International Journal of Medicine 2025; 7(11): 77-93

INTERNATIONAL JOURNAL OF MEDICINE

International Journal of Medicine

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**Review Article**

# Comparison of parkin's score and new Ballards core in gestational age assessment of neonate.

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**Abstract**

***Background***: Introduction: Gestational age (GA) is important to evaluate the risks of morbidityand mortality in newborns, both normal and sickand may modifythe line of management. Widely used Expanded New Ballard (ENBS) is complex and needs an expert medical professional to assess. New Ballard Score (NBS) and Parkin Score (PS) are easy to perform with good inter-observer reliability. Theaim was to compare these scores for their ability in predicting GA. ***Aim and objective:*** The Aim of the Study is to compare the accuracy of Parkin's score (PS) and New Ballard score (NBS) to assess the gestational age (GA) in newborns. ***Methodology***. This was a prospective observational based study conducted at Narayana medical college and hospital, Jamuhar over a period of 18 months. In this study a total of 197 newborns (27– 44 weeks gestation) delivered in or admitted to the Pediatrics/Obstetrics-Gynecology departments within 24 hours of birth were enrolled. ***Conclusion***: The Parkin scoreand NewBallard Score (NBS)arewidelyused to determine the gestational age of newborns. Although NBS is more preciseandcommonlypreferred,theParkinscorebasedsolelyonphysicalsign simpler, faster, and less intrusive, making it ideal for infants in incubators and settings with limited resources. It minimizes discomfort, lowers the risk of infection, and requires less handling than NBS. This makes the Parkin score especially useful for nurses and paramedical workers in community and peripheral healthcare centers.While it may be slightly less sensitive, the Parkin score still provides a fairly accurate estimation of gestational age, offering a practical and convenient option in resource-constrained environments.

**Keywords**: GLMP -gestational age by last menstrual period confirmed,GA-gestational age, LGA-large for gestational age, LMP-Last menstrual period, LSCS-lowersegment cesarean section. NBS-New Ballard Score, PS-Parkins Score, SGA- small for gestational age.

## Introduction:

The knowledge of gestational age is important for obstetricians and, neonatologists and it is routinely estimated both prenatally and postnatally5-7. Gestational age is the main prognostic factor than neonatal weight for the prognostic and other neonatal problem which arises soon after birth.

Knowledge of new born babies Gestational age (GA) may modify the care given, the risks of morbidity and mortality, and help in risk categorization and prognostication1. Thus, it is necessary to estimate the GA of newborns as minute change in the medication and intravenous fluid does impact on the prognosis.

Last menstruation period and /or 1sttrimester ultrasonography is considered for the estimation of gestational age of newborn. Problem arises when this date is not known or there is no certainty with the date. Some receive false information, such as those with irregular menstruation or those who used oral contraceptives just before conception2. In clinical practice,there is a significant needforan accuratemethod to estimate gestational age. This need is especially importantfor sick and low birth weight infants, as most complications arise in these groups. Therefore, any effective method should be applicable and reliable for use in such vulnerable newborns.

The common methods for assessment of GA postnatally are the New Ballard Score (NBS). Component of NBS are physical and neurological characters of newborn. Neurological characters of New Ballard score have interpersonal observational bias so many pediatricians use only physical characteristicstodeterminetheGestational age2. Itisfoundthatestimationof gestational age is more accurate when examination is done within 24 hoursof. life.Uptillday7,NBSisatrustworthyandvalidclinicalmethodforGAassess ment2.

Parkins observed that neurological assessment in Dubowitz and Amiel Tison scoring was difficult and physical characteristics were enough in gestational age estimation in neonates, Although we have various other methods for determining gestational age in neonates and many of them do employ both physical and neurological criteria for deriving gestational age, physical characteristics were adequate in predicting maturity2,3.It has advantages over other methods that it is simpler and easier method, it has no subjective neurological criteria so lesser interpersonal variation and lesser false over prediction of maturity9.Healthcare professionals in primarycare and secondary care settings, such as community health centers and local hospitals, can perform this task1, So need of specialist/pediatriciandecreases with Parkins score. Therearecertain drawbacks of thismethod as it is not useful before27 weeks of gestation and only4 criteria are used in this score (6, 9, and 10). If even one criterion is inaccurately evaluated, it can significantly affect the final estimate of maturity.

The distinct features assessed by the New Ballard scoring system in newborns are as under: -

**Newborn posture:**

The examination of newborn is done when baby is at rest. The muscle tone of the baby and resistance shown b each group of muscle determinesthe character of posture. Fetus is present as semi-flexed position inside uterus

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DOI: 10.5455/im.974550
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andwithmaturityitslowlyassumestogainuniversalflexedpositionwhich arises from lower limb and then involve the upper limbs.
Procedure:

The baby is placed supine position for the assessment and if the baby is in prone then we have to wait until the baby gets into relaxed position. A gentle manipulation of all four limbs is done by slightly extending if baby is in flexed position or by slightly flexing if baby found to be in extended position. This will make baby come in comfort position and help in knowing thebaseline position of baby.

**II. SquareWindow:**
Itreferstotheextentof wristflexionachievedduetowristflexibilityand the resistance of the extensor muscles to being stretched.
Procedure:

For this assessment the examiner keeps the baby'sfinger straight and gently apply pressure on the back of the hand of hand close to thefinger. The angle is observed between the newborn palm and forearm and is compared with the table

| | | | | | | |
|---|---|---|---|---|---|---|
| Points | -1 | 0 | 1 | 2 | 3 | 4 |
| Angle | >90° | 90° | 60° | 45° | 30° | 0° |

**Recoilingofupper limbs:**
In this criterion, the biceps tone during flex on of hand is examined. This is performed by extending the upper limb for a brief period and allowing it to recoil, followed by measuring the amount of recoil in that newborn
Procedure:

Position the infant in a supine posture and use one hand to support the baby's elbow, which is typically maintained in a flexed position. Next, extend the baby's arm briefly and then promptly release it to identify appreciate and measure the angle of recoiling. Using the provided table, we can determine the individual score. Very premature infants will exhibit reduced arm recoiling. In contrast, mature infants (Term and Post-term) will demonstrate good arm recoiling, with their hands positioned near their face. Avoid maintaining the arms in an extended position for prolonged periods, as this may result in weakness of the flexor muscles in a newborn infant.

**PoplitealAngleofkneejoint:**

The central goal of this procedure is to assess the tone of the knee joint's flexor muscleswhich is determined by the resistance displayed by the flexor muscles when they are extended to the opposing side.
Procedure:

When the newborn is quiet and comfortable, position the neonate on their back after removing the diapers. Flex the knee and hip, and carefully place the thigh over the baby's abdomen. Wait for the baby to acclimate tothis new position. Then, with one hand, hold the sides of the baby's foot while theotherhandsupportsthethigh.Gradually weextendtheleguntilresistance is observed. Certain babies may display prominent hamstring muscles when tightened, which can be regarded asa clearpoint.This angleformed between the thigh and leg iscalled as the popliteal angle.

**Scarf sign:**
The main goal in this context is to evaluate the muscle tone of the flexors associated with the shoulder joint.
Procedure:

By keeping baby in supine and maintaining the baby's head in the midline, carefully place one hand across the chest while the other hand stabilizes the infant's elbow. We carefully and simultaneously feel the resistance from the posterior flexor muscles of the shoulder girdle during the stretching of the hands across the chest. This can be regarded as a key indicator in assessing the tone of the shoulder girdle muscles, suggesting that they can be moved without significant tension.
Thescoreisgivenasthe following:

**HeeltoEartest:**

The keygoal here is to assess the muscle tone of thepelvic joint which can be accomplished by measuring the resistance provided against the stretching of the muscles.
Procedure:

By keeping the baby insupine position, we gently flex the lower limb and align it alongside the baby's abdomen. It is essential to allow the baby time to comfortably adjust to this new position. Next, while supporting the sides of thebaby's thigh with one hand, graspthefootand drawit towards the ear on the corresponding side. The resistance encountered during the muscle stretch towards the ear serves as the endpoint.

Thepointscanbegivenwhentheresistanceisfeltasfollows:

| Point | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Location Description | Heelis at the levelof theear | Heel is at the level of thenose | Heel is at the level of thechin | Heelis at the levelof the nipple | Heelisat the level of the umbilicus | Heelisat the level of the femoral crease |

Textureoftheskin.
Skin of newborn matures with the development of baby. In the earlier stages of development, the skin of newbornlooks very transparent and adheres closely. As time progresses, it becomes smoother and gradually toughens. In the final stages, the fetal skin shrinks, develops red rashes, and flakes off. Over time, the developing fetus forms a protective layer called vernix caseosa, which becomes more visible as pregnancy progresses. As gestationnearsitsend,theinfantstartstopassmeconium.Thissubstance can sometimes irritate the skin, leading to a rough, leathery, or cracked skintexture.

| Score | -1 | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| SKIN | Sticky, friable, transparent | gelatinous, red, translucent | smoot hpink, visible veins | superficial peeling &/or rash, few veins | cracking, pale areas, rare veins | parchment, deep cracking, no vessels | leathery, cracked, wrinkled |

Lanugoofthe skin:
The fetus's entire body is shrouded in a fine layer of hair referred to as Lanugo. In the early stages of development, lanugo is absent. It starts to appear around the sixth month of gestation. Over time, it becomes more abundant, and by the 7thmonth, it generally covers the upper back and shoulder. As the pregnancy continues, the fetus gradually takes on a flexed posture. Simultaneously, there is a thinning of lanugo, which typically affects the lower back and the lumbo-sacral area. In fully Term baby has no lanugo present over skin.
Factors such as metabolic, familial, hormonal and nutritional aspects has effect on quantity and distribution of lanugo in newborns for a certain gestational age. Babies born to mothers with diabetes often display a unique lanugo distribution, particularlyon the upper back and earsas gestation nears its conclusion. It is important to assess thescore appropriately

| Score | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| lanugo | none | Sparse | abundant | thinning | bald areas | mostly bald |

A. Footcreases:

The presence of creases on the sole of the foot depends on how mature the fetus is. In the initial stages of pregnancy, there are no footcreases present in the fetus. As the pregnancy continues, the fetus within uterusis in flexed posture. This condition, superimposed with dehydration, results in the development of the plantar crease. Thisfirst involves the upper section of the foot and gradually extends to the heel as the fetus matures completely.

Thesuitableboxcanbechosenbasedonthefoot creases.

| score | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Plantar Surface | <40 mm (heel-toe) | 40–50 mm (heel-toe) | >50 mm, no crease | faint red marks | anterior transverse crease only | Creases ant. 2/3 | creases over entire sole |

B.MeasurementofFootlength:

Determining the foot length is significant factor that can be relevant for newborns, particularly in cases where the foot crease is not appropriate, such as with very premature infants. This can be achieved by measuring the distance with tape from the great toes to the tip of the heel. It is essential to measure with the foot fully extended.

Thescoringmethodisasfollows:

| Point | LengthofFoot |
|---|---|
| -2 | <40mm |
| -1 | Between40mmand50mm |
| 0 | >50mm |

**Measurementofbreastsize:**
Breast tissue growth is a significant factor in maturity assessment of a newborn.Thebreasttissuedevelopment iscontingentuponvariouselements, including the hormonal status of the mother and the nutritional status of the newborn.

**Procedure:**
Measure the breast mass in millimeters by holding the breast mass between the thumb and the index finger. The points are outlined as follows:

| Point | Description |
|---|---|
| -1 | Whenthenippleis indiscernible |
| 0 | Whenthenippleishardlynoticeable |
| 1 | Whenthebreastbudisnot palpable |
| 2 | Whenthebreastbuddiameteris1-2mm |
| 3 | Whenthebreastbuddiameteris3-4mm |
| 4 | Whenthediameterofthebreastbudisabove5mm |

Caution: If there isa disparityin themass of the breastbud oneitherside, itis recommended to choose the larger one. Gynecomastia in infants caused by maternal hormonal effects generally manifests within two days post-delivery.

**Earfirmness**:
The ears firmness of baby is dependent on the volume of ear cartilage. The amount and configuration of ear cartilage depends on the baby's maturation and gestation. The two key features that should be highlighted are the ear recoil and the ear cartilage distribution and thickness.
**Procedure:**
Assessing the thickness of ear by gently palpate the cartilage of the baby. The following step is to evaluate the flexibility of the ear fold by molding

it into an unusual shape and observing its recoiling. In the early stages, there is no recoiling of the ear fold, and the ear remains flat due to the absence of cartilage formation. As maturity advances, the speed of recoiling also increases. Additionally, the curvature of the ear fold improves with the development of well-formed cartilage. Depending upon the score, respective box is selected.

| Sign | -1 | -2 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Eye/Ear | lids fused loosely | lids fused tightly | lids open, pinna flat, stays folded | sl. curved pinna; soft; slow recoil | well-curved pinna; softbut ready recoil | formed &firm, instant recoil | thick cartilage, ear stiff |

v.b.Eyeliddevelopment:

The maturation of eyelids can additionally be included in the assessment of a newborn's maturity status. In this context, we will observe whether the eyelids of the newborn baby are capable of being opened or not.

Procedure:

By gently applying pressure over the eyelid when the eyelids are stucked together. It is to be done when the baby is calm and not crying.

| Point | Description |
|---|---|
| -2 | Thefusedeyelidsaredifficulttoseparateduringtheearlyperiodof maturation |
| -1 | Asmaturityincreases,thosefusedeyelidscouldbepartlyseparable |
| 0 | Attheendofmaturation,eyelidsarekept open |

Accordingtotheabovescoringmethods,anappropriateboxis selected

Genitals–Male

In male newborn, the gonads commence their differentiation along the specified pathway. Gonadal development depends upon the maturation of the newbornandtheinfluenceofhormones.Duringtheseventhmonth,the gonad begins its descent along the gubernaculum into the inguinal canal. During early eighth month, the gonads are located within the inguinal canal. By the end of this month, the gonads extend into the superior ring of inguinal canal. During the descent of the male gonads, the scrotal skin gradually develops with increase in pigmentation and rugosities with the maturation. In the early stages of pregnancy, the male gonads have not yet descended, resulting in a scrotum that appears empty with a reduced number of rugosities and pigmentation. As maturation advances, the gonads descend, and the skin of scrotal shows more pigmentation and greater rugosities. The scrotum's size also increases and becomes pendulous. Generally, the gonads will descend slightly earlier on the left side in comparison to the right side.

For undescended gonads, if the condition occurs on one side, the evaluation may rely on the unaffected side. However, if both sides are affected, the scoring will correspond to the other variables employed in the newborn assessment

**genitals –Female**

The examiner here maintains the infant's leg in a semi flexed with little abducted position. In preterm female babies, the clitoris is distinctlyprominent, and the labia is flat. With maturation, the external genitalias expand, leading to the labia majora eventually becoming large enough to entirely enclose the clitoris and labia minora. Following these findings, the appropriate square is selected, and scoring is performed

**Aims and objectives**

I. TheaimofthestudyistocomparetheaccuracyofParkin'sscore(PS)and New Ballard score (NBS) to assess the gestational age (GA) in newborns.

II. Todetermine theaccuracyof Parkins score in assessmentof gestational age of babies with Last menstrual period (LMP)/1STtrimester USG.

III. TodeterminetheaccuracyofNewBallardScoreinassessmentofgestational age with last menstrual period (LMP)/1STtrimester USG.

IV. TocompareanddeterminetheaccuracyofParkin'sScorewithNewBallard Score in assessment of gestational age with LMP/1STtrimester USG

**Material and Methods:**

All newborns who were delivered in Narayan medical college from 27-44 weeks of gestation are enrolled.

Using structured proforma, details were filled including baby and mother details with antenatal history and delivery details.

The assessments of newborn was tried to be done by two different investigatorsfor2differentmethodswhichwastakenwithin 24hours oflife.Boththeinstigatorswereblindedregardingthegestationalage.

The gestational age of the baby from both the method is being compared with LMP/1sttrimester USG in terms of reliability and accuracy.

Placeofstudy:

- DepartmentofPediatrics,Narayan MedicalCollege&Hospital, Jamuhar.
- Department of Obstetrics & Gynaecology, Narayan Medical College & Hospital, Jamuhar.

**Studydesign:**

Prospectiveobservationalhospital-basedstudy.

Durationofstudy:

- The Study was conducted over a period of 18 months (1stJune 2023 to 30thNovember 2024).

**Studypopulation**:

- All new born from gestational age between 27-44 weeks deliveredindepartmentofObstetricsoroutbornbroughtwithin24hours of life in department of Pediatrics were enrolled.

**Samplesize**:

- 197newborns

**Inclusioncriteria:**

- Newbornswhoselastmenstrualperiod(LMP)and/or1sttrimester USG scan were available for gestational age estimation
- New-born in Narayan Medical College, in the first 24 hours of life from gestational age between 27-44 weeks.

**Exclusioncriteria:**

- Neonates conceived while taking oral contraceptives or whose mothershaveirregularmenstrualcycles.
- Neonateswithseverecongenitalmalformations.
- Neonateswhose LMP and/or USG scan datewere unavailable.

- Neonatewhowasverysick(likesevererespiratorydistresssyndrome, Birth asphyxia, severe MAS, septicemia etc.) or on ventilator support, and require minimum handling.
- Newborns of mothers who had taken any drugs which causes any neonatal CNS depression.
- Neonateswhoseparentsdeniedforconsent.

Studytools:

(i) Caserecords
(ii) Clinicalevaluation
(iii) Parkin’sScore
(iv) NewBallardScore
(v) StatisticalAnalysis:

The collected data were analyzed with Graph Pad Version 8.4.3.
For categorical variables, descriptive statistics, frequency analysis, and percentage analysis were employed, while for continuous variables, the meanand SD was utilized.
Paired t-test was used to find the significant accuracy between bi-variate samples in paired group.
Pearson'sCorrelationwasusedfortheassessment and relationship between the variables

**RESULTS**

197 new born from gestational age between 27-44 weeks were included in our study. Their maternal age distribution is given in table 1.

Table1:AgeDistributionofMothersofStudySubjects

| AgeGroup | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| ≤20 | 4 | 2.03 | 0.06-4.00 |
| 21-25 | 78 | 39.60 | 32.79-46.41 |
| 26-30 | 92 | 46.70 | 39.74-53.66 |
| 31-35 | 19 | 9.64 | 5.42-13.86 |
| ≥36 | 4 | 2.03 | 0.06-4.00 |

Age in Mean±SD: 26.48±3.72

Table 1 shows the age distribution of mothers in the study, with the majority (46.70%)fallingin the26-30age group,followed by39.60% in the21-25 group. The mean maternal age was 26.48 ± 3.72 years, indicating a relatively young cohort. Very few mothers were ≤20 or ≥36 years old, suggesting these age groups were underrepresented.

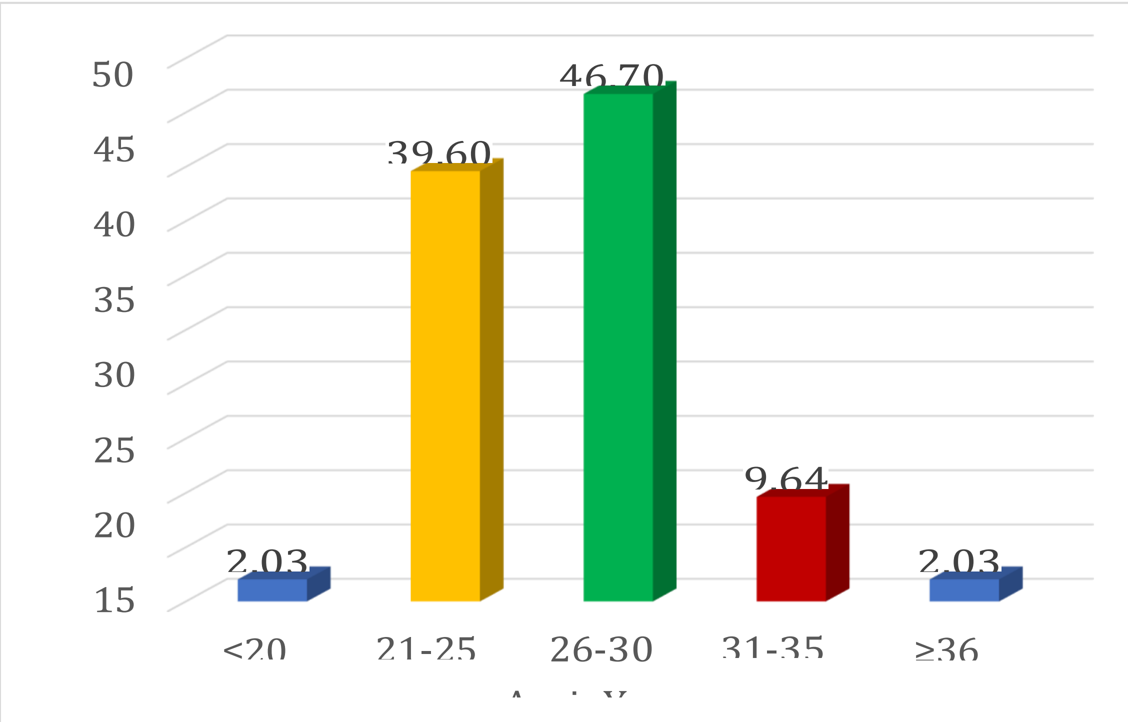



**Figure1:AgeDistributionofMothersofStudySubjects**

**Table2:DistributionofStudySubjectswithrespectto Gender**

| Gender | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Male | 128 | 65.00 | 58.08–71.92 |
| Female | 69 | 35.00 | 28.08–41.92 |

Table 2 describes newborn gender distribution, with males (65.00%) outnumbering females (35.00%).

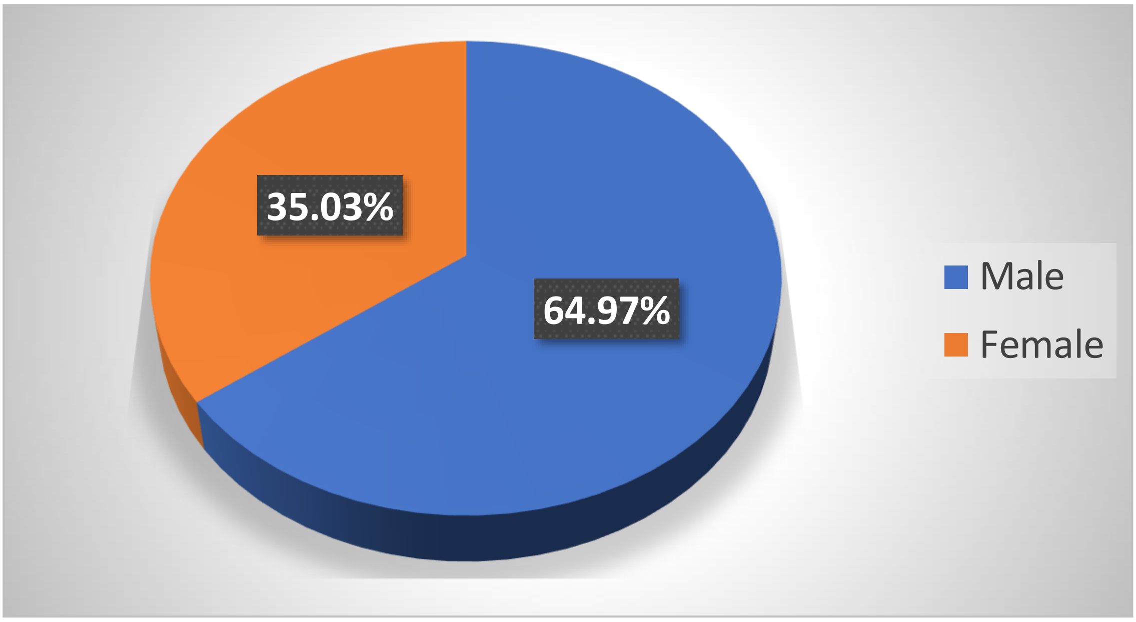



**Figure2:DistributionofStudySubjectswithrespecttoGender**

**Table3:DistributionofStudySubjectswithrespecttoBirth Weight**

| BirthWeight | Numberof Patients | %of patients (n=197) | 95%CIof% |
|---|---|---|---|
| Short for GestationalAge (SGA) | 60 | 30.46 | 24.32–36.60 |
| Largefor GestationalAge (LGA) | 9 | 4.57 | 1.66–7.48 |
| Appropriate for GestationalAge (AGA) | 128 | 65.00 | 58.08-71.92 |

BirthWeightin mean±SD:2.59±0.57

Table 3categorizes birth weight, with most newborns (65.00%) appropriate for gestationalage(AGA).However, 30.46% were smallfor gestationalage (SGA), highlighting a notable proportion with potential growth restrictions

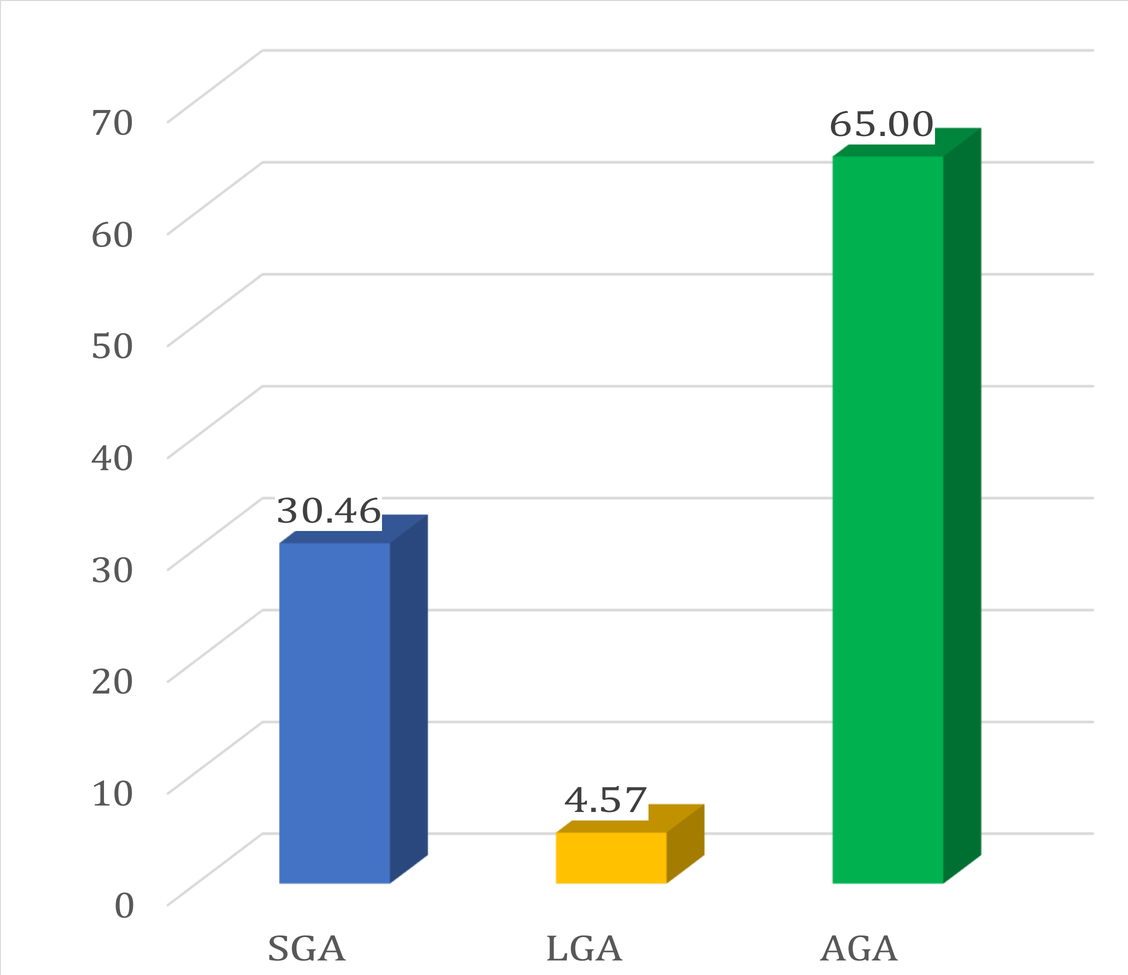



**Figure3:DistributionofStudySubjectswithrespecttoBirthWeight**

**Table4:DistributionofStudySubjectswithrespecttoModeof Delivery**

| ModeofDelivery | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Vaginal | 48 | 24.37 | 18.47-30.27 |
| LSCS | 149 | 75.63 | 69.73-81.53 |

Table 4 outlines the mode of delivery, with a high rate of cesarean sections (LSCS, 75.63%) compared to vaginal deliveries (24.37%), suggesting a preference or medical necessity for surgical deliveries in this cohort.

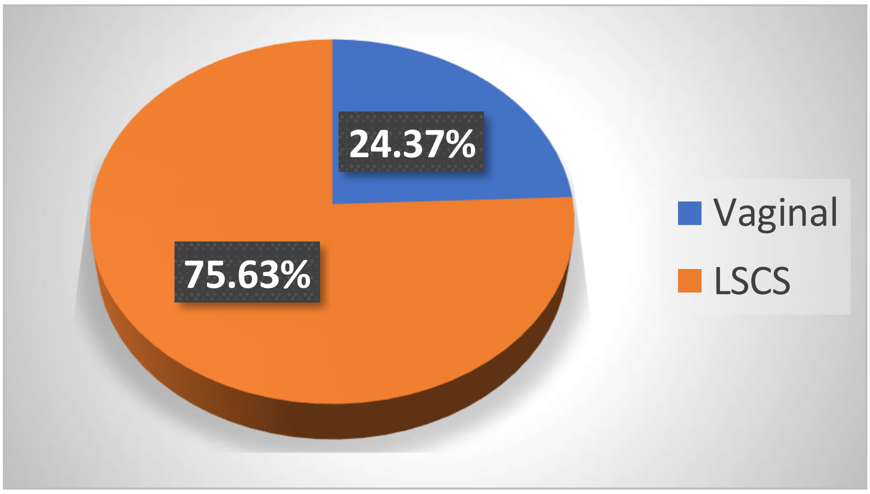



**Figure4:DistributionofStudySubjectswithrespecttoModeofDelivery**

**Table5:DistributionofMothersofStudySubjectswithrespecttoGravida Status**

| Gravida | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| 1 | 82 | 41.62 | 34.78-48.46 |

| | | | |
|---|---|---|---|
| 2-3 | 97 | 49.24 | 42.22-56.26 |
| 4-5 | 13 | 6.60 | 3.06-10.14 |
| >5 | 5 | 2.54 | 0.32-4.76 |

Table 5 presents the gravida status of mothers, revealing that nearly half (49.24%) had 2-3 pregnancies, while 41.62% were primigravida (first pregnancy). A small proportion (6.60%) had 4-5 pregnancies, and only 2.54% had more than five, indicating most mothers were either first-time or had limited prior pregnancies

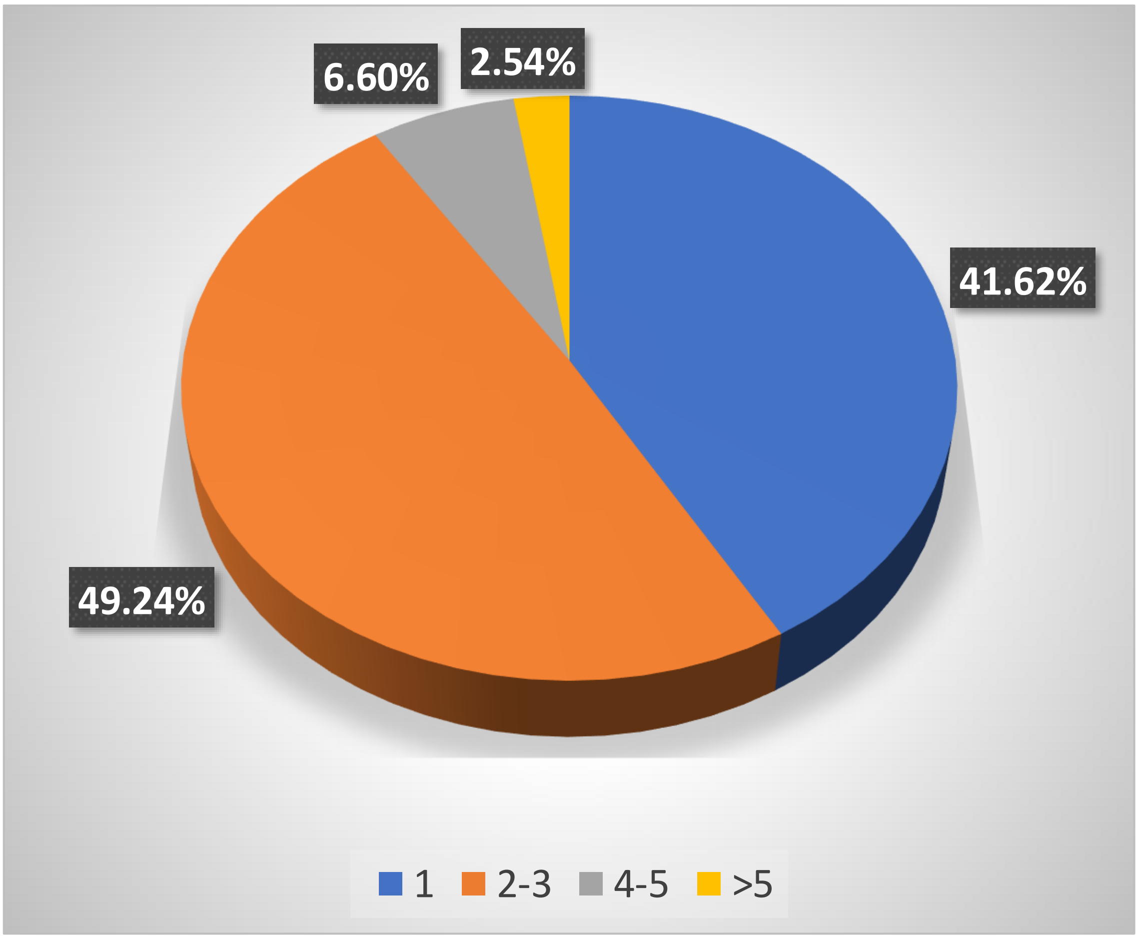



Fig5:DistributionofMothersofStudySubjectswithrespecttoGravida Status

**Table6:DistributionofStudySubjectswithrespecttoPeriodofGestation by LMP**

| POGin Weeks | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| 28-32 | 14 | 7.11 | 3.71– 10.51 |
| >32-34 | 8 | 4.06 | 1.34–6.78 |
| >34-<37 | 48 | 24.37 | 18.56–30.18 |
| 37-40 | 100 | 50.76 | 43.74–57.78 |
| >40 | 27 | 13.71 | 9.00– 18.42 |

POGinMean±SD:37.37±2.71

Table 6displays the period of gestation (POG) by last menstrual period (LMP). The majority (50.76%) delivered at term (37-40 weeks), while 24.37% were late preterm (>34-<37 weeks). The mean POG was 37.37 ± 2.71 weeks, aligning with typical gestational ranges

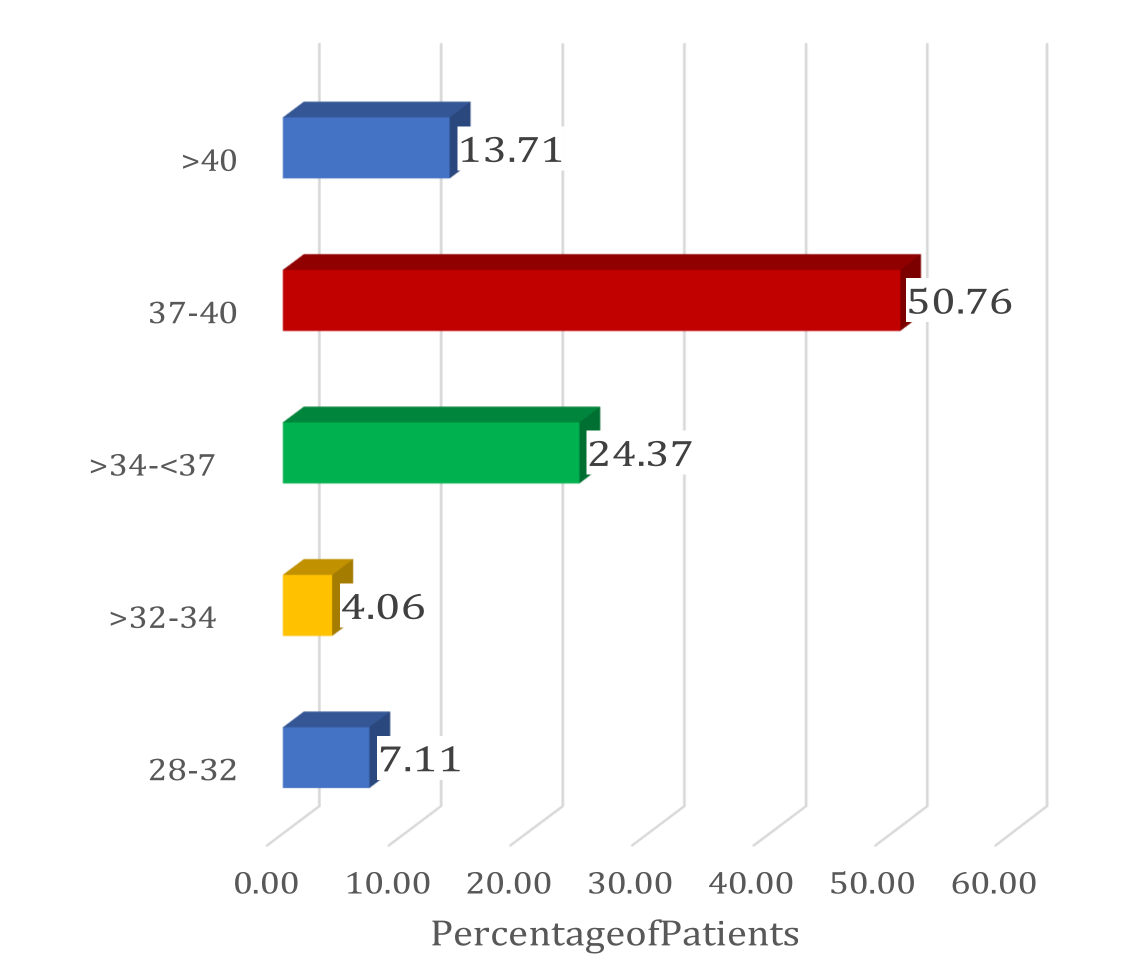



Fig6:DistributionofStudySubjectswithrespecttoPeriodofGestation by LMP

**Table 7: Distribution of MotherofStudySubjectswithrespectto Gestational Hypertension**

| Gestational Hypertension | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 8 | 4.06 | 1.34–6.78 |
| Absent | 189 | 95.94 | 93.22–98.66 |

Table 7highlights gestational hypertension prevalence, which was low(4.06%).The vastmajority(95.94%)hadnohypertension, suggestingitwasnot a major factor in this cohort.

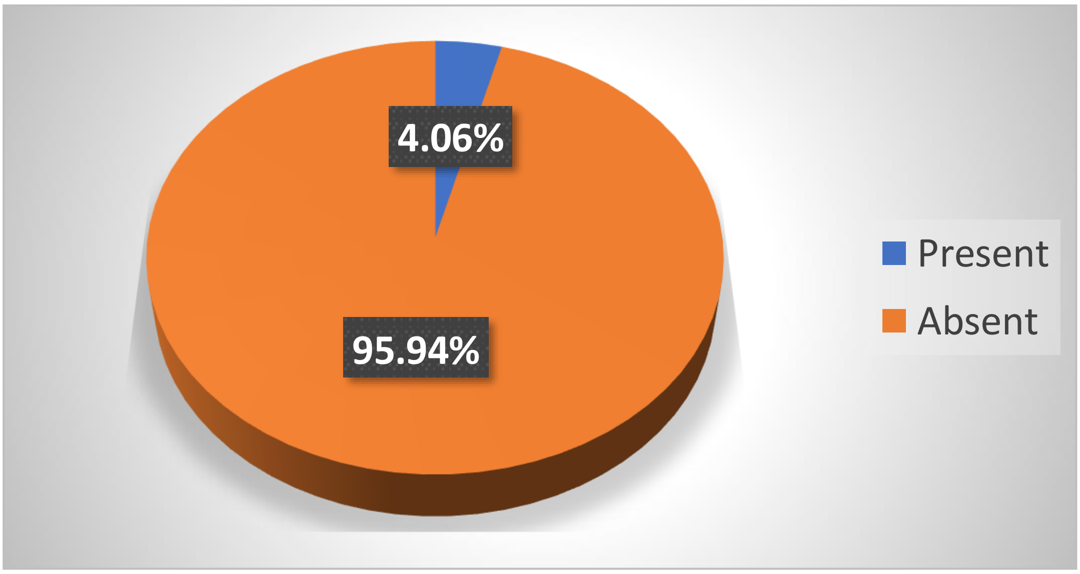



**Fig7:DistributionofMotherofStudySubjectswithrespecttoGestational Hypertension**

**Table8:DistributionofStudySubjectswithrespecttoMeconium-Stained Labor (MSL)**

| MSL | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 5 | 2.54 | 0.33–4.75 |
| Absent | 192 | 97.46 | 95.25–99.67 |

Table8indicatesthatMSLwasrare(2.54%),withmostdeliveries(97.46%) unaffected, implying minimal fetal distress in this population.

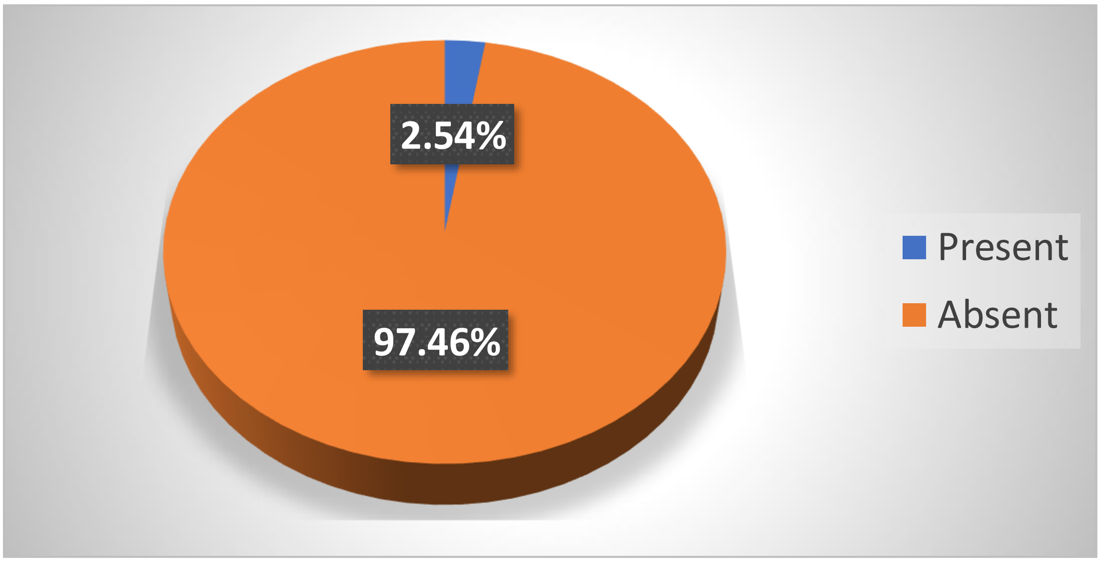



**Fig8:DistributionofStudySubjectswithrespecttoMeconium-Stained Labor (MSL)**

**Table9:DistributionofStudySubjectswithrespectto Oligohydramnios**

| Oligo-hydramnios | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 3 | 1.52 | 0.00–3.24 |
| Absent | 194 | 98.48 | 96.76–100.00 |

**Table 9 shows oligohydramnios was uncommon (1.52%), with 98.48% of cases unaffected, suggesting it was not a significant complication in the study.**

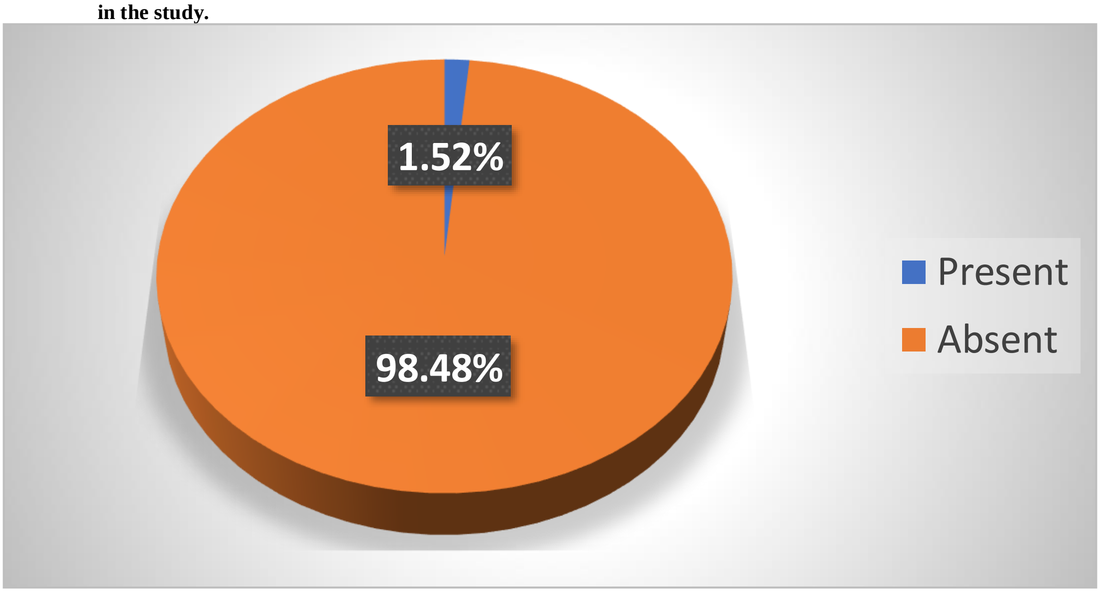



**Fig9:DistributionofStudySubjectswithrespectto Oligohydramnios**

**Table 10:DistributionofStudySubjectswithrespecttoPROM**

| PROM | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 3 | 1.52 | 0.00–3.24 |
| Absent | 194 | 98.48 | 96.76–100.00 |

Table 10reports that premature rupture of membranes (PROM) was rare (1.52%), with almost all cases (98.48%) unaffected, indicating low risk for infection or preterm delivery.

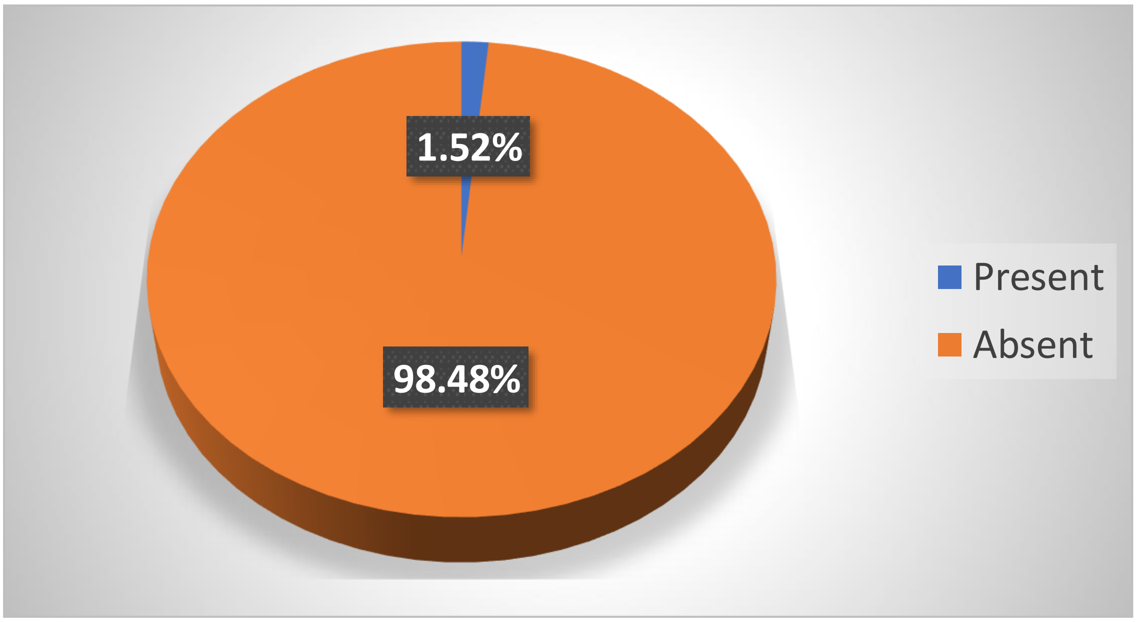



**Figure10:DistributionofStudySubjectswithrespecttoPROM**

**Table11:DistributionofMotherofStudySubjectswithrespectto Hypothyroidism**

| Hypothyroidism | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 27 | 13.71 | 9.00– 18.42 |
| Absent | 170 | 86.29 | 81.58–91.00 |

Table 11reveals hypothyroidism was present in 13.71% of mothers, a notable proportion; while 86.29% were unaffected, suggesting thyroid dysfunction may warrant further investigation.

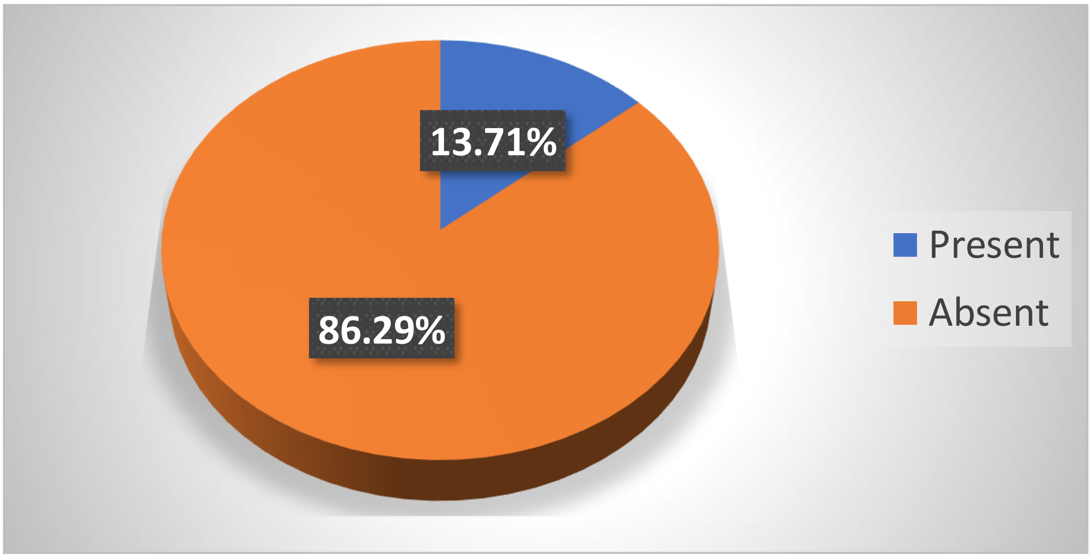



**Figure11:DistributionofMotherofStudySubjectswithrespectto Hypothyroidism**

**Table12:DistributionofMotherofStudySubjectswithrespectto Gestational Diabetes Mellitus (GDM)**

| GDM | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Present | 7 | 3.55 | 1.00–6.10 |
| Absent | 190 | 96.45 | 93.90–99.00 |

**Table 12 shows gestational diabetes mellitus (GDM) was uncommon (3.55%), with 96.45% unaffected, indicating low metabolic disorder prevalence in the cohort.**

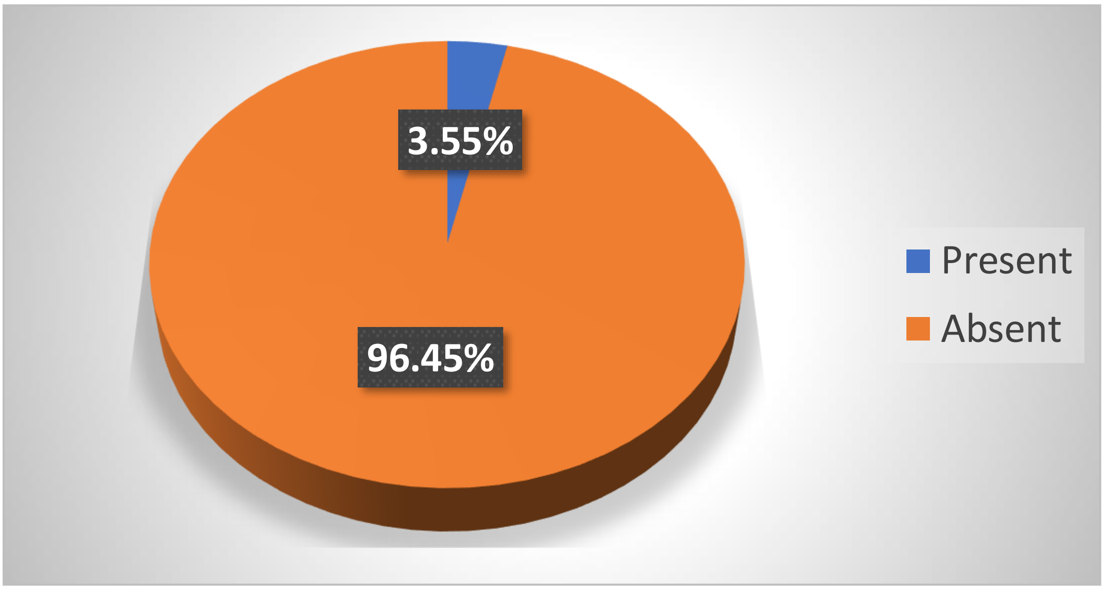
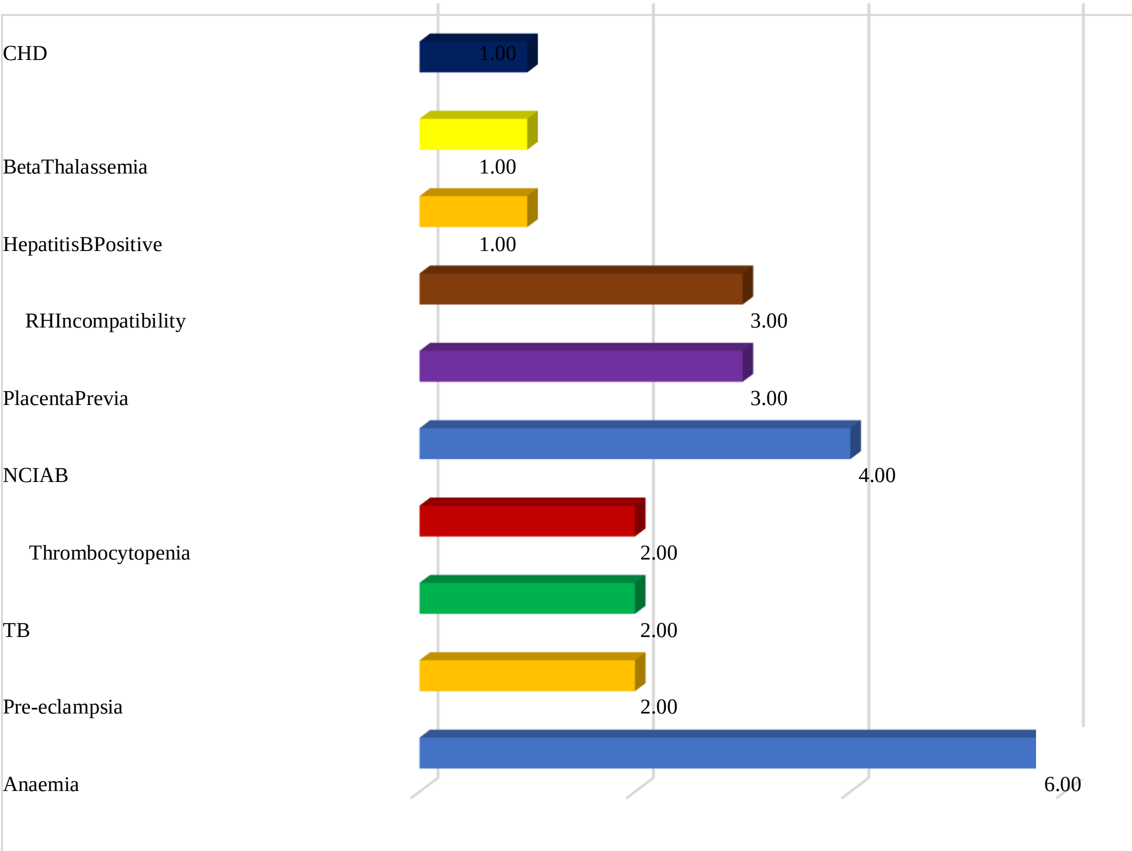



**Figure12:DistributionofMotherofStudySubjectswithrespecttoGDM**

**Table13:DistributionofStudySubjectswithrespecttoOtherAssociated Disease/Event**

| Associated Disease/Event | Numberof Patients | %ofpatients (n=197) | 95%CIof% |
|---|---|---|---|
| Anaemia | 6 | 3.05 | 0.63%–5.47% |
| Pre-eclampsia | 2 | 1.02 | 0.00%–2.43% |
| TB | 2 | 1.02 | 0.00%–2.43% |
| Thrombocytopenia | 2 | 1.02 | 0.00%–2.43% |
| NCIAB | 4 | 2.03 | 0.08%–3.98% |
| PlacentaPrevia | 3 | 1.52 | 0.00%–3.02% |
| RHIncompatibility | 3 | 1.52 | 0.00%–3.02% |
| HepatitisBPositive | 1 | 0.51 | 0.00%–1.51% |
| Beta Thalassemia | 1 | 0.51 | 0.00%–1.51% |
| CHD | 1 | 0.51 | 0.00%–1.51% |

Table 13lists other associated diseases, with anaemia (3.05%) being the most common. Otherconditions(e.g., pre-eclampsia, TB)wererare (<2%),indicating low comorbidity prevalence overall



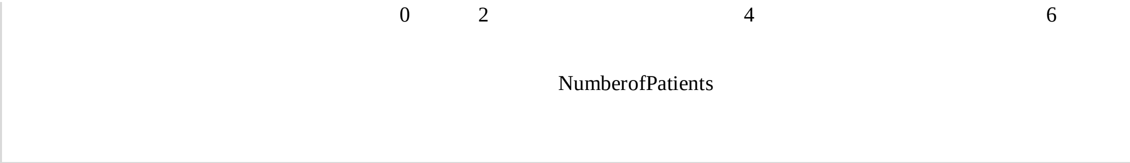



**Figure13:DistributionofStudySubjectswithrespectto Associated Disease/Event**

**Table14:ComparisonofGestationalAgewithrespecttoLastMenstrual Period(LMP),ParkinsScore (PS),andNewBallardScore(NBS)(n=197)**

| Method | GAin Weeks | |
|---|---|---|
| | Mean | SD |
| LastMenstrualPeriod(LMP) | 37.37 | 2.71 |
| ParkinsScore(PS) | 37.44 | 2.37 |
| NewBallardScore(NBS) | 36.04 | 2.44 |
| Pairedttest(LMPvsPS) | 0.5409(t=0.6125,df=196) | |
| Pairedttest(LMPvsNBS) | <0.0001(t=10.81,df=196) | |
| Pairedttest(PSvsNBS) | <0.0001(t=14.21,df=196) | |

Table 14 compares gestational age (GA) estimates derived from the Last Menstrual Period (LMP), Parkins Score (PS), and New Ballard Score (NBS). The mean GA by LMP (37.37 ± 2.71 weeks) closely aligns with PS (37.44 ± 2.37 weeks), as indicated by a non-significant paired t-test (p=0.5409), suggesting strong agreement between these methods. However, NBS (36.04 ± 2.44weeks)significantlyunderestimatedGAcomparedtobothLMP(p<0.0001) and PS (p<0.0001). This discrepancy raises concerns about NBS's reliability in accurately assessing GA when LMP is the reference standard

Figure14:ComparisonofGestationalAgewithrespecttoLastMenstrual Period (LMP), Parkins Score (PS), and New Ballard Score (NBS) (n=197)

**Table 15:Comparison of CategoricalGestational Age with respect to Last MenstrualPeriod(LMP),ParkinsScore(PS),and NewBallardScore(NBS) (n=197)**

| Method | NumberofPatients(%) | | |
|---|---|---|---|
| | Pre-Term (<37Wks) | Term (37-40Wks) | Post-Term (>40Wks) |
| LMP | 70 (35.53) | 100(50.76) | 27(13.71) |
| ParkinsScore(PS) | 57(28.93) | 133(67.51) | 7 (3.55) |
| NBSScore | 106(53.81) | 87 (44.16) | 4 (2.03) |
| Chi-SquareTest(LMP vsPS) | 0.0001 | | |
| Chi-SquareTest(LMP vs NBS) | <0.0001 | | |
| Chi-SquareTest(PS vs NBS) | <0.0001 | | |

Table 15 categorizes GA into pre-term, term, and post-term groups acrossLMP, PS, and NBS. While LMP classified 35.53% as pre-term, PS and NBS showeddifferingproportions(28.93%and53.81%,respectively).Chi-square tests revealed highly significant differences (p<0.0001) between all methods, particularlywithNBSoverestimatingpre-termcasescomparedtoLMP.This suggests that while PS may align more closely with LMP in categorical classification, NBS exhibits poor validity, misclassifying a substantial number of cases, particularly by overestimating pre-term births.

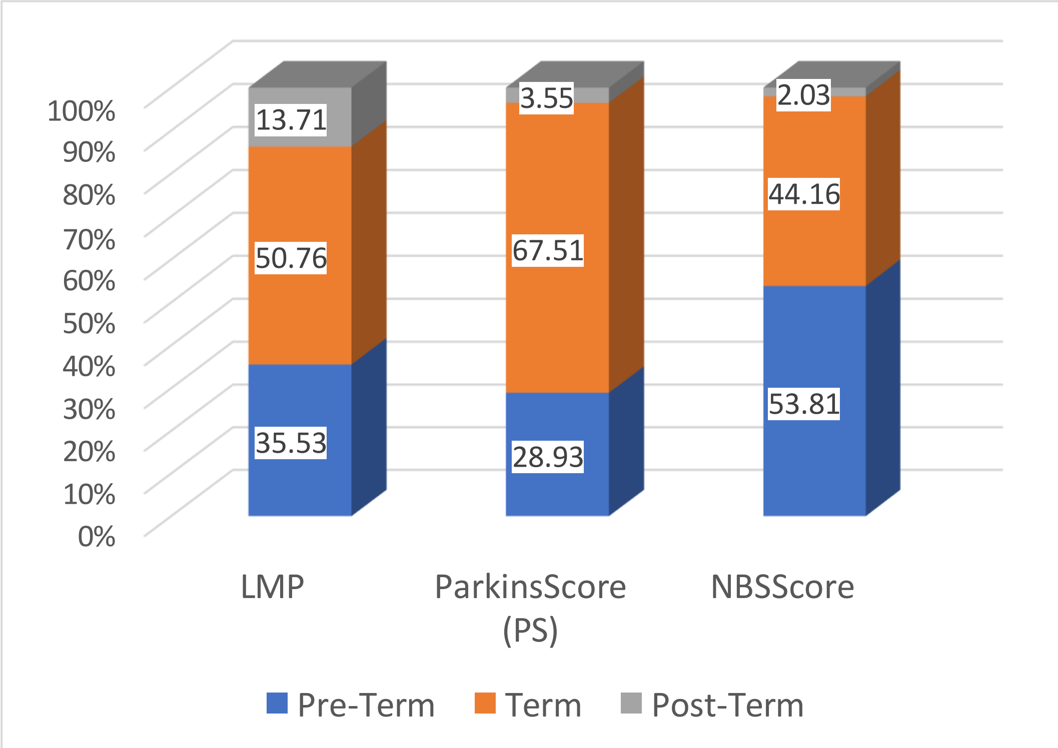



**Figure 15: Comparison of Categorical Gestational Age with respect to LastMenstrualPeriod(LMP),ParkinsScore(PS),andNewBallardScore (NBS) (n=197)**

**Table16:AccuracyofParkinsScoreinPredictingPre-TermGestational Age (<37 Weeks) with LMP as Standard**

| GA(LMP) | GA(ParkinsScore) | |
|---|---|---|
| | <37Weeks | ≥37Weeks |
| <37Weeks | 49(TP) | 21(FN) |
| ≥37Weeks | 8(FP) | 119(TN) |

**Table17:AccuracyofNBSScoreinPredictingPre-TermGestational Age (<37 Weeks) with LMP as Standard**

| GA(LMP) | GA(NBS Score) | |
|---|---|---|
| | <37Weeks | ≥37Weeks |
| <37Weeks | 64(TP) | 6(FN) |
| ≥37Weeks | 42(FP) | 85(TN) |

**Table 18: Comparison of Accuracy of Parkins and NBS Score for predicting Pre-Term Delivery with LMP as Gold Standard**

| Statistic | ParkinsScore | NBSScore |
|---|---|---|
| Sensitivity | 70.00% | 91.43% |
| Specificity | 93.70% | 66.93% |
| PositivePredictive Value | 85.96% | 60.38 |
| NegativePredictive Value | 85.00% | 93.41 |
| Accuracy | 85.28% | 75.63 |

Table 18evaluates theaccuracyof PSand NBS in predictingpre-term GA (<37 weeks) using LMP as the gold standard. PS demonstrated higher sensitivity (70.00%) and specificity (93.70%) compared to NBS (91.43% sensitivity, 66.93% specificity). However, NBS's high sensitivity came at the cost of lower specificity, leading to more false positives. PS also outperformed NBS in positive predictive value (85.96% vs.60.38%)andoverall accuracy(85.28% vs. 75.63%). These results indicate that PS is a more reliable and valid tool for GA estimation, whereas NBS, despite its sensitivity, lacks precision and may overdiagnose pre-term cases.

Thefigure16 illustratesthecorrelationbetween GAfrom ParkinsScoreandGA from LMP using a scatter plot with a trend line. The data points are distributed around the trend line, indicatinga strongpositive correlation, as reflectedbythe Pearson correlation coefficient (r = 0.8219) with a 95% confidence interval (CI) of 0.7706 to 0.8626. The R squared value of 0.6755 suggests that approximately67.55%of the variance in GAParkins Score can beexplained by GA LMP. Additionally, the statistically significant p-value (less than 0.0001) reinforces the reliability of this correlation. This figure highlights the strong association between these two measures, which may be valuable for further research or clinical applications.

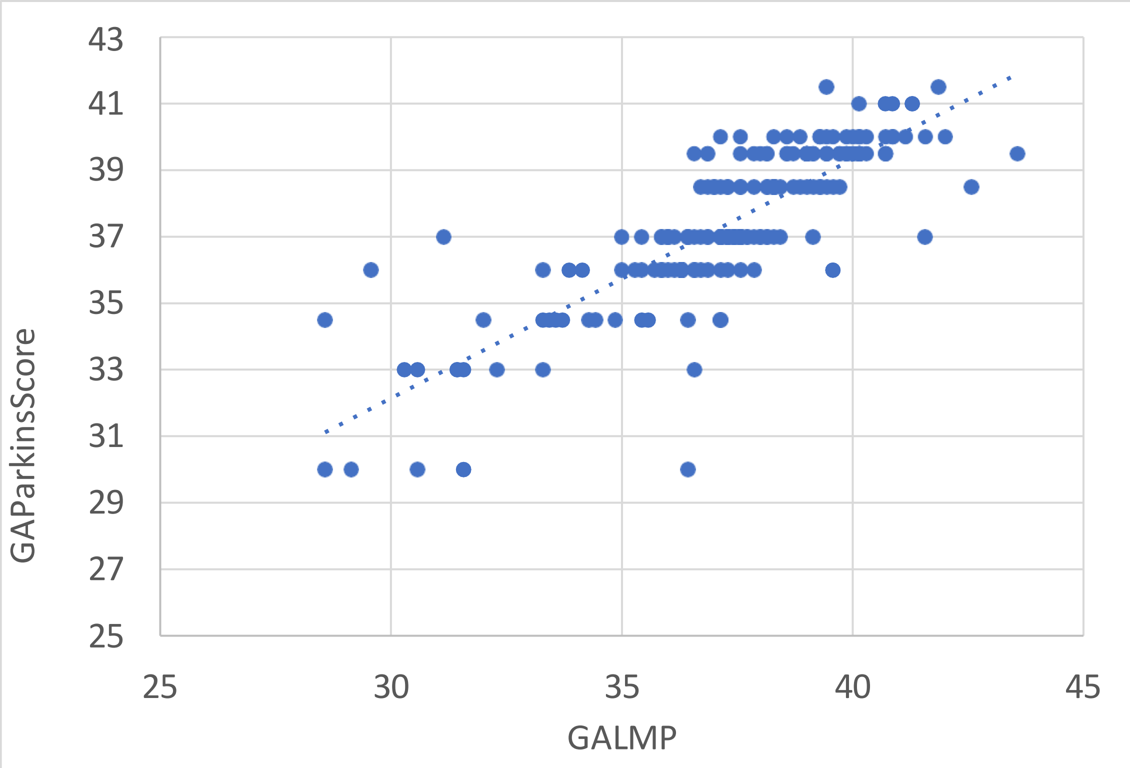



**Figure16:CorrelationofGAfromParkinsScorewithGAfromLMP**

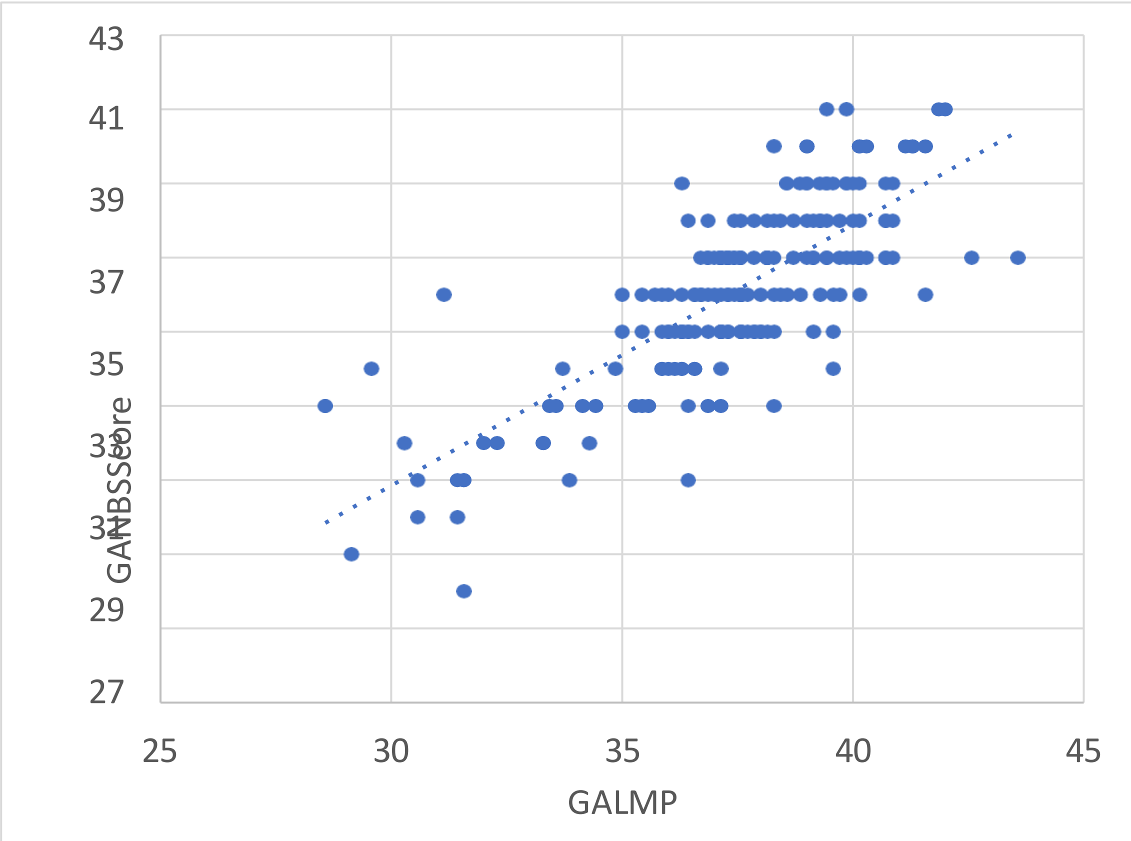



**Figure17:CorrelationofGAfromNBSScorewithGAfrom LMP**

Pearsonr:0.7797;95%CI:0.0.7182to0.8291

Rsquared:0.6080, P(two-tailed):<0.0001

The Pearson correlation coefficient (r = 0.7797) with a 95% confidence interval (CI) of 0.7182 to 0.8291 suggests a significant relationship between the two variables. The R squared value of 0.6080 implies that approximately 60.80% of the variance in GA NBS Score can be explained by GA LMP. Additionally, the statistically significant p-value (less than 0.0001) reinforces the reliability of this correlation

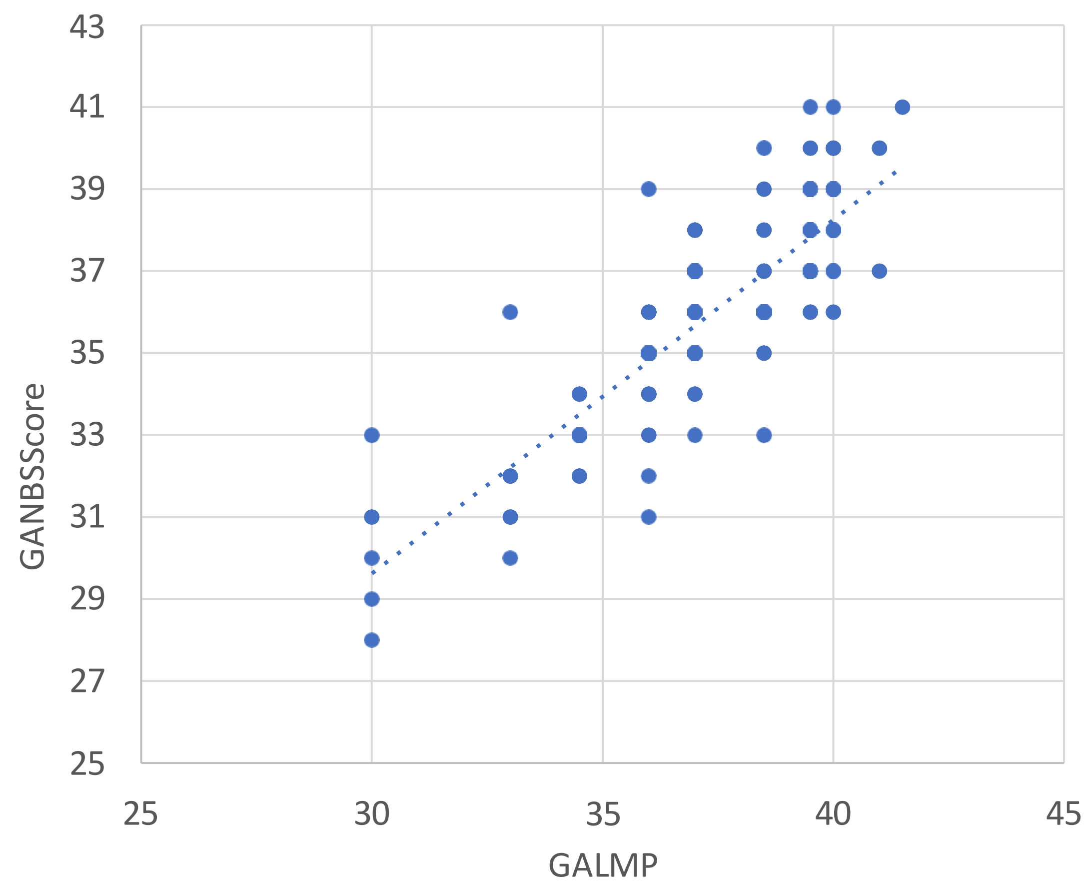



**Figure18:CorrelationofGAfromNBSScorewithGAfromParkinsScore**

**DISCUSSION**

The present study evaluated clinical, radiological and peri-operative predictors of poor functional outcome in 53 patients undergoing ORIF for ankle fractures. At 6 months, 71.7% of patients had good functional outcome (OMAS ≥60), while 28.3% had poor outcome, and multivariate analysis identified age >50 years, BMI ≥28 kg/m², trimalleolar fractures, syndesmotic injury, delay to surgery ≥7 days and postoperative infection as independent predictors of poor function (Tables 5–8).These findings are consistent with contemporary literature that highlights both patient-related and injury-/treatment-related factors as key determinants of long-term recovery after ankle fractures.[7,9]

In our cohort, the mean age was 41.8 ± 13.6 years, with nearly three-quarters of patients below 50 years and a clear male predominance (64.2%).This pattern reflects the high exposure of middle-aged, working-age men to outdoor and high-risk activities. Court-Brown and Caesar similarly reported that ankle fractures are common in adults, with a large burden in the middle-aged population even though incidence rises further in the elderly.[14] The mean BMI of 27.4 kg/m² in our series indicates that most patients were overweight, and comorbidities such as diabetes (20.8%), hypertension (26.4%), smoking (32.1%) and alcohol use (28.3%) were frequent. These comorbidities and lifestyle factors have been repeatedly associated with poorer functional and patient-reported outcomes after ankle fractures in prognostic studies.[7,9]

Slip or fall was the most common mechanism of injury (54.7%), followed by road-traffic accidents (39.6%), indicating a mixture of low- and high-energy trauma typical for ankle fractures.Weber B (47.2%) and Weber C (41.5%) fractures predominated, and almost 80% of fractures were bi- or trimalleolar, with syndesmotic injury present in 35.8% and Grade I–II open fractures in 11.3%. This distribution mirrors other ORIF series, where unstable Weber B/C and multi-malleolar fractures form the majority of surgically treated injuries.[9,8] Syndesmotic disruption and complex fracture patterns (e.g. trimalleolar injuries) have consistently been linked with inferior long-term function and higher rates of complications and reoperation.[7,9]

Most patients (67.9%) underwent surgery within 7 days of injury, while 32.1% had delayed fixation (≥7 days). Fixation of the posterior malleolus was required in 22.6% and syndesmotic fixation in 35.8% (mainly screw fixation), reflecting adherence to current principles of stabilising the posterior tibial plafond and distal tibiofibular joint in unstable patterns. Intraoperative complications were rare (5.7%).

These figures are comparable with other prospective cohorts where careful soft-tissue assessment and standardised techniques minimise intraoperative adverse events.[7,8] Early weight-bearing (≤3 weeks) was initiated in 39.6% of patients, with the remainder progressing later, according to fracture stability and soft-tissue status. Superficial and deep wound infections occurred in 7.5% and 3.8% of cases, respectively, and malunion/malreduction was seen in 11.3%. The mean radiological union time was 13.4 ± 2.1 weeks.These rates are within the ranges reported in the literature, where infection after ankle ORIF typically occurs in 4–10% and malalignment in 5–15% of patients.[15,16]

Functional scors improved substantially over time. Mean OMAS increased from 52.4 ± 14.2 at 3 months to 71.6 ± 15.8 at 6 months, and AOFAS scores from 63.8 ± 11.5 to 78.4 ± 12.7 over the same period. At 6 months, 71.7% of patients achieved a good functional outcome (OMAS ≥60), whereas 28.3% were categorised as having poor outcome (OMAS <60).This pattern of meaningful improvement between 3 and 6 months is in line with other outcome studies that show continued recovery well into the first postoperative year.[7,9] Balaji et al. reported comparable mean OMAS and AOFAS scores at 6 months in their prospective cohort of surgically treated unstable ankle fractures, confirming that our overall functional results are broadly similar to other Indian and international experiences.[8]

When patients were stratified into good and poor outcome groups, those with poor outcome were significantly older (49.6 vs. 38.9 years) and had higher BMI (29.0 vs. 26.7 kg/m²). They also had a higher prevalence of diabetes (40% vs. 13.1%) and smoking (53.3% vs. 23.6%). These observations align with the findings of Audet et al., who reported that increased BMI, tobacco and alcohol use, and medical comorbidities were associated with worse patient-reported outcomes at mid-term follow-up after ankle fractures.[7] Lorente et al., in a recent systematic review, likewise concluded that advanced age, high BMI, diabetes and smoking are consistent predictors of poorer function and health-related quality of life.[9]

Complex fracture configurations were strongly associated with poor outcome in our series. Patients with poor outcome more frequently had Weber C fractures (66.7% vs. 31.6%) and trimalleolar fractures (60% vs. 21.1%), and syndesmotic injuries were also significantly more common (60% vs. 26.3%). Delayed surgery ≥7 days occurred in 60% of the poor outcome group compared with 21.1% of the good outcome group. These results corroborate earlier evidence that fracture complexity and syndesmotic disruption are important prognostic factors. Audet et al. found that more severe fracture patterns and fracture-dislocations were associated with lower functional scores.[7] Balaji et al. similarly showed that unstable patterns (often Weber C and bimalleolar/trimalleolar fractures) and less-than-optimal radiographic restoration were linked with poorer outcomes in their prospective cohort.[8] The negative impact of surgical delay on outcome in our study is also consistent with the wider literature. Studies emphasise timely fixation, once soft tissues permit, to reduce swelling-related complications and to facilitate accurate reduction; delays have been associated with higher infection rates and worse functional recovery.[8,15]

Postoperative infection and malreduction/malunion were markedly over-represented in the poor outcome group: any infection occurred in 26.7% vs. 5.2%, and malreduction/malunion in 26.7% vs. 5.2% of patients. Ovaska et al. showed that deep infection after internal fixation of ankle fractures can have catastrophic consequences, with diabetes, smoking, alcohol abuse and malreduction significantly increasing the risk of treatment failure and long-term disability.[15] Our findings echo this, underlining that meticulous soft-tissue handling, strict asepsis, precise reduction and early detection and management of complications are critical for preserving function.

On multivariate logistic regression, age >50 years, BMI ≥28 kg/m², trimalleolar fracture pattern, syndesmotic injury, delay to surgery ≥7 days and postoperative infection remained independent predictors of poor functional outcome at 6 months. This reinforces the concept that both non-modifiable (age, fracture complexity) and modifiable (timing of surgery, infection control) factors jointly shape prognosis. Our results are in agreement with Audet et al. and Lorente et al., who emphasise that patient-related risk factors must be considered alongside fracture severity and treatment quality when counselling patients and planning follow-up.[7,9] Balaji et al. also reported that careful attention to fracture reduction and optimisation of comorbidities can improve functional outcomes even in unstable patterns.[8]

From a clinical standpoint, elderly, overweight patients with trimalleolar fractures and syndesmotic disruption represent a high-risk group who should receive targeted counselling, more intensive rehabilitation and closer follow-up. Avoiding unnecessary delay to surgery, ensuring anatomical reduction (especially of the posterior malleolus and syndesmosis) and stringent prevention and management of postoperative infection are practical, modifiable strategies that may improve long-term functional outcomes in such patients.

**Conclusion**

In this study of 53 patients undergoing ORIF for ankle fractures, the majority (71.7%) achieved good functional outcomes by 6 months; however, nearly one-third continued to experience significant functional limitation. Poor outcomes were strongly associated with older age, higher BMI, diabetes, smoking, complex fracture patterns (particularly trimalleolar and Weber C injuries), syndesmotic disruption, delayed surgery and postoperative complications such as infection and malreduction. Multivariate analysis confirmed age >50 years, obesity, trimalleolar fractures, syndesmotic injury, surgical delay ≥7 days and postoperative infection as independent predictors of poor recovery. These findings highlight the importance of early surgical intervention, meticulous anatomical reduction, aggressive management of comorbidities and prevention of complications to optimise postoperative functional outcomes following ankle fracture fixation.

**Acknowledgement: None**
**Conflict of Interest: None**

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