Testing Cardiac Output Of Long Distance Runners With Exercise

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Abstract
A vital of thirty male and female distance runners randomly drawn participated in the study. Two variables were examined to reveal cardiac output prior and following exercise. The F-values for cardiac output prior and following exercise for male and female participants were 14.7 and 0.3 respectively compared to the critical value of 3.35. Therefore, Scheffe Multiple Comparison Method (S-method) was used as the post hoc analysis to identify the source of the significant difference in the cardiac output prior and following exercise. As a result of the follow-up verification, the S-value for male and female cardiac outputs were 5.0 L.min' and 25.0 L.min ' respectively (5,0 L. nun^{1}). It was therefore, revealed that exercise increases the amount of blood pumped per minute by the heart. Thus, it was recommended that preparticipation health examination should be conducted before engaging in long distance training and competitions to prevent injuries and sudden death.

Keywords: *Cardiac output, exercise, stroke volume, heart rate, long distance running.*

Introduction.

Exercise is a unique mechanism used to test the various functions of the body (lyawe, 2018). Hence, as exercise begins, the blood flow to the muscles increases, and as the intensity of the exercise increases, the heart pumps more blood to the muscles to maintain the increase in energy, thus, maintaining a state of homeostasis (Wasserman. Hunasen. Casaburi & Whipp, 2019). They stressed that during exercise however, the body physiological mechanisms respond to the interaction of physiological mechanisms that enable the cardiovascular and respiratory systems to support the increased energy demand of contracting muscles.

Therefore, long distance running on the other hand, is a unique exercise which provides human beings the opportunity to develop, balance overcome inertia and accelerate the centre of gravity against resistance (Bates & Hamill. 2016). Thus, to perform a certain task in any given sport activity involves working specific muscles or organs and systems at an increased resistance, such as the heart and lungs to propel non-oxygenated blood to the lungs and oxygenated blood to the peripheral tissues in accordance with their metabolic requirement (Braunwald, 2017). It is on this premise that Foss and Keteyian (2018) see cardiac output as the amount of blood ejected, per minute by the heart, specifically, by the left ventricle. Wasserman. Hansen. Casaburi and Whipp (2018) asserted that cardiac output increases rapidly at the start of exercise or during transition from rest to steady-state exercise level by increasing stroke-volume and heart-rate in order to provide the flow to serve the muscles. They observed that heart rate increases as vagal tone decreases while stroke-volume increases due to increased cardiac inotropy and increased venous return resulting from pressure gradients. Thus, they maintained that this is caused by the compression of veins by contracting muscles and decreased intra-thoracic pressure with accompanying increased dept of breathing.

However, as exercise continues, cardiac output rises gradually until it reaches a plateau when

blood flow meets the exercise metabolic requirement (Whipp & Wasserman. 2019). They remarked that further increases in cardiac output are predominantly achieved by increasing heart-rate with stroke-volume remaining relatively constant especially at a work-rate of approximately 30% of peak Vo^. Nevertheless, cardiac output still varies considerably at rest due to emotional condition that alters the cortical outflow to the cardiovascular nerves and to nerves that modulate the arterial resistance (McArdle. Katch. & Katch. 2020). They infer that the maximal cardiac output reflects the functional capacity of the cardiovascular system. To this end. with renewed interest in exercise, increased participation in recreational activities and handsome reward now placed on competitive sports, there is need for examination of people to assess their suitability for a sport, and advise high performance athlete based on thorough cardiovascular evaluation of the cardiac output. Thus, this is absolutely essential in relation to pre and post participation in exercise, especially long distance races.

Therefore, this study is being instituted to reveal the relevance of preparticipation health examination in relation to cardiac output of long distance male and female runners in determining training regimens/routine to improve cardiovascular function, prevent injuries and sudden death (Agbonodor, et al, 2022).

Hypotheses:

The following hypotheses were formulated and tested at 0.05 alpha level:

1. The mean of cardiac output prior to exercise does not differ significantly from the mean of cardiac output following exercise.
2. The mean of male and female cardiac output prior to exercise does not differ significantly from the mean of male and female cardiac output following exercise.

Method

Research Design: The pre-test - post-test quasi-experimental design involving control and experimental groups was used in this study to test cardiac-output of long distance male and female runners with exercise.

Sample and Sampling Technique The simple random sampling technique was used to select the participants for the experiment. The test was conducted based on thirty (30) participants randomly selected from the sixty five *(65)* participants of 1.500m long distance races in Asaba 2022 National Sport Festival, Delta State. The participants consisted of fifteen (15) of each of male and female long distance runners.

Instrumentation.

The research instrument for this study was experimentation. It was an adaptation of Wasserman, Hansen. Casaburi and Whipp's (1997) protocol. Test was the main procedure for collecting data on individuals (participants) performing 1,500m task.

Thus, in order to prevent experimental error, the performers[1] cardiac outputs prior and after the task (1,500 race) were taken three (3) times each, at 3 different occasions. The mean value of the results was recorded and used for data analysis.

Method of Data Analysis

The One-way Analysis' of Variance (ANOVA) was used to test the hypotheses. If there was significant difference, the Scheffe Multiple Comparison method (S-method) was used to identify the source of the significant differences between pre and post tests. The alpha level was set at 0.05.

Results and Discussion

The results of the present study are presented in tables 1-3

Table 1: One way analysis of variance (ANOVA) showing the cardiac output prior and after exercise (unit: l.min"[1])

Groups	SS	DF	MS	F-Cal	F-Table
Between	0.135	2	0.067	14.4	3.35
Within	0.124	27	0.005		
Total	0.259	29	0.072		
Variable		Prior 1,500m task		After 1.500m task	
Cardiac-output (L.min^{-1})	4.88 ⊥ 1.07			4.99 ⊥ 0.81	
F - value		14.7			
S - value		5.0 L.min^{-1} 1,500m task.		25. OL. mm^{-1} After 1.500mtask>piior	

P<.05; S = Significance; DF=29

In table 1, analysis of variance (ANOVA) was used to determine the significance of the difference in the cardiac-output prior and following exercise (1,500m task). The F- value of 14.7 was found to be statistically significant as it is greater than the table-value of 3.35 at 0.05 level of significance with 2 and 27 degrees of freedom. Thus, the hypothesis that the mean of cardiac-output prior to exercise does not differ significantly from the mean of cardiac-output following exercise was rejected. This shows that there was a significant difference in the cardiac-output of long distance runners using exercise (1.500m task) as a mechanism .($p > 0.05$). Therefore, the present result seems justified by the submission of Whipp and Wasserman (1999) as well as Foes and Keteyian. (2018) mat cardiac-output increases rapidly at the start of exercise or during transition from rest to steady-state exercise level by increasing stroke-volume and heart-rate. This is necessary in order to provide the flow to serve the muscles in accordance with their metabolic requirements. However, this necessitated probing into a post-hoc analysis to identify the source of the significance.

Table 2: Scheffe Multiple Comparison Method (S. method) showing difference in cardiac-output prior and after exercise.

Variables	Result	Inference/decision
Cardiac output prior to exercise	5.0 L. mn"l	
Cardiac output after exercise	250 L.min"1	After 1.500m task prior 1 ,500m task

The cardiac output of 5.0 L. min"' was recorded at prior exercise test while 25.0 L.min" was recorded after exercise. The implication is that there was a difference in cardiac output prior and after exercise.

Thus, the difference in variation was brought about by differential exercise stress as exercise continues, in which cardiac output rises gradually until it reaches a plateau when blood flow meets the exercise metabolic requirements. This is a reflection of the functional capacity of the cardiovascular system of the participants. Therefore, as a result of the follow-up verification, there was a significant difference in cardiac output prior to exercise compared to after exercise (prior 1,500m task > after 1,500m task) ($p < 0.05$).

Table 3: One-way Analysis of Variance (ANOVA) **showing difference in the male and female cardiac-output prior and after exercise (unit: L.min'[1]).**

GROUP	SS	DF	MS	F-CAL	F-TABLE
Between	0.89	2.0	0.45		
Within	36.77	27	1.36	0.3	3.35
Total	37.66	29	1.81		
Variable	Prior 1.500m task		After 1.500m task		
Cardiac -output (L.min"[1])	5.59 ±2.35		4.96 ±88		
F-value .	0.3				

P<0.05; NS = Not Significance; DF = 29

As the computed F-value is less than the tabular. F-value (0.3<3.35) at 0.05 level of signifiance with 2 and 27 degrees of freedom, the null hypothesis which states that the mean of male and female cardiac-output prior to exercise would not differ significantly from the mean of male and female cardiac-output following exercise was accepted. This shows that there was no significant difference between male and female participants cardiac-outputs prior to and after 1.500m task parameter. This, therefore, justifies the position that both male and female runners had similar functional capacity of the cardiovascular system. Therefore, there was no follow-up verification to identify the possible source of the significant difference between male and female participants prior and after exercise.

Conclusion And Recommendations

The results of the study revealed that the hypothesis relating to cardiac output of long distance runners prior and following exercise was statistically significant, depicting that exercise had effect on the cardiac output of the participants. The hypothesis relating to male and female cardiac outputs in relation to prior and following exercise was statistically non significant, depicting that the cardiac functional capacity of male and female participants prior and following exercise was similar.

It was therefore concluded that exercise propels

non-oxygenated blood to the lungs and oxygenated blood to the peripheral tissues in accordance with their metabolic requirements. Thus, it increases the amount of blood pumped per minute by the heart.

However, it is recommended that:

1. Cardiac output pre-participation health examination should be conducted before engaging athletes in training/competition to prevent injuries and sudden death.
2. All forms of organized exercise programmes should be engaged in to increase the cardiovascular function of concerned individuals.
3. Exercise should be a routine for both recreational and high-level athletes to increase cardiac outputs.

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