Racial Differences on Post Exercise Heart Rate Recovery in Healthy Sedentary Adult Males-- A Meta-Analysis Study

Sana Soomro*, Kausar Abbas Saldera, Ufaque Batool, Raheela Manghi

Department of Physiology, Basic Medical Science Institute, Jinnah Postgraduate Medical Center, Karachi, Pakistan

Abstract:

Introduction: Post-exercise heart rate recovery (PEHRR) is the measure of parasympathetic function of heart which decreases the heart rate as the person stops exercising. The post exercise heart rate recovery is easily measurable index of heart parasympathetic activity. The post – exercise heart rate recovery is computed as peak heart rate minus the heart rate measured after 1 min of termination of exercise. The risk of cardiovascular disease in individual with African background is greater as compared to Caucasians and Asian population. The aim of this study was to analyze the difference in post exercise heart rate recovery in individuals from different ethnic backgrounds. **Methods:** A thorough literature search was carried out on PubMed, Google Scholar and PakMediNet with articles published between 2007 till 2021. The articles with post – exercise heart rate recovery in male adults with different ethnic backgrounds were included. A total of 8 studies were included after meeting the inclusion criteria for the meta-analysis. The studies that measured heart rate recovery after 1 minute of termination of exercise were included. **Results:** Out of 174 subjects 51 individuals were Africans, 104 were Asians and 19 were Caucasians. The post exercise heart raterecovery was not found to be statistically significant between the individuals from different ethnic groups (p value-0.258). **Conclusion:** The post – exercise heart rate recovery is not influenced by the racial differences. Further research on larger scale assessing the impact of parasympathetic activity in terms of heart rate recovery in individual from different ethnic background is required as very limited data is available till date.

*Correspondence: Sana Soomro, MPhil scholar, Basic Medical Science Institute, Jinnah Postgraduate medical center, Karachi. Tell -923322323907, Email:sana.soomro@gmail.com

Introduction

The autonomic nervous system controls the various functions of body's viscera; the performance of individual during the exercise depends on the maximum functioning of autonomic nervous system[1]. The autonomic nervous system involves two main division i.e. sympathetic and parasympathetic nervous system [2]. The most important organ system that is studied widely in relation to autonomic physiology is cardiovascular system which involves both sympathetic and parasympathetic activity [3]. The heart rate increases as soon as individual starts exercising representing the intact function of sympathetic nervous system, but as individual stops workout the heart rate starts to decline which signifies the intact parasympathetic system[4, 5]. When the parasympathetic activity decrease or the sympathetic activity is enhanced, this condition is referred as 'autonomic imbalance' which increases the risk of death due to cardiac diseases [6] as workload on heart is increased which predispose patient at the risk of developing arrhythmias [7]. The heart rate is the most crucial tool for the assessment of intensity of exercise [8]. During the exercise the impulses from higher brain centers travel to the medullary cardiovascular center to change the arterial pressure to the higher level whereby increasing heart rate by deactivating

parasympathetic activity [9]. The overall adjustment in the heart rate is made to increase cardiac output, which is the product of heart rate to stroke volume, to meet the metabolic demand of the body during exercise[3]. About 20% of world population lives sedentary life [10], with total 1.26 million deaths occurs as a result of living sedentary life [11]. The sedentary style of living life produces the autonomic imbalance in individual's life [12], with sympathetic activity becoming predominant in physical inactive individuals [13].

Post exercise heart rate recovery (PEHRR) is defined as the decline in the rate of heart after the exercise has been terminated [14, 15]. PEHRR is the cheap, noninvasive and easily measurable tool which is readily used in clinical settings to estimate the heart parasympathetic activity [16, 17]. Heart rate recovery is the time required to decrease the heart rate after the exercise which denotes the degree of autonomic nervous system activation, with parasympathetic being overriding post exercise [18]. The post – exercise heart rate recovery is calculated as peak heart rate minus the heart rate measured after 1 minute of termination of exercise [16]. Higher PEHRR indicates the physical fitness of individual [19]. Reduced PEHRR measured after the 1 and 2 minutes of exercise is considered as the determinant of parasympathetic dysfunction [20]. Normally the decline in heart rate is about 12 to 22 beats or more after 1 min of exercise in recovery phase, but the decline in heart rate after 2 minutes of exercise is associated with worst cardiovascular outcomes [21]. The heart rate less than 12 beats per minute measured after 1 minute of exercise in recovery phase is considered abnormal [21]. The PEHRR measured at 1st min of exercise termination is considered important marker of heart parasympathetic activity [21]. The slower reduction in heart rate after exercise in recovery phase denotes depressed vagal activity to heart [22, 23]. Low post – exercise heart rate recovery indicates poor cardiovascular fitness which is generally affected by obesity and metabolic derangement in individual [13] and hence predicts the mortality in the patients with cardiovascular dysfunction[18, 23, 24].

Globally every year large number of individual dies as a result of cardiovascular diseases [25]. Men are more prone to cardiovascular diseases and mortality associated with cardiovascular events as compare to females [26]. The sedentary life style is one of the major risk factor for the development of cardiovascular related diseases [27]. The autonomic functions become abnormal in individuals with cardiovascular disease, with sympathetic system become enhanced and parasympathetic system becomes depressed [28]. African individuals have greater propensity to develop cardiovascular diseases as compared to the white owing to the fact that they tend to be more obese as compared to the Caucasians [29, 30] but Asians as compared to Caucasian have lower prevalence of cardiovascular disease [28].The study by Schutte *et al*. [29] report that Asians as compared to Caucasians have higher chances of developing cardiovascular disease. The comparison of autonomic recovery after exercise in Africans, Caucasian and Asians has not been studied and if any variability in heart rate recovery exist between the individuals belonging to different racial background.

Methodology:

This meta-analysis study was conducted in the department of Physiology, Basic medical science Institute, Jinnah postgraduate medical Centre, Karachi. A thorough systemic literature search using electronic data bases of Google Scholar, PubMed and PakMediNet with articles and abstract published in English language was carried out from 2007 till 2021. The published abstracts and articles were searched via aforementioned search engines with the use of following keywords 'Heart rate recovery', 'Asian', 'African', 'Caucasian', 'Europeans', Sedentary and 'Adult males'.

The inclusion criteria for the study were as follows;

1) Studies published between 2007 till 2021

2) Adult males between 18 to 66 years of age

3) Post exercise Heart rate measured after 1 minute of cessation of exercise

4) Individuals without any cardiovascular, metabolic, pulmonary, musculoskeletal and peripheral vascular diseases

5) Body mass index (BMI) < 25 Kg/m^2.

6) Sedentary individuals for last 6 months

7) Subjects from different ethnic backgrounds

5 cross sectional studies in total that met above mentioned inclusion criteria were included in which peak heart rate (PHR) and post exercise heart rate after 1 min of exercise in recovery phase (HR$_1$min) were measured in male sedentary adults. The subjects were divided into 3 groups according to major ethnic background i.e. Africans, Asians and Caucasians. The post exercise heart rate recovery (PEHRR) was measured using formula Peak heart rate – Postexercise heart rate after 1 min of cessation of exercise in recovery phase [31].

Statistical Analysis

The data was collected in Microsoft Excel which included mean age, height, weight, BMI, peak exercise heart rate, heart rate measured after 1 min of termination of exercise in recovery phase, sample size of each study selected for the meta-analysis. The data was analyzed using SPSS version 22. The age and BMI was reported as mean and standard deviation. ANOVA was applied to assess the significant difference between the groups. Results were considered significant with P value of <0.05.

Results

Out of 174 individuals from the five studies selected, 51 individuals were Africans, 104 were Asians and 19 were Caucasians, included in the meta-analysis study (Fig 1). The African subjects were Nigerians, Caucasians comprised of subjects from Serbia and Asian constituted Indian, Japanese and South Korean.
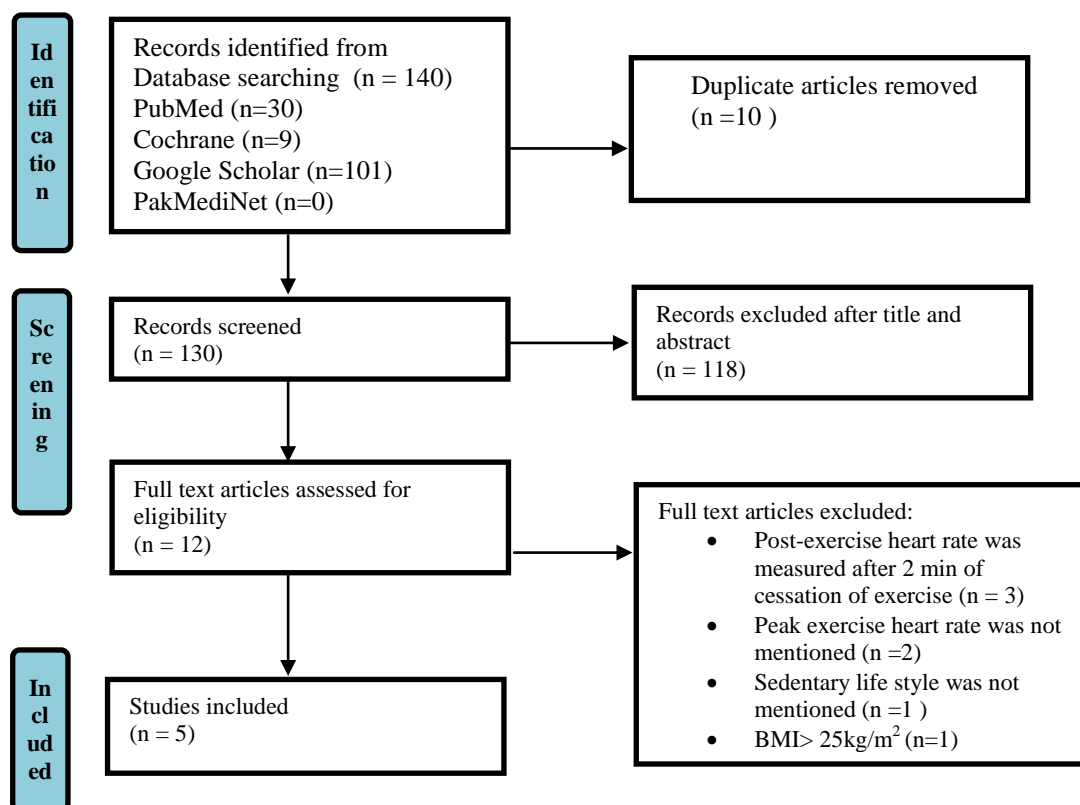
Figure1: PRISMA flow diagram

Table 1 shows the basic characteristics of studies included in the meta-analysis. The mean age of subjects in the study was lowest 19.9 ± 1.0 years to the highest age of 49.1 ± 5.6 years. The mean BMI of the study subjects was lowest 21.7 ± 2.1 kg/m^2 and maximum value of 24.84 kg/m^2.
Table 2 shows the different criteria for estimating sedentary life style, exercise protocol and measurement of heart rate by each study.
Table 3 and **Figure 2** shows the different heart rate indices among the various ethnic groups. The Peak heart rate in Caucasians was highest as compared to Africans and Asians with no significant difference found among the different ethnic groups (p-0.063). The decline in heart rate at the end of exercise in recovery phase which is denoted by HR_1min and post exercise Heart Rate Recovery (PEHRR) was found to be more in Caucasian than Asian than African individuals but no significance (p-0.258)was noted in terms of heart rate recovery.

Table 1: General Characteristics of Cross-Sectional Studies

Author	Publication year	No of Males	Country of Origin	Age (Years)	BMI (Kg/m^2)
Patil [32]	2012	30	India	25.9 ± 2.3	22.5 ± 1.36
Barak [33]	2011	19	Serbia	19.9 ± 1.0	24.84
Oyeyemi [13]	2015	51	Nigeria	24.84 ± 3.19	21.85 ± 3.02
Kwon [34]	2014	50	S. Korea	49.1 ± 5.6	$23.9\,2 \pm 2.0$
Matsuo [35]	2014	12	Japan	29.8 ± 6.9	22.0 ± 1.7
Matsuo [36]	2014	12	Japan	28.5 ± 7.7	21.7 ± 2.1

Values expressed as mean ± Standard Deviation

HAIT – high intensity aerobic interval trainingCAT**-**continuous aerobic training, BMI – body mass index

Table 2: Sedentary criteria and exercise protocol of cross-sectional studies

| Author	Sedentary criteria	Exercise protocol	Heart rate measurement
Patil [32]	-	Harvard step test	Digital electronic device
Oyeyemi [13]	Individual spending 450 minutes per day in sitting position	25 watt Work load exercise till heart rate reached 70% of maximum heart rate	Digital electronic device
Barak [33]	Individual not engaged in regular physical exercise for last 6 months	Wingate anaerobic test	Digital electrocardiogram
Kwon [34]	Exercise for less than 30 minutes for less than 3 times a week	Treadmill test	12 lead EGG
Matsuo [35]	Individual not engaged in regular exercise for past 12 months	3 days a week cycling HAIT- individual VO$_2$ max reaching 80% CAT- individual VO$_2$ max reaching 60-65%	12 lead EGG

HAIT – High intensity aerobic interval training, CAT – Continuous aerobic training, VO$_{2max}$ – maximal oxygen consumption

Table 3: PHR, HR_1min and PEHRR among different ethnic groups

Variable	Africans	Asians	Caucasians	P-value
PHR (b/m)	113.55±16.56	164.89±17.69	183.1±3.1	0.063
HR_1min (b/m)	96.59 ± 14.35	138.14±11.15	153.1±3.0	0.034*
PHRRe (b/m)	16.96±2.21	26.74±10.18	30.00±5.0	0.258

Values expressed as mean ± Standard Deviation, PHR – Peak heart rate, HR_1min – heart rate after 1 minute of exercise, PHHRe – Post exercise heart rate recovery, b/m – beats per minute
*P value of < 0.05 is considered significant
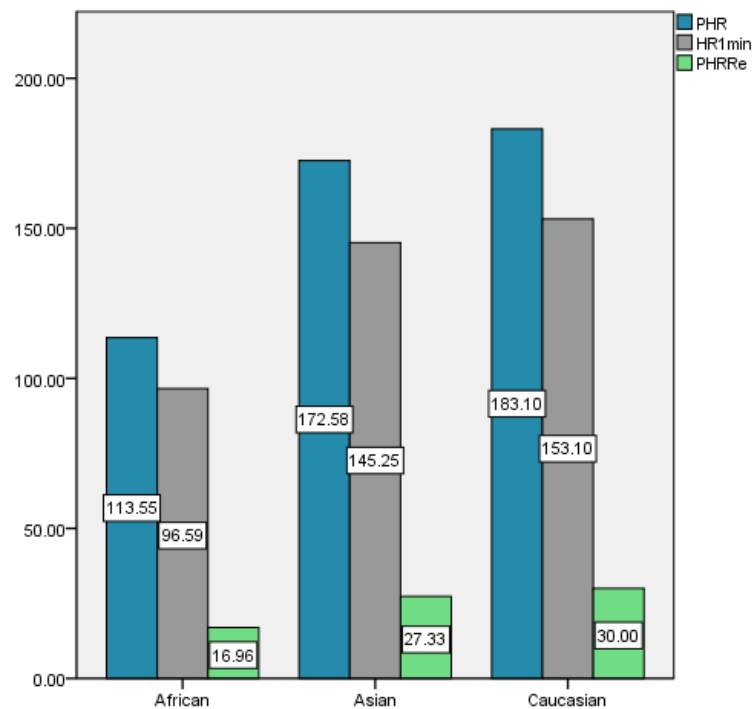
Figure: 2 Variation in heart rate parameters in different ethnic groups

Discussion

The post exercise heart rate recovery refers to the reduction in the heart rate when the individual has stopped exercising [36]. During exercise the sympathetic arm of autonomic nervous system is predominated which results in increased heart rate, whereby after the exercise is over the parasympathetic arm activates which leads to recovery of heart rate back to baseline [37, 38]. The post exercise heart rate recovery is used clinically to predict future cardiovascular events [14]. Individuals who are not exercisers, die early as compared to individuals who engage themselves in physical activities, with frequent exercises starting as early as individual reaches adulthood save the person from later risk of developing cardiovascular disease [39]. The imbalance in autonomic nervous system functioning occurs frequently in the patients with cardiovascular disease with parasympathetic system becomes depress and sympathetic system becoming enhanced [39, 40]. It is the established fact that heart is mainly regulated by autonomic nervous system which may be influenced by different ethnicities; but the variation in heart autonomic response to exercise in terms of ethnic differences hasn't been studied extensively [41, 42]. The data measuring the parasympathetic activity by heart rate variability is available between different

ethnic groups but the data of comparative studies on ethnic differences on heart rate recovery is lacking.

The current meta-analysis study included five previous studies on sedentary males to analyze the ethnic differences on heart rate recovery in individuals with normal body mass index. The heart rate recovery in Caucasian was not found to be significant among individuals from different ethnic backgrounds. Although statistically no differences found but the heart rate recovery was observed to be bit higher in Caucasians than Asians and Africans individuals. The findings of this study is consistent with the Esco [30] whereheart rate recoveryin African origin individuals measured 1 minute after the exercise reached maximum intensity was not found to be different as compared to white individuals. The study by Choi *et al* (2006) [43] on ethnic differences on parasympathetic activity observed the decrease parasympathetic activity in African descendants of America as compared to Caucasian Americans. Also the study by Vranish 2018 [44] O'Neil 2017 [45], Colangelo2020 [46] and Zion 2003 [47] observed that sympathetic system in African origin individuals is enhanced as compared to the white males.The higher arterial stiffness in African origin individuals causes the sustained stretch of afferent fibers decreases the sensitivity of cardio-inhibitory area thereby decreasing parasympathetic outflow and increasing sympathetic outflow to heart [44, 47]. The parasympathetic activity in Asians is also lower than the Caucasian [48, 49]. As the studies on autonomic functions of heart has not been studied in detail in Asians and African individuals so the underlying mechanism of autonomic differences on heart activity among individuals from different racial background remains unclear[7, 50].

Concluson
The current meta-analysis study concludes that post exercise heart rate recovery in healthy sedentary males is not influenced by the ethnic differences. The study on larger scale is required to assess the variation in autonomic activity of heart.

Consent for Publication
Not applicable.

Standards Of Reporting
PRISMA guidelines and methodology were followed.

Conflict of Interest
The authors declare no conflict of interest, financial or otherwise.

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