"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"

BY

DR. KARUNAA. S

DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY

IN

OBSTETRICS AND GYNAECOLOGY

Under the Guidance of

DR. SHEELA.S.R, M.S. OBG

Professor

Department of Obstetrics and Gynaecology .

Under the Co-Guidance of

DR.KALYANI.R,

MD.PATHOLOGY

Professor and Head

Department of Pathology.

SRI DEVARAJ URS MEDICAL COLLEGE,

TAMAKA, KOLAR-563101

APRIL –MAY 2022

ALMA MATER

SRI DEVARAJ URS MEDICAL COLLEGE

R.L. JALAPPA HOSPITAL AND RESEARCH CENTRE

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA

DECLARATION BY THE CANDIDATE

I, hereby declare that this dissertation entitled **"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"** is a bonafide and genuine research work carried out by **Dr.KARUNAA.S** under the guidance of **Dr.SHEELA.S.R,** Professor, Department of Obstetrics and Gynaecology, Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of University regulation for the award **"M.S.DEGREE IN OBSTETRICS AND GYNAECOLOGY**", the examination to be held in April/May 2022 by SDUAHER. This has not been submitted by me previously for the award of any degree or diploma from the university or any other university.

Date:

Place: Kolar

Signature of the candidate

Dr.KARUNAA.S

Postgraduate

Department of Obstetrics and Gynaecology

Sri Devaraj Urs Medical College,

Tamaka, Kolar.

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY" is a** bonafide research work done by **Dr.KARUNAA.S**, under my direct guidance and supervision at Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of the requirement for the degree of **"M.S. IN OBSTETRICS AND GYNAECOLOGY"**

Date:

Place: Kolar

Signature of the Guide

Dr. SHEELA .S.R

Professor

Department of Obstetrics and Gynaecology

Sri Devaraj Urs Medical College

Tamaka, Kolar – 563101

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

CERTIFICATION BY THE CO-GUIDE

This is to certify that this dissertation titled **"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE – A CASE CONTROL STUDY"** is a bonafide research work done by **DR.KARUNAA.S** in partial fulfilment of the requirement for the degree of "**MS** in **OBSTETRICS AND GYNAECOLOGY"**.

Date:

Place: Kolar

Signature of the Co-Guide

DR. KALYANI.R

Professor and Head

Dept. of Pathology,

Sri Devaraj Urs Medical College

Tamaka ,Kolar-563103

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND

RESEARCH, TAMAKA, KOLAR, KARNATAKA

CERTIFICATE BY THE HEAD OF DEPARTMENT

This is to certify that the dissertation entitled "**COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE – A CASE CONTROL STUDY"** is a bonafide research work done by **DR.KARUNAA.S**, under supervision of **DR.RATHNAMMA.P** Associate professor and Head, Department of Obstetrics and Gynaecology at Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of the requirement for the degree of **"M.S. IN OBSTETRICS AND GYNAECOLOGY".**

Date:

Place: Kolar

Signature of the Head of Department

Dr. RATHNAMMA.P

Associate Professor and Head

Department of Obstetrics and Gynaecology

Sri Devaraj Urs Medical College,

Tamaka ,Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT AND PRINCIPAL

This is to certify that the dissertation entitled "**COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"** is a a bonafide research work done by **DR.KARUNAA.S,** under the supervision of **DR.RATHNAMMA.P**, Associate Professor and Head of Department of Obstetrics and Gynaecology, Sri Devaraj Urs Medical College, Kolar, in partial fulfilment of University regulation for the award "**M.S. DEGREE IN OBSTETRICS AND GYNAECOLOGY".**

Signature of the Head of Department

Dr.RATHNAMMA.P
Associate Professor & Head
Department of Obstetrics and Gynaecology
Sri Devaraj Urs Medical College
Kolar
Date:
Place: Kolar

Signature of the Principal

Dr. P.N SREERAMULU
Principal
Sri Devaraj Urs Medical College
Tamaka, Kolar

Date:
Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA

ETHICAL COMMITTEE CERTIFICATE

This is to certify that the Ethical Committee of Sri Devaraj Urs Medical College, Tamaka, Kolar has unanimously approved **Dr.KARUNAA.S**, student in the Department of Obstetrics and Gynaecology at Sri Devaraj Urs Medical College, Tamaka, Kolar to take up the dissertation work entitled "**COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"** to be submitted to the Sri Devaraj Urs Academy of Higher Education and Research Centre,Tamaka, Kolar**.**

Date:

Place: Kolar

Signature of the Member Secretary

Ethical Committee

Sri Devaraj Urs Medical College

Tamaka, Kolar – 563101

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR, KARNATAKA

COPY RIGHT DECLARATION BY THE CANDIDATE

I hereby declare that Sri Devaraj Urs Academy of Higher Education and Research, Kolar, Karnataka shall have the rights to preserve, use and disseminate this dissertation in print or electronic format for academic / research purpose.

Date: Signature of the Candidate

Place: Kolar **DR.KARUNAA.S**

Drillbit Softtech India Pvt. Ltd

Certificate of Plagiarism Check for Dissertation

Author Name	Dr.KARUNAA.S
Course of Study	MS.OBSTETRICS AND GYNAECOLOGY
Name of Guide	DR SHEELA SR
Department	OBSTETRICS AND GYNAECOLOGY
Acceptable Maximum Limit	10%
Submitted By	librarian@sduu.ac.in
Paper Title	COMPARISON OF ERYTHROCYTE INDICES IN PRE-ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTER – A CASE CONTROL STUDY
Similarity	7%
Paper ID	421621
Submission Date	2021-12-01 17:19:02

Signature of Student

Signature of Major Adviser

Head of the Department

University Librarian

Coordinator, UG & PG Programs
UG&PG Program, Faculty of Medicine
Sri Devarj Urs Academy
of Higher Education & Research,
Tamaka, Kolar- 563103

* This report has been generated by DrillBit Anti-Plagiarism Software

ACKNOWLEDGEMENT

*First and foremost, I express my profound gratitude to **ALMIGHTY** for all the blessings I have received till date.*

*Later I thank my parents **M.P.SENGOTTAIAN** and **DR.M.AMIRDHAMBAL** and my husband **DR.JOE LOURDU PRADEEP** for giving me continuous encouragement, unfailing support and unconditional love throughout my life.*

I would like to acknowledge all those who have supported me, not only to complete my dissertation, but throughout my post-graduation course.

*I wish to express my heart full indebtedness and owe a deep sense of gratitude to my mentor and guide **DR.SHEELA SR** Professor of Department of Obstetrics and gynaecology for being very helpful throughout the study and offered her valuable guidance and support to fully understand and complete this study. Through her vast professional knowledge and expertise, she ensured that I understand everything before I apply the information in my study. Without her constant supervision and advice completion of this dissertation would have been impossible. Her, sense of punctuality, strict adherence to academic schedule, humility and knowledge have been highly inspirational for the whole of my postgraduation period*

*I am also immensely grateful towards my co-guide, **DR.KALYANI.R**, Professor and Head, Dept. of pathology , for being very helpful throughout the study and providing her expertise and valuable time towards guiding and teaching me.*

*I am sincerely thankful to **DR.RATHNAMMA.P** Associate professor and Head, Department of Obstetrics and Gynecology, for encouraging me to the highest peak, paying close and*

continuous attention towards me to finish all tasks and also providing her kind support, valuable suggestions, immense patience and great care. Her precious advice on both the dissertation as well as the path of my career has been priceless

I wish to express my heart full indebtedness and owe a deep sense of gratitude to my mentors ***DR.VASANTHKUMAR,*** *Professor, Department of Obstetrics and gynaecology and* ***DR .MUNIKRISHNA.M*** *Professor, Department of Obstetrics and gynaecology for being very helpful throughout the study and offered their valuable guidance and support to fully understand and complete this study.*

I sincerely thank all the associate professor ***DR.VIMARSHITHA****, Department of OBG, SDUMC, Kolar, for her constant guidance and encouragement.*

I sincerely thank all the assistant professors ***DR PAVITHRA, DR DIVYA, DR NANDHINI and DR CHANDRACHUR*** *Department of OBG, SDUMC, Kolar, for their constant guidance and encouragement.*

I sincerely thank all the senior residents ***DR AASHRITHA and DR YASHASHWINI,*** *Department of OBG, SDUMC, Kolar, for their constant guidance and encouragement.*

My Heartfelt thanks to my other seniors ***DR CHAITHANYA AMAR, DR. TEJASHREE, DR.NEHA B S, ,DR.SADHANA, DR SUKINI, DR KRATHIKA KAMATH*** *FOR their support and co-operation and help in carrying out in this study and throughout the post-graduation course.*

*I express my sincere thanks to my colleagues and dear friends****, DR.SHREYASINGH, DR.DEEKSHA, DR.SUDHA MURALI, DR. JYOSTNA, DR.MEGHNA and DR JAHNAVI***

*I would like to thank my brothers **R.BHAVAN ARAVIND** and **R.ARUNAN** for their moral support and motivation throughout my life.*

*I am also thankful to all the **INTERNS** and **STAFF** for their valuable help while performing the study, I thank my beloved friends **DR.EVANGELIN, DR. ROHINI, DR.HEMA, DR. PAVITHRA.T.R and DR.CAMILA CHRISTY** for their constant moral support and giving their time whenever I have needed it the most.*

*I express my special thanks to all my **PATIENTS** and their families, who in the final conclusion are the best teachers and without whom this study would have been impossible.*

DATE: **DR. KARUNAA.S**

PLACE: KOLAR

COMPARISON OF ERYTHROCYTE INDICES IN PRE- ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTER – A CASE CONTROL STUDY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

HDP	Hypertensive disorders of pregnancy
GH	Gestational hypertension
PE	Preeclampsia
E	Eclampsia
IUGR	Intrauterine Growth Restriction
SGA	Small for Gestational Age
NFHS	National Family health Survey
MCV	Mean Corpuscular Volume
MCH	Mean Corpuscular Haemoglobin
MCHC	Mean Corpuscular Haemoglobin Concentration
PCV	Packed cell volume
RBC	Red Blood Cell
RDW	Red cell Distribution Width
DIC	Disseminated Intravascular Coagulation
IHSSP	International Society for the Study of Hypertension in Pregnancy
P:Cr	Protein:Creatinine

A:Cr	Albumin:Creatinine
BMI	Body mass index
CC	Central Cavity
ECL	Echogenic cystic lesions
SMC	Smooth Muscle Cells
HELLP	Haemolysis, Elevated liver enzymes, Low platelets
LMIC	Low middle-income countries
SD	Standard deviation
Fl	Femtolitres
Pg	Pictogram
PLT	Platelet
WBC	White Blood Cell
Hb	Haemoglobin
HTC	Haematocrit
DDC	Drought Duration Curve

ABSTRACT

Background: hypertensive disorders affects upto 10% of all pregnancies globally. Pre-eclampsia is a complex systemic syndrome that occurs after twenty weeks of gestation.Erythrocytes, the most abundant cells in the bloodstream, suffer greatly from the effects of Pre-eclampsia and the disease is related with salient changes in the morphology of erythrocytes

Aim and Objective: Document the erythrocyte indices in patients with pre-eclampsia and to document the erythrocyte indices of normotensive pregnancy and to compare and correlate the erythrocyte indices between the pre-eclampsia and normotensive pregnancy

Methodology: A case control study was performed among singleton 48 normotensive and 48 hypertensive pregnant women after twenty weeks of gestation delivered at RLJH hospital Kolar from January2020 - June 2021. Complete blood count was sent for all the patients to estimate erythrocyte indices. The data collected was entered in MS excel and analysed using IBM.SPSS statistics software 23.0 Version.

Results: On comparing the mean values of erythrocyte indices between the normotensive group and preeclampsia group Red Cell distribution width was found to be significantly raised and other parameters were found to be not statistically significant. The mean of Red Cell distribution width of Pre-eclampsia group was 17.44 % and the level was higher than the mean of Red Cell distribution width of normotensive group (13.26 %).difference between the two was 4.177 and difference was statistically significant (p-value: 0.0001) by Independent T test. The development of pre-eclampsia was not determined by age, parity and gestational age.

Conclusion: Red cell width distribution shall be used as simple,applied, non- invasive and inexpensive parameter for prediction of preeclampsia

Keywords: Red cell width distribution, Hypertensive Disorders of Pregnancy.

INTRODUCTION

INTRODUCTION

Pregnancy Induced Hypertension affect up to 10% of all pregnancies globally. These multi-system illnesses are made from of gestational hypertension, preeclampsia and eclampsia.[1] Pre-eclampsia is defined as a systemic syndrome characterised by new-onset of hypertension (blood pressure – systolic >140mm Hg, diastolic >90mm Hg on two occasions at least 4 hours apart, or in severe cases SBP >160mm Hg and DBP >110mm Hg) and protein/ creatinine ratio of >0.3 or protein >5 g in a 24 h urine sample, or >3 g after twenty weeks of gestational age in pregnant women, which resolves closer to 6th week in two samples obtained 6 hours apart from a patient on bed rest)postpartum.[2] Preeclampsia is characterised by hypertension and any signs of end organ damage without proteinuria. [2]

Eclampsia is well-defined as start of seizures in pregnant females who have preeclampsia. Additional symptoms such as oliguria, headache, cerebral or else visual disturbances, dyspnoea with less SPO_2 or pulmonary oedema, epigastric/right upper-quadrant pain, thrombocytopenia, renal function compromise, haemolysis, weakened liver role of unknown aetiology, vomiting, and reduced foetal movements later twenty weeks of gravidity are also present in cases of severe preeclampsia.[2]

As a specific, direct cause of maternal mortality, preeclampsia-eclampsia is second only to haemorrhage.[3] Preeclampsia in the mother can lead to the progression of cardiovascular disorders such as persistent hypertension, ischemic heart disease, and stroke later in life.[4–6] Intra Uterine Growth Restriction (IUGR) is common in children born during pre-eclamptic pregnancies as well as Small for Gestational Age (SGA).[7,8]Preeclampsia also increases the odds of stroke, CAD besides metabolic syndrome during adult life in the children born from pre-eclamptic pregnancies.[9–11]

Pregnancy induced Hypertension are directly linked to 7–8% of maternal mortality in India and around the world..[3,12] Preeclampsia is the most frequent hypertension condition associated with pregnancy.[13] As per NFHS-3, (National Family Health Survey, 2005-06), the incidence of pre-eclampsia was noticed to be higher. This result was grounded on self-reported symptoms that was suggestive of preeclampsia or else eclampsia by women who had a live birth in the five years preceding the survey, the incidence of eclampsia and preeclampsia in India might be higher (~7.4-11.3% and 28% respectively) as compared to its incidence worldwide.[14,15]The incidence of preterm births recorded in India is the highest in the world;[16] and PIH (preeclampsia – 36%, chronic hypertension – 5%, eclampsia – 4.8%) are the most prominent risk factors of preterm births reported in India.[17]

Defective trophoblast invasion, increased inflammatory response which occurs as a corollary of alterations in immune system are observed as the main cause of pre-eclampsia The latter predisposes to pre-eclampsia by wrong placentation, microvascular thrombosis, increased permeability of capillaries and increased tone of blood vessels.[18,19]

During normal pregnancy, distinctive changes are observed in the haemoglobin concentration and in the RBC indices. These modifications are due to the physiologic haemodilution. MCV, MCH, MCHC, RDW and also RBC count are known as the RBC indices. The size of red blood cell is measured by MCV. MCH determines the amount of haemoglobin each red blood cell. The amount of haemoglobin per unit volume is indicated by MCHC. [20]

Red cell size variation (also called anisocytosis) is indicated by RDW.RDW is the parameter that replicates the initial variations in RBC. All of these parameters are important for detecting and investigating anemia.[21] They are usually evaluated in a fully automated haematology analyser, as part of the complete blood count.

In pre hypertensive patients, the value of RDW is found to be higher. Prehypertension is referred to as a state of slightly raised (or) elevated blood pressure in non-pregnant state which when dietary changes and lifestyle changes were not made, may move on to the hypertensive state.[22] In patients with history of cardiovascular disorders, vascular disorders and diabetic ketoacidosis, the correlation between RDW percent with other mortality factors, both cardiac and non-cardiac was investigated.[23,24]

Red cell distribution width RDW is employed as marker in certain conditions. It is especially used in the recognition of anaemia of iron deficiency, megaloblastic anaemia which occurs as a consequence of vit B12 deficiency and folate deficiency.[25] There are copious studies that demonstrate the association between cardiovascular disease besides thrombotic disorders and RDW.[23] Usually pre hypertensive and hypertensive patients have high RDW values. RDW is a significant marker which is contemplated as a separate risk factor for death.

The literatures on correlation between erythrocyte indices with pre-eclampsia have been limited. The goal of our research is to assess the association that exists between preeclampsia and red blood cell indices among antenatal women.

AIMS & OBJECTIVES

AIMS AND OBJECTIVES

1. To document the erythrocyte indices in patients with pre-eclampsia
2. To document the erythrocyte indices in normotensive pregnancy
3. To compare and correlate the erythrocyte indices between the pre-eclampsia and normotensive pregnancy

RESEARCH QUESTION

Is there any association of erythrocyte indices with the development of pre-eclampsia among pregnant women on comparison to normotensive pregnancy after twenty weeks of gravidity?

NULL HYPOTHESIS

The development of pre-eclampsia among pregnant women on comparison to normotensive pregnancy after twenty weeks of gravidity with abnormal erythrocyte indices is due to chance but not real.

ALTERNATE HYPOTHESIS

The development of pre-eclampsia among pregnant women on comparison to normotensive pregnancy after twenty weeks of gravidity with abnormal erythrocyte indices is real but not due to chance.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Hypertensive disorders of pregnancy[26]

ISSHP defines PIH as new onset hypertension (140 mmHg systolic or 90 mmHg diastolic) after twenty weeks' gravidity. This definition encompasses three types:

- Chronic hypertension
- Gestational hypertension
- Pre-eclampsia (de novo (or) superimposed on chronic hypertension).

The effects of these conditions can have a momentous impact on both maternal and child health. The effects can be considerable even in the short and long term. A mother with gestational hypertension is at the risk of being hypertensive in the future with the risk being two to four-fold. The individual has a twofold risk of mortality from cardiovascular causes and stroke risk increases by 1.5 times. The foetal risks include

- IUGR (Intrauterine Growth Restriction)
- Oligohydramnios
- Placental abruption
- Preterm birth
- Foetal distress and
- Death of foetus in utero.

Even the foetus is at risk of cardiovascular problems in the future which includes early onset hypertension, stroke and ischemic heart disease. Regardless of the existence of coexisting pregnancy complications, the above risks remain for both baby and mother.

Certain risks like placental abruption, DIC (Disseminated intravascular Coagulation), Hepatic failure, AKI and cerebral haemorrhage occurs during pregnancy.

Preeclampsia can be quite harmful and life-threatening for both baby and mother. Overall, preeclampsia and eclampsia accounts for 10 to 15% of maternal deaths.[27]

Classification of Hypertension During Pregnancy[28]

Hypertensive conditions during classification of pregnancy with the time period of twenty weeks- as

Arterial hypertension occurring prior to gravidity with onset before twenty weeks and onset or occurrence of arterial hypertension after twenty weeks.

The first category includes:

i. essential chronic or secondary arterial hypertension;
ii. White coat hypertension
iii. "Masked" hypertension.

The hypertension group contains

i. transitory gestational hypertension;
ii. gestational hypertension; and
iii. preeclampsia, which is isolated (or) superposed on chronic hypertension and develops at twenty weeks or more.

A systolic blood pressure equal to or more than 140 mmHg and/or a diastolic blood pressure equivalent or bigger than 90 mmHg are considered arterial hypertension in this group. It is measured in a blood pressure monitor that is properly calibrated and appropriate on two separate occasions and the interval should be at least 4 to 6 hours

apart. This is for the woman's biotype, which is being assessed and by and is overseen by a competent specialist.

The following requirements must one or above must be met in order for preeclampsia to occur:

a. Proteinuria (ratio of proteinuria/ creatininuria > 0.3 mg/mg, or a urine dipstick test that is equivalent to or superior than 1+, or when proteinuria of more than 300 mg every 24 hours);
b. Alterations in renal insufficiency is a function of maternal organs that might occur. shown by hepatic impairment, as seen by an increase in transaminases; creatinine ≥ 1.02 mg/dL double the normal values, right hypochondrial pain, also called epigastralgia, Scotomas or prolonged cephalgia followed by hyperreflexia or confusional state are symptoms of neurological consequences. states or eclampsia or cerebrovascular accident also known as amaurosis; and haematological complications like thrombocytopenia or haemolysis;
c. Uteroplacental abnormalities: restriction of the growth of fetus; changes in the umbilical artery which is measured by Doppler velocimetry, especially when combined with altered functions of uterine arteries.

History of Pre-eclampsia[28]

As per some authors of German origin, the first reports of eclampsia dates back to 2200 BC, observed in papyri of ancient Egypt. The word eclampsia originates from the Greek éklampsis which means “bright light”.

Eclampsia has been around for almost 2000 years. It was agreed as a disease which is characterized by seizures (convulsive), typical of late pregnancy, which ended at childbirth. Late-nineteenth-century scientists were enthusiasts of caregiver pragmatism. They found the

bloated appearance of women who have had seizures and that of the oedema associated with Bright's disease, a disease of an abrupt glomerulonephritis onset and characterized by proteinuria.

Thereafter, urinary abnormalities in females who are pregnant with seizures when searched, it was discovered that they had proteinuria. With the advent of non-invasive measurement of blood pressure, it was detected BP of these women had increased. It was been already identified by that time proteinuria and arterial hypertension were shown to be present before the initiation of the disease. Therefore, it was defined that the "preeclampsia" hypertensive condition, is a serious, progressive character that could lead to a chain of events with grave ramifications for the lives of both mother and baby.

Even today, studies on hypertensive conditions that portray important consequences during the gravidity, show varied incidence which changes depending on the meticulousness of the population studied, and mostly exceeds 10% in some regions. Preeclampsia besides eclampsia was graded second and sometimes third in the world as causes of maternal morbidity and mortality.

Pre-eclampsia[29]

Pre-eclampsia is tough to define because it is a syndrome categorized by a group of clinical features. There are no gold standard features for pre-eclampsia. Numerical features exist such as arterial blood pressure, proteinuria is determined by thresholds, which are arbitrary in nature. As a result, whereas the definitions appear to be exact, they are not properly secured. Only a definition based on more than one distinct pathogenic features will suffice.

New onset hypertension (systolic >140 mmHg and diastolic >90 mmHg) is now recognised by the ISSHP.with one or more additional symptoms.: proteinuria, and other organ problems in the mother such as liver, kidney, brain or haematological involvement, and characterised

by utero- placental dysfunction manifested as foetal growth restriction and Doppler ultrasound findings showing irregular blood flow between the placenta and uterus

The American College of Obstetricians and Gynaecologists besides ISSHP both propose that the phrases "severe" and "moderate" pre-eclampsia be used interchangeably. These expressions was not used now, as all cases should be considered threatening. By contrast, there is a differentiation with a watershed of 34 weeks' gestational age, a distinction is made between the early and late onset types of the condition, which is becoming more well recognised.

Diagnostic criteria for preeclampsia[26]

Preeclampsia is known as gestational hypertension that occurs at or after twenty weeks of pregnancy and is associated with new-onset maternal or uteroplacental dysfunction.

Table 1: Diagnostic criteria for preeclampsia

Gestational hypertension	
Systolic blood pressure of more than 140 mm Hg and/or a diastolic blood pressure of more than 90 mm Hg To confirm hypertension, BP should be checked repeatedly. A liquid crystal sphygmomanometer with suitable size cuff. is preferred. Or, if unavailable an appropriately standardised automated device.	
Accompanied by at ≥1 of the following new-onset conditions:	
Proteinuria	Initial urinalysis using an automated dipstick. Visual analysis can be utilised if audio analysis is not available. If dipstick comes positive (≥1+), confirm with spot urine. The values are If P: Cr is less than 30 mg/mmol or A: Cr is less than 8 mg/mmol, it is abnormal.
Renal complications	Acute Kidney Injury is suspected when creatinine ≥ 90 umol/L
Liver complications	Transaminases elevated, with or without epigastric stomach pain in the right upper quadrant
Neurological	Eclampsia, Blindness, stroke, clonus, and severe and persistent visual scotomata are all examples of altered mental status are some of the

complications	conditions that can occur.
Haematological complications	Thrombocytopenia (when platelet count < 150000/µL, DIC (disseminated intravascular coagulation) and haemolysis
Uteroplacental dysfunction	Foetal growth restriction, abnormal umbilical artery Doppler wave form analysis, stillbirth

Determinants for pre-eclampsia from three systematic reviews[30–32]

- Chronic hypertension
- Antiphospholipid antibody syndrome
- Systemic lupus erythematosus
- Pre-gestational diabetes
- Chronic renal disease
- Multifetal pregnancy
- Pre-pregnancy BMI >30
- Previous stillbirth
- Nulliparity
- Maternal age >40
- Increased pre-pregnancy BMI
- Long interval between successive pregnancies (more than 5 years)
- Ignorance and illiteracy
- Previous pre-eclampsia
- Assisted reproduction

- Previous history of IUGR
- Previous placental abruption

Pathogenesis of Pre-eclampsia[27]

Defective remodelling of the spiral arteries during trophoblast invasion is the most well-known predisposing factor for preeclampsia. Long before the clinical appearance of preeclampsia, immunologically mediated abnormal trophoblastic invasion leads to formation of a placenta in which the uterine spiral arteries fail to undergo the normal thinning out of muscular walls that permit enhanced perfusion of the placenta. As a consequence, perfusion of intervillous space is impaired, leading to placental hypoxia. In placentas from pregnancies from patients with advanced pre-eclampsia numerous placental infarcts was exposed along with narrowing of the arterioles which is sclerotic. Pre-existing hypertension, chronic renal illness, obesity, diabetes mellitus, multiple pregnancies, hydatidiform mole, and thrombophilias are all determinants for preeclampsia (factor V Lei- den, antiphospholipid syndrome, and antithrombin III deficiency). There was also a higher vulnerability to angiotensin II's vasopressor effects, most likely due to enhanced plasma angiotensin I concentrations/bradykinin B2 receptor heterodimers.

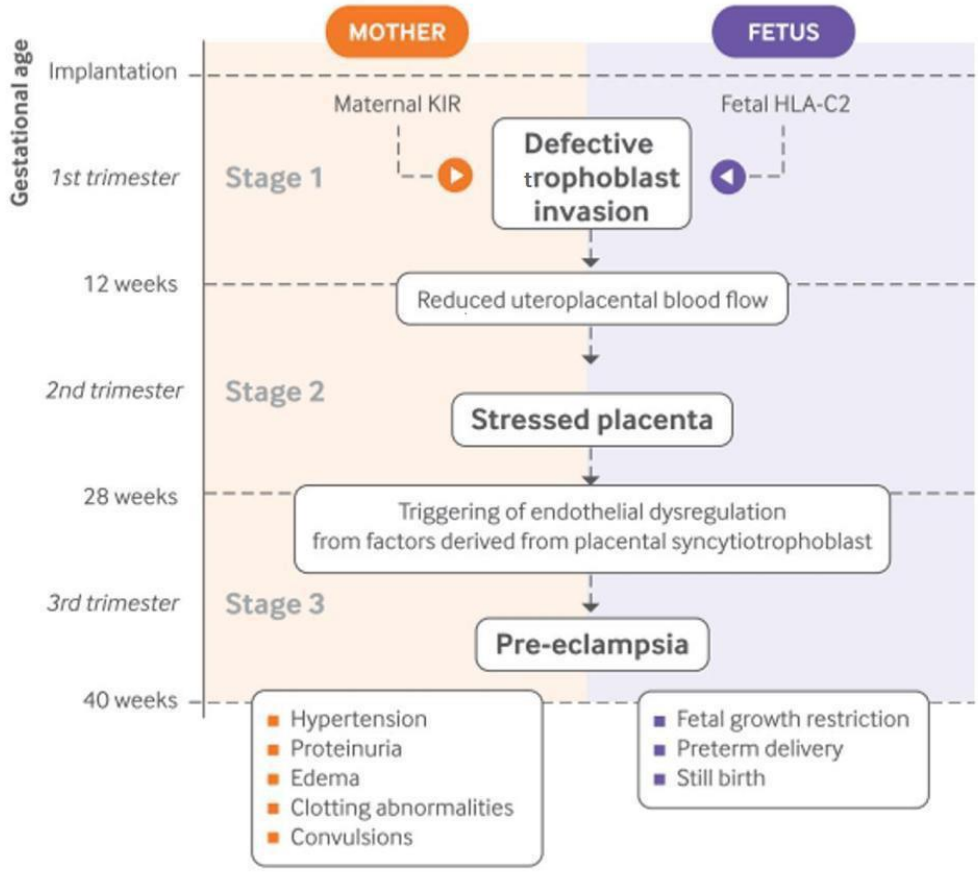


Figure 1: Pathogenesis of pre-eclampsia with the subsequent effects on mother and fetus.[29]

The placenta responds to stress when trophoblast uterine connections fail in the first trimester. The villous tree's growth and development is harmed, which inhibits oxygen and nutrient transport to the foetus. When the syncytiotrophoblast is stressed, it can release a variety of substances into the systemic circulation. These variables generate an aberrant systemic inflammatory response, which disrupts the maternal endothelium's hemostatic activities, such as coagulation regulation, fluid transport, and blood pressure management.

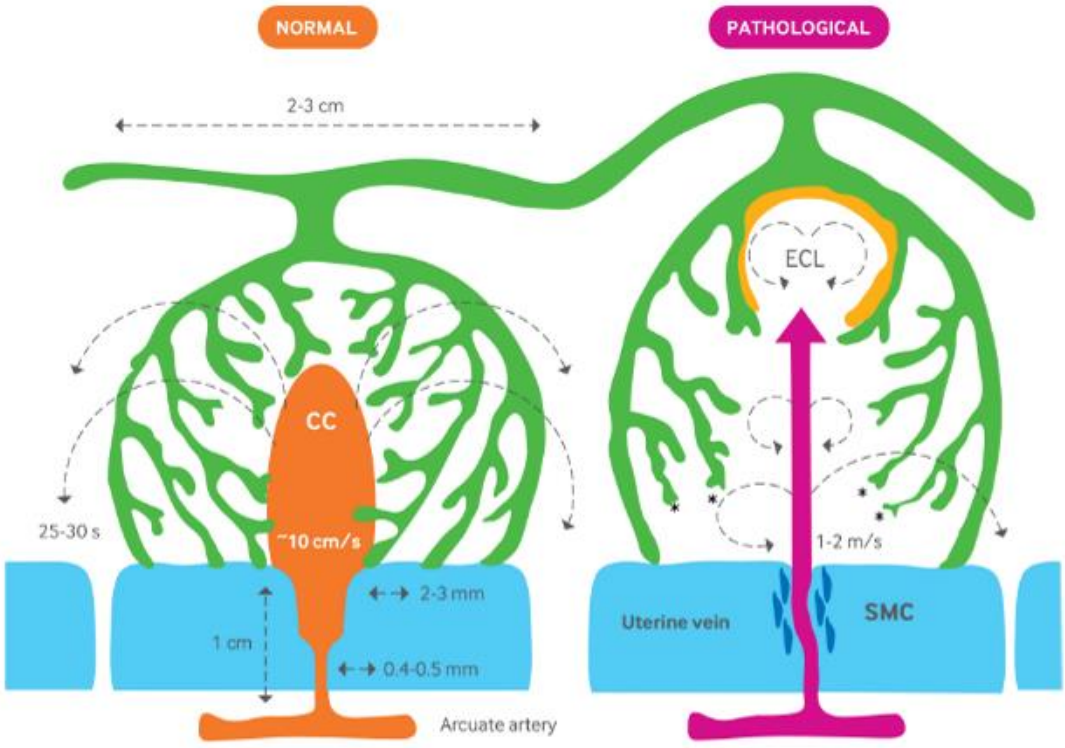


Figure 2: Diagrammatic representation of the effects of spiral artery remodelling on the inflow of maternal blood into the intervillous space in normal and pathological pregnancies.[29]

In a normal pregnancy, dilatation of the distal section of the spiral artery reduces the velocity of the arriving blood, and the blood is carried into the central cavity (CC) of the placental lobule, where it is uniformly dispersed between the villi. The transit time of the uterine vein is believed to be in the range of 25-30 seconds, enabling plenty of time for oxygen exchange. In pathological pregnancies, where minimal conversion occurs, maternal blood enters the intervillous region in a jet-like spurt at a speed of 1-2 m/s. The turbulent flow (shown by the circular arrows in the picture) damages the villi, resulting in echogenic cystic lesions (ECL) bordered with thrombus (stippled). There will be a reduction in transit time, which will result in a reduction in oxygen exchange. Trophoblastic microparticulate debris may be pushed away from villi's surface. Smooth muscle cells (SMC) are suppressed.

Screening[29]

Pre-eclampsia is difficult to detect because it is frequently asymptomatic. Symptoms such as epigastric discomfort or a strong headache often signal a terminal crisis, such as eclampsia or the HELLP (haemolysis, increased liver enzymes and low platelets) syndrome, which necessitates an early pregnancy termination. Screening healthy women for pre-eclampsia in the early stages has proven to be very effective in reducing maternal and neonatal complications.

Pre-eclampsia is uncommon before twenty weeks, but it becomes more common as the pregnancy progresses to term and beyond. As a result, the number of checks is larger by 3rd trimester. Because these were the first features to be filed and are easy and cheap to assess, screening was mostly predicated on the timely finding of new onset hypertension and proteinuria. They've been launched, and they've proven to be empirical and effective. Various studies in low- and middle-income countries (LMICs) have consistently documented the value of appropriate prenatal screening.

In high-income countries, the situation is different. Circulating biomarkers or a Doppler ultrasonography examination of the uteroplacental circulation can diagnose impending or active pre-eclampsia. This is effective for the early onset form of the condition, but not for the late onset variant.

Placental or maternal indicators may be discovered in the bloodstream. Maternal indicators of endothelial activation include new hypertension and proteinuria, but placental syncytio-trophoblast factors are more upstream in the pathophysiology and are likely to be more precise. Increased ratio of sFlt-1/Pig, which causes foetal growth limitation caused by placental mal-perfusion, is an excellent marker of the placental component of pre-eclampsia.

To improve prediction efficiency, a combination of demographic and clinical parameters linked with maternal blood pressure, Doppler measures of uterine arteries, and blood biomarker factors assessment were put together.

Treatment of overt pre-eclampsia[29]

The difference in maternal mortality is high in low middle-income countries, with a drastic reduction in maternal mortality in high income countries in the mid-20th century, is clarified by careful monitoring of maternal condition and timely delivery with increasing disease progression. In the most recent Enquiry into Maternal Deaths in the UK, there were no deaths due to pre-eclampsia. The foetus in utero, on the other side, is in danger due to the morbidity and mortality associated with early delivery. Although it is desirable to slightly prolong pregnancy in order to allow the foetus to mature, there is presently no medication that can reverse the pathophysiology and enhance the result. However, it carries the danger of intrauterine foetal death due to uterine artery constriction. Antihypertensive treatment is casted-off to prevent maternal cerebral haemorrhage, and magnesium sulphate is casted-off as an anticonvulsant. A few trials guide the selection of antihypertensives in the treatment of preeclampsia, although experience is the most important factor in determining efficacy besides security for both fetus and mother

Magnesium sulphate is more effective than other pharmacological medicines at treating or preventing seizures, and it is also safe when taken properly. Overdosage, on the other side, can cause respiratory and heart failure, thus it should be used with caution and only in women who are pregnant.

Erythrocyte Indices[33]

The most prevalent blood cells are red blood cells (RBC), also known as erythrocytes. The fundamental purpose of these corpuscular components in vertebrate creatures is to transport oxygen from the lungs to the peripheral tissues via the circulatory system. Erythrocytes without a nucleus and fashioned as biconcave discs in mammals are flattened and depressed in the middle, with a dumbbell-shaped cross section and a torus-shaped edge. The volume of erythrocytes varies greatly amongst vertebrates. RBCs have a diameter of 6 to 8 mm and a thickness of 2 mm in humans. An erythrocyte's overall (physiologic) volume is thus normally between 80 and 100 fL, with an overall surface area of about 136 mm2.

RBCs may experience significant alterations in their normal volume (increased or decreased) in specific circumstances. The plasma membrane's inherent plasticity, combined with the comparatively low number of intracellular molecules (mostly haemoglobin), allows for extraordinary size and volume contraction and expansion.

Erythrocytes can thus swell to a spherical form of 150 fL (i.e. macrocytosis) or shrink to 60 fL or even less (also known as microcytosis) without significant loss of membrane integrity or cell damage. The degree of heterogeneity in RBC volume, known as anisocytosis, is traditionally measured using a simple equation in which the standard deviation (SD) of RBC volumes is divided by MCV of the erythrocytes, then multiplied by 100 to express data as a percentage (i.e. [SD of RBC volumes]/ [MCV]*100). RBC distribution width is the final output of this equation (RDW). It is derived from the MCV theoretically, and its value is controlled by the average erythrocyte volume (i.e., the MCV). An upsurge in the value of RDW over a typical range is known as anisocytosis, which can be caused by the presence of tiny and large RBCs, or both.

Definition of Red Cell indices[34]

MCV, MCH, and MCHC were initially proposed by Win Trobe in 1929 to define the size of the red blood cell and haemoglobin content. These numbers, known as red cell indices, are helpful in determining the cause of anaemia. Red cell indices can be determined using the values of haematocrit, haemoglobin, and RBC count. Electronic devices now count it automatically.

MCV is a unit of measurement for the red blood cells size that is measured in femtoliters (10-15; fL) or cubic microns (m3). MCV has been calculated to have a normal value of 87±7 fl.

MCH test determines how much haemoglobin / red blood cell is in a person's blood. MCH is reported to have typical values of 29±2 picograms (pg.) per cell.

The MCHC determines the amount of haemoglobin per unit volume of blood. In contrast to MCH, MCHC is a relationship between haemoglobin content and cell volume. It's expressed as a percentage or in grammes per decilitre of red blood cells. The normal MCHC concentration is 34± 2 g/dl. RDW represents the coefficient of variation of the volume distribution (size) of RBC and is expressed as a percentage.

RDW has a typical value of 13 1.5 percent. Certain diseases, on the other side, induce a large rise in cell size variation. RDW values that are higher suggest more size variation. In human red blood cells, the normal reference range for RDW-CV is 11.5–15.4 percent. The findings of the RDW test are frequently used in conjunction with MCV as a diagnosis for anaemia, which aids in determining the various causes of the anaemia. It is mostly casted-off to regulate the cause of anaemia.

PHYSIOLOGIC CHANGES IN NORMAL PREGNANCY[27]

Physiologic adaptations of varied type occur during normal pregnancy. There is plasma volume expansion, a fall in mean arterial pressure and systemic vascular resistance, and an increased cardiac output. The blood pressure fall usually peaks at the commencement of the second trimester, and is a result of several factors, including vascular angiotensin II refractoriness, increased endothelial prostacyclin, and nitric oxide production. If the blood pressure fall is significant, it may obscure the diagnosis of pre-existing mild hypertension, particularly in the pregnant women who do not have blood pressure check-ups before pregnancy. In addition, red cell volumes and plasma increase by 40% and 25%, respectively all through pregnancy. These changes begin as soon as the fourth week of pregnancy and peak around the 28th week. The increase in red cell mass is lesser than the increase in plasma volume, which leads to pregnancy's physiologic anaemia. Despite a 30% to 50% rise in plasma volume at term, there is a reduction in plasma renin activity, an increase in atrial natriuretic peptide levels, and a consequent drop in systemic blood pressure due to a reduction in systemic vascular resistance.

Pregnancy haematological profile

Because it is a trustworthy indicator and a simple, fast, and cost-effective test, the haematological profile is measured all over the world to estimate general health.[35] Furthermore, one of the elements influencing pregnancy and its outcome is the haematological profile.[36,37] Changes in haematological indices such as RBC count, haemoglobin (Hb) concentration, platelet (PLT) count, and WBC count occur during pregnancy and can be seen. Some of these, such as RBC and PLT counts, are reduced as due to physiological hemodilution that happens during pregnancy,[38,39] while others, such as the WBC count, are increased.

Changes in RBCs during pregnancy

Between the sixth and the twenty-fourth week of pregnancy, plasma volume increases by 25–80 percent.[40] When iron and folate are supplemented, however, the rise in RBC mass is reported to be roughly 30% between the twelfth and thirty-sixth week of pregnancy.[41] Physiological anaemia is caused due to a disparity between the rate of rise in plasma volume and the rate of increase in RBC mass. Plasma volume increases at a slower rate in late pregnancy, resulting in a modest increase in haematocrit. Because of these physiological changes, defining appropriate haematological references for pregnant women is problematic.[42]

Erythrocyte indices in Pregnancy

The values of threshold erythrocyte indices determine anaemia and its classifications, however they change depending on age, gender, and physiological situations like pregnancy.[42,43] The number of red blood cells (RBC), haematocrit (HTC), and haemoglobin concentration (Hb) measurements represent the erythroid mass, which is reduced in anaemia.[42] The morphology (size and degree of haemoglobinization) of their blood cells is theoretically related with the cause and functional classification of anaemia. MCV, MCH, and MCHC indicate the morphology (size and degree of haemoglobinization) of their blood cells.[42] In the overall population, erythrocyte indices follow a Gaussian pattern.

In the overall population, erythrocyte indices follow a Gaussian pattern. The RBC, HTC and Hb values in the pregnancy puerperal cycle behave following a physiological curve (concavity turned upward), with the lowest point between the 24th and 28th weeks of pregnancy and a gradual increase from this point until birth, returning to initial levels in approximately the 6th week postpartum.[42,44] However, alterations in morphological erythrocyte indices and the nosologically meaning of such alterations are not well

established. The few studies published[42,44–46] MCH and MCHC can also experience significant drops in normal pregnancy, which become accentuated closer the third trimester; and MCV experiences an increase, which follows the same time sequence, but does not deviate from normal ranges for healthy women at fertile ages and returns to pre-pregnancy levels in the late puerperal period. [44–46]

Erythrocyte morphology in preeclampsia[47]

PE's pathophysiology is yet unknown, however it is linked to the advancement of hypertension and proteinuria, as well as preterm delivery and growth retardation. Foetal growth is regulated on various levels, and a successful placentation is essential for a healthy maternal-foetal relationship throughout the pregnancy. In PE, failure of trophoblastic invasion of the spiral arteries might compromise blood flow as well as oxygen and nutrition delivery to the foetus.

Normal human gravidity was connected with inflammatory changes and with a profound hyperlipidaemia state that seem to be enhanced in PE. Fibrinoid material and foam cells are deposited, which are often observed in spiral arteries, which may cause a reduction in blood flow and enhanced interaction between inflammatory activation products and the surrounding cells. Inflammatory cells such as neutrophils and macrophages/monocytes, being important sources of oxygen metabolites and proteases, can cause damage to neighbouring red blood cells (RBC).

Erythrocyte composition is distorted in conditions of preeclampsia. The levels of intracellular calcium,[48] potassium chloride and total osmoles were greater in preeclampsia compared to normal pregnancy.[49] These changes could be detected as early as 14 weeks gravidity.[49] The

changes are probably compensatory reflecting the plasma osmolalityhomeostasis.[49] The total blood volume is reduced inpreeclampsia,[50] while osmotic pressure of colloid is lower.

Erythrocyte morphology is altered in preeclampsia. In preeclamptic and eclamptic women, the proportion of schistocytes and echinocytes was much higher than in typically pregnant women.[51] These erythrocyte abnormalities were thought to reflect the lipid makeup of the women's plasma.[51] Increased lipid concentrations in the plasma are linked to higher lipid concentrations in the erythrocyte membrane, which may be echinocytogenic.[52]

Preeclamptic women have a larger MCV of erythrocytes than non-pregnant women but a lower MCV than typically pregnant women,[52,53] when equated to the erythrocyte population in patients with normal pregnancy, the erythrocyte population in preeclamptic patients in late pregnancy has a higher specific gravity (Fig. 4). [53,54] Preeclamptic patients' cumulative DDC curve mirrors that of non-pregnantwomen.[53,54] This finding was made regardless of the degree of preeclampsia.[53] The similarity of the DDC curve of preeclamptic patients' erythrocytes to that of non-pregnant women could indicate a comparable population age distribution. The presence of older erythrocytes in pre-eclampsia may reflect a disruption in a process that occurs normally during pregnancy, namely, the early removal of erythrocytes from circulation. Indeed, when compared to women in normal pregnancy, patients with preeclampsia had lower amounts of IgG, which is essential for phagocytosis of senescent and degraded erythrocytes, as well as impaired phagocytic cell function.[55] The existence of a denser and smaller erythrocyte in preeclamptic patients, on the other side , could indicate cellular dehydration, as indicated by higher MCHC levels.[53] When compared to normal pregnancy, preeclampsia causes a considerable drop in colloid osmotic pressure while serum osmolality stays unchanged.[50] As a result, fluid flux from erythrocytes to intravascular space may occur, reflecting net fluid transfer into the interstitium.

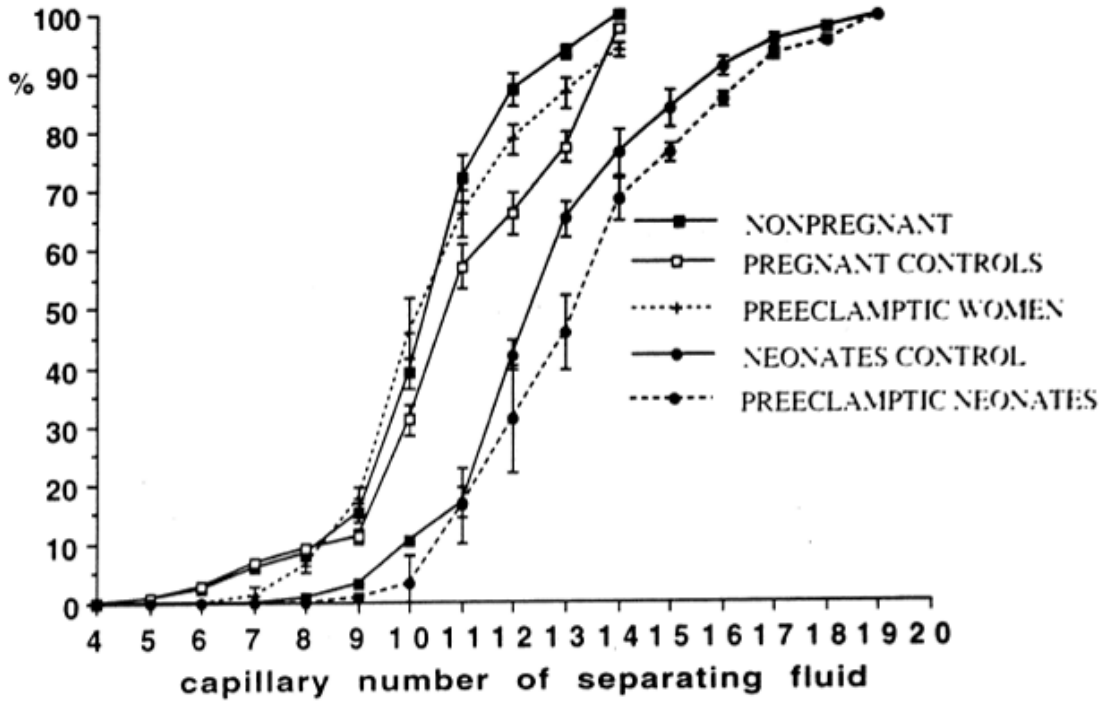


Figure 3: DDC curve

The DDC curve is well-known, and it is calculated by calculating means for each separating fluid of preeclamptic women's blood, normal pregnant women (pregnant controls), non-pregnant women, and preeclamptic women's umbilical cord blood (preeclamptic neonates), and umbilical cord blood of women with normal pregnancy (neonates' control).

In preeclampsia, a link between erythrocyte changes and hypercoagulability has recently been discovered. The modification of erythrocytes has been hypothesised as the cause of preeclamptic patients' whole blood coagulation time being shorter than that of normal pregnant women.[56] Our idea is that in preeclampsia, disruption of the erythrocyte senescence process leads to hypercoagulability.[57] This supports the idea that removing cells before they become functionally dysfunctional is preferable to removing them after they become functionally flawed.

Relevant articles supporting relationship between erythrocyte indices and Pre-eclampsia

1. Hernandez et al. conducted an observational study in Mexico in which 119 samples were examined; 74 percent of the samples had aberrant erythrocyte morphology, and the most common abnormality was the presence of schistocytes in up to 39 percent of the samples. Descriptive analysis revealed a degree of connection to independent variables with a Cramer's V = 0.41 value (p 0.05). A high number of patients with PIH, according to the data, have morphologic alterations in their erythrocytes in their peripheral blood smear.[58]
2. Sezer et al conducted a study in Turkey that encompassed 102 patients diagnosed as preeclampsia and 98 healthy pregnant women. The median RDW in the preeclampsia group was 15%, while it was 13.9 percent (13-15.6) in the control group (p0.01). The mean MCV of preeclampsia group was 80.427.26 (fL) compared to 83.882.31 (fL) in the control group (p=0.003). Furthermore, the mean MCHC value in the preeclampsia group was 33.661.71 (g/dL) compared to 33.091.48 (g/dL) in the control group (p=0.012). MCH and RBC values, on the other hand, show no association between the groups. (p>0.05).[59]
3. 118 pregnant women presented with preeclampsia and 120 normal pregnant women were encompassed in a study conducted by Yilmaz et al in Turkey. Standard CBC and RDW levels were determined in blood samples. The preeclampsia group's RDW values were significantly greater than the control group's (15.23 1.96 vs 14.48 1.70, p 0.05). RDW levels were significantly greater in the severe preeclampsia group than in the moderate preeclampsia group, according to subgroup analysis (15.08 2.07, 15.92 1.99, p 0.05). RDW and preeclampsia, as well as the severity of the illness, were discovered to be linked in this study.[25]

4. Freitas et al. conducted a study in Brazil60 that comprised twenty patients with normal blood pressure and 16 patients with Preeclampsia. Pre-eclampsia exhibited poor pregnancy outcomes, worsening hematologic values, and erythrocytes that were osmotically extra stable in vitro but isotonic in the in vivo medium. Hyper flow in the orbital area was also identified as compared to normotensive subjects. An analysis of anthropometric, hematologic, and hemodynamic variable quantity in Pre-eclampsia patients found that erythrocytes with lesser volumes and lesser levels of haemoglobin favour a improved gestational outcome since they are stable and related with a reduction in the disease's hemodynamic changes. This should imply that microcytosis propensity, which is most likely related to a compensatory mechanical selection process, is a beneficial characteristic in the condition.[60]
5. Kurt et al. did a study in Turkey that included 52 with preeclampsia (35 moderate and 17 severe) and 50 controls of pregnancy patients. In terms of haemoglobin and platelet counts, RDW values, SBP and DBP, proteinuria, and white blood cell counts, there were no significant changes between the pregnant women with pre-eclampsia and the control group (WBC). The pre-eclampsia group had significantly increased C-reactive protein levels. Furthermore, when comparing patients with severe preeclampsia to those with mild preeclampsia. RDW levels were considerably higher in severe preeclampsia. RDW levels were shown to be linked to both in this investigation.[61]
6. Wang sen-yu et al conducted a retrospective study in China with 149 pregnancies with PHD (67gestational hypertension, 39 mild preeclampsia, 24 severe preeclampsia, and 19 eclampsia) and 70 healthy pregnant women as controls. Varying pregnant women groups had different RDW at different gestational times (20th week, 24th week, 28th week), but pregnant women in the same group had no difference from

20th week to 28th week (P > 0.05). RDW was observed as a risk factor for PHD (odds ratio 2.683; 95 percent confidence interval 1.472–6.096), and the ideal RDW-CV threshold was 14.1 percent to predict PHD using the ROC curve, with 72.5 percent sensitivity and 77.9 percent speciality. RDW, as a new chronic inflammatory mediator and a high-risk factor for PHD, was observed as to have clinical significance in predicting the incidence of PHD in this investigation.[62]

7. In Nigeria, Ajibola et al did a cross-sectional study with 274 pregnant women who registered at the Lagos University Teaching Hospital or the Lagos State University Teaching Hospital. The research was conducted in a prenatal clinic. Overall, the results were given as mean standard deviation [SD]: haematocrit 30.16 percent 5.55 percent; haemoglobin concentration 10.94 1.86 g/dL; cell volume 78.30 5.70 fL; corpuscular haemoglobin level 28.57 2.48 pg; and corpuscular haemoglobin concentration 36.45 1.10 g/dL. When grouped by trimesters, the value of packed cell volume in the first trimester was 32.07 percent 6.80 percent; in the second trimester, 29.76 percent 5.21 percent; and in the third trimester, 33.04 percent 3.88 percent. For women in their forties, the mean SD haemoglobin concentrations were 11.59 2.35 g/dL, 10.81 1.72 g/dL, and 10.38 1.27 g/dL, respectively.[63]
8. In a study conducted by Elgari et al in Saudi Arabia, eighty preeclamptic moms were recruited, with normal pregnant women serving as controls. The haematological parameters were examined. The findings revealed a substantial link between preeclampsia and low birth weight, premature/caesarean delivery, and proteinuria (P 0.001). RDW, PCV, MCV, MCH, MCHC, and lymphocytes were significantly lower (P value 0.01) than normal women, although haemoglobin and neutrophils were significantly greater (P value 0.01). When cord blood was compared to normal blood, comparable results were discovered. Furthermore, there were positive and substantial

connections between preeclamptic women and their new-borns in Haemoglobin (r2 = 0.075, P 0.05), PCV values (r2 = 0.084, P 0.01), MCV values (r2 = 0.077, P 0.05), MCHC values (r2 = 0.115, P 0.01), and RBC value (r2 = 0.086, P 0.01).[64]

9. The systematic review in addition meta-analysis done by Adam et al comprised 11 case control studies with over-all of 951 cases and 2024 controls. The mean and standard deviation of the RDW level was appreciably greater in pre eclamptic when compared to controls. Difference in the mean was found to be 0.85. 8 literature were done which compared RDW level in the mild pre-eclampsia (N = 360) with severe cases (N = 354) of preeclampsia. The RDW level was significantly higher in severe preeclamptic women compared to those with mild preeclampsia. The mean difference was 1.07. The difference between the two groups was statistically significant. Severe preeclampsia had greater RDW levels than those with mild preeclampsia..[65]
10. Bask et al did a cross sectional investigation in the department of Obstetrics & Gynaecology at Dhaka Medical College Hospital, Dhaka, from January 2012 to December 2013.They studied 100 patients and put them into two groups: group A and group B. Fifty preeclamptic patients were placed in group A, while 50 healthy pregnant women were placed in group B. The average haematocrit value of the group was investigated. Preeclamptic patients had a haematocrit of 34.88±1.03, while normal pregnant women had a haematocrit of 31.94±1.2. The difference between the two groups (P value 0.001) was significant.Normal pregnant women, mild preeclamptic women, and severe preeclamptic women had mean haematocrit values of 31.94±1.2, 33.31±2.57, and 35.62±2.95, respectively. It was statistically significant as well (P value 0.001). The haematocrit value of preeclamptic individuals is substantially higher than that of normal pregnant women (P0.05), according to this study. There is a significant link between increased haematocrit and preeclampsia.[66]

MATERIAL & METHODS

MATERIALS AND METHODS

STUDY DESIGN:

A case control study was carried out among singleton normotensive and hypertensive pregnant women after twenty weeks of gravidity.

STUDY SITE

The present study was carried out among normotensive pregnant women and preeclampsia patients after twenty weeks of gravidity in the department of gynaecology and obstetrics at RLJH Hospital Kolar.

STUDY PERIOD

From January 2020 to June 2021 and one year six months

STUDY POPULATION

All the pregnant mothers who came with normal BP readings and preeclampsia patients after twenty weeks of gravidity delivered at RLJH Hospital were considered as study population.

SAMPLE SIZE CALCULATION

$$n = \frac{2s_p^2 [Z_{1-\alpha/2} + Z_{1-\beta}]^2}{\mu^2_d}$$

$$S_p^2 = \frac{S_1^2 + S_2^2}{2S_1^2}$$

Where

S_1^2 - standard deviation in the first group

S_2^2 - standard deviation in the second group

$\mu^2 d$ - mean difference between the samples

α - Significance level

$1-\beta$ - Power

S_1 -2.31

S_2 – 7.86

$\mu^2 d$ – 3.46

α - 5%

Power - 80%

Sample difference based on difference on Mean corpuscular volume reported between the pregnant women with normal BP readings and preeclampsia patients with the mean difference of 3.46 mentioned in the study conducted by Sezer et al[59] at Turkey.

The required sample size was computed by the above-mentioned formula with 80% power, 95% confidence interval, 5% α error and it was 45 patients per group.

Total sample size was 90. But 96 samples were collected and presented in result.

SAMPLING METHOD

All pregnant women with normal BP readings and preeclampsia patients after twenty weeks of gravidity delivered at RLJ hospital during the period from January 2020 to June 2021 were taken up for the study.

INCLUSION CRITERIA:

There are 2 groups considered

- Group A – 48 singleton normotensive pregnant women after twenty weeks of gravidity
- Group B- 48 singleton pregnancy with hypertension developed after twenty weeks of gravidity.

EXCLUSION CRITERIA:

- Patient with coagulation disorders like Idiopathic thrombocytopenia, sickle cell disease,
- Viral hepatitis, cholestatic jaundice,
- Acute fatty liver,
- Malaria,
- Drug induced hepatitis
- Dengue fever
- Chronic hypertension

ETHICAL CONSIDERATIONS:

The current Study was permitted by institutional human ethics committee. Informed written consent was obtained from all the participants and only those participants willing to sign the informed consent were counted in the study. The jeopardies and profits related in the study and voluntary nature of participation were clarified to the participants before getting consent. Confidentiality of the study samples was maintained.

DATA COLLECTION PROCEDURE:

After getting the written informed consent and the patient rewarding the inclusion criteria were involved. The sample of 48 normotensive and 48 pre eclamptic patients were considered. All pregnant women enrolled for the study was clinically scrutinised and

diagnosed to be either normotensive or hypertensive women based on the diagnostic criteria for pre-eclampsia as revealed in Table 1.

Blood pressure and proteinuria was assessed in all the subjects. And for the patient with hypertension repeat BP measurements after 4 hours were recorded. Data on presence of nausea, vomiting, headache, urine output less than 400ml/ 24hrs, haemogram, hypoproteinaemia, raised liver enzymes, deranged LFT, presence of haemolysis was noted.

Complete blood count was referred for all the patients and the erythrocyte indices such as Mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, RDW, and RBC count was documented with standard procedure and compared between the two groups. The red blood cell indices were quantified as part of the automated complete blood count using a Mindray BC 6800 analyser.

STUDY VARIABLES

- Age
- Gestational Age
- Gravida
- Mode of Delivery
- Hb count
- RBC Count
- PCV
- MCV
- MCH
- MCHC
- RDW
- Associated Maternal Conditions

DATA ANALYSIS

- The gathered data were entered in Ms excel and analysed using IBM.SPSS statistics software 23.0 Version.
- To describe the data in descriptive statistics frequency, percentage analysis was used for discrete variables. Mean, Median and Standard deviation was used for continuous variables.
- All Quantitative variables were checked for normal distribution within each category of explanatory variable by histograms and normality by Q-Q plots. Shapiro- wilk test was also performed to evaluate normal distribution.
- To describe the data in inferential statistics Discrete variables in the two groups were compared for statistically significant difference using Chi Square test or Fisher's exact test. Continuous variables in the two groups were compared for statistically significant difference using Independent T test.
- Data was also represented using histogram, multiple bar chart, line diagram and also box and whisker plot.
- In all the above statistical tools the probability value 0.05 was considered as significant level.

RESULTS

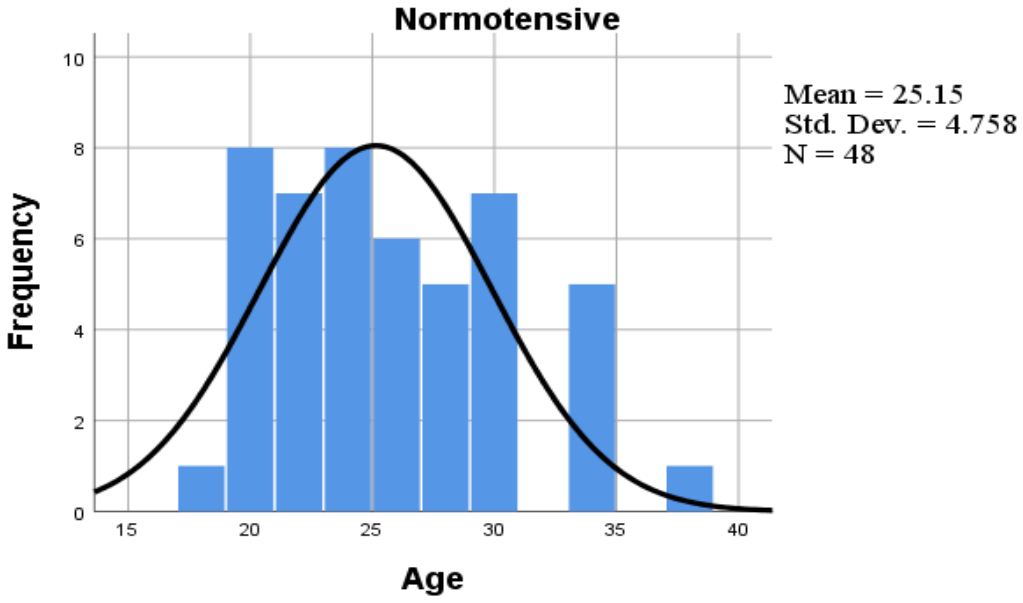
RESULTS

Table 2: Age distribution of both normotensive and Pre-eclampsia group

Age	Normotensive	Pre-eclampsia
Mean	25.15	24.65
Median	24.50	23.00
Mode	19	23
Std. Deviation	4.758	5.444
Minimum	18	18
Maximum	37	38

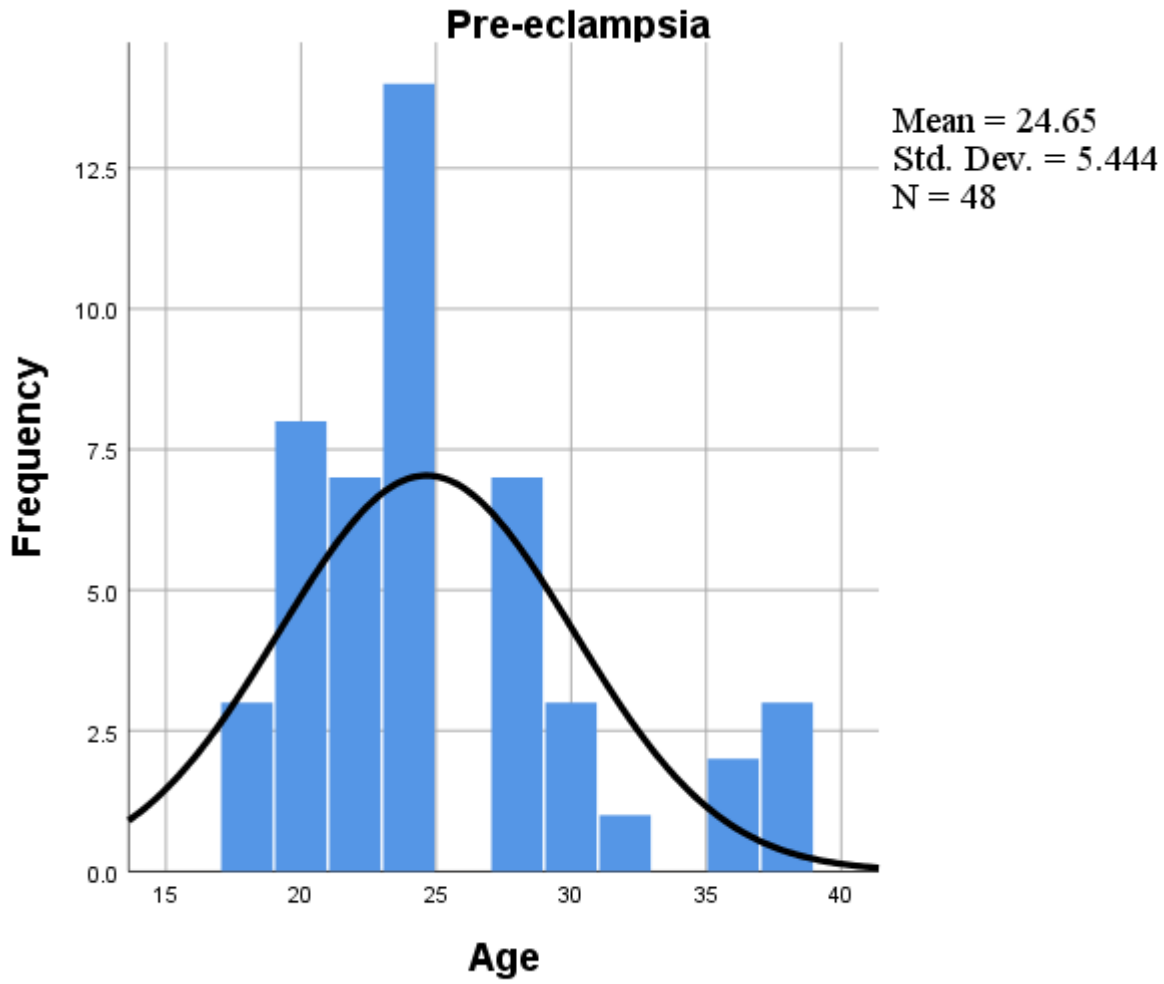
Comment: In the present study the mean age of the normotensive group was 25.15±4.758 and the mean age of the pre-eclampsia group was 24.65± 5.444. The mean age of both Normotensive and Pre-eclampsia group is nearly closer together.

Figure 4: Age distribution of Normotensive group



Comment: In the present study the mean age of the normotensive group was 25.15±4.758 and the age distribution of Normotensive group was shown in the histogram.

Figure 5: Age distribution of Pre-eclampsia group



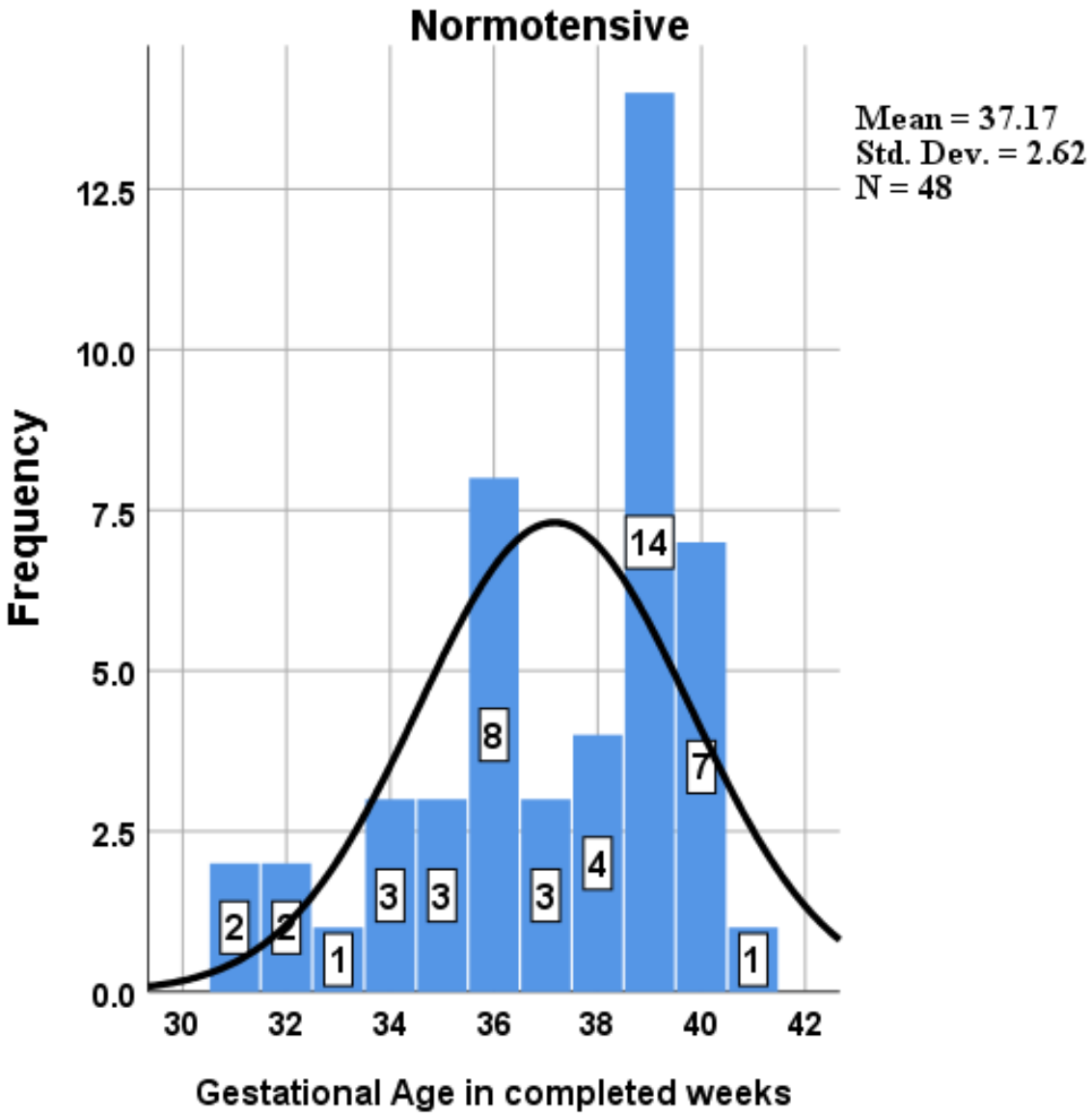
Comment: In the present study the mean age of the pre-eclampsia group was 24.65 ± 5.444 and the age distribution of pre-eclampsia group was shown in the histogram.

Table 3: Distribution of both normotensive and Pre-eclampsia group with respect to Gestational age in completed weeks

Gestational age in completed weeks	Normotensive	Pre-eclampsia
Mean	37.17	36.92
Median	38.00	37.50
Mode	39	38
Std. Deviation	2.620	3.017
Minimum	31	28
Maximum	41	41

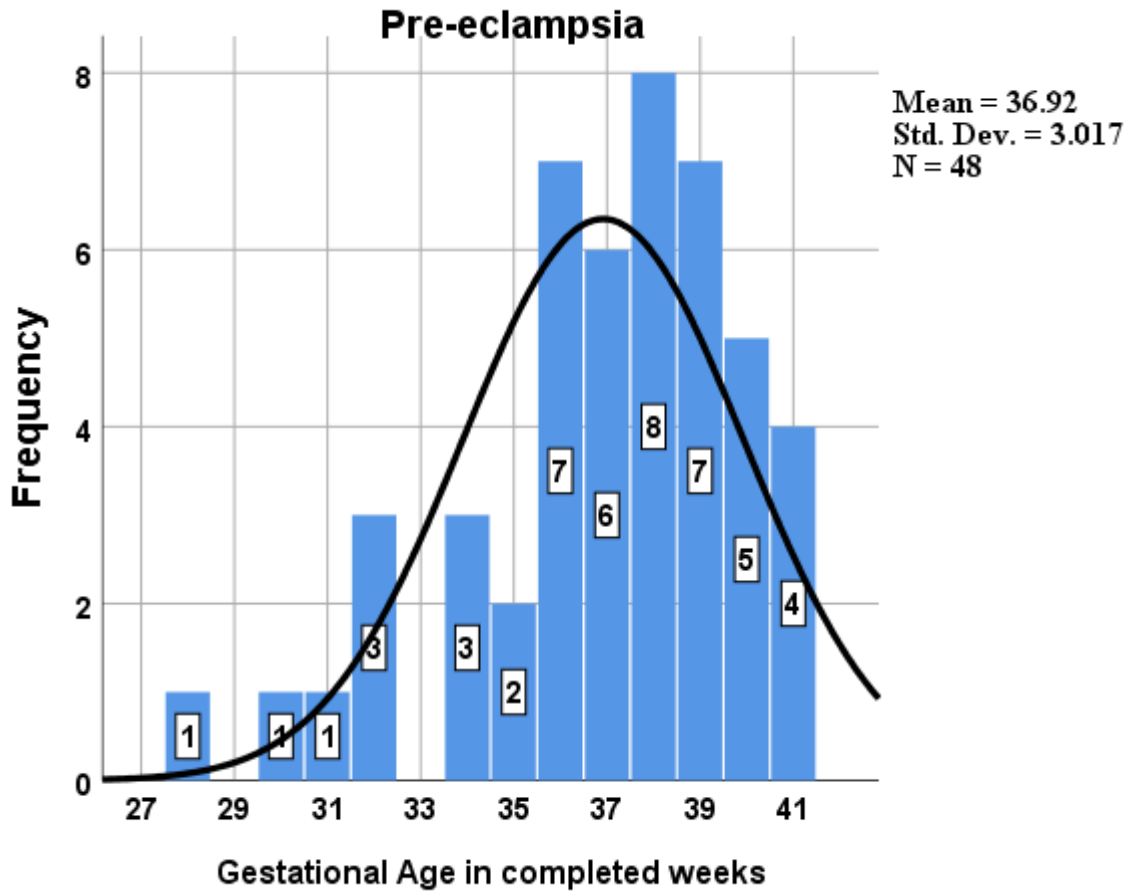
Comment: In the present study the mean gestational age of the normotensive group was 37.17 ± 2.620 and the mean gestational age of the pre-eclampsia group was 36.92 ± 3.017. The mean gestational age in completed weeks of both Normotensive and Pre-eclampsia group is nearly closer together.

Figure 6: Distribution of Normotensive group with respect to Gestational age in completed weeks



Comment: In the present study the mean gestational age of the normotensive group was 37.17 ± 2.620 and the gestational age distribution of Normotensive group was shown in the histogram.

Figure 7: Distribution of Pre-eclampsia group with respect to Gestational age in completed weeks



Comment: In the present study the mean gestational age of the normotensive group was 36.92 ± 3.017 and the gestational age distribution of Normotensive group was shown in the histogram.

Table 4: Distribution of gravida in both Normotensive and Pre-eclampsia group

Gravida	Normotensive		Pre-eclampsia		Total	
	N	%	N	%	N	%
Primi	23	47.9	23	47.9	46	47.9
Gravida 2	18	37.5	14	29.2	32	33.3
Gravida 3	6	12.5	7	14.6	13	13.5
Gravida 4	1	2.1	2	4.2	3	3.1
Gravida 5	0	0	2	4.2	2	2.1
Total	48	100	48	100	96	100.0
Chi-square value = 2.910			***p-value = 0.573***			

Comment: Among the 48 normotensives, nearly half of them are primi (47.9%) and 37.5% comes under gravida 2 and 12.5% belongs to gravida 3. Among the 48 pre-eclampsia, nearly half of them are primi (47.9%) and 33.3% comes under gravida 2 and 13.5% belongs to gravida 3. The proportion of primi gravida is higher than that of other gravidas in both normotensive and pre-eclampsia group. This difference in proportion between these groups was not statistically significant by Chi-square test (p-value: 0.573). Hence the number of gravidas didn't influence the development of pre-eclampsia

Figure 8: Component Bar-chart showing distribution of gravida in both Normotensive and Pre-eclampsia group.

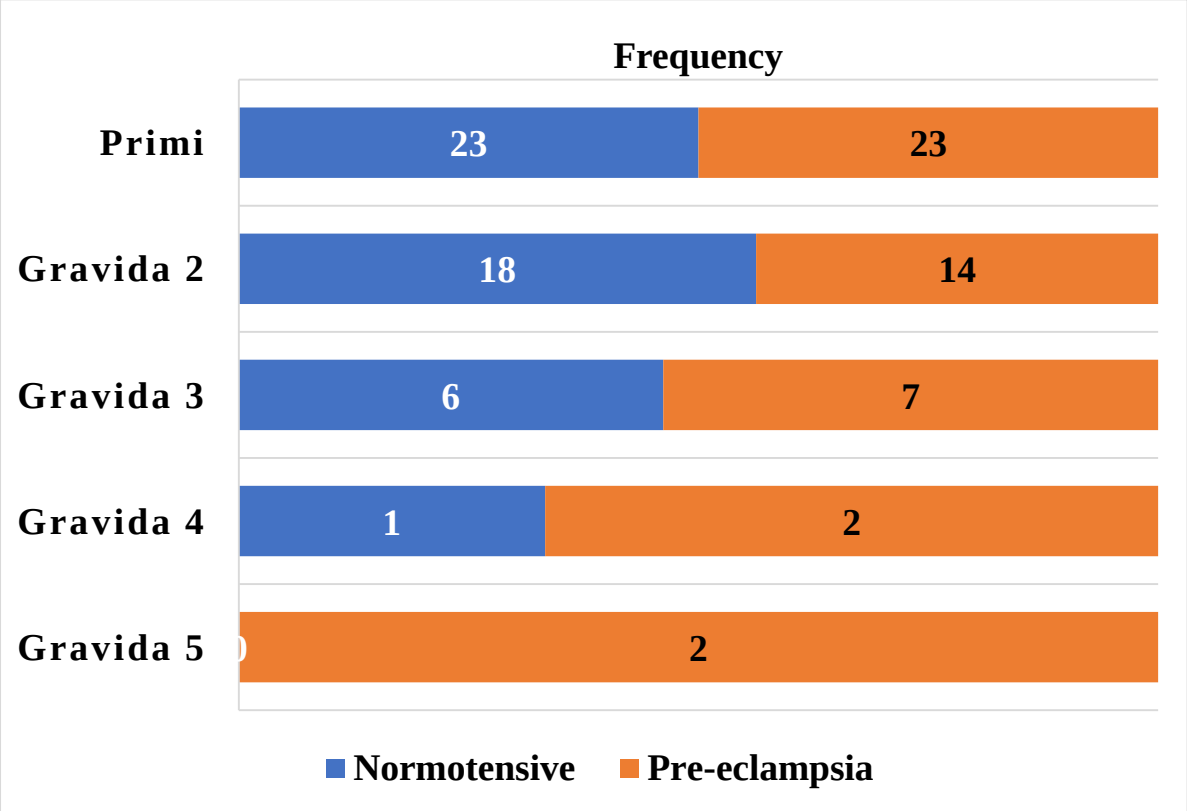


Table 5: Distribution of both Normotensive and Pre-eclampsia group with respect to mode of delivery

Gravida	Normotensive		Pre-eclampsia		Total	
	N	%	N	%	N	%
NVD	31	64.6	25	52.1	56	58.3
LSCS	17	35.4	23	47.9	40	41.7
Total	48	100	48	100	96	100.0
Pearson Chi-Square value = 1.543			***p-value = 0.214***			

Comment: Among the 48 normotensives, nearly 64.6% delivered by Normal Vaginal delivery and 35.4 % delivered by Caesarean section. Among the 48 pre-eclampsia, nearly 58.3% delivered by Normal Vaginal delivery and 41.7% delivered by Caesarean section. The proportion of Normal Vaginal delivery is higher than that of LSCS in both normotensive and pre-eclampsia group. This difference in proportion between the groups was not statistically significant by Chi-square test (p-value: 0.214). Hence development of preeclampsia did not influence the mode of delivery in our study.

Figure 9: Distribution of both Normotensive and Pre-eclampsia group with respect to mode of delivery

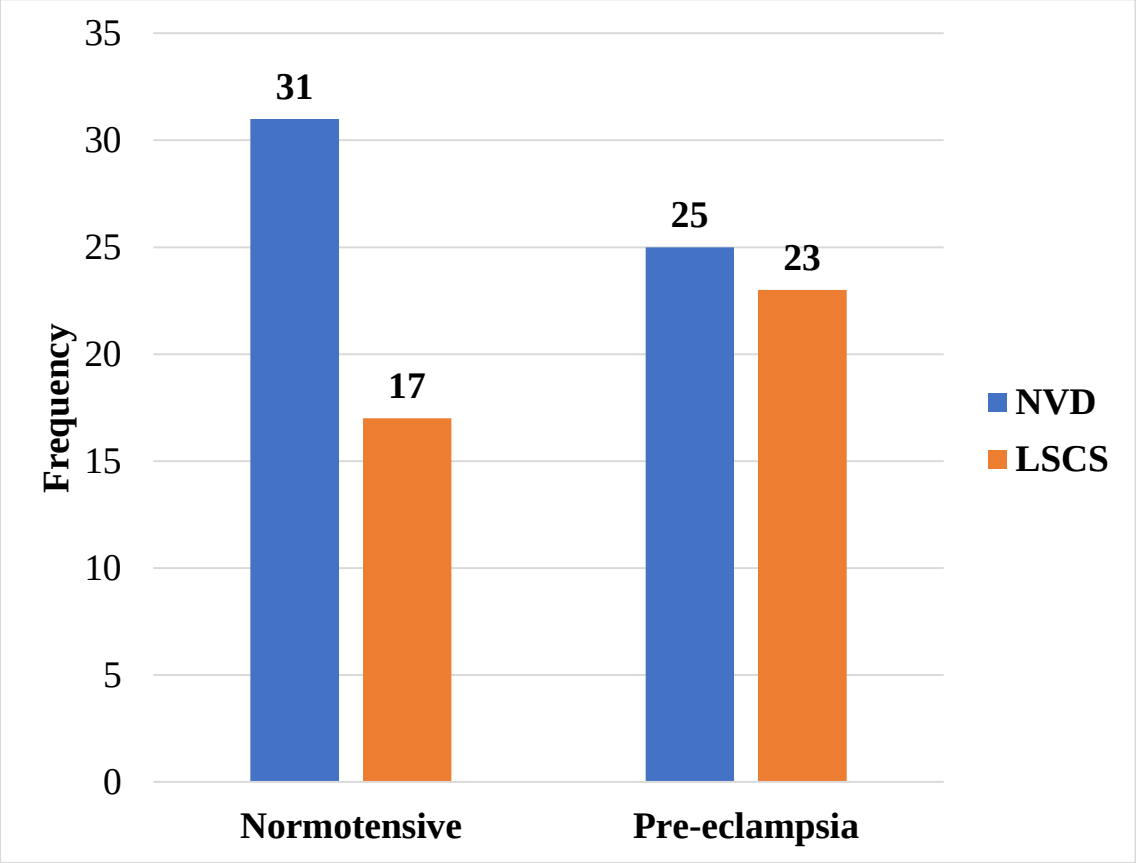


Table 6: Distribution of Normotensive group with respect to Associated Maternal Conditions

Associated Maternal Conditions in Normotensive group	Frequency	Percentage
Hypothyroid	2	4.2
Obstructed Labour	1	2.1
Oligohydramnios	1	2.1
Placenta Previa	1	2.1
PROM	8	16.7
Rh Negative	2	4.2
None	33	68.8
Total	48	100.0

Comment: The most common condition in normotensive pregnant mothers was Premature rupture of membrane (16.7%), followed by that are hypothyroidism and Rh-Negative incompatibility (4.2%). Nearly 68.8% didn't presented with any associated Maternal Conditions.

Figure 10: Distribution of Normotensive group with respect to Associated Maternal Conditions

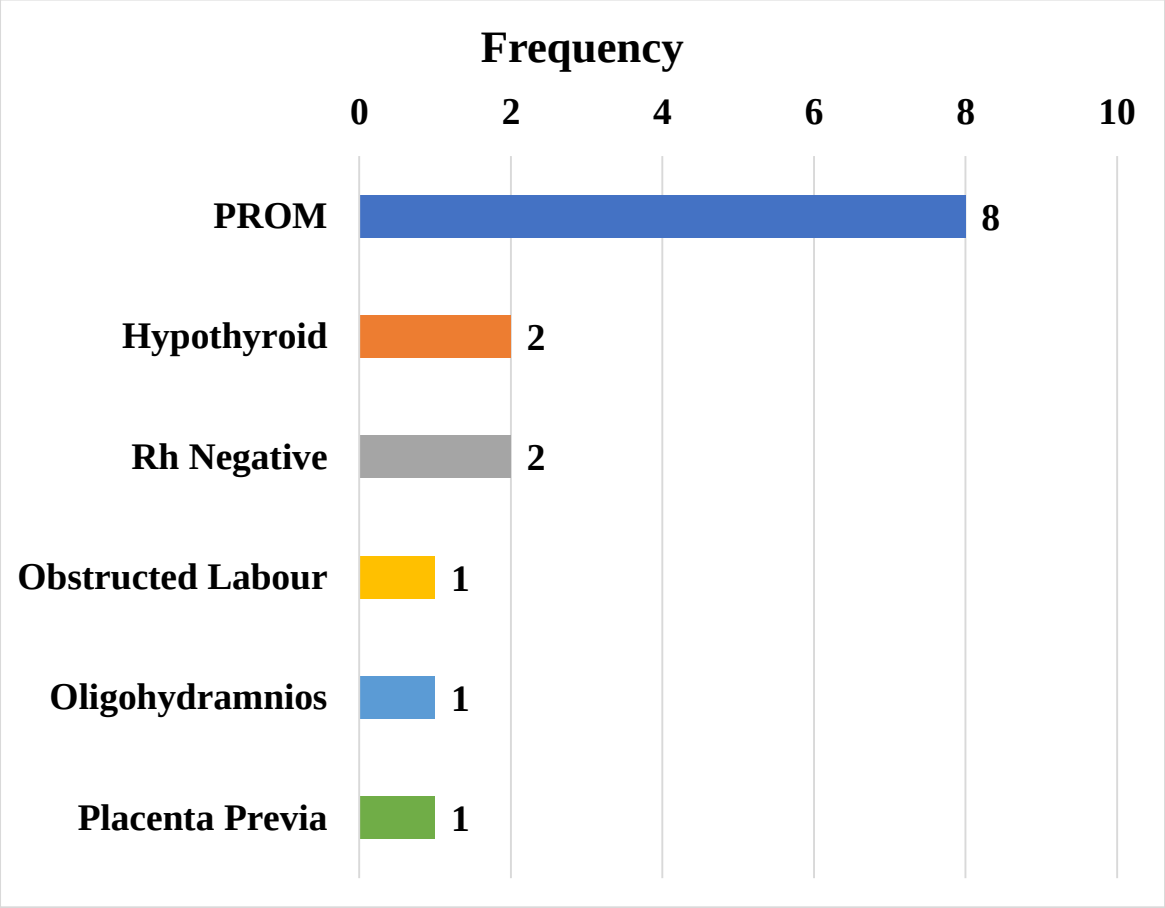


Table 7: Distribution of Pre-eclampsia group with respect to Associated Maternal Conditions

Associated Maternal conditions in Pre-eclampsia	Frequency	Percentage
Abruption	2	4.2
Antepartum Eclampsia	3	6.3
Breech	3	6.3
GDM	3	6.3
Hypothyroid	4	8.3
Imminent Eclampsia	4	8.3
PROM	3	6.3
Rh Negative	1	2.1
None	25	52.1
Total	48	100.0

Comment: The most common condition in pre-eclampsia pregnant mothers was Hypothyroidism and Imminent Eclampsia (8.3%). Nearly 52.1% didn't presented with any associated Maternal Conditions.

Figure 11: Distribution of Pre-eclampsia group with respect to Associated Maternal Conditions

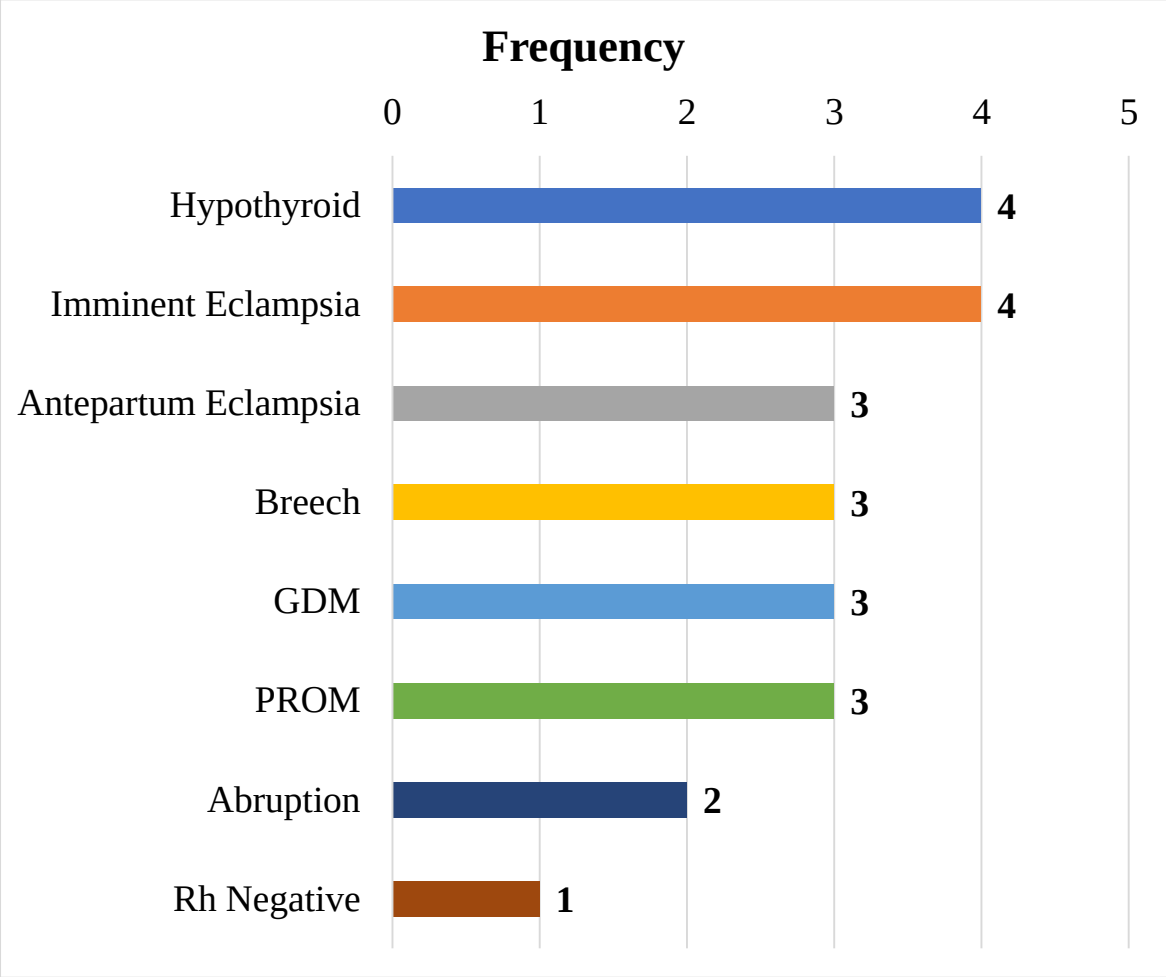


Table 8: Comparison of both Normotensive and pre-eclampsia group with respect to age group by Chi-square test

Age group	Normotensive		Pre-eclampsia		Total	
	N	%	N	%	N	%
16-20	9	18.8	11	22.9	20	20.8
21-25	18	37.5	21	43.8	39	40.6
26-30	15	31.3	10	20.8	25	26.0
31-35	5	10.4	1	2.1	6	6.3
36-40	1	2.1	5	10.4	6	6.3
Total	48	100.0	48	100.0	96	100.0
Chi-square value = 6.764			***p-value = 0.149***			

Comment: Among the 48 normotensives, nearly 37.5% belongs to age group 21-25 and 31.3% belongs to age group 26-30. Only 2.1% belongs to age group 36-40. Among the 48 pre-eclampsia, nearly 40.6% belongs to age group 21-25 and 26% belongs to age group 26-30. Only 6.3% belongs to age group 36-40. The proportion of pregnant women between 16-20, 21-25, 36-40 years in pre-eclampsia group was higher when compared to pregnant women in normotensive. The proportion of pregnant women between 26-30, 31-35 years in pre-eclampsia group was lower when compared to pregnant women in normotensive. This difference in proportion between these groups was not statistically significant by Chi-square test (p-value: 0.149). Hence the age factor did not influence the development of pre-eclampsia.

Figure 12: Comparison of both Normotensive and pre-eclampsia group with respect to age group by Chi-square test

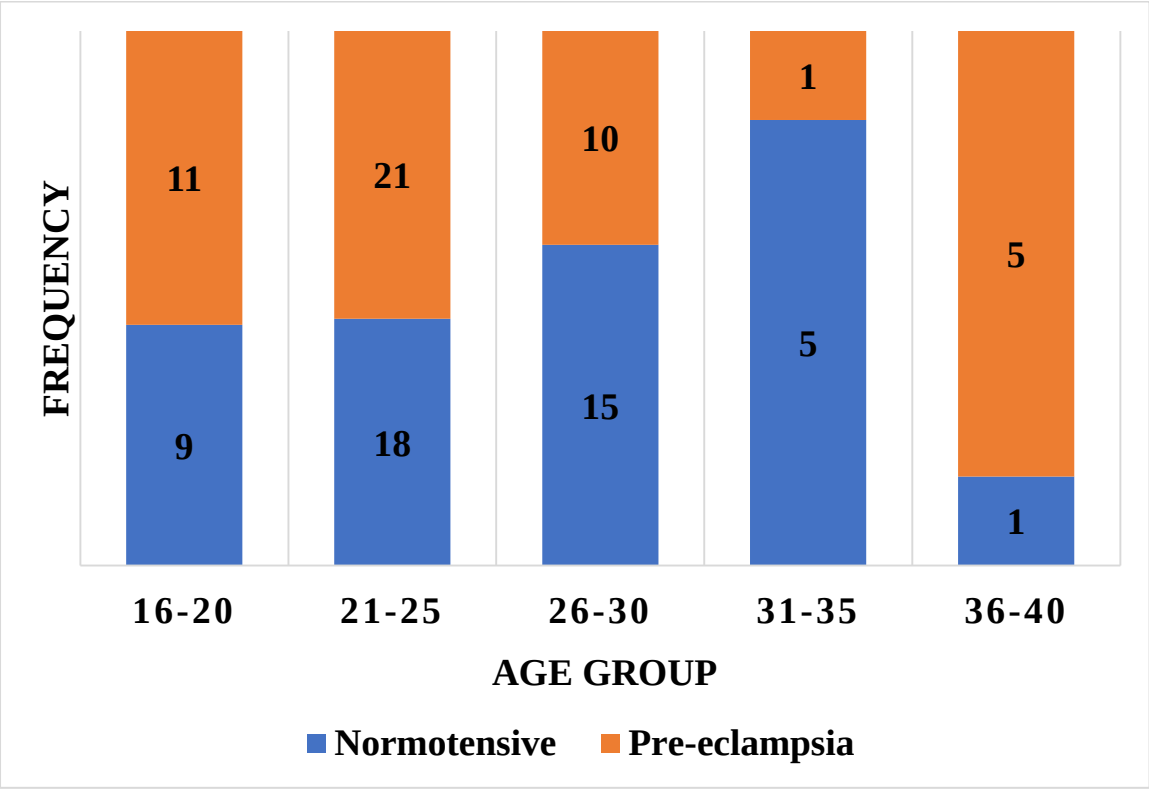


Table 9: Comparison of Gestational Age in weeks of pregnant women with normotensive and pre-eclampsia by chi-square test.

Gestational age in completed weeks	Normotensive		Pre-eclampsia		Total	
	N	%	N	%	N	%
26-30 weeks	0	0	2	4.2	2	1.9
31-35 weeks	11	22.9	9	18.8	20	19.2
36-40 weeks	36	75	33	68.8	69	66.2
41-42 weeks	1	2.1	4	8.3	5	4.8
Total	48	100	48	100	96	100.0
Pearson Chi-Square value = 4.130				***p-value =0.248***		

Comment: Among the 48 normotensives, nearly 75% belongs to 36-40 weeks of gravidity and 22.9% belongs to age group to 31-35 weeks of gravidity. Only 2.1% belongs to age group 41-42 weeks of gravidity. Among the 48 pre-eclampsia, nearly 66.2% belongs to 36-40 weeks of gravidity and 19.2% belongs to age group to 31-35 weeks of gravidity. Only 4.8% belongs to age group 41-42 weeks of gravidity. The proportion of pregnant women between 36-40 weeks of gravidity in both normotensive and pre-eclampsia group was higher when compared to pregnant women in other weeks of gravidity. This difference in proportion between these groups was not statistically significant by Chi-square test (p-value: 0.248). Hence the period of gravidity did not influence the development of pre-eclampsia.

Figure 13: Comparison of Gestational Age in completed weeks of pregnant women with normotensive and pre-eclampsia by chi-square test.

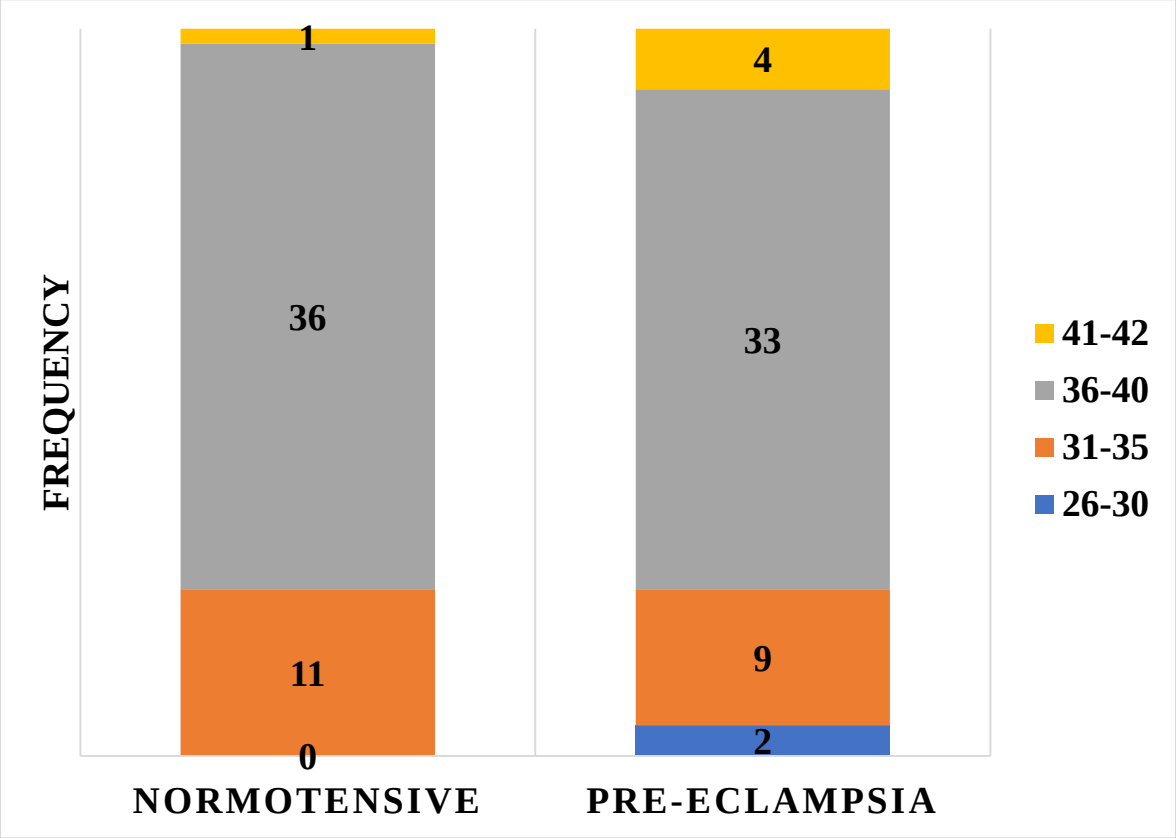


Table 10: Haemoglobin distribution of both Normotensive and Pre-eclampsia group

Haemoglobin level (g/dl)	Normotensive	Pre-eclampsia
Mean	10.490	10.873
Median	10.350	10.950
Mode	10.1	12.4
Std. Deviation	1.8848	1.8395
Minimum	6.5	6.6
Maximum	14.5	15.2

Comment: In the present study the mean Haemoglobin level of the normotensive group was 10.490 ± 1.88 and the mean Haemoglobin level of the pre-eclampsia group was 10.873 ± 1.83. The mean Haemoglobin level of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 11: Comparison of Normotensive and Pre-eclampsia group with respect to Haemoglobin distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	10.490	1.8848	0.2720	0.316
Pre-eclampsia (48)	10.873	1.8395	.2655	

Comment: The mean Hb level of Normotensive group was 10.490 besides the mean age of Pre-eclampsia group was 10.873. The difference linking the two mean was 0.383 and such difference was statistically not significant (p-value: 0.316) by Independent T test. Hence, the development of pre-eclampsia did not influence level of haemoglobin the among pregnant women after 20 weeks of gravidity.

Figure 14: Comparison of Normotensive and Pre-eclampsia group with respect to Haemoglobin distribution by Independent samples T test

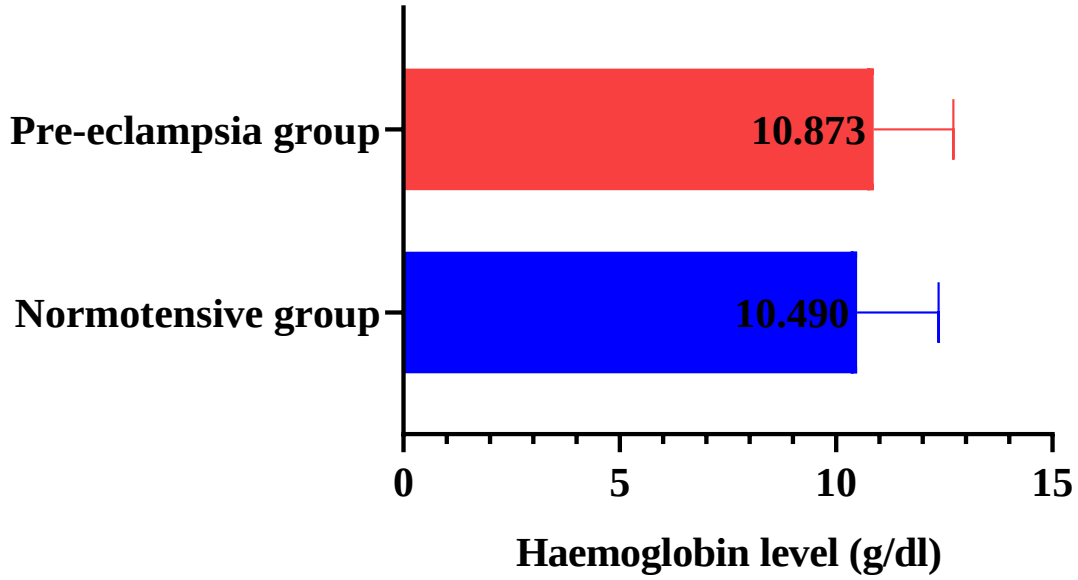


Table 12: RBC count distribution of both Normotensive and Pre-eclampsia group

Red Blood Cell count	Normotensive	Pre-eclampsia
Mean	4.0273	4.1177
Median	0.08977	0.11583
Mode	4.035	4.18
Std. Deviation	0.62195	0.80246
Minimum	1.9	1.92
Maximum	5.19	5.67

Comment: In the existing study the mean RBC count of the normotensive group was 4.02 ± 0.62 and the mean RBC count of the pre-eclampsia group was 4.11 ± 0.802. The mean RBC count of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 13: Comparison of Normotensive and Pre-eclampsia group with respect to RBC count distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	4.027	0.621	0.089	0.539
Pre-eclampsia (48)	4.117	0.802	0.115	

Comment: The mean RBC count of Normotensive group was 4.027 and the mean RBC count of Pre-eclampsia group was 4.117. The difference linking the two mean was 0.09 and such difference was statistically not significant (p-value: 0.539) by Independent T test. Hence, the development of pre-eclampsia did not influence the RBC count among pregnant women after twenty weeks of gravidity.

Figure 15: Comparison of Normotensive and Pre-eclampsia group with respect to RBC count distribution by Independent samples T test

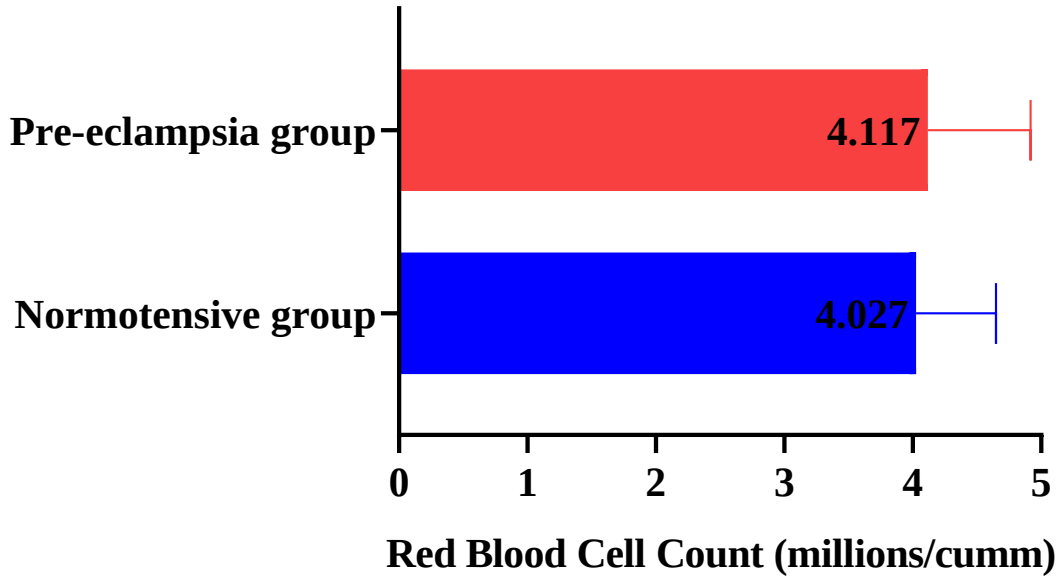


Table 14: Packed Cell Volume distribution of both Normotensive and Pre-eclampsia group

Packed Cell Volume (%)	Normotensive	Pre-eclampsia
Mean	34.4423	33.146
Median	0.64964	0.84581
Mode	34.25	33.8
Std. Deviation	4.50082	5.85996
Minimum	19.5	18.9
Maximum	47.9	47.2

Comment: In the existing study the mean Packed Cell Volume of the normotensive group was 34.44 ± 4.50 and the Packed Cell Volume of the pre-eclampsia group was 33.14 ± 5.85. The mean Packed Cell Volume of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 15: Comparison of Normotensive and Pre-eclampsia group with respect to Packed Cell Volume distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	34.4423	4.5008	0.64964	0.227
Pre-eclampsia (48)	33.1460	5.8599	0.84581	

Comment: The mean Packed Cell Volume of Normotensive group was 34.4423 and the mean Packed Cell Volume of Pre-eclampsia group was 33.1460. The difference amongst the two mean was 1.2963 and thus difference was statistically not significant (p-value: 0.227) by Independent T test. Hence, development of pre-eclampsia does not influence the Packed Cell Volume among pregnant women after twenty weeks of gravidity.

Figure 16: Comparison of Normotensive and Pre-eclampsia group with respect to Packed Cell Volume distribution by Independent samples T test

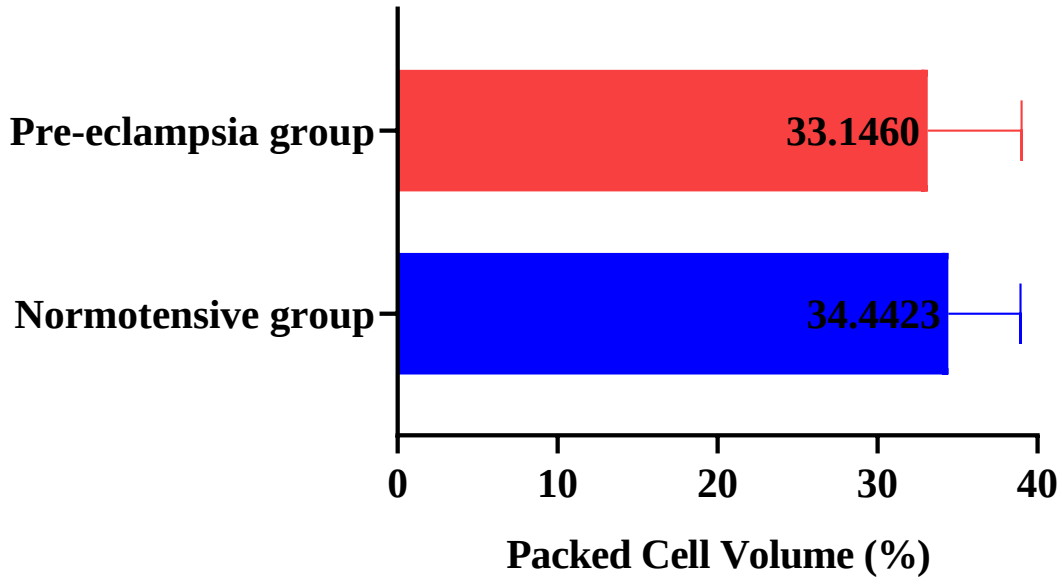


Table 16: Mean Corpuscular Volume distribution of both Normotensive and Pre-eclampsia group

Mean Corpuscular Volume (fl)	Normotensive	Pre-eclampsia
Mean	82.837	80.665
Median	1.1918	1.5028
Mode	83.55	81.6
Std. Deviation	8.2574	10.4117
Minimum	62.8	51.5
Maximum	102.6	109.9

Comment: In the contemporary study the mean of MCV of the normotensive group was 82.83 ± 8.25 and the mean of MCV of the pre-eclampsia group was 80.65 ± 10.41. The mean of MCV of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 17: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Volume distribution by Independent samples T test.

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	82.837	8.2574	1.1918	0.260
Pre-eclampsia (48)	80.665	10.4117	1.5028	

Comment: The mean of MCV of Normotensive group was 82.837 and the mean of Mean Corpuscular Volume of Pre-eclampsia group was 80.665. The difference amongst the two mean was 2.172 and such difference was statistically not significant (p-value: 0.260) by Independent T test. Hence, development of pre-eclampsia does not influence the level of MCV among pregnant women after twenty weeks of gravidity.

Figure 17: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Volume distribution by Independent samples T test.

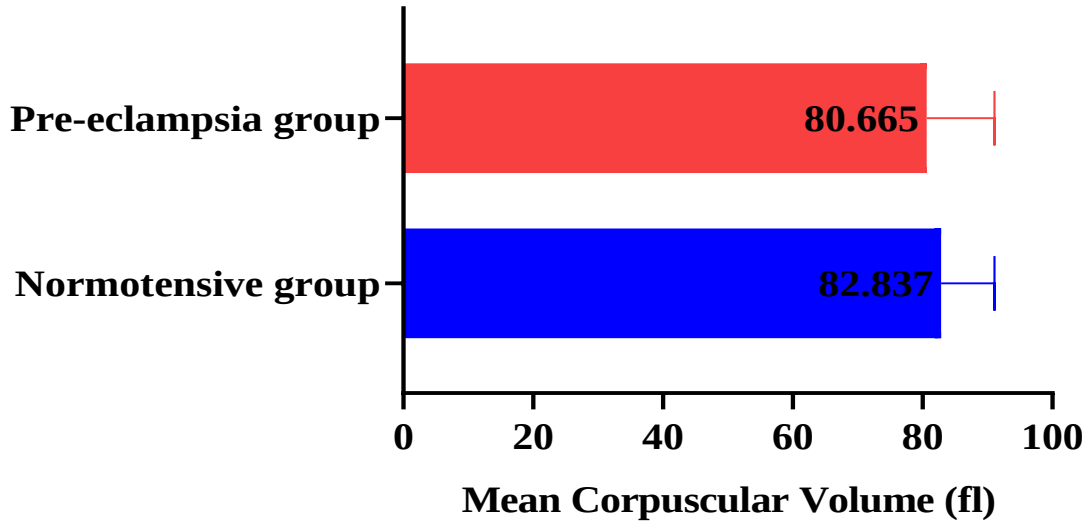


Table 18: Mean Corpuscular Haemoglobin distribution of both Normotensive and Pre-eclampsia group

Mean Corpuscular Haemoglobin (fl)	Normotensive	Pre-eclampsia
Mean	28.585	27.735
Median	0.5757	0.6327
Mode	28.5	27.8
Std. Deviation	3.9885	4.3838
Minimum	20	16.1
Maximum	38.9	39.1

Comment: In the contemporary study the mean of MCH of the normotensive group was 28.58 ± 3.98 and the mean of MCH of the pre-eclampsia group was 27.73 ± 4.38. The mean of MCH of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 19: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Haemoglobin distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	28.585	3.9885	0.5757	0.323
Pre-eclampsia (48)	27.735	4.3838	0.6327	

Comment: The mean of MCH of Normotensive group was 28.585 and the mean of Mean Corpuscular Haemoglobin of Pre-eclampsia group was 27.735. The difference amongst the two mean was 0.85 and such difference was statistically not significant (p-value: 0.323) by Independent T test. Hence, the level of MCH was not influenced by the development of pre-eclampsia among pregnant women after twenty weeks of gravidity.

Figure 18: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Haemoglobin distribution by Independent samples T test

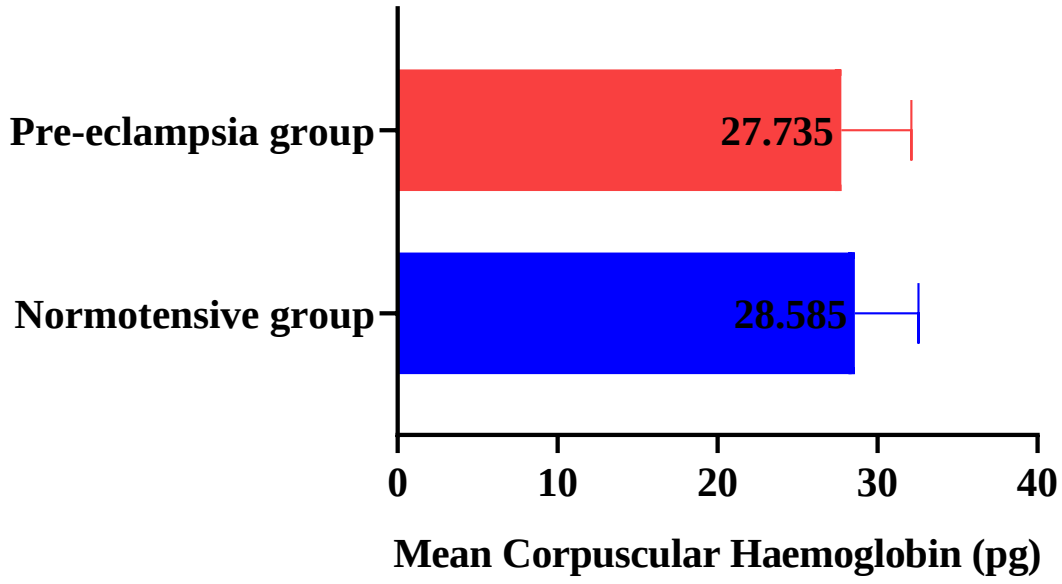


Table 20: Mean Corpuscular Haemoglobin Concentration distribution of both Normotensive and Pre-eclampsia group

Mean Corpuscular Haemoglobin Concentration (%)	Normotensive	Pre-eclampsia
Mean	33.598	33.917
Median	0.312	0.2792
Mode	33.7	34.25
Std. Deviation	2.1616	1.9346
Minimum	28.2	28.2
Maximum	37.9	37.1

Comment: In the present study the mean of MCHC of the normotensive group was 33.59 ± 2.16 and the mean of MCHC of the pre-eclampsia group was 33.91±1.93. The mean of Mean Corpuscular Haemoglobin Concentration of both Normotensive and Pre-eclampsia group is nearly closer together.

Table 21: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Haemoglobin Concentration distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	33.598	2.1616	0.3120	0.448
Pre-eclampsia (48)	33.917	1.9346	0.2792	

Comment: The mean of MCHC of Normotensive group was 33.598 and the mean of MCHC of Pre-eclampsia group was 33.917. The difference amongst the two mean was 0.319 and such difference was statistically not significant (p-value: 0.448) by Independent T test. Hence, the level of MCHC was not influenced by the development of pre-eclampsia among pregnant women after twenty weeks of gravidity.

Figure 19: Comparison of Normotensive and Pre-eclampsia group with respect to Mean Corpuscular Haemoglobin Concentration distribution by Independent samples T test

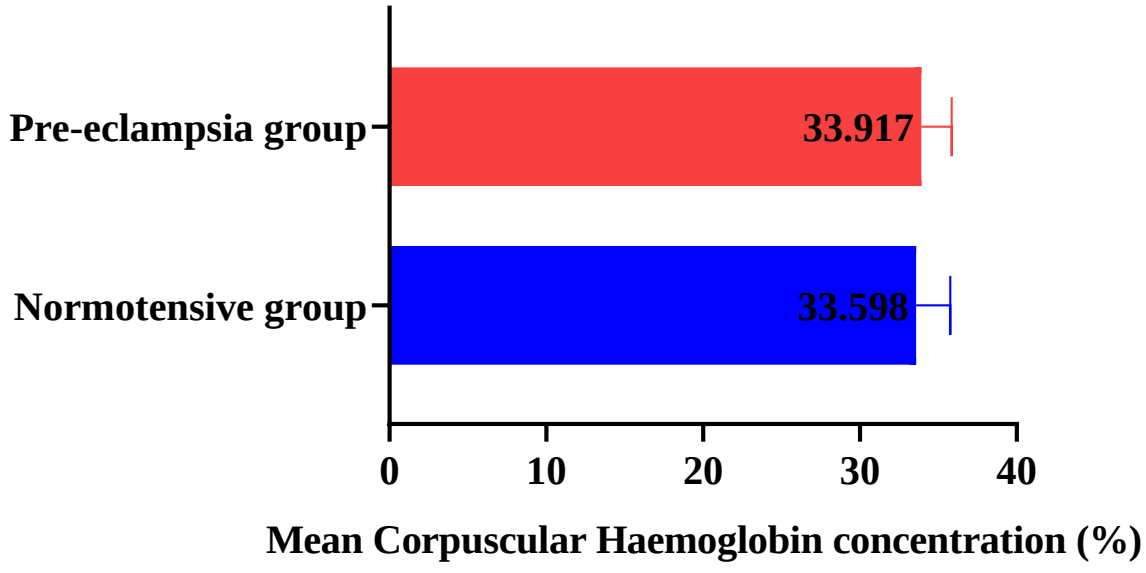


Table 22: Red Cell distribution width distribution of both Normotensive and Pre-eclampsia group

Red Cell distribution width (%)	Normotensive	Pre-eclampsia
Mean	13.2688	17.4458
Median	0.19628	0.55232
Mode	13.1	16.35
Std. Deviation	1.35988	3.82656
Minimum	10.5	10.6
Maximum	18.9	27.7

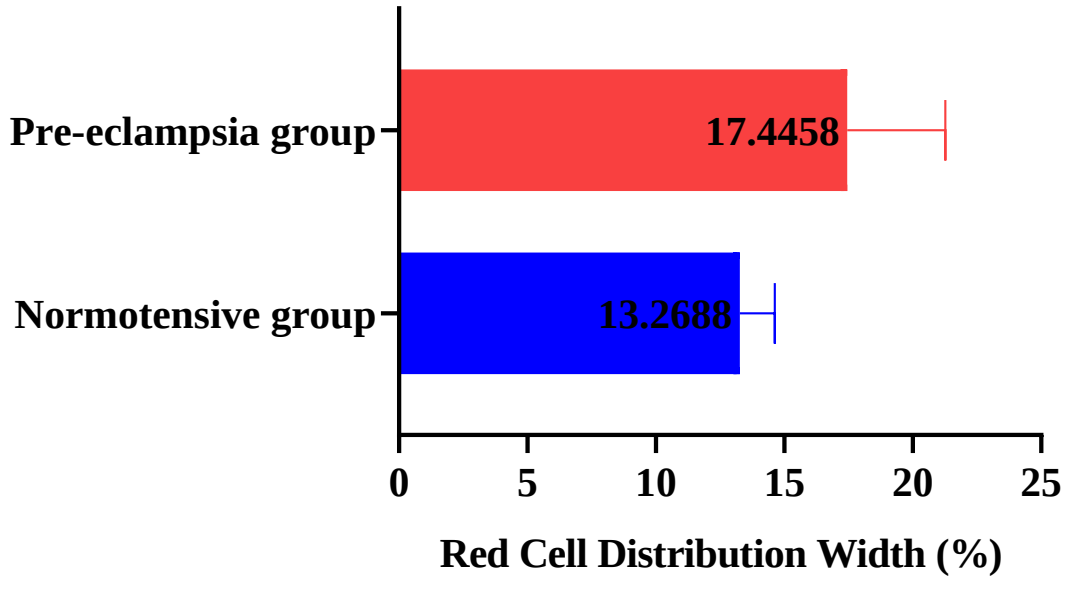
Comment: In the present study the mean of RDW distribution of the normotensive group was 13.26 ± 1.35 and the mean of RDW of the pre-eclampsia group was 17.44 ± 3.82. The mean of RDW of Pre-eclampsia group was 17.44 % and this level was higher than the mean of RDW of normotensive group (13.26 %).

Table 23: Comparison of Normotensive and Pre-eclampsia group with respect to Red Cell distribution width (RDW) distribution by Independent samples T test

Group(N)	Mean	Std. Deviation	Std. Error Mean	p-value
Normotensive (48)	13.2688	1.35988	0.19628	0.0001
Pre-eclampsia (48)	17.4458	3.82656	0.55232	

Comment: The mean of RDW of Normotensive group was 13.2688 and the mean of RDW of Pre-eclampsia group was 17.4458. The difference amongst the two mean was 4.177 and such difference was statistically significant (p-value: 0.0001) by Independent T test. Hence, the development of preeclampsia increased the levels of RDW among pregnant women after twenty weeks of gravidity.

Figure 20: Comparison of Normotensive and Pre-eclampsia group with respect to Red Cell distribution width (RDW) distribution by Independent samples T test



DISCUSSION

DISCUSSION

The case control study was conducted among 48 normotensive pregnant women and 48 pre-eclampsia patients after twenty weeks of gravidity attending the department of Obstetrics and gynaecology at RLJ hospital Kolar from January 2020 to June 2021 for one year six months. Erythrocyte indices such as Hb, MCV, MCH, MCHC, RDW and RBC count was recorded with standard procedure and compared between the 2 groups. This aim to compare the erythrocyte indices between the pre-eclampsia and normotensive pregnancy after 20 weeks of gravidity and also to determine the association between the erythrocyte indices and the development of pre-eclampsia among pregnant women.

Table 24: Comparison of Age between normotensive and Pre-eclampsia patients with similar articles

Author (Year)	Mean age of Normotensive group	Mean age of Pre-eclampsia group
Current study	25.15 ± 4.758	24.65 ± 5.444
Sezer et al[59] (2015)	28.55 ± 4.91	30.94 ± 6.02
Kurt et al[61] (2015)	27 ± 2	28 ± 2
Freitas et al[60] (2019)	25.60 ± 6.36	26.19 ± 7.92

In the current study it was observed that the mean age of the normotensive group was 25.15 ± 4.758 years with the range of 18-37 years and the mean age of the pre-eclampsia group was 24.65 ± 5.444 years with the range of 18-3 years. The mean age of both Normotensive and Pre-eclampsia group is nearly closer together. This difference in mean between these groups

was not statistically significant by Independent T test (p- value: 0.6330). Hence the age factor cannot influence the development of pre-eclampsia.

The present study findings can be related with the subsequent three similar studies. The mean age of the normotensive group was 28.55 ± 4.91 years and the mean age of the pre-eclampsia group was 30.94 ± 6.02 years which was observed in the study conducted by Sezer et al by 2015 in Turkey[59]. The mean age of the normotensive group was 27 ± 2 years and the mean age of the pre-eclampsia group was 28 ± 2 years which was observed in the study conducted by Kurt et al by 2015 in Turkey[61]. The mean age of the normotensive group was 25.60 ± 6.36 years and the mean age of the pre-eclampsia group was 26.19 ± 7.92 years which was observed in the study conducted by Freitas et al by 2019 in Japan.[60]

The age factor didn't influence the development of pre-eclampsia in the present study. Similar finding was observed in the study conducted by Freitas et al by 2019 in Japan[60] and in the study conducted by Kurt et al by 2015 in Turkey.[61] But in contrast to our finding, the development of pre-eclampsia was influenced by age factor in the study conducted by Sezer et al by 2015 in Turkey.[59] This difference in age means between the similar studies can be clarified by different study settings and also due to the sampling technique followed in various studies.

Table 25: Comparison of Gestational Age between normotensive and Pre-eclampsia patients with similar articles

Author (Year)	Mean gestational age of Normotensive group	Mean gestational age of Pre-eclampsia group
Current study	37.17 ± 2.620	36.92 ± 3.017
Sezer et al[59] (2015)	37.04 ±1.42	37.03 ± 0.94
Kurt et al[61] (2015)	37.6 ± 1.5	37.3 ± 0.9
Freitas et al[60] (2019)	40 (39.5–40.5)	37.5 (35–39)
Sivakumar et al[67] (2007)	38.6	37.4

In the current study it was observed that the mean gestational age of the normotensive group was 37.17 ± 2.620 weeks with the range of 31-41 weeks and the mean gestational age of the pre-eclampsia group was 36.92 ± 3.017 weeks with the range of 28-41 weeks. The mean gestational age of both Normotensive and Pre-eclampsia group was observed to be nearly closer together. This difference in mean between these groups was not statistically significant by Independent T test (p- value: 0.6657). Hence the gestational age factor didn't influence the development of pre-eclampsia.

The present study findings can be linked with the succeeding three similar studies. The mean gestational age of the normotensive group was 31.04 ± 1.42 weeks and the mean gestational age of the pre-eclampsia group was 37.03 ± 0.94 weeks which was observed in the study conducted by Sezer et al by 2015 in Turkey[59]. The mean gestational age of the normotensive group was 37.6 ± 1.5 weeks and the mean gestational age of the pre-eclampsia group was 37.3 ± 0.9 weeks which was observed in the study conducted by Kurt et al by 2015 in

Turkey[61]. The mean gestational age of the normotensive group was 40 weeks with the range of 39.5to 40.5 weeks and the mean gestational age of the pre-eclampsia group was 37 weeks with the range of 35 to 39 weeks which was observed in the study conducted by Freitas et al by 2019 in Japan.[60]

The gestational age factor didn't influence the development of pre-eclampsia in the present study. Similar finding was observed in the study conducted by Kurt et al by 2015 in Turkey.[61] But in contrast to our finding, the development of pre-eclampsia was influenced by gestational age factor in the study conducted by Freitas et al by 2019 in Japan[60] and in the study conducted by Sezer et al by 2015 in Turkey.[59] Similar find was also observed in study conducted by Sivakumar et al[67] by 2007 in Pondicherry. This difference in gestational age means between the similar studies can be elucidated by different study settings and also due to the sampling technique followed in various studies based on the age of pregnant mother.

Table 26: Comparison of Mode of delivery between normotensive and Pre-eclampsia patients with similar articles

Author (Year)	**Normotensive group**		**Pre-eclampsia group**	
	NVD (%)	**LSCS (%)**	**NVD (%)**	**LSCS (%)**
Current study	64.6	35.4	52.1	47.9
Freitas et al[60] (2019)	21.1	78.9	12.5	87.5
Sezer et al[59] (2015)	45.9	54.1	16.7	83.3

It was observed in the contemporary study that among the normotensive group, 64.6% of the samples delivered by Normal Vaginal delivery and only 35.4% of the samples delivered by

Lower segment Caesarean section. Among the pre-eclampsia group, 52.1% of the samples delivered by Normal Vaginal delivery and only 47.9% of the samples delivered by Lower segment Caesarean section. In contrast to our finding the study conducted by Freitas et al by 2019 in Japan[60] observed that 21.1% of the samples delivered by Normal Vaginal delivery and only 78.9% of the samples delivered by Lower segment Caesarean section. Among the pre-eclampsia group, 12.5% of the samples delivered by Normal Vaginal delivery and only 87.5% of the samples delivered by Lower segment Caesarean section.

Also in the study conducted by Sezer et al by 2015 in Turkey[59] observed that 45.9% of the samples delivered by Normal Vaginal delivery and only 54.1% of the samples delivered by Lower segment Caesarean section. Among the pre-eclampsia group, 16.7% of the samples delivered by Normal Vaginal delivery and only 83.3% of the samples delivered by Lower segment Caesarean section.

The proportion of Normal Vaginal delivery is higher than that of LSCS in both normotensive and pre-eclampsia group. This difference in proportion between the groups was not statistically significant by Chi-square test (p-value: 0.214). Hence the development of pre-eclampsia did not influence the mode of delivery. Similar finding was observed in the study conducted by Freitas et al by 2019 in Japan.[60]

Table 27: Comparison of Number of gravidas between normotensive and Pre-eclampsia patients with similar articles

Author (Year)	Normotensive group		Pre-eclampsia group	
	First Pregnancy	Second pregnancy and above	First Pregnancy	Second pregnancy and above
Current study	47.9	52.1	47.9	52.1
Freitas et al[60] (2019)	21.05	78.95	50	50
Sezer et al[59] (2015)	25.5	74.6	40.2	59.8
Mtali et al[1] (2019)	47.2	52.8	52.8	47.2

In the current study, the proportion of primigravida was 47.9% and the proportion of others gravida was 52.1% in normotensive group. Likewise, the proportion of primigravida was 47.9% and the proportion of others gravida was 52.1% in pre-eclampsia group. This study can be compared with study conducted by Mtali et al in 2019 at Tanzania[1] in which the proportion of primigravida was 47.2% and the proportion of others gravida was 52.8% in normotensive group. Likewise, the proportion of primigravida was 52.8% and the proportion of others gravida was 47.2% in pre-eclampsia group.

In contrast to our study the proportion of primigravida was only 21.05% and 25.5% among the normotensive group in the study conducted by Freitas et al by 2019 in Japan[60] and Sezer et al by 2015 in Turkey[59] respectively.

In the contemporary study, the proportion of primi gravida is better than that of other gravidas in both normotensive and pre-eclampsia group. This difference in proportion between these groups was not statistically significant by Chi-square test (p-value: 0.573). Hence the number of gravidae did not influence the development of pre-eclampsia. This

study can be compared with the study done by conducted by Freitas et al by 2019 in Japan[60], Mtali et al in 2019 at Tanzania[1], Kurt et al by 2015 in Turkey.[61]

Comparison of Erythrocyte indices between Normotensive and Pre-eclampsia group

Haemoglobin level

In the current study, the mean Hb level of Normotensive group was 10.490 and the mean age of Pre-eclampsia group was 10.873. The difference between the two mean was 0.383 and this difference was statistically not significant (p-value: 0.316) by Independent T test. Hence, the development of pre-eclampsia did not influence the level of haemoglobin among pregnant women after 20 weeks of gravidity. This finding was supported in various studies such as the study conducted by Sezer et al by 2015 in Turkey[59], Kurt et al by 2015 in Turkey[61], Freitas et al by 2019 in Japan[60], Sivakumar et al[67] by 2007 in Pondicherry, Yilmaz et al in Turkey by 2016[25] and not supported in the study conducted by Mtali et al in 2019 at Tanzania[1].

Red Blood Cell Count level

In the current study, the mean RBC count of Normotensive group was 4.027 and the mean RBC count of Pre-eclampsia group was 4.117. The difference between the two mean was 0.09 and such difference was statistically not significant (p-value: 0.539) by Independent T test. Hence, the development of pre-eclampsia didn't influence the RBC count among pregnant women after 20 weeks of gravidity. This finding was supported in various studies such as the study conducted by Sezer et al by 2015 in Turkey[59], in Pondicherry, Mtali et al in 2019 at Tanzania[1], and not supported in the study conducted by Sivakumar et al[67] by 2007.

Packed Cell Volume level

In the current study, the mean Packed Cell Volume of Normotensive group was 34.4423 and the mean Packed Cell Volume of Pre-eclampsia group was 33.1460. The difference between

the two mean was 1.2963 and such his difference was statistically not significant (p-value: 0.227) by Independent T test. Hence, the development of pre-eclampsia didn't influence Packed Cell Volume among pregnant women after twenty weeks of gravidity. This finding was supported in various studies such as the study conducted by Sezer et al by 2015 in Turkey[59], Freitas et al by 2019 in Japan[60], Sivakumar et al[67] by 2007 in Pondicherry, Yilmaz et al in Turkey by 2016[25] and not supported in the study conducted by Mtali et al in 2019 at Tanzania[1].

Mean Corpuscular Volume level

In the current study, the mean of MCV of Normotensive group was 82.837 and the mean of Mean Corpuscular Volume of Pre-eclampsia group was 80.665. The difference between the two mean was 2.172 and such difference was statistically not significant (p-value: 0.260) by Independent T test. Hence, the development of pre-eclampsia did not influence the level of Mean Corpuscular Volume among pregnant women after twenty weeks of gravidity. This finding was supported in the study conducted by Freitas et al by 2019 in Japan[60], and not supported in the study conducted by Sezer et al by 2015 in Turkey[59], Mtali et al in 2019 at Tanzania[1], Sivakumar et al[67] by 2007 in Pondicherry.

Mean Corpuscular Haemoglobin level

In the current study, the mean of MCH of Normotensive group was 28.585 and the mean of Mean Corpuscular Haemoglobin of Pre-eclampsia group was 27.735. The difference between the two mean was 0.85 and such difference was statistically not significant (p-value: 0.323) by Independent T test. Hence, the development of pre-eclampsia didn't influence the level of MCH among pregnant women after twenty weeks of gravidity. This finding was supported in various studies such as the study conducted by Sezer et al by 2015 in Turkey[59], Freitas et al

by 2019 in Japan[60], Sivakumar et al[67] by 2007 in Pondicherry and not supported in the study conducted by Mtali et al in 2019 at Tanzania[1].

Mean Corpuscular Haemoglobin Concentration level

In the current study, the mean of MCHC of Normotensive group was 33.598 and the mean of MCHC of Pre-eclampsia group was 33.917. The difference between the two mean was 0.319 and such difference was statistically not significant (p-value: 0.448) by Independent T test. Hence, the development of pre-eclampsia did not influence the level of MCHC among pregnant women after twenty weeks of gravidity. This finding was supported in various studies such as the study conducted by Freitas et al by 2019 in Japan[60], Sivakumar et al[67] by 2007 in Pondicherry and not supported in the study conducted by Sezer et al by 2015 in Turkey[59], Mtali et al in 2019 at Tanzania[1].

Red Cell distribution width level

Table 28: Comparison of RDW between normotensive and Pre-eclampsia patients with similar articles

Author (Year)	Mean RDW of Normotensive group	Mean RDW of Pre-eclampsia group
Current study	13.26 ± 1.359	17.44 ± 3.82
Sezer et al[59] (2015)	13.9 (13-15.6)	15 (13.8-16.57)
Kurt et al[61] (2015)	16.9 ± 1.7	14.1 ± 1.1
Freitas et al[60] (2019)	13.67 ±1.48	13.80 ± 2.10
Yilmaz et al[25] (2016)	14.48 ± 1.70	15.23 ± 1.96
Viana-Rojas[68] (2017)	13.4 ± 0.7	14.7 ± 1.4

In the current study, the mean of Red Cell distribution width of Pre-eclampsia group was 17.44 % and such value was greater than the mean of RDW of normotensive group (13.26 %). The difference between the two mean was 4.177 and this difference was statistically significant (p-value: 0.0001) by Independent T test. Hence, the development of pre-eclampsia increased the level of Red Cell distribution width among pregnant women after twenty weeks of gravidity.

This finding was supported in various studies such as the study conducted by Sezer et al by 2015 in Turkey[59], Kurt et al by 2015 in Turkey[61], Yilmaz et al in Turkey by 2016[25] and Mtali et al in 2019 at Tanzania[1]. In the systematic review besides meta-analysis by Ishag Adam et al in Sudan by 2019[69] comprised eleven case control studies totally 951 cases and 2024 controls. They concluded that RDW level was significantly higher in women with preeclampsia likened to controls. Based on the current study and also with similar studies thereby strengthening its contemplation for usable indicator for preeclampsia/ eclampsia in clinical case management.

The RDW is an easily obtainable cheaper hematologic parameter exhibiting a disparity in erythrocyte volume (anisocytosis). It is a constituent of the full blood picture which is a regular investigation demanded by clinicians. RDW is considered as a beneficial marker of systemic inflammatory response besides variations in the levels of haematological parameters. Besides, current literature has revealed these potential markers to be of prognostic as well as clinical predictive parameters in various benign and malignant diseases including coronary artery disease, inflammatory diseases, preeclampsia and gynaecological or gastro- intestinal malignancies.

Even though the precise mechanism behind the elevated level of RDW is not yet fully unstated, high-RDW levels may be a replication of augmented inflammation or defective

erythropoiesis or haemolysis. Inflammatory cytokines could damage iron metabolism that curtail red blood cells lifespan with amplified Red Cell distribution width as outcome. C-reactive protein and ESR was also connected with RDW.

Besides inflammation, oxidative stress as well as oxidative damage might also influence to anisocytosis and raised RDW. The inflammatory course, oxidative strain besides hypoxia with red blood cell destruction can justify the raised level of RDW in preeclampsia.

CONCLUSION

CONCLUSION

A case control study has been performed among singleton 48 normotensive and 48 hypertensive pregnant women after twenty weeks of gravidity. The development of pre-eclampsia was not determined by age, parity, mode of delivery and gestational age. On comparing the mean values of erythrocyte indices between the normotensive group and preeclampsia group only RDW was found to be significantly raised in pre-eclampsia and other parameters like Hb, PCV, MCV, MCV and MCHC were observed to be not statistically significant. Based on the current study the mean of Red Cell distribution width of Pre-eclampsia group was 17.44 % and this level was higher than the mean of RDW of normotensive group (13.26 %). The difference between the two mean was 4.177 and this difference was statistically significant (p-value: 0.0001) by Independent T test. Hence, the development of pre-eclampsia causes increase in the levels of RDW among pregnant women after twenty weeks of gravidity. Hence this finding strengthens contemplation role as clinical indicator in patient management. This study considered the RDW as a new chronic inflammatory marker and can be used for prediction of pre eclampsia and help in improving the fetal and maternal outcome.

.

SUMMARY

SUMMARY

Hypertensive disorders affect up to10% of all pregnancies globally. These multi-system illnesses are made from of gestational hypertension (GH), preeclampsia(PE) and eclampsia (E).[1] Pre-eclampsia is defined as a systemic syndrome characterised by new-onset of hypertension (blood pressure –systolic >140mm Hg, diastolic >90mm Hg on two occasions at least 4hours apart, or in severe cases systolic blood pressure>160mm Hg or diastolic pressure >110mm Hg) and proteinuria (protein [mg]/creatinine [mg] ratio of>0.3 or protein >5 g in a 24 h urine sample, or >3 g after twenty weeks of gestation in pregnant women, which resolves within 6th week in two samples obtained 6 hours apart from a patient on bed rest)postpartum.[2] Preeclampsia is characterised by hypertension and any signs of end organ damage in the absence of proteinuria. [2] Preeclampsia-eclampsia is the second most common , direct cause of maternal mortality next to haemorrhage .[3] The main aim of the obstetrician is to control blood pressure and to prevent maternal and neonatal complications due to preeclampsia .A total of 96 subjects were included in the study.Group A() were 48 participants and Group B ()were 48 participants. In the current study it was observed that the mean age of the normotensive group was 25.15 ± 4.758 years with the range of 18-37 years .Mean age of the pre-eclampsia group was 24.65 ± 5.444 years with the range of 18-37 years. Mean age of both non pre eclamptic and pre-eclampsia group is nearly closer together. The age factor didn't influence the pre-eclampsia development in our study. The mean gestational age of the normotensive group was 37.17 ± 2.620 weeks with the range of 31-41weeks and the mean gestational age of the pre-eclampsia group was 36.92 ± 3.017 weeks with the range of 28-41 weeks.Among the group B, 64.6% of the samples delivered by Normal Vaginal delivery and only 35.4% of the samples delivered by Lower segment Caesarean section. Among the preeclampsia group, 52.1% of the samples delivered by Normal Vaginal delivery

and only 47.9% of the samples delivered by Lower segment Caesarean section. Hence the mode of delivery cannot be influenced by pre-eclampsia.All the erythrocyte indices such as Red blood cells number (RBC), haematocrit (HTC) and hemoglobin concentration (Hb) values indicate the erythroid mass, the reduction of which results in anemia.[42](RDW) red cell distribution width were documented and analysed .Red Cell distribution width mean of Pre-eclampsia group was 17.44 % and this level was higher than the mean ofRed Cell distribution width of normotensive group (13.26 %). The difference of two mean was 4.177 and this was significant statistically (p-value: 0.0001) by Independent T test. Hence, the development of pre-eclampsia increased the level of Red Cell distribution width among pregnant women.

RECOMMENDATIONS

Red cell width distribution can be used as simple, applied, non- invasive and inexpensive parameter for prediction of preeclampsia

Need for longitudinal studies on Red cell width distribution in early pregnancy with close follow up of nutritional status of participants by measuring iron, folate and vitamin B_{12} levels. But large cohort studies are needed to understand the cause of increasing levels of Red cell width distribution in patients with preeclampsia.

LIMITATIONS

1. RDW was not investigated for the prognosis and severity of the disease with in patients with preeclampsia
2. RDW may be increased in many clinical events causing ineffective erythro- poiesis, such as haemolysis, transfusion, and deficiency of iron, vitamin B12, or folate.
3. This study was conducted after the occurrence of the disease itself (preeclampsia) making it to difficult to define the cause-effect process.
4. This study should need larger sample size, thus determine whether RDW was independent risk factor in forecasting the occurrence of Preeclampsia
5. The cut off of RDW was not determined
6. No information on drug usage by study participants noted.
7. The sample was drawn from patients attending Hospital, the results cannot properly be generalized to the national population

BIBLIOGRAPHY

REFERENCES

1. Mtali YS, Lyimo MA, Luzzatto L, Massawe SN. Hypertensive disorders of pregnancy are associated with an inflammatory state: Evidence from hematological findings and cytokine levels. BMC Pregnancy Childbirth. 2019;19(1):1–9.
2. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. Vol. 122, Obstetrics and gynecology. Obstet Gynecol; 2013 Nov.
3. Khan K, Wojdyla D, Say L, Gülmezoglu A, Van Look P. WHO analysis of causes of maternal death: a systematic review. Lancet (London, England). 2006 Apr 1;367(9516):1066–74.
4. Smith GC, Pell JP, Walsh D. Pregnancy complications and maternal risk of ischaemic heart disease: a retrospective cohort study of 129,290 births. Lancet (London, England). 2001 Jun;357(9273):2002–6.
5. Bellamy L, Casas J-P, Hingorani AD, Williams DJ. Pre-eclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis. BMJ. 2007 Nov;335(7627):974.
6. Irgens HU, Reisaeter L, Irgens LM, Lie RT. Long term mortality of mothers and fathers after pre-eclampsia: population based cohort study. BMJ. 2001 Nov;323(7323):1213–7.
7. Odegård RA, Vatten LJ, Nilsen ST, Salvesen KA, Austgulen R. Preeclampsia and fetal growth. Obstet Gynecol. 2000 Dec;96(6):950–5.
8. Backes C, Markham K, Moorehead P, Cordero L, Nankervis C, Giannone P. Maternal preeclampsia and neonatal outcomes. J Pregnancy. 2011;2011:214365.
9. Ryckman KK, Borowski KS, Parikh NI, Saftlas AF. Pregnancy Complications and the

Risk of Metabolic Syndrome for the Offspring. Curr Cardiovasc Risk Rep. 2013 Jun;7(3):217–23.

10. Stojanovska V, Scherjon SA, Plösch T. Preeclampsia As Modulator of Offspring Health. Biol Reprod. 2016 Mar;94(3):53.
11. Kajantie E, Eriksson JG, Osmond C, Thornburg K, Barker DJP. Pre-eclampsia is associated with increased risk of stroke in the adult offspring: the Helsinki birth cohort study. Stroke. 2009 Apr;40(4):1176–80.
12. Montgomery AL, Ram U, Kumar R, Jha P. Maternal mortality in India: causes and healthcare service use based on a nationally representative survey. PLoS One. 2014;9(1):e83331.
13. Duley L. The global impact of pre-eclampsia and eclampsia. Semin Perinatol. 2009 Jun;33(3):130–7.
14. Agrawal S, Walia GK, Staines-Urias E, Casas JP, Millett C. Prevalence of and risk factors for eclampsia in pregnant women in India. Fam Med Community Heal. 2017;5(4):225–44.
15. Agrawal S. Prevalence and Risk Factors for Symptoms Suggestive of Pre-Eclampsia in Indian Women. J Women's Heal Issues Care. 2014;03(06).
16. Malik A, Jee B, Gupta SK. Preeclampsia: Disease biology and burden, its management strategies with reference to India. Pregnancy Hypertens. 2019;15(October 2018):23–31.
17. Patil S, Patil K. Analysis of risk factors of late preterm birth: A case-control study. Indian J Heal Sci Biomed Res. 2017;10(3):283.
18. Pijnenborg R, Bland JM, Robertson WB, Brosens I. Uteroplacental arterial changes related to interstitial trophoblast migration in early human pregnancy. Placenta. 1983;4(4):397–413.

19. Saito S, Shiozaki A, Nakashima A, Sakai M, Sasaki Y. The role of the immune system in preeclampsia. Mol Aspects Med. 2007 Apr;28(2):192–209.

20. Bessman JD, Gilmer PRJ, Gardner FH. Improved classification of anemias by MCV and RDW. Am J Clin Pathol. 1983 Sep;80(3):322–6.

21. Sultana GS, Haque SA, Sultana T, Rahman Q, Ahmed ANN. Role of red cell distribution width (RDW) in the detection of iron deficiency anaemia in pregnancy within the first 20 weeks of gestation. Bangladesh Med Res Counc Bull. 2011 Dec;37(3):102–5.

22. Tanindi A, Topal FE, Topal F, Celik B. Red cell distribution width in patients with prehypertension and hypertension. Blood Press. 2012 Jun;21(3):177–81.

23. Montagnana M, Cervellin G, Meschi T, Lippi G. The role of red blood cell distribution width in cardiovascular and thrombotic disorders. Clin Chem Lab Med. 2011 Dec;50(4):635–41.

24. Liu D-S, Jin Y, Ma S-G, Bai F, Xu W. The ratio of red cell distribution width to mean corpuscular volume in patients with diabetic ketoacidosis. Clin Lab. 2013;59(9–10):1099–104.

25. Yılmaz ZV, Yılmaz E, Küçüközkan T. Red blood cell distribution width: A simple parameter in preeclampsia. Pregnancy Hypertens. 2016;6(4):285–7.

26. Fox R, Kitt J, Leeson P, Aye CYL, Lewandowski AJ. Preeclampsia: Risk Factors, Diagnosis, Management, and the Cardiovascular Impact on the Offspring. J Clin Med. 2019 Oct 1;8(10).

27. Jim B, Sharma S, Kebede T, Acharya A. Hypertension in pregnancy: A comprehensive update. Cardiol Rev. 2010;18(4):178–89.

28. Mayrink J, Costa ML, Cecatti JG. Preeclampsia in 2018: Revisiting Concepts, Physiopathology, and Prediction. Sci World J. 2018;2018.

29. Burton GJ, Redman CW, Roberts JM, Moffett A. Pre-eclampsia: pathophysiology and clinical implications. BMJ. 2019;366:1–15.

30. Abalos E, Cuesta C, Carroli G, Qureshi Z, Widmer M, Vogel JP, et al. Pre-eclampsia, eclampsia and adverse maternal and perinatal outcomes: a secondary analysis of the World Health Organization Multicountry Survey on Maternal and Newborn Health. BJOG. 2014 Mar;121 Suppl:14–24.

31. Duckitt K, Harrington D. Risk factors for pre-eclampsia at antenatal booking: systematic review of controlled studies. BMJ. 2005 Mar;330(7491):565.

32. Bartsch E, Medcalf KE, Park AL, Ray JG. Clinical risk factors for pre-eclampsia determined in early pregnancy: systematic review and meta-analysis of large cohort studies. BMJ. 2016 Apr;353:i1753.

33. Salvagno GL, Sanchis-Gomar F, Picanza A, Lippi G. Red blood cell distribution width: A simple parameter with multiple clinical applications. Crit Rev Clin Lab Sci. 2015;52(2):86–105.

34. Sarma PR. Red Cell Indices. Clin Methods Hist Phys Lab Exam. 1990;

35. Shen C, Jiang Y-M, Shi H, Liu J-H, Zhou W-J, Dai Q-K, et al. A prospective, sequential and longitudinal study of haematological profile during normal pregnancy in Chinese women. J Obstet Gynaecol (Lahore). 2010;30(4):357–61.

36. Klebanoff M, Shiono P, Selby J, Trachtenberg A, Graubard B. Anemia and spontaneous preterm birth. Am J Obstet Gynecol. 1991;164(1 Pt 1):59–63.

37. Allen LH. Anemia and Iron Deficiency: Effects on Pregnancy Outcome, Available: hp. 2000.

38. Cabaniss CD, Cabaniss ML. Hematologic Problems in Pregnancy. 1987;

39. Kelton JG, Cruickshank M. Medical Complications During Pregnancy. 1988;

40. Lund CJ, Donovan JC. Blood volume during pregnancy: significance of plasma and

red cell volumes. Am J Obstet Gynecol. 1967;98(3):393–403.

41. Taylor DJ, Lind T. Red cell mass during and after normal pregnancy. BJOG An Int J Obstet Gynaecol. 1979;86(5):364–70.

42. Bresani C, Souza A, Batista-Filho M. Erythrocyte indices in the second trimester of pregnancy: Are reference values well established? Rev Bras Hematol Hemoter. 2009 Feb 1;31.

43. Yip R. Significance of an abnormally low or high hemoglobin concentration during pregnancy: special consideration of iron nutrition. Am J Clin Nutr. 2000 Jul;72(1 Suppl):272S-279S.

44. Milman N, Byg KE, Agger AO. Hemoglobin and erythrocyte indices during normal pregnancy and postpartum in 206 women with and without iron supplementation. Acta Obstet Gynecol Scand. 2000;79(2):89–98.

45. van Buul EJ, Steegers EA, Jongsma HW, Eskes TK, Thomas CM, Hein PR. Haematological and biochemical profile of uncomplicated pregnancy in nulliparous women; a longitudinal study. Neth J Med. 1995 Feb;46(2):73–85.

46. Tam KF, Lao TT. Hemoglobin and red cell indices correlated with serum ferritin concentration in late pregnancy. Obstet Gynecol. 1999 Mar;93(3):427–31.

47. Catarino C, Rebelo I, Belo L, Rocha-Pereira P, Rocha S, Bayer Castro E, et al. Erythrocyte changes in preeclampsia: Relationship between maternal and cord blood erythrocyte damage. J Perinat Med. 2009;37(1):19–27.

48. Sowers JR, Zemel MB, Bronsteen RA, Zemel PC, Walsh MF, Standley PR, et al. Erythrocyte cation metabolism in preeclampsia. Am J Obstet Gynecol. 1989 Aug;161(2):441–5.

49. Bolton LM, Thomas TH, Macphail S, Taylor A, Davison JM, Dunlop W. Alterations in erythrocyte chloride content accompanying the changes in erythrocyte hydration

and potassium content in normal human pregnancy: a comparison with pregnancy induced hypertension. BJOG An Int J Obstet Gynaecol. 1993;100(7):679–83.

50. Lurie S, Mamet Y. Red blood cell survival and kinetics during pregnancy. Eur J Obstet Gynecol Reprod Biol. 2000;93(2):185–92.

51. Cunningham FG, Lowe T, Guss S, Mason R. Erythrocyte morphology in women with severe preeclampsia and eclampsia. Preliminary observations with scanning electron microscopy. Am J Obstet Gynecol. 1985 Oct;153(4):358–63.

52. Ordovas JM, Pocovi M, Grande F. Plasma lipids and cholesterol esterification rate during pregnancy. Obstet Gynecol. 1984 Jan;63(1):20–5.

53. Lurie S. Density distribution of erythrocyte population in preeclampsia. Gynecol Obstet Invest. 1992;33(2):94–7.

54. Lurie S. Comparison of age distribution of umbilical cord erythrocytes in preeclampsia versus uncomplicated pregnancy. Obstet Gynecol. 1996;88(2):180–3.

55. Berge LN, Astensen M, Revhaug A. Phagocytic cell activity in pre eclampsia. Acta Obstet Gynecol Scand. 1988;67(6):499–504.

56. Kaibara M, Mitsuhashi Y, Watanabe T, Tamiaki F, Nishihira M, Sadatsuki M, et al. Effects of red blood cells on the coagulation of blood in normal and preeclamptic pregnancies. Am J Obstet Gynecol. 1999;180(2):402–5.

57. Lurie S, Glezerman M. Erythrocyte life span, preeclampsia, and hypercoagulability. Am J Obstet Gynecol. 1999;181(5):1276.

58. Hernández Hernández JD, Villaseñor OR, Del Rio Alvarado J, Lucach RO, Zárate A, Saucedo R, et al. Morphological Changes of Red Blood Cells in Peripheral Blood Smear of Patients with Pregnancy-related Hypertensive Disorders. Arch Med Res. 2015;46(6):479–83.

59. Avcıoğlu SN, Demircan Sezer S, Altınkaya SÖ, Küçük M, Kurt Ömürlü İ, Yüksel H.

Erythrocyte Indices in Patients with Preeclampsia. Meandros Med Dent J. 2015;16(2):35–42.

60. Rodrigues de Freitas MA, da Costa AV, Medeiros LA, Cunha LM, Filho UC, da Silva Garrote Filho M, et al. The role of the erythrocyte in the outcome of pregnancy with preeclampsia. PLoS One. 2019;14(3):1–17.

61. Kurt RK, Aras Z, Silfeler DB, Kunt C, Islimye M, Kosar O. Relationship of red cell distribution width with the presence and severity of preeclampsia. Clin Appl Thromb. 2015;21(2):128–31.

62. Sen-yu W, Chao X. Assessment of the relationship between red blood cell distribution width and preganecy hypertension disease. J Obstet Gynaecol Res.2016;42(10):1258–62.

63. Akinbami AA, Ajibola SO, Rabiu KA, Adewunmi AA, Dosunmu AO, Adediran A, et al. Hematological profile of normal pregnant women in Lagos, Nigeria. Int J Womens Health. 2013 May 2;5(1):227.

64. Elgari MM, Khabour OF, Alhag SM. Correlations between changes in hematological indices of mothers with preeclampsia and umbilical cord blood of newborns. Clin Exp Hypertens. 2019;41(1):58–61.

65. Adam I, Mutabingwa TK, Malik EM. Red cell distribution width and preeclampsia: a systematic review and meta-analysis. Clin Hypertens. 2019 Jul 15;25:15.

66. Basak SK, Begum K, Rashid M, Yasmin N, Begum H. Haematocrit value in preeclampsia. Bangladesh J Obstet Gynecol. 2015;30(2):80–5.

67. Sivakumar S, Vishnu Bhat B, Badhe BA. Effect of pregnancy induced hypertension on mothers and their babies. Indian J Pediatr. 2007;74(7):623–5.

68. Viana-Rojas JA, Rosas-Cabral A, Prieto-Macías J, Terrones-Saldívar MC, Arcos-Noguez P, Bermúdez-Gómez J, et al. [Relation of red cell distribution width and mean

platelet volume with the severity of preeclampsia]. Rev Med Inst Mex Seguro Soc. 2017;55(2):176–81.

69. Adam I, Mutabingwa TK, Malik EM. Red cell distribution width and preeclampsia: a systematic review and meta-analysis. Clin Hypertens. 2019 Dec;25(1).

ANNEXURE

ANNEXURE -1

PROFORMA

"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"

NAME: GENDER:

AGE: OCCUPATION:

ADDRESS: RELIGION:

UHID NO: I.P NO:

DATE &TIME OF ADMISSION: DATE OF DISCHARGE:

CHIEF COMPLAINTS:

HISTORY OF PRESENT PREGNANCY:

OBSTETRICAL HISTORY: Obstetrical score

GRAVIDA	PARA	LIVING	ABORTION

Married life: Consanguineous: marriage

YES	NO

Booked at RLJH	Booked case outside	Un booked case

MENSTRUAL HISTORY: PMC
LMP: / /

EDD: / /

C - EDD:

POG: Weeks days

	PRESENT	ABSENT
Regular		
Irregular		
Clots		
Dysmenorrhea		

PAST HISTORY:

Any h/o diabetes mellitus

Any h/o Hypertension

Any h/o Epilepsy

Any h/o bronchial asthma

Any h/o thyroid disorders

Any h/o cardiac disorder

Any h/o previous surgeries

Any h/o drug allergies

FAMILY HISTORY:

PERSONAL HISTORY

Diet:

Appetite:

Smoking:

Alcohol:

Bowel and bladder habits:

GENERAL PHYSICAL EXAMINATION

	Pallor	Icterus	Cyanosis	Clubbing	Lymphadenopathy	Edema
Present						
Absent						

Pulse bpm Blood pressure: mmHg

R/R: cpm Temp**:**

CVS: RS:

Breast:

Spine:

Thyroid:

P/A:

Uterus Corresponds to gestational age: Lie or presentation:

Contractions: FHR: bpm

INVESTIGATIONS: CBC (/ /):

BLOOD GROUP:

BLEEDING TIME:

CLOTTING TIME:

Hb	RBC	PCV	MCV	MCH	MCHC	RDW

WBC	NEUTROPHILS	LYMPHOCYTES	EOSINOPHILS	MONOCYTES	BASOPHILS

URINE ALBUMIN: RBS:

HIV: HBsAg:

VDRL:

MODE OF DELIVERY:

CONDITION OF THE PATIENT ON DISCHARGE: Satisfactory / Unsatisfactory

ANNEXURE -2

PATIENT CONSENT FORM

"COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I have understood that I have the right to refuse consent or withdraw it at any time during the study and this will not affect my treatment in any way. I consent voluntarily to participate in this study

Name of Participant_____

Signature/ thumb print of Participant _____

Date _____

Statement by the researcher/person taking consent:

I have accurately read out the information sheet to the potential participant and to the best of my ability made sure that the participant understands that the following will be done: 2 ml venous blood sample taken for measurement of **erythrocyte indices in complete blood count**

I confirm that the participant was given an opportunity to ask questions about the study and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily. Name of Researcher/person taking the consent: Dr. Karunaa.S

Signature of Researcher /person taking the consent_____

Date _____

Name and Address of Principal Investigator:
Dr.Karunaa.S

R.L Jalappa Hospital Tamaka,
Kolar.

ANNEXURE 3

PATIENT INFORMATION SHEET

STUDY TITLE: "**COMPARISON OF ERYTHROCYTE INDICES IN PRE ECLAMPSIA AND NORMOTENSIVE PREGNANCY IN A TERTIARY CARE CENTRE –A CASE CONTROL STUDY"**

PLACE OF STUDY: SRI DEVARAJ URS MEDICAL COLLEAGE ATTACHED TO R.L.JALAPPA HOSPITAL AND RESEARCH, TAMAKA, KOLAR

This study was be approved by insititutional ethical committee.The information collected will be used only for poster presentation and publication.There is no compulsion to agree to participate. You are requested to sign/provide the thumb impression only if you voluntarily agree to participate in the study.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revelaed. You will not rececive any monetary benefits to participate in this study.

This informed consent document is intended to give you a general background of study. Please read the following information carefully and discuss with your family members .You can ask your queries related to study at any time during the study.

If you are willing to participate in the study you will be asked to sign an informed consent form by which you are acknowledging that you wish to participate in the study and entire procedure will be explained to you by the study doctor. You are free to withdraw your consent to participate in the study any time without explantation and this will not change your future care.

For any clarification you are free to contact the investigator

PRINCIPAL INVIGILATOR: DR KARUNAA.S

CONTACT: 9655046162

EMAIL ID: karunaasenz@gmail.com

ANNEXURE-4

KEY TO MASTER CHART

A – AGE

B –GESTATIONAL AGE

C –GRAVIDA

D –MODE OF DELIVERY

E –HB COUNT

F –RBC COUNT

G –PCV

H – MCV

I –MCH

J - MCHC

K – RDW

L – ASSOCIATED MATERNAL CONDITIONS

A-AGE

1. 18-20
2. 21-25
3. 26-30
4. 31-35
5. 36-40

B-GESTATIONAL AGE

1. 21weeks- 29 weeks+6 days
2. 30weeks-32weeks +6days
3. 33weeks-35weeks +6 days

4. 36weeks-36weeks+ 6 days
5. 37weeks-39weeks+6days
6. >40weeks

C- GRAVIDA

1. PRIMI
2. GRAVIDA-2
3. GRAVIDA-3
4. GRAVIDA-4
5. GRAVIDA-5

D- MODE OF DELIVERY

1. VAGINAL
2. LSCS

E- HAEMOGLOBLIN

1. <7g/dl
2. 7-8.9g/dl
3. 9-10.9g/dl
4. >11g/dl

F- RBC

1. <3.8mil/mm^3
2. 3.8-4.8mil/mm^3
3. >4.8mil/mm^3

G-PCV

1. <36%
2. 36-46%
3. >46%

H- MCV

1. <83fl

2. 83-101fl
3. >101fl

I-MCH

1. <27pg
2. 27-32pg
3. >32pg

J- MCHC

1. <31%
2. 31-34%
3. >34%

K-RDW

1. <11.6%
2. 11.6-14%
3. >14%

L-ASSOCIATED MATERNAL CONDITIONS

1. NONE
2. OLIHYDRAMNIOS
3. ABRUPTIO PLACENTA
4. PLACENTA PREVIA
5. RH NEGATIVE PREGNANCY
6. HYPOTHYROIDISM
7. BREECH
8. OBSTRUCTED LABOR
9. PROM
10. GDM
11. ANTEPARTUM ECLAMPSIA
12. IMMINENT ECLAMPSIA

MASTER CHART

Master chart 1 -Normotensive (group A- controls)

SR NO	UHID NO	A	B	C	D	E	F	G	H	I	J	K	L
1	760101	4	5	2	2	4	3	2	1	1	2	2	1
2	857206	2	5	2	1	3	2	1	1	2	3	2	1
3	796579	1	6	1	2	4	1	1	2	2	3	3	1
4	823240	3	5	1	2	3	2	1	1	1	2	3	1
5	823236	3	6	1	2	4	2	1	1	2	3	3	8
6	856077	4	4	2	2	4	1	1	1	2	3	2	9
7	823537	4	5	3	1	3	3	1	1	1	1	3	2
8	814840	1	6	1	2	4	3	1	1	1	2	3	1
9	822796	1	5	2	1	4	3	2	2	2	3	2	1
10	821373	2	2	2	1	2	2	1	1	1	2	2	1
11	831598	3	6	1	1	2	1	1	3	3	3	3	1
12	831901	3	6	3	1	3	2	1	1	1	2	2	1
13	814685	2	3	2	1	3	1	1	1	1	2	2	9
14	831906	1	5	1	1	2	2	1	1	1	1	2	1
15	813247	3	5	2	2	3	3	1	1	1	2	2	6
16	823759	1	5	2	2	4	2	1	1	1	2	2	1
17	734252	2	5	3	1	4	2	1	2	2	3	2	1
18	810614	2	5	1	2	4	3	2	1	2	3	2	1
19	829789	3	4	3	2	4	2	2	2	3	3	2	1
20	813233	1	3	1	2	4	2	3	2	2	3	3	1
21	810378	3	3	1	2	4	2	2	2	2	2	2	1
22	800792	3	3	1	1	3	1	1	2	2	3	1	9
23	817302	3	4	1	2	4	2	1	1	2	3	2	1
24	828574	3	2	1	1	4	2	1	2	2	3	2	6
25	815833	3	4	3	2	4	1	1	2	3	3	2	1
26	838084	2	5	1	1	4	2	1	2	2	3	2	1
27	809998	1	4	1	1	2	2	1	2	2	2	2	9
28	901004	2	5	1	1	3	2	2	3	3	2	2	5
29	899017	2	4	2	1	1	1	1	2	2	1	1	1
30	796969	3	4	2	1	3	2	1	2	2	3	2	1
31	788359	2	5	1	1	3	2	1	1	2	2	3	5
32	899607	1	2	1	1	1	1	1	2	2	3	2	9
33	897097	3	3	4	2	3	2	1	2	1	1	2	4
34	900664	1	5	1	1	2	1	1	1	2	3	2	1
35	901618	2	5	1	1	4	3	2	2	3	2	2	9
36	832393	2	4	2	1	3	1	1	2	1	2	2	1

SR NO	UHID NO	A	B	C	D	E	F	G	H	I	J	K	L
37	874925	4	3	2	1	2	1	1	2	2	2	2	9
38	889524	2	3	2	1	3	2	2	1	2	2	2	1
39	899023	3	6	2	1	3	2	2	2	2	1	2	1
40	902562	2	6	2	1	3	1	1	2	1	2	2	1
41	902614	2	4	1	1	2	1	2	2	1	2	2	9
42	902610	3	6	2	1	3	2	1	1	2	3	2	1
43	900037	2	5	1	1	3	1	1	2	2	3	2	1
44	899017	2	5	2	1	2	1	1	2	2	1	1	1
45	949011	5	2	1	1	4	2	2	2	2	2	2	1
46	949367	2	5	1	1	3	1	1	2	2	3	3	1
47	949340	2	5	2	2	3	2	1	1	1	2	2	1
48	948871	4	5	3	2	4	2	1	1	2	2	2	1

Master chart 2- Hypertensive (group B- cases)

SL NO HY	IP NO	A	B	C	D	E	F	G	H	I	J	K	L
1	678521	3	5	3	1	3	1	1	2	2	2	3	3
2	702492	5	1	5	1	4	3	1	1	1	2	3	7
3	807861	2	2	2	2	4	3	2	1	1	3	3	1
4	698287	2	5	1	1	2	2	1	1	1	1	3	1
5	835080	1	5	1	1	4	2	1	1	2	3	3	10
6	798647	3	2	2	2	4	2	3	2	2	2	3	1
7	671881	2	5	3	2	4	3	2	1	1	2	3	7
8	832338	2	5	4	2	4	2	2	2	2	2	3	1
9	698121	1	5	1	1	4	3	1	1	1	2	3	1
10	752336	1	5	1	1	2	1	1	3	3	3	3	1
11	775289	1	5	1	2	2	1	1	2	3	3	3	5
12	832769	2	6	1	2	4	3	2	1	1	3	3	1
13	830038	3	4	1	1	4	1	1	2	2	3	2	10
14	831587	3	6	3	2	4	3	2	2	2	2	3	1
15	832468	2	4	1	1	4	3	2	1	1	3	3	1
16	848812	2	5	1	2	4	2	1	1	2	3	3	1
17	833824	3	5	1	1	4	2	2	2	3	3	2	9
18	825038	3	4	5	1	4	2	1	2	2	3	3	1
19	830822	2	4	2	1	3	1	1	2	3	3	3	3
20	760242	2	6	1	1	3	1	1	2	2	2	3	1
21	845251	4	2	2	1	4	2	2	1	2	2	3	10
22	849381	3	6	3	1	4	2	1	1	1	3	3	1
23	849045	2	3	1	1	4	3	2	1	1	1	3	1
24	849107	1	6	2	2	4	2	1	1	1	3	3	1
25	848152	2	6	1	2	3	2	1	1	1	2	3	9
26	880035	2	5	2	1	1	1	1	1	1	3	3	1
27	885326	2	3	3	1	3	3	1	1	1	1	3	11
28	877008	4	4	2	1	3	1	1	1	1	1	3	12
29	876290	4	3	4	1	3	2	2	2	3	3	3	1
30	885252	2	4	2	2	3	1	1	2	2	3	1	7
31	885251	2	5	2	2	4	2	1	2	2	3	3	12
32	884111	2	2	1	1	3	3	1	1	1	1	1	1
33	886010	1	5	2	2	3	1	1	1	2	3	3	1
34	879893	2	4	2	1	4	2	1	1	2	3	3	11
35	882280	3	5	3	2	3	2	1	1	1	2	3	6
36	881263	1	5	1	2	4	2	1	1	1	3	3	12

SL NO HY	IP NO	A	B	C	D	E	F	G	H	I	J	K	L
37	879965	2	6	1	1	2	1	1	1	2	3	3	1
38	879894	1	5	2	2	4	2	1	2	2	3	3	1
39	882502	2	5	1	2	3	2	1	1	1	2	2	6
40	884039	1	5	1	2	3	3	1	1	1	2	3	9
41	861947	4	6	1	1	4	2	2	1	2	3	3	6
42	872566	4	2	3	2	3	2	1	1	1	3	3	12
43	876279	2	3	1	1	3	1	1	2	2	2	3	1
44	879416	1	5	1	2	3	2	2	2	2	3	3	1
45	878659	3	5	2	2	3	1	1	2	2	3	3	6
46	901002	2	5	1	1	4	2	2	1	2	3	3	1
47	949756	2	6	1	2	3	1	1	3	3	3	3	1
48	948567	3	3	2	2	3	2	1	1	1	2	3	11