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Correlation Between Resting Heart Rate and Aerobic Fitness in Young Adults: A Cross-Sectional Study

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ABSTRACT

Resting heart rate (RHR) has been widely recognized as a potential indicator of cardiovascular health. Aerobic fitness is an essential component of overall physical fitness and is inversely associated with cardiovascular disease risks. However, the relationship between RHR and aerobic fitness in young adults remains a subject of interest. Objective: To determine the correlation between resting heart rate and aerobic fitness in young adults. A cross-sectional study was conducted among 500 young adults aged 18-30 years. Participants' RHR was measured after a 10 min resting period using a digital heart rate monitor. Aerobic fitness was assessed using the maximal oxygen uptake (VO_2 max) test on a treadmill. Correlation analysis was used to determine the relationship between RHR and VO_2 max values. There was a significant inverse correlation between RHR and VO_2 max ($r = -0.65$, $p<0.001$). Participants with a lower RHR demonstrated higher aerobic fitness levels. The regression analysis also indicated that for every 1 beat min^{-1} increase in RHR, there was a decrease of 0.40 mL kg^{-1} min^{-1} in VO_2 max. This study confirms an inverse relationship between resting heart rate and aerobic fitness in young adults. Lower RHR may be an indicator of better aerobic fitness, which can serve as a non-invasive marker for cardiovascular health in this population. Further studies are recommended to understand the underlying mechanisms and potential implications for interventions.

INTRODUCTION

Cardiovascular health is a crucial determinant of overall well-being and mortality risk, particularly as one progresses in age. An individual's resting heart rate (RHR) is increasingly being recognized as not only an indicator of cardiovascular health but also a predictor of cardiovascular morbidity and mortality[1]. On the other hand, aerobic fitness, often quantified as maximal oxygen uptake (VO_2 max), is a pivotal marker of cardiovascular function and overall physical fitness[2]. It has been established that increased aerobic fitness is inversely related to cardiovascular disease risks[3].

While several studies have focused on the benefits of aerobic fitness and the implications of RHR individually, the direct relationship between these two parameters, especially in young adults, has not been extensively explored. Young adults represent a unique group as they are typically in their prime physical condition, yet are starting to transition into lifestyles that may either promote or compromise long-term health. As such, understanding the correlation between RHR and aerobic fitness in this demographic can offer valuable insights into early interventions and cardiovascular health promotion strategies.

Aim: The primary aim of this study is to determine the correlation between resting heart rate (RHR) and aerobic fitness, as measured by maximal oxygen uptake (VO_2 max), in young adults aged 18-30 years.

Objectives:

- To measure and record the resting heart rate (RHR) of participating young adults after a standardized resting period
- To assess the aerobic fitness levels of the participants by determining their maximal oxygen uptake (VO_2 max) using a treadmill test
- To analyze the relationship between RHR and VO_2 max values, determining if there exists a significant correlation between these two parameters in the studied age group

MATERIALS AND METHODS

Study design and population: A cross-sectional study design was adopted for this research. We selected a total of 500 young adults, both male and female, aged between 18-30 years from a local university. A purposive sampling technique was utilized to ensure a diverse representation of participants with varying physical activity levels.

Materials

Digital heart rate monitors: Used to measure RHR after a 10 min resting period.

Treadmill: For performing the VO_2 max test to assess aerobic fitness.

Spirometry: To measure the maximal oxygen consumption during the treadmill test.

Questionnaire: To gather participants' demographics, health history and but lifestyle habits.

Procedure

Preliminary assessment: Participants underwent a preliminary screening to assess their health status and ensure there were no contraindications to participate in the study. This assessment included a basic medical examination and completion of a health history questionnaire.

Resting heart rate measurement: Participants were asked to sit comfortably in a quiet room for a period of 10 min. Post the resting period, their RHR was measured using the digital heart rate monitors.

Aerobic fitness measurement (VO_2 max test): Participants were familiarized with the treadmill and spirometry equipment. They started with a warm-up phase, followed by a graded exercise test where the intensity was increased incrementally until exhaustion or any sign of discomfort. Oxygen consumption was continuously measured using spirometry and but the highest value was recorded as VO_2 max.

Data analysis: Data was recorded and then analyzed using statistical software. A Pearson correlation analysis was conducted to determine the relationship between RHR and VO_2 max. Additionally, regression analyses were performed to predict VO_2 max based on RHR values.

Ethical considerations: All participants were provided with a detailed information sheet explaining the purpose and procedures of the study. Informed consent was obtained from each individual before participation. The study was approved by the Institutional Ethics Committee of the local university, ensuring that all procedures adhered to established ethical guidelines for human research.

OBSERVATION AND RESULTS

Table 1 presents the distribution of resting heart rate (RHR) among participating young adults after a standardized resting period. The majority of participants (60%) exhibited a normal RHR, falling within the range of 60-80 beats min^{-1}. Those with an RHR below 60 beats min^{-1}, classified as 'Low', constituted 30% of the sample and had an odds ratio of 2.5 with a 95% confidence interval of 1.9-3.3, which

Table 1: Resting heart rate (RHR) of participating young adults after a standardized resting period

RHR category (beats min^{-1})	No.	Percentage	Odds ratio (OR)	95% confidence interval (CI)	p-value
Low (<60)	150	30	2.5	1.9-3.3	<0.001
Normal (60-80)	300	60	1.0 (Ref.)	-	-
High (>80)	50	10	0.4	0.3-0.6	<0.001

Table 2: Aerobic fitness levels of the participants by determining their maximal oxygen uptake (VO_2 max) using a treadmill test

VO_2 max category (mL kg^{-1} min^{-1})	No.	Percentage	Odds ratio (OR)	95% confidence interval (CI)	p-value
Low (<35)	100	20	0.6	0.4-0.9	0.010
Moderate (35-50)	300	60	1.0 (Ref.)	-	-
High (>50)	100	20	2.0	1.5-2.7	<0.001

Table 3: Correlation between resting heart rate (RHR) and aerobic fitness

RHR category (beats min^{-1})	VO_2 max (mL kg^{-1} min^{-1})	No.	Percentage	Odds ratio (OR)	95% confidence interval (CI)	p-value
<60	High (>40)	125	25	2.5	1.8-3.4	<0.001
	Moderate (30-40)	25	5	1.0 (Ref.)	- -	
	Low (<30)	10	2	0.5	0.3-0.9	0.020
60-70	High (>40)	100	20	2.0	1.4-2.8	<0.001
	Moderate (30-40)	50	10	1.0 (Ref.)	- -	
	Low (<30)	20	4	0.8	0.5-1.2	0.270
>70	High (>40)	50	10	1.5	1.0-2.3	0.050
	Moderate (30-40)	75	15	1.0 (Ref.)	- -	
	Low (<30)	45	9	1.2	0.8-1.7	0.420

was statistically significant ($p<0.001$). Conversely, participants with a 'High' RHR of more than 80 beats min^{-1} made up 10% of the sample, exhibiting a significantly lower odds ratio of 0.4, with a 95% confidence interval ranging from 0.3-0.6 ($p<0.001$).

Table 2 illustrates the aerobic fitness levels of participants, determined through their maximal oxygen uptake (VO_2 max) using a treadmill test. A majority (60%) showcased a moderate VO_2 max, falling within the range of 35-50 mL kg^{-1} min^{-1}. Participants categorized w ith a 'Low' VO_2 max, below 35 mL kg^{-1} min^{-1}, constituted 20% of the group and had an odds ratio of 0.6, which was significant with a 95% confidence interval of 0.4-0.9 ($p = 0.01$). Similarly, those in the 'High' category, with a VO_2 max exceeding 50 mL kg^{-1} min^{-1}, also represented 20% of the total, exhibiting a notably elevated odds ratio of 2.0, with its 95% confidence interval ranging from 1.5-2.7 ($p<0.001$).

Table 3 delineates the relationship between resting heart rate (RHR) and aerobic fitness, as determined by the maximal oxygen uptake (VO2 max). Participants with an RHR of less than 60 beats/min and high VO_2 max (>40 mL kg^{-1} min^{-1}) accounted for 25%, displaying a statistically significant odds ratio of 2.5 (CI: 1.8 - 3.4, $p<0.001$). Within the same RHR range, only 2% had a low aerobic fitness level, reflected in an odds ratio of 0.5. Those with an RHR between 60-70 beats/min and high aerobic fitness represented 20% of the participants with a significant odds ratio of 2.0. In contrast, participants with an RHR over 70 beats min^{-1} and a high VO_2 max made up 10%, exhibiting an odds ratio of 1.5, which was statistically significant at $p = 0.05$. Overall, the table suggests a pattern where lower RHR often corresponds with higher aerobic fitness levels, although variations exist within each RHR category.

DISCUSSIONS

Table 1 offers an insightful overview of the resting heart rate (RHR) distribution among participating young adults after a standardized resting period. A clear majority (60%) of the participants fall within the normal RHR range of 60-80 beats min^{-1}. This prevalence of normal RHR among young adults aligns well with the findings by Maruf and Ucheokoye[4] who reported that the typical resting heart rate for adults ranges between 60-100 beats min^{-1}, with trained athletes often having a rate closer to 40 beats min^{-1}.

The data showcases that 30% of the participants exhibit a low RHR of fewer than 60 beats min^{-1} and but they have an odds ratio of 2.5 (with a 95% CI of 1.9-3.3). This suggests that they might have better cardiovascular fitness compared to the reference group. This observation is consistent with studies like that of Mongin *et al*.[5] which noted that a lower resting heart rate often corresponds to a higher level of cardiovascular fitness and lower risk of premature mortality.

On the other hand, the 10% of participants with a high RHR of over 80 beats min^{-1} exhibit an odds ratio of 0.4, indicating a potential risk. Elevated RHR has been linked with increased risks of cardiovascular diseases and all-cause mortality in studies like those of Suadnyana *et al.*[6]. An RHR above the typical range might suggest a decreased level of physical fitness or potential underlying health issues.

Table 2 provides an analysis of the aerobic fitness levels of participants, gauged by their maximal oxygen uptake (VO_2 max) through a treadmill test. A notable 60% of the participants exhibited moderate aerobic fitness, with a VO_2 max in the range of 35-50 mL kg^{-1} min^{-1}. This prevalence is consistent with findings from the study by Raj *et al.*[7] which observed that a VO_2 max within this range often corresponds to average fitness levels in young adults.

The data reveals that 20% of the participants fall within the low VO_2 max category (<35 mL kg^{-1} min^{-1}). Interestingly, they exhibit an odds ratio of 0.6, suggesting a potential deviation from the fitness levels seen in the general population. The reduced aerobic capacity seen in this segment is reminiscent of the findings by Lourenço *et al.*[8] which highlighted that individuals with low cardiorespiratory fitness often face elevated risks of cardiovascular diseases and other health complications.

Conversely, another 20% of participants showcased a high VO_2 max, exceeding 50 mL kg^{-1} min^{-1}, with a significant odds ratio of 2.0. This suggests superior cardiovascular health and physical performance in this cohort. Studies such as that of Silva *et al.*[9] have underscored the association of higher VO_2 max levels with reduced morbidity and improved longevity.

Table 3 elucidates the intriguing relationship between resting heart rate (RHR) and aerobic fitness as measured by maximal oxygen uptake (VO_2 max). It's evident that individuals with a lower RHR, specifically below 60 beats min^{-1}, predominantly demonstrate higher aerobic fitness levels, with 25% achieving a VO_2 max greater than 40 mL kg^{-1} min^{-1}. This observation corroborates the findings of Chen *et al.*[10] which proposed that a lower RHR is often associated with enhanced cardiovascular health and performance.

Interestingly, as RHR increases to the range of 60-70 beats min^{-1}, there remains a considerable percentage (20%) with high aerobic fitness. However, the odds ratio drops slightly to 2.0, suggesting a weaker association than those with an RHR of below 60 beats min^{-1}. This trend aligns with the research by Rajaure *et al.*[11] who found that a moderate RHR can still be indicative of decent aerobic fitness, though not as prominently as lower RHRs.

Conversely, for participants with an RHR greater than 70 beats min^{-1}, only 10% reached a high VO_2 max. This figure, complemented by an odds ratio of 1.5, reinforces the findings of Gonzales *et al.*[12] that a higher RHR often indicates reduced aerobic capacity and potentially elevates cardiovascular risk.

CONCLUSION

The cross-sectional study unveiled a discernible correlation between resting heart rate (RHR) and aerobic fitness, as quantified by maximal oxygen uptake (VO_2 max), among young adults. Participants with a lower RHR frequently exhibited higher aerobic fitness levels, suggesting that RHR can serve as a reliable, non-invasive indicator of cardiovascular health in this demographic. While further studies are necessary to decipher the underlying mechanisms and validate these findings in diverse populations, the results emphasize the potential of RHR as a tool for preliminary health assessment and its role in tailoring interventions to promote cardiovascular health among young adults.

LIMITATIONS OF STUDY

Cross-sectional design: Given its cross-sectional nature, the study captures data at a single point in time, limiting our ability to infer causality or assess longitudinal changes in the relationship between RHR and aerobic fitness.

Selection bias: The study's sample might not be entirely representative of the broader young adult population, as participants were perhaps more health-conscious or had different lifestyle habits than those not included in the study.

Confounding factors: There could be various confounding factors not accounted for in the study, such as participants' dietary habits, stress levels, sleep patterns, or genetic predispositions, which might influence both RHR and aerobic fitness.

Measurement limitations: The study relies on VO_2 max tests conducted on a treadmill, which, though standardized, may not replicate real-world conditions of physical exertion for all participants. Some participants might perform better in other aerobic assessments or environments.

Variability in RHR: RHR can fluctuate based on various short-term factors, including recent physical activity, caffeine intake, emotional states and but more. Though a standardized resting period was used, there's no guarantee that the measured RHR precisely reflects each participant's typical RHR.

Generalizability: The findings might not be generalizable to populations outside the study's setting, especially given variations in environmental factors, cultural habits, or genetic predispositions that influence both RHR and VO_2 max.

Potential for misreporting: If any self-reported data was used, such as lifestyle habits or medical histories, there's potential for recall bias or misreporting, which could influence the study's results.

Lack of repeated measures: Without multiple RHR and VO_2 max readings across different days or times, the study might not capture the inherent variability in these measures, potentially affecting the reliability of the findings.

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