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Differences in Cardiorespiratory Responses with Three Set-Paced Submaximal Endurance Tests in Community-Dwelling Older Adults

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ABSTRACT

International Journal of Exercise Science 17(4): 1026-1037, 2024. A variety of submaximal exercise tests are commonly used in clinical practice to determine an individual's exercise capacity and cardiorespiratory fitness. This study explored differences in cardiorespiratory and perceived exertion responses following the completion of three set-paced exercise tests. A prospective, observational, cross-sectional design assessed 30 healthy community-dwelling older adults, who participated in three submaximal exercise tests, including seated marching (SM), standing marching (STM), and standing stepping (STS). Each test was three minutes in length and required the participant to step at a set pace. Heart rate (HR), blood pressure (BP), rate of perceived exertion (RPE), and submaximal oxygen uptake (VO_2) were measured before and after each test. Repeated measures ANOVA with Bonferroni correction tested for differences. Statistically significant differences between pre and post exercise values were noted for HR, SBP, RPE and VO_2 ($p < 0.01$) between the three activities. Additionally, 3-minutes of standing stepping triggered the highest cardiorespiratory responses with a mean metabolic equivalent (MET) of 6.18 compared to seated stepping that triggered the lowest responses with a mean MET value of 1.98. The results of this study provide meaningful data on significant differences noted in cardiorespiratory and perceived exertion elicited following the completion of three set-paced stepping exercises. Based on the results, STM and STS can be categorized as moderate intensity activities, while three minutes of set paced SM is light intensity activity. Further research is warranted to validate these findings in older adults with multiple comorbidities and in those consuming cardiac medications that alter hemodynamic responses.

KEY WORDS: Aerobic fitness, oxygen consumption, geriatrics

INTRODUCTION

A formal assessment of cardiorespiratory fitness is a fundamental component of the examination in older adults aged 65 years and older. A compelling position paper by American Heart Association challenges all clinicians to consider the assessment of cardiorespiratory endurance as a clinical vital sign (18). Growing evidence has established that low levels of cardiorespiratory fitness are associated with increased all-cause mortality and elevated risk for cardiovascular diseases (10, 12). An abundance of endurance tests exists to measure an individual's cardiorespiratory fitness. These include the use of both maximal and submaximal exercise tests. Older adults are often unable to perform maximal exercise testing during routine clinical practice making submaximal testing preferable for assessing cardiorespiratory fitness (9). Conversely, submaximal exercise testing overcomes many of the limitations of maximal exercise testing and appears to have greater applicability in older adults.

Exercise specialists can utilize submaximal field tests to evaluate an individual's cardiorespiratory fitness (13). These submaximal field tests do not rely on treadmills and cycle ergometers that are unavailable outside laboratory settings, and employ simple endurance activities such as walking and stepping to assess cardiorespiratory function (4, 7, 17). The most commonly used submaximal field tests include the six-minute walk test (6MWT), two-minute walk test and two-minute step test. In all of these tests, the participant performs the activity in a self-paced format. Self-paced aerobic tests allow participants to determine their preferred pace for the duration of the test.

Alternatively, incorporating a set-paced aerobic field test challenges participants to perform an endurance activity with a predetermined pace they are required to maintain for the duration of the test. Bohannon et al. conducted an investigation comparing hemodynamic responses after three minutes of set paced stepping and a self-paced six-minute walk test in 189 participants (3). He found that set paced stepping had higher hemodynamic responses compared to self-paced walking. This brings into question the need for further investigation to assess intensity levels of various activities that are set-paced that can be used in clinical practice. A resting MET level has been defined by a VO_2 level OF 3.5 mL O_2/kg/min; however, these values have not yet been widely accepted (6). Empirical evidence reported by Gunn et al. and Byrne et al. have found the widely accepted resting metabolic rate of 3.5 mL O_2/kg/min to be an overestimation of resting energy expenditure (6, 11). In both reports, mean resting oxygen consumption were reported in the range of 2.5-3.0 mL O_2/kg/min. Ainsworth et al. categorized light intensity as any activity less than 3 METs in intensity, moderate intensity activities to be 3 to 6 METs, and vigorous intensity activities performed over 6 METs (1). Determining the appropriate intensity level of set-paced activities during an assessment is essential to determine the appropriate intensity of exercises that can be subsequently prescribed to older patients and clients.

Given the ubiquity of submaximal tests used in clinical practice, this study aimed to assess differences in heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), VO_2, and rate of perceived exertion (RPE) measures obtained following the completion of three submaximal set-paced endurance tests in community-dwelling older adults. The three set-paced tests included the 3-Minute Seated Marching Test (SM), 3-Minute Standing Marching Test (STM), and 3-Minute Standing Step Test (STS). These tests have been validated for use in older adults as tests for aerobic capacity and function (4). While the standing marching test is typically performed for two minutes, to be consistent across the three different types of challenges, all three tests were done for three minutes in duration.

This study provides clinical insights on differences in cardiorespiratory responses achieved with set-paced marching in the seated versus standing position as well as stepping onto an elevated step. The hypotheses for this study included 1) stepping onto an elevated step for three minutes will yield the highest hemodynamic responses of HR, SBP, VO_2, and RPE and 2) hemodynamic responses for standing marching will be greater than three minutes of seated marching. The hypotheses for higher values with standing marching and stepping compared to seated marching was conceptualized because stepping in the standing position challenges dynamic balance, requiring weight shifting and movement for every single leg stance during the stepping maneuver. Additionally, standing stepping is a dynamic movement that incorporates a larger metabolic need and the additional recruitment of global body muscle contractions to maintain balance and prevent excessive postural swaying throughout the test.

METHODS

Participants

A power analysis conducted with G*POWER 3.1 (Universitat Kiel, Germany) determined that 28 participants were needed in the present study for a power of 0.80, with an effect size of 0.25 and an $\alpha = 0.05$. A convenience sample of 30 community-dwelling older adults ages 60–89 recruited from the St. Louis Metropolitan area participated in this study. Inclusion criteria included older adults ages 60–89 who were ambulatory and able to climb a flight of stairs with or without an assistive device, and able to follow basic commands. Exclusion criteria included a resting HR greater than 100 bpm, a documented arrhythmia, a history of pneumonia or upper respiratory infection in the last six months, a history of COVID or flu in the last three months, or a history of chronic lung disease. Any participant who required more than standby assistance with transfers and ambulation or reported a history of claustrophobia were excluded from the study. All participants reviewed and signed an informed consent document approved by the Maryville University Institutional Review Board. This study followed all ethical guidelines involved in conducting, collecting and reporting data in exercise science as identified by Navalta and colleagues (16).

Protocol

This investigation used a prospective, observational, cross-sectional, within-groups research design. Data collection for each participant occurred on a single visit. This study involved collecting cardiorespiratory data including HR, BP, RPE, and VO_2 before and after the completion of three, 3-minute submaximal set-paced endurance tests.

Participants were randomly assigned an order to perform SM, STM, and STS. Participants were instructed to draw from an envelope containing a total of six folded slips of paper. Each slip of paper drawn by the participant delineated the order of tests for that participant. Using a factorial analysis, six different orders of tests were determined, with each order represented in the six slips of paper.

Prior to exercise testing, participants were fit with Polar HR Monitor, and resting BP, HR, and VO_2 were recorded. Individuals with a resting HR over 100 bpm were provided a 10-minute rest period seated, after which vital signs were re-recorded in the upright position. If a participants' HR continued to be over 100 bpm they were not able to participate in the study. After being fit for the VO_2 mask, the researcher provided an explanation and demonstration of each test. The participants were given a ten second period to listen to the metronome beat and practice the given activity to the beat of the metronome prior to the initiation of each test.

The following procedures were used for the SM test. The participant sat in a standard 18" chair without armrests and a 10.25" step was placed in front to allow for full knee extension. The step was placed one and a half feet in front of the chair. The step was placed to ensure that the participant was able to easily tap each foot on the step. Participants were asked to tap each foot on the step in a four-step pattern with each beat of the metronome that involved tapping the right foot on the step, right foot returned to the floor, left foot on the step, and left foot returned to the floor. The metronome was set to a rhythm of 88 beats per minute. The participant was allowed to perform a practice trial of three to four steps before the test began to ensure the participant's understanding of the test and their ability to step to the beat of the metronome. On the command "Go" the timer was started and the participant continued stepping for the three-minute duration of the test. If the participant was unable to remain on beat with the metronome, the researcher cued the participant to re-establish rhythm. Participants were not provided any other verbal feedback during the test other than being informed of their completion of the halfway mark for the test. HR, BP and VO_2 were assessed before and within thirty seconds of the completion of the test. Participants reported their RPE at the termination of the activity.

The second test utilized was the STM test. Prior to the initiation of stepping, participants were measured for step height by placing a mark halfway between the iliac crest and superior aspect of the patella on the right lower extremity. At this level, tape was placed on a wall adjacent to the participant to create a marker to notify the participant of the appropriate step height to achieve during the activity. The participants were allowed to choose whether they wanted to stand facing the wall or parallel to the wall. A chair was placed on the other side of the participant to hold onto for balance if necessary. The participant was informed to march in a four-step pattern with each step corresponding to the beat of the metronome. The four-step pattern for this test included the right leg lifted to the height of the tape with the first beat, right leg lowered to the ground on the second beat, left leg lifted to the height of the tape with the third beat, and finally left leg lowered to the ground with the fourth beat. The metronome was set to a speed of 88 beats per minute. Once again, the participant was allowed to perform a practice trial of three to four steps before the test began to ensure the participant's understanding of the test and their ability to attain the necessary height and step to the beat of the metronome. Once the timer was started, if the participant was unable to remain on beat with the metronome, or failed to lift their leg to the appropriate height, the researcher cued the participant to re-establish rhythm or height. No other verbal cues were provided to participants during the procedure, except a notification of completion of the halfway mark for the test. Heart rate, BP, and VO_2 measurements were recorded in the seated position before the activity and within 30 seconds following completion of the activity, Additionally, participants reported their RPE at the end of the test.

The final test utilized in this study was the STS test. For this test, the participant began by standing in front of a 10.25′′ step. A researcher demonstrated the stepping procedure. The four-step pattern for this test involved the participant stepping up onto the step with the right foot on the first beat, followed by bringing the left foot up onto the step on the second beat, subsequently lowering the body down by bringing the right foot down to the floor in the third beat, and finally placing the left foot down to the floor on the fourth beat. The metronome was set to a tempo of 88 beats per minute. The participant was allowed to perform a practice trial of three to four steps before the test. Arm motion was allowed based on the participant's comfort. On the command "Go" the timer was started and the participant continued stepping for the three-minute duration of the test. To prevent limb lead fatigue, the participant was allowed to switch the leading leg if necessary. If the participant was unable to remain on beat with the metronome, the researcher cued the participant to re-establish rhythm. No other verbal cues were provided to participants during the procedure, except a notification of completion of the halfway mark for the test. HR, BP, and VO_2 measurements were recorded in the seated position before the activity and within 30 seconds following completion of the activity, Additionally, participants reported their RPE at the end of the test.

A standardized 5-minute passive rest period was used between the three tests to ensure the participant received adequate rest and recovery. After recording HR and BP for the final test, the participant was provided a final 5-minute passive sitting cooldown. Water was provided as requested for each participant.

Heart rates were recorded through a Polar H10 heart rate sensor. The Polar heart rate monitor measured HR with the Polar strap placed around the chest at the level of the xiphoid process. The Polar HR Monitor has Bluetooth compatibility with the VO_2 Master app, which allowed the researchers to see both HR and VO_2 simultaneously within the app. Schaffarczyk et al. compared the results of an electrocardiogram (ECG), which is considered the gold standard in measuring HR, with the Polar HR Monitor. The researchers compared ECG heart rate readings with Polar HR Monitor and found high correlation values between ECG and Polar monitor pre-exercise (0.95), during exercise (1.0), and post-activity (0.86) (19).

A second outcome involved the assessment of RPE at the completion of each of the three tests. The 6 to 20 RPE scale developed by Borg was used to collect participantive ratings of perceived exertion (5). Borg's RPE provides a means to assess an individual's participantive discernment of the intensity they perceive during exercise. To this effect, Borg developed a 15-point scale (6-20) to provide a simple approximation of HR, where in a 1-point increase in RPE correlated with an approximate 10-point increase in HR. In other words, participants with a HR of 150 beats per minute during exercise will report an RPE value of 15. For this study, the participant was given a visual of the numerical scale on a piece of paper that also provided verbal descriptors that correlated with specific numbers on the scale. The researchers verbalized descriptors to the participant at the completion of each test. The participant confirmed the specific descriptor, and the researcher documented the number that correlated with the descriptor.

Blood pressure was measured using a Sun Tech automatic BP device. The Sun Tech automatic BP devices turn the oscillatory vibrations produced by blood flowing through the arteries during systole and diastole into electrical signals. The arterial wall vibrations are transferred through the air inside the BP cuff to a transducer monitor where the BP is displayed to the reader (2). The sphygmomanometer cuff was maintained on the same arm for all tests. A researcher supported the arm with the BP cuff at the level of the heart, and the BP was automatically measured by the Sun Tech device. In addition to this device, the BP value was confirmed by one researcher who used a stethoscope to listen to the Korotkoff sounds while the automatic cuff deflated. If there was a discrepancy greater than 5 mmHg between the value recorded by the Sun Tech device and the researcher, then the reading documented was the BP value heard by the researcher.

Finally, The VO_2 Master Pro measured VO_2 throughout each test. The VO_2 Master Pro kit has four mask sizes (petite, extra small, small, and medium), a head strap, a resting mouthpiece size, and filters for the mouthpiece. Filters used were for individual use only and each mouthpiece and head strap were thoroughly cleaned and air dried before being used on other participants. The VO_2 Master Pro mask was placed around the participants mouth and nose and secured using a head strap. The researchers confirmed the seal of the mask by asking the participant to hold a deep breath of air while the researcher blocked the airway opening. The participant was then instructed to breathe out forcefully while the researcher checked for any escaping air around the seal. Additionally, The VO_2 Master Pro must be calibrated to each participant's O_2 flow rate. The correlation coefficient for VO_2 between the VO_2 Master compared the Parvomedics metabolic cart deemed an r-value of 0.93 (15).

Statistical Analysis

Data were entered for storage into Microsoft Excel which was then imported into the statistical package Jamovi (Version 1. 2. 27). Descriptive statistics were performed for sample characteristics. The major outcome variables included HR, SBP, DBP, VO_2, and RPE. The independent variables included the three self-paced submaximal tests including the SM, STM, and STS. A within-participants repeated measures analysis of variance (ANOVA) test was used to assess for differences in HR, SBP, DBP, VO_2, and RPE between the three self-paced submaximal tests. Significance was set at a p value of 0.05 for all statistical tests. A Bonferroni adjustment was utilized in the statistical analysis to determine where statistical differences existed between each of the three activities. Rate of perceived exertion scores, although measured in an ordinal scale, was utilized in parametric statistical tests. Gaito summarized that the original categorization of ordinal data, if normal in distribution, can be considered as a continuous variable and used in statistical processes including analysis of variance (8). All data were checked for normality and no significant deviations were found resulting in the use of parametric tests for analysis of the data.

RESULTS

The sample that was statistically analyzed consisted of 30 participants. The demographic data for the 30 participants is shown in Table 1. The participant pool consisted of 16 males and 14 females. These were community dwelling older adults with a mean age of 70.2 ± 8.4 years. Participants recorded a healthy body mass index with a mean weight of 74.5 ± 12.5 kilograms and a mean height of 1.7 ± 0.09 meters. Additionally, sixty percent of the participant pool did not report having a cardiac comorbidity or report taking any cardiac medications. Ten out of the thirty participants did report taking one cardiac medication while one participant reported consuming two cardiac medications. Participants did inform the researchers that their cardiac medications were consumed on the date of testing.

Table 1. Participant data for sample of 30 participants.

Variable	Mean (SD)
Age (years)	70.2 (8.4)
Height (meters)	1.7 (0.09)
Weight (kilograms)	74.5 (12.5)
Body Mass Index (kg/m^2)	26.5 (3.3)
Variable	Frequency
Gender	14 Female, 16 Male
Cardiac Comorbidities	18 No and 12 Yes
Cardiac Medications	19 No and 11 Yes

Mean pre-exercise and post-exercise scores with standard deviations (SD) for HR, SBP, DBP, VO_2, MET, and RPE scores are categorized for each of the three submaximal tests in Table 2. No significant differences were noted in pre- exercise HR, SBP, DBP and VO_2 values between the three activities. This finding reflects homogeneity in resting baseline values for all outcome variables. As the rest interval between tests was standardized at 5 minutes it was important to assess if participants attained baseline resting values after the completion of each activity. As noted pre activity HR and BP values between the three activities were homogenous at baseline indicating that the 5 minute rest interval was sufficient to allow participants to attain resting baseline values.

Post exercise HR values were analyzed for differences using a within-participants repeated measures ANOVA. The analysis investigated for differences between the mean [95%CI] post exercise HR values following SM, STM and STS that were recorded as 88.97 [83.48–94.45] beats per minute, 103.67 [97.74–109.60] beats per minute, and 126.63 [120.54–132.72] beats per minute respectively. The results of the within participants repeated measures ANOVA revealed statistically significant differences $F(2,52) = 174.1$, $p < 0.01$. These differences represent a large effect size eta square (η^2) = 0.55. Additionally, the results of a Bonferroni post hoc analysis using t-tests revealed statistically higher HR following standing stepping compared to standing marching $t(26) = 11.6$, $p < .001$, and seated marching $t(26) = 16.1$, $p < 0.001$. A statistically significant difference was also noted between SM and STM $t(26) = 8.4$, $p < 0.001$ with higher post exercise HR values with STM compared to SM.

The mean [95% CI] post exercise SBP values following SM, STM and STS were recorded as 138.07 [130.84–145.29] mm Hg, 157.37 [148.58–166.15] mm Hg, and 186.00 [173.53–198.47] mm Hg respectively. The results of a within participants repeated measures ANOVA comparing post exercise SBP between the three activities revealed statistically significant differences $F(2,52) = 72.8$, $p < 0.01$. These differences represent a large effect size eta square (η^2) = 0.37. Further, Bonferroni post hoc *t*-test analyses indicated significant differences between SM, STM, and the STS. Post exercise SBP following STS was significantly higher than post exercise SBP for STM $t(26) = 7.21$, $p < .001$ and SM $t(26) = 11.26$, $p < .001$. Additionally, post exercise SBP for STM was significantly higher than post exercise SBP for SM $t(26) = 5.16$, $p < .001$.

Table 2. Descriptive data for the three submaximal exercise tests.

Variable	Time	Mean SM [95% CI]	Mean STM [95% CI]	Mean STS [95% CI]
Sample Size		30	30	26
HR (beats per minute)	Pre	76.83 [72.05–81.62]	74.77 [70.32–79.21]	75.15 [70.86–79.44]
	Post	88.97 [83.48–94.45]	103.67 [97.74–109.60]	126.63 [120.54–132.72]
SBP (mm Hg)	Pre	133.40 [126.71–140.09]	130.50 [123.40–137.60]	131.04 [123.25–138.82]
	Post	138.07 [130.84–145.29]	157.37 [148.58–166.15]	186.00 [173.53–198.47]
DBP (mm Hg)	Pre	67.70 [63.67–71.73]	66.67 [62.97–70.36]	67.22 [63.56–70.88]
	Post	68.10 [64.01–72.19]	67.10 [62.81–71.39]	70.41 [64.65–76.17]
VO_2 (mL/kg/min)	Pre	2.52 [2.07–2.97]	2.65 [2.31–2.99]	2.52 [2.03–3.01]
	Post	4.99 [4.10–5.88]	9.99 [7.29–12.69]	15.59 [12.86–18.32]
MET	Post	1.98 [1.82–2.33]	3.63 [2.75–4.78]	6.18 [5.10–7.26]
RPE	Post	9.13 [8.48–9.78]	11.30 [10.65–11.95]	13.85 [13.08–14.63]

HR = Heart Rate; SBP = Systolic Blood Pressure, DBP = Diastolic Blood Pressure; VO_2 = Oxygen Consumption; MET = Metabolic Equivalents; RPE = Rate of Perceived Exertion; SM = Seated Marching Test; STM = Standing Marching Test; STS = Standing Step Test; CI = Confidence Interval

The results for a within participants repeated measures ANOVA comparing differences in post exercise DBP between the SM, STM, and STS indicated no statistically significant differences between the three activities $F(2,52) = 0.87$, $p = 0.43$. Further, using Bonferroni post hoc *t*-tests, no statistically significant differences were found between the SM and STM, SM and STS as well as the STM and STS respectively ($p > 0.05$).

Post exercise RPE were analyzed following the completion of each of the three set-paced endurance activities. A within-participants repeated measures ANOVA compared differences in post exercise RPE scores between the SM, STM and STS. Statistically significant differences were noted with $F(2,52) = 176.52$, $p < 0.01$ and a large effect size eta square (η^2) = 0.56. Additionally, the results of a Bonferroni post hoc analysis using *t*-tests revealed statistically higher RPE following standing stepping 13.85 [13.08–14.63] compared to post exercise RPE with standing marching 11.30 [10.65–11.95], $t(30) = 11.6$, $p < .001$, and seated marching 9.13 [8.48–

9.78], $t(26) = 16.36$, $p < 0.001$. A statistically significant difference was also noted between SM and STM $t(26) = 8.85$, $p < 0.001$ with higher RPE values with STM compared to SM.

Statistically significant differences in post exercise VO_2 values were analyzed between the three tests using a within participants repeated measures ANOVA. The results of the analyzed revealed statistically significant differences between SM, STM, and the STS $F(2, 348) = 41.1$, $p <.001$. These differences represent a large effect size eta square (η^2) = 0.44. The mean [95% CI] post exercise VO_2 values following SM, STM and STS were recorded as 4.99 [4.10–5.88] mL O_2/kg/min, 9.99 [7.29–12.69] mL O_2/kg/min, and 15.59 [12.86–18.32] mL O_2/kg/min respectively. Bonferroni post hoc *t*-test analyses indicated statistically significant differences in post exercise VO_2 between the three activities. Post exercise VO_2 following STS was statistically significantly higher than post exercise VO_2 for STM $t(24) = 4.5$, $p < .001$ and SM $t(24) = 13.5$, $p < .001$. Additionally, post exercise VO_2 for STM was statistically significantly higher than post exercise VO_2 for SM $t(24) = 3.5$, $p < .001$.

DISCUSSION

This investigation aimed to investigate differences in cardiorespiratory responses following completion of three set-paced three-minute activities. A total of 30 community-dwelling individuals older than 60 years of age volunteered to participate in this study. All 30 participants completed the 3SM, 3STM while 26 participants completed the 3STS. No adverse events were noted by any of the participants during their performance during the three tests.

As hypothesized, the results of this study indicate that three minutes of set-paced standing stepping was the most challenging of the three activities. As noted in the results, participants demonstrated the highest HR, SBP, DBP, VO_2, and RPE scores after completing the 3STS compared to the other two activities. The findings of this study were similar to the findings reported by Bohannon who determined average HR and RPE scores to be significantly higher after three minutes of set-paced stepping in standing compared to six minutes of self-paced walking (3). Additionally, this investigation reported higher mean HR values of 127 beats per minute after completing the 3STS compared to the average cumulative HR of 107 beats per minute found by Bohannon. A possible reason for this difference is likely due to the fact that Bohannon included a sample of healthy individuals that ranged from 18 years of age to 85 years of age. The large variability in the ages of participants could be a factor that caused mean HR values to be relatively lower compared to the current study that primarily focused on older individuals between the ages of 60 and 89 years of age.

Findings of the current study for SBP revealed statistically significant differences when comparing seated marching, standing marching, and standing stepping. We believe the significantly higher SBP with standing stepping compared to marching or seated stepping is attributed to the greater workload placed on the leg musculature to propel the body upwards onto the step. Physiologically, two major factors, including the cardiac output and total peripheral resistance influence blood pressure during activity (14). The findings of this investigation confirm the incremental increase in workload from seated marching, to standing marching and standing stepping, subsequently promoted an incremental increase in cardiac output which was reflected as increases in the SBP at the completion of each of the three set-paced activities.

Based on the Borg RPE relationship to HR, perceived exertion scores in this study were consistently higher than HR values following the completion of each of the three activities. As noted in the results, mean post-activity HR values were 89 bpm, 104 bpm and 127 bpm for the 3SM, 3STM and 3STS respectively. Based on these HR values, the expected RPE scores would be 9, 10 and 12 for the three respective tests. However, in looking at the results, mean RPE scores reported by participants upon completion of each of the three activities were 9, 11 and 14. These findings suggest that the relationship between HR and RPE may not always be consistent, thereby warranting the need for further research. The variability between HR and RPE was highest with three minutes of set-paced standing stepping. Participants perceived this activity to be much more challenging than what their HR values revealed after completion of the activity. The correlation between HR and RPE may have been compromised when participants exercised with a tight mask fitted around their face. The use of the mask during exercise could have triggered higher RPE responses due to a higher work of breathing. Further research is warranted to investigate the correlation between HR and RPE values with and without the use of a tight-fitting mask during exercise.

Additionally, eleven out of the thirty participants, reflecting 36% of the sample were prescribed with at least one cardiac medication which may have blunted the HR response during exercise. Due to a small sample size, a sub-group analysis on differences in cardiorespiratory responses in those who consumed cardiac medications compared to those who did consume cardiac medications was not conducted. For individuals who do consume certain cardiac medications, RPE is essential to obtain during exercise in combination with HR values to help determine the intensity of exercise. Further research is needed to investigate the relationship between HR and RPE responses during exercise in older clients who present with comorbidities and prescribed with medications that influence HR.

To our knowledge this is the first study to compare oxygen uptake values and subsequent metabolic equivalent (MET) levels at rest and following the completion of three set-paced submaximal tests in community dwelling older individuals. The findings of our study in older community dwelling adults complements prior research with mean VO_2 values at rest to be 2.52 mL O_2/kg/min before SM, 2.65 mL O_2/kg/min prior to STM, and 2.52 mL O_2/kg/min recorded at rest before STS respectively (6, 11). The results of this study reveal STM and STS to have MET levels consistent with moderate intensity exercise as reported by Ainsworth with MET levels between 3 and 6, while SM categorized as light exercise with a MET level lower than 3 METs (1).

The findings of this investigation can be relevant to exercise specialists and rehabilitation professionals in three broad ways. First, the findings of this study provide the clinician with an understanding of preliminary data on expected cardiorespiratory and perceived exertion responses following the completion of three set-paced activities each performed for a duration of three minutes. Additionally, this research study provides the clinicians with new knowledge on statistically significant differences between post exercise scores in HR BP, RPE and VO_2 after completion of the three set-paced submaximal activities. Finally, clinicians are now informed of STM and STS categorized as moderate intensity activities, while three minutes of set paced SM to be a light intensity activity. Based on the results of this study, clinicians should consider that three minutes of set-paced sitting may not always be advisable due to its potential to underestimate fitness level or fail to show progress in response to intervention in patients who are capable of doing higher intensity exercise.

Several potential limitations limit the ability of these findings to be generalized to the larger population of older adults. This small sample of convenience of health community dwelling older adults does not reflect the larger population of older adults. Rehabilitation professionals are often challenged with exercising patients with multiple comorbidities and prescribed with multiple medications. These findings noted in healthy community dwelling older adults cannot be generalized to all older adults. Additionally, as stated eleven out of the thirty participants were taking cardiac medications. These individuals taking cardiac medications could have presented with a blunted HR and BP response during exercise. The current investigation did not control for medications in the analysis. Future research should evaluate the impact on HR, BP and RPE responses in individuals prescribed with various cardiac medications compared to those not taking these medications.

In summary, this is a novel investigation that reports statistically significant differences in cardiorespiratory and perceived exertion responses following the completion of three set-paced three-minute submaximal activities. In older adults, 3-minutes of standing stepping triggered the highest cardiorespiratory responses with mean MET levels of 6.19 compared to seated stepping that triggered the lowest responses with a mean MET value of 1.97. Further research is warranted to validate these findings in more diverse population including older adults with multiple comorbidities and in those consuming cardiac medications that alter hemodynamic responses.

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