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Assessment of some hematological parameters of hypertensive patients in public hospitals of Harar, eastern Ethiopia: a comparative cross-sectional study

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This is to certify that the thesis prepared by Beza Sileshi, entitled: **Assessment of some hematological parameters of hypertensive patients in public hospitals of Harar, eastern Ethiopia: a comparative cross-sectional study** and submitted in partial fulfillment of the requirements for Master of Science degree in Clinical Laboratory Sciences (Hematology and Immunohematology) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abbreviations and Acronyms

BP	Blood pressure
CBC	Complete blood count
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
EDTA	Ethylene diamine tetra acetate
HCT	Hematocrit
HFSUH	Hiwot Fana Specialized University Hospital
HGB	Hemoglobin
HTN	Hypertension
IL	interleukin
IQR	Interquartile range
MCH	Mean cell hemoglobin
MCHC	Mean cell hemoglobin concentration
MCV	Mean cell volume
mmHg	Millimeters mercury
MPV	Mean platelets volume
NCD	Non-Communicable disease
PLT	Platelets
RDW	Red cell Distribution Width
SBP	Systolic blood pressure
SCF	Stem cell factor
SOP	Standard operating procedure
WBC	White blood cell

Abstract

Background: Hypertension is a major health problem worldwide and it's associated with increased risk of cardiovascular disease. Even though hypertension has impact on hematological parameters and alteration of hematological indices may indicate increased risk to cardiovascular diseases, the relationship between hematological parameters and hypertension is little studied.

Objective: To compare hematological parameters between hypertensive patients and normotensive adult groups from January 1 to March 30 at Hiwot Fana specialized university hospitals and Jugel hospitals, Harar, eastern Ethiopia.

Methods: Institutional based comparative cross-sectional study was conducted from January 1 to March 30 2020 at Jugel and Hiwot Fana hospital, Harar, eastern Ethiopia. Convenient sampling technique was used to recruit 102 hypertensive patients from 2 hospitals and 102 healthy controls from blood bank. Participant's socio-demographic and clinical information were collected using pre-tested semi structured questionnaire. Blood sample was collected and analyzed by Beckman Coulter DxH 500 analyzer for complete blood count. Data was entered and analyzed using SPSS 20. Independent *t*-test and Mann Whitney *u*-test were used for comparison between groups. Spearman's correlation was used for correlation test. *P* values less than 0.05 was considered the level of significance.

Result: 102 hypertensive and 102 healthy controls were enrolled in this study. 61.8 % of participants were females. The median ± IQR value of WBC, Hgb, HCT, RDW and MPV were significantly higher in hypertension group compared to apparently healthy normotensive groups. Additionally, RBC, HCT and RDW showed statistically significant positive correlations with blood pressure indices (systolic and diastolic). WBC count and RDW were significantly positively correlated with Body mass index. Duration of illness in hypertension patients was also significantly correlated with PLT and MPV.

Conclusion: The median values of WBC, Hgb, HCT, RDW and MPV were significantly higher compared to apparently healthy normotensive individuals. Hence, it is important to assess hematological parameters for hypertensive individuals which may help to prevent complications associated with hematological aberrations. However, further longitudinal studies are required to understand hypertensive associated changes in hematological parameters.

Key words: Blood pressure, Hypertension, Hematological parameters, Harar, Ethiopia

1. Introduction

1.1 Background

Hypertension (HTN) is defined as high blood pressure. Blood pressure is the power of blood exerted to the walls of arteries as the heart pumps blood(1). Normal range of blood pressure (BP)is defined as levels <120/80 mmHg. Systolic blood pressure of 120–139 mmHg or diastolic blood pressure 80–89 mmHg is classified as prehypertension. These patients are at increased risk for progression to hypertension(2). Hypertension is a reading of systolic blood pressure (SBP) ≥140 mmHg and or diastolic blood pressure (DBP) ≥90 mmHg(3). Stage one hypertension is defined as SBP 140-159 mmHg or DBP of 90-99 mmHg(3). While stage two hypertension is SBP of ≥160 mmHg and DBP of ≥ 100 mmHg(3).

The pathophysiology of hypertension is unknown. In about 95-97 % of hypertension cases there is no known cause and its characterized as primary hypertension. In the remaining small percent an underlying disease is responsible for the raised blood pressure (4).Often times, hypertension shows no symptoms up until it has done substantial damage to the cardiovascular system. Thus, its often called "silent killer". High blood pressure can make blood vessels to develop bulges and weak spots which makes them likely to collapse and burst(5). When left uncontrolled hypertension could also cause a heart attack, kidney failure, stroke and sometimes death(6).

Many recent guidelines on management of hypertension emphasis that total Cardio vascular risk should be quantified so that the type and intensity of treatment can be personalized to the degree of overall risk rather than the level of Blood Pressure elevation alone (7). Identifying patients with high risk of developing cardiovascular disease (CVD) allow an earlier introduction of antihypertensive treatment for correction of the cardiovascular risk and to weaken the progression of silent vascular damage before a clinical disease develops(8).

Since hypertension leads to functional disturbances in many systems of the body there is possibility of hypertension altering hematological parameters of the body too(9). During hypertension very important alterations in rheological, mechanical and biochemical characteristics of erythrocytes and of blood flow have been shown(10). It is very relevant the increase in blood viscosity, the decrease in red blood cell (RBC) deformability, the formation of RBC "rouleaux" and RBC

aggregates. These hemorheological determinants can favor an increase of peripheral resistances and of arterial blood pressure, causing or worsening hypertension(10).

Hypertension also causes an increase in WBC count and raised platelet activation(11-13). These alterations may worsen the microcirculation and augment an end-organ damage(14). Even if the definitive pathophysiologic mechanism of hypertension with blood rheology is unknown, evidences show that there is a step by step relation between the severity of HTN, hypertensive complications and hematological parameters(9).

1.2 Statement of the Problem

Hypertension is the leading cause of cardiovascular disease and premature death globally. 1.13 billion people are suffering from HTN worldwide (15). Sub-Saharan Africa is no different. Evidences show that hypertension is widespread problem in the region and it has been documented to be as high as 38 % in some communities(16). In Ethiopia, it's estimated that about 19.6% of the population have hypertension(17). A study from Dire Dawa indicated that 24.43 % of the population have hypertension.

Although hypertension is a preventable and modifiable risk factor of CVD, its prevention and control has not yet received appropriate attention in many developing countries(18). Ethiopia is one of the lower income countries that is bothered by communicable and non-communicable diseases. A surveillance in Addis Ababa reported that 51% of all deaths were due to non-communicable disease, of which CVD accounts for 24 % and hypertension was responsible for 12 % of the CVD deaths (19).

Hypertension is a state of elevated systemic blood pressure that causes marked increment of cardiovascular risk. Cellular elements of the blood contribute to the viscosity, volume and coagulability of the blood there by playing a significant role in regulating blood pressure (8). Recently it has been shown that hypertension is associated with high leukocyte count (18-20) and high levels of Red cell distribution width (RDW) (21-23). Studies also revealed that platelets (PLT) have essential role in indicating risk of CVD (24, 25). In addition, increased hematocrit (HCT) is considered as a risk for HTN(20, 21).

Even though evidences show that hematological indices have a prognostic value in primary hypertension, the absolute pathophysiology of hypertension regarding hematology is unknown (8). There are only small no of researches conducted regarding the relationship of hypertension with hematology.

While some research has been done to assess the association between hematological parameters and hypertension, there is still a broad variation in hematological profile of hypertensive patients between different researches worldwide. For example, a study by Enawegaw et al(12) and babu et (8)al found significantly higher hematocrit and hemoglobin in hypertension patients compared to controls whereas a study by Divya R. et al (22)found significantly lower HGB and HCT levels

in hypertension patients compared to controls. In addition, a study by enawegaw et al(12) found significantly higher MCV levels in hypertensives compared to controls while a study by babu et (8) al found significantly lower MCV levels in hypertension patients compared to controls. Besides, there are only very few studies conducted regarding hematological parameters of hypertension patients in Ethiopia. So, this study aimed to assess hematological alteration of hypertension patients at Hiwot fana Specialized University Hospital (HFSUH) and Jugel hospitals, Harar, eastern Ethiopia.

1.3. Significance of the study

This study assessed the alteration of hematological profile in hypertension patients compared to normotensive individuals. The results of the study will be useful for hypertension patient's better treatment with respect to minimizing risk of complication development. It will also be useful for clinicians as prognosis and follow up tool of hypertensive individuals. The finding of this study is important to provide information for policy makers and health administrators regarding the routine assessment of hematological indices in hypertension patients to decrease risk of developing complications. This study will also be used as baseline for other researchers.

2. Literature review

During hypertension very important alterations in rheological, mechanical and biochemical characteristics of erythrocytes and of blood flow have been shown(10). It is very relevant the increase in blood viscosity, the decrease in red blood cell (RBC) deformability, the formation of RBC “rouleaux” and RBC aggregates(9). These hemorheological determinants can favor an increase of peripheral resistances and of arterial blood pressure, causing or worsening hypertension(10).

A comparative study from turkey published in 2012 was aimed to search whether RDW values differ between the healthy population and the patients with pre-hypertension and hypertension. the study included 128 hypertension, 74 prehypertension and 36 healthy controls. they found out that after adjustment for some confounding variables mean red cell distribution width levels were 15.26± 0.82 for prehypertension, 16.54 ±0.91 for hypertension and 13.87 ±0.94 for controls. RDW were also correlated with SBP and DBP. Therefore the study concluded RDW is higher in prehypertension and hypertension patients compared with controls (23).

A different study from Basel, Switzerland was published in 2012. The study compared RDW in 123 hypertensive patients compared to 65 gender and age matched controls. The results revealed that hypertensive patients have higher value of RDW when in comparison with to healthy controls(24).

Italian research by Cirillo m. et al was a cross-sectional study aimed to assess the relation of haematocrit with hypertension among 2,809 men and women aged 25-74 years at north central Italy. The result of this study revealed that hypertensive group have higher hematocrit level than the control group independent of confounders. Hematocrit was also positively correlated to systolic and diastolic pressures(25).

A cross sectional study from Brazil in 1999, had 145 study participants which includes 76 normotensives and 69 hypertensives. Its objective was to assess the possibility of finding other abnormal result on routine use of blood tests in hypertensive patients. The results showed that the mean values for haemoglobin, mean cell volume, leucocyte count and platelets were not significantly different between the two groups(26).

A cohort study was conducted in Korea for five years (2006 -2013). This study was aimed at investigating cross sectional (and also longitudinal) association between haemoglobin and hypertension. It performed a cross-sectional comparison on 1629 men and 2708 women. The result revealed that mean haemoglobin level was significantly higher in people with hypertension than in controls (13) .

In 2015 Indian, Sangreddy. a comparative cross-sectional study aimed at investigating the haematological changes in primary hypertension was conducted. it Compared 100 hypertensive and 100 normotensive individuals and found out that the mean values of Haemoglobin, Erythrocyte count, Leucocyte count and Thrombocyte count are found to be higher in hypertensive group. The mean value of Haematocrit and MCHC was also significantly higher in hypertensive group when compared to controls. However, the mean level of Mean cell volume is significantly lesser in hypertension patients. The mean level of MCH was not statically different between the groups(8).

A case control study conducted in males in kerela, India was published in 2016 and the results showed that Within the hypertensive and control groups the mean levels of Haemoglobin and Haematocrit were significantly higher in controls compared to hypertensive patients. Haemoglobin and haematocrit also showed a negative correlation with systolic blood pressure among the cases (22).

Another comparative cross-sectional study by Al-Muhana FA et al conducted in Saudi Arabia was aimed to determine the lipid profile, complete blood count and other biochemical parameters in normotensive and hypertensive individuals. It was published in 2006. The study showed hypertensive group have mean value of 13.11±1.67, 6.42±1.45 and 277.7±71.7 for Hgb, WBC and platelets respectively which was significantly higher than the normotensive group. (27).

A cohort study from Iran with a 7 year follow up having 9808 participants was published in 2016. It was conducted to investigate association of hematological parameters with HTN. The study revealed that people with hypertension have higher levels of WBC, RBC, HGB, HCT and MCH compared to controls. While MCHC, PDW and PLT showed no significant difference between the two groups. The rest parameters, MCV and RDW were lower in the HTN group(11).

A different comparative cross-sectional study aimed to assess any possible sex variations in hemorheological changes in some Nigerian hypertensive patients. The study had 100 study Participants. It found out that there is a significant positive correlation between relative plasma viscosity and systolic blood pressure and negative correlations between hematocrit and systolic pressure in male hypertensive patients. In female hypertensives ,there were positive correlations between relative plasma viscosity and systolic and diastolic blood pressures ,as well as whole blood relative viscosity and systolic blood pressure(28).

When we come to Ethiopian literature, a cross sectional study from Gonder by Enawgaw et al was aimed to assess haematological parameters of hypertensive patients compared to controls. This study included 126 hypertensive patients and 126 controls. This study reported that the level of WBC, RBC, HGB, HCT and PLT were positively correlated with systolic and diastolic blood pressures. Findings of this study also showed that the level of WBC, RBC, HGB, HCT, MCV MCHC, RDW, MPV and PDW were significantly higher in people with hypertension compared to controls(12).

3. Objectives

3.1 General Objective

- To compare hematological parameters between hypertensive patients and normotensive adult groups and to correlate hematological parameters with blood pressure indices in hypertensive patients from January 1 to March 30 at HFSUH and Jugel hospitals, Harar, eastern Ethiopia.

3.2 Specific objectives

- To compare hematological parameters between hypertensive and control groups.
- To correlate hematological parameters with blood pressure indices in hypertension patients.
- To correlate hematological parameters with body mass index in hypertensive patients.
- To correlate hematological parameters with duration of illness in hypertensive patients.
- To compare hematological parameters between controlled blood pressure and poorly controlled blood pressure in case group.

4. Hypothesis

The Null Hypothesis (HO)

There is no significant difference between hematological parameters of normotensive versus hypertensive adults.

5. Materials and Methods

5.1. Study area

The study was conducted at Jugel and Hiwot fana specialized university hospitals, Harar, eastern Ethiopia. Harar town is found in Harar National Regional State, 527 kilometer east of Addis Ababa, the capital city of Ethiopia. It is present at an elevation of 1917 meter above sea level. Based on the 2007 national census conducted by central statistical agency of Ethiopia the total population was 183,415. And 60% of the total population were living in urban areas, where as the rest of the population were living in rural kebeles around Harar. The region has six Hospitals, eight health centers, and twenty health posts (29).

HFSUH is a tertiary level teaching hospital related to College of Health and Medical Sciences of Haramaya University, Ethiopia. It is the major referral hospital in the eastern part of the country serving a population close to 3 million (28). The follow up of hypertension patients at HFSUH is found under the internal medicine department. It has 4 specialists,3 residents, many intern students and 2 nurses. There are around 80 hypertensive patients on follow up in this hospital (28).

Jugel Hospital is a regional general hospital found in Harar town, run by the Harari Regional Health Bureau. This hospital was established in 1902. It has 105 inpatient beds. The general staff Composition of Hospital is 239. There are around 70 hypertensive patients on follow up in this hospital.

5.2 Study design and Period

A comparative cross-sectional study was conducted from January 1 to March 30 ,2020, G.C.

5.3. Population

5.3.1. Source population

All hypertensive patients attending at Jugel and Hiwotfana specialized university hospital and all blood donors at Harari blood bank were taken as a source population for hypertensive group and control group respectively.

5.3.2. Study population

All adult hypertensive patients present in Jugel and HFSUH at data collection time were used as study population for hypertensive group. While, age and sex matched screened healthy blood donors during the study period were used as study population for control group.

5.4. Inclusion and Exclusion criteria

5.4.1. Inclusion criteria

Cases

- Confirmed hypertensive patients who are on follow up.
- Aged between 18 and 65 years,
- Consented to participate in the study.

Controls

- Age and sex matched normotensive screened apparently healthy blood donors.

5.4.2. Exclusion criteria

Adults which have a history of chronic disease, having history of infectious diseases, alcohol consumers, smokers, patients taking antibiotic, treatment for anemia, patients with systemic diseases, pregnant, and those with secondary hypertension are excluded.

5.5. Study Variables

5.5.1. Dependent variables

- Hematological parameters (WBC, RBC, HGB. HCT, MCV, MCH, MCHC, RDW, RDW - SD, PLT, MPV)

5.5.2 Independent variables

- Blood pressure

- Duration of illness
- Body mass index (BMI)
- Status of blood pressure (controlled or uncontrolled)
- Sociodemographic characteristics

5.6. Sample size determination and sampling method

5.6.1. Sample size determination

The sample size was determined based on variance and mean of HGB from a study conducted in India(8) using comparison between two means (double population) Formula with a confidence interval (CI) of 95% and power of 80%.

Calculation

$$n_1 = n_2 = \frac{(z_{\alpha/2} + z_{\beta})^2 (\sigma_1^2 + \sigma_2^2)}{\Delta^2}$$

n = $(1.96+0.84)^2$ $(1.25^2+ 1.68^2)$/ **(**$10.80-11.90)^2$

n = 93

n = 93 for control and 93 for case groups

n=186

n = 186 + 10% non-response rate

n = 204

5.6.2. Sampling method

A total of 102 hypertensive subjects from HFSUH and Jugel Hospital were included conveniently in this study. Whereas 102 age and sex matched screened blood donors were used as controls. Moreover, we used proportional allocation formula to allocate sample size in the two hospitals.

$n_h = (N_h / N) * n$

where $\mathbf{n_h}$ is the sample size for stratum *h*,

$\mathbf{N_h}$ is the population size for stratum *h*,

N is total population size, and n is total sample size.

There was a total of 80 and 70 hypertensive patients on follow up in HFSUH and Jugel hospitals respectively.

Accordingly, HFSUH = (80/150) *102=54.4 ≈**54** and Jegula = (70/150) *102= 47.6 ≈**48**

So, we took 54 Hypertensive patients from HFSUH and another 48 hypertensives from Jugel hospital.

5.7. Measurement and data collection

5.7.1 Data collection procedure

Before the data collection, consent was obtained from each participant. In-depth interview and review of medical records was used for exclusion. 3 ml of venous blood was collected from participants by qualified phlebotomist and the sample was run in hospital laboratory by qualified laboratory professional. A face-to-face interview was used to obtain socio-demographic data. Anthropometric data such as height and weight were also collected from each participant to determine body mass index (BMI). Blood pressure measurement was also taken.

5.7.2. Blood pressure and anthropometric measurement

- The data regarding anthropometric variables such as height (to the nearest centimeter without shoes) and weight (to the nearest 0.1 kg) was collected and body mass index were calculated as weight in kilograms divided by height in meter squared.
- Blood pressure (BP) was measured by qualified personnel (nurse) using an analog sphygmomanometer and stethoscope.
- For blood pressure measurements, measurement was taken twice and average value was used.

5.7.3. Hematological analysis

3 ml venous blood was collected according to standard operating procedure under aseptic condition by venipuncture from hypertensive patients and normotensive blood donors (controls). The blood sample was transferred into EDTA tube containing K3 EDTA and gently mixed by inverting the tube 5-6 times to prevent clotting. After the blood were collected, complete blood count (CBC) analysis was performed immediately by Beckman Coulter DxH 500 hematology analyzer. DxH 500 Coulter® analyzer has a counting speed of 60 samples per hour. The analyzer produces 5- part differentiation of WBC with 20 parameters (WBC, RBC, HGB, HCT ,MCV ,MCH ,MCHC RDW, RDW-SD ,PLT ,NE, LY ,MO ,EO ,BA ,NE# LY# MO# EO# BA#) (30).

5.7.3.1. Principle of CBC by DxH 500Coulter®

WBC, RBC and PLT count

Uses electrodynamic focusing and electrical impedance method. WBC, RBC and PLT are counted and sorted by the electrical impedance method, which is based on the measurement of changes in electrical impedance produced by a particle passing through an aperture. During each analysis cycle, the sample is aspirated, diluted and mixed before the determination for each parameter were performed(30).

HGB measurement

Uses modified Cyanmethemoglobin (525 nm). The lytic reagent used for the WBC prepares the blood so the system can count leukocytes and measure the amount of hemoglobin. The lytic reagent rapidly and simultaneously destroys the erythrocytes and converts a substantial proportion of the hemoglobin to a stable pigment. The absorbance of the pigment is directly proportional to the hemoglobin concentration of the sample(30).

WBC Differential

The COULTER VCS established WBC differential technology using three measurements: individual cell volume, high-frequency conductivity and laser-light scatter.(30)

5.8. Data quality assurance

5.8.1. Data collection tool Quality assurance

The data collectors (lab professionals) were trained on the purpose of the study, data collection and handling procedure by the principal investigator prior the data collection period. The principal investigator was supervising daily for the completeness of data collection tools. The data were entered at the end of each day to a statistical software**.**

5.8.2. Pre-analytic

Blood samples were collected by qualified laboratory professional after study subjects were rested and sitting comfortably in a portable chair. After ensuring all the necessary materials and equipment's for blood drawing procedure are available, and the rubber-type with closure tape tourniquet put on the arm of a study participant. skin preparation was made by rubbing skin area near to the suitable vein using 70% ethyl alcohol. Using EDTA tube and sterile needle of sized 19-23gauge .3 ml blood samples were collected from antecubital vein of study participants. After blood withdrawal, each sample will be inspected visually by gently mixing the tube and observe for clots. And each sample will also be checked prior to analysis for sample acceptable criteria. The rejection criteria were:

1. Sample Quality: hemolyzed, leaked tube, clotted

2. Sample Volume: Inadequate or overfilled sample

3. Sample Labelling: Improperly labelled, unlabeled, mislabeled, miss matched with the

Questionnaire code and collection of specimens in wrong tube

5.8.3 Analytic

Prior to analysis, IQC and whole blood samples were homogenized by inverting 8-10 times. Running daily the three level of commercial controls by Beckman Coulter UniCel® DxH 500 Coulter hematology cell controls (Low, Normal and High). Processing IQC and whole blood at

room temperature (27.5±0.5°C). Analysis was performed by following standard operating procedure (SOP) after running and passing of these levels of controls**.**

5.8.4. Post Analytic

- Inspect histogram prior to documenting complete blood count value results
- The results were recorded and appropriately secured.

5.9 Data analysis and interpretation

Data was cleaned, edited and checked for completeness before entering in to the computer for analysis. Data was entered and analyzed using SPSS version 20 software. The results are presented on graphs and tables. The normality of data distribution was checked by statistical tools of Kolmogorov-Smirnov (K-S). Data of the different hematological parameters were stated as mean (±SD) for parametric data and median with interquartile range for non-parametric data. Comparison of variables between hypertension patients and controls was done with independent t-test for parametric data and Mann-Whitney U test for non-normally distributed data. Correlation of hematological parameters with blood pressure indices was tested by Spearman's correlation. In all conditions, P value less than 0.05 was considered as statistically significant. Data analysis and interpretation was made by principal investigator.

5.10. Operational definitions

Hematological parameters: are parameters such as RBC parameters including; RBC count, HB, HCT, RBC indices like MCV, MCH, RDW, MCHC; WBC parameters including total WBC counts, and platelet parameters including total platelet count and MPV**.**

Case group: Cases are confirmed hypertensive patients who are on follow up at Jugel and HFSUH included in the study.

Control group: Controls are normotensive apparently healthy screened blood donors from Harar blood bank which are included in the study.

Hypertension: Hypertension is defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg or taking antihypertensive treatment (2).

Pre hypertension: is defined as systolic blood pressure of 120 -139mm Hg and or diastolic pressure of 80-89 mm Hg (2).

Stage 1 hypertension: a sub type of hypertension with systolic pressure of 140-159mm Hg or diastolic pressure of 90-99 mmHg (2).

Stage 2 hypertension: is a subtype of hypertension with systolic pressure of greater than or equal to 160mmHg or diastolic pressure of greater than equal to 100 mmHg (2).

Duration of hypertension: is duration of hypertension illness since date of diagnosis expressed in months.

Alcohol consumption: is defined as use of 7 or more alcoholic drinks per week for women and 14 or more alcoholic drinks per week for men.

Cigarette smoking: is defined as someone who smokes any tobacco product either daily or occasionally.

Controlled blood pressure: It is the blood pressure that is controlled by antihypertensive drug(s) and/or non-pharmacological treatment, that is, systolic blood pressure (SBP) is lower than 140 mmHg and diastolic blood pressure (DBP) is lower than 90 mmHg.

Uncontrolled or poorly controlled blood pressure: It is the blood pressure not well controlled despite the antihypertensive drugs prescribed, that is, SBP is greater than or equal to 140 mmHg and/or DBP is 90 mmHg or more.

5.11. Ethical consideration

Ethical clearance was obtained from the research and an ethical review committee of Medical Laboratory Sciences of Addis Ababa University, Ethiopia. Before the starting of data collection, permission was obtained from Harari health bureau and hospital heads. Also, after explaining the purpose and relevance of the study, informed written consent was obtained from each study participant. To ensure confidentiality, the name and other personal identifiers of participants was not registered on the questionnaire. Participants were informed that the selection to the study is voluntary and they have the right not to respond for questions that they are not comfortable with.

The confidentiality of the information collected was maintained by using code numbers for participants**.** The results of the complete blood count were informed to the physician.

5.12 Dissemination of the result

The findings of this research will first be presented to scientific communities of Addis Ababa University, Department of medical laboratory science. After getting approval from Addis Ababa University, a copy of the thesis report will be disseminated to the study participants (Harar city). The result will be communicated to Harari regional health bureau and other concerned institutions. The findings of this research will also be presented on different conferences. Finally, it will be sent to appropriate journals for publication.

6. Results

6.1. Sociodemographic and clinical characteristics of the study participants

The study included 204 study participants that comprise 102 hypertensive patients with mean age of 51.11 ± 8.4 years and 102 controls with mean age of 48.65 ± 8.85 years. 63 (61.8 %) were females in both case and control groups. The majority of hypertensive patients (85.3%) and control group (83.3%) were urban dwellers. Majority of respondents 60 (58.8%) of the cases and 48 (47.1%) of controls were married (58%). Regarding education 43.1% (44) of hypertensive had primary school while 59(57.9%) of controls had up to preparatory school.

The mean and standard deviation value of the systolic and diastolic pressure of the cases were 138.36±16.25, and 85.61 ±9.28 respectively. The mean of body mass index of the participants was 24.22 ± 3.93 for cases and 23.37 ± 3.57 for control groups. The stage of blood pressure of the patients was also determined and 8.8 %, 38.2 %, 37.3 % and 15.7 % were staged as normal, prehypertension, stage 1 and stage 2 respectively. The details of socio demographic and clinical characteristics are summarized in table 1.

Table1: Socio-demographic and clinical characteristics of study participants at HFSUH and Jugel Hospitals, Harar, eastern Ethiopia, 2020 (n=204).

Variables		**Case**	**Control**
Age (in years)	<35	4(3.9%)	6(4.9%)
	35-55	63(61.8%)	60(59.8%)
	>55	35(34.3%	36(33.3%)
	Mean	48.85 ± 8.99	51.11 ± 8.4
Sex	Male	39(38.2%)	39(38.2%)
	Female	63(61.8%)	63(61.8%)
Residence	Urban	87(85.3%)	85(83.3%)
	Rural	15(14.7%)	17(16.7%)
Marital status	Single	7(6.9%)	34(33.3%)

	Married	60(58.8%)	48(47.1%)
	Divorced and widowed	35(35.3%)	20(19.6%)
Educational status	Illiterate	22(21.6%)	12(11.8%)
	Primary (1-8)	44(43.1%)	16(15.7%)
	Secondary (9-12)	28(27.4%)	59(57.9%)
	Diploma and above	8(7.8%)	15(14.7%)
Body mass index	Mean + SD	24.22 ± 3.93	23.37 ± 3.57
Blood Pressure Indices (mmhg)	Systolic BP	138.36±16. 25	111.03 ± 6.04
	Diastolic BP	85.61 ± 9.28	73.71± 3.75
Stage of blood pressure	Normal	9 (8%)	102 (100%)
	Prehypertension	39(38.2%)	
	Stage 1	38(37.3 %)	
	Stage 2	16(15.7%)	
Duration of illness (in years)	< 5 years	52(51.0%)	
	5-10 years	35(34.3%)	
	>10	15(14.7%)	
	Mean	60.66 ± 43.50 months	

6.2. Comparison of hematological parameters between hypertensive and control groups

The normality of the variables was tested and all hematological parameters except platelets were non-normally distributed, so all variables except platelets are expressed by median plus interquartile range and compared by Manny Whitney test. While platelet is expressed by mean ± SD and tested by independent t test.

The result of this study showed that there was a statistically significant increase in WBC count, HGB, HCT, RDW and MPV in hypertensive compared to normotensive controls. In contrast, RBC, MCV, MCHC, MCH and PLT showed no statistically significant difference (Table 2).

Table 2: Comparison of hematological profile of Hypertensive and control group at HFSUH and JUGEL hospital, Harar, Ethiopia, 2020(n=204).

Parameters	**Hypertensive (n=102)**	**Healthy controls(n=102)**	**P value**
	Median ± IQR	Median ± IQR	
WBC (10^3/ul)	6.52 ± 3.08	5.29 ± 2.27	<0.001
RBC (10^6/ul)	4.78± 0.79	4.70 ± 0.75	0.055
HCT (%)	42.45 ± 5.42	40.60 ± 4.33	0.001
HGB (g/dl)	14.50 ± 1.93	13.78 ± 2.13	0.027
MCV (fl)	88.05± 8.84	88.55 ± 11.98	0.394
MCH (pg)	29.80 ± 2.78	30.40 ± 2.03	0.118
MCHC(g/dl)	34.00 ± 1.92	34.35 ± 3.95	0.192
RDW CV (%)	13.85 ±1.60	13.60 ± 1.55	0.018
RDW SD (fl)	43.90 ± 5.30	42.03 ± 2.85	0.063
MPV (fl)	9.50 ± 2.22	9.04 ± 1.06	0.024
	Mean ± SD	Mean ± SD	
PLT Count(10^3/ul)	250. 47 ± 75.72	244.99 ± 82.24	0.714

6.3. Correlation of hematological parameters with blood pressure indices among hypertensive individuals

A spearman's product-moment correlation was run to assess the relationship between various hematological parameters and the blood pressure indices among hypertensive individuals. The

result showed that there was a weak positive correlation between RBC and systolic BP (r=. 231, P= 0.020) as well as diastolic BP (r=0.251, P=0.11). HCT and RDW are other variables that showed significant positive correlations with systolic and diastolic blood pressures. The rest of the hematological variables like WBC, MCV, MCHC, MCH, RDW-SD, PLT count, and MPV didn't show significant correlation with blood pressure indices. The details of correlation result are mentioned in table 3 below. Scatter plots are also drawn for selected variables (Fig 1 to Fig 4).

Table 3: Correlation of hematological parameters with blood pressure indices among hypertensive individuals at HFSUH and Jugel hospitals, Harar, Eastern Ethiopia,2020 (n=102).

Variables	Systolic blood pressure	Diastolic Blood pressure
	Correlation coefficient (p value)	Correlation coefficient (p value)
WBC (10^3/ul)	.180 (0.070)	.102 (0.310)
RBC (10^6/ul)	.255 (0.010) **	.241(0.015) *
HGB (g/dl)	.156 (0.117)	.183(0.065)
HCT (%)	.219 (0.027) *	.354 (0.001) **
MCV (fl)	-.162 (0.103)	.030 (0.767)
MCH (pg)	.076 (0.450)	.127 (.204)
MCHC (g/dl)	.145(0.147)	.181(0.069)
RDW - CV (%)	.418 (0.001) **	.281(0.004) **
RDW - SD (fl)	.186(0.061)	.152 (0.127)
PLT Count(10^3/ul)	- .070 (0.484)	.079 (0.430)
MPV (fl)	.046 (0.647)	.098 (0.329)

* = for p-value ≤ 0.05, ** = for p-value ≤ 0.01

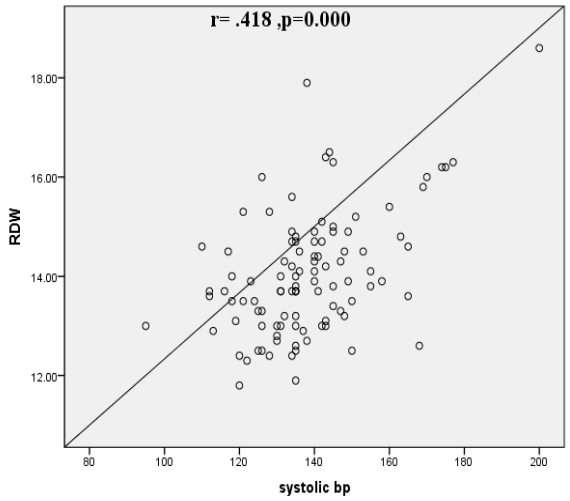

Figure 1: Relationship of RDW with Systolic blood pressure at HFSUH and Jugel hospitals, Harar, Eastern Ethiopia, 2020(n=204).

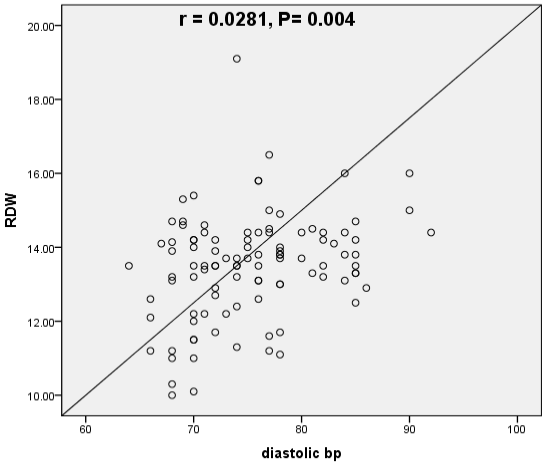

Figure 2: Relationship of RDW with Diastolic blood pressure at HFSUH and Jugel hospitals, Harar, Eastern Ethiopia, 2020(n=204).

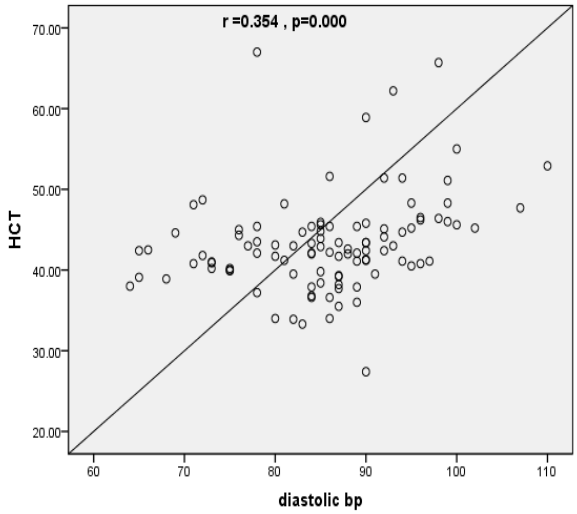

Figure 3: Relationship of HCT with diastolic blood pressure at HFSUH and Jugel hospitals, Harar, Eastern Ethiopia, 2020(n=204).

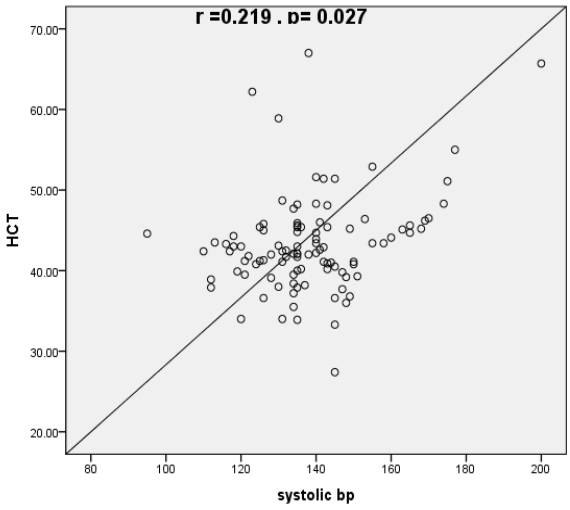

Figure 4: Relationship of HCT with Systolic blood pressure at HFSUH and Jugel hospital, Harar, Eastern Ethiopia, 2020(n=204).

6.4. Correlation of hematological indices with duration of illness and body mass index

Spearman correlation was done to assess linear relationship between some hematological parameters and body mass index. Correlation of BMI with RDW and WBC count achieved significant but weak positive correlation in hypertensive patients. Likewise, bivariate correlation was run to assess relationship between various hematological parameters and duration of illness. MPV achieved significant positive correlation with duration of illness. Platelet count on the other hand had negative correlation with duration of illness among the cases. (Table 4)

Table 4: Correlation of hematological parameters with body mass index and duration of illness among hypertensive individuals at HFSUH and Jugel hospitals, Harar, Eastern Ethiopia,2020(n=102).

Variables	BMI r (P)	Duration of illness r (P)
WBC	.208(0.036) *	.155(0.119)
RBC	.114(0.253)	.126(0.206)
HGB	.034(0.736)	.125(0.211)
HCT	.011(0.915)	.060(0.552)
MCV	-.154(0.122)	-.064(0.524)
MCH	.014(0.890)	-.123(0.217)
MCHC	.019(0.850)	-.127(0.205)
RDW	.198(0.046) *	.049(0.622)
RDW – SD	.030(0.763)	-.075(0.455)
PLT COUNT	.190(0.056)	-.219(0.027) *

MPV	-.022(0.828)	.255(0.010) *

* = for p value ≤ 0.05, ** = for p value ≤ 0.01

6.5. Comparison of hematological parameters between controlled blood pressure vs uncontrolled blood pressure in case group.

Comparison of hematological parameters was done between hypertensive patients who have controlled blood pressure vs those who have uncontrolled (poorly controlled) blood pressure. when the normality of the variables was tested using tests of normality after grouping in controlled and poorly controlled blood pressure. PLT count, MPV, MCV, and MCH were normally distributed. While WBC count, RBC count, MCHC, RDW- CV, RDW-SD, HGB and HCT were not normally distributed so normally distributed variables were tested using independent t test while non parametric variables were tested using Mann Whitney U Test.

The results of the comparison revealed that the levels of HCT, RDW- CV, RDW- SD, MCHC were significantly higher in poorly controlled BP patients compared to controlled blood pressure hypertensive patients. The details of the comparison are put in table 5 below.

Table 5: Comparison of hematological profile of controlled blood pressure and poorly controlled blood pressure in hypertensive patients at HFSUH and JUGEL hospitals, Harar, eastern Ethiopia, 2020(n=102).

Parameters	**Controlled blood pressure (n=48)**	**Poorly controlled blood pressure (n=54)**	**P value**
	Median ± IQR	**Median ± IQR**	
WBC (10^3/ul)	6.00 ±2.34	7.40 ± 4.09	0.154
RBC (10^6/ul)	4.67 ± 0.88	4.87 ± 0.81	0.064
HCT (%)	42.05 ± 5.80	43.40 ± 5.27	0.050
HGB (g/dl)	14.20 ± 2.13	14.50 ± 2.08	0.319
MCHC(g/dl)	33.80 ±1.40	34.25 ±1.83	0.042
RDW CV (%)	13.55 ±1.10	14.40 ± 1.45	0.001

RDW SD (fl)	42.40 ±3.77	44.90 ± 6.40	0.022
	Mean ± SD	**Mean ± SD**	
MCV (fl)	89.10 ± 6.11	87.43 ± 6.30	0.820
MCH (pg)	29.54 ±2.33	29.82 ±2.00	0.214
PLT Count(10^3/ul)	239.19 ± 71.26	260.51 ±78.78	0.380
MPV (fl)	9.57 ±1.35	9.48 ± 1.49	0.304

7. Discussion

The cellular components of blood contribute to the viscosity, volume and coagulability of blood thus, playing a vital role in regulating blood pressure(9). The aims of this study were to compare hematological profile of hypertension patients compared to normotensives as well as to correlate blood pressure indices with hematological parameters. In this study, the median values of WBC count, Hemoglobin, Hematocrit, RDW and MPV were significantly higher in hypertensive patients compared to controls. In the bivariate correlation analysis, Red blood cell count, Hematocrit and RDW showed positive correlation with blood pressure indices. Correlation of BMI with RDW and WBC count achieved significant positive correlation in hypertensive patients. In addition, duration of hypertension was positively and negatively correlated with MPV and PLT respectively, in hypertension group.

The results showed that hypertensive groups have significantly higher median ± IQR value of WBC count (6.52 ± 3.08) compared to normotensives (5.29 ±2 .27). This finding is in line with Enawegaw et al (31), Babu et al (8), Al muhana et al (27) and Emamian et al (11). In contrast to this another study by Reis RS et al (26) and Divya r et al (22) showed no statistically different result in WBC count. This difference could be due to sample size variation because these studies smaller sample size. The higher leukocyte count could be due to the vascular damage in people with hypertension which leads to activated cytokine system. cytokines such as SCF are produced to repair the endothelial injury and since these stem cells take part in proliferation and differentiation of hematopoietic cells, it might induce leucocyte differentiation(32). Activated white blood cells are more adherent to the vascular endothelium and might also yield more cytokines triggering capillary leukocytosis and consequent amplified vascular resistance, thereby causing an increase in blood pressure(33).

In the present study, the median values of hemoglobin were found to be significantly higher in the hypertensive (14.50±1.93) than in control (13.78±2.13) group. Studies from India (8), Iran (11) ,Korea (13) and Gondar , Ethiopia (12) found similar results. In contrast, studies from Brazil(26), Saudi (27)and India(22) Showed contradicting result. This difference could be due to differences in study design because the study from India used were done only in males , the study from Saudi were in newly diagnosed .The reason behind the increment of HGB in hypertensive patients are not entirely known but it might be related to endothelial dysfunction and subsequent increased

concentrations of growth factors(34) . Evidences show that concentration of serum hepatocyte growth factor is positively associated with hypertension and increased hemoglobin concentration. As growth factors boost hematopoiesis, which produces red blood cells, HGB levels may rise with increasing concentration of growth factors(35, 36).

In the present study, the median values of hematocrit were found to be significantly higher in the hypertension (42.45±5.42) than control (40.60±4.33) group. Previous studies also showed similar results. (8, 11, 12, 25) .On the other hand ,study by Divya and colleagues (22) found significantly lower hematocrit levels in hypertensive patients compared with controls. Study by Al muhana et al (27) also found no significant difference in hematocrit between the two groups . The reasonable mechanisms underlying the association between HCT and blood pressure is that HCT is a determinant factor for high whole blood viscosity during hypertension(37). This may lead to a peripheral resistance to blood flow and high blood pressure(38). Evidences show that, most hypertensive patients exhibit increased blood viscosity compared with healthy controls. therefore, high hematocrit in hypertension could reflect a true increase in red blood cell mass as well as hemoconcentration caused by a reduction in plasma volume(25).

In our study, RDW increased significantly in hypertensive groups (13.90 ± 1.65) compared to normotensive (13.60 ± 1.55) individuals. This result is in line with studies by Tanindi A. et al(23) and Gunebakmaz O.et al(24). Another study from Iran by Emanain M. et al(11) found contradicting result. The increased RDW is supported by evidences that suggest Higher red cell distribution width arise from ineffective erythropoiesis caused by chronic inflammation(39). Inflammatory cytokines have been found to smother the maturation of red blood cells, which enable juvenile red cells to enter into the circulation and increases the heterogeneity in size(40).

This study also revealed that the median value of mean platelet volume is higher in hypertensive patients (9.55 ± 2.22) compared to controls (9.04 ± 1.06). This result is in accordance with a study conducted in Gondar ,Ethiopia (12). The possible explanation for the increased mean platelet volume is vascular complication in hypertensive patients. High blood pressure causes endothelial damage, which leads to increased platelet activation and initiation of platelet production. Evidences suggest that platelet consumption increases at the site of injured blood vessel which causes larger PLTs to escape from the bone marrow. And since larger platelets are hemostatic ally more active, they become a risk for coronary thrombosis and myocardial infraction (41, 42).

When we come to spearman bivariate correlation of hematological parameters and blood pressure indices. HCT level was significantly positively correlated with both systolic (r =0.219) and diastolic (r= 0.354) blood pressures. This finding is in line with studies from Ethiopia (12) and Italy (25) .A study from Nigeria(28) however, found a negative correlation between HCT and blood pressure indices. The reason behind positive correlation of Hematocrit with blood pressure are unknown but it might be related to an increase in red blood cell mass which increases with blood pressure(25).

RBC count was also weakly and positively correlated with systolic (r=0.255) and diastolic (r=0.241) blood pressures in our study. This result is in accordance with Enawegaw et al (12).This association could be explained by the augmentation of growth factors due to distended vascular injury caused by increased blood pressure (9). Then again Red cell distribution width was also positively correlated with systolic (r= 0.418) and diastolic (r=0.281) blood pressures. This positive correlation could be related to the amplified chronic inflammation which comes from increased blood pressure(39).

With respect to the correlation of hematological indices with body mass index in hypertensive patients, WBC count achieved positive correlation with BMI(r=0.208) in this study. This could be due to the fact that adipose tissue is a great source of inflammatory factors, such as interleukin(IL) -6 and IL-8, which are also important inducers of WBC production(43).

RDW also achieved significant positive correlation with BMI (r= 0.198) in this study. The reason might be due to the fact that obesity is characterized by chronic, low grade, systemic inflammation which could lead to impaired erythropoiesis there by elevating RDW(44).

In present study, duration of illness since diagnosis achieved significant negative correlation with platelet count (r =- 0.219) and positive correlation with mean platelet volume (r=0.255). This could be due to the fact that vascular complication in hypertensives worsens with longer duration. This means the vascular injury and consequent platelet activation leads to consumption of platelets and escaping of larger platelets from the bone marrow(45) . This could lead to lower platelet count and high mean platelet volume.

This study showed that hypertensive patients who have poorly controlled BP have significantly higher levels of HCT, MCHC, RDW- CV and RDW -SD compared to controlled BP in hypertensive patients. The possible explanation for increase HCT in poorly controlled BP could be due to the increased red blood cell mass and viscosity seen in hypertensive patients(14), and the reason for the increased RDW is due to the greater chronic inflammation present in poorly controlled BP which can cause bone marrow dysfunction leading to release of immature erythrocytes and subsequent anisocytosis which increase the level of RDW(39). MCHC was also increased in patients who have uncontrolled BP the reason for this might be the increased hemoglobin concentration seen in hypertensives(34).

8. Strength and limitation of the study

8.1. Strength of the study

- The strength of the study is it assessed the relationship between hematological parameters and BMI as well as duration of illness in hypertensive patients.

8.2. Limitation of the study

- Due to nature of the study design (cross- sectional) showing temporal relationships is difficult.
- The study used convenient sampling technique which is not representative.

9. Conclusion and Recommendation

9.1. Conclusion

In the present study, the median values of the parameters of WBC count, Hemoglobin, Hematocrit, RDW and MPV was significantly higher in hypertension patients compared with controls. In the bivariate spearman correlation analysis, RBC count, HCT and RDW showed significant correlation with blood pressure indices. WBC count(r=0.208) and RDW(r=0.198) were also significantly correlated with Body mass index. Duration of illness achieved significant correlation with PLT (r= - 0.219) and MPV (r = 0.255). Additionally, HCT, RDW-CV, RDW-D and MCHC were significantly higher in patients who have uncontrolled blood pressure compared to those who have controlled blood pressure.

9.2. Recommendation

Based on the above finding, the following recommendation are forwarded

- it is important to assess changes in hematological parameters for hypertension patients because it may indicate risk of developing complications before it occurs.
- Further longitudinal cohort studies are recommended to clarify definitive pathophysiologic mechanism of hypertension regarding hematological indices.

10. References

1. WHO. A global brief on hyper tension World Health Day. 2013.
2. WHO. International Society of Hypertension (ISH) statement on management of hypertension. Journal of Hypertension. 2003;1(21): 1983-92.
3. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, JL IJ. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. hypertension. 42. 2003;6:1206-52.
4. beevers Gareth, Lip Gregory Y H, Eoin OB. . The pathophysiology of hypertension BMJ. 2001;322.
5. AE D. Hypertension and vascular disease. . Am J Hypertens. 1991;4(2):103S.
6. John M. Flack, Rosalind Peters, Tariq Shafi, Hisham Alrefai, Samar A. Nasser, Crook E. Prevention of Hypertension and Its Complications: Theoretical Basis and Guidelines for Treatment JASN 2003;14:92-8.
7. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. International Society of Hypertension global hypertension practice guidelines. . J Hypertens. 2020;38:982-1004.
8. Babu KR, Solepure A, R. S. Comparison of hematological parameters in primary hypertensives and normotensives of sangareddy. Int J Biomed. 2015;6(5):309-15.
9. Karabulut A, A K. Clinical implication of hematological indices in the essential hypertension. World J Hypertens. 2015;5(2):93-7.
10. Cicco G, c PA. Red blood cell (RBC) deformability, RBC aggregability andtissue oxygenation in hypertension. Clin Hemorheol Microcirc. 1999;21(169):e77.
11. Emamian M, Hasanian SM, Tayefi M, Bijari M, Movahedian far F, M S. Association of hematocrit with blood pressure and hypertension. Journal of clinical laboratory analysis. 2017;31(6):e22124.
12. Enawgaw B AN, Terefe B, Asrie F, Melku M. A comparative cross-sectional study of some hematological parameters of hypertensive and normotensive individuals at the university of Gondar hospital, Northwest Ethiopia. BMC hematology. 2017;17(1):21.

13. Kim NH, Lee JM, Kim HC, Lee JY, Yeom H, JH L. Cross-sectional and longitudinal association between hemoglobin concentration and hypertension: A population-based cohort study. . Medicine. 2016;95(41).
14. Merad-boudia H, Dali-Sahi M, Kachekouche Y, Medjati N. Hematologic disorders during essential hypertension. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2019;13(2):1575-9.
15. Mills KT, Stefanescu A HJ. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16:223-37.
16. Guwatudde D, Nankya-Mutyoba J, Kalyesubula R, Laurence C, Adebamowo C, I A. The burden of hypertension in sub-Saharan Africa: a four-country cross sectional study. BMC public health. 2015;15(1):1211.
17. Kibret KT MY. Prevalence of hypertension in Ethiopia: a systematic meta-analysis. Public Health Reviews. 2015;36(1):14.
18. Campbell NR, D L. Hypertension in sub-Saharan Africa: a massive and increasing health disaster awaiting solution. Cardiovascular journal of Africa. 2015;26(4):152.
19. A M, Haile Mariam D, T. A. The Double Mortality Burden Among Adults in Addis Ababa, Ethiopia, 2006-2009. . CDC,Preventing Chronic Disease: . 2012;9.
20. Liu X, Liang J, Qiu Q, Sun Y, Ying P, F T. Association of hematocrit and pre-hypertension among Chinese adults: the CRC study. Cell biochemistry and biophysics. 2015;71(2):1123-8.
21. Jae SY, Kurl S, Laukkanen JA, Heffernan KS, Choo J, YH C. Higher blood hematocrit predicts hypertension in men. Journal of hypertension. 2014;32(2):245-50.
22. R. D, V. A. A study of hematological parameters and anthropometric indicators in hypertensive and normotensive males. . nternational Journal of Current Research and Review 2016;8(4):6.
23. Tanindi A, Topal FE, Topal F, B. C. Red cell distribution width in patients with prehypertension and hypertension. Blood pressure. 2012;21(3):177-81.
24. Gunebakmaz O, Kaya MG, Duran M, Akpek M, Elcik D, Eryol NK. Red blood cell distribution width in 'non-dippers' versus 'dippers'. Cardiology. 2012;123(3):154-9.
25. Cirillo M, Laurenzi M, Trevisan M, Stamler J. Hematocrit, blood pressure, and hypertension. The Gubbio Population Study. Hypertension. 1992;20:319-26.

26. Reis RS, Benseñor IJ, . LP. Laboratory assessment of the hypertensive individual. Value of the main guidelines for high blood pressure. Arq Bras Cardiol. 1999;73(2):201-10.

27. Al-Muhana FA, Larbi EB, Al-Ali AK, Al-Sultan A, Al- Ateeeq S, Soweilem L. Haematological, lipid profile and other biochemical parameters in normal and hypertensive subjects among the population of the eastern province of Saudi Arabia. . East african medical journal. 2006;83(1):44-8.

28. Ighoroje A, D D. Sex variations in the haemorheological parameters of some hypertensive Nigerians as compared to normotensive. Niger J Physiol Sci. 2005;20(1):338.

29. National census of Ethiopia, central statistical agency (CSA),2007. 2007.

30. DXH500 hematology analyzer operator's manual.Beckmancoulter .2015.

31. Gebrie A, Gnanasekaran N, Menon M, Sisay M, A Z. Evaluation of lipid profiles and hematological parameters in hypertensive patients: Laboratory-based cross-sectional study. SAGE open medicine. 2018;6.

32. Brown D, Giles WH, Croft JB. White blood cell count: an independent predictor of coronary heart disease mortality among a national cohort. Journal of clinical epidemiology. 2001;54:316-22.

33. Kim DJ, Noh JH, Lee BW, Choi YH, Chung JH, Min YK, et al. The associations of total and differential white blood cell counts with obesity, hypertension, dyslipidemia and glucose intolerance in a Korean population. . J Korean Med Sci. 2008;23:193-8.

34. Kadota K, Shimizu Y, Nakazato M, Noguchi Y, Koyamatsu J, Yamanashi H, et al. Hemoglobin as a response marker of endothelial cell damage in elderly nonoverweight non-anemic subjects. Acta Medica Nagasakiensia. 2016;60:103-8.

35. Takai K, Hara J, Matsumoto K, Hosoi G, Osugi Y, Tawa A, et al. Hepatocyte growth factor is constitutively produced by human bone marrow stromal cells and indirectly promotes hematopoiesis. Blood. 1997;89(5):1560-5.

36. Nakamura Y, Morishita R, S N. A vascular modulator,hepatocyte growth factor, is associated with systolic pressure. Hypertension. 1996;28:409-13.

37. B. S. Red cell fluidity in hypertension. . Clin Hemorheol Microcirc. 1998;21(3-4):179-81.

38. Y. Ç, G. D, M. P, Ç. AB. Effect of hematocrit on blood pressure via hyperviscosity. American Journal of Hypertension. 1999;12(7):739-43.

39. Li N, Zhou H, Q T. Red blood cell distribution width: a novel predictive indicator for cardiovascular and cerebrovascular diseases. . Disease markers 2017:23.
40. Turchetti V, Bellini MA, Guerrini M, S. F. Evaluation of hemorheological parameters and red cell morphology in hypertension. . Clin Hemorheol Microcirc. 1999;21:285-9.
41. Inanc T, Kaya MG, Yarlioglues M, Ardic I, Ozdogru I, Dogan A, et al. The mean platelet volume in patients with non-dipper hypertension compared to dippers and normotensives. Blood Press. 2010;19(2):81-5.
42. Sahin I, Karabulut A, Avci, II, Okuyan E, Biter HI, Yildiz SS, et al. Contribution of platelets indices in the development of contrast-induced nephropathy. Blood Coagul Fibrinolysis. 2015;26(3):246-9.
43. Farhangi MA, Keshavarz SA, Eshraghian M, Ostadrahimi A, AA S-Y. White blood cell count in women: relation to inflammatory biomarkers, haematological profiles, visceral adiposity, and other cardiovascular risk factors. J Health Popul Nutr. 2013;31:58-64.
44. Alrubaie A, Majid S, Alrubaie R, FA K. Effects of Body Mass Index (BMI) on complete blood count parameters. inflammation. 2019;8(11).
45. Yarlioglues M, Kaya MG, Ardic I, Dogdu O, Kasapkara HA, Gunturk E, et al. Relationship between mean platelet volume levels and subclinical target organ damage in newly diagnosed hypertensive patients. Blood Press. 2011;20(2):92-7.

Annex 1: Standard Operating Procedure (SOP)

Standard operating procedures for blood collection

Equipment

• 21-gauge needle for each participant with closed vacutainer system
• Blood collection tubes for each participant
• Tourniquet
• Box of nitrile /vinyl gloves
• 70% Alcohol wipes
• Cotton balls/swabs
• Bandages
• Pillow/pad for raising arm to comfortable elevation
• Apple/orange juice and snacks for fasting participants
• Disposable, single use materials or equipment are to be used whenever possible
• Any reusable materials or equipment must be cleaned and disinfected with
Alcohol-based sanitizers before use with another participant

Safeguards /safety procedures

• A new pair of disposable latex/vinyl gloves is used with each participant. Gloves are for single-procedure use only. Gloves should always be removed using a glove-to-glove or skin-to-skin technique which will prevent contaminating the hands.
• The use of gloves does not replace the need for hand hygiene. Hands should be properly washed before the gloves are put on and after the gloves are removed. Hand hygiene is also needed before and after the replacement of gloves during a procedure or in between tasks.

• Participants are reminded to do no heavy lifting for 24 hours.

Procedure for drawing blood

Steps 1; Assemble equipment
Collect all the equipment needed for the procedure and place it within safe pack which is simple for transport to collection site and place easy reach on a flat surface table ensuring that all the items are clearly visible.

Step 2; Identify and prepare the participants and allow to sit comfortably preferably be stretching his/her arm

Step 3; Perform hand hygiene and put on gloves

Step 4; Select the site of injection

Step 5; apply the tourniquet

Step 6; Prepare the arm by swabbing the antecubital fossa with a gauze pad or cotton moistened with 70% alcohol.

Step 7; insert the needle properly into the vein

Step 8; draw the required amount of blood

Step 9; Fill the laboratory sample tubes and mix properly

 When obtaining multiple tubes of blood, use vacutainer tubes with a needle and tube holder. This system allows the tubes to be filled directly. If this system is not available, use a syringe or winged needle set instead.

 If a syringe or winged needle set is used, best practice is to place the tube into a rack before filling the tube. To prevent needle-sticks, use one hand to fill the tube or use a needle shield between the needle and the hand holding the tube.

 Pierce the stopper on the tube with the needle directly above the tube using slow, steady pressure. Do not press the syringe plunger because additional pressure increases the risk of hemolytic.

 Where possible, keep the tubes in a rack and move the rack towards you. Inject downwards into the appropriate colored stopper. DO NOT remove the stopper because it will release the vacuum.

 If the sample tube does not have a rubber stopper, inject extremely slowly into the tube as minimizing the pressure and velocity used to transfer the specimen reduces the risk of hemolysis. DO NOT recap and remove the needle.

 Before dispatch, invert the tubes containing additives for the required number of times (as specified by the local laboratory).

Step 10; Draw samples in the correct order and label the sample using unique code of participants

Step 11; Clean contaminated surfaces and complete patient procedure

Step 12; Prepare samples for transportation

Step 13; Clean up spills of blood or body fluids

Sop of Unicell DxH 500 Hematology analyzer

Purpose: The DxH 500 analyzer is a quantitative, automated hematology analyzer for in-vitro diagnostic use in screening patient populations in clinical laboratories. The DxH 500 analyzer provides the following: CBC and Leukocyte 5-Part Differential (Diff).

Principle: The DxH 500 CBC analysis is based on the electrical impedance counting, absorption spectrophotometry methods and VCSn technology. Electrical impedance is used to count and size WBCs, RBCs, and platelet. This method counts and sizes cells by detecting and measuring changes in electrical resistance (electrical current) when a cell suspended in a conductive liquid pass through a small aperture. The change produces a measurable electrical pulse and the number of pulses is proportional to the volume and size of the cell that produced it. The system counts the individual cells and provides cell size distribution. The size of the blood cell is detected as electric pulses and the number of blood cells is calculated by counting the pulses. Each pulse is amplified and compared to internal reference voltage channels. These channels are delineated by calibrated size discriminators to accept only pulses of certain amplitude.

Absorption Spectrophotometry is the method used to measure Hgb. Methemoglobin chromogen is formed and measured when sample is mixed with a cyanide-free lytic reagent. An LED light source and photodetector are used to detect the chromogen at 525 nm. The Hgb concentration is directly proportional to the light absorption of the sample. An initial blank reading is made on reagents only, and then a comparison of the blank and sample readings determines the Hgb concentration.

The VCSn module in DxH 500 system uses the Multi-Transducer Module (MTM), to all Diff, by measuring additional multiple angles of light scatter, a major improvement over the single light scatter measured by conventional flow cytometry. The volume conductivity and scatering at different angle (VCSn) module is responsible for controlled sample preparation and delivery of

the prepared sample to the flow cell for analysis of the WBC differential, reticulocyte, and NRBC. The VCSn module includes the Air Mix and Temperature Control (AMTC) and the Multi-Transducer Module (MTM). In the flow cell, low-frequency direct current measures volume, while high-frequency (RF) current senses cellular internal content through measuring changes in conductivity.

Specimen Requirements

Whole blood collected in an EDTA tube.

The instrument aspirates 12 μL of patient sample.

Samples are stable at room temperature for eight hours

Cause for rejection: hemolysis, clotted specimen, insufficient volume, unlabeled specimen.

Reagents

Coulter DxH diluent (store at 2 - 40° C)

Coulter DxH Lyse reagent (store at 2 - 40° C)

Coulter DxH cleaner (store at 2–25° C)

NB. All reagents are cyanide-free and stable for about 60 days after opening except the cleaner, it is stable for 90 days.

Equipment: DxH 500 Coulter Cellular Analysis System.

Procedure

- Hold the specimen to allow Bar Code Reader to scan the specimen label. OR type specimen identifier. Place the cursor at the end of the last character of the Specimen ID and press enter.
- Verify the Specimen Identifier and Test request. Follow the prompts on the screen.
- Mix the specimen by inverting the tube 8 times.
- Place the specimen into the correct tube position.
- Remove the plug while taking care not to allow blood scatter

- Set the tube to the sample probe and in that condition, press the start switch
- The buzzer sounds two times - "beep, beep" - and when the LCD screen displays "Analyzing," remove the tube. After that, the unit executes automatic analysis and displays the result on the LCD screen. Then the unit turns to the Ready status, becoming ready for analysis of the next samples.
- When the LCD screen displays "Ready," prepare the next samples and repeat the above procedures.
- Send the result to the release dialog box.
- Press PRINT REPORT for a hardcopy of the report

Quality control

Quality control checks performed daily according to the laboratory's protocol. Commercial controls materials are properly warmed and mixed according to the manufacturers' recommendations. The controls are handled according to the manufacturers' recommendations and the laboratory's protocol.

Annex 2: Subject information sheet

Subject information sheet in English version

Title of the Research Project: Assessment of some hematological parameters of hypertensive patients in public hospitals of Harar, eastern Ethiopia: a comparative cross-sectional study.

Principal Investigator: Beza Sileshi (BSc, MSc candidate)

Name of the Organization: Hiwot Fana Specialized university hospital and Jugel hospital , Eastern Ethiopia .

Introduction

You are invited to participate as a study subject in a research conducted by MSc candidate, from Addis Ababa University. Your participation is voluntarily. The research teams will include one principal investigator, two advisors; one from Addis Ababa University hematology department and one from HFSUH internal medicine department. Please take as much time as you need to read or listen in the information sheet.

Purpose of the Research Project

We are asking you to take part in this study because we will try to compare between hypertensive patient and normotensive patient in terms of hematological profile.

Procedures and the expected participation

If you are willing to participate, you need to understand the purpose of the study and give your consent. Not only this but also specimen collected from you will be used for the research purpose, and the results of your sample will be exposed to some concerned professional staffs as it is needed. The required clinical sample will be collected by medical laboratory professional. Then, you are requested to give your consent to the sample collector. After consent, a sample will be taken from your vein. Moreover, there will be a face-to-face interview for additional questions.

Potential risks and Discomforts

During collection of specimen from you, appropriate precaution will be taken and all samples will be collected by trained health professionals. If anything happened, appropriate medical care will be provided to you.

Confidentiality

We respect your privacy and confidentiality. Any information that identifies you will not be shared with anyone else outside the study team. The information we will collect from you as part of the study will be kept in a locked file cabinet, or be protected by a password on the computer only accessible to personnel involved in the study. There is no sensitive issue that you will be asked related with your social desirability but any information that is obtained in connection with this study and that can be identified with you will remain confidential.

Potential benefits to subjects and/or to the society

You will not receive any payment for your participation in this research study as compensation. However, based on the diagnosis result you will be treated in view of that. In addition, the result of the study will be beneficial for prognosis and follow up of Hypertensive patients. Hence, you are indirectly benefiting other patients and the society in this respect.

Participation and Withdrawal from the Study

The participation is voluntary and you have the right not to participate in this study. You may withdraw at any time and place without consequences of any kind. You may also reject to give any sample. You can ask any questions regarding to this study and you have a right to get a laboratory diagnosis result free.

Contact information

If you have any questions about this study you can contact the following principal investigators and advisors for further information.

Beza Sileshi **,** Phone: 0939182754 **E-mail:** mailbeza.sileshi@gmail.com

Fekadu Uregessa , Phone :0923330640 **E- mail :** urgessafekadu@gmail.com

Moges Wordofa , Phone 0984742173 **E- mail :** heranmakmow@gmail.com

Subject information sheet in Amharic version

የተሳታፊዎች ፈቃድና መተማመኛ ቅፅ

የአጥኝው ስም: ቤዛ ስለሺ

የተቋሙ ስም: አዱስ አበባ ዩኒቨርሲቲ የህክምና ና ጤና ሳይንስ ኮላጅ የሕክምና ሊቦራቶሪ ትምህርት ክፍሌ

የጥናቱርዕስ : የደም ግፊት ያለባቸው ሰዎች እና ጤነኛ ሰዎች የደም ቆጠራ ማነፃፀር

መግቢያ

በአዲስ አበባ ዩኒቨርሲቲ ጤና ሳይንስ ኮሌጅየ ሕክምና ላቦራቶሪ ሳይንስ ት/ክፍል በማስተርስ ድግሪ ተማሪ የመመረቂያ ጥናት ላይ እዲሳተፉ ተጋብዘዋል፡፡እባክዎ በዚህ ጥናት ለመሳተፍ ከመስማማትዎ በፊት ከዚህ ቀጥሎ የሚገኘዉን ምንባብ በ ጥሞና ያንብቡና ግልጽ ያልሆነልዎትን ማንኛዉም ሃሳብ ይጠይቁ፡፡የእርስዎ በዚህ ጥናት ላይ የሚኖርዎት ተሳትፎ ሙሉ በሙሉ በበጎ ፈቃደኝነት ላይ የተመሰረተ ነዉ፡፡በዚህ ጥናት ዉስጥ ላለመሳተፍ ወይም ለመሳተፍ ከወሰኑ በጎላ ለማቋረጥ የሚወስኑ ቢሆንም እንኩዋ በ ዚህ ሆስፒታል የሚሰጠዉ ማንኛዉም አገልግሎት አይቋረጥም፡፡ በጥናቱ ለመሳተፍ የሚስማሙ ከሆነ የስምምነት ቅጹ ላይ በጹሁፍ ወይም በጣት ፊርማ ማስቀመጥ ይጠበቅዎታል፡፡

የጥናቱ ተሳታፊ ለመሆንየ ሚጠበቅበዎት ምንድንነው?

በዚህ ጥናት ለመሳተፍ የሚስማሙ ከሆነ ናሙናዎ ለጥናቱ እንዲሚዉል መስማማት ይጠበቅብዎታል፡፡ከተወሰደዉ ናሙና ላይ የሚገኙ መረጃዎች ከዚህ ሆስፒታል ዉጭ ለሚገኙና ለስራዉ አግባብነት ላላቸዉ ሰዎች ቢነገር የማይቃወሙ መሆኑን መስማማት ይጠበቅብዎታል፡፡ ይሁን እንጅ ይህ አይነቱ መረጃ የርስዎን ማንነት የሚገልጡ መረጃዎችን ማለትምስም፤አድራሻና የስልክቁጥር የመሳሰሉትን መረጃዎቸን አይጨምርም፡፡ ይልቁንም ለዚህ አገልግሎት ብቻ የሚዉል እርስዎን ለማወቅ የሚያስችል መለያቁጥር ጥቅም ላይ እንዲዉል ይደረጋል፡፡ በተጨማሪም ስለርስዎ አጠቃላይ የጤና ሁኔታ ለሚቀርቡ አንዳንድ ተጨማሪ ጥያቄዎች መልስ መስጠት ይኖርብዎትአል፡፡

በዚህ ጥናት መሳተፍ የሚያስከትላቸዉ ቸግሮች ምንድን ናቸዉ?

ናሙና በሚሰበሰብበት ወቅት ምንም አይነት የከፋ ችግር አያጋጥምዎትም፡፡ ሆኖም ግን ናሙናዉን ለመሰብሰብ ልምድ ያለዉ ባለሙያ ስለሚመደብና አስፈላጊዉ የጥንቃቄ እርምጃ ስለሚወሰድ የህመም ስሜት አይኖርም፡፡

የህክምና መረጃ በሚስጥር ተጠብቆ መቆየት የሚችለዉ እንዴት ነዉ?

ስለራስዎ የሰጡት ማንኛዉም መረጃና ከተወሰደዉ ናሙና ላይ የተገኘዉ የላቦራቶሪ ዉጤት የሚዉለዉ ለጥናቱ አላማ ብቻ ነዉ፡፡ይህን ማህደር ሊያገኙ የሚችሉት የተወሰኑ የጥናቱ ተባባሪ ሰዎች ብቻ ናቸው፡፡ከዚያም በላይ ስለእርስዎ ያለውን ማንኛውንም መረጃ የተለየ የይለፍቃል ባለው የኮምፒውተር የመረጃ ማህደር ውስጥ እንዲቀመጥ ይደረጋል፡፡

በዚህ ጥናት መሳተፍ የሚያስገኛቸው ጥቅሞች ምንድንናቸው ?

ይህ ጥናት የማስተርስ ዲግሪ መመረቂያ እንደመሆኑ መጠን በዚህ ጥናት በመካፈልዎ በገንዘብ የሚያገኙት ጥቅም ባይኖርም ከጥናቱ በሚገኘው ውጤት ግን ተጠቃሚ ነ ዎት::የእርሶዎ ተሳትፎ የእርስዎንና የወገንዎትን **የደም ግፊት** ለማወቅና ለማከታተል ከፍተኛ ጥቅም ይኖረዋል::

በዚህ ጥናት ተሳታፊ የመሆንዎ መብቶች ምንድን ናቸው ?

በዚህ ጥናት መሳተፍ ሙሉበሙሉ በእርስዎ ፈቃደኝነት የተመሰረተ በመሆኑ በማንኛውም ሰዓትና ቦታ የማቋረጥ ሙሉመብት የተጠበቀ ከመሆኑም በላይ እራስዎን ከጥናቱ በማግለልዎ ምክንያት የሚቀርብዎት ምንም አይነት የሆስፒታል አገልግሎት አይኖርም::ከዚህም በተጨማሪ ጥናቱን በተመለከተ ማንኛውንም አይነት ጥያቄ የመጠየቅና ገለጻ የማግኘት መብት አለብዎት::የላብራቶሪ ምርመራ ውጤቱንም በነጻ ማግኘት ይችላሉ::ነገርግን እርስዎ በሚሰጡን መረጃ የችግሩን ስፋት ለመከላከል እና ለመቆጣጠር ጠቃሚ ስለሆነ ለሚቀርብልዎት ጥያቄ ቀጥተኛ መልስ ይሰጡን ዘንድ በታላቅ አክብሮት እንጠይቃለን::

ጥያቄ ካለኝ ወይም ችግር ቢያጋጥመኝ ምን ማድረግ ይገባል?

ይህንን ጥናት በተመለከተ ወይም ከዚህ ጥናት ጋር በተዛመደ መልኩ ስለሚያጋጥሙ ድንገተኛ አደጋዎች ወይም ጥያቄ ካለዎት በሚመለከተው አድራሻ ይጠቀሙ

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Information sheet in Afaan Oromoo Version

ddeeffaannoo Hirmaattottaa qoraannoo kaanafi kennaammu Qoraataan qoraannoo kanaa

Beezaa Siileeshii

Mataa dureen qoraannoo kana: Dhigaa namaa fayyaa fi kan dhiibbaa dhiigaa qaban wal bira qabnee qoraannoo dhiigaa taasisuuf.

Seensaa:

Qoraannoo baarattootni Yuunvaarsittii finfiinnee koolleejjii fayyaa Diipaartmeenti Meedikaal Laboratorii saayinsii Digrii lammaaffa (Maasteris) eebifaamuuf gaaggeessaan irraati akka hirmaataan carraan isiinif kennaame jiraa. Qoraannoo kanaa irraati hirmaachuuf waalgaluu keessaan dursitaan oddeeffaannoo armaan gadii kanaa xiyyeeffaanan akkaa dubistaani fi gaaffii dhimmaa qoraannoo kanaa ilaalchisee isiinit umaame kamuu akka gaafataan kabaajadhaan isiini gaafanna.

Kaayyoon Qoraannoo kanaa:

Dhigaa namaa fayyaa fi kan dhiibbaa dhiigaa qaban wal bira qabnee qoraannoo dhiigaa taasisuuf.

Haala Qoraannoon itti addeemsifaamu:

Qoraannoo kanaa keessaatti hirmaachuuf yoo murteessitaan namoon qoraannoo kanaa kan gaaggeessan gaaffiii daqiqaa 10 fudhaatu isiin gaafatani ulfaatina dheerina, dhiibbaa dhigaa keessaan safaaruun dhigaa milileetirii seedii (3 ml) siin irraa fudhaachun waan dhignii akka hin ragaane godhuu EDTA tuubit naquun Qoraanna hemaatolojjii, irraatti addeemsifaama

Qoraannoo kanaa irraati hirmaachuuf waantotaa namaarraa egaamu:

Qoraannoo kanaa irraati hirmaachuuf yoo fedhaan ta ‘ee sammuudni keessaan qoraannoof akka oluu heyaamama ta‘uu qabduu. Akkasumaasi bu ‘uudhan qoraannoo kanaara argaammuu akkumaa barbaachisuma isaatti ‘qamaa addaa addaa yoo qaaqaabe kaan hin mormiine yoo ta‘ee.Haa ta‘uu malee oddeeffaannoo eenyuummaa keessaan ibsuu kaneen akka maqaa teessoo fi bilbilaa keessaan kan daabarsinee hin keeninee ta‘uu ibsaa. Koodii dhimmaa kanaaf oluu qofaa kan fayyaadamnu ta‘aa. Daabalataanis dhimmaa fayyaa keessaan ilaalchisee gaaffii isaani gaafannuu deebii keessaan nuuf laachuutu isiiniraa eegamaa.

Qoraannoo kanaarrati hirmaachuun miidhaa qaqaabsisaa?

Yeroo saammudni fudhaatamuu miidhaan isiinira gaahuu hin jiruu. Ogeessii sammuudaa kanaa funaanu gahuumsaa fi muxxaannoo kan qabuu waan ta ‘ee hordooffii barbaachisaa waan godhuuf dhuukkubiin siniiti dhagahamuu hinjiruu.

Bu’aan qoraannoo kana

Oddeeffaannoo isiin irraa guraamesi ta ‘ii bu‘aan qoraannoo saammuda keessaan kaan oluu dhimmaa qoraannoo kaannaa qofaafi. Gaalmee kanaasi ilaalu kaan daanda ‘aan qamaa qoraannoo kanaa gaaggeessuu qofa. Oddeeffaannoo keessaan komputeeraa keessaa gaalchuun akka qama birootif hin saxilaamne passwordii gaargaraan cufaamee kayyaama.

Qoraannoo kanaarratti hirmaachuuni bu’aa maal argaamsisaa?

Qoraannooni kuun masteersii digrii eebifaamuuf kan rawwaatamuu waan ta ‘ee kaaffaltiin asirraati hirmaachuu keessaanif kafaalamu hin jiruu. Haa ta ‘uu malee bu‘aa qoraannoo kanaarra argaammuun fayyaadamoo tatuu. Hirmaannaan keessaanin isiinis ta ‘ee laammiin keessaani hammaa qoraannoo dhigaa laboraatorii bu‘uurreffamee irraa fayyaadamoo ta‘uu.

Mirgii qoraannoo kanaarrati hirmaachuu maal fa’aa?

Qoraannoo kanaarrati hirmaachuu fedhaa keessaani irraatti kaan bu ‘urreefame waan ta‘ee yeroo barbaadaanitti qoraannoo kanaa addaan kutaani bahuuf mirgaa guutuu qabduu. Kanaan waaliqabate taajaajille hospitaala isiinraa hafuu tokkoole hin jiraatuu. Qoraannoo kanaa ilaalchise gaaffii kamuu gaafaatani ibsaa gahaa argaachuu mirgaa guutuu qabduu. Bu ‘aa qoraannoo labooraatorii kaaffalti malee argaachuufilee mirgaa ni qabduu. Haa ta ‘uu malee oddeeffaannoon isiini nuuf keennitaan hammaa rakkoo hir‘iisuu ykn dhabaamsisuuf waan nuu gaargaarruf gaaffiiwwaan gafaatamtaanif deebii sirrii akkaa nuuf deebistaan kabaajaadhan isiini gafaanna.

Gaaffii yoon qabaadhee ykn ammoo yoo raakkoon naa muddatee maal gochuun qabaa?

Qoraannoo kanaa ilaalchisee ykn qoraannoo kanaan waaliqabate rakkoon tasaa isiini mudaate yokaan gaaffiin yoo jiraate teessoo armaan gaadi faayyaadama.

Beezaa Siileeshii mobayila +251-939-182-754 Email: mailbeza.sileshi@gmail.com

Fikaaduu Urgeessaa mobayila +251-923-330-640 Email: urgessafekadu@gmail.com

Mooges Wordofaa mobayila 0984742173 E- mail : heranmakmow@gmail.com

Annex 3: Consent form

Consent form in English version

I have read, or have had this document read to me in a language that I understand, and I understand the purposes, procedures and risks of this research project as described within it. I understand that at any time I may withdraw from this study without giving a reason. I have had an opportunity to ask questions and I am satisfied with the answers I have received. I know that no special payment for being participating in the study. I freely agree to participate in this study, as described. I understand that I was given a signed copy of this document to keep.

Name of participant. _____ Age____Address_____Signature_____Date_____

Interviewer's name_____Signature_____

Principal investigator Name_____ Signature_____

Consent form in Amharic version

የተሳታፊዎች ስምምነት ማረጋገጫ

የተሳታፉው ስም ……

እኔ ስሜ **ከላይ** የተጠቀሰው ተሳታፊ የደም ግፊት ያለባቸው ሰዎች እና ጤነኛ ሰዎች የደም ቆጠራ ማነፃፀር ጥናት ላይ በቂ ገለጻ ተደርጎልኛል፡፡ለጥናቱ ምደም ናሙና እንደሚያስፈልግ ተገልጾልኛል፡፡የጥናቱንም አላማዎችም ተረድቻለሁ፡፡በቃለ መጠይቁ ላይ የገለጽኳቸው መረጃዎች በሙሉ በሚስጥር የተጠበቁ እንደሚሆኑ ተነግሮኛል፡፡በጥናቱ ላይ ያለመሳተፍና ማንኛውንም መረጃ ያለመስጠት እንዲሁም በማንኛውም ጊዜ ከጥናቱ ራሴን የማግለል መብቴ የተጠበቀ እንደሆነ ተገልጾልኛል፡፡ስለዚህ ለዚህ ጥናት መረጃና የስምምነት ቃሌን የሰጠሁት በአጠቃላይ ሁኔታውን በመረዳትና በፍጹም ፍቃደኝነት ነው፡በተጨማሪም ጥያቄ ለመጠየቅ ተፈቅዶልኝ ለማወቅ የፈለኩትን ያህል ማብራሪያ አግኝቻለሁ፡፡የዚህ ጥናት ተሳታፊ በመሆኔ የማገኘው ጥቅም የሁሉንም ምርመራ ውጤት በነጻ ማግኘት እንደሆነ ተረድቻለሁ፡፡በአጠቃላይ እኔ ከላይ በመተማመኛ ቅፅ የተጠቀሱትን ሁሉ በሚገባና በተረጋጋ መንፈስ አንብቤዋለሁኝ፡፡ስለዚህ በዚህ ጥናት ለመሳተፍ ፈቃደኛ መሆኔን በፊርማዬ አረጋግጣለሁ፡፡

ፉርማ…… ቀን …….

የአጥኚው ስም …… ፉርማ …… ቀን ……

ስለትብብሮ አመሰግናለው!

Consent form in Oromiffa version

Kaayyoon qoranno kanaa garaajarummaa dhiibbaa dhigaa dhukubsatota dhigaa qamaa nagaa(sirrii)tae kan hospitaala hiwot faanaa fi jeguula beekuuf akka tae odeetanno gahaan naaf kennamera. Buaan qurannoo kkanaas akka anaafi namoota bira walaanut gargaaru fi fuldurattis istrateeji fi sirna walansaa fi dhukubicha namoota irratti beeku akkasumas Kn dhukuba dhiibaa dhiigaa itoophiyaatiif nifayyada. Akkasumas buaan qorannu koo ana qottaf akka ibsamu odeettannoo argadheera. Qorataan qoranno kanaa gutumatti hubadheera. Fedhii kotin wanta qoranno labratoriitif barbaachisu dhiga barbaachisu kenneera dabalatanis buaan qoranno labraatorii bilisaa irratti hundaa.

Ani _____hybannu qoranno kana hunda argahera odeetanno barbaachiso fi dhiga tau akka doktarrin jedhuti kennuf fedhii koonan ibsa.

Mallattoo_____ guyyaa_____

Annex 4 Questionnaire for hypertension patients and controls

A. English Version

Data collection questionnaire designed for "Assessment of some hematological parameters of hypertensive patients in public hospitals of Harar, eastern Ethiopia: a comparative cross-sectional study."

Study group _____

Code: _____

Sr. No.	**Questions**	**Possible Responses**
1.	Age (in years)	_____
2.	Sex	1. Male 2. Female
3.	Educational level	1. Illiterate 2. Primary (1-8) 3. Secondary(9-10) 4. Preparatory (11-12) 5. Graduate and above
4.	Occupational status	1. Governmental 2. Private 3. Farmer 4. Merchant 5. Student 6. Driver 7. House wife 8. other
5.	Marital status	**1.** Married **2.** Single **3.** Divorced

		4. Widowed
6.	Residency	1. Urban 2. Rural
7.	Weight:	_____kg
8.	Height:	_____cm
9.	BMI (By calculation as: Wight in Kg/Height $(cm)^2$)	_____
10.	Duration of hypertension since diagnosis in months. (this is for case group only)	_____
11.	Blood pressure	Systolic _____mmHg Diastolic_____ mmHg
12.	Use of drug for blood pressure control.	1. Yes 2. No

Eligibility screening questions (From interview and medical record review)

R.no	Questions	Possible responses
1	Type of hypertension (for case group only)	1. Primary hypertension **2.** Secondary hypertension
2	Pregnancy (for case group only)	1. Yes 2. No
3	Medical history of any of disease conditions like diabetes mellitus, cardiac disease, kidney and liver diseases, etc..	1. Yes 2. No
4	History of infectious diseases signs or symptoms	1. Yes 2. No
5	Taking of antibiotics, iron, vitamin B12 or folate supplementations or any other medications	1. Yes 2. No
6	use of alcohol	1. Yes 2. No
	How much a week	----------
7	Current use of ciggarate	1. Yes 2. No

B. Amharic version

ተ.ቁ	ጥያቄ	መልስ
1	ዕድሜ	
2	ጾታ	1.ወንድ 2. ሴት
4	የትምህርት ሁኔታ	1.ያልተማረ 2. የመጀመሪያ ደረጃ (1-8) 3. 2ኛ ደረጃ (9-10) 4. መሰናዶ 5 . 12 ክፍል በላይ
5	የስራ ሁኔታ	1. የመንግስት ሰራተኛ 2. የግል ሰራተኛ 3.ገበሬ 4.ነጋዴ 5 .ተማሪ 6. ሾፌር
6	የጋብቻ ሁኔታ	1. ያላገባ(ባች) 2. ያገባ(ባች) 3. የፈታ(ታች) 4. የሞተችበት(ባት)
7	መኖሪያ	1.ከተማ 2. ገጠር
8	ክብደት	…… ኪሎ ግራም
9	ቁመት	…….. ሲቲ መትር
10	ቦዲ ማስ ኢንዴክስ	…….
11	ግፊቱ ከተገኘ ምን ያህል ጊዜ ሆነው (በአመት)	…….
12	የደም ግፊት	ሲስቶሊክ ……. mmHg ዳይቶሊክ ……. mmHg

የጥናቱ ተሳታፊዎችን መመልመያ መጠይቅ

ተ.ቁ	ጥያቄ	መልስ
1	የደም ግፊት አይነት	1.”ፕራይመሪ” 2. “ስከደሪ”
2	እርገዘነ	1.አዎ 2. የለም
3	ሲጋራ ያጨሳሉን ?	1.አዎ 2. የለም
	መልሱ አዎ ከሆነ	1 ከዚህ በፊት 2. አሁንም ድረስ
4	የአልኮን መጠጥ ይጠጣሉ	1.አዎ 2. የለም
	መልሶዎ አዎ ከሆነ በሳምንት ስንት ጊዜ	.....
5	በተላላፊ በሽታዎች ወይም ምልክት	1. አዎ 2. የለም
6	ክሮኒክ በሽታዎች እንደ ስኳር የልብ በሽታ የኩላሊት በሽታ የጉበት በሽታ እና የመሳሰሉት አለቦት?	1.አዎ 2. የለም
7	የህክምና መዳኒቶች እንደ አቲባዮቲክስ ቢታሚን ቢ 12 ፎሌት ወይም ሌላ መዳሀኒት እየወሰዱ ነው?	1. አዎ 2. የለም

C. 0romiffa questionnaire

Gattiwaan Dhiyaatan

Lakk	Daaffii	Deebiiwaan deebitaman
1	Umrii(waggaadhan)	_____
2	Saala	1. Dhiira 2. Dhalaa
4	Sadarkaa barnootaa	1. sadarkaalammaffaa(9-10) 2. sadarkaatokkoffaa(1-8) 3. sad. 2ffa (9-10) 4. qophaahina(11-12) 5. kutaa 12 ol
5	Sadarkaa hojii	1. Hojjetaa mootummaa 2. hojjetaa dhuunfaa 3. Qonnaan bulaa 4. daldalaa 5. Barataa 6. konkolaachisaa
6	Iddoo jireenyaa	1. magaalaa 2. baadiyyaa
7	haala jireenyaa	1. kanfuudhe(heerumte) 2. kanhinfuune(hinheerumne) 3. kan hike(hiikte) 4. kanjalaaduhe(duute)
8	Wfaatina gamaa	_____kg
9	Dheerina gaamaa	_____cm
10	Bodii maas indeksi(BMI)	----------
11	Dhiigaa dafqa hanga isin qabee hammam gaye?	……..
12	Gosa dhigaa hanga isaa	_____mmHg

Gucha hirmaatoota ittin calalan.

Lakk	Daaffii	Deebiiwaan deebitaman
1	Dhiiga danfaa erga beekame yero hangam tae	1. primary 2. secondary
2	Uulfa qabdu	1. eeyyee 2. lakkii
3	Tamboo nixuuxxaa?	1. Eeyyee 2. Lakkii
	Yoo eyyee tae	1. Kanaan dura 2. Amman illee
4	Dhugaati alkolii nidhuddaa?	1. Eeyyee 2. Lakkii
	Yoo eyyee tae torbaniti hangam ?	_____
5	Dukkuba daddarboon qabamtee beektu yookiin mallattoolee dhukkuboota daddarboo qabdu.	1. Eeyyee 2. Lakkii
6	Dhukuubotta akka onne, sukkarra,dibee tiruu, dhibe kaleefikkf ni qabdaa?	1. Eeyyee 2. Lakkii
7	Qorricha fayya kannnen akka antibotics, vitamin B12, fooleeti faa fudhattee beektan ?	1. Eeyyee 2. Lakkii

Declaration

I, the undersigned, declare that this M.Sc. thesis is my original work, has not been presented for a degree in this or any other university and that all sources of materials used for the thesis have been duly acknowledged

M.Sc. candidate: **Beza Sileshi (B.Sc.)**

Signature: _____

Date of submission: _____

This Thesis has been submitted with our approval as advisors.

Advisor: **Fekadu Uregessa (M.Sc , Assistant professor, PhD candidate)**

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.

Advisor: **Moges Wordofa (M.Sc.)**

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.