Effects of Acute Physical Exercise on Coagulation in Obese subjects and its relation to Blood Lactate and Lipid Levels

BY

AWOT SUNDAY LUKE (MSC. MED. PHYSIOLOGY)

H56/70089/2013

THIS THESIS IS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER IN SCIENCE IN MEDICAL PHYSIOLOGY OF THE UNIVERSITY OF NAIROBI.

DECLARATION

This Thesis is my original work and has not been presented for a degree in any other University.

Signature …… Date ……

Dr Awot Sunday Luke

H56/70089/2013

Supervisors Approval:

This Thesis has been submitted for review with our approval as University Supervisors.

1. Signature …… Date ……

   Prof Kihumbu Thairu,PhD

   Department of Medical Physiology

   University of Nairobi

2. Signature …… Date ……

   Dr. Gordon Ogweno,MMed

   Department of Medical Physiology

   Kenyatta University

3. Signature…… Date……

   Dr F.O Bukachi,PhD

   Chairman,

   Department of Medical Physiology

   University of Nairobi

ACKNOWLEGMENTS

I wish to express my utmost gratitude to my supervisor Prof Kihumbu Thairu..He has been a source of encouragement and inspiration. Dr Gordon Ogweno for his constant support and guidance throughout the realization of this thesis. Dr Peter Waweru who has greatly contributed to my scope and understanding of Medical physiology.

I appreciate the insight from all Lecturers from the Department of Medical Physiology. Their critical appraisal was pivotal in conceptualization of my work. Ms. Clara Maigacho, who provided technical support in conducting thromboelastography. Mr. Wilfred Gatua, of Kenyatta National Hospital, hematology laboratory who helped in analysis of the blood samples.

To my colleagues, Dr Denis Rono, Dr Douglas Mwaniki, Dr Faraj Alkizim, Mr Eliphas Gitonga and Mrs. Rose Kamenchu for their intellectual and moral support throughout our course work. My enduring gratitude to my husband, Mr Benard Barasa for cheering me on.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEDICATION

To my mother Dina Disan Olweny for being my rock and my late father Mr. Luke Ipoto Ojok for having led by example.

DEFINITION OF SIGNIFICANT TERMS

Acute Exercise refers to planned, repetitive and scheduled activity done within a time frame of less than 30 minutes. It requires a substantial amount of effort and results in significant increase in heart rate and rapid breathing.

Obesity is defined as excessive fat accumulation that has negative health implications.

Body mass index is a measure of weight for height ratio that gives an index of healthiness. It is calculated as body mass in kilograms divided by the square of the body height in meters.

Coagulation in medical terms refers to the process by which a blood clot is formed. A hypercoagulable state is associated with thromboembolic disease, while a hypocoagulable state predisposes one to bleeding tendencies.

Lactate is a product of glycogen metabolism in anaerobic states like during acute exercise.

Lipids can be broadly defined as fatty acids and their derivatives.

ABBREVIATIONS & ACRONYMS

ACoTS	Acute Coagulopathy of Trauma/ Shock
ANOVA	Analysis of variance
APTT	Activated partial thromboplastin time
ATP	Adenosine triphosphate
BMI	Body Mass Index
Cf DNA	Cell free DNA
DVT	Deep vein thrombosis
ECG	Electrocardiogram / Electrocardiography
EDTA	Ethylenediaminetetraacetic acid
HDL	High-density lipoprotein
HDL-C	High-density lipoprotein-Cholesterol
INR	International Normalised Ratio
LDL	Low-density lipoprotein
PT	Prothrombin time
NETS	Neutrophil Extracellular traps
RBC	Red Blood Cell
SEM	Standard Error of Mean
TEG	Thrombelastography
TF	Tissue factor
WHO	World Health Organisation
PMP	Procoagulant microparticles

ABSTRACT

BACKGROUND

Long term physical activity is beneficial in reduction of both body weight as well as attendant death from cardiovascular diseases. However activation of haemostasis has been reported in laboratory analysis after intense physical activity. This incongruence between benefit of long term physical exercise and laboratory coagulation analysis probably arises from studies carried out in plasma, and not whole blood in isolation. Furher the studies did not correlate test results to lactate and lipid levels which are both raised during exercise.

Objective: The aim of the present study was to investigate the effect of acute physical activity on blood coagulation in obese and non obese individuals, correlating with changes in lactate and lipid profiles.

SETTING: Medical Physiology Department, Kenyatta University, Nairobi

MATERIALS and METHODS

Obese and control groups (10 individuals in each group, 5 females and 5 males), aged 18 to 39 years were recruited after signing written consent. Anthropometric data which included height, weight, abdominal circumference, wrist circumference and BMI were taken for each subject. The subjects underwent Harvard step test exercise for 5 minutes. Venous blood collection, haemodynamic measurements and electrocardiography were carried out at baseline before, within 1 minute after and 45 minutes after exercise. Laboratory tests were carried out for each subject. These tests were haemogram, lipid

profile, blood gas analysis, coagulation by routine and thromboelestography tests for all blood samples. Data were analyzed using independent t- test, correlation analysis and repeated measures ANOVA. Results were expressed as mean ± SD. The statistical difference was considered significant at $P < 0.05$.

RESULTS

Mean BMI for obese individuals was 33.6 while non-obese was 21.1. Acute physical activity was associated with increase in haemodynamic measurements, blood lactate and blood lipids, which returned to baseline values concurrently. However, no statistical differences were seen for lactate between the two groups at rest (1.66 ±1.37(C) vs. 1.06±0.62 (T), within 1 minute after exercise (8.24 ±2.47(C) vs. 9.21±1.50 (T) and at time of recovery (3.15 ±1.56(C) vs. 4.00±3.00 (T).The levels of LDL equally showed statistical significance across time in the two groups. Baseline means were (2.08±0.53(C) vs. 2.72±0.42(T)) (p=0.008) at rest, (2.23±0.69(C) vs2.93± 0.33(T)) (p=0.012) after exercise ,(2.000±0.537 vs. 2.730±0.435) (p=0.004) at time of recovery. Routine coagulation, serum based tests did not change significantly, but whole blood based thromboelastographic maximum amplitude changed significantly with time and between the subjects($p<0.005$).

There was no correlation between blood lactate and routine coagulation in the experimental group. Lactate levels correlated positively with R value ($r(10) = 0.75$, $P<0.01$) at 45 minutes. While there was negative correlation between lactate and G value ($r(10) = -0.68$, $p < 0.03$.) Correlation of lipid profile and coagulation were not statistically significant for LDL and Cholesterol ratio.

CONCLUSION

Lactate and lipid levels were shown to increase after exercise and returned to normal at rest in both the obese and non obese subjects. However the changes in the two did not have a linear correlation with routine coagulation indicators as well as thromboelestography. Thus, the study concludes that lactate cannot be used as a predictor for development of hypercoagulabilty in vivo leading to an increased risk of thrombus formation. Likewise, lack of significant correlation between changes in lipid profile, especially LDL, cannot explain the differences seen thus far in coagulation after exercise. Demonstration of coagulation changes in whole blood, but not in plasma following acute physical activity warrants further investigation.

KEYWORDS

Acute exercise, Obesity, coagulation, Blood lactate, Lipids.

CHAPTER ONE: INTRODUCTION

1.1 Background

Globally, the prevalence of obesity is on a sharp increase owing to adoption of sedentary lifestyles and nutritional disorders. As a result, these individuals are at high risk of cardio metabolic derangements accounting for over 50% of new onset heart attacks and strokes (Fernandez-Sanchez, 2011). The beneficial effect of regular physical exercise on weight reduction and treatment for cardiovascular diseases has been known for a long time, especially on thromboembolism. A key postulate is that physical activity by increasing mobility in the so called Virchow's triad, retards thrombus formation. However, this paradigm is derived from epidemiological data, in hospital patients and in trained individuals exercising over a period of time. A number of empirical laboratory results, though conflicting, indicate that exercise induces hypercoagulability (Rauramaa, 1999) and also hypocoagulability. The in-congruency between laboratory tests and clinical observations remains undetermined.

Physical exercise is associated with production of many compounds, particularly free radicals and oxidative stress, and levels increase with the intensity of activity, especially if exhaustive (Vina, 2000; Stief, 2000). Free radicals are produced by biochemical processes that take place within aerobic organisms. These compounds originate from biochemical processes in the degradation of ATP, conversion of hypoxanthine to uric acid and auto oxidation of oxyhaemoglobin and oxymyoglobin. Lipid peroxidation leads to rise of the free radicals in circulation. (Rahman, 2007). On the haemostatic system, free radicals are known to promote platelet aggregation, activation of coagulation cascade and ultimately thrombosis/atherosclerosis (Vina, 2000). Free radicals are involved in

pathogenesis of many cardiovascular diseases, especially atherogenesis, promotion of blood clotting and platelet aggregation (Mimic, 1999). Paradoxically it is still unclear the coexistence with free radical formation and the beneficial effects of physical exercise on mitigating cardiovascular risk factors.

Lactate is an intermediate between anaerobic and aerobic metabolism. Lactate levels accumulate in proportion to intensity of muscular activity. In blood, lactate exists as lactic acid thus contributing to acidosis responsible for its physiological consequences. Acidosis/acidemia as part of lethal triad in trauma shock has long been considered a factor in impairment of haemostasis in the clinical syndrome of Acute Coagulopathy of Trauma/ Shock (ACoTS) (Brohi, 2008). Although this postulate is reinforced by in vitro findings that lactic acid acts as a free radical scavenger and inhibitor of platelet aggregation, empirical evidence in clinical settings is still conflicting.

Differences in methodological approaches are of note in interpretation of results from different studies. Foremost is analysis of sub components of blood, like conducting tests on plasma without contribution from cellular elements thus giving an incomplete picture. Moreover, test results have been correlated to physiological variables like blood pressure or heart rate, but correlation to blood lactate and lipid levels which also change with exercise intensity remain undetermined. This current study addresses correlations between blood lactate levels and changes in lipid profiles with coagulation following acute exercise.

Obese subjects are at increased risk of death from cardiovascular diseases, especially from thromboembolism (Redinger, 2007). Physical exercise is often prescribed for weight

loss but associated with blood hypercoagulability though data is conflicting. It is not known to what extent exercise induced hypercoagulability is related to other biochemical markers produced during physical activity and what role these compounds contribute to thromboembolism associated with obesity.

CHAPTER TWO: LITERATURE REVIEW

2.1 Obesity

World Health Organisation (WHO, 2014) estimates that 39% of adults are overweight and 13% are considered obese. In Kenya, 12.3% of the urban female population is obese (WHO, 2003). Despite being preventable, obesity is associated with health impairments that include increased of morbidity and mortality from heart attack and thromboembolic complications (Redinger, 2007). Most studies have relied on body mass index (BMI) a useful tool in determining the health index and classification of overweight and obesity. Using this criteria, individuals have been classified into underweight (BMI<18), normal (18.5-24.99), overweight (>25.00), obese class I (30.00-34.99), obese class II (35.00-39.99) and obese class III (40.00) (WHO, 2015). Body mass index is widely used because it is easy to measure, relatively cheap, and has clear cut-off points that are nearly accurately correlated with body fat levels. (Harvard school of public health, 2016).

Other alternative methods such as waist- to- mid abdomen circumference are used as a predictor of disease development, morbidity and mortality (Adegbija et al, 2015). Despite its limitations which include lack of correlation between body fat content and changes associated with ageing, Body mass index still remains widely used for determination of obesity (Rothman, 2008).

2.2 Physical activity in obesity

Obesity results from an imbalance between energy input and output. Age, body fat, gender, genetic factors and exercise can determine total calorie expended. Physical

activity remains the most variable and modifiable factor in determining energy expenditure (Jakicic, 2005).

Exercise is defined as a planned, structured and repetitive activity aimed at improving physical fitness and health status. Physical activity mitigates obesity by increasing total energy expenditure. It also slows development of abdominal obesity by reducing fat around the waist. In addition to this it decreases depression and anxiety (Penedo et al, 2005).

About 17% of all sudden cardiac deaths occur after a vigorous bout of physical activity. (Albert, 2000), with the highest risk being during or within one hour of exertion. (Thompson, 2007). However regular physical exercise has been shown to reduce risks in both transient and long term periods. (Corrado et al, 2006; Whang, 2006; Thompson, 2007).

Most studies that have addressed the question of effects of physical activity and coagulation omitted the BMI of the subjects. Without BMI information the risk factor for hypercoagulability is open to speculation. Empirical data of studies done on coagulation in exercise are discordant owing to different study designs(Rauramaa, 1999, Most studies have been done on normal healthy individuals with little comparison to obese individuals hence the importance of this study.

2.3 Coagulation

Traditionally, thrombus formation has been viewed, arising from Virchow's triad of stasis or immobility, alteration of blood composition or hypercoagulability, and endothelial damage. With exercise there is increased blood flow which would mitigate one of the Virchow's triads; though deep vein thrombosis (DVT) still continues being reported

suggesting another factor is at play related to physical activity. None of the studies have demonstrated endothelial damage, therefore strongly suggesting alteration of circulating factors may be the key sentinel pathway. The studies that have attempted to address this question have largely relied on assays of plasma in routine coagulation tests (Prothrombin Time PT, activated Partial Thromboplastin Time ,aPTT) . These studies have produced differing results. For example, while Lamprecht reported normal results (Lampretch, 2013), Watts found hypocoagulability (Watts, 1991). A major limitation in their study designs was reliance on plasma analysis without taking into account contribution from cellular components. It is now known that tissue factor (TF), initiator of extrinsic coagulation pathway, though previously considered to arise from exposed collagen is expressed a thousand fold from activated monocytes (Monroe, 2001) and RBC (Ninnivagi et al, 2011). Furthermore, the routine coagulation assays involve addition of exogenous coagulation activators such as thromboplastin(200 pM TF). This factors are used at concentrations which are several times higher than physiological levels (of up to 40 pM TF). This high level of activators probably abrogates any factor deficiency/excess that may occur in association with exercise and therefore may explain lack of strong correlation between the factors studies in this work that were expected to influence coagulation outcome.

Currently coagulation is regarded as a cell based model(Monroe,2001) with coagulation factor reactions occurring on cellular surfaces. In this model, the physiological source of TF is monocytes and RBC. Hence the present study will examine coagulation of whole blood which will encompass the cellular component and its role in haemostasis.

2.4 Whole blood-Thromboleastography (TEG)

Thromboelestography is a coagulation method performed on whole blood that gives us data on the dynamics of clot development, its stabilization and dissolution that reflect *in vivo* haemostasis. In providing information about the speed and strength of clot formation it gives an analysis of how well the factors involved in haemostasis are functioning (Milind, 2012).

Normal range values for coagulation have been outlined and explained in an article by (Scarpelini ,2009) on coagulation parameters in healthy adult volunteers using TEG.

In Lamprecht's (2013) study involving TEG on blood from obese women after a bout of walking exercise that did not demonstrate a change in coagulation profile only measured lipid profile and lactic acid pre-exercise without reporting changes thereafter in relation to coagulation tests. However, it is difficult to generalize the findings of this study owing to some limitations inherent in study design. These were, lack of cross gender comparison, walking is none intensive and therefore less likelihood of lactic acid accumulation. Although lactic acid was measured before activity, no data was presented post exercise.

2.5 Lactic acid and Physical activity.

At rest blood lactate levels are negligible, but levels rise with intensity of anaerobic metabolism during physical activity. Lactate has been postulated to provide antioxidant benefits and thus acting as free radical scavenger and possibly contributing to the beneficial effects of exercise in mitigating cardiovascular risk (Groussard C et al, 2000). The effect of lactic acidosis, if any, on coagulation and haemostasis has not been established. Though in vitro study demonstrated lactic acid impairs coagulation (Engstrom M et al, 2006) this may not be so in vivo.

Numerous studies have been conducted in both trained and untrained individuals, but they have focused on the levels of lactate rise after exercise and fall post exercise through to the recovery period. (Goodwin et al.2007; Alfaro et al, 2002). To the best of our knowledge no one has done a study to establish the correlation between lactate and coagulation *in vivo*.

In view of the above, then, it is important to establish the correlation between a rise or fall in lactic acid on coagulation. This will provide insight to establish beneficial or detrimental effects of accumulated lactic acid in vivo on coagulation. It will also help explain the incidences of sudden cardiac death as a result of thromboembolic phenomenon in individuals who engage in a vigorous bout of exercise without having underlying cardiac diseases.

2.6 Lipid profile and physical activity

During physical activity, blood lipids increase (Bhatti et al, 2001). Lipids especially negatively charged phospholipids accelerate blood coagulation. In most studies of coagulation in relation to exercise, lipid levels are rarely measured despite its known role as a promoter of coagulation.

All measurements on lipids are increased in obesity and overweight individuals except high density lipoprotein (HDL) (Bhatti et al, 2001). This increase has demonstrated a linear correlation between the body weight fat and levels of cholesterol, triglycerides and LDL (Szcygielska et al, 2003).

The effects of exercise on lipids have been studied though not comprehensively. Some of the studies established a significant change in the lipid levels with exercise, while others

did not demonstrate any effect of exercise on lipids. (Leoan et al. 2001; Katzmarzyk et al. 2001).

A study in men with hypercholesterolemia found triglyceride levels to be higher and Total cholesterol level was lowered after a single bout of exercise. Higher levels of high-density-lipoprotein, cholesterol (HDL-C), HDL_3-C, apo A-I, and apo B were demonstrated after exercise as well. While total cholesterol, HDL3-C, apoA-I and apo B lowered, Levels of HDL-2 were found to be higher post exercise (Stephen et al, 1997).

Measurements for Low-density lipoprotein (LDL), High-density lipoprotein (HDL), Triglycerides, Total cholesterol will be done in this study. An article by Arsenault et al established an association between cardiovascular risks and lipids (Arsenault et al, 2011). They demonstrated that higher levels of LDL had a linear correlation with development of cardiovascular disease, as well as lower levels of HDL. The present study therefore aims to investigate the effects of acute physical activity on lipid profile before, immediately after and at the recovery period, to correlate the outcomes with coagulation and provide a better understanding of the dynamics of lipids and their corresponding role in coagulation during exertion.

CHAPTER THREE: MATERIALS AND METHODS

Hypothesis

Ho: Lactate levels and lipid profile status have no correlation with coagulation following acute exercise.

H1: Lactate levels and lipid profile status have a correlation with coagulation following acute exercise.

Overall Objective

The main objective of the study is to investigate the effects of acute physical exercise on coagulation and its correlation with blood lactate and lipid levels in obese subjects.

Specific Objectives

The specific objectives are:

1. To determine the effects of acute physical exercise on blood coagulation in obese and non-obese subjects using Thromboelastography.
2. To compare effects of acute aerobic exercise on coagulation status in obese vs. non-obese subjects
3. To examine the correlation between coagulation status with blood lactate and lipid levels.

3.1 Study design

The study was designed as a comparative, experimental and analytical experiment, to establish the effects of acute exercise on coagulation in obese subjects and its correlation to blood lactate and lipid levels.

3.1.1 Location

The study was carried out at Kenyatta University Main campus, Ruiru, at the department of Medical Physiology and the Laboratory complex building.

3.1.2 Study population

Sample size determination and recruitment procedures

Sample size based on previous similar studies that had similar samples sizes (Wang et al, 1994; Weiss et al, 1998).

Total number of subjects was 20, with 10 subjects in each group. Each group had 5 males and 5 females. Males in the control group are aged ranging from 21 to 28, while in the experimental group between 21 to 39 years.

Females in the control group are aged between 19 and 30 years while obese females are aged between 20 and 31 years. They were all staff and students of Kenyatta university community.

Allocation to study groups

Group 1: Obese subjects, BMI >30

Group 2: Non-obese subjects (matched for age and gender), BMI <24

3.2 Eligibility criteria

Human subjects-Healthy sedentary human subjects who met the following criteria

- Inclusion criteria: - Subjects must sign an informed consent, completion of medical and physical activity/well being questionnaire. Must be aged between 18 to 45 years, No smoking or alcohol intake within a week of participation. Must have fasted overnight. No trauma for last one month, sedentary lifestyle, no dietary or nutritional supplement use within last 4 weeks prior to test. All participants were of African origin.

- Exclusion criteria: - Subjects who did not consent, those who were below 18 and above 45 years of age, subjects who do not fit the criteria of exercise eligibility as described in sports medicine. This includes: smokers of cigarettes or marijuana, recent trauma in the last one month, taking lipid lowering or anti-platelet drugs, recent surgery or illness, diabetes mellitus, dyslipidaemia, diagnosis of osteoporosis and osteopenia. Expectant women were not included in the study.

3.3 Acute physical exercise and laboratory Protocols

Study subjects were requested to sign informed consent form before recruitment and complete the Health history questionnaire for screening of health status (Appendices 1 and 3).

3.3.1 Baseline Anthropometric and physiological measurements

Baseline anthropometric measurements of all the subjects were taken using a Seca® stadiometer (height) and weight on digital bathroom scale (Eastmart®) with subject in light clothing. The values obtained were then tabulated and the BMI calculated using the formula BMI = Weight in Kg/ Square of height in meters (Appendix 3). All subjects with a BMI >30 were assigned to the test group while those with a BMI <30 were assigned to the control group. Care was taken to ensure that the subjects in both experimental groups were matched both in terms of sex, age and health status.

3.3.2 Blood pressure measurement

Blood pressure was measured before exercise, immediately after exercise and after 40 minutes of rest. This was carried out as described by the American Heart Association Blood pressure monitoring guideline, 2014. Subjects were seated on a comfortable chair with straight back and feet on the floor. A fitting cuff was used and placed at the ante cubital fossa with the hand resting on a flat surface at the heart level. All subjects did not

engage in any physical activity 30 minutes to the time of blood pressure measurement. An automated BP machine, Sphygmomanometer MA1 was used.

3.3.3 Electrocardiography (ECG)

A standard resting 12-lead recording was made during quiet respiration, with subjects in a supine position. The ECG was recorded at standard sweep speed of 25mm/s and 0.1 mV/mm amplitude. ECG were analyzed for any cardiac abnormalities. Analysis and reporting was done according to Sokolow-Lyon index as follows: Sum of S wave in V1 and R wave in V5 or V6 >/= 3.5 mV (35 mm) and/or R wave in aVL >/= 1.1 mV (11 mm) to determine and exclude left ventricular hypertrophy.

3.3.4 Aerobic exercise

All individuals were subjected to the Harvard step test using the protocol by (Jain et al., 1991). Briefly the test was performed by the individuals stepping on and off a standard step apparatus (stepping height 46 cm) at a rate of 30 steps/ minute for 5 minutes. The stepping rate was controlled using a metronome.

Scoring of results was done using the fitness index score which is described as (100 x test duration in seconds) divided by (2 x sum of heart beats in the recovery periods).

Fitness Index score. Table 1

rating	fitness index (long form)
excellent	> 96
Good	83 – 96
Average	68 – 82
low average	54 – 67
Poor	< 54

(Referenced from: Fox et al. 1973).

Harvard step test requires is cost effective and easy to use. However the stepping height of 46 cm presents a challenge to short subjects while tall subjects will generally use less energy to step up.

All the Non obese subjects were able to complete the entire 5 minute step test. While all the male obese subjects were able to complete, not all female obese subjects managed to complete the entire 5 minutes. Two completed with great difficulty .One was unable to complete the test and was replaced by another subject of the same gender and obesity status.

3.3.5 Blood sample collection procedures

Blood samples (at least 15mls during every collection) were collected non-traumatically via venous puncture of ante cubital vein using G18 needle before exercise following overnight fast, 1 minute after and 45 minutes after exercise. The collected blood was then

placed into polypropylene tubes and divided in aliquots. During each blood sampling, the first 5 mls was discarded to avoid inadvertent coagulation activation and the second 10 mls taken for analysis. Samples for TEG testing and routine coagulation testing (PT and aPTT) in 3.8% citrated tubes, and those samples for lactate and lipid profile were placed in tubes containing sodium fluoride. A full haemogram on EDTA blood samples were analyzed using a coulter counter (model).

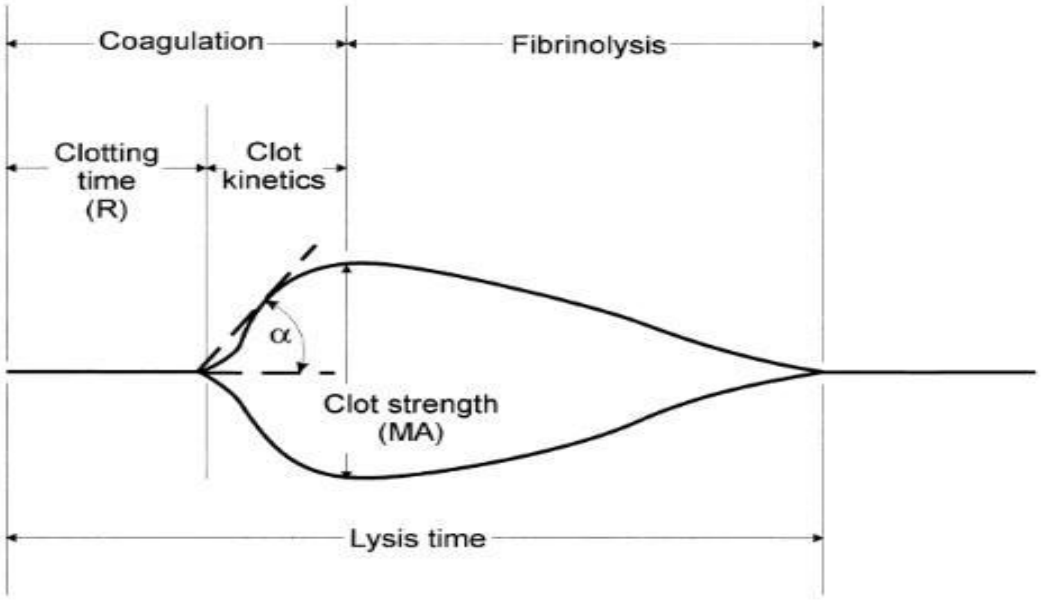
3.3.6 Coagulation testing procedures

Thromboelastography of whole blood was conducted according to the protocol by (Hanke et al., 2010) with minor modifications. Briefly Thromboelastography procedures in the blood collected before exercise were analyzed in the presence and absence of added 0.2 M lactic acid (1:4 dilution), while procedures in those collected after exercise were analyzed according to manufacturers' instructions. TEG parameters, R, K, alpha and Ma were recorded. Routine coagulation tests (aPTT, PT, INR) were carried out on CSL coagulometer.

Thromboelastography

Thromboelastography allows for coagulation monitoring by determining kinetics of clot formation and growth as well as the stability and strength of the formed clot.

The below diagram shows a thromboelastrogram.



Referenced from: De Wolf A, 2012.

In summary R time is a reflection of coagulation factor levels, it describes the time until the initial fibrin formation. Angle represents the level activity of fibrinogen. It is a representation of fibrin build up and cross linking. MA gives a reflection of both the fibrinogen activity and platelet function representing the maximal clot strength.

TEG parameters have been described in volunteer adults (Scapelini et al, 2009)

R(reaction time); 5- 15 minutes, K(coagulation time) 3 – 6 minutes, α(clot formation range)> 45°,MA(maximum amplitude) 50-60 mm. G value is a log derivative of MA which also represents clot strength. EPL represents percentage of clot that has lysed after 30 minutes.

3.3.7 Assay of blood lactate and plasma lipid profile

Blood lactate was measured immediately within the Department of medical Physiology using the i-STAT® 1 portable clinical analyzer.

Bloud samples were centrifuged at 1500 g and the supernatant plasma stored in ice cold pack and transported to university of Nairobi clinical laboratory at Kenyatta National Hospital for assays.

3.4 Data Analysis

All the data were analyzed by Independent T test and repeated measures (ANOVA) and expressed as means ± standard error of means (SEM). Differences were considered significant if $P < 0.05$.

3.5 Ethical and Logistical considerations

These protocols together with detailed protocols were submitted to the ethical committee for approval. Approval for the study was granted by Board of Post graduate studies at both The University of Nairobi and Kenyatta University. Subjects were given information about the study in a language best understood before signing a written consent form. Confidentiality of all information and samples was maintained at all times.

This study was conducted according to the guidelines of the Declaration of Helsinki for research on human subjects 2013(World medical Association, 2013).

CHAPTER FOUR: RESULTS

4.1Baseline Data

4.1.1Anthropometric data

Twenty subjects were divided into two groups of 10 subjects each.

The two groups each consisted of 5 males and 5 females in each group.

Table 1. Anthropometric data of normal subjects (n=10)

	Minimum	Maximum	Mean	Std. Deviation
Age	19.0	30.0	23.8	3.939
BMI	17.62	25.1	21.06	2.340
Height	155.0	183	169.3	6.155
Waist circumference	66.0	87	79.66	1.437
Weight	51.7	76.9	60.33	8.680
Wrist circumference	14	18	16.37	8.052

Table 2: Anthropometric data of obese subjects (n=10)

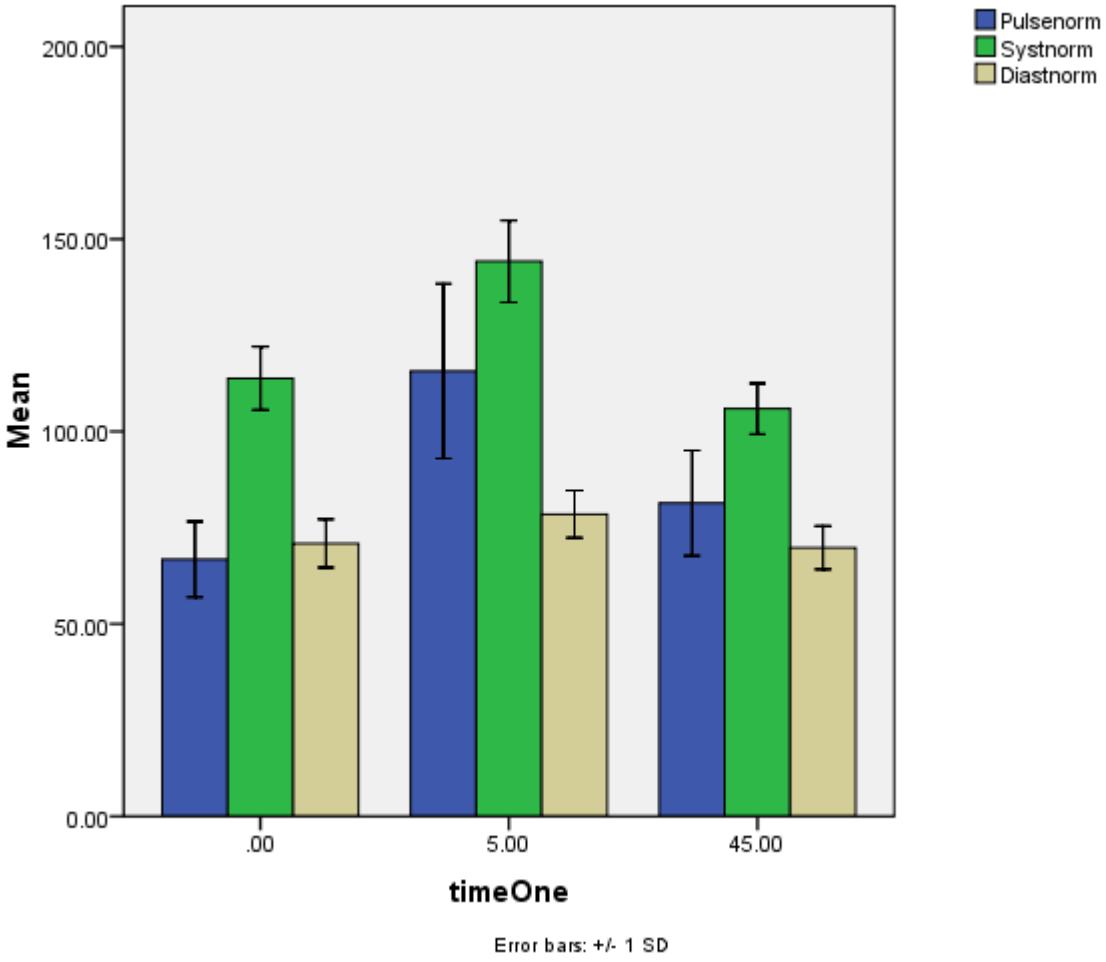
	Minimum	Maximum	Mean	Std. Deviation
Age	20.0	39.0	26.0	7.118
BMI	30.4	41.93	33.604	3.536
Height	155.0	177.0	166.7	7.454
Waist circumference	97.0	128.0	105.4	8.810
Weight	84.0	111.4	93.08	7.982
Wrist circumference	15	19.5	17.59	1.593

4.1.2 Haemodynamics

Before exercise, Heart rate demonstrated statistical differences (66.8±9.807(C) vs. 78.0± 12.780(T)) (p=0.042) between the non-obese and obese subjects.

At recovery systolic blood pressure was demonstrated to be higher between the obese subjects (109.5± 66073(C) vs119.1 ±9.746 (T)) (p=0.002).

Higher diastolic blood pressures was found at recovery between the non-obese and obese subjects (69.6 ±5633(C) vs. 77.7± 64.644(T)) (p=0.009).



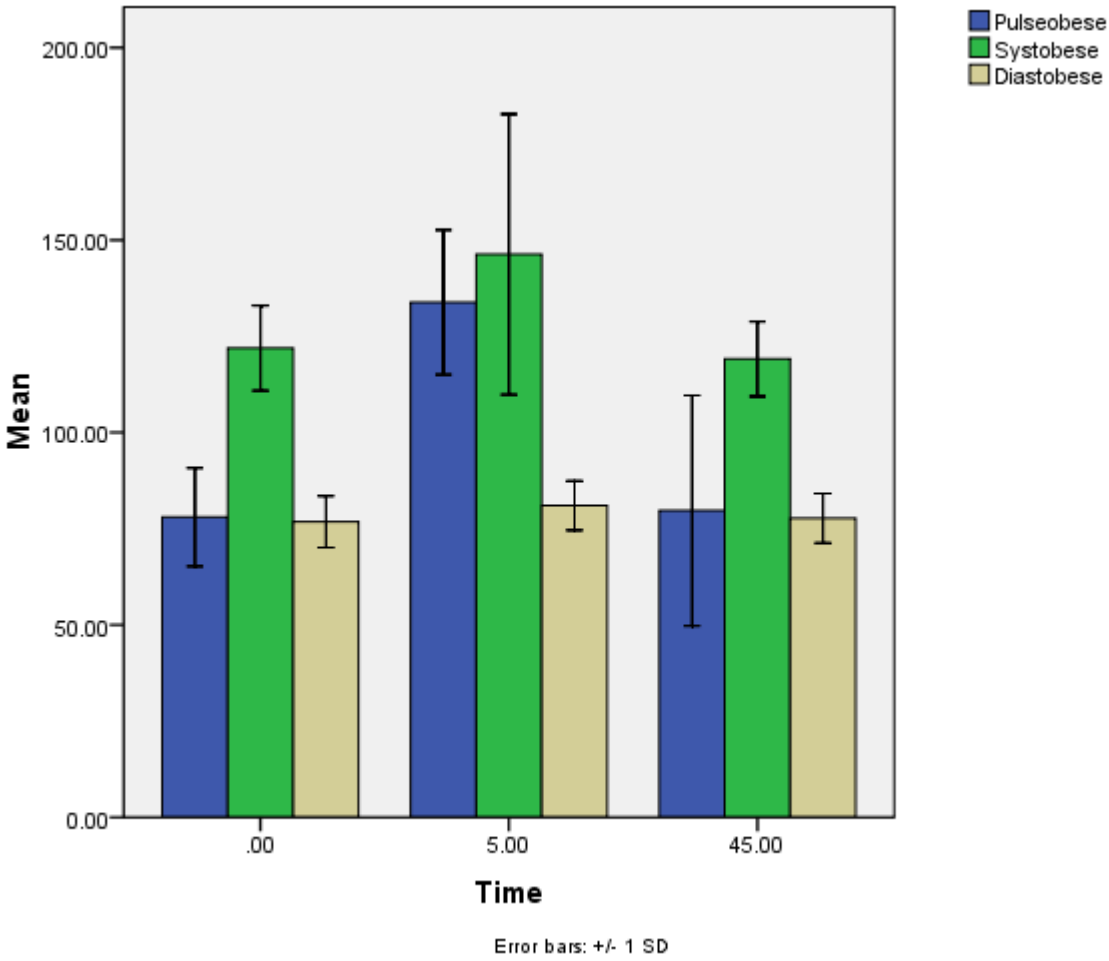
Time

0 Mins: Pre exercise

5Mins: Post exercise

45 Mins: Recovery time

Figure 1: Haemodynamic parameters across time. Normal Subjects



Time

0 Mins: Pre exercise

5Mins: Post exercise

45 Mins: Recovery time

Figure 2: Haemodynamic parameters across time obese Subjects

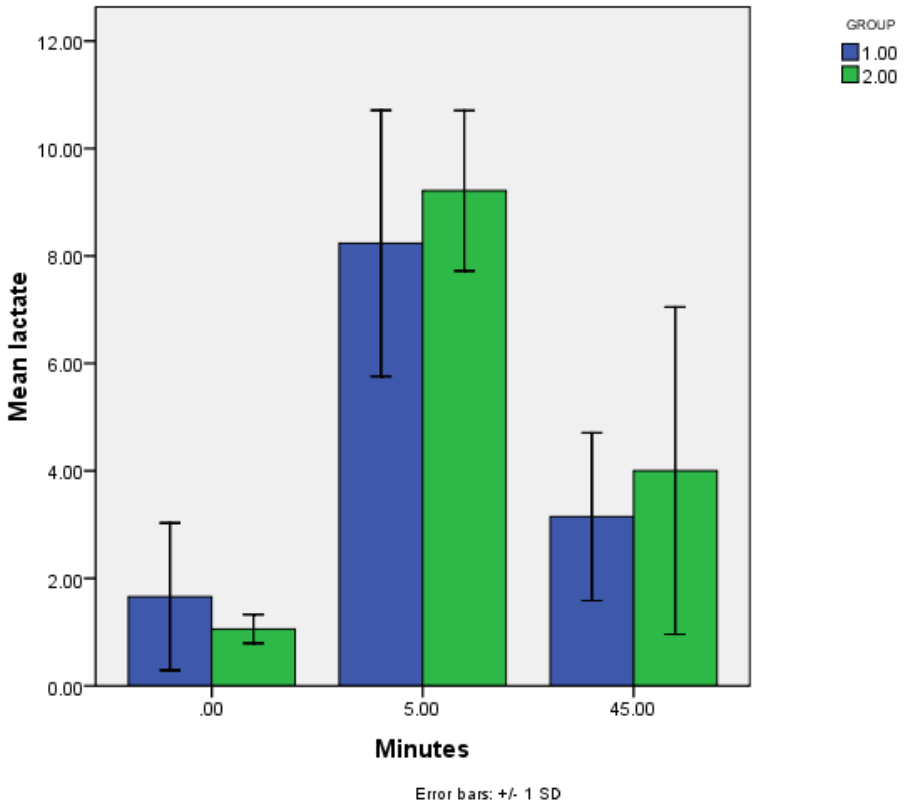
4.1.3 Lactate levels

No statistical differences were demonstrated between the non-obese and obese subjects across time i.e. at rest, after exercise and before exercise. As demonstrated in Table 3.

Table: 3 Lactate levels

Groups	At rest	Five minutes	Forty Five minutes
Control	1.66±1.37	8.24±2.47	3.15±1.56
Test	1.06±0.63	9.21±1.49	4.00±3.00

P >0.005(control vs Test)



Group 1: Non-obese

Group2: Obese.

Time

0 Mins: Pre exercise

5Mins: Post exercise

45 Mins: Recovery time

Figure 3: Lactate levels across time

4.1.4 Lipid profile

Lipid profile measured four parameters. Total cholesterol, Triglyceride levels, High density lipoprotein, and Low density lipoprotein.

Cholesterol levels were found to be higher among the obese across time. At rest (4.120±0.803(C) vs 4.820± 0.494(T)) (p=0.033). At five minutes (4.330±0.743(C) vs 5.040 ±0.472(T)) (p=0.022) and at forty five minutes (4.020±0.727 vs 4.850± o.674) (p=0.016) respectively.

Low Density Lipoprotein levels among the obese were higher than that of non-obese subjects across time. Baseline means were (2.080±0.525(C) vs 2.72±0.421(T)) (p=0.008) at rest, (2.230±0.685(C) vs2.930± 0.334(T)) (p=0.012) after exercise, (2.000±0.537(C) vs 2.730±0.435(T)) (p=0.004) at time of recovery.

Table 4: Lipid profile

Parameter	Subjects	At rest	After exercise	At recovery
Total Cholesterol	Control	4.1200± 0 .80250	4.3300±0.74244	4.0200±0.72694
	Test	4.8200±.49396	5.0400±0.47188	4.8500± 0.67371
Triglycerides	Control	0.9100±0.39567	1.14000±0.51683	0.8500±0.38944
	Test	1.0100±0.34140	1.2200±0.34254	1.0100±0.43576
LDL	Control	2.0800±0.52451	2.2300±0.68484	2.0000±0.53748
	Test	2.7200±0.42111	2.9300±0.33350	2.7300±0.43474
HDL	Control	1.4300±0.23118	1.5600±0.20111	1.4200±0.23476
	Test	1.5400±0.21187	1.6400±0.23190	1.5800±0.20976
Cholesterol ratio	Control	2.9280±0.66180	2.8050±0.52322	2.8850±0.61848
	Test	3.2050±0.67416	3.2050±0.57079	3.1260±0.64509

P>0.005

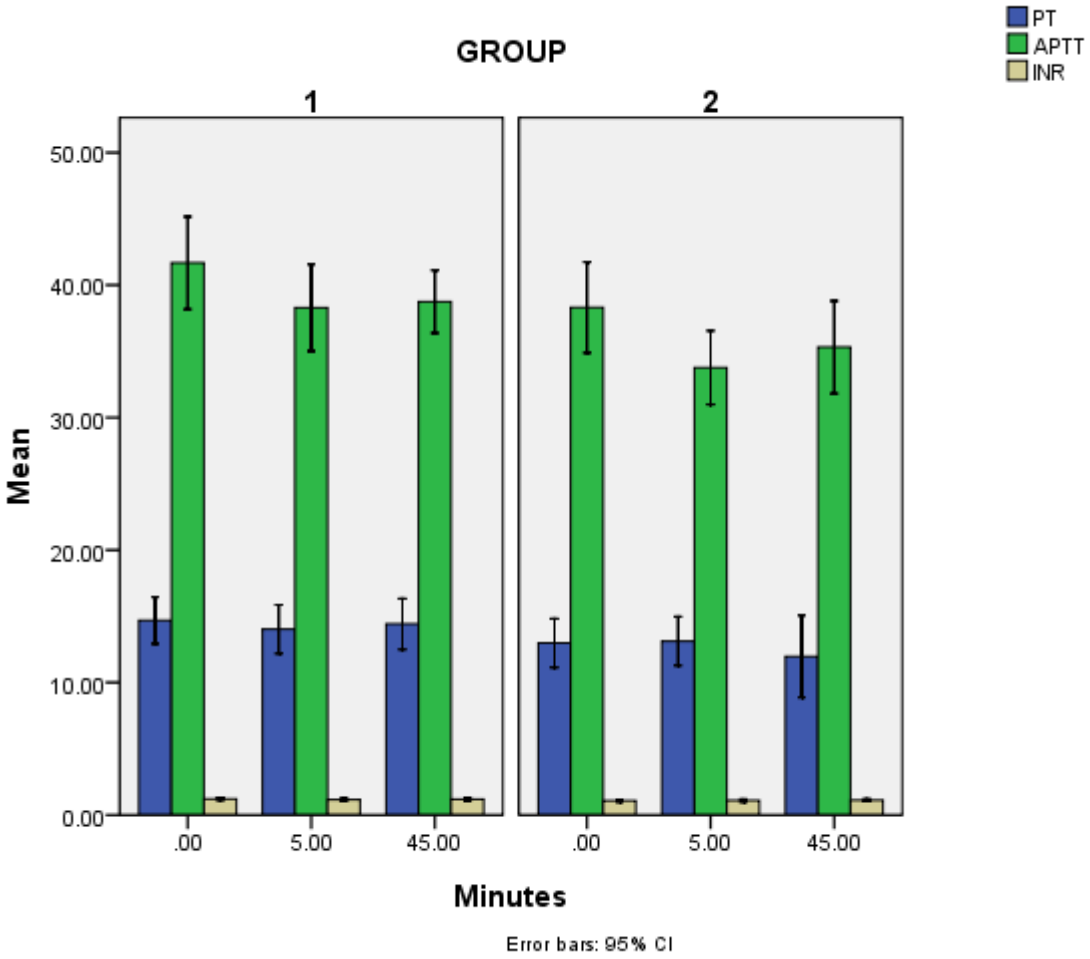
4.1.5 Coagulation profile.

Comparison of the means demonstrated values for aPTT immediately after exercise to be higher in the experimental group at rest(38.2900±4.58123(C) vs 33.7600±3.88936(T)) (p=0.029) . INR at rest was higher in the non-obese (1.2100±0.13703(C) vs 1.0800±0.13984(T)) (p=0.05) .

Table 5: Coagulation profile

Parameter	**groups**	**At rest**	**After exercise**	**At recovery**
Prothrombine time	Control	14.6800±2.45981	14.0200±2.56506	14.4200±2.68692
	Test	12.9800±2.58405	13.1200±2.58061	11.9700±4.32102
Activated partial prothrombine time	Control	41.6700±4.87626	38.2900±4.58123	38.7400±3.30831
	Test	38.3100±4.79594	33.7600±3.88936	35.3100±4.87977
International Normalization ratio	Control	1.2100±0.13703	1.1600±0. .11738	1.2000±0. .13333
	Test	1.0800±0. .13984	1.0900±0. .13703	1.1200±0. .13166

P>0.005



Group 1: Non-obese

Group2: Obese.

Time

0 Mins: Pre exercise

5Mins: Post exercise

45 Mins: Recovery time

Figure 4: Routine coagulation results across time

4.1.6 Thromboleastography

Coagulation was measured using Thromboelastography in addition to traditional coagulation profile.

T test analysis showed lower values for the non-obese subjects only for the MA (Maximal amplitude level) (53.3000±6.045(C)vs 58.3800 ±3.366(T)) (p=0.032) at recovery. All other parameters had no statistical differences among the non-obese and obese at rest, after exercise and at forty five minutes as shown in table 6.

Table 6: TEG analysis

Parameter	Subject	At rest	Five minutes	Forty Five minutes
R	Control	8.9100±2.941	8.8400±3.366	8.8100 ±2.077
	Test	9.5800±1.992	10.2300±2.776	7.6700 ±2.253
K	Control	3.3400±1.469	3.1300 ±1.545	3.3500 ± 1.016
	Test	3.2700±0.981	3.1500±1.202	2.6500 ±0.752
Angle	Control	50.1700±11.852	51.9800 ±10.206	48.7100 ±10.269
	Test	49.6700±8.422	50.5300±9.535	55.1600 ±6.984
MA	Control	53.7600±7.421	54.1000± 10.027	53.3000±6.050
	Test	54.7500±6.081	57.1100 ±4.147	58.3800±3.366
G	Control	6.0200±1.867	6.2800 ± 2.069	5.8700 ±1.407
	Test	6.2500±1.686	6.7500± 1.111	6.8900 ±1.140
EPL	Control	1.0000±1.268	3.0000 ± 5.494	1.1800 ±1.184
	Test	1.5400 ±1.065	0.7400±0.837	0.7400±1.171
AMM	Control	51.4100 ±6.661	49.9400±17.452	51.8200± 8.155
	Test	52.3300± 6.440	54.7700 ±4.211	54.1300 ±5.732
LY30	Control	0.9400± 1.303	2.8700±5.548	0.9000 ±0.952
	Test	1.0000±0.0943	0.6600±0.858	0 .7400±1.171

P=>0.005

4.1.7 Blood gas analysis

Blood gas analysis did not show any statistical differences between the control and the test group. PH, PO2,PCO2,HCO3,BE(base excess) SO2 and TCO2 were measured.

Table 7: Blood gas analysis

Parameter	Groups	At Rest	Five Minutes	Forty Five
PH	Control	7.3±0.1	7.2±0.1	7.4±0.4
	Test	7.4±0.2	7.3±0.2	7.4±0.3
PO2	Control	25.5±6.3	36.3±13.2	23.2±5.7
	Test	25.7±7.6	38.0±16.8	29.9±10.9
PCO2	Control	40.4±10.1	34.9±5.0	36.2±4.1
	Test	37.8±5.3	35.8±8.5	35.0±4.3
HCO3	Control	21.3±2.4	13.70±2.9	20.3±2.1
	Test	21.4±2.4	20.2±18.7	19.1±1.8
BE	Control	-4.5±2.0	-14.2±3.7	-5.3±2.2
	Test	-4.1±2.2	-12.9±3.1	-6.5±2.0
SO2	Control	42.0±15.7	53.4±19.9	38.7±14.2
	Test	43.9±17.4	54.7±25.9	50.9±18.5
TCO2	Control	22.4±2.5	14.9±3.0	21.4±2.0
	Test	22.6±2.5	14.6±3.3	20.1±2.0

4.1.8 Haemogram

Higher platelet values were demonstrated for the non obese before exercise (3.2±65.4(C) vs 3.0±58.4 (T)) (p=0.05).Mean corpuscular volume(MCV) immediately after exercise was noted to be statistical higher in the obese subjects as compared to the non obese

subjects (80.5±7.4(C) vs 86.9±3.3 (T)) (p=0.02). Erythrocytes, Haemoglobin, hematocrit, Mean Corpuscular Hemoglobin (MCH and Mean Corpuscular Hemoglobin Concentration (MCHC) were measured but did not demonstrate statistical differences between the two groups.

Table 8: Haemogram (n=10)

Parameters	Groups	At rest	Five minutes	Forty Five Minutes
Haemoglobin	Control	14.3±1.3	15.3±1.4	14.2±1.4
	Test	14.5±1.1	15.2±1.1	14.4±1.0
Red Blood Cells	Control	5.5±1.0	5.8±1.2	5.5±1.1
	Test	5.4±0.4	5.7±0.5	5.5±0.5
Platelets	Control	3.2±65.4	3.8±49.4	3.2±36.1
	Test	3.0±58.4	3.4±63	2.8±82.0
Hematocrit	Control	45.3±5.5	47.0±6.1	44.4±6.2
	Test	46.0±2.8	48.6±3.1	45.8±3.3
MCV	Control	80.7±6.9	80.5±6.9	79.5±7.4
	Test	85.5±2.9	86.8±3.3	1.6+251.4
MCHC	Control	31.5±1.9	32.2±1.8	29.6±9.3
	Test	31.0±1.6	30.9±2.0	31.2±1.7
MCH	Control	25.8±3.0	26.2±3.2	26.0±3.0
	Test	26.5±2.1	26.8±2.5	26.6±2.2

White Blood cells

Obese subjects were noted to have higher neutrophils immediately after exercise (2.8±0.8(C) vs 3.8±1.1 (T)) (p=0.032) and at forty five minutes (2.1±0.8(C) vs 3.0±0.6 (T)) (p=0.008) as compared to the non obese.

Monocytes were much higher among the non obese at time of rest (9.6±3.7 (C)6.4±2.4)((T))(p=0.039) and time of recovery(9.9±3.7(C) vs 5.5± 3.2(T))(p=0.012)

Eosinophiles also demonstrated higher levels among the experimental group immediately after exercise (4.8±2.2(C) vs 2.5±1.9) (T)) (p=0.026).

Table 9: Neutrophils

Parameters	Subjects	At Rest	Five minutes	Forty five minutes
White Blood Cells	C	5.2±0.7	7.9±2.3	5.1±1.1
	T	5.8±1.1	8.8±1.8	6.3±1.7
Neutrophiles	C	2.1±0.7	2.8±0.8	2.1±0.8
	T	2.7±1.0	3.8±1.1	3.0±0.6
Neutrophiles %	C	39.5±10.0	37.7±15.2	39.4±8.3
	T	47.3±14.8	43.7±14.8	52.5±16.1
Lymphocytes	C	2.3±0.6	4.0±1.9	2.3±0.5
	T	2.3±0.8	4.4±1.7	2.6±1.5
Lymphocytes%	C	44.6±10.1	53.9±13.4	45.3±8.4
	T	41.1±12.2	43.2±19.1	39.3±13.9
Eosinophiles	C	0.2±0.2	0.4±0.2	0.2±0.2
	T	0.2±0.2	0.2±0.3	0.2±0.2
Eosinophiles%	C	4.1±3.3	4.8±2.2	4.4±3.2
	T	2.9±2.2	2.5±1.9	2.3±2.5
Monocytes	C	0.9±1.4	0.7±0.3	0.5±0.2
	T	0.4±0.2	0.6±0.2	0.4±0.2
Monocytes%	C	9.6±3.7	14.8±18.7	9.9±3.9
	T	6.4±2.4	6.4±2.4	5.5±3.2
Basophiles	C	0.2±0.2	0.1±0.1	0.1±0.0
	T	0.2±0.3	0.1±0.1	0.1±0.1
Basophiles%	C	2.2±1.3	1.6±1.4	2.0±1.2
	T	2.5±4.2	1.4±1.7	1.2±1.5

4.2 Bivariate Analysis

Correlation analysis was carried out using Pearson correlation coefficient for haemodynamics, lactate levels, lipid levels, heamogram and blood gas analysis with coagulation test which were routine coagulation and TEG analysis.

4.2.1 Haemodynamics.

Hemodynamics and coagulation.

Systolic blood pressure.

In the control group no relationships were established between systolic blood pressure and coagulation analysis both for routine coagulation and TEG across time.

Analysis within the experimental demonstrated a positive correlation between systolic blood pressure at rest and APPT at rest($r(10)0.75$, $p<0.01$) for routine coagulation only. Correlations for systolic pressure and TEG analysis in the experimental group were not statistically significant.

Diastolic blood pressure

Correlations of diastolic blood pressure and coagulation analysis across time in the control group were shown to be statistically not significant.

In the experimental group diastolic pressure at rest and PT at rest correlated negatively($r(10) =-0.77$, $p<0.01$.) Negative correlation was equally found between diastolic pressure at rest and INR at rest($r(10) =-0.70$, $p<0.03$) for routine coagulation analysis.

TEG analysis showed demonstrated a negative correlation between diastolic pressures at rest and R value at rest($r(10) =-0.69$, $p<0.03$) only in the obese individuals.

Heart rate

Analysis for TEG demonstrated a negative correlation between heart rate at recovery time and K value($r(10) = -0.78$, $p<0.01$.) in the Non obese. Positive correlation was shown between heart rate at α angle value($r(10) = 0.76$, $p<0.01$) in the same group.

The correlations of Heart rate and APTT time at recovery was found to have a negative correlation ($r(10) = -0.73$, $p<0.02$.) among the Obese. In the same group negative correlation was found between heart rate and R value immediately after exercise($r(10) = -0.8$, $p<0.05$). Heart rate and K value at 5 minutes demonstrated negative correlation($r(10) = -.85$, $p < 0.01$). This was also true for heart rate and G value immediately after exercise($r(10) = -.90$, $p<0.01$.) in the experimental group.

Table 11: Correlation analysis for Hemodynamic parameters pg 69, 70

4.2.2 Lactate and coagulation.

Lactate blood level correlated positively with PT and INR at rest($r(10) = 0.89$, $p<0.01$) and ($r(10) = 0.78$, $p<0.01$) respectively. At time of recovery, lactate was positively correlated with PT and INR values($r(10) = 0.65$, $p<0.04$) and($r(10) = 0.92$, $p<0.01$.) in the control group.

No correlation was shown between blood lactate and routine coagulation in the experimental group.

Lactate and R value were shown to have a positive correlation($r(10) = 0.75$, $P<0.01$) while lactate and G value were found to be inversely correlated in obese subjects ($r(10) = -0.68$, $p < 0.03$.)

Table 12: Correlation analysis of lactate and coagulation pg 72

4.2.3 Lipid profile and Coagulation.

Total Cholesterol and coagulation

Correlation of total cholesterol with routine coagulation test did not demonstrate any statistical significance in both the normal subjects as well as the obese group.

However in the experimental group, positive correlation was shown between total cholesterol and K value after exercise for ($r(10) = 0.67$, $p < 0.04$.)

Triglyceride and Coagulation

Triglyceride levels and coagulation analysis for correlation did not show any statistically significant results for routine coagulation in both the control and experimental groups.

In the experimental group, triglyceride levels demonstrated positive correlation with K and G values at rest ($r(10) = 0.71$, $p < 0.02$) and($r(10) = -0.76$, $p < 0.01$) respectively.

HDL and coagulation

High density lipoproteins had an inverse relationship with routine coagulation test at rest in the experimental group($r(10) = 0.67$, $p < 0.04$).

No correlations were illustrated in the obese group between HDL and routine coagulation parameters at time of rest, after exercise as well as recovery time

A strong positive correlation between HDL and G value was demonstrated immediately after exercise ($r(10) = 0.78$, $p < 0.01$.) EPL value and LY30 value, similarly demonstrated ($r(10) = -0.77$, $p < 0.01$) and($r(10) = -0.77$ $p < 0.01$) respectively in the experimental group.

A negative correlation was noted between HDL and R value p=-0.01. This was similar between HDL and EPL p=-0.005 only for TEG in the control group.

In the experimental group, a positive correlation was seen between HDL and EPL p=0.03 only for TEG.

LDL and coagulation

Correlations of LDL and Coagulation were not significant in both experimental groups using either routine coagulation or TEG at rest, after exercise and at recovery.

Cholesterol ratio and coagulation

Total cholesterol ratio and coagulation did not illustrate any correlations in the experimental group.

An inverse correlation was show between total cholesterol ratio and LY30 time at rest ($r(10) = -.71$, $P<0.02$) in the control group only for TEG.

Table 4.2.3 at the appendix show the correlation of lipid profile and coagulation.

Table 13: a and b, Correlation analysis for lipids and coagulation pg 72, 73

4.2.4 Heamogram and Coagulation

Red blood cells and coagulation

After exercise, erythrocyte count was positively correlated with R value($r(10) = 0.70$, $P<0.03$.) Negative correlation was demonstrated between RBCs and G value after exercise and at recovery time, ($r(10) = -0.69$, $p<0.03$) and ($r(10) = -0.69$ $p<0.03$) respectively for coagulation analysis with TEG in the experimental group.

Red blood cells correlated positively across time with R value at rest($r(10)=0.65$,$p<0.04$), after exercise($r(10)=0.71$, $p<0.02$) and at recovery($r(10)=0.76$,$p<0.01$) in the experimental group. Negative correlation was established between Red blood cells level and α angle across time with($r(10)=-.64$, $p<0.05$)at rest,($r(10)=-.78$ $p<0.01$) after

exercise and(r(10)= -.77p<0.01)at forty five minutes for analysis of coagulation using TEG.

Heamoglobin level and coagulation

In the control group no correlations were illustrated between levels of hemoglobin and coagulation for both routine coagulation analysis using TEG over time.

However in the experimental group, heamoglobin levels demonstrated an inverse correlation with INR only across time i.e. at baseline(r (10) =-0.84, p<0.01) immediately after exercise(r (10) =-.70, p<0.03) and at 45 minutes recovery time(r (10) = -0.91, p <0.01) for routine coagulation.

Coagulation analysis with TEG for normal subjects showed R value and heamoglobin were positively correlated (r (10) =0.65 p<0.04) at rest, hemoglobin and EPL demonstrated inverse correlation(r (10) =-0.67, p< 0.04) at time of recovery,

Hemoglobin levels and LY30 were found to be inversely correlated (r (10) =-0.67, p<0.04) at time of recovery.

Platelets and coagulation

Data were statistically not significant for correlation between Platelet level with routine coagulation and TEG across time in both the control and experimental group.

Haematocrit Level and coagulation

In the control group, results were not statistically significant for correlation of hematocrit level and routine coagulation test across time.

Normal subjects demonstrated a negative correlation for hematocrit level with PT time at rest(r (10) =-0.65, P<0.04). Haematocrit level and APTT showed a positive correlation at

time of rest($r(10) = 0.80$, $p < 0.05$.) within the same group. At time of recovery, INR was inversely correlated with hematocrit level ($r(10) = -0.90$, $p < 0.01$).

Among the Obese, a positive correlation was illustrated between R value and Hematocrit level measures at rest($r(10) = 0.64$, $p < 0.05$). This was similar for K value and hematocrit level both at rest and after exercise($r(10) = 0.70$, $p < 0.05$) and($r(10) = 0.78$, $p < 0.01$) respectively. An inverse correlation was shown between α angle at rest($r(10) = -0.69$, $p < 0.03$) and after exercise($r(10) = -0.83$, $p < 0.01$) for the same group.

The control group showed a positive relationship at time of recovery between K value and hematocrit level($r(10) = 0.69$, $p < 0.03$). However correlation was negative between α angle and hematocrit level($r(10) = -0.65$, $p < 0.04$).

Mean corpuscular Volume and coagulation.

Correlation of MCV and coagulation for obese subjects were not statistically significant for routine coagulation across time. However for the experimental group a negative correlation was demonstrated only for MCV and PT at time of recovery($r(10) = -0.85$, $p < 0.01$).

In analysis of coagulation using TEG in the control group, an inverse correlation was demonstrated at forty five minutes between R value and MCV ($r(10) = -0.67$, $p < 0.03$). Equally α angle value was found to have a positive relationship with MCV ($r(10) = 0.76$, $p < 0.01$) at 45 minutes.

Mean Corpuscular haemoglobin and coagulation.

Relationship between coagulation and MCH was not statistically significant among the experimental group.

Obese subjects demonstrated negative correlation between MCH and K value($r(10) = -0.79$, $p<0.01$) as well as between MCH and α angle($r(10) = 0.83$, $p<0.01$) only for analysis with TEG. Routine coagulation analysis among the obese were not statistically significant.

Mean corpuscular haemogram concentration and coagulation.

Routine coagulation analysis and MCHC among both the normal and obese subjects were not statistically significant. Similarly, no correlation was illustrated between MCHC and analysis of coagulation with TEG in the experimental group.

At time of recovery a negative correlation was shown between MCHC and K value($r(10) = -0.68$, $p<0.03$) while a positive correlation was demonstrated between MCHC and α angle value($r(10) = 0.82$, $p<0.01$) only in the control groups.

Table 14: a and b, Correlation analysis for RBCs and coagulation

White cell count and coagulation

Correlation analysis between WBCs and routine coagulation did not illustrate any statistical significance in both groups across time. Similarly no correlation was demonstrated between WBCs and TEG analysis in both the control and experimental groups.

Neutrophils and coagulation

Neutrophils count and routine coagulation did not demonstrate a relationship in both the control and experimental groups.

Equally no correlation was observed between neutrophils and TEG analysis in both the control and experimental groups at rest, after exercise and at time of recovery.

Lymphocytes and coagulation

No correlation was demonstrated between lymphocytes and routine coagulation across time in both the control and experimental groups.

The experimental group did not show any linear relationship with analysis of TEG.

At time of recovery, a positive correlation was demonstrated between lymphocytes and MA value($r(10) = 0.73$, $p < 0.02$) and between G vale and lymphocytes($r(10) = 0.73$, $p < 0.02$).

At rest EPL was positively correlated with lymphocytes ($r(10) = 0.78$, $p < 0.01$).

Monocytes and coagulation

Correlation between monocytes and routine coagulation did not illustrate any statistical significance across time in both the control and experimental group.

In the control group, analysis for TEG demonstrated a Positive correlation between monocytes % and R value($r(10) = 0.85$, $p < 0.01$), Monocots % and K value($r(10) = 0.94$, $p < 0.01$) after exercise. However correlation between G value and monocytes % demonstrated a strong negative correlation ($r(10) = -0.86$ $p < 0.01$) after exercise.

In the experimental group, no correlations were illustrated between monocytes and TEG analysis.

Basophils and coagulation

No relationship was observed between basophile and routine coagulation profile among the normal subjects. While in both the control and experimental groups correlation analysis were not statistically significant for TEG coagulation results and basophils.

Basophils and PT demonstrated a positive correlation at recovery time($r(10) = 0.73$, $p<0.02$) in the control group. Similar results were illustrated between basophiles and INR ratio after exercise($r(10) = 0.72$, $p<0.02$) and at recovery time($r(10) = 0.75$, $p<0.02$) for obese subjects.

Eosinophils and coagulation

TEG analysis in the experimental group did not illustrate any correlation with eosinophils. Equally, no correlation was observed between eosinophils and routine coagulation in the control group.

Negative correlation was demonstrated between eosinophils and APTT at time of recovery($r(10) = -.69$, $p<0.03$) only for routine coagulation in the experimental group.

Positive correlation was illustrated between eosinophils and K value at recovery time($r(10) = 0.64$, $p<0.05$) as well as in eosinophils %($r(10) = 0.64$, $p<0.05$) in the control group with TEG. The α angle value and eosinophils was negatively correlated($r(10) = -0.65$, $p<0.04$), so was eosinophils % and α angle value($r(10) = -0.64$, $p<0.05$) at forty five minutes.

Table 15a and 15 b, correlation analysis for White blood cells and Coagulation page

4.2.5 Blood gas analysis and coagulation.

Blood PH and TEG analysis did not illustrate any correlation in both the control and experimental groups.

In obese subjects, Blood PH was negatively correlated with PT at rest and at time of recovery ($r(10) = -0.73$, $p<0.01$) and($r(10) = -0.67$, $p<0.04$) respectively. Similarly, INR and blood PH at rest($r(10) = -0.64$, $p<0.05$) and at forty five minutes($r(10) = -0.69$, $p<0.03$) respectively demonstrated an inverse relationship. No correlation was established between APTT and blood Ph within this group.

A positive correlation was illustrated between blood Ph and INR at recovery time only for the experimental group($r(10) = 0.71$, $p<0.02$).

Oxygen partial pressure and coagulation

Analysis of correlation for TEG and blood PH did not show any correlation across time in the control group.

An inverse relationship was observed between PaO2 and APTT after exercise only for routine coagulation($r(10) = -0.65$, $p<0.05$) among the obese.

No correlation was shown between PaO2 and routine coagulation analysis in the experimental group.

PaO2 demonstrated a negative correlation with R value for TEG analysis of coagulation only at recovery time($r(10) = -064$, $p<0.05$) in the normal subjects.

Carbon dioxide partial pressure and coagulation

In the control group no correlations were observed between PaCO2 and TEG coagulation analysis. Routine coagulation markers, PT and INR at rest in the control group demonstrated a positively relationship with PaCO2($r(10) = 0.87$, $p<0.01$) and($r(10)$

=0.75, p<0.01) respectively. No correlation was illustrated with APTT across time within the same group. Positive correlation was demonstrated between R value and PaCO2 at 5 minutes (r (10) =0.72, p<0.02) and at 45 minutes(r (10) =0.74, p<0.01).Similar results were demonstrated for correlation between PaCO2 and K value at 5 minutes(r (10) =0.72, p<0.02) and at 45 minutes(r (10) =0.66, p<0.04). An inverse relationship was illustrated between PaCO2 and α angle at 5 minutes(r (10) =-.74, p<0.02) and at 45 minutes(r (10) =-.70, p<0.03) for analysis of TEG in the experimental group.

Blood Bicarbonate level and coagulation.

Blood bicarbonate levels were positively correlated with PT at rest in the obese subjects (r (10) =0.70, p<0.03). In the experimental group a similar linear positive correlation was illustrated between PT and blood HCO3 level at time of recovery (r (10) =0.70, p<0.03) only for routine coagulation. No relationship was observed between HCO3 and TEG analysis in the control group.

Only MA value and HCO3 after exercise demonstrated a negative correlation(r (10)-0.71, p<0.03) in the experimental group for TEG analysis.

Base Excess and Coagulation

Correlation analysis among the obese subjects were not statistically significant for –BE and routine coagulation as well as using TEG analysis.

A positive relationship was illustrated between PT and -BE at time of recovery(r (10) =0.67, p<0.04) for routine coagulation in the experimental group.

No correlations were observed between TEG analysis and –BE in the experimental group.

Oxygen saturation Content and coagulation.

Correlation analysis were not statistically significant between oxygen saturation and coagulation in both control and experimental groups across time.

Carbon dioxide saturation level and coagulation

Among both the normal and obese subjects, No relationship was demonstrated between TCO2 and TEG coagulation analysis. Routine coagulation and TCO2 correlation analysis were not statistically significant for the experimental group. Only PT at rest demonstrated a positive correlation with TCO2 ($r(10) = 0.76$, $p < 0.02$) for the control group.

Table 16: a and b, Correlation analysis for BGAs and coagulation

4.3 Analysis of repeated measures ANOVA.

Repeated measures ANOVA was carried out for lactate levels and lipid profile vis a vie the coagulation makers both routine coagulation and TEG. Test for sphericity was performed using Mauchly's Test ($p \leq 0.05$).Values considered significant were corrected using Green house Geissler's test ($p \leq 0.05$).

4.3.1 Lactate and coagulation.

There was a significant effect between lactate level increase after acute exercise and increase of Prothrombine time ($F(1.457) = 63.794$, $P < 0.000$). However within the groups, no statistical differences were shown ($F(1.457) = 1.346$, $P < 0.276$).

Likewise for APTT and INR, no statistical differences were shown between groups ($F(1.457) = 63.794$, $P < 0.000$) and ($F(1.457) = 63.794$, $P < 0.000$) respectively.

Lactate and TEG

Repeated measures ANOVA analysis, did not show any statistically significant data for lactate and TEG values within the groups

4.3.2 LDL and coagulation

LDL, just like lactate did not demonstrate any statistically significant results between the two groups for analysis of repeated measures with routine coagulation as well as TEG.

CHAPTER FIVE: DISCUSSION

Exercise leads to the activation of the sympathetic system. This leads to increase in the circulation of adrenaline, nor epinephrine. The net effect is an increase in the production of cell derived microparticles which lead to increase of tissue factor level (Sossdorf, 2011). The role of Tissue factor as a major contributor to development of thrombi has been shown. (Losche, 2005)

Increase in Platelet levels after exercise leads to a rise in platelet derived micro particle (Chen, 2010). Procoagulant microparticles are associated with a procoagulant state and one of the factors involved in its rise is the shear stress associated with vascular activity during exercise. PMP itself forms a great pool for the release of Tissue factor and induction of release of Neutrophil derived microparticles (Chen, 2010; Losche, 2005).

Exercise induced neutrophilia was demonstrated in this study. Obese individuals recorded a higher level of neutrophilia. Besides neutrophilia exercise has been shown to increase NETs who provide an additional amour of defense against pathogens and have been implicated in development of thrombi. This process is usually protective in forming a network that traps pathogens. (Fuchs, 2010). However an excess of NETs leads a thromboembolic state (Brühl, 2012).

In this present study, findings of significant changes in only Ma that correlated to leukocytosis at 5 minutes is in contrast to Lamprecht (2013) who found significant change in only CFT and alpha angle. Present study results showed that acute exercise renders blood hypercoagulable irrespective of whether in obesity or non obese consistent with other studies (Graham et al, 2005) (Wang et al, 1994; Weiss et al, 1998). The

exercise induced hypercoagulability can be explained probably on the basis of release of procoagulant microparticles (Sossdorf, 2010) and neutrophils nuclear extracellular traps (Beiter et al, 2014) from the accompanying neutrophilia. This indicates contribution of cellular components in blood coagulation which is not observed with plasma assays. However, MP and NETS were not measured in this present study and therefore ascribing the cause of hypercoagulability can only be speculative.

Although levels were shown to rise after acute exercise which returned to baseline levels, there was no correlation with either routine tests (PT and APTT) or TEG parameters. This is inconsistent with in vitro (Engstrom M et al, 2006) and clinical studies (Brohi, 2008) found that increase in lactate levels induce hypocoagulability. This suggests that though lactate may be scavenger for free radicals that are procoagulant and released during exercise, another factor may be at play. Therefore, discordance in lactate levels and coagulation in trauma situations and exercise may be due to different factors. While trauma is accompanied by release of cytokines that induce fibrinolytic pathways, exercise releases NETS and MPs that are procoagulant. Thus lactate is a weak modulator of coagulation factors which can be overridden.

Acute physical exercise in the present study caused a rise in all lipid parameters. This was consistent with results from result that indicate acute exercise leads to a significant rise in Total cholesterol and HDL, with prolonged exercise having significant effects in changes for LDL and Triglycerides(Thompson et al,2001; Sgouraki et al, 2011). The changes noted in total cholesterol, as well as LDL count after exercise was statistically higher among the obese than in normal subjects. This is in line with results found by (Greene et al, 2012). Correlations of lipids with coagulation parameters were not statistically significant to infer the use of lipid levels in predicting coagulation pattern after exercise in the present study. However, a study done to establish association between lipid levels

and global coagulation parameters demonstrated a correlation between hypercholesteremia and hypertriglyceridemia with hypercoagulability (Kim et al, 2015). The association between lipid levels and coagulation may not have been demonstrated due to a small sample size.

Circulating cell free DNA has been shown to correlate with Neutrophile MPO after exercise. At the same time a concurrent rise in DNase activity after exercise provide an outlet to excess levels of cf DNA and thus mitigating its hypercoagulable and inflammatory effects (Velders, 2014). In the same study, it was shown that DNase activity is correlated to lactate levels. Although our study did not show the correlation between lactate and coagulation, from velders work, a rise in lactate levels does confer protection from the development of thromboembolic states after and during exercise. Increase DNAase activity rids the body of circulating cell free DNA implicated in inflammatory states (Swarup et al, 2007).

This present study has a number of limitations. Lack of statistical significance between most variables and coagulation parameters can probably be due to small sample size: 10 subjects were used in each group. Relatively, exercise testing on Havard step test lacks standardization since not all subjects can make the same number of steps within the 5 minute required. The 46cm height of the step test proves difficult for short individuals. The study can be extended by use of a treadmill to provide a more robust physical assessment of subjects. Also, there was lack of control of other factors that influence coagulation such as diet, hydration status, previous alcohol intake and beverage intakes.

Changes in coagulation following acute physical exercise have no correlation with lipid profile and blood lactate levels in serum. This confirms the null hypothesis. While in whole blood a positive trend of correlation between coagulation and changes in blood

lactate and lipid levels was established, hence it negates the null hypothesis and affirms the alternative hypothesis.

CONCLUSION

The present study concluded that lipids cannot be used an indicator for risk of development of thrombus in vivo. Similarly rise in blood lactate level cannot be used as a tool for prediction of clot formation. This is because following acute exercise blood lactate and lipid levels were not found to significantly correlate with coagulation using serum based tests. However, coagulation analysis using whole blood following physical activity showed positive correlation. This indicates that coagulability changes in whole blood during acute exercise requires further investigation aiming at better understanding of the impact of acute exercise on coagulation cascade in vivo.

RECOMMENDATIONS

The present study recommends:

(a) TEG was more sensitive than plasma based routine coagulation tests in exercise, and therefore is to be recommended for analysis of coagulation.

(b) Further studies with a larger sample needs to be carried out to show whether the trends in coagulation which were not statistically significant would yield different results.

REFERENCES

1. Adegbija O, Hoy WE, Wang Z Waist circumference values equivalent to body mass index points for predicting absolute cardiovascular disease risks among adults in an Aboriginal community: a prospective cohort study BMJ Open 2015;5:e009185. doi: 10.1136/bmjopen-2015-009185
2. Albert CM, Mittleman MA, Chae CU, Lee IM, Hennekens CH, & Manson JE. (2000). Triggering of sudden death from cardiac causes by vigorous exertion. New England Journal of Medicine, 343, 1355-1361.
3. Alfaro, L. Palacios, Torras, R (2002). Blood lactate levels during a combined water-based exercise test in elite lifesaving athletes V., Journal of Exercise Physiology, 2002;5(1):1-4.
4. American Heart Association. Blood Pressure monitoring guideline, 2014. http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/High-Blood-Pressure-or-Hypertension. Accessed March 4, 2016.
5. Beiter T1, Fragasso A2, Hudemann J2, Schild M3, Steinacker J4, Mooren FC3, Niess AM2.Neutrophils release extracellular DNA traps in response to exercise. J ApplPhysiol (1985). 2014 Aug 1;117(3):325-33. doi: 10.1152/japplphysiol.00173.2014. Epub 2014 May 15.
6. Benoit J. Arsenault, S. Matthijs Boekholdt & John J. P. Kastelei (2011). Nature Reviews Cardiology. Lipid parameters for measuring risk of cardiovascular disease
7. Bhatti R, Shaikh DM (2007). The effect of exercise on blood parameters. Pak J Physiol. 2007;3(2).
8. Brohi K, Cohen MJ, Ganter MT, Schultz MJ. (2008) Acute Coagulopathy of Trauma: Hypoperfusion Induces Systemic Anticoagulation and Hyperfibrinolysis. J Trauma, pp; 64: 1211-1217
9. Caspersen CJ, Powell KE, Christenson GM (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research.Public Health Rep. Pp; 100:126-31.
10. Chen YW, Chen JK, Wang JS (2010). Strenuous exercise promotes shearinduced thrombin generation by increasing the shedding of procoagulant microparticles from platelets. Thromb Haemost. 2010 Aug;104(2):293-301.

11. Corrado D, Basso C, Pavei A, Michieli P, Schiavon M, Thiene G.Trends in sudden cardiovascular death in young competitive athletes after implementation of a preparticipation screening program. JAMA. 2006 Oct 4;296(13):1593-601.
12. Crouse, SF, et al. (1997). Effects of training and a single session of exercise on lipids and apolipoproteins in hypercholesterolemic men. J Appl Physiol 1997;83:2019-28.
13. De Wolf A, 2012.Thromboelastography, (TEG). http://www.wvtv.be/documenten/5ee21af923794b014abe4a4697e0a0c8.pdf. Accessed April 7, 2016.
14. Edward L. FoxCharles E. BillingsJr.Robert L. BartelsRobertBasonDonaldMathews.Fitness standards for male college students. InternationaleZeitschriftfürangewandtePhysiologieeinschließlichArbeitsphysiologie.September 1973, Volume 31, Issue 3, pp 231–236
15. Engstrom M, Schott U, Nordstrom CH, Romner B, Reinstrup P. Increased lactate levels impair the coagulation system--a potential contributing factor to progressi.ve hemorrhage after traumatic brain injury. J NeurosurgAnesthesiol. 2006 Jul;18(3):200-4.
16. Fernandez-Sanchez A, Madrugal-Santillan E, Bautista M, Esquivel-Soto, et al.(2011). Inflammation, oxidative Stress and Obesity. Intl J Mol Sci, Pp(12):3117-3132
17. Fuchs TA, Brill A, Duerschmied D, Schatzberg D, Monestier M, Myers DD Jr, et al (2010). Extracellular DNA traps promote thrombosis. Proc Natl Acad Sci. USA 107: 15880–15885, 2010.
18. Global Database on Body Mass Index, WHO publication, 2003. Accessed September 2,2015.
19. Global Database on Body Mass Index, WHO publication, 2015. Accessed september 2,2015.
20. Global Health Observatory (GHO) data, WHO publication, 2014. Accessed September 2,2015.
21. Goodwin, M. L., Harris, J. E., Hernández, A., & Gladden, L. B. (2007). Blood Lactate Measurements and Analysis during Exercise: A Guide for Clinicians.Journal of Diabetes Science and Technology (Online), 1(4), 558–569.
22. Graham,T and Thrall, G.Y.H. Lip (2005). Exercise and the Prothrombotic State. A Paradox of Cardiovascular Prevention or an Enhanced Prothrombotic State? Arteriosclerosis, Thrombosis, and Vascular Biology, 2005; 25: 265-266 doi: 0.1161/01.ATV.0000154579.11213.da

23. Greene, N. P., Martin, S. E. and Crouse, S. F. (2012), Acute Exercise and Training Alter Blood Lipid and Lipoprotein Profiles Differently in Overweight and Obese Men and Women. Obesity, 20: 1618–1627. doi: 10.1038/oby.2012.65
24. Groussard C, Morel I, Chevanne M, Monnier M, Cillard J, et al. (2000). Free Radical Scavenging and Antioxidant Effects of Lactate ion: an in vitro Study. J Appl Physiol, pp; 89: 169-175
25. Groussard C,et al. (2003). Changes in blood lipid peroxidation markers and antioxidants after a single sprint anaerobic exercise. European Journal of Appllied Physiology; pp89: 14-20
26. Hanke AA, Staib A, Gorlinger K, Perrey M, et al.(2010). Whole Blood Coagulation and Platelet activation in the Athlete: A Comparison of Marathon, Triathlon, and Long Distance Cycling. Eur J Med Res, 2010; 15: 59-65
27. Harvard school of public health, Obesity prevention source, 2016. Accessed February 3, 2016.
28. Jain SC1, Rai L, Valecha A, Jha UK, Bhatnagar SO, Ram K.Effect of yoga training on exercise tolerance in adolescents with childhood asthma. J Asthma. 1991;28(6):437-42.
29. Jakicic JM, Otto AD.Physical activity considerations for the treatment and prevention of obesity.Am J ClinNutr. 2005 Jul;82(1 Suppl):226S-229S.
30. Jung-Ah Kim, M.D.,1Ji-Eun Kim, M.S.,2 Sang Hoon Song, M.D.,1 and Hyun Kyung Kim, M.D..Influence of Blood Lipids on Global Coagulation Test Results. Published online 2014 Dec 8. doi: 10.3343/ alm.2015.35.1.15. Ann Lab Med. 2015 Jan; 35(1): 15–21.
31. Jung-Ah, K, Ji-Eun, K, Sang H,S, Hyun, K,K (2015). Influence of Blood Lipids on Global Coagulation Test Results .Annals of laboratory medicine. Ann Lab Med 2015;35:15-21
32. Katzmarzyk, Peter T. et al (2011). Changes in blood lipids consequent to aerobic exercise training related to changes in body fatness and aerobic fitness. Metabolism - Clinical and Experimental , Volume 50 , Issue 7 , 841 - 848
33. Lamprecht M, Moussali H, Ledinski G, Leschink B, et al. (2013). Effects of a single Bout of Walking Exercise on Blood Coagulation Parameters in Obese Women. J Appl Physiol, 2013; 115: 57-63

León, AS, Sánchez OA (2001). Response of blood lipids to exercise training alone or combined with dietary intervention. Med Sci Sports Exerc 2001;33:502-15.

35. Losche, W (2005). Platelets and tissue factor. Platelets. Exercise is a potent stimulus for enhancing circulating DNase activity. 2005;16:313–9.

36. Maik Sossdorf, Gordon Philipp Otto, Wolfgang Lösche, Holger H W Gabriel (2010). Article in Medicine and Science in Sports and Exercise. December 2010,
37. Martin, E, Ulf, S, Carl-Henrik, N, Bertil, R, Peter, R. Neurosurg, A (2006). Increased lactate levels impair the coagulation system--a potential contributing factor to progressive hemorrhage after traumatic brain injury. July; 18(3): 200–204. doi: 10.1097/01.ana.0000211002.63774.8a
38. Martina Velders a, Gunnar Treff a, Katja Machus a, Edit Bosnyák b, Jürgen Steinacker a, Uwe SchumannaClinical Biochemistry 47 (2014) 471–474
39. MartinaVeldersa, GunnarTreffa, KatjaMachusa, EditBosnyákb, JürgenSteinackera, UweSchumanna. Exercise is a potent stimulus for enhancing circulating DNase activity. Clinical Biochemistry.Volume 47, Issue 6, April 2014, Pages 471-474
40. Matthew, LG., et al.(2007). Blood Lactate Measurements and Analysis during Exercise: A Guide for Clinicians., J Diabetes Sci Technol. Jul; 1(4): 558–569. Published online 2007 Jul. PMCID: PMC2769631
41. Maureane,H, Dougald M. (2001). Monroe III A cell-based model of hemostasis article in Thrombosis and Haemostasis microparticles from platelets. Thromb Haemost. 2010;104:293–301.
42. Milind Thakur, Aamer B Ahmed. A Review of Thromboelastography. International Journal of Perioperative Ultrasound and Applied Technologies, January-April 2012;1(1):25-29
43. Milind, T, Aamer, B,H (2012). A review of Thromboelastography. Int Journal Periop Applied Technology 2012; 1(1): 25-29
44. Mimic-Oka J, Simic DV, Simic TP (1999). Free Radicals in Cardiovascular Diseases. UC 612.17. Medicine and Biology, pp;6(1): 11-22
45. Monroe DM, Hoffman M .A cell-based model of hemostasis.ThrombHaemost. 2001 Jun;85(6):958-65.
46. Ninivaggi M, Dargaud Y, van Oerle R, de Laat B, Hemker HC, Lindhout T. Thrombin generation assay using factor IXa as a trigger to quantify accurately factor VIII levels in haemophilia A. J Thromb Haemost 2011; 9: 1549–55.
47. Ninivaggi M, Dargaud Y, van Oerle R, de Laat B, Hemker HC, Lindhout T .Thrombin generation assay using factor IXa as a trigger to quantify accurately factor VIII levels in haemophilia A. J ThrombHaemost. 2011 Aug;9(8):1549-55. doi: 10.1111/j.1538-7836.2011.04358.x.

48. Penedo, Frank Ja; Dahn, Jason R (2005). Exercise and well-being: a review of mental and physical health benefits associated with physical activity. March 2005 - Volume 18 - Issue 2 - p 189–193
49. Rahman K. Studies on free radicals, antioxidants, and co-factors. Clinical Interventions in Aging. 2007;2(2):219-236.
50. Rauramaa, Vaisanen SB. (1999). Physical activity in the Prevention and treatment of a thrombogenic profile in the Obese: Current Evidence and Research Issues. Med Sci Sports Exerc, pp; 31(11): Suppl S631-S634
51. Redinger, R. N. (2007). The Pathophysiology of Obesity and Its Clinical Manifestations. Gastroenterology & Hepatology, pp 3(11), 856–863.
52. Rothman, K J (2008). International Journal of Obesity 32, S56–S59; doi:10.1038/ijo.2008.87
53. Scarpelini, S., Rhind, S.G., Nascimento, B., Tien, H., Shek, P.N., Peng, H.T., et al (2009). Normal range values for thromboelastography in healthy adult volunteers. Brazilian Journal of Medical and Biological Research, 42(12), 1210-1217. Epub October 30, 2009. Retrieved November 08, 2015, from
54. Sgouraki E, Tsopanakis A, Tsopanakis C. Acute exercise. (2001): Response of HDL-c, LDL-c lipoproteins and HDL-c subfractions levels in selected sport disciplines. J Sports Med Phys Fitness 2001;41:386-91.
55. SossdorfM , Gordon P Otto , Ralf A Claus , Holger H W Gabriel , Wolfgang Lösche. Cell-Derived Microparticles Promote Coagulation After Moderate Exercise. Med Sci Sports Exerc 43 (7), 1169-1176. 7 2011
56. Stephen F. Crouse, Barbara C. O'Brien, Peter W. Grandjean, Robert C. Lowe, J. James Rohack, John S. Green. Effects of training and a single session of exercise on lipids and apolipoproteins in hypercholesterolemic men. Journal of Applied Physiology Dec 1997, 83 (6) 2019-2028;
57. Stephen, FC. (2012). Acute Exercise and training alter Blood Lipid and Lipoprotein Profiles Differently in Overweight and Obese Men and Women. Obesity Volume 20, Issue 8:1618-27.
58. Stief TW, Kurz J, Doss MO, Fareed J (2000). Singlet Oxygen Inactivates Fibrinogen, Factor V, Factor VIII, Factor X, and Platelet Aggregation of Human Blood. Thromb Res, 2000; 97: 473-480
59. Swarup V, Rajeswari MR. Circulating (cell-free) nucleic acids—a promising, noninvasive tool for early detection of several human diseases. FEBS Lett. 2007 Mar 6;581(5):795-9. Epub 2007 Feb 2.

60. Szczygielska A, Widomska S, Jaraszkiewicz M, Knera P, Muc K (2003). Blood lipids profile in obese or overweight patients. Ann Univ Mariae Curie Sklodowska [Med] 58, 343–349 (abstract)
61. Thomas, B, Annunziata, F,1 Jens, J (2014). Neutrophils release extracellular DNA traps in response to exercise, Appl Physiology 117: 325–333, 2014
62. Thompson PD, et al. (2001). The acute versus the chronic response to exercise. Med Sci Sports Exerc 2001;33(Suppl 6):S438-S45.
63. Thompson PD, Franklin BA, Balady GJ, Blair SN, Corrado D, Estes NA 3rd, et al. (2007). Exercise and acute cardiovascular events placing the risks into perspective: a scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology. Circulation, 115(17), 2358-2368
64. Thompson, PD, Crouse SF, Goodpaster B, Kelley D, et al (2001). The acute versus the chronic response to exercise. Med Sci Sports Exerc. 2001 Jun;33(6 Suppl):S438-45; discussion S452-3
65. U.S. Dept. of Health and Human Services. (2008). Physical Activity Guidelines for Americans; 2008. Accessed January 30, 2012.
66. Vina J, Gomez MC, Lloret A, Marquez R, Minana, et al. (2000) Free Radical in Exhaustive Physical Exercise: Mechanism of Production, and Protection by Antioxidants. IUBMB Life, 2000; 50: 271-277
67. Von Bruhl ML, Stark K, Steinhart A, Chandraratne S, Konrad I, Lorenz M, et al (2012). Neutrophils and platelets cooperate to initiate and propagate venous thrombosis in mice in vivo. J Exp Med 209: 819 –835, 2012.
68. Wang, J.S. (1994). Different effects of strenuous exercise and moderate exercise on platelet function in men.Circulation. 1994; 90: 2877-2885 doi: 10.1161/01.CIR.90.6.2877
69. Watts EJ. Haemostatic changes in long-distance runners and their relevance to the prevention of ischaemic heart disease. Blood Coagul Fibrinolysis 1991; 2: 221–5.
70. Weiss C, Seitel G, Bartsch P. Coagulation and fibrinolysis after moderate and very heavy exercise in healthy male subjects. Med Sci Sports Exerc 1998; 30: 246–51PubMed
71. Whang W, Manson JE, Hu FB, Chae CU, Rexrode KM, Willett WC, et al. (2006). Physical exertion, exercise, and sudden cardiac death in women.JAMA, 295, 1399-1403
72. World Medical Association. Declaration of Helsinki. JAMA. November 27, 2013 Volume 310, Number 20.

APPENDICES

Appendix 1: Subject/ patient information and consent explanation form

Statement of consent

(To be translated into language best understood by participants/subjects at the time of administering consent)

Title: Effects of Acute Physical Exercise on Coagulation in Obese subjects and its relation to Blood Lactate and lipid levels

Background information: Obese individuals are at increased risk of premature deaths from heart attacks and stroke than non obese individuals. It is thought that these arise from accelerated formation of blood clots inside the body. As part of prevention and treatment, physical exercise is often prescribed with the assumption that alongside weight reduction, increased blood flow and muscular activity will retard blood clot formation as well. However, evidence for benefit are derived from population studies (epidemiology) and little is known about how, in obese individuals, acute physical activity and other chemicals released following exercise influences blood coagulation.

Purpose of study

The major aim of this study is to find out how clotting changes following physical activity in obese individuals in comparison to normal, and its correlation to blood lactate and lipid levels which are also elevated during exercise. The information will contribute to our understanding of role of exercise in treatment and prevention of blood coagulation related complications of obesity in medical management of obesity complications through physical activity.

Your role as a study participant

You will be required to provide consent for providing previous medical information, physical medical examination to detect any underlying medical condition that may be aggravated by exercise. When found to be medically fit, you will be requested to perform a standardized physical activity under observation. You also be requested to allow for collection of 10 cc of blood specimens before, immediately after and 40 minutes post exercise for laboratory testing of blood lactate, total blood count and lipid levels. Your participation is voluntary without coercion or intimidation. No further demands will be made. The provided blood samples will be processed as per the study protocol and discarded according to the public health regulations.

Rights as a participant

You can refuse to consent or withdraw from the study at any time without penalty or discrimination to you. You have a right to explanation about the study aims and what test will be done on the sample of blood provided. Confidentiality will be maintained at all times. You have a right to be treated fairly and with human dignity at all times, without tricks or deception. No judgment will be made about your weight or ability to perform exercise that may be construed to be injurious to your dignity.

Risks involved

No risks are known except pain at venepuncture. However, some people who are physically unfit may find the physical activity exhausting. In case you develop chest pain or difficulty in breathing during exercise, the researcher who is a qualified medical practitioner will attend to you promptly and refer if necessary.

Benefits as a participant

You will be given a copy of the laboratory test results on blood samples collected from you at no cost. These together with the health evaluation and physical check-up will be

used to stratify your obesity related risk factors and feedback offered to you at no additional cost.

Consent declaration

I have been informed about the nature of the research and risks involved. I have had a chance to ask questions which have been answered to my satisfaction. If I have further clarifications about the study, am permitted to ask questions at any stage. I have been given no guarantee about the outcome. My participation is voluntary without any coercion whatsoever. I am at least eighteen years of age, having been born _____. I understand also that I may withdraw from the study at any time or refuse to answer a particular question without penalty. By appending signature in this document is evidence of my willingness to participate and follow all instructions as prescribed during the study period.

I agree to participate in the study titled: **Effects of Acute Physical Exercise on Coagulation in Obese subjects and its relation to Blood Lactate and lipid levels**

Name of subject/Guardian: _____Signature/thumb print:_____

Name of person obtaining consent ----------Sign----------

Name of witness: _____Signature/thumb print:_____

Date: _____Time:_____

The above document is to be signed in duplicate, with one copy being kept by the researcher and the other by the subject.

Appendix 2: Health History Questionnaire

HEALTH HISTORY QUESTIONNAIRE			
Study Title: **Effects of Acute Physical Exercise on Coagulation in Obese subjects and its relation to Blood Lactate and lipid levels**			
Participant ID.		Date:	
Please answer the following questions to the best of your knowledge:			
1.	Are you currently involved in regular physical activity/exercise programme?	Yes	No
2.	Are you currently under a doctor`s care?	Yes	No
3.	Do you have a pacemaker or automatic implanted cardiac defibrillator (AICD)?	Yes	No
4.	Do you have, or suspect that you have, any circulatory problems or vascular (problems with your veins or arteries) disorders, conditions, disorders, or diseases?	Yes	No
5.	Do you have, or suspect that you have, any rheumatoid (joint) or muscular conditions, disorders or diseases?	Yes	No
6.	Has your doctor ever told you that you may have a heart valve problem?	Yes	No
7.	Do you experience numbness, tingling, or decreased sensation in extremities, or have other neurological problems, conditions, disorders, or diseases?	Yes	No
8.	Do you have any problems, conditions, disorders or diseases that affect your ability to keep your balance?	Yes	No

9.	Are you currently taking any **prescription** medications? *(If YES, please list all prescription medications.)*	Yes	No
10.	Are you taking any over-the-counter medications or supplements? *(If YES, please list below.)*	Yes	No
11.	Have you suffered from a lower extremity injury in the past 6 months?	Yes	No
12.	Has your doctor ever told you that you have heart disease?	Yes	No
13.	Have you ever had a heart attack?	Yes	No
14.	Have you ever had a stroke?	Yes	No
15.	Have you ever had chest pain when exercising?	Yes	No
16.	Has your doctor ever told you that you have a heart murmur?	Yes	No
17.	Does anyone in your immediate family have any important cardiac conditions? (e.g. Marfan syndrome, long-QT syndrome)	Yes	No
18.	Has your doctor ever told you that you have high blood pressure?	Yes	No
19.	Have you had a heart aneurysm?	Yes	No
20.	Have you ever had thyroid disease?	Yes	No
21.	Are you currently a smoker or have quit within the last six months?	Yes	No

23.	Do you suffer from exercise induced asthma?	Yes	No
24.	Have you ever fainted for any unknown reasons?	Yes	No
25.	Have you experienced any heat illnesses such as heat exhaustion or heat stroke?	Yes	No
26.	Have you been told that you are a diabetic?	Yes	No
27.	Have you been told that you have cancer?	Yes	No
28.	Are there any other medical problems (past or present) not already mentioned that we should know about? If YES, please explain below:	Yes	No

Appendix 3: Anthropometry And Physical Examination Form

Participants ID.....

Age..... Gender.....

Height..... Weight..... Resting blood pressure.....

Resting heart rate.....

Waist circumference.....

Wrist circumference.....

Reference Correlation Tables. These tables were generated from STATA 2013. Some of the data in these tables are referred to in the thesis.

Table 10: Correlation of Demographic data (normal, obese)

Group	Gender	Age	Height	Weight	Waist circumference	Wrist circumference	BMI
Normal							
Gender	1.0000						
Age	-0.0359	1.0000					
Height	-0.5937	-0.2133	1.0000				
Weight	-0.3492	0.2603	0.6128	1.0000			
Waist circumference	0.2802	0.5379	-0.0459	0.3609	1.0000		
Wrist circumference	-0.4596	0.3112	0.5865	0.8643	0.3437	1.0000	
BMI	0.2437	0.7128	-0.4255	0.2675	0.7744	0.1785	1.0000
	Gender	Age	Height	Weight	Waist circumference	Wrist circumference	BMI
Obese							
Gender	1.0000						
Age	-0.5992	1.0000					
Height	-0.6615	0.4479	1.0000				
Weight	-0.1746	0.4985	0.6201	1.0000			
Waist circumference	0.4540	-0.0677	-0.0851	0.4390	1.0000		
Wrist circumference	-0.5766	0.6541	0.3952	0.4845	0.0975	1.0000	
BMI	0.8704	-0.5092	-0.7455	-0.0912	0.5897	-0.3827	1.0000

Table: 11 (a): Correlation of Hemodynamics and clotting (normal)

	Systolic pressure	Diastolic pressure	Pulse	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Normal														
Systolic pressure	1.0000													
Diastolic pressure	0.5352	1.0000												
Pulse	0.5694	0.5300	1.0000											
PT	-0.1775	-0.1310	-0.2484	1.0000										
APTT	-0.1015	0.0928	-0.1588	0.1081	1.0000									
INR	-0.1815	-0.1325	-0.2038	0.9296	0.0403	1.0000								
R	-0.0295	0.0156	-0.1845	0.0634	0.3542	-0.0592	1.0000							
K	-0.1243	-0.0453	-0.2953	0.0657	0.3081	-0.0072	0.7849	1.0000						
αAngle	0.1433	0.0866	0.3203	-0.1158	-0.2910	-0.0433	-0.7939	-0.9934	1.0000					
MA	0.0820	-0.0279	0.0983	0.0396	-0.1591	0.0360	-0.2187	-0.4557	0.4212	1.0000				
G	0.0742	-0.0382	0.0893	0.0676	-0.1590	0.0587	-0.2135	-0.4429	0.4072	0.9983	1.0000			
EPL	-0.0410	0.0720	-0.0774	-0.0369	-0.0906	0.0293	-0.0797	-0.2277	0.2128	0.0381	0.0175	1.0000		
Amm	0.0868	-0.0791	0.0554	-0.0157	-0.1820	-0.0284	-0.1957	-0.3489	0.3296	0.9013	0.9057	-0.2475	1.0000	
CLY30	-0.0488	0.1206	0.0528	-0.0548	-0.1436	0.0326	-0.3655	-0.4497	0.4525	0.0254	0.0084	0.8221	-0.1663	1.0000

Table 11 (b): Correlation of Hemodynamics and clotting (obese)

	Systolic pressure	Diastolic pressure	Pulse	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Obese														
Systolic pressure	1.0000													
Diastolic pressure	0.5874	1.0000												
Pulse	0.2423	0.1994	1.0000											
PT	-0.1889	-0.1699	0.0675	1.0000										
APTT	0.2033	0.1554	-0.4639	-0.0646	1.0000									
INR	-0.3290	-0.3071	0.0733	0.7977	-0.0273	1.0000								
R	0.3716	0.3773	0.0147	-0.5396	0.1834	-0.6271	1.0000							
K	0.2401	0.2905	-0.1826	-0.5941	0.0872	-0.6598	0.8851	1.0000						
αAngle	-0.2227	-0.2724	0.1965	0.5828	-0.0999	0.6405	-0.8995	-0.9835	1.0000					
MA	-0.0927	-0.3049	0.1587	0.3203	0.1007	0.4524	-0.3502	-0.5693	0.5172	1.0000				
G	-0.0262	-0.2745	0.1795	0.3262	0.0396	0.4172	-0.3038	-0.5088	0.4663	0.9454	1.0000			
EPL	-0.2005	-0.1369	0.0102	0.0335	0.0268	0.1610	-0.1110	-0.1846	0.1939	-0.1083	-0.0927	1.0000		
Amm	0.0969	-0.1748	0.0907	0.1567	0.1399	0.2074	-0.0679	-0.2494	0.2147	0.8130	0.8613	-0.3808	1.0000	
CLY30	-0.2915	-0.1504	0.1228	0.1812	-0.1703	0.3104	-0.2561	-0.2998	0.3046	-0.0299	-0.0315	0.9048	-0.3987	1.0000

Table 12: Correlation of lactate and clotting (normal and obese)

	Blood lactate	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Normal												
Blood lactate	1.0000											
PT	0.0490	1.0000										
APTT	-0.2568	0.1081	1.0000									
INR	0.0175	0.9296	0.0403	1.0000								
R	0.0570	0.0634	0.3542	-0.0592	1.0000							
K	-0.0452	0.0657	0.3081	-0.0072	0.7849	1.0000						
αAngle	0.0516	-0.1158	-0.2910	-0.0433	-0.7939	-0.9934	1.0000					
MA	0.1707	0.0396	-0.1591	0.0360	-0.2187	-0.4557	0.4212	1.0000				
G	0.1676	0.0676	-0.1590	0.0587	-0.2135	-0.4429	0.4072	0.9983	1.0000			
EPL	0.1767	-0.0369	-0.0906	0.0293	-0.0797	-0.2277	0.2128	0.0381	0.0175	1.0000		
Amm	0.0977	-0.0157	-0.1820	-0.0284	-0.1957	-0.3489	0.3296	0.9013	0.9057	-0.2475	1.0000	
CLY30	0.1481	-0.0548	-0.1436	0.0326	-0.3655	-0.4497	0.4525	0.0254	0.0084	0.8221	-0.1663	1.0000
	Blood lactate	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Obese												
Blood lactate	1.0000											
PT	-0.0673	1.0000										
APTT	-0.2345	-0.0646	1.0000									
INR	-0.1548	0.7977	-0.0273	1.0000								
R	0.2025	-0.5396	0.1834	-0.6271	1.0000							
K	0.0705	-0.5941	0.0872	-0.6598	0.8851	1.0000						
αAngle	-0.0792	0.5828	-0.0999	0.6405	-0.8995	-0.9835	1.0000					
MA	0.1466	0.3203	0.1007	0.4524	-0.3502	-0.5693	0.5172	1.0000				
G	0.1447	0.3262	0.0396	0.4172	-0.3038	-0.5088	0.4663	0.9454	1.0000			
EPL	-0.2698	0.0335	0.0268	0.1610	-0.1110	-0.1846	0.1939	-0.1083	-0.0927	1.0000		
Amm	0.0986	0.1567	0.1399	0.2074	-0.0679	-0.2494	0.2147	0.8130	0.8613	-0.3808	1.0000	
CLY30	-0.1943	0.1812	-0.1703	0.3104	-0.2561	-0.2998	0.3046	-0.0299	-0.0315	0.9048	-0.3987	1.0000

Table 13 (a): Correlation of lipid profile and clotting (normal)

	Chol	TG	HDL	LDL	Chol Ratio	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Normal																
Chol	1.0000															
TG	0.2762	1.0000														
HDL	-0.3448	-0.1991	1.0000													
LDL	0.7930	0.4681	0.3951	1.0000												
Chol Ratio	0.3637	0.4845	-0.6515	0.2075	1.0000											
PT	-0.1869	-0.2743	0.3222	0.0513	-0.2447	1.0000										
APTT	-0.0317	-0.3532	0.1040	0.0409	-0.1864	0.1081	1.0000									
INR	-0.2585	-0.2931	0.3770	-0.0212	0.1863	0.9296	0.0403	1.0000								
R	0.3307	-0.0475	-0.0064	0.1902	0.2419	0.0634	0.3542	-0.0592	1.0000							
K	0.2660	-0.0867	-0.2050	0.1015	0.3684	0.0657	0.3081	-0.0072	0.7849	1.0000						
αAngle	-0.2828	-0.1138	0.2262	-0.1227	-0.4072	-0.1158	-0.2910	0.0433	-0.7939	-0.9934	1.0000					
MA	-0.0760	-0.0559	0.4166	0.2439	-0.2276	0.0396	-0.1591	0.0360	-0.2187	-0.4557	-0.4212	1.0000				
G	-0.0622	-0.0560	0.3922	0.2261	-0.2092	0.0676	-0.1590	0.0587	-0.2135	-0.4429	-0.4072	-0.9983	1.0000			
EPL	-0.1760	-0.0518	-0.0447	0.1261	-0.1235	-0.0369	-0.0906	0.0293	-0.0797	-0.2277	-0.2128	-0.0381	-0.0175	1.0000		
Amm	-0.1580	-0.0031	0.3923	0.2444	-0.1280	-0.0157	-0.1820	0.0284	-0.1957	-0.3489	-0.3296	-0.9013	-0.9057	-0.2475	1.0000	
CLY30	-0.2473	-0.0007	0.1418	0.1359	-0.3450	-0.0548	-0.1436	0.0326	-0.3655	-0.4497	-0.4525	-0.0254	-0.0084	-0.8221	-0.1663	1.0000

Table 13 (b): Correlation of lipid profile and clotting (obese)

	Chol	TG	HDL	LDL	Chol Ratio	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Obese																
Chol	1.0000															
TG	0.1690	1.0000														
HDL	0.0986	-0.3423	1.0000													
LDL	0.7035	0.4203	0.0352	1.0000												
Chol Ratio	0.6279	0.3579	-0.6439	0.4539	1.0000											
PT	-0.0185	-0.3616	0.4309	0.1186	-0.2406	1.0000										
APTT	-0.1540	-0.2599	0.0460	-0.0791	-0.1980	-0.0646	1.0000									
INR	0.2794	0.3558	-0.4954	-0.0252	-0.4798	0.7977	-0.0273	1.0000								
R	-0.3617	-0.4575	0.0606	-0.3136	0.2874	-0.5396	0.1834	-0.6271	1.0000							
αAngle	0.3467	0.4278	-0.1526	-0.1599	-0.3694	0.5828	-0.0999	0.6405	-0.8995	-0.9835	1.0000					
MA	-0.1867	-0.1740	0.0324	-0.1948	-0.1543	0.3203	0.1007	0.4524	-0.3502	-0.5693	0.5172	1.0000				
G	-0.1844	-0.0686	0.0512	-0.2225	-0.1710	0.3262	0.0396	0.4172	-0.3038	-0.5088	0.4663	-0.9454	1.0000			
EPL	-0.1737	-0.1222	-0.2203	-0.1692	-0.2788	0.0335	0.0268	0.1610	-0.1110	-0.1846	0.1939	-0.1083	-0.0927	1.0000		
Amm	-0.1369	-0.0249	-0.1137	-0.2271	-0.0075	0.1567	0.1399	0.2074	-0.0679	-0.2494	0.2147	-0.8130	-0.8613	-0.3808	1.0000	
CLY30	-0.1817	-0.1034	-0.3151	-0.1825	-0.3171	0.1812	-0.1703	0.3104	-0.2561	-0.2998	0.3046	-0.0299	-0.0315	-0.9048	-0.3987	1.0000

Table 14 (a): Correlation of Red blood cells and Coagulation (Normal)

	Hb	Rbcs	Plts	Hem	MCV	MCHC	MCH	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Normal																		
Hb	1.0000																	
RBCs	0.8591	1.0000																
Plts	-0.2756	-0.2697	1.0000															
Hem	0.9294	0.9148	-0.3260	1.0000														
MCV	-0.3771	-0.6567	0.2666	-0.4327	1.0000													
MCHC	-0.4701	-0.7085	0.3822	-0.7011	0.4775	1.0000												
MCH	-0.4560	-0.7786	0.4144	-0.6313	0.8316	0.8479	1.0000											
PT	0.3128	0.3428	-0.4219	0.4629	0.0096	-0.5345	-0.3080	1.0000										
APTT	0.1326	0.0392	-0.1186	0.0821	0.2831	-0.0376	0.1294	0.1081	1.0000									
INR	0.2642	0.3006	-0.4265	0.4109	-0.0342	-0.4915	-0.2990	0.9296	0.0403	1.0000								
R	0.4096	0.3562	-0.3431	0.3555	-0.1049	-0.2414	-0.1408	0.0634	0.3542	-0.0592	1.0000							
K	0.5094	0.6305	-0.4562	0.5427	-0.4647	-0.4837	-0.5233	0.0657	0.3081	-0.0072	0.7849	1.0000						
αAngle	-0.5195	-0.6331	0.4824	-0.5572	0.4747	0.5022	0.5306	-0.1158	-0.2910	-0.0433	-0.7939	-0.9934	1.0000					
MA	-0.1290	-0.2848	0.3892	-0.1013	0.3398	0.1786	0.3910	0.0396	-0.1591	-0.0360	-0.2187	-0.4557	-0.4212	1.0000				
G	-0.1238	-0.2766	0.3712	-0.0915	0.3345	0.1670	0.3802	0.0676	-0.1590	-0.0587	-0.2135	-0.4429	-0.4072	0.9983	1.0000			
EPL	-0.0860	-0.1401	0.0544	-0.0590	0.1696	-0.0629	0.0692	-0.0369	-0.0906	-0.0293	-0.0797	-0.2277	-0.2128	0.0381	0.0175	1.0000		
Amm	-0.0534	-0.1574	0.4097	-0.0554	0.1513	0.1506	0.2623	-0.0157	-0.1820	-0.0284	-0.1957	-0.3489	-0.3296	0.9013	0.9057	-0.2475	1.0000	
CLY30	-0.1541	-0.2613	0.1655	-0.1813	0.2840	0.1215	0.2410	-0.0548	-0.1436	-0.0326	-0.3655	-0.4497	-0.4525	0.0254	0.0084	0.8221	-0.1663	1.0000

Table 14(b): Correlation of Red blood cells and Coagulation (Obese)

	Hb	Rbcs	Plts	Hem	MCV	MCHC	MCH	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Obese																		
Hb	1.0000																	
RBCs	0.5463	1.0000																
Plts	-0.0412	-0.0369	1.0000															
Hem	0.6896	0.7628	-0.2541	1.0000														
MCV	-0.1236	-0.4907	-0.2221	-0.0527	1.0000													
MCHC	-0.3226	-0.5335	-0.0581	-0.1844	0.5275	1.0000												
MCH	-0.3069	-0.5617	-0.0862	-0.1203	0.8288	0.8902	1.0000											
PT	-0.6045	-0.5356	-0.2560	-0.5280	-0.1513	-0.0222	-0.0879	1.0000										
APTT	-0.0739	-0.1281	-0.3548	-0.0576	-0.0134	-0.3503	-0.1538	-0.0646	1.0000									
INR	-0.7041	-0.5731	-0.1503	-0.5995	-0.0461	-0.0267	-0.0123	-0.7977	-0.0273	1.0000								
R	0.5514	0.5299	-0.0965	0.6552	-0.1675	-0.0211	-0.0914	-0.5396	-0.1834	-0.6271	1.0000							
K	-0.4747	-0.6157	-0.1659	-0.6145	-0.2627	-0.1208	-0.1969	-0.5941	-0.0872	-0.6598	-0.8851	1.0000						
αAngle	-0.5018	-0.5794	-0.2013	-0.5995	-0.2134	-0.0647	-0.1372	-0.5828	-0.0999	-0.6405	-0.8995	-0.9835	1.0000					
MA	-0.2464	-0.3050	-0.1951	-0.1445	-0.1809	-0.0837	-0.1269	-0.3203	-0.1007	-0.4524	-0.3502	-0.5693	-0.5172	1.0000				
G	-0.2400	-0.2107	-0.1632	-0.0478	-0.1269	-0.0380	-0.0248	-0.3262	-0.0396	-0.4172	-0.3038	-0.5088	-0.4663	-0.9454	1.0000			
EPL	-0.1408	-0.0218	-0.0335	-0.1685	-0.0897	-0.1637	-0.1778	-0.0335	-0.0268	-0.1610	-0.1110	-0.1846	-0.1939	-0.1083	-0.0927	1.0000		
Amm	-0.1111	-0.0898	-0.1553	-0.1012	-0.1005	-0.0243	-0.0346	-0.1567	-0.1399	-0.2074	-0.0679	-0.2494	-0.2147	-0.8130	-0.8613	-0.3808	1.0000	
CLY30	-0.2046	-0.0835	-0.1825	-0.3206	-0.1054	-0.1128	-0.1240	-0.1812	-0.1703	-0.3104	-0.2561	-0.2998	-0.3046	-0.0299	-0.0315	-0.9048	-0.3987	1.0000

Table 15(a) Correlation of white blood cells with coagulation, Normal subjects

	WBCs	LYM	LYM%	Neu	Neu%	Mon	Mon%	Eos	Eos%	Bas	Bas%	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
WBCS	1																					
LYMP	0.8135	1																				
LYMP%	0.1947	0.5867	1																			
Neu	0.6106	0.2334	-0.319	1																		
Neu%	-0.2318	-0.5937	-0.6539	0.5732	1																	
Mon	0.4553	0.2438	-0.0901	0.1004	-0.3193	1																
Mon%	-0.0913	-0.3011	-0.3466	-0.2191	-0.1177	0.531	1															
Eos	0.2266	0.1459	0.0667	-0.17	-0.3602	0.4025	0.3655	1														
Eos%	-0.0778	-0.0919	0.0352	-0.3518	-0.255	0.1321	0.2603	0.8448	1													
Bas	0.1459	-0.0375	-0.3352	-0.0848	-0.1825	0.6619	0.5634	0.3697	0.1398	1												
Bas%	-0.1422	-0.2004	-0.2389	-0.4064	-0.2589	0.4165	0.3867	0.1717	0.2435	0.6711	1											
PT	-0.0647	-0.1581	-0.2999	-0.2645	-0.1924	0.5053	0.5569	0.3038	0.3252	0.6545	0.6312	1										
APTT	-0.3496	-0.2429	-0.0601	-0.3697	0.0098	-0.2486	0.1384	-0.0719	0.0177	0.2467	0.2332	0.1081	1									
INR	-0.1355	-0.2082	-0.2684	-0.3121	-0.2021	0.4819	0.499	0.2512	0.2715	0.6164	0.6669	0.9296	0.0403	1								
R	0.1253	0.075	-0.1589	-0.0314	-0.0739	-0.0905	0.2584	0.3011	0.2244	0.2478	-0.0576	0.0634	0.3542	-0.0592	1							
K	-0.0701	-0.1297	-0.2615	-0.2004	-0.1241	0.0161	0.4513	0.3681	0.3664	0.3333	0.1152	0.0657	0.3081	-0.0072	0.7849	1						
α angle	0.0688	0.1487	0.2788	0.1895	0.1101	-0.0481	-0.4796	-0.3591	-0.3574	-0.3476	-0.1304	-0.1158	-0.291	-0.0433	-0.7939	-0.9934	1					
MS	0.1922	0.1498	0.304	0.002	-0.1095	0.1025	0.0098	-0.0415	-0.0307	-0.2523	0.0812	0.0396	-0.1591	0.036	-0.2187	-0.4557	0.4212	1				
G	0.1905	0.1341	0.2778	0.0119	-0.0968	0.1161	0.0288	-0.0447	-0.0302	-0.2327	0.0969	0.0676	-0.159	0.0587	-0.2135	-0.4429	0.4072	0.9983	1			
ELP	0.0665	0.2152	0.1268	-0.0038	-0.0381	-0.0409	-0.4116	0.0623	0.1003	-0.1973	0.0201	-0.0369	-0.0906	0.0293	-0.0797	-0.2277	0.2128	0.0381	0.0175	1		
Amm	0.2381	0.1404	0.217	0.0532	-0.0939	0.1186	0.0509	-0.0305	-0.0167	-0.2104	0.0719	-0.0157	-0.182	-0.0284	-0.1957	-0.3489	0.3296	0.9013	0.9057	-0.2475	1	
CLY30	-0.0375	0.2057	0.2336	-0.0921	-0.0842	-0.1219	-0.4786	-0.0891	-0.0471	-0.3146	-0.0408	-0.0548	-0.1436	0.0326	-0.3655	-0.4497	0.4525	0.0254	0.0084	0.8221	-0.1663	1

Table 15 (b): Correlation of white blood cells with coagulation, Obese subjects

	WBCs	LYM	LYM%	Neu	Neu%	Mon	Mon%	Eos	Eos%	Bas	Bas%	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
WBCS	1																					
LYMP	0.747	1																				
LYMP%	0.2315	0.7011	1																			
Neu	0.474	-0.0969	-0.6228	1																		
Neu%	0.3773	0.8126	0.8746	0.5475	1																	
Mon	0.5623	0.5583	0.2235	0.2507	-0.3213	1																
Mon%	0.0736	0.1962	0.1135	0.0342	-0.1523	0.7969	1															
Eos	0.6508	0.353	-0.1437	0.5559	-0.0378	0.4665	0.1786	1														
Eos%	0.3407	0.0764	0.3262	0.5629	-0.1721	0.4416	0.2939	0.8439	1													
Bas	0.0673	0.2864	0.433	-0.4501	-0.4203	0.2001	0.2503	-0.0199	-0.158	1												
Bas%	0.0599	0.3598	0.4988	0.5162	-0.561	0.3564	0.4255	0.0739	0.2289	0.6906	1											
PT	-0.2063	-0.2052	-0.0927	-0.1044	0.1618	-0.0913	-0.1752	-0.2079	-0.1042	-0.0816	-0.0374	1										
APTT	-0.3397	-0.348	-0.2105	-0.2522	-0.108	-0.3766	-0.1858	-0.3563	-0.439	-0.2159	-0.218	-0.0646	1									
INR	-0.1929	-0.2047	-0.0887	-0.1004	-0.1833	-0.0137	-0.0878	-0.1987	-0.1083	-0.0361	-0.145	-0.7977	-0.0273	1								
R	-0.2666	-0.3029	-0.1042	-0.0022	-0.2553	-0.1004	-0.1551	-0.0463	-0.1101	-0.053	-0.2128	-0.5396	-0.1834	-0.6271	1							
K	-0.1672	-0.1895	-0.0429	-0.0258	-0.128	-0.0831	-0.001	-0.1069	-0.0201	-0.0336	-0.0638	-0.5941	-0.0872	-0.6598	-0.8851	1						
α angle	-0.1458	-0.1909	-0.0421	-0.0172	-0.1136	-0.088	-0.0072	-0.0303	-0.0899	-0.0082	-0.0634	-0.5828	-0.0999	-0.6405	-0.8995	-0.9835	1					
MS	-0.0336	-0.1098	-0.1742	-0.1576	-0.1762	-0.1356	-0.0091	-0.0861	-0.0416	-0.0202	-0.0928	-0.3203	-0.1007	-0.4524	-0.3502	-0.5693	-0.5172	1				
G	-0.0423	-0.0613	-0.1755	-0.22	-0.1716	-0.1391	-0.0008	-0.0074	-0.0202	-0.0053	-0.1506	-0.3262	-0.0396	-0.4172	-0.3038	-0.5088	-0.4663	-0.9454	1			
ELP	-0.2819	-0.1377	-0.0126	-0.1778	-0.0064	-0.1278	-0.3579	-0.0428	-0.1697	-0.2932	-0.0139	-0.0335	-0.0268	-0.161	-0.111	-0.1846	-0.1939	-0.1083	-0.0927	1		
Amm	-0.0839	-0.0446	-0.21	-0.2187	-0.1282	-0.0297	-0.0973	-0.0021	-0.0197	-0.1422	-0.1385	-0.1567	-0.1399	-0.2074	-0.0679	-0.2494	-0.2147	-0.813	-0.8613	-0.3808	1	
CLY30	-0.2581	-0.1554	-0.0294	-0.1221	-0.0383	-0.0891	-0.2476	-0.0801	-0.1213	-0.4079	-0.0496	-0.1812	-0.1703	-0.3104	-0.2561	-0.2998	-0.3046	-0.0299	-0.0315	-0.9048	-0.3987	1

Table 16 (a): Correlation of blood gas analysis coagulation (normal)

	PH	PO2	PCO2	HCO-	BE	SPO2	SPCO2	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Normal																		
PH	1.0000																	
PO2	-0.2975	1.0000																
PCO2	-0.1459	-0.4954	1.0000															
HCO-	0.5477	-0.5343	0.6048	1.0000														
BE	0.6759	-0.5293	0.4835	0.9732	1.0000													
SPO2	-0.0574	0.9593	-0.5947	-0.4470	-0.4005	1.0000												
SPCO2	0.5343	-0.5156	0.6232	0.9946	0.9690	-0.4338	1.0000											
PT	-0.1542	0.1437	0.2983	0.2800	0.1749	0.0742	0.2963	1.0000										
APTT	0.0884	-0.3271	0.3373	0.2857	0.2734	-0.3200	0.2788	0.1081	1.0000									
INR	-0.1194	0.1432	0.2391	0.2487	0.1564	0.0775	0.2617	0.9296	0.0403	1.0000								
R	-0.0178	-0.0744	0.1307	0.0914	0.0601	-0.0915	0.0744	0.0634	0.3542	-0.0592	1.0000							
K	0.0534	-0.0482	0.3066	0.2823	0.2530	-0.0441	0.2759	0.0657	0.3081	-0.0072	0.7849	1.0000						
αAngle	-0.0545	0.0399	-0.2855	-0.2790	-0.2471	0.0370	-0.2715	-0.1158	-0.2910	-0.0433	-0.7939	-0.9934	1.0000					
MA	-0.0423	0.0636	-0.2058	-0.2676	-0.2597	0.0597	-0.2536	0.0396	-0.1591	0.0360	-0.2187	-0.4557	0.4212	1.0000				
G	-0.0345	0.0636	-0.1823	-0.2423	-0.2351	0.0579	-0.2266	0.0676	-0.1590	0.0587	-0.2135	-0.4429	0.4072	0.9983	1.0000			
EPL	-0.1420	0.0937	-0.1019	-0.1234	-0.1670	0.0824	-0.1448	-0.0369	-0.0906	0.0293	-0.0797	-0.2277	0.2128	0.0381	0.0175	1.0000		
Amm	0.0975	-0.0341	-0.1511	-0.1645	-0.1269	0.0219	-0.1391	-0.0157	-0.1820	-0.0284	-0.1957	-0.3489	0.3296	0.9013	0.9057	-0.2475	1.0000	
CLY30	-0.1484	-0.1112	0.0198	-0.0283	-0.0826	-0.1481	-0.0366	-0.0548	-0.1436	0.0326	-0.3655	-0.4497	0.4525	0.0254	0.0084	0.8221	-0.1663	1.0000

Table 16 (b): Correlation of blood gas analysis and coagulation (Obese)

	PH	PO2	PCO2	HCO-	BE	SPO2	SPCO2	PT	APTT	INR	R	K	α angle	MA	G	EPL	Amm	CLY30
Obese																		
PH	1.0000																	
PO2	0.2220	1.0000																
PCO2	-0.4059	-0.6621	1.0000															
HCO-	0.1371	0.5960	0.5875	1.0000														
BE	0.3961	0.4229	0.4238	0.8077	1.0000													
SPO2	0.3681	0.9692	-0.7251	-0.5197	-0.2745	1.0000												
SPCO2	0.3242	0.4724	0.5440	0.8271	0.9518	-0.3436	1.0000											
PT	0.0401	0.1477	-0.2030	0.1100	0.1075	0.1841	0.0662	1.0000										
APTT	0.3541	0.1558	0.0893	0.3990	0.4361	-0.0590	0.4480	-0.0646	1.0000									
INR	0.1400	0.1727	-0.3230	0.0340	0.0781	-0.2282	0.0242	0.7977	-0.0273	1.0000								
R	-0.2639	-0.2426	0.5139	0.0550	0.0295	-0.3476	0.0411	-0.5396	0.1834	-0.6271	1.0000							
K	-0.1588	-0.2540	0.4779	0.1354	0.0628	-0.3268	0.1219	-0.5941	0.0872	-0.6598	0.8851	1.0000						
αAngle	-0.1594	-0.2264	-0.4509	-0.0993	-0.0442	-0.3018	-0.0832	0.5828	-0.0999	0.6405	-0.8995	-0.9835	1.0000					
MA	-0.0040	-0.0638	0.2387	0.3592	0.1562	0.0938	0.2041	0.3203	0.1007	0.4524	-0.3502	-0.5693	0.5172	1.0000				
G	-0.0203	-0.1409	-0.2229	-0.3751	-0.1827	-0.1493	-0.2142	0.3262	0.0396	0.4172	-0.3038	-0.5088	0.4663	0.9454	1.0000			
EPL	0.2646	0.0521	-0.0807	-0.0874	-0.2043	-0.0915	-0.1102	0.0335	0.0268	0.1610	-0.1110	-0.1846	0.1939	-0.1083	-0.0927	1.0000		
Amm	-0.0316	-0.0682	-0.1435	-0.3063	-0.1405	-0.0693	-0.1492	0.1567	0.1399	0.2074	-0.0679	-0.2494	0.2147	0.8130	0.8613	0.3808	1.0000	
CLY30	-0.1306	-0.1316	-0.1693	-0.0644	-0.0421	-0.1579	-0.0556	0.1812	-0.1703	0.3104	-0.2561	-0.2998	0.3046	-0.0299	-0.0315	0.9048	-0.3987	1.0000