ORIGINAL RESEARCH

An observational assessment of the effect of exercise on blood pressure, heart rate, respiratory rate and other physiological blood parameters in healthy adults

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ABSTRACT
Aim: The aim of the present study was to assess the effect of exercise on blood pressure, heart rate, respiratory rate and other physiological blood parameters in healthy adults.**Methods:** A study was conducted on a sample of 100 participants who underwent thorough screening to identify any notable deviations from their baseline health measurements. The participants were instructed to engage in physical activity for a duration of 30 minutes, and subsequent observations were documented.**Results:** The average age, height, weight, and body surface area of the subjects were 23 ± 3 years, 172 ± 12 cms, 68 ± 14 kgs, and 1.9 ± 0.4, respectively. The average heart rate before and after exercise was 78 ± 4 bpm and 175 ± 8 bpm respectively. The average respiratory rate was 18 ± 2 bpm and 26 ± 2.7 bpm, respectively. The average systolic blood pressure was 112 ± 8.0 mmHg and 144 ± 7.0 mmHg, respectively. The average bleeding time was 1.80 ± 0.5 min and 1.60 ± 0.5 min, respectively. The average clotting time was 3.60 ± 0.7 min and 3.30 ± 0.70 min, respectively. The average Platelet count was 3.60±0.7 and 3.40±0.68, respectively. The average white blood cell count was 7832 ± 770 and 8370 ± 690, respectively.**Conclusion:** The findings from the study can be utilised to enhance an individual's health by improving their baseline health and achieving superior performance during future physical exercise. Customised, programmed, and recommended exercise will undoubtedly elicit a positive physiological response, which can be harnessed to enhance the functional capacity of every system in the human body.
Key words: Hypertension, hemostatic equilibrium, thrombocytic, fibrinolytic and cardiovascular diseases

INTRODUCTION

Cardiovascular disease (CVD) is the primary cause of illness and death on a global scale.[1] A sedentary lifestyle, characterised by persistently low levels of physical activity, is increasingly acknowledged as a prominent contributor to the development and progression of cardiovascular disease (CVD), among the many risk factors. In contrast, engaging in consistent physical exercise and activity is linked to notable and extensive improvements in overall health and a greatly reduced risk of cardiovascular disease (CVD).[2]

One of the main objectives in healthcare is to enhance life expectancy and significantly enhance the quality of ageing by reducing the duration of illness and disability to a shorter time towards the end of one's life.[3] The average lifespan has seen significant growth over the last centuryand the duration of a healthy life with no disabilities has also been expanding. Engaging in consistent physical exercise and activity throughout one's lifetime has been shown in several studies to enhance both life expectancy and disability-adjusted life expectancy.[6,7] The positive impacts of physical exercise on the rehabilitation of cardiac patients and persons at risk or prone to illness, stemming from a lack of physical activity, are well-documented.[8]

Physical activity programmes have successfully reduced both systolic and diastolic blood pressure in hypertensive adults, and they may also be useful in adolescents.[10-12] Given the potential for blood pressure values in adolescence to persist throughout adulthood, it is important to assess this likelihood.[10] Repetitive engagement in mild activities, when accompanied by a prescribed exercise regimen, has an antihypertensive impact of 10-15 mmHg on systolic BP. The precise process by which blood pressure decreases has yet to be fully understood. However, there is evidence suggesting a link between sodium depletion, reduction in blood volume, and the observed decrease in blood pressure. It is plausible that the extended time of exercise treatment may have led to the depletion of salt stores via sweating. Exercise is a valuable addition to sodium restriction and diuretics in treating simple moderate hypertension.[8]

In younger individuals, hypertension often arises from a condition of elevated cardiac output, whereas in older individuals, hypertension is more commonly caused by heightened peripheral vascular resistance[13] and hardening of major arteries.[14] Due to age-related variations in the aetiology of hypertension, it remains uncertain whether the existing exercise recommendations for hypertension are entirely applicable to older individuals.[15]

The objective of the current investigation was to evaluate the impact of physical activity on blood pressure, heart rate, respiratory rate, and other physiological blood parameters in individuals who are in good health.

MATERIALS AND METHODS

The study was conducted on 100 volunteers and they were carefully screened for any significant deviation of health from the normal basal findings. The subjects were made to exercise for 30 minutes and the following observations were recorded.

COLLECTION OF ANTHROPOMETRIC DATA

a) Age
b) Height
c) Weight
d) Body Surface Area

DETERMINATION OF PHYSIOLOGICAL PARAMETERS

a) Heart rate
b) Blood pressure
c) Respiratory rate
d) Bleeding time
e) Clotting time
f) Leucocyte count
g) Platelet count

MEASURING THE HEIGHT

The participant was instructed to stand on a level surface and remove any footwear, headbands, or other head accessories that might potentially interfere with an accurate measurement.The participant was instructed to position himself against a wall, ensuring that his head, shoulders, and buttocks are in contact with the wall. The line of sight and the position of the chin should be parallel to the floor. The subject's height is measured using a wall-mounted metallic tape measure.

MEASURING THE WEIGHT

A digital weighing balance was utilized to determine the weight of the students. Prior to commencing the measurement, the scale was calibrated to a value of zero. The students were requested to take off heavy clothing’s (such as coats, jackets , and vests), bags, shoes and heavy accessories such as belts with hefty belt buckles. In addition, individuals should empty their pockets of all items, such as currency (coins), writing instruments, wallets, and documents. Each student was requested to go on the scale and stand stationary in the centre of the scale platform with the feet slightly apart and the body weight distributed evenly on both feet. The arms should be in a state of relaxation, hanging loosely at the sides of the body. Digital scales are highly sensitive to movement and any movement may affect the weight measurement, thus students must remain quite still and the values were recorded.

MEASURING THE BODY SURFACE AREA

Body Surface Area (BSA) measures the total surface area of the body. The Mosteller formula is most commonly used formula in practice and in clinical trials. The Mosteller formula takes the square root of the height (cm) multiplied by the weight (kg) divided by 3600.

$$BSA\ (m2) = \sqrt{(Height\ (cm) \times weight\ (kg)/3600)}$$

MOTORIZED TREADMILL

All the individuals were forced to walk on the treadmill for 30 min- utes and physiological data were recorded. The treadmill is a VENKY brand athletic model called GIH. The treadmill includes a motor-powered infinite corrugated hard rubber track 450mm wide that may be operated at any pace upto 12 kmph. It is possible to set the pace to easy mode, so that an average person may walk for hours and it can also be adjusted to high-speed mode, so that the best runners can be weary in a very short period.

HEART RATE

Method used to study heart rate is auscultation method. The auscultation is done with stethoscope in sitting position. The area auscultated is Mitral Valve.

BLOOD PRESSURE

The approach used is the auscultation method. The participant is instructed to assume a comfortable seated position. The arm cuff is fastened, the brachial artery is felt in the cubital fossa, and the diaphragm of the stethoscope is placed on the brachial artery. The air pump is subjected to increasing pressure until the mercury level exceeds the reading obtained using the palpatory technique. The pressure is progressively released until the audible sound is produced. The point symbolises the systolic pressure.

As the pressure is progressively removed, a puffing noise is followed by a banging or tapping sound that intensifies and then abruptly transitions into a gentler blowing sound. The abrupt shift in Krotokoff sounds, from a loud pounding to a gentle blowing sound, is interpreted as the diastolic pressure. As the abrupt change cannot be accurately measured, the absence of sound might be used as the measurement for diastolic pressure.

RESPIRATORY RATE

It is studied by inspection of the respiratory movements of the chest and abdomen. One inspiration and expiration make up one cycle.

STETHOGRAPHY

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BLEEDING TIME

Method used is Duke’s bleeding time. Get a finger prick (3-4mm) and note the time. The blood should flow freely without squeezing. Remove the blood drop every 30 seconds by absorbing them along the edge of a clean filter paper without pressing on the puncture and number them 1 onwards. Note the time when bleeding has stopped, that is when there is no trace of blood spots on the paper. Note that the successive spots are smaller, till there is no blood spot. Count the number of spots on the filter paper and express the result in minutes and seconds. Normal bleeding time is 1-5 minutes.

CLOTTING TIME

Method used is capillary blood coagulation time. Get a deep finger prick and allow the blood to flow freely without squeezing.

Discard the first 2-3 drops and allow a large drop to form. Fill a capillary tube with blood by dipping one of its open ends in the drop. The blood rises and fills the tube by capillary action. Note the time. Break off 1 cm bits of the tube from one end every 30 seconds, and look for the formation of fibrin threads between the broken ends. The end-point is reached when fibrin threads span a gap of 5mm between the broken ends. Note the time. Normal coagulation time is 3-6 minutes.

WHITE BLOOD CELL COUNT

Procedure: The finger is cleaned with spirit, pricked with a sterile needle. Clean and dried WBC pipette is taken and blood sucked up to 0.5 mark. Immediately diluting fluid is sucked up to 11 marks. The pipette is held between the thumb and the fore finger, in horizontal position mixing of blood and diluting fluid is done. The Neubaur’s chamber is charged with the dilutant. The counting is done for WBC.

PLATELET COUNT

Fresh blood is diluted in a RBC pipette with Rees-Ecker fluid, and the stained platelets are then counted in a hemocytometer.

COMPOSITION

Brilliant Cresyl Blue -0.05 gm Sodium citrate -3.80 gm

Formaldehyde -0.2ml (40% formaldehyde solution) Distilled water -100 ml

Brilliant Cresyl Blue used for staining the platelets. Formaldehyde prevents the fungal growth. Sodium Citrate prevents the clotting of blood.

Freshly-filtered platelet solution id drawn to the mark of 0.5 in the RBC pipette.

Finger prick is given and blood is drawn into the pipette so that solution reaches the 1.0 mark. Reese-Ecker is taken in the pipette with blood upto the mark of 101. Mix the contents of the bulb for 2 minutes (this gives a dilution of 1 in 200). The purpose of taking 0.5 volume of platelets which occurs if blood is first taken into the pipette. The first 2 drops are discarded and charge the counting chamber in the usual manner and platelet count is done in group of 5 in 16 squares each and calculated the number in 1mm3 of undiluted blood.

RESULTS

Table 1: Demographic Data

Parameters	Mean	SD±	SE±	Confidence Interval (95%)	
				LL	UL
Age (years)	23	3	0.4	22	25
Height (cms)	172	12	1.9	168	175
Weight (kgs)	68	14	22	64	73
BSA (m2)	1.9	0.4	0.04	1.75	1.88

The mean age, height, weight and body surface area of the subject were 23 ± 3 years, 172 ± 12 cms, 68 ± 14 kgs and 1.9 ± 0.4 respectively.

Table 2: Change in Heart Rate, respiratory rate, SBP, bleeding time, clotting time, Platelet Count in lakhs and WBC before and after exercise

Heart Rate	Mean	SD±	SE±	ConfidenceInterval (95%)	
				LL	UL
Before exercise	78	4	0.5	76	78
After exercise	175	8	1.5	172	178
Respiratory Rate					
Before exercise	18	2	0.3	17	18
After exercise	26	2.7	0.5	25	27
SBP					
Before exercise	112	8	1	110	116
After exercise	144	7	1	146	147
Bleeding time					
Before exercise	1.8	0.5	0.07	1.6	1.9
After exercise	1.6	0.5	0.2	1.40	1.63
Clotting time					
Before exercise	3.6	0.7	0.008	3.4	3.8
After exercise	3.3	0.70	0.2	2.88	3.36
Platelets count					
Before exercise	3.6	0.7	0.08	3.4	3.8
After exercise	3.4	0.68	0.2	2.88	3.36
WBC count					
Before exercise	7832	770	125	7585	8080
After exercise	8370	690	112	8082	8565

The mean Heart rate before and after exercise was 78 ± 4 bpm and 175 ± 8 bpm respectively. The mean Respiratory rate was 18 ± 2 bpm and 26 ± 2.7 bpm respectively. The mean Systolic blood was 112 ± 8.0 mmHg and 144 ± 7.0 mmHg respectively. The mean Bleeding time was 1.80 ± 0.5 min and 1.60 ± 0.5 min respectively. The mean Clotting time was 3.60 ± 0.7 min and 3.30 ± 0.70 min respectively. The mean Platelet count was 3.60±0.7 and 3.40±0.68respectively. The mean WBC count was 7832 ± 770 and 8370 ± 690 respectively.

DISCUSSION

The study of exercise physiology has gained significant importance in the field of research and discourse. The work of pioneers in cardiovascular rehabilitation centres has brought significant attention and recognition to the importance of exercise in the recovery of cardiac patients and individuals at risk of disease due to physical inactivity. The scientific validity of exercise today is supported by research conducted in the fields of physical education, exercise physiology, and medicine. Cardiovascular disease (CVD) is the primary cause of illness and death on a global scale. A sedentary lifestyle, characterised by consistently low levels of physical activity, is now acknowledged as a prominent contributor to poor cardiovascular health among the various risk factors that predispose to the development and progression of cardiovascular disease (CVD). On the other hand, engaging in consistent exercise and physical activity is linked to notable and extensive improvements in overall health and a significantly reduced risk of cardiovascular disease (CVD). Multiple longitudinal studies have demonstrated that higher levels of physical activity are correlated with a decrease in overall mortality and may slightly enhance life span, primarily due to a significant decrease in the likelihoodof developing cardiovascular and respiratory disorders.[16] Supporting this concept, research has shown that the mortality rates of both men and women are negatively correlated with their levels of cardiorespiratory fitness. This correlation remains significant even when considering other factors that predict cardiovascular mortality, such as smoking, hypertension, and hyperlipidemia.[17]

The average age, height, weight, and body surface area of the participants were 23 ± 3 years, 172 ± 12 centimetres, 68 ± 14 kilogrammes and 1.9 ± 0.4, respectively. The average heart rate prior to and following exercise was 78 ± 4 beats per minute (bpm) and 175 ± 8 bpm, respectively. There was an abrupt rise in heart rate at the beginning of the performance, which then levelled off at a slightly lower rate as the exercise continued. The initial rapid elevation in heart rate during the start of exercise is caused by a "anticipatory" response generated by the cerebral cortex. This response diminishes as exercise apprehension subsides, leading to a sustained increase in heart rate. The heart rate returns to its pre-exercise basal level within 5 to 6 minutes after the termination of exercise.[18] The mean Respiratory rate was 18 ± 2 bpm and 26 ± 2.7 bpm respectively. Rashida Bhatti *et al*.[19], found the mean systolic blood pressure was 118.64 ± 8.05mmHg and 139.32 ± 12.5 mmHg before and after exercise respectively and the mean diastolic blood pressure was 77.59 ± 7.19 mmHg and 110.91 ± 14.79 mmHg before and after exercise respectively.

The mean Systolic blood was 112 ± 8.0 mmHg and 144 ± 7.0 mmHg correspondingly. The mean Bleeding time was 1.80 ± 0.5 min and 1.60 ± 0.5 min respectively. The mean Clotting time was 3.60 ± 0.7 min and 3.30 ± 0.70 min correspondingly. The mean Plateletcount was 3.60±0.7 and 3.40±0.68respectively.The mean WBC count was 7832 ± 770 and 8370 ± 690 correspondingly. With regard to above changes in hemostatic mechanisms during the exercise the insight to this is originated from the observation that sudden deaths are reported in immediate post exertion period by all probability such deaths occur due to thrombo-occlusive disease. The constituents of body which can cause increase in tendency for thrombosis includes-

A. Rise in viscosity of blood.
B. Decrease in velocity of blood flow.

Leading to some degree of stasis of blood associated with this there occur activity of inert clotting factors which produces enhance rate of blood coagulation and shortening of bleeding time and clotting time.

Gimenez *et al*.[20], both trained and untrained subjects were made to exercise for 15 minutes and the results showed that both groups differ in maximal work load and total exercise, but increase in total WBC count lymphocytes and platelet count has occurred in both the trained as well as untrained groups. There appears to be no difference between untrained and trained subjects in the increase of WBC and platelet count. The total platelet count were higher in trained subjects both at rest and after exercise. This appears related to the higher level of exercise performed by trained subjects. Inference Considering that exercise raises the platelet count, the higher resting levels seen in trained participants may indicate a lasting reaction to prior bouts of activity.

CONCLUSION

The findings derived from the research may be used to enhance an individual's health by improving their fundamental well-being and optimizing their performance in following physical activities. Customized,algorithmically designedand recommended exercise will certainly elicit a positive physiological reaction, which may be harnessed to enhance the operational ability of every system in the human body.

REFERENCES

1. CDC, N. (2015). Underlying Cause of Death 1999-2013 on CDC WONDER Online Database, Released 2015. Data are From the Multiple Cause of Death Files, 1999-2013, as Compiled from Data Provided by the 57 Vital Statistics Jurisdictions Through the Vital Statistics Cooperative Program (Accessed Feb. 3, 2015).
2. Nystoriak MA, Bhatnagar A. Cardiovascular effects and benefits of exercise. Frontiers in cardiovascular medicine. 2018 Sep 28;5:135.
3. Tesch-Römer, C.; Wurm, S. Wersind die Alten? TheoretischePositionenzum Alter und Altern. In Gesundheit und Krankheitim Alter; Robert Koch Institut, Ed.; Robert Koch Institut: Berlin, Germany, 2009; pp. 7–30.
4. Reimers, C.D.; Knapp, G.; Reimers, A.K. Does Physical Activity Increase Life Expectancy? A Review of the Literature. J. Aging Res. 2012, 2012, 9.
5. Samitz, G.; Egger, M.; Zwahlen, M. Domains of physical activity and all-cause mortality: Systematic review and dose-response meta-analysis of cohort studies. Int. J. Epidemiol. 2011, 40, 1382–1400.
6. May, A.M.; Struijk, E.A.; Fransen, H.P.; Onland-Moret, N.C.; de Wit, G.A.; Boer, J.M.; van der Schouw, Y.T.; Hoekstra, J.; Bueno-de-Mesquita, H.B.; Peeters, P.H.; *et al*.The impact of a healthy lifestyle on Disability-Adjusted Life Years: A prospective cohort study. BMC Med. 2015, 13, 287.
7. Bronnum-Hansen, H.; Juel, K.; Davidsen, M.; Sorensen, J. Impact of selected risk factors on quality-adjusted life expectancy in Denmark. Scand. J. Public. Health 2007, 35, 510–515.
8. Rekha GS, Garapati S, Anjum A. Study On Effect Of Exercise On Blood Pressure, Heart Rate, Respiratory Rate And Physiological Blood Parameters. Int J Anat Appl Physiol. 2020 Sep 10;6(2):135-43.
9. Andrade S, Lachat C, Ochoa-Aviles A, Verstraeten R, Huybregts L, Roberfroid D, Andrade D, Camp JV, Rojas R, Donoso S, Cardon G. A school-based intervention improves physical fitness in Ecuadorian adolescents: a cluster-randomized controlled trial. International Journal of Behavioral Nutrition and Physical Activity. 2014 Dec;11(1):1-7.

10. O'Donovan C, Greally P, Canny G, McNally P, Hussey J. Active video games as an exercise tool for children with cystic fibrosis. Journal of Cystic Fibrosis. 2014; 13(3): 341-346.
11. Luísa Dias Quitério A. School physical education: The effectiveness of health-related interventions and recommendations for health-promotion practice. Health Education Journal. 2013; 72(6), 716-732.
12. Pradeep A. Praveen, Roy A, Prabhakaran D. Cardiovascular Disease Risk Factors: A Childhood Perspective. The Indian Journal of Pediatrics. 2013; 80(S1): 3-12.
13. Cheitlin MD. Cardiovascular physiology: changes with aging. Am J GeriatrCardiol. 2003; 12: 9-13.
14. Montain SJ, Jilka SM, Ehsani AA, Hagberg JM. Altered hemodynamics during exercise in older essential hypertensive subjects. Hypertension. 1988; 12: 479- 484.
15. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. American College of Sports Medicine position stand: exercise and hypertension. Med Sci Sports Exerc. 2004; 36: 533-553.
16. Paffenbarger Jr RS, Hyde R, Wing AL, Hsieh CC. Physical activity, all-cause mortality, and longevity of college alumni. New England journal of medicine. 1986 Mar 6;314(10):605-13.
17. Blair SN, Kampert JB, Kohl HW, Barlow CE, Macera CA, Paffenbarger RS, Gibbons LW. Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. Jama. 1996 Jul 17;276(3):205-10.
18. Deuk-Ja Oh, HyeonOk Hong, Bo-Ae Lee. The effect of strenuous exercise on resting heart rete, blood pressure and maximal oxygen uptake. J exerc. Rehabil. 2006: 12(1): 42-46. PMID: 26933659.
19. Bhatti R, Shaikh DM. The effect of exercise on blood parameters. Pakistan Journal of physiology. 2007 Dec 31;3(2).
20. Gimenez M, Mohan-Kumar T, Humbert JC, De Talance N, Teboul M, FJ AB. Training and leucocyte, lymphocyte and platelet response to dynamic exercise. The Journal of Sports Medicine and Physical Fitness. 1987 Jun 1;27(2):172-7.