



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

**INTERNATIONAL JOURNAL
OF CURRENT RESEARCH**

International Journal of Current Research

Vol. 17, Issue, 02, pp.31700-31703, February, 2025
DOI: <https://doi.org/10.24941/ijcr.48433.02.2025>

RESEARCH ARTICLE

HEART RATE RECOVERY USING YMCA STEP TEST IN HYPERTENSIVE PATIENT - AN OBSERVATIONAL STUDY

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ARTICLE INFO

Article History:

Received 25th October, 2024

Received in revised form

20th November, 2024

Accepted 24th January, 2025

Published online 27th February, 2025

Key Words:

Hypertension, Heart Rate Recovery, YMCA Step Test, Cardiovascular Fitness, Autonomic Function.

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ABSTRACT

Hypertension remains a major public health problem associated with significant morbidity and mortality. Heart rate recovery (HRR) is an indicator of cardiovascular health and autonomic function, with impaired HRR linked to worse cardiovascular outcomes. This study aimed to observe HRR using the YMCA Step Test in hypertensive patients. An observational study was conducted with 50 hypertensive patients. The YMCA Step Test assessed HRR by measuring heart rate pre-test, immediately post-test, and at 1 post-test. Results showed a significant rise in heart rate immediately post-test, followed by a progressive decline, indicating efficient recovery. Variations in HRR were observed among different age and gender groups. These findings highlight the importance of regular HRR assessment and tailored exercise programs in managing hypertension.

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Citation: Chaitanya Ahire and Dr. Sambhaji Gunjal Ph.D. 2025. "Heart rate recovery using ymca step test in hypertensive patient - an observational study". *International Journal of Current Research*, 17, (02), 31700-31703.

INTRODUCTION

Hypertension remain a major public health problem that is associated with considerable morbidity and mortality. Lower HRR represents and autonomous imbalance and is related to worse cardiovascular outcome.¹ Hypertension is a progressive Cardiovascular syndrome arising from complex and interrelated causes.² Progression is strongly associated with functional and structural cardiac and vascular abnormalities that damage the heart, kidney, brain, vasculature and other organ and lead to premature morbidity and death² In addition hypertension is frequently associated with diabetes mellitus and obesity which lead to negative outcome such as stroke, myocardial infarction, atherosclerosis and heart failure.³ Prehypertension (PHT), defined as systolic blood pressure (SBP) between 120 and 139mm Hg or diastolic blood pressure (DBP) between 80 and 89mm Hg, in individuals who are untreated diseases known to predict future development of hypertension and is associated with increased risk of developing a cardiovascular event.⁴ Stages of hypertension:-staging is disease process such as hypertension is an assesment of the extend to which the disease has advanced at a particular time.

Prevalance: Hypertension is a leading risk factor for the global burden of disease.^{1,2} In 2000 A.D. global estimate suggested approximately two-thirds of stroke and one-half of ischaemic heart disease were attributable to blood pressure. In 2005, this global burden was projected to rise from 0.9 billion in the year 2000 to 1.58 billion in 2025.⁴

World Health Organization estimates low- and middle-income countries (LMIC) account for two-thirds of hypertensive patients and it's of rising public health concerns in developing world including Nepal.^{3,5} In Nepal, a meta-analysis based on twenty-three studies reported the overall prevalence of hypertension at 28.4% (95% CI: 22.4-34.7%).³ With these rising concerns, it's important to understand the level of awareness, treatment, and control of hypertension to develop evidence-based strategies. In united states ,the prevalence of Pre hypertension among adults aged >20 years is about 27%.³ In 2015, roughly 1.13 billion individuals were affected by hypertension worldwide³ and it has been estimated that in 2025, ~1.56 billion individuals will be affected by hypertension.³ Heart rate recovery: -Heart rate recovery (HRR) is the difference between your heart rate just after you finish exercising and your peak heart rate during exercise, when your heart is working the hardest. Health care professionals frequently measure your heart rate at the one-minute mark and compute your HR from that value. Your HR can indicate a lot about your future risk of developing heart disease. Due to damage to the autonomic nerve fibers that innervate the heart and blood vessels, Cardiac Autonomic Neuropathy (CAN) causes anomalies in heart rate control and vascular dynamics, increasing the risk of Sudden Cardiac Death (SCD) in patients with diabetes mellitus (DM). The early sign of is decreased heart rate variability. In healthy persons and those who have been referred for diagnostic testing, attenuated heart rate recovery (HRR) after a maximal activity test is a predictor of mortality.⁵ Hypertension is a leading modifiable risk factor for cardiovascular diseases (CVDs), which account for nearly 30%

of global mortality.⁶ This chronic condition is associated with significant alterations in autonomic nervous system function, often manifesting as delayed heart rate recovery (HRR) after exercise. HRR is defined as the rate at which the heart rate decreases following physical activity and is recognized as a non-invasive, prognostic marker for cardiovascular and autonomic health.^{6, 7} Impaired HRR reflects diminished parasympathetic reactivation and persistent sympathetic activation, both of which are predictive of adverse cardiovascular outcomes. The YMCA step test is a widely accepted and cost-effective tool to evaluate cardiovascular endurance and recovery. Its structured protocol provides a consistent measure of exercise capacity and HRR across diverse populations, including hypertensive patients. This test, by gauging the cardiovascular system's response to submaximal exercise, offers valuable insights into an individual's autonomic function.^{7, 8} In hypertensive individuals, autonomic imbalance contributes to a blunted HRR, making it a critical metric for assessing their cardiovascular risk and fitness. Previous studies have underscored the clinical significance of delayed HRR in predicting mortality and guiding exercise-based interventions. Furthermore, exercise testing such as the YMCA step test offers a practical approach for early identification of autonomic dysfunction in hypertensive patients.^{6, 7}

METHODOLOGY

This study was conducted at the Pravara Institute of Medical Science and took place within the Dr. A.P.J Abdul Kalam College of Physiotherapy, PIMS Loni. The research spanned a duration of six months, and data was primarily collected by the principal investigator. An observational study design was employed to explore heart rate recovery using the YMCA Step Test in hypertensive patients. A sample size of 50 participants was selected using a convenient sampling method. Participants were recruited based on specific selection criteria. Inclusion criteria consisted of patients aged between 40 and 60 years, those undergoing antihypertensive treatment, and individuals who were willing to participate in the study. Participants were also required to have a clinical diagnosis of hypertension, with systolic blood pressure (SBP) greater than 140 mm Hg and diastolic blood pressure (DBP) greater than 90 mm Hg. Exclusion criteria was applied to enhance the study's validity and included patients in the age group of 40-60 years, those in the pre-hypertensive stage, and individuals with co-morbid conditions such as asthma, diabetes, known cardiac diseases, and neurological conditions (including CVA, GBS, Parkinsonism, tremors, and craniotomy). Patients with a history of heart attack were not considered for the study. The data collected was meticulously recorded and analyzed to evaluate the heart rate recovery patterns in hypertensive patients following the YMCA Step Test.

MEASUREMENT TOOL: The primary measurement tool used in this study was the YMCA Step Test, a standardized sub-maximal exercise test that assesses cardiovascular fitness and heart rate recovery (HRR). Participants were instructed to step up and down a 12-inch platform at a metronome-paced rate of 96 beats per minute for three minutes. Heart rates were measured using a calibrated heart rate monitor at pre-test, immediately post-test, and at one minutes post-test.

Data collection and analysis: Data was meticulously conducted by the principal investigator after ethical clearance

was obtained, and informed consent was secured from all participants, ensuring adherence to institutional ethical guidelines. Each participant's heart rate data was recorded on structured data sheets, which were later entered into a secure digital database for analysis. The entire process was designed to ensure accuracy and consistency. The analysis involved computing the mean heart rates at different intervals and performing paired t-tests to determine statistical significance between pre-test and post-test heart rates at various time points. The data was analyzed to identify trends in heart rate recovery, and variations were observed among different demographic subgroups, such as age and gender. The results provided insights into cardiovascular fitness and autonomic function in hypertensive patients, highlighting the importance of regular HRR assessments in managing hypertension.

Procedure: Participants were recruited from Dr. A.P.J Abdul Kalam College of Physiotherapy, PIMS-DU, based on the inclusion and exclusion criteria. After obtaining informed consent, each participant underwent the YMCA Step Test. The test involved stepping up and down on a 12-inch platform at a metronome-paced rate of 96 beats per minute for three minutes. Heart rates were recorded at pre-test, immediately post-test, and at one minutes post-test using a heart rate monitor. The data was then collected, recorded, and analyzed to assess heart rate recovery in hypertensive patients. This procedure ensured a comprehensive evaluation of cardiovascular fitness and autonomic function, contributing to the development of targeted interventions for hypertension management.

RESULTS

Gender Distribution Among Participants: This study included a total of 50 hypertensive participants, comprising 64% males (32 participants) and 36% females (18 participants). The higher representation of male participants in the study reflects demographic patterns often observed in studies on hypertension. This gender distribution is critical in understanding the variability in response to exercise and rehabilitation interventions across different genders.

Age Distribution Among Participants: Participants were categorized into two age groups: 40-50 years and 50-60 years. Among the 50 participants, 27 individuals were aged between 40-50 years, while the remaining 33 participants were aged between 50-60 years. This age distribution is significant as it encompasses middle-aged to older adults, a demographic that is often at higher risk for hypertension. The inclusion of participants from these age groups ensures that the findings are relevant to the population most affected by hypertension.

YMCA Step Test Results: The YMCA Step Test was utilized as an outcome measure to assess heart rate recovery in hypertensive patients. The mean heart rate (HR) was recorded at three different stages: pre-test, immediately post-test, and one minute post-test. The results revealed significant changes in HR, which provide insights into the cardiovascular fitness and recovery capacity of the participants. Pre-test HR: The mean pre-test HR was 84.02 beats per minute (bpm). This value represents the baseline cardiovascular fitness of the participants before the physical exertion of the step test.

Immediate Post-test HR: The mean HR increased significantly to 129.82 bpm immediately after the test. This increase indicates a robust cardiovascular response to exercise,

reflecting the body's heightened demand for oxygen and energy during physical activity. The immediate rise in HR is a critical indicator of cardiovascular fitness, demonstrating the participants' ability to respond to physical stress. One Minute Post-test HR: One minute after the test, the mean HR decreased to 112.3 bpm. This reduction illustrates the participants' ability to recover from exercise, highlighting efficient cardiovascular and autonomic function. The gradual decline towards baseline levels signifies good cardiovascular health and recovery capacity, which is especially important for hypertensive patients. Efficient recovery post-exercise indicates good autonomic control, which is vital for overall cardiovascular health. Statistical Analysis: Paired t-tests were conducted to compare pre-test HR with post-test HR at various time points. The results showed statistically significant differences ($p < 0.0001$), underscoring the reliability of the observed changes in heart rate. These findings suggest that the YMCA Step Test is an effective measure of cardiovascular fitness and recovery in hypertensive patients. Figure 1 provides a visual representation of the mean HR values at different stages of the test. Clinically, the implications of these findings are significant. Regular HRR assessments can serve as an effective tool for tracking cardiovascular health and evaluating the effectiveness of lifestyle or therapeutic interventions. By identifying patients with impaired HRR, healthcare providers can implement early and targeted interventions to improve cardiovascular fitness and manage hypertension more effectively. Tailored exercise programs based on HRR data can enhance parasympathetic reactivation and overall cardiovascular resilience, particularly in high-risk groups.

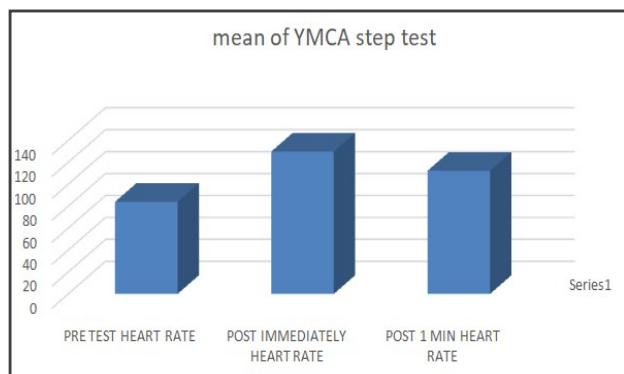


Fig. 1. Mean of Heart Rate during YMCA step test

The study also emphasizes the necessity for long-term monitoring of HRR to track patients' progress and adapt treatment plans accordingly. Regular assessments can demonstrate tangible improvements in cardiovascular health, thereby motivating patients to adhere to their exercise and treatment regimens. Furthermore, the use of practical, cost-effective tools like the YMCA Step Test in routine clinical assessments can optimize hypertension management, especially in resource-limited settings. Overall, the results provide significant insights into the cardiovascular fitness and autonomic function of hypertensive patients, reinforcing the need for personalized healthcare strategies to improve cardiovascular outcomes. The findings highlight the value of integrating HRR assessments into standard clinical practice, offering a practical approach to managing hypertension and enhancing patient care. By focusing on HRR as a marker of cardiovascular health, this study contributes to the development of effective interventions that can mitigate the risks associated with hypertension and improve the quality of life for patients. Regular monitoring and tailored interventions

based on HRR data can lead to better cardiovascular health and reduced morbidity and mortality among hypertensive populations.

DISCUSSION

The present study assessed heart rate recovery (HRR) using the YMCA Step Test in hypertensive patients, providing significant insights into their cardiovascular fitness and autonomic function. The findings revealed that hypertensive participants exhibited a marked increase in heart rate immediately post-test, with a mean rise from 84.02 beats per minute (bpm) at pre-test to 129.82 bpm post-test. This immediate cardiovascular response underscores the cardiovascular system's capacity to meet the elevated oxygen and energy demands during physical exertion. The substantial rise in heart rate signifies the effectiveness of the body's acute response to exercise, which is crucial for sustaining physical activity. One of the critical aspects observed was the recovery phase, where the heart rate gradually declined to 112.3 bpm at one minute post-test.

These significant reductions, highlighted by the statistical analyses ($p < 0.0001$), illustrate the reactivation of the parasympathetic nervous system and the efficiency of the cardiovascular system in returning to baseline levels. Efficient HRR reflects a well-functioning autonomic nervous system, which is paramount in hypertensive patients who are at increased risk for cardiovascular events. The study also delved into demographic variations, particularly focusing on age and gender differences in HRR. Older participants (above 60 years) exhibited slower HRR compared to their younger counterparts. This finding is consistent with existing literature that suggests age-related declines in autonomic and cardiovascular function. In older individuals, the diminished parasympathetic reactivation and persistent sympathetic activation post-exercise contribute to slower recovery, emphasizing the need for tailored interventions that address these age-specific physiological changes. Gender differences were also noteworthy, with females demonstrating slightly prolonged recovery times compared to males. This gender-based disparity could be attributed to inherent differences in cardiovascular autonomic regulation and hormonal influences, necessitating gender-specific approaches in managing cardiovascular health in hypertensive patients.

The clinical implications of these findings are profound. Regular assessments of HRR in hypertensive patients can serve as a critical tool for monitoring cardiovascular health and guiding therapeutic interventions. Efficient HRR indicates good autonomic control and cardiovascular health, while slower HRR signals a potential for higher cardiovascular risk. Identifying patients with impaired HRR enables healthcare providers to implement early and targeted interventions, such as personalized exercise programs and lifestyle modifications, to enhance cardiovascular fitness and manage hypertension more effectively. Furthermore, the study highlights the practical utility of the YMCA Step Test as an effective and cost-efficient method for evaluating HRR. This submaximal exercise test, with its simplicity and minimal equipment requirements, can be easily integrated into routine clinical practice, particularly in resource-limited settings. The consistent and reproducible measures provided by the YMCA Step Test offer valuable insights into the cardiovascular system's response to physical stress, aiding in the identification of high-risk individuals who may benefit from closer

monitoring and more intensive interventions. In addition to clinical practice, the findings underscore the importance of long-term monitoring of HRR to track patients' progress and adapt treatment plans accordingly. Regular HRR assessments can demonstrate tangible improvements in cardiovascular health, thereby motivating patients to adhere to their exercise and treatment regimens. The ability to track HRR trends over time allows healthcare providers to make informed decisions about medication adjustments, lifestyle changes, and overall management strategies for hypertension. However, it is essential to acknowledge the limitations of the study. The relatively small sample size of 50 participants may limit the generalizability of the findings. Future studies with larger sample sizes are needed to confirm these results and enhance their reliability. Additionally, the observational design of the study precludes the establishment of causal relationships between HRR and cardiovascular outcomes. Longitudinal studies that follow hypertensive patients over an extended period could provide more comprehensive insights into the long-term impact of HRR on cardiovascular health.

CONCLUSION

The YMCA Step Test has proven to be a valuable tool in assessing heart rate recovery (HRR) among hypertensive patients, providing crucial insights into their cardiovascular fitness and autonomic function. The findings highlighted significant trends in heart rate responses, with efficient HRR indicating good autonomic control and cardiovascular health. The study underscores the importance of regular HRR assessments for monitoring and guiding therapeutic interventions, particularly in high-risk groups such as older adults and females. assessments into routine clinical practice.

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