Original Research Article

RECOVERY AND ADIPOSITY INDICES AMONG SEDENTARY YOUNG ADULTS FOLLOWING A STRUCTURED PHYSICAL ACTIVITY

Abstract

BACKGROUND: Physical activity has been shown to have positive impact on health and in the long term results in improved physical fitness and quick recovery in cardiovascular parameters after sub-maximal exertion. Clinical evaluation of cardiovascular recovery as a prognostic tool for cardiovascular diseases has been subject of interest and many factors has been established to influence recovery.

OBJECTIVE: This study sought to investigate the relationship between adiposity indices and cardiovascular recovery indices in sedentary young adults following a structured physical activity.

MATERIALS AND METHODS: A total of two hundred and eleven (211) young adults (127 males and 84 females) participated in this study. Subjects performed a sub-maximal exercise on a cycle ergometer until they attain 60-70% of their age predicted maximum heart rate following which the heart rate and blood pressure recovery was measured after 1 minute, 3 minutes and 5 minutes. Prior to the exercise, participants' anthropometric parameters were measured and adiposity indices recorded.

RESULTS: Results showed a significant positive correlation between waist-hip ratio and heart rate recovery, a significant negative correlation between percentage body fat and heart rate recovery, a significant positive weak correlation between body mass index and systolic blood pressure recovery. There was no significant relationship between any of the adiposity indices and diastolic blood pressure recovery. Some levels of differences exist between body adiposity and recovery indices.

CONCLUSION: Body adiposity should be taken into consideration in preventing the risk of cardiovascular diseases occasioned by slow recovery after physical activity.

Key words: Adiposity, Recovery indices, Sedentary, Physical Activity

Introduction

Physical activity has been shown to have positive impacts on health and in the long term results in improved physical fitness and quick recovery in cardiovascular parameters after sub-maximal exertion or stress [1]. Routine physical activity reduces stress and enhances psychological wellbeing which is particularly important for prevention and management of cardiovascular diseases, among other chronic diseases [2]. It is also known to reduce risks for many adverse health outcomes. Engaging in some forms of physical activity is better than non-participation in any form of physical activity [2]; however, for most health outcomes, substantial benefits are achieved if amount of physical activity gradually increases through higher intensity, greater frequency, and/or longer duration [3]. Its health benefits mainly occur with at least 150 total minutes of moderate intensity or at least 75 min of vigorous intensity aerobic physical activity per week, though additional merits ensue with more physical activity [4].

Despite evidence in support of health benefits of regular physical activity, sedentary lifestyle is still globally prevalent [5], and has been associated with impairment of cardiovascular system. Several recommendations have been made towards tackling physical inactivity. Of these, increasing leisure-time physical activity has received enormous attention [6], notwithstanding, health challenges associated with sedentary lifestyle remain major problem and risk for global health. These risks include obesity, high fatigability tendency, and unstable arterial pressure leading to hypertension and hypertensive heart disease, poor glucose metabolism leading to diabetes mellitus, atherosclerosis, among others [7]. Physical inactivity has been associated with overweight/obesity, fatigue, hypertension, diabetes and stress intolerance, and the current rate of these factors worldwide has been described as an epidemic or even a pandemic [8]. Routine assessment of these risks during health and medical interview is imperative to ensure complete inspection of the cardiovascular system. This will serve a preventive measure to sudden, unexpected death on account of heart failure, cardiac arrest and stroke.

However, in assessment of cardiovascular system, measuring vital signs such as blood pressure and heart rate is prevalent while recovery indices are often neglected [9]. Recovery indices are time taken for cardiovascular parameters to return to resting value. Examples include heart rate recovery (HRR) which, simply, is the rate at which the heart rate declines from either maximal or sub-maximal exercise to resting levels, maximum oxygen consumption rate recovery which represents time taken to restore the amount of oxygen transported and used in cellular metabolism to resting or near resting value [9]. On the other hand, blood pressure recovery (BPR) is defined as the time it takes blood pressure to recover to resting position after physical stress. It has been reported to be an index of autonomic function [10]. HRR and BPR have been identified as a powerful and independent predictor of cardiovascular and all-cause mortality in healthy adults in with CVD and diabetes [11].

The health of the parasympathetic nervous system and the cardiovascular system post-exercise can be determined by calculating HRR during recovery from exercise [12]. Parasympathetic nervous system (PNS) activity declines as one ages leading to a slower HRR but can be improved through regular exercise [12]. Coronary artery disease pre-hypertension, hypertension, and all-cause mortality is strongly associated with an abnormal HRR [14] [15] [16] and could be associated with insufficient stimulation of the PNS after exercise. Similar to HRR, abnormal BPR values have been shown to be linked to cardiovascular diseases and all-cause mortality [17].

Over the last several years, clinical evaluation of heart rate recovery as a prognostic tool for CVD has been subject of interest [18]. HRR has also been reported to be a remarkable complement to the medical and physical assessment of an individual. Heart rate recovery to resting level can take one hour after light or moderate exercise, four hours after long-duration aerobic exercise, and even up to 24 hours after intense or maximal exercise [19], depending on interactions of factors such as exercise intensity, body composition and level of physical fitness [20] [21] [22] [23].

Heart rate recovery (HRR) and blood pressure recovery (BPR) are fairly popular topics among researchers looking at its effect on the specific mechanisms behind the phenomenon. Few studies, however, have been conducted in on sedentary young adults. The overall functionality and integrity of the cardiovascular system is better captured by recovery indices than mere rise and fall in cardiovascular parameters [24]. For example, analysis of heart rate variability before and after exercise can provide useful information about autonomic control of the cardiovascular system [25].

In addition, cardiovascular parameters are very individualistic, and this further limits the utility of traditional measures of variability in prognosticating health or clinical outcome. Recovering from stress/exertion is associated with reduced body activation level when parasympathetic activation dominates the ANS over sympathetic activity [26]. It is therefore important to provide applied measures of cardiovascular integrity such as heart rate recovery, blood pressure recovery index and its relationship with body adiposity among others which take into consideration the dynamic changes in autonomic activity and individuality of persons.

Methods

Two hundred and eleven (211) young adults consisting of 127 males and 84 females who were found to be sedentary upon assessment with international physical activity questionnaire participated in this study. The study was conducted in the gymnasium of the Department of Medical Rehabilitation, University of Nigeria, Enugu Campus. The study was approved by the University Ethical Committee. All participants filled and signed a consent declaration authorizing their participation.

Procedures

Participant’s level of physical activity was evaluated using International Physical Activity Questionnaire (IPAQ). Prior to the study, participants were assessed for readiness to participate in the study using Physical Activity Readiness Questionnaires (PAR-Q). Anthropometric indices were evaluated as follows:

Body Mass Index (BMI): The researcher measured the heights of the participants to the nearest centimetre using the stadiometer (Secca, England). Doing this, the researcher ensured that the participants stood erect and barefoot, with their backs touching the stadiometer, their arms held laterally by their sides and with the two feet closely apposed. Also, the weight of each participant was measured using a weighing scale (Beurer, Germany), while the participant was putting on light clothing to avoid errors.

The Body Mass Index (BMI) was calculated from the weight (kg) and height (m^2) (weight/height^2).

Waist-Hip Ratio: Waist and hip circumferences were measured using a tape measure **(**butterfly brand, China) and duplicate measurements were taken at each site and were obtained in a rotational order. The waist-hip ratio was calculated by dividing the waist circumference (cm) by the hip (cm).

Percentage Body Fat: Percentage body fat was obtained using a Bi-Impedance Electronic Fat Analyser (Beurer, Germany). The height, age, gender and level of physical activity of the participants were inputted into the analyser and the participant steps on the fat analyser bare footed after which the percentage body fat was read off.

After obtaining the anthropometric indices, participants were made to rest for 10 minutes after which the resting blood pressure and heart rate were measured using an electronic sphygmomanometer. The maximum heart rate of each participant was evaluated by subtracting their age from 220 (220-age) and target heart rate obtained by calculating 60-70 percent of the maximum heart rate. The participants cycled in a bicycle ergometer (Egojin JK 2100, Korea) until they reached their individual target heart rates. Once the target heart rate is reached, the participant stops and the recovery heart rate and blood pressure is measured after 1 minute, 3 minutes and 5 minutes.

Statistical Data analysis

Data was analysed using the Statistical Package for Social Sciences software version 24 (SPSS Inc., Chicago, U.S.A.). The normality of the distributions was assessed with the Shapiro-Wilk test. Parametric and non-parametric statistics were selected accordingly. Descriptive statistics of frequency and percentages was used to summarize and present the data obtained. Pearson Correlation and Spearman's analysis was used to test the relationship between the recovery indices and each of anthropometric indices. Level of significance was set at $P<0.05$.

Results

A total of two hundred and eleven (211) individuals participated in this study. The participants have a mean age, BMI, PBF, WHR, RHR, SBPRI and DBRI of 22.76±4.87 years, 23.01±3.63 (KG/M^2), 25.98±3.63, 0.85±0.12cm, 76.25±11.62BPM, 116.93±13.26mmHg and 76.11±9.69 mmHg respectively (table 1).

Significant positive weak correlation exists among WHR & HRRI 1 (r=0.201, p=0.004), WHR & HRRI 2 (r=0.240, p=0.240), WHR & HRRI 5 (r=0.250, p=0.000). However, there is a significant negative weak correlation between %BF & HRRI 1 (r = -0.16, p=0.019), %BF & HRRI 2 (r= -

0.212, p=0.002), %BF & HRRI 5 (r= -0.267, p=0.000). There is a non-significant negative correlation between BMI & HRRI 1, BMI & HRRI 2 and BMI & HRRI 5 (table 2).

There is a significant positive weak correlation between BMI & SBPRI (r=0.148, p=0.032), %BF & SBPRI (r=0.132, p=0.032) while a non-significant negative weak correlation exists between WHR & SBPRI (r= -0.06, p=0.0383), WHR & DBPRI (r= -0.008, p= 0.383), WHR & DBPRI (r= -0.008, p=0.912). There is also a non-significant positive weak correlation between BMI & SBPRI (r=0.061, p=0.381), %BF & DBPRI (r=0.088, p=0.206) (Table 3).

Table 1: Descriptive Statistics of Physical Characteristics of the Participants (N=211) showing the mean and standard deviation

Characteristics	Mean ±SD
Age (Years)	22.76 ± 4.87
Body Mass Index (KG/M^2)	23.01 ±3.63
Percentage Body Fat (%)	25.98 ±5.95
Waist Hip Ratio (cm)	0.85 ±0.12
Resting Systolic Blood Pressure (mmHg)	116.93 ±13.26
Resting Diastolic Blood Pressure (mmHg)	76.11 ±9.69
Resting Heart Rate (BPM)	76.25 ±11.62
Heart Rate after 1 minute	102.48 ±17.98
Heart Rate after 3 minutes	94.01 ±14.70
Heart Rate after 5 minutes	92.84 ±13.54
Systolic Blood Pressure after 1 minute	143.19 ±19.98
Systolic Blood Pressure after 3 minutes	128.80 ±16.92
Systolic Blood Pressure after 5 minutes	120.77 ±15.86
Diastolic Blood Pressure after 1 minutes	76.97 ±10.91
Diastolic Blood Pressure after 3 minutes	74.64 ±10.25
Diastolic Blood Pressure after 5 minutes	73.83 ±10.71
Heart Rate Recovery Index1	26.82 ±19.82
Heart Rate Recovery Index3	35.32 ±17.13
Heart Rate Recovery Index5	36.49 ±16.63

Systolic Blood Pressure Recovery Index	13.03 ±18.03

Table 2: Relationship between Anthropometric Parameters and Heart Rate Recovery Indices

	Variables	R-value	p-value
HRR1 1	WHR	0.201	0.004*
	BMI	-0.06	0.931
	%BF	-0.16	0.019*
HRRI 2	WHR	0.240	0.000*
	BMI	-0.015	0.832
	%BF	-0.212	0.002*
HRRI 5	WHR	0.250	0.000*
	BMI	-0.051	0.464
	%BF	-0.267	0.000*

Key: HRRI 1-Heart Rate Recovery Index after 1 minute, HRRI 3- Heart Rate Recovery Index after 3 minutes, HRRI 5- Heart Rate Recovery Index after 5 minutes, WHR-Waist-Hip-Ratio, BMI-Body Mass Index, %BF-Percentage Body Fat

Table 3 Relationship between anthropometric parameters and blood pressure recovery indices

Variables		Rho	p-value
SBPRI	WHR	-0.060	0.383
	BMI	0.148	0.032*
	%BF	0.132	0.032*
DBPRI	WHR	-0.008	0.912
	BMI	0.061	0.381
	%BF	0.088	0.206

Key: SBPRI-Systolic Blood Pressure Recovery Index, DBPRI-Diastolic Blood Pressure Recovery Index, WHR-Waist-Hip-Ratio, BMI-Body Mass Index, %BF-Percentage Body Fat

Discussion

Measurement of heart rate recovery can indicate cardiovascular health through non-invasive techniques [27]. Results from the present study were in agreement with few previous studies on how fast heart rate declines during first minute of recovery [14] [28]. The values seen in this study on the recovery protocol can be concluded to be a result of reactivation of the parasympathetic nervous system and deactivation of the sympathetic nervous system to decrease heart rate immediately after exercise. Generally, males appear to have faster heart rate recovery than females [11].

The result from the present study also showed a significant positive correlation between heart rate recovery index and Waist-Hip Ratio (WHR). This finding is in agreement [29] which found a significant association between waist hip ratio and heart rate recovery where adolescent boys with abnormal WHR were found to be three times more likely to obtain lower HRR value than their counterparts with normal WHR. This finding is clinically important to sports physiotherapists and athletic trainers who work with athletes that compete in different sports with little time to recover. The knowledge that reducing waist-hip ratio may quicken recovery is an asset for winning competitions. Dimkpa and Oji indicated that the best predictors of HRR were BMI in males and WHR in females [30]. Fidan-Yaylali et al, reported negative correlation between HHR and waist circumference [32]. Similar correlations were reported by [32] [33] [34]. These were not in agreement with our study which reported positive correlation. While the present researcher went ahead to correlate HRR with WHR, the above studies considered only waist circumference and this may be the cause of the disagreement. It is important to note that waist circumference which is often considered the best index of central or visceral obesity was less closely associated with HRR than WHR. This suggests that taking into consideration the ratio of waist to hip may provide a more reliable screening and modification of HRR and other cardiovascular risks based on waist circumference. WHR has been reported to be a better predictor of obesity and cardiovascular diseases than waist circumference.

Windham et al [33] reported that increased waist circumference, was associated with decreasing heart rate variability variables in younger participants. The study also reported no effect on heart rate variability with increasing BMI. A cross-sectional study by Yi et al [34] that involved apparently healthy Korean adults found that the waist-to-hip ratio and percentage of body fat mass were better indicators of low Heart Rate Variability measures than BMI. This is consistent with our study which showed that BMI has a non-significant negative correlation with HRR. Poliakova et al [32] opined that Waist circumference, and percentage body fat presented an independent association with Heart Rate Variability, whereas BMI presented no association. This is also consistent with the finding of this study. These findings may show that changes in autonomic function not detected during rest might be observed following exercise. It is therefore necessary not to only rely on measurements at rest.

HRR has been shown to be independently related to indices of obesity-BMI, WC, and WHR and strengthen the usefulness of these anthropometric indices in predicting cardiovascular risks as illustrated by Dimkpa and Oji [30]. It is surprising that HHR significantly correlated positively with WHR since it is well known that overweight and obesity are associated with cardiovascular diseases and increased mortality and morbidity. The prognostic significance of HRR after exercise as a risk factor for all-cause and cardiac mortality in healthy subjects has been demonstrated. Furthermore, obesity is a risk factor for cardiovascular diseases.

The present study correlated %BF and BMI, an established risk factor for cardiovascular function with HRR and found that HHR has a significant negative correlation with %BF and BMI. This finding is consistent with the findings of Redzal et al [35]. Poliakova et al [32] showed that %BF presented an independent association with heart rate variability. Jezdimirovic et al [36] reported a strong positive trend between %BF and HRR, this is not consistent with this study. While they considered only non-obese children and adolescence in their study, we involved young sedentary adults in our study and this may be the cause of the disagreement in results. Another possible reason is the difference in exercise protocols used in both studies as well as level of physical fitness of the participants. Difference in exercise protocols have shown to affect HRR outcome [37].

During any form of exercise, increase in heart rate is due to gradual withdrawal of parasympathetic activity while further increment in heart rate is caused by sympathetic action [38]. Heart rate recovery at 1 minute is due to vagal reactivation while 2 minutes and beyond are due to combination of vagal reactivation, clearance of metabolites and reduction in sympathetic action [39].

Blood pressure is somewhat proportional to blood flow [40]. During exercise, blood pressure increases in a stepwise progression as the exercise intensity increases in order to meet up with the oxygen demand of muscles [41]. Systolic blood pressure typically rises by 10±2 mmHg per metabolic equivalent (MET) increase and can reach the maximum at peak exercise while diastolic BP changes slightly or does not change at all [40].

Clinical evaluation of Systolic Blood Pressure Recovery (SBPR) as a tool for making prognosis of various cardiovascular abnormalities in patients undergoing structured physical activity has received numerous attention and delay in SBPR has shown to be associated with increased risk of angina, hypertension and stroke [42]. SBPR has also been linked to age, physical fitness and heart rate recovery. In the present study, the researcher collected data from apparently healthy sedentary young adults with similar age distribution and found SBPR values after exercise consistent with Fletcher et al [4] and Wielemborek-musial et al [43]. The SBPR after first minute obtained in this study was somewhat consistent with the findings of Dimkpa and Ugwu [11].

This study found a significant positive correlation between SBPR and BMI as well as percentage body fat. This is in agreement with Dimkpa and Ugwu [11] where BMI was found to be associated positively (r =0.106; p<0.01) with SBPR. The present findings in which SBPR is positively correlated with risk factors that increase cardiovascular risks strengthen the previously reported significance of SBPR after exercise test as a prognostic tool for the evaluation of cardiovascular abnormalities. Changes in SBPR are thought to be due to changes in systemic vascular resistance [42]. It may also be due to changes in sympathetic and parasympathetic activities and baroreflex sensitivity [17]. Our findings suggest that an increase in level of adiposity will lead to increase in SBPR (slower SBPR) and vice versa. It also suggests that BMI and percentage body fat were the better obesity index that explained variations in SBPR in sedentary adults following a structured physical activity. This study did not find any correlation between SBPR and waist to hip ratio. A study by Dimkpa and Ugwu, [11] found WHR to be the best predictor of SBPR in females. This is not in agreement with our findings and could be because of the higher number of males used in our study compared to females. It could also be due to differences in the exercise protocol used by both studies.

Findings from this study showed a non-significant correlation between Diastolic Blood Pressure Recovery and each of Body Mass Index, Percentage Body Fat and Waist-Hip Ratio. While the researcher is aware that diastolic blood pressure seldom increases during exercise, there may be a drop in diastolic blood pressure during the recovery phase of exercise due to vasodilatation. To the best of the researcher's knowledge, no study has been conducted linking diastolic blood pressure recovery to indices of adiposity.

Conclusion

Some levels of differences exist between body adiposity and recovery indices. Body adiposity should be taken into consideration in preventing the risk of cardiovascular diseases occasioned by slow recovery after physical activity.

Limitations

This study presents some limitations, the measuring instrument used for determining the percentage body fat was not the gold standard. Dual X-ray absorptiometry or hydrostatic weighing would have given a more reliable estimate of body composition. Finally, there was no randomization in the selection of participants; rather, participants were purposely recruited. Further studies should be carried out on recovery indices of sedentary adults using a larger sample size and randomising different body compositions.

Ethical Permission: As per the international standard Ethical approval was obtained from College of Medicine Research Ethic committee, University of Nigeria and was preserved by the author.

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