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Original Research Article

A Cross-Sectional Study on the Correlation Between Resting Heart Rate and Blood Pressure Patterns in Adults

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Abstract:

Background: Resting heart rate (RHR) and blood pressure (BP) are important cardiovascular measures which represent autonomic function and cardiovascular fitness. A higher RHR has been linked to higher sympathetic drive, which can impact BP and cardiovascular disease.

Aim: To evaluate the correlation between RHR and BP patterns among adults.

Methodology: This was an observational cross-sectional study carried out for a year at the Department of Physiology, Shri Ramkrishna Institute of Medical Sciences and Sanaka Hospital, Durgapur. A total of 100 adults were enrolled. Heart rate and BP were recorded at rest. Descriptive statistics and Pearson correlation were used for data analysis.

Results: Most of the respondents were aged between 30 and 50 years (45%). The correlation between systolic BP and RHR was found to be significantly positive ($r = 0.42$, $p < 0.05$) and diastolic BP ($r = 0.38$, $p < 0.05$). The people who had higher RHR s (>80 bpm) had higher rates of prehypertension and hypertension.

Conclusion: The level of BP is positively related to RHR among adults. RHR monitoring can be a convenient and inexpensive measure of early detection of people at risk of hypertension and cardiovascular diseases.

Keywords: Resting heart rate, Blood pressure, Hypertension, Cardiovascular risk, Autonomic function.

Introduction

RHR is a basic physiological measurement which reflects the number of heart beats per minute when a person is in a total rest [1]. It is commonly accepted to be an accurate measure of the functioning of the autonomic nervous system, a dynamic interaction between sympathetic (acceleratory) and parasympathetic (inhibitory) effects on the heart [2]. The average RHR amongst adults is usually 60-100 beats per minute, although there can be a significant change in the range with a clinical implication [3]. Reduced RHR are typically linked to superior cardiovascular fitness and more favorable parasympathetic tone, whereas higher RHR are typically linked to hyper sympathetic activity or stress or underlying cardiovascular malfunction [4].

BP, another key cardiovascular determinant, is the pressure of the flowing blood on the arterial walls. It is mostly defined by cardiac output and the peripheral vascular resistance that are highly dependent on the activity of the autonomic nervous system [5]. BP is usually given in units of systolic blood pressure (SBP) which is the pressure at cardiac contraction and diastolic blood pressure (DBP) which is the pressure at cardiac relaxation [6]. BP is a complicated process that incorporates neural, hormonal and vascular mechanisms, to maintain an appropriate perfusion of tissues and to preserve vascular integrity [7].

The association between RHR and BP is of significant clinical value with the two being regulated by the same physiological pathways especially the autonomy nervous system [8]. The heightened sympathetic tone, besides raising the heart rate, also leads to vasoconstriction, augmented cardiac output, and finally the elevated BP levels [9]. On the other hand, decreased parasympathetic activity weakens the heart to sustain cardiovascular stability, which further increases these effects . Thus, RHR could be regarded as an indirect but useful indicator of cardiovascular regulation and hemodynamic condition.

High RHR has always been linked with poor cardiovascular diseases, such as hypertension, coronary artery disease, stroke, and general mortality. Epidemiological research has shown that those people who have higher heart rates during the rest have a higher risk of developing hypertension though other traditional risk factors are not present. The pathological processes include a long-term sympathetic overactivity, augmented myocardial oxygen demand, endothelial dysfunction and progressive arterial stiffness [10]. The alterations may affect the compliance of the vascular and lead to the onset and progression of hypertension.

Hypertension, in itself, is a large public health problem that has an impressive percentage of the adult population in the world [11]. It is a dominant adjustable risk factor to cardiovascular morbidity and mortality, and plays a significant role as a predisposing factor to myocardial infarction, heart failure, chronic kidney disease, and cerebrovascular accidents. Though it has developed in terms of diagnosis and treatment, hypertension can be silent in the initial stages and hence its name a silent killer. Early detection of risk individuals is thus a key to successful prevention and control [12].

Past studies have pointed to a positive relation between RHR and BP levels where those with a higher RHR are more inclined towards prehypertension and hypertension. Physiological mechanisms underlying this association encompass the high cardiac workload, decreased arterial elasticity, and dysfunctional endothelial functions, which are all associated with high vascular resistance [13]. Also, lifestyle causes like physical inactivity, stress, obesity, smoking and poor dietary habits can be simultaneous causes of both RHR and BP, making their relationship even stronger.

As RHR is a non-invasive, inexpensive, and easy parameter to measure, it has significant potential as a readily available clinical measure to identify early risk stratification in general population. In contrast to most sophisticated diagnostic instruments, RHR can be easily measured in clinical and community environments without requiring specific equipment or a lot of training, thus being very feasible to conduct mass screening and regular check-up procedures [14]. The pattern of BP and RHR are interconnected and understanding the relationship between the two is a good indicator of the cardiovascular activity of a person as both are closely related by underlying physiological processes, especially the autonomic nervous system. The increased heart rate at rest could be indicative of the increased sympathetic activity that is commonly linked to high BP and increased likelihood of developing hypertension and other cardiovascular issues. Thus, the analysis of this relationship can assist in the discovery of people in their early years when they can be under a higher risk, even prior to the manifestation of open clinical symptoms.

In this regard, the current study will be aimed at examining the relationship between RHR and BP in adults, and the goal will be to produce evidence to justify the use of RHR as the predictor of cardiovascular risk [15]. Through a systematic study of this association, the research will contribute to the existing evidence on the topic and support the clinical significance of integrating RHR into routine cardiovascular evaluation. Moreover, the results will also point at the significance of early diagnosis and preventive healthcare methods, promoting the incorporation of such simple physiological parameters as RHR into the routine screening procedures. In the end, this strategy is capable of supporting timely interventions, encouraging healthier lifestyle decisions, and assisting in decreasing the total burden of hypertension and the related complications at an individual level and at a population-level.

Methodology

Study Design: The current research was structured as a cross-sectional observational study that was intended to test the association between RHR and BP pattern in adults. The cross-sectional approach was selected because it is possible to evaluate the two variables at the same time in a specific population, thus obtaining correlations and trends without intervention. This type of design is especially appropriate when one is interested in the relationships between physiological parameters and determining possible risk indicators within a comparatively short time.

Study Area: The research was carried out in the Department of Physiology, Shri Ramkrishna institute of medical science and Sanaka hospital, Durgapur, West Bengal, India.

Study Duration: The research was carried out during One year.

Study Participants: The study population consisted of adult individuals who met the predefined inclusion and exclusion criteria.

Inclusion Criteria

- Adults between the ages of 18 and 65 years.
- Participants with informed consent and willingness to participate.
- Subjects who seemed healthy and not acutely ill within time frame of examination.

Exclusion Criteria

- Patients who have a known history of cardiovascular diseases including hypertension, coronary artery disease, or arrhythmias.
- Subjects who were on antihypertensive medication or beta-blockers, which might affect heart rate and BP.
- Pregnant women, because of the physiological changes in the cardiovascular parameters.

- Patients with endocrine (e.g., thyroid dysfunction) and other systemic illnesses that are known to influence heart rate and BP.

These were used to reduce the likelihood of confounding factors and assure accuracy and validity of the observed associations.

Sample Size: The study involved 100 participants. It was believed that the sample size was sufficient to identify statistically significant relationships between the variable of RHR and BP. The participants were sampled through the convenience methodology, according to their availability and eligibility within the study period.

Procedure: The participants were all analyzed in standardized conditions to have uniformity and reliability of measurements. Before data collection the participants had been informed of the procedure and advised not to have caffeine, smoke or engage in vigorous exercise at least 30 minutes before assessment. All participants were afterwards requested to take their time and sit in a comfortable position at least 10 minutes in a quiet place until they reached a true resting state. A calibrated digital pulse monitor was used to measure the RHR when the participant was relaxed and not under stress due to any immediate physical or emotional circumstances. A standard mercury or aneroid sphygmomanometer was used to measure the BP with a correspondingly sized cuff with the patient seated and the arm at the heart level. Three BP readings were recorded at 2-3 minute intervals to increase the accuracy of the measurements and an average of the readings was taken to analyze them. The values of BP were then categorized as per the standard clinical guidelines into normal BP, prehypertension, and hypertension. All the information such as demographic traits and physiological measurements were recorded in a structured and pre-validated proforma. A high level of participant confidentiality and anonymity was taken care of in the course of the study and all ethical issues were followed in regards to the institutional standards.

Statistical Analysis: Data obtained were tabulated and analyzed using the SPSS version 25.0. Descriptive statistics, such as mean, standard deviation, frequency, and percentage were calculated to outline the demographic and clinical features of the study population. Pearson correlation coefficient was used to determine the strength and direction of the linear association between RHR and BP parameters (systolic and diastolic) to evaluate the relationship between the two continuous variables. Moreover, suitable comparative analyses were made where it was required to determine differences in different categories. The p-value of below 0.05 ($p < 0.05$) was taken to be statistically significant meaning that the observed associations could not have been as a result of a coincidence.

Results

There were 100 adult subjects in the current study, which is a significant sample size to conduct any meaningful statistical analysis. The gathered data were tabulated and followed through to the analysis to guarantee clarity, accuracy and reliability of the results. There has been a systematic presentation of the results in form of well-planned tables that can easily compare and interpret different parameters. A descriptive explanation is also provided to each of the tables in order to better understand the trends, patterns and relationships observed in the data. This integrated exposition of quantitative tabulation and qualitative interpretation allows a thorough assessment of the results of the study, making the findings easily available and analytically sound to readers.

Table 1: Demographic Characteristics of Participants (n = 100)

Parameter	Frequency (n)	Percentage (%)
Age (years)		
18–29	25	25
30–50	45	45
51–65	30	30
Gender		
Male	60	60
Female	40	40

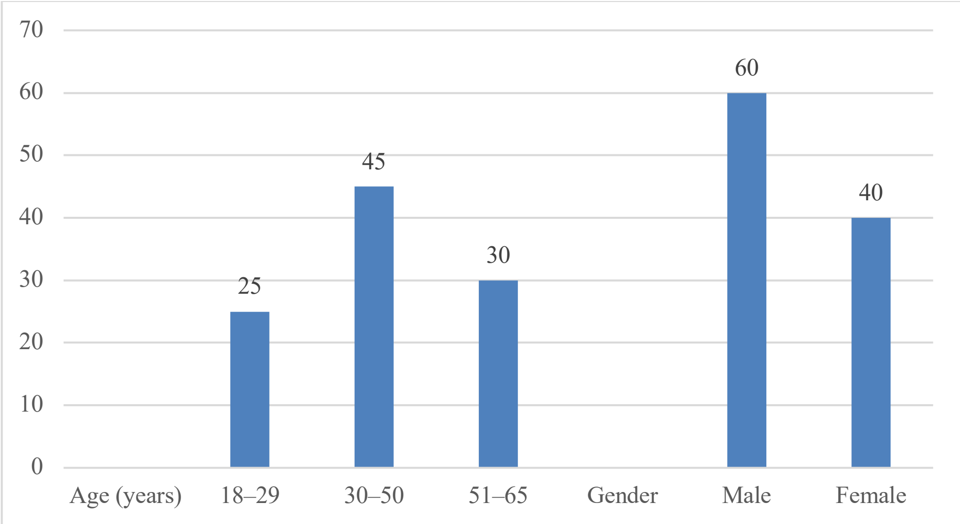

Figure 1: Graphical presentation of Demographic Characteristics of Participants

Table 1 provides the demographics of the participants in the study. Most of the participants were within the 30-50 years age bracket (45%), then 51-65 years (30%) and 18-29 years (25%), with most participants being middle-aged. With regard to gender, 60 percent of the study population were males and 40 percent were females, indicating a male dominance in the sample.

Table 2: Distribution of RHR

RHR Category (bpm)	Frequency (n)	Percentage (%)
<60	10	10
60–80	55	55
>80	35	35

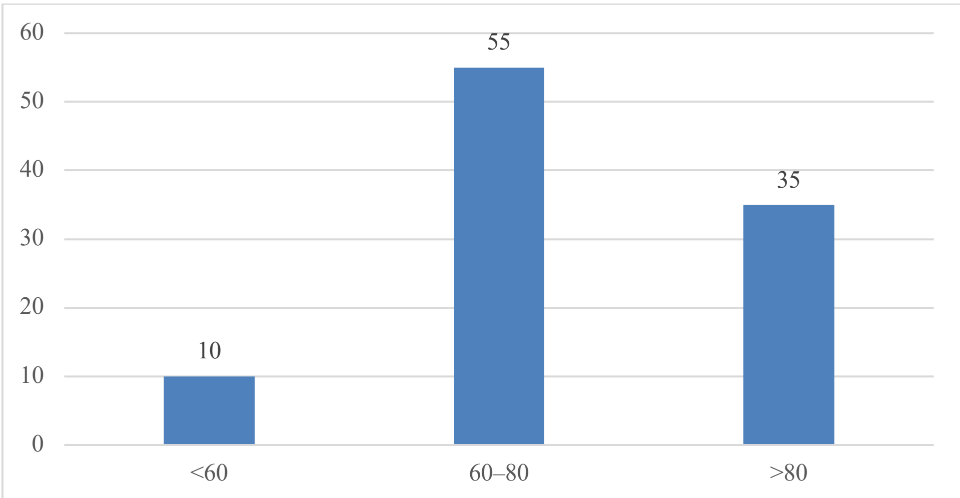

Figure 2: Graphical presentation of Distribution of RHR

Table 2 shows the distribution of the RHR among the participants. Most of the patients (55%), fell within the normal range of heart rate (60-80bpm). Another significant percentage (35) had a high heart rate (>80 bpm) during rest, a phenomenon that can be attributed to a heightened sympathetic response. A lower number (10 percent) were found to have a RHR of less than 60 bpm, which was perhaps an indicator of greater parasympathetic tone or greater cardiovascular fitness.

Table 3: BP Classification

BP Category	Frequency (n)	Percentage (%)
Normal	40	40
Prehypertension	35	35
Hypertension	25	25

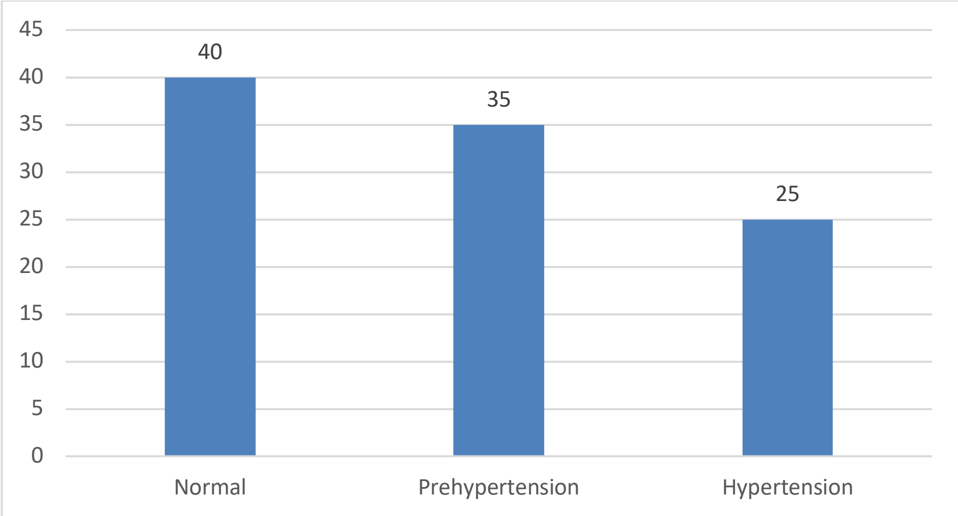

Figure 3: Graphical presentation of BP Classification

Table 3 shows how BP was classified among the study participants with a variation in different classification categories. Only 40% of the people were found to have normal BP meaning that less than half of the population under study was within the healthy range. In the meantime 35 percent of the responders were classified as pre-hypertensive which is a significant percentage of those who are at a higher risk of developing hypertension unless proper preventive steps are taken. This observation supports the significance of early diagnosis and lifestyle change in such group to avert cardiovascular complications in the future. Moreover, the prevalence of high BP in the study population was significant as 25% of the participants were hypertensive. The existence of such a significant percentage of hypertensive people indicates the increasing load of cardiovascular risk factors and the necessity of efficient screening, sensitization, and early medical intervention to regulate and control the level of BP.

Table 4: Correlation Between RHR and BP

Parameter	Correlation Coefficient (r)	p-value
RHR vs Systolic BP	0.42	<0.05
RHR vs Diastolic BP	0.38	<0.05

Table 4 shows the relationship between the heart rate at rest and the BP parameters where there is a significant relationship between these cardiovascular variables. The results revealed that there was a moderate positive correlation between the RHR and systolic BP ($r = 0.42$) and the RHR and diastolic BP ($r = 0.38$). Both these correlations were found to be statistically significant ($p < 0.05$), which means that the perceived relationships are not likely to have happened as a result of chance occurrence. Such results indicate that patients who have more fast heart rates have more chances of obtaining high systolic and diastolic BP levels. This association is directed at a physiological relationship, which could be facilitated by the autonomic nervous system, especially higher sympathetic nervous system activity. Increased sympathetic tone may result in vasoconstriction and high heart rate, as well as increased cardiac output, and thus increased heart rate and BP.

Discussion

The current research examined the association between RHR and BP patterns in adults and proved that there is significant positive correlation between RHR and systolic and diastolic BP (Lina Sapranaviciute-Zabazlajeva et al., 2017) [15]. The results reveal that people who have higher RHR have higher chances of having high BP levels, such as prehypertension and hypertension. This further confirms the idea that RHR is not just a simple physiological fact but a significant factor of cardiovascular health (Mary K. Schubauer-Berigan et al., 2018) [16].

The noted relationship between high RHR and high BP can be attributed to physiological processes that occurred in the body especially the influence of the autonomic nervous system. The upsurge in RHR is a common indication of an elevated sympathetic nervous system activity and/or decreased parasympathetic (vagal) tone. Increased sympathetic activity results in higher cardiac output, constriction of peripheral vessels and greater vascular resistance which result in the elevation of BP levels (Elzbieta

Suliga et al., 2017) [17]. Also, the chronic sympathetic activity is reported to induce structural and functional alterations in blood vessels such as arterial hardening and endothelial dysfunction, which also worsens hypertension.

The results of this research are in accordance with the earlier epidemiological and clinical researches that have indicated that there is a positive correlation between RHR and BP. A number of studies have found high RHR as a predictive variable of hypertension and cardiovascular morbidity (Arif Syauqy et al., 2018) [18]. The correlation observed in this study ($r = 0.42$ systolic BP and $r = 0.38$ diastolic BP) is moderate and is consistent with previous findings, indicating that though RHR is not the only factor of BP, it has a strong contributory effect.

The most interesting finding during the current study was the fact that those subjects who had a RHR of more than 80 beats per minute were more prone to prehypertension and hypertension. This observation shows that RHR can be useful as a non-invasive, simple, and cost-effective screening tool to identify a person at a higher risk of developing cardiovascular diseases. RHR is easily measured, with only minimal equipment and expertise, and can be implemented as part of a regular clinical examination and community screening in health programs.

More so, lifestyle and behavioral issues seem to be very important in affecting the RHR as well as the BP. Sympathetic activity and cardiovascular efficiency decreasing factors are known as chronic stress, sedentary lifestyle, obesity, smoking and unhealthy dietary patterns (Rui Wei et al., 2015) [19]. The latter is especially related to physical inactivity, which was accompanied by an increase in the RHR and inadequate vascularity, whereas regular physical activity has been found to reduce the RHR and enhance BP regulation. Likewise, psychological stress may engage neuroendocrine mechanisms leading to an increase in heart rate and BP in the long run.

The results of the current research provide insights into the significance of early detection and preventive measures in the context of cardiovascular risk reduction. Lifestyle modification interventions, including regular physical activity, stress management, balanced nutrition, and tobacco/excess alcohol use are potentially very important in enhancing autonomic balance and cardiovascular outcomes. A combination of monitoring RHR and BP could therefore be a more holistic evaluation of the cardiovascular status of an individual.

The study has some limitations although it yields important findings. The cross-sectional design fails to provide an opportunity to determine a cause-effect relationship between the RHR and BP. Moreover, the small sample size and one-centre environment can be considered as a limitation to the external validity of the findings (Zheng Yang et al., 2017) [20]. It is suggested to conduct future research in larger, more diverse groups and longitudinal designs to further investigate this relationship and prove causality.

Conclusion

The current research finds that the RHR exhibits a strong and positive correlation with BP trends in adults, and high RHR is always connected to a high systolic and diastolic BP, and, thus, a high risk of cardiovascular morbidity. It is an important relationship as it gives some insight into the underlying physiological mechanisms, and specifically the role of autonomic imbalance, whereby increased activity of the sympathetic nervous system is a contributing factor to an increase in heart rate as well as peripheral vascular resistance, which in turn causes a prolonged rise in BP. These data support the idea that cardiovascular parameters are not independent of each other and cannot be measured separately. Since RHR is a non-invasive, inexpensive, and easy to measure clinical measure, it has significant potential as a supplementary screening method to identify persons at risk of developing hypertension and other cardiovascular ills. Its routine measurement, which is used with regular BP measurement in the clinical and community health care environment, could improve early detection, timely intervention, and improved risk stratification. Additionally, the paper highlights the paramount role of preventive measures, especially lifestyle changes, in reducing the risk of cardiovascular disease. Regular physical exercise, a healthy and low sodium diet, proper stress management skills, a healthy body weight, and avoiding tobacco and excessive alcohol use are just some of the interventions that can help in regulation of heart rate and BP. Taken together, these results support the idea of a more comprehensive and preventive strategy on cardiovascular health, where awareness, early screening, and long-term changes in lifestyle are important to decrease the increase in hypertension burden and enhance long-term health outcomes.

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