



Effect of Sustained Isometric and Isotonic Exercises on Blood Pressure and Heart Rate Variability – A Comparative Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Isometric exercises are contractions of a particular muscle which doesn't noticeably change length and the affected joint doesn't move [1]. Isotonic exercises involve contracting muscle shortens against a constant weight, as when lifting a weight [2,3]. These two different types of exercise have profound changes in the body affecting the respiratory and cardiovascular systems [4]. Studies comparing the effectiveness of isotonic and isometric exercises on blood pressure and heart rate variability (HRV) were scanty [5].

Objective: The present study planned to investigate and compare the efficacy of isometric as well as isotonic exercises on changes in blood pressure, heart rate and HRV.

Materials and methods: 10 normal healthy subjects in the age group 17-20 years of both genders participated in the study. All the subjects were assessed under three different conditions: Resting state, After isotonic exercises (20 repetitions of straight leg raise) and After isometric exercises (2 mins of sustained abdominal exercises). After each procedure, blood pressure and heart rate variability were calculated.

Results: Isometric exercises cause reduction of systolic and diastolic blood pressure, mean arterial pressure while pulse rate increases significantly. Isotonic exercises increase the systolic and diastolic blood pressure and mean arterial pressure significantly. The result is statistically significant with $p < 0.050$.

Conclusion: Thus it can be concluded an innovative finding that isometric exercise causes profound decline in blood pressure and increased heart rate variability thus showing a negative impact on cardiovascular health. So it can be concluded that isotonic exercise improves the circulation and supports the cardiovascular system and strengthens the muscle, improves bone density and boosts cardiac function

Keywords: Isotonic; isometric; exercise; blood pressure; pulse rate; HRV; innovative.

1. INTRODUCTION

There are two types of exercise: isotonic and isometric [6]. Isotonic exercise is performed by rhythmic muscular contractions that involve muscle length, using a relatively small force. Isometric exercise involve no change in muscle length but done with by a relatively large force [7].

Isometric exercise with sustained voluntary contractions of a muscle have a unique effect on the cardiovascular system [8,9]. At the onset of isometric exercise, increased heart rate, cardiac output and sympathetic outflow are responsible for the initial increases in SBP and DBP [10]. Generally compared to dynamic exercises, isometric exercises elicit a stronger chemoreflex response, as blood flow within and the release of metabolites from the muscle is limited [11].

Blood pressure is the lateral pressure exerted by blood on the walls of the arteries. This parameter is highly sensitive to changes in exercise either isometric or isotonic. Heart rate variability has been used as a noninvasive method to evaluate heart rate regulation by the parasympathetic and sympathetic divisions of the autonomic nervous system. It is accepted that regular enhanced exercises can effectively restore arterial blood pressure [12-14]. There is limited evidence that resistance training may also lower blood pressure, but the published results are equivocal, with some studies showing decreases. Hypertension is characterised by increased blood pressure and autonomic dysfunction, both thought to be improved with exercise training [15]. Our team has extensive knowledge and research experience that has translate into high quality publications[16–25]. The aim of the study is to compare the blood pressure and heart rate variability after performing isometric and isotonic exercises [26].

2. MATERIALS AND METHODS

2.1 Sample Size

10 normal healthy subjects in the age group 17-20 years of both genders participated in the study. The subjects with muscle injury, history of cardiovascular problem and menstrual periods were excluded from the study. The independent variables are age, sex, height, weight, BMI and the dependent variable is the effect of exercise on all the parameters. The subjects were assessed under three different conditions:

1. Resting state.
2. After isotonic exercises. (20 repetitions of straight leg raise) - After a resting period of one hour, isometric exercises were asked to perform.
3. After isometric exercises (2 mins of sustained abdominal exercises)

The changes in BP were determined using a sphygmomanometer. The systolic and diastolic BP are determined auscultatory method, mean arterial pressure is $DBP + 1/3$ of pulse pressure, pulse rate was determined in the radial artery and pulse pressure is determined by the difference between SBP- DBP. HRV was determined in lead 2 ECG. HRV was calculated using 30:15 (ratio which is calculated as a quotient of the maximal (around 30th heartbeat) to minimal (near 15th heartbeat) RR interval in this period.).

The data was analysed using paired independent t-test using SPSS Version 23.0 with p value < 0.05 .

3. RESULTS

Isometric exercises cause reduction of systolic($p=0.002$) and diastolic blood pressure

($p=0.029$), mean arterial pressure($p=0.008$) and increase in pulse rate ($p=0.002$) compared to resting state and isotonic exercises which is statistically significant($p<0.05$). (Fig 1&2) Isometric exercises cause decrease in pulse pressure ($p=0.602$) while there is a mild increase in heart rate variability ($p=0.285$) but it was non-significant ($p>0.05$) (Fig 3).

Isotonic exercises increase the systolic ($p=0.012$) and diastolic blood pressure ($p=0.003$) and mean

arterial pressure ($p=0.007$) with statistical significance. ($p<0.05$) (Fig 1 &2). Isotonic exercises increase pulse pressure ($p= 0.567$) and pulse rate ($p=0.125$) and decrease heart rate variability ($p=0.265$). (Fig 3, 5, 6) This result is non-significant with ($p>0.05$).

There was no significant changes in heart rate variability in isometric and isotonic exercisers compared to resting state (Fig 6).

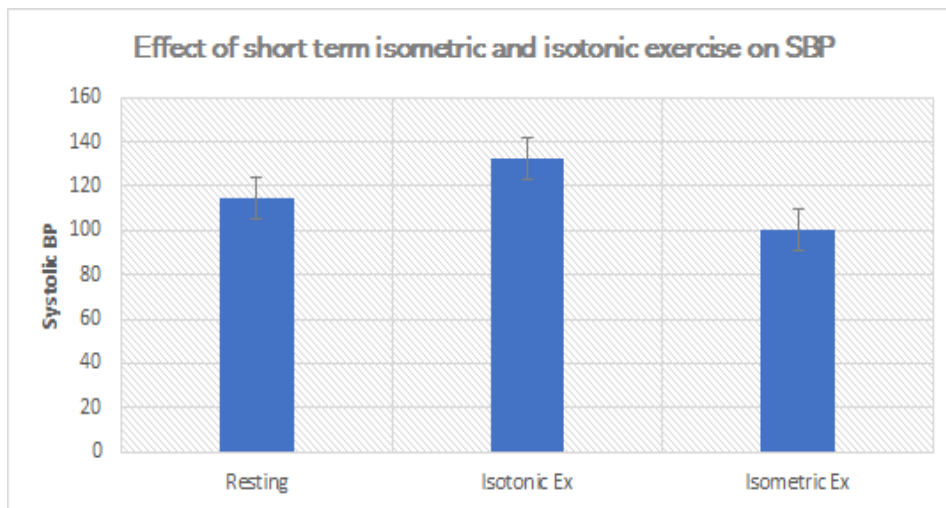


Fig. 1. The bar graph represents the comparison of systolic blood pressure before exercises and after isometric and isotonic exercises. X axis represents the type of the exercise and Y axis represents systolic blood pressure. It is observed that systolic blood pressure increases after isotonic exercises compared to isometric exercises and the value was statistically significant with $p\text{-value}= 0.002$ ($p<0.05$)

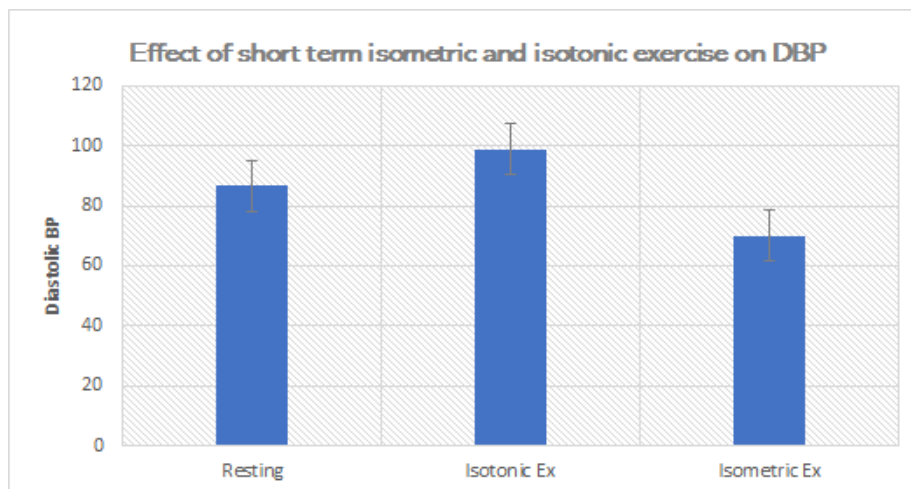


Fig. 2. Represents the bar graph showing the comparison of diastolic blood pressure before exercise and after isometric and isotonic exercises.X axis represents the type of the exercise and Y axis represents diastolic blood pressure. It is observed that diastolic blood pressure increases after isotonic exercises compared to isometric exercises and the values was statistically significant with $p\text{-value}= 0.029$ ($p<0.05$)

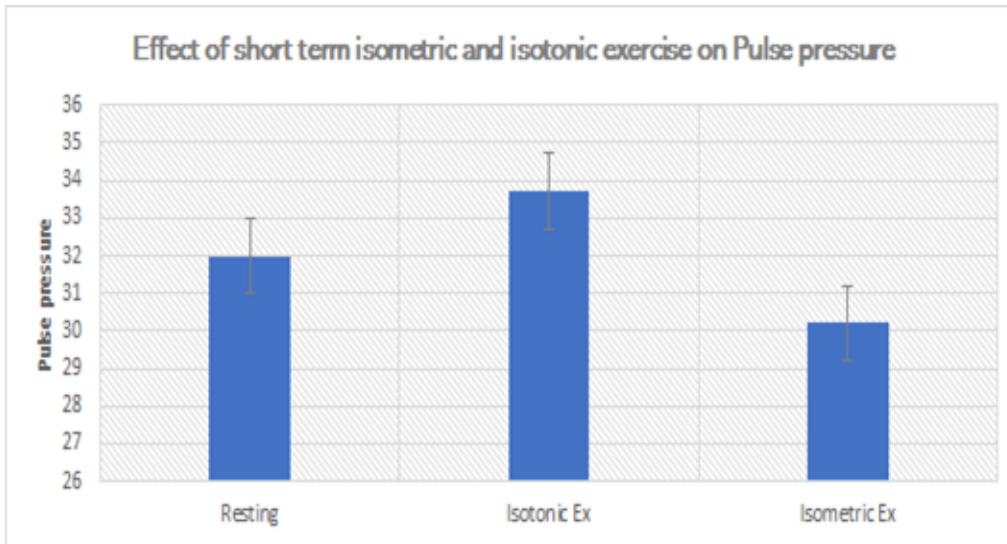


Fig. 3. The bar graph represents the comparison of pulse pressure before exercise and after isometric and isotonic exercises. X axis represents the type of the exercise and Y axis represents pulse pressure. It is observed that pulse pressure showed an insignificant increase after isotonic exercises compared to isometric exercises with p-value= 0.602 ($p < 0.05$)

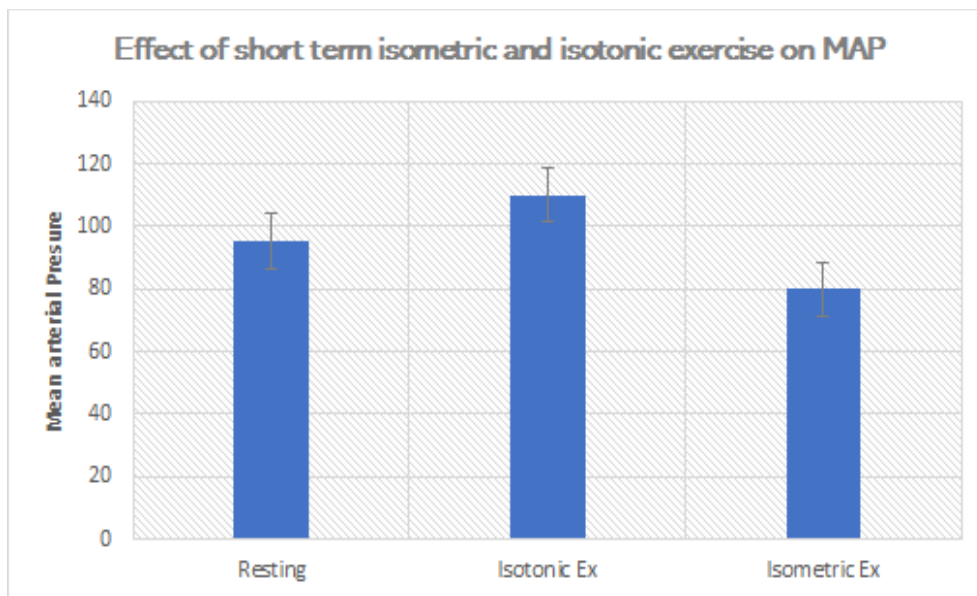


Fig. 4. The bar graph represents the comparison of mean arterial pressure before exercises and after isometric and isotonic exercises. X axis represents the type of the exercise and Y axis represents mean arterial pressure. It is observed that mean arterial pressure increases after isotonic exercises compared to isometric exercises and the value was statistically significant with p-value= 0.008 ($p < 0.05$)

4. DISCUSSION

The present study observed a reduced SBP, DBP, MAP and it was consistent with previous reports by Millar et al, who observed that reduced systolic BP and diastolic BP in five minutes after isometric exercise at 30% MVC

[27]. The differences might be that short term isometric exercises have a hypotensive effect which is fast and is perhaps only temporary and could return after 15 minutes [28,29]. There was a significant increase in pulse rate after isometric exercise due to sympathetic stimulation as an anticipatory effect of exercise [30].

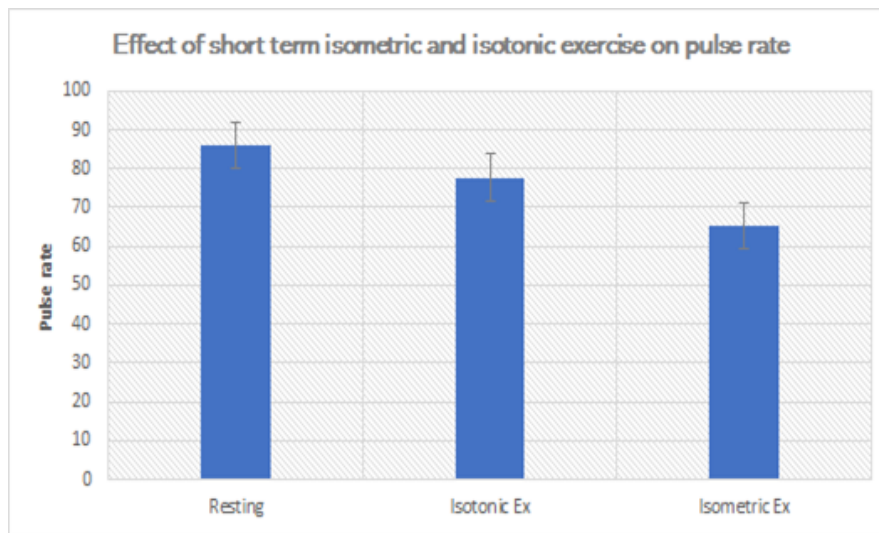


Fig. 5. The bar graph represents the comparison of pulse rate before exercises and after isometric and isotonic exercises. X axis represents the type of the exercise and Y axis represents pulse rate. It is observed that pulse rate increases after isometric exercises compared to isotonic exercises and the value was statistically significant with p-value= 0.002(p<0.05)

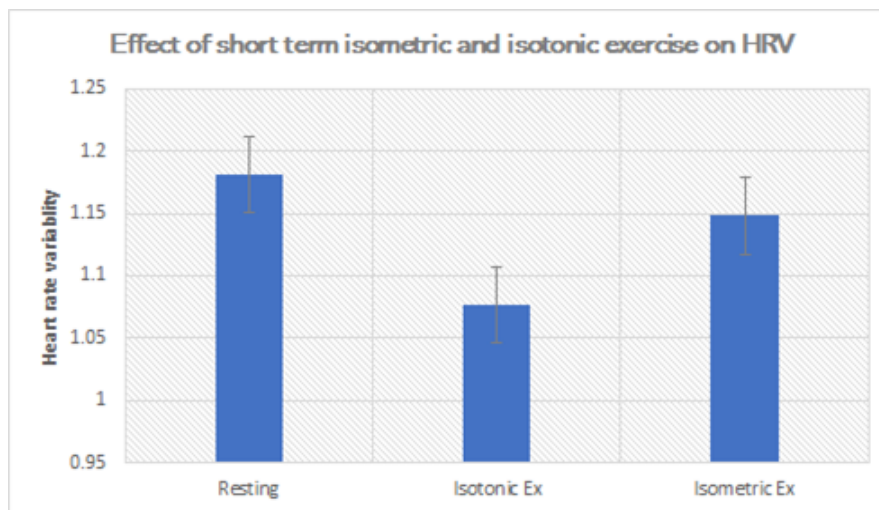


Fig. 6. The bar graph represents the comparison of systolic and diastolic blood pressure before exercises and after isometric and isotonic exercises. X axis represents the type of the exercise and Y axis represents heart rate variability. It is observed that heart rate variability decreases after isotonic exercises while after isometric exercises it increases. It is observed that heart rate variability showed an insignificant increase after isometric exercises compared to isotonic exercises with p-value= 0.285 (p<0.05)

After isotonic exercise, the SBP showed an increase due to increased venous return to the heart and increased DBP and PR may be due to increased peripheral resistance and sympathetic stimulation (Guyton and hall 2000) The increase in SBP and DBP is an important mechanism for improving the circulation and meeting the oxygen demand of the [31] tissues.

There was a non-significant increase in HRV after isometric exercise compared to isotonic exercise.[31] This may be attributed to the lower sample size taken [32,33].

Previous reports suggested that Isotonic exercise involves volume overload of the heart and improves oxygen consumption, increases the

heart rate, stroke volume and cardiac output which increases the systolic blood pressure [34,35]. During isotonic exercise, there is a decrease in peripheral resistance and the diastolic blood pressure may fall [36]. In contrast to our findings, Isometric exercise increases the pressure overload to the heart and induces a sudden increase of blood pressure, whereas the increase in oxygen consumption and cardiac output is limited [37]. This increased load in isometric exercise may be difficult to control, which makes isometric exercise unsuitable [38].

The limitation of the study is that the sample size taken is very small with only 10 subjects hence to compare for a better statistical significance, a larger perspective should be taken [39]. This study is limited to comparing the heart rate variability and blood pressure after performing isometric and isotonic exercises alone, the study can be extended to compare the respiratory and blood parameters as well in future [40].

5. CONCLUSION

Thus it can be concluded that isometric exercise causes profound non significant decline in blood pressure and increased heart rate variability, indicating a negative impact on cardiovascular health compared to isotonic exercise. So, isotonic exercises would be a better suitable exercise regime as it strengthens the muscle, improves bone density and boosts cardiac function.

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CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline participant consent and ethical approval has been collected and preserved by the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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