exercise Protocols

Attendance at exercise sessions in the LAB group and self-reported sessions in the HOM group varied during the training period, but the HOM group reported a decrease in participation from 100-90% during the first 6-weeks, to 90-74% in the last 6-weeks. Five of the LAB participants completed less than three sessions per week in the last 6 weeks, averaging 2 out of 3 completed sessions. Overall the average attendance to the prescribed protocols was 81% (29 of 36 sessions; range 50% to 100%) in LAB and 82% (29.5 sessions; range 38% to 100% in HOM).

Influence of HTN Self-Care Behaviors on Changes in RBP

No significant changes were detected in H-SCALE scores across study time points for any study group (P>0.05).

Discussion

The present investigation is the first to evaluate the effects of unsupervised home-based IET, utilizing a web-based video platform, on laboratory measured RBP. This is one of a few studies to explore the efficacy of home-based IET, which hitherto have mainly involved laboratory-based training programs. It is also the first to employ a three-group design with a direct comparison of laboratory-based IET with home-based IET in otherwise healthy, but hypertensive adults. Furthermore, to the knowledge of the authors, this is the first IET study to gather data on lifestyle behaviors using a qualitative tool like the H-scale. The primary finding was that HOM and LAB-based IET elicited no statistically significant reduction on either SBP or DBP after 12 weeks of handgrip IET compared to CON. However, our results did show a greater reduction in SBP in both LAB and HOM groups at week 12 that was sustained below baseline measurements after 6-weeks (week 18) of detraining when compared to CON.

Simply knowing about, and understanding the health benefits of physical activity appears to be an insufficient stimulus for engagement in habitual exercise [54]. Considering the challenges associated with overcoming barriers to participating in exercise interventions, reduced participation could be explained by an interaction between personal, social and environmental factors, which can either encourage or inhibit an individual from participation [55]. Thus, it is important that exercise like IET can be completed outside the lab/gym (unsupervised) to combat compliance barriers, including the use of specialized equipment, time and cost [15-17, 20]. Home-based exercise further eliminates the necessity for regular laboratory or gymnasium visits and associated travel. Moreover, it has been suggested that for some groups of people, home-based exercise is strongly preferred in lieu of group participation [56, 57].

In review of the literature, recent emphasis has been placed on the use of home-based training programs to manage and treat chronic diseases and disorders, like HTN [47]. While scarce, of those reported the preferred exercise modality has been aerobic training. Farinatti et al. [32] employed a 4-month walking program, and Hua et al. [34], 12 weeks of low intensity walking. Both investigations reported reduced RBP (SBP -6 and DBP -9 mmHg; SBP -11±9.4, DBP 5.2±5.9 mmHg, respectively). Similarly, Staffileno et al. [36] utilized 8 weeks of walking and stair-climbing in African American women with HTN or pre-HTN and observed a significant 6.4 mmHg reduction in SBP. Finally, Farinatti [33] investigated the effects of a 16-month home-based walking protocol on hemodynamic and metabolic markers (blood lipids) in 22 women diagnosed with HTN. After 16 months of home training, significant reductions in SBP (4.5 ± 0.3 mmHg) and DBP (2.5 ± 0.6 mmHg) were observed. While not significant in the present study the magnitude of reductions in SBP was similar with those of other home-based aerobic and isometric exercise programs [21, 32-34, 36, 46].

There are few studies investigating the effects of home-based exercise programs on RBP and even fewer utilizing IET for RBP control as outlined previously. For example, two modalities have been used, including isometric handgrip exercise [21], like that of the present study and isometric wall squat exercise [46]. Wiles et al. [46] used a novel wall squat training program for 4 weeks in a randomized crossover design and observed significant reductions in resting SBP (4±5 mmHg) and DBP (3±3 mmHg). Shortly thereafter the same researchers published a second study further validating their protocol for home use [58].

However, wall squat exercise places significant stress on the knees, hips and lower back and requires considerable initial muscle strength. It also requires balance and coordination. Furthermore and the wall squat training of Wiles et al. [58] requires participants to measure their HR and use a goniometer. It also involves a demanding incremental wall squat exercise test at baseline and subsequent exercise sessions [46, 58]. While appropriate for younger able-bodied individuals, this type of training program is unlikely to be appropriate for hypertensive older participants, especially since they often present with significant comorbidities including obesity [59], type II diabetes [60] and musculoskeletal disorders [61]. Moreover, the American Heart Association recognizes handgrip IET as a favorable modality for larger cohort programs, given its simplicity and convenience, achieving or exceeding target improvements in reducing RBP [5].

Using an identical protocol to the present investigation, Goessler et al. [21] published the first home-based handgrip IET study and observed significant reductions in SBP and DBP over an 8-week period (5 mmHg). However, a direct comparison was made using self-selected home-based aerobic exercise training (avg. ~110 minutes/week) vs. prescribed home-based handgrip IET (~33 minutes/ week). Reductions in BP were observed during clinic measured resting but not 24-hour ambulatory BP following IET but in both following aerobic exercise [21]. Therefore, aerobic exercise training was claimed to be more effective at lowering both resting and ambulatory BP, compared to IET. However, this is a questionable comparison, given the variation in total exercise volume between study groups (handgrip IET = 33 min/week vs. aerobic training ~110 min/week).

Furthermore, in the study by Goessler [21], participants reported a loss of interest during the home-based IET, which may have been a factor in the declining compliance (96% at the start of the study and 63% at the end). These authors utilized a fully programmable ZONA Health handgrip device with integrated software. Despite on-screen prompts via the handheld device, combined with monitored tele-coaching, this method may have been less visually-appealing and engaging compared to lab-based training, resulting in a negative effect on compliance. In the present study, we created an instructional YouTube video in an attempt to mimic face-to-face studies that have promoted a sense of social support, while still relying on participants to be self-motivated; an important element in successful home-based exercise compliance [62].

Unlike other IET studies [7, 25, 26, 63], the number of exercise sessions completed by IET training participants was not 100% (LAB 81% and HOM 82%). However, we believe a degree of "personal" engagement and on-screen "social support" via instructional video may have been, in part, responsible for higher average levels of compliance observed in our study compared to the study by Goessler et al [21]. We report similar levels of compliance in both LAB and HOM participants, which aligns with similar but non-significant reductions in RBP across IET groups. A possible limitation of our study, as well as that of Goessler [21], was that the IET protocol did not change throughout the training period. Published recommendations for periodic variation in exercise type, intensity and duration have been linked to increased adherence and interest [62] as a part of home-based exercise strategies. Thus, there is the need to develop an IET program, which includes a wider variety of simple isometric exercise modes. This may prove most successful in encouraging older hypertensive participants to perform IET in the home.

Limited data exists on the characteristics of RBP changes upon cessation of IET. Few studies have assessed the potential for sustained reductions in RBP during a detraining period ranging from 2-4 weeks [8, 12]. Results of the present study are in line with previous unpublished data from our laboratory, which indicate that RBP was not only lowered but also observed below baseline measures for an additional 6 weeks despite no longer participating in IET. Thus, these data may be used in support of longer-lasting training adaptations, as elicited following IET. Additional detraining protocols exploring the mechanisms responsible for these longer-lasting reductions in resting blood pressure, following IET, are now required to confirm our results.

HTN self-care behavior data were collected to provide some information about participants' health behaviors outside of the IET program that may influence changes in RBP. No statistically significant differences in frequency of engagement in HTN self-care behaviors were detected across any time points in any study group. This finding may provide additional evidence that the IET protocol was indeed responsible for the clinically meaningful changes in RBP observed in the present study. However, it is worth noting that the small sample size in the present study may have precluded our ability to detect statistical significance in HTN self-care behavior changes. Researchers should consider continuing to collect and statistically control for HTN-related lifestyle behaviors among participants in future IET investigations.

Larger randomized trials are still required in order to truly establish the efficacy of IET on a public scale [5]. Isometric handgrip, when prescribed at 30% of MVC 3 days per week for 6-12 weeks in pre-hypertensive and hypertensive adults is an effective modality of exercise to elicit both clinically-relevant and statistically significant reductions in RBP in both laboratory or gymnasium-based and home-based settings [7,12, 21, 25, 26, 30, 64]. This is highlighted by data from our lab and others, which suggests a degree of heterogeneity in responsiveness of participants who complete IET programs [7,12, 21, 25, 30, 63, 64]. Thus, extrapolating the success of smaller randomized control trials and cohort studies to generalize the effects of IET more broadly, is inappropriate. However, with the success of published trials including the present study, future isometric handgrip investigations can be designed and implemented with greater confidence. Simple, cost effective, home-based IET programs can be implemented so as to not only effectively lower RBP but to also be integral to the success of HTN management, reaching a greater population who may be unable to otherwise engage in exercise-based HTN management strategies [21].

Conclusions

In conclusion, a 12-week home-based IET program lowered RBP (albeit not statistically significant) to a similar extent to that of a previously used laboratory-based intervention, in hypertensive adults. As a result of the present study, home-based IET can be implemented with some confidence, in participants who have a wide range of RBP. The findings of the present study also demonstrate that longer training programs can induce sustained post-training reductions in RBP, especially in those with HTN, (i.e. a training effect). These findings support the implementation of community-based exercise programs to combat HTN.

Tables

Table 1: Subject Demographics (N=22)

Group	N	Male (N)	Female (N)	Age (mean)	BMI (mean)	HTN >130 or 81 mmHg	HTN Medication
CON	5	2	3	47 ± 9 yrs.	27 ± 7	N = 4	N = 4
LAB	8	2	6	53 ± 5 yrs.	26 ± 6	N = 2	N = 8
HOM	9	2	7	47 ± 12 yrs.	25 ± 5	N = 6	N = 8

Values are means ± SEM; CON: control; LAB: lab-based training; HOM: home-based training; BMI: body mass index; HTN: hypertension.

Table 2: Participant resting blood pressure at weeks 0 (baseline), 6, 12 and week 18 (detraining).

Group		BL (week 0) mean ± SEM	6-weeks mean ±SEM	12- weeks mean ± SEM	Detraining (18-weeks) mean ± SEM
CON	SBP (mmHg)	137 ± 4.5	134.4 ± 3.9	134.7 ± 4.2	136.4 ± 2.3
	DBP (mmHg)	86.8 ± 3.4	82.8 ± 3.2	78.7 ± 3.7	87.8 ± 1.2
LAB	SBP (mmHg)	137.6 ± 3.7	131.3 ± 3.3	128.5 ± 4.1	129.31 ± 2.9
	DBP (mmHg)	87.1 ± 3.2	85.8 ± 2.5	84.3 ± 2.1	83.1 ± 2.9
HOM	SBP (mmHg)	137.7 ± 4.1	129.7 ± 5	128.0 ±3.4	132.2 ± 3.4
	DBP (mmHg)	88.4 ± 0.8	82.8 ± 1.5	81.6 ± 2.0	83.8 ± 1.8

Values are means ± SEM (CON group n = 5; LAB group n = 8; HOM group n = 9) CON: control; LAB: lab-based training; HOM: home-based training; BL: baseline; SBP: resting systolic blood pressure; DBP: resting diastolic blood pressure.

Figures and Figure Legends

Figure 1. Still image captured from Video 2, step-by-step instruction for home-based IET.

Figure 2: Home-Based (HOM) IET participant tracking packet. Sheets were completed for all isometric handgrip session's weeks 1-12 of exercise.

Figure 3: Overview of changes in resting SBP between groups; weeks 0 -18 (i.e. training period and detraining).

Figure 4: Delta (Δ) difference in resting SBP across all three groups. Difference is relative to baseline (week 0).

Figure 5: Delta (Δ) difference in resting SBP across all three groups including RBP restricted to participants with baseline RBP 130/81 and above. Difference is relative to baseline (week 0).

Figure 6: Overview of changes in resting SBP between groups; weeks 0 vs. 12 (i.e. training).

Figure 7: Overview of changes in resting SBP between group restricted to a RBP of >130/81 mmHg; weeks 0 vs. 12 (i.e. training).

Figure 8: Individual participant responses from week 0 (baseline) to week 18 (detraining).

Figure 1.

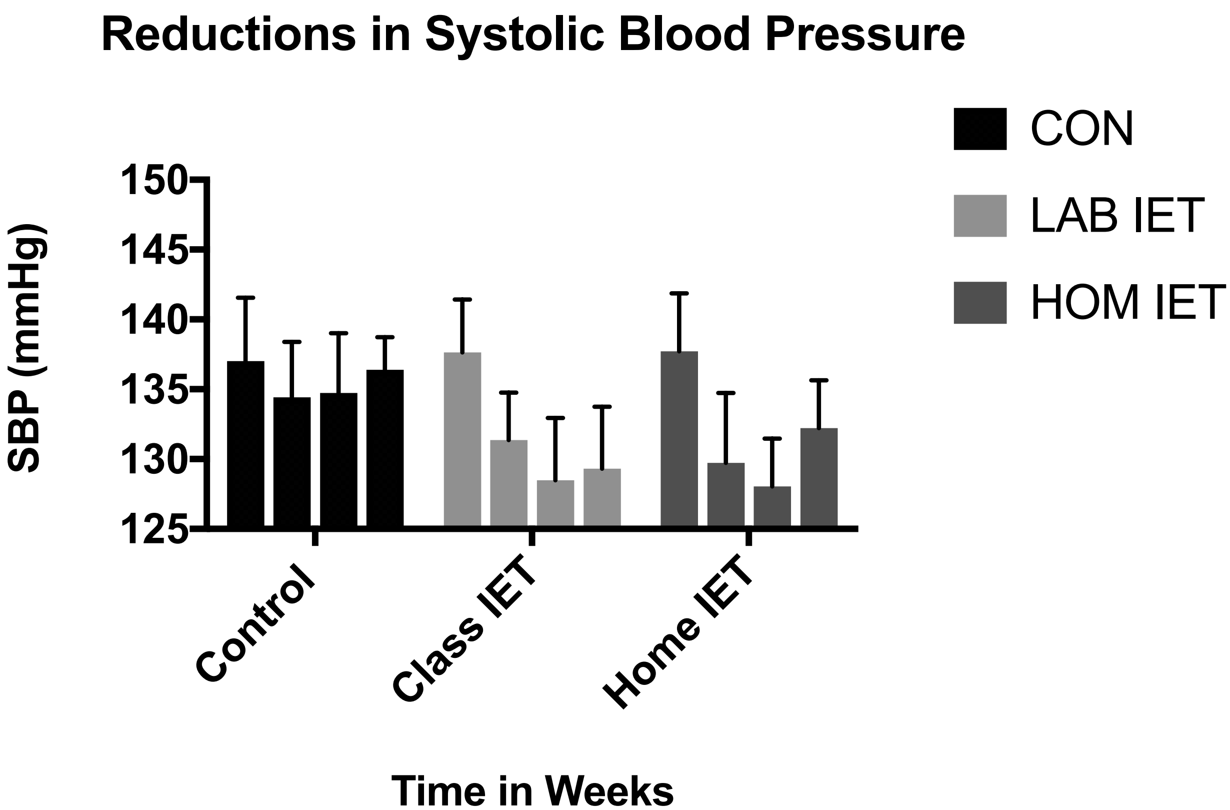
Figure 2.

Week 1:___/___/______-___/___/______

Instructions:	Please complete this log each time you use your handgrip device. Record the maximal voluntary contraction (MVC) for each of the three squeezes in the space provided. Choose the highest of the three readings and type it in the orange box provided. Use your chart provided to find the 30% value and write it in the blue box provided.

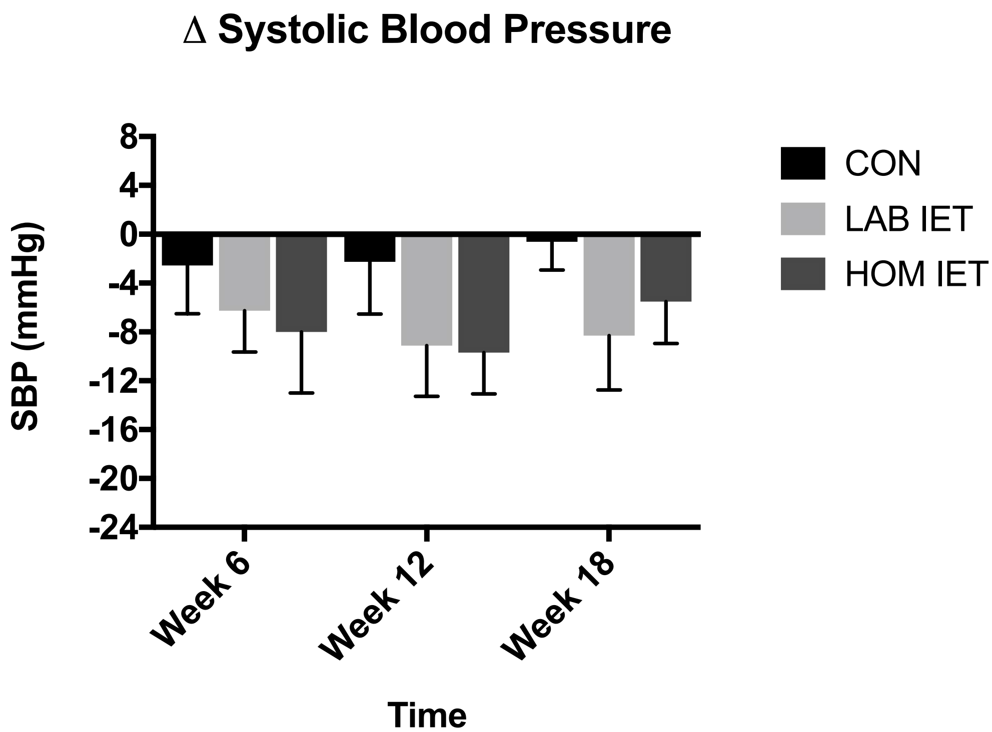
Date: __/__/____	Squeeze 1:		Record your highest squeeze in the orange box		Use your chart to find the 30% value. Type it in the blue box.	
	Squeeze 2:					
	Squeeze 3:					
Date: __/__/____	Squeeze 1:		Record your highest squeeze in the orange box		Use your chart to find the 30% value. Type it in the blue box.	
	Squeeze 2:					
	Squeeze 3:					
Date: __/__/____	Squeeze 1:		Record your highest squeeze in the orange box		Use your chart to find the 30% value. Type it in the blue box.	
	Squeeze 2:					
	Squeeze 3:					

Figure 3.



Reductions in Systolic Blood Pressure
CON
LAB IET
HOM IET
150
145
140
135
130
125
SBP (mmHg)
Control
Class IET
Home IET
Time in Weeks

Figure 4. & 5


Δ Systolic Blood Pressure
SBP (mmHg)
8
4
0
-4
-8
-12
-16
-20
-24
Week 6
Week 12
Week 18
Time
CON
LAB IET
HOM IET

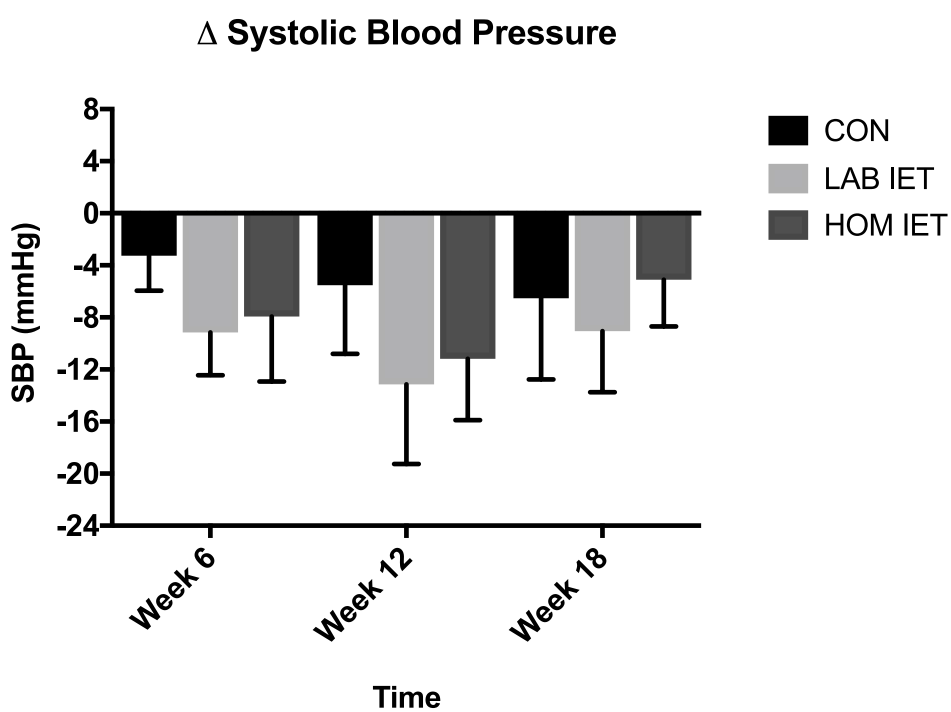
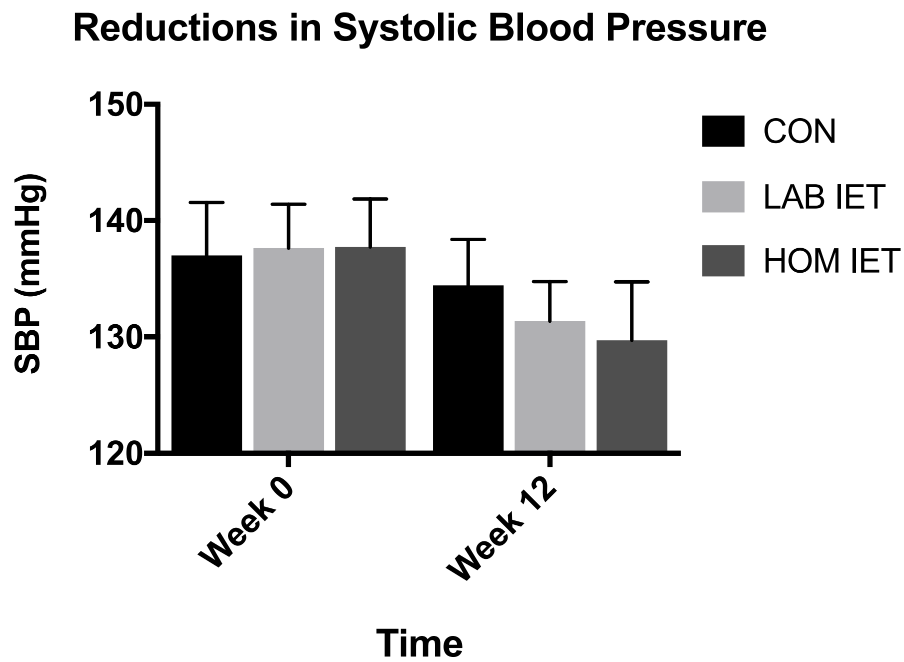

Δ Systolic Blood Pressure
SBP (mmHg)
8
4
0
-4
-8
-12
-16
-20
-24
Week 6
Week 12
Week 18
Time
CON
LAB IET
HOM IET

Figure 6 & 7


Reductions in Systolic Blood Pressure
SBP (mmHg)
150
140
130
120
CON
LAB IET
HOM IET
Week 0
Week 12
Time

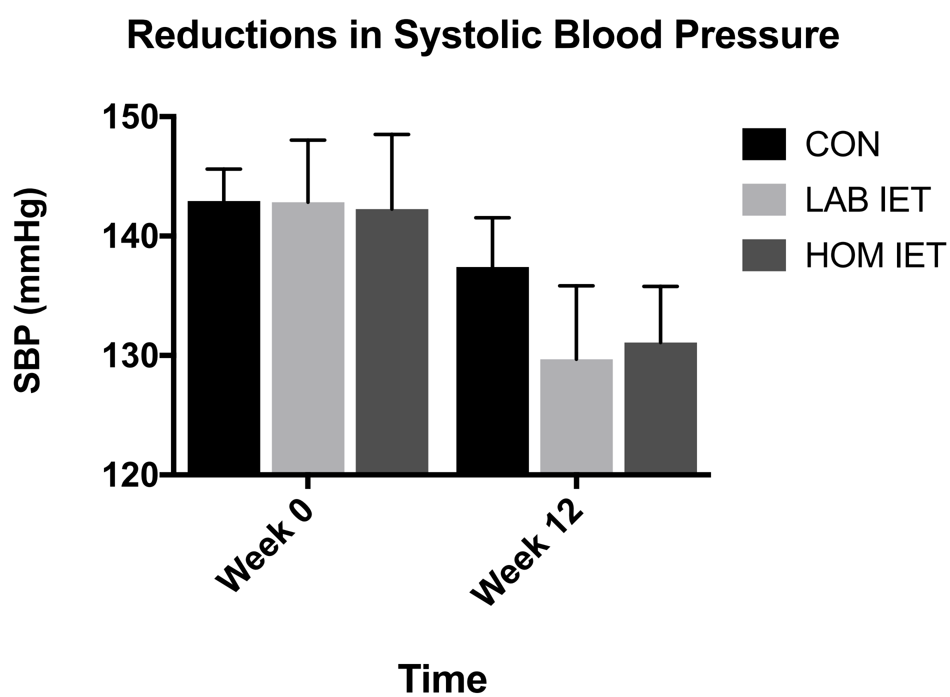
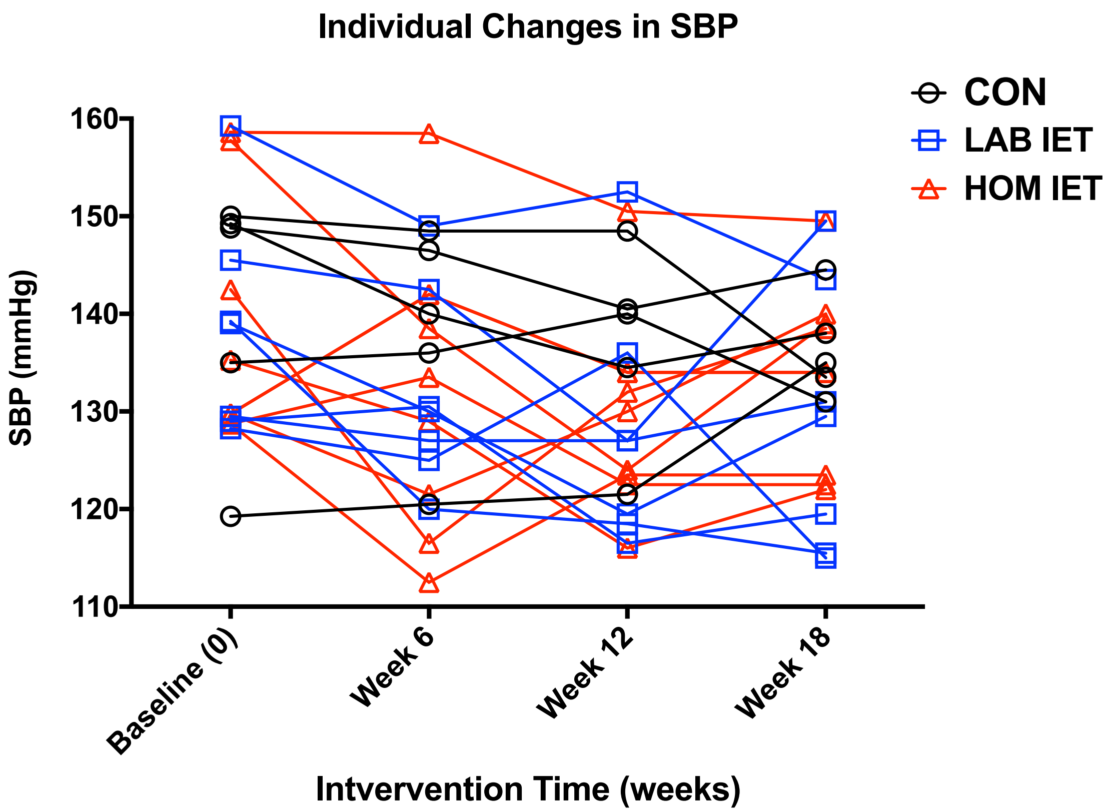

Reductions in Systolic Blood Pressure
SBP (mmHg)
150
140
130
120
CON
LAB IET
HOM IET
Week 0
Week 12
Time

Figure 8.



Individual Changes in SBP
CON
LAB IET
HOM IET
160
150
140
130
120
110
SBP (mmHg)
Baseline (0)
Week 6
Week 12
Week 18
Intvervention Time (weeks)

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