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Assessment Of Fetal Maturity At Various Gestational Ages Using Modified Dubowitz Scoring System

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Abstract

Objective: Using a modified Dubowitz scoring system, evaluate and compare the maturity of neonates born at different gestational ages into three groups: 28+0 to 35+6 weeks, 36+0 to 36+6 weeks, and 37+0 to 37+6 weeks.

Methods: This prospective observational research was carried out at Holy Family Hospital, Rawalpindi, in units 1 and 2 of the Department of Obstetrics and Gynaecology. The research covered all neonates born between 28+0 and 37+6 weeks of gestation. Following clearance from the ERB and authorization from the hospital administration, data collecting began. After the informed consent of the parent /guardian of the neonate, a detailed maternal and neonatal history was taken including demographic data and obstetric history. All neonates enrolled in the study were divided into three groups. Group A include neonates delivered between 28+0 - 35+6 weeks. Group B includes neonates delivered between 36+0 - 36+6 weeks and group C includes neonates delivered between 37+0 - 37+6 weeks. Fetal maturity of all three groups was estimated by using Modified Dubowitz scoring and secondary fetal outcomes (Birth weight, APGAR score & complications of prematurity) were also measured. Data was entered on pre-designed proforma.

Results: SPSS version 25 was used to enter and evaluate the data. Determining neonatal maturity using a modified Dubowitz scoring system was the main result. The assessment of birth weight, APGAR score, and preterm problems are secondary fetal outcomes.

Conclusion: According to the study's findings, newborns of varying gestational ages can benefit from using the Modified Dubowitz score as a valuable tool to predict fetal development. Additionally, the study finds that the idea of the early maturation of Asian populations in our community is valid. This will help us make decisions on whether to do iatrogenic preterm births in complex circumstances.

MeSH Keywords: neonate, Dubowitz syndrome .

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1. Introduction

Preterm birth is defined as delivery occurring before 37 weeks of gestation. In wealthy nations, the incidence is 8.6%, whereas in poor countries, it is 10%.[1] One million neonatal fatalities occur each year due to preterm delivery, the world's greatest cause of death for children under five. Almost the majority of these deaths occur in low and middle-income nations.[2] Preterm labour, preterm pre-labour rupture of membranes (PPROM), and cervical weakening are all included in spontaneous preterm birth (SPB).[3,4] A planned delivery that takes place before 37 weeks of gestation because of fetal or maternal factors is referred to as an iatrogenic preterm birth. Of all preterm births, around 30–40% are caused by external factors.[5] It covers maternal health issues, fetal causes, and obstetric problems. Respiratory distress ranks first among the several problems linked to preterm delivery. Because of greater fetal maturity, the fetal outcomes improve dramatically with increasing gestational age.[6] Determining the true fetal maturity is therefore crucial to forecasting the baby's prognosis and appropriate management of high-risk post-date pregnancies and prevention of prematurity-related complications. Ultrasound in the first trimester is the gold standard but in low- and middle-income countries where the pregnant female hardly access the health services during her first trimester, it would be a real challenge to assess the gestational age. A recent study reported New Ballard Score plus birth weight was the accurate method for GA determination.[7] Literature makes it clear that Asian fetuses grow earlier than those of Western populations.[8] For us to make an informed choice on the timing of iatrogenic preterm births and the expected result of spontaneous preterm delivery, we must have an evaluation of the expected maturity of fetuses at different gestational ages in our community. If cycle parameters and the last menstrual period's beginning date can be precisely

determined, the last menstrual period (LMP) can accurately predict gestational age.[9] When successive measures are taken, symphysis-fundal height (SFH), a less expensive and practical option, seems to be more accurate than other non-ultrasound-based techniques for predicting gestational age at birth. A crucial component of prenatal treatment is SFH measurement at every visit, which also serves as a helpful tool for identifying pregnancies at risk for unfavourable outcomes. However, body mass index and gestational age affect the accuracy of SFH.[10] The above 2 options can be used in the antenatal period. The Ballard Score (BS), which is accessible after the infant is delivered, uses postnatal evaluation of the physical and neurological markers of neonatal development to predict a gestational age range.[10,11] A Study was conducted in India to develop the scoring system as a tablet app, with potential scalability, to assess its feasibility and validate whether it can accurately predict prematurity independently of birth weight in a large sample of newborns.[12] Another study conducted in 2023 used to determine the correlation between gestational age (GA) estimated using the last menstrual period (LMP), ultrasound (USG), and newborn screening (NBS), aiding healthcare workers in choosing an alternative method for estimating GA when LMP is unknown. This study shows a strong correlation between the above three.[13]

Different systems of grading have been devised to assess the gestational age of a baby. Parkin's score, the new Ballard score, and the Dubowitz score. The Dubowitz score has two limitations. Its overestimation of gestational age in preterm babies is one of its drawbacks. The Dubowitz examination underestimated the gestational age by 2.8 weeks in a study involving 110 preterm neonates whose mean gestational age was determined by the LMP and best obstetric estimate to be 28.3 weeks. This approach's lengthy requirement, which takes 15 to 20 minutes to complete, is another problem. This makes it challenging to apply to sick or extremely preterm neonates. The Modified Dubowitz scoring system, which was created by eliminating the neurological criteria and adding the mid-arm and head circumferences, is a rapid and widely used instrument for evaluating a newborn's maturity and has a strong correlation with gestational age.[14]

The implementation of the Dubowitz assessment has been limited because of examination complexity and training requirements. A study conducted in India reported the acceptable level of competence of the trainees after a workshop by the trainer.[15]

With the use of the Modified Dubowitz Score, newborns born at various gestational ages will have their maturity levels evaluated and compared in this study. Three groups of neonates—28+0 - 35+6 weeks, 36+0 - 36+6 weeks, and 37+0 - 37+6 weeks—were formed. Literature review shows that at a given gestational age, the various ethnic groups have different fetal maturation levels thus variable neonatal outcomes. Asian population shows advanced fetal maturation as compared to white population.[16,17] In complex circumstances, the notion of the earlier maturation of the Asian population in our community will inform our judgement regarding when to do an iatrogenic preterm birth. The possibility of providing the same neonatal care at 36 weeks that is provided to the newborns at 37 weeks may arise, particularly given the babies' demonstrated increased maturity at 36 weeks. This will provide evidence to decide on elective deliveries during the 36th week, reducing the morbidity & mortality of mothers and fetuses during this risky waiting period. This will also reduce the burden on our limited health care facilities.

2. Materials & Methods

After obtaining permission from the Ethical Review Board (letter#122/IREF/RMU/2021) and Board of Advance Studies and Research (letter #15/2/RMU, dated 15/3/2022) was carried out over 6 months in two units of the Department of Obstetrics and Gynecology, Holy Family Hospital, Rawalpindi. A total of 300 neonates delivered between the gestational age of 28-37+6 weeks were included via non-probability convenient sampling. All neonates enrolled in the study were divided into three groups. Group A include neonates delivered between 28^{+0} - 35^{+6} weeks. Group B includes neonates delivered between 36^{+0} - 36^{+6} weeks. Group C includes neonates delivered between 37^{+0} - 37^{+6} weeks. In women whose gestational age assessment is not satisfactory, or with multiple pregnancies, any fetal/neonatal and maternal diseases (Hypertensive disorders of pregnancy, Diabetes Mellitus & chronic diseases) affecting fetal maturity and fetal growth were excluded from the study. After the informed consent of the parent /guardian of the neonate, a detailed maternal history was taken with special emphasis on maternal age and mode of delivery. Neonatal history encompasses gender, weight, APGAR score and NICU admission. Fetal maturity of the

neonates of all three groups was estimated by using the Modified Dubowitz scoring system. Head circumference, mid-arm circumference, skin texture, ear shape, breast size, and genitalia are the six features that make up this model. wherein the circumference of the head is measured in centimetres using a flexible, non-stretchable measuring tape on the occiput, the most noticeable area on the back of the head, and slightly above the eyebrows, or supraorbital ridges. Mid-arm circumference was taken with the help of measuring tape, first by flexing the arm, and marking the mid-point between the olecranon process and acromion then with arm by side wrapping a measuring tape around the arm with an upper border of tape on the mark and taking the measurement in cm. Other features are Skin texture, Ear form, Breast tissue and Genitalia were noted (Table 1). The total score was calculated. A score of ≥7 showing normal; 4-6 fairly low; ≤3 critically low fetal maturity. Secondary fetal outcomes Birth weight, APGAR score at 1 and 5 min, hypothermia & complications of prematurity (severe intraventricular hemorrhage, seizures, sepsis, hypoxic ischemic encephalopathy) were also noted. The data will be entered and analyzed using SPSS version 25. Quantitative variables like head circumference, mid-arm circumference and breast size, APGAR score, and birth weight are expressed as mean ± standard deviation. Qualitative variables like skin texture, ear form, gender & complications of prematurity are as frequency and percentages. Difference between all groups is assessed by applying a t-test or chi-square test. P values ≤ 0.05 are considered statistically significant.

Table 1: Modified Dubowitz Score

	Criterion	0	1	2	3	4	5
1	**Head circumference**	<25.4	≥25.4-<28.8	≥28. 8-<30.6	≥30.6-<33.4	≥33.4-<34.7	≥34.7
2	**Mid-arm circumference**	<6.9	≥6.9-<7.9	≥7.9-<8.6	≥8.6-<9.9	≥9.9-<10.7	≥10.7
3	**Skin texture**	Very thin gelatinous	Thin and smooth	Smooth, medium thickness, rash or superficial peeling	Slight thickening, superficial cracking and peeling, especially hands and feet	Thick parchment-like, superficial or deep cracking	
4	**Ear form**	Pinna flat or shapeless, little or no incurving of edge	Incurving part of the edge of the pinna	Partial incurving of whole pinna	Well-defined incurving of the whole pinna		
5	**Breast tissue**	No breast tissue palpable	Breast tissue on one or both sides <0.5cm diameter	Breast tissue on both sides, one or both sides 0.5-1cm	Breast tissue on one or both sides >1cm		
6	**Male genitalia**	No testis in the scrotum	At least one testis high in the scrotum	At least one testis right down			
	Female genitalia	Labia majora widely separated, labia minora protruding	Labia majora almost cover labia minora	Labia majora completely cover labia minora			

Score	**Maturity**
≤3	Critically Low fetal maturity
4-7	Fairly low fetal maturity
≥7	Normal maturity

3. Results

A total of 300 neonates delivered in the hospital were included and sub-divided into 3 groups.

Group A included neonates delivered between 28^{+0} - 35^{+6} weeks, Group B between 36^{+0} - 36^{+6} weeks and Group C between 37^{+0} - 37^{+6} weeks.

Head circumference: Table no 2 shows that in group A maximum number of neonates have a score of 3 (N=59) followed by a score of 2 (N=20). In group B maximum neonates have a score of 5(N=59) followed by 4 (N=38). In group C maximum neonates have a score of 5 (N=55) followed by a score of 4 (N=44). which shows that head circumference was normal and comparable in groups B and C.

Mid-arm circumference: In group A maximum neonates have a score of 2 (N=47) followed by a score of 3 (N=44). In group B maximum neonates have a score of 3 (N=59) followed by score 2(N=29). In group C maximum neonates have a score of 3 (N=55%) followed by a score of 4 (N=30). The majority of neonates in groups B and C have comparable mid-arm circumferenceSkin texture: In group A maximum neonates have a score of 2(N=88).

Table 2: Modified Dubowitz score in all three groups

SN	Parameters	Score	28+0 to 35+6 (Group A) N=100	36+0 to 36+6 (Group B) N=100	37+0 to 37+6 (Group C) N=100	P Value
1	Head circumference (cm)	≥25.4-<28.8 =1 ≥28.8 -<30.6 = 2 ≥30.6-<33.4 =3 ≥33.4 -<34.7 =4 ≥34.7 =5	5 (5%) 20 (20%) 59 (59%) 14 (14%) 2 (2%)	3 (3%) 38 (38%) 59 (59%)	1 (1%) 44 (44%) 55 (55%)	0.000
2	Mid-arm circumference (cm)	≥6.9 - <7.9 =1 ≥7.9 - <8.6 =2 ≥8.6 -<7.9 =3 ≥9.9 - <10.7 =4 ≥10.7 =5	6 (6%) 47 (47%) 44 (44%) 3(3%)	29 (29%) 59 (59%) 12(12%)	13(13%) 55(55%) 30(30%) 2(2%)	0.000
3	Skin texture	Thin and smooth =1 Smooth, medium, thickness, superficial Peeling =2 Slight, thickening, superficial cracking =3 Thick and superficial or deep thickening =4	3(3%) 88(88%) 9(9%)	8(8%) 69 (69%) 18(18%) 5(5%)	62(62%) 34(34%) 4(4%)	0.000
4	Ear form	Incurving of part of the edge of pinna =1 Partial incurving of the whole of pinna =2 Well-defined incurving of the whole of Pinna =3	3(3%) 61(61%) 36(36%)	18(6%) 82(82%)	11(11%) 89(89%)	0.000
5	Breast tissue	Breast tissue on one or both sides <0.5cm =1 Breast tissue on both sides one or both 0.5 to 1cm =2 Breast tissue on both sides one of two > 1cm =3	13(13%) 59(59%) 28(28%)	9(9%) 91(91%)	1(1%) 99(99%)	0.000
6	Male genitalia	At least one testis high in scrotum =1 At least one test right down =2	25 30	8 36	2 48	0.000
	Female genitalia	Labia major almost covers labia minor = 1 Labia major completely covers labia minor =2	30 15	5 51	2 48	

In group B maximum neonates have a score of 2(N=69) followed by a score of 3 (N=18). In group C maximum neonates have a score of 2 (N=62) followed by a score of 3 (N=34). Skin texture gets better as gestational age advances.

Ear form: In group A maximum neonates (N= 61) have a score of 2. In group B maximum neonates have a score of 3(N=82). In group C maximum neonates have a score of 3 (N=89). No significant difference was noted between groups B and C regarding ear form.

Breast tissue In group A maximum neonates have a score of 2(N=59) followed by a score of 3(N=28). In group B maximum neonates have a score of 3(N=91). In group C maximum neonates have a score of 3 (N=99). Breast tissue development was normal in the majority of neonates

Development of genitalia In group A maximum neonates have a score of 1 (N=55). In groups B and C maximum neonates have a score of 2(N=183).

Results showed that the mean Dubowitz score was low in neonates delivered at a gestational age of 28^{+0} to 35^{+6} but the score was comparable in groups B and C.

The mean age of the mothers was comparable in all three groups.

In all three groups, almost 3/4 of mothers were delivered vaginally and 1/4 by elective Cesarean section.

Table 3: Total Modified Dubowitz Score in 3 groups

Group	Mean ±SD	P-Value
28^{+0} to 35^{+6}	13.19±1.905	0.211
36^{+0} to 36^{+6}	17.02±1.25	
37^{+0} to 37^{+6}	18.05±1.22	

A significant difference was noted between the groups regarding the mode of delivery as the P value is 0.025.

There is no significant difference regarding the gender-wise distribution of neonates in the three groups. The mean weight of neonates was comparable in group B (36^{+0} to 36^{+6}) and group C (37^{+0} to 37^{+6}) which shows that the neonates attain appropriate weight even at 36 weeks while in groups A mean weight was 2.067 kg as this group comprised of preterm neonates. The APGAR score of neonates at 1 min and 5 min is comparable in

group B and group C while a little low APGAR score is in group A.

Secondary fetal outcome of neonates showed that hypothermia, NICU admission, need for resuscitation and neonatal morbidity were significantly higher in group A as compared to group B and group C.

Table 4: Demographic details of mother and neonates

SN	Parameters					p-value
			Maternal outcomes			
			28^{+0} to 35^{+6}	**36^{+0} to 36^{+6}**	**37^{+0} to 37^{+6}**	
1.	**Mean Age of mother**		23.7±4.3	25.5±4.4	24.1±4.1	0.039
2.	**Mode of delivery**	**SVD**	74(24.6%)	87((87%)	70(70%)	0.025
		LSCS	26(8.6%)	13(4.3%)	30(30%)	
		Fetal outcomes				
			28^{+0} to 35^{+6}	**36^{+0} to 36^{+6}**	**37^{+0} to 37^{+6}**	
3.	**Gender**	**Male**	55(55%)	44(44%)	50(50%)	0.297
		Female	45(45%)	56(56%)	50(50%)	
4.	**Weight in kg (Means)**		2.06±0.65	2.68±0.47	3.03±0.46	0.000
5.	**APGAR score (Range)**	**1 min**	4-8	6-8	7-8	.000
		5 min	6-10	8-10	8-10	
6.	**Hypothermia**	**Present**	26(26%)	8(8%)	7(7%)	0.000
		Absent	74(74%)	92(92%)	93(93%)	
7.	**NICU admission**	**Yes**	39(39%)	4(4%)	5(5%)	0.000
		No	61(61%)	96(96%)	95(95%)	
8.	**Need for resuscitation**	**Yes**	17(17%)	3(3%)	2(2%)	0.000
		No	83(83%)	97(97%)	98(98%)	
9.	**Major neonatal morbidity**	**Present**	44(44%)	10(10%)	7(7%)	0.000
		Absent	56(56%)	90(90%)	93(93%)	

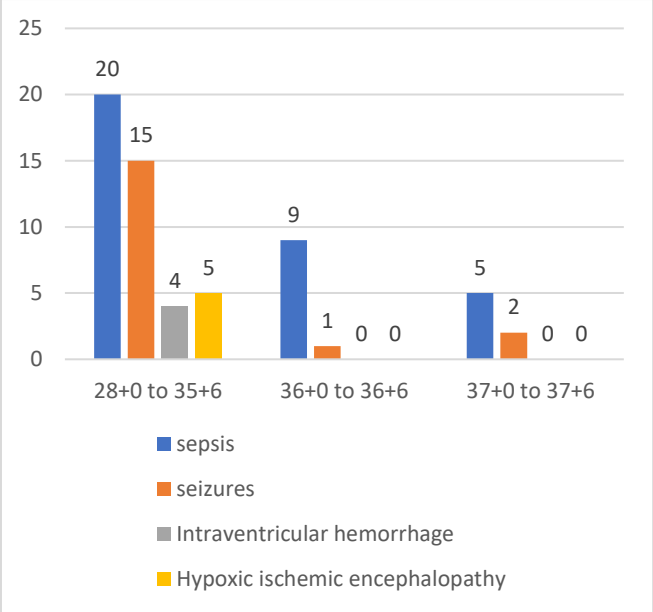

Figure 1: Neonatal morbidity in three groups

One-fourth of the total neonates suffered from major neonatal morbidity, out of which sepsis was on top followed by seizures. (Figure 1)

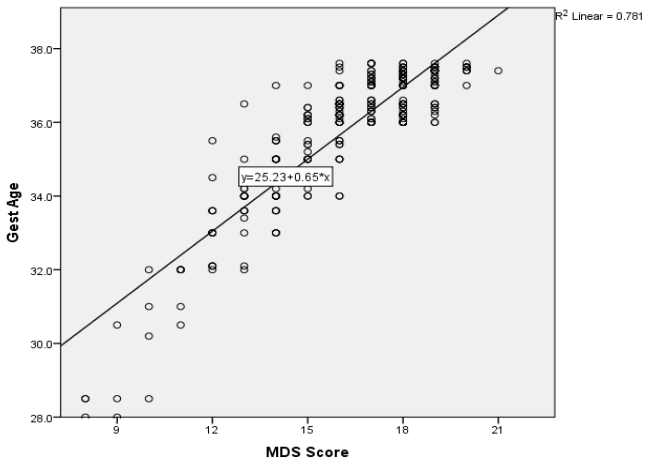

Figure 2: Scatter plot showing the correlation of gestational age and Modified Dubowitz Score

The above plot shows a strong positive linear correlation between gestational age ≥ 36 weeks and Dubowitz score. Outliers are more below this gestation

Correlations

		Gest Age	MDS Score
Gest Age	Pearson Correlation	1	.884**
	Sig. (2-tailed)		.000
	N	300	300
MDS Score	Pearson Correlation	.884**	1
	Sig. (2-tailed)	.000	
	N	300	300

***. Correlation is significant at the 0.01 level (2-tailed).*

4. Discussion

Reducing preterm birth-related morbidity and death in low- and middle-income countries by accurately determining gestational age is a critical public health goal. Traditionally, postnatal clinical evaluation of newborn maturity has supplanted the determination of gestational age, posing challenges in identifying the most accurate assessment tool due to a dearth of data comparing various grading systems. Furthermore, the quality of published material on the accuracy of scoring instruments is compromised by potential bias in patient selection, testing methodology, and reference standards. Nevertheless, the Dubowitz and Ballard techniques emerge as the predominant assessment instruments, with 26 research studies validating the Dubowitz Score, particularly in lower-middle-income nations.[18]

In the systematic review encompassing 18 published papers, the Dubowitz and Ballard scores were the predominantly utilized instruments, corroborated either by ultrasonography dating or maternal recollection of the previous menstrual cycle. The Dubowitz score demonstrated a remarkable ability to date newborns within 2.6 weeks of ultrasound dating, while the Ballard score achieved a comparable precision within 3.8 weeks. These findings underscore the reliability of the Dubowitz technique, attributing its efficacy to the positive correlation between accuracy and the number of evaluated factors. However, it is noteworthy that the Dubowitz technique demands proficient administration, necessitating staff training and a lengthier completion time (typically 15 to 20 minutes).[19]

Complications arise in clinical settings where preterm newborns may be erroneously classified as full-term, potentially overlooking their vulnerability. Conversely, newborns with developmental restrictions may have their gestational age underestimated. Scholars such as Dubowitz and Finnstrom posit that the individual components of physical assessment are more closely associated with gestational age. Additionally, this study's findings lend support to the concept of early maturation among the Asian population.

This investigation assesses the performance of a modified Dubowitz technique in determining gestational age within our population, demonstrating its utility across diverse groups with a fair degree of accuracy. Notably, the mean Dubowitz score for the studied groups at 36 weeks suggests sufficient fetal maturation in high-risk pregnancies, aiming to avert adverse outcomes and reduce morbidity.[20,21]

The study reveals a median correlation value of 0.6 for various physical and neurologic symptoms employed in different scoring systems, indicating a reasonable to moderate association with gestational age. Despite potential influences from newborn morbidity, neurologic indicators exhibit association coefficients comparable to physical criteria. Given that our study exclusively utilizes physical indicators, it presents a practical option for obstetricians in low-resource settings where access to paediatricians may be challenging.[22]

With a median correlation value of 0.6, the majority of distinct physical and neurologic symptoms that have been employed in various scoring systems show a reasonable to moderate association with gestational age. The majority of neurologic indicators had association coefficients that were comparable to the physical criteria, despite the possibility that neurologic signals are more influenced by newborn morbidity (birth hypoxia, neonatal infection, maternal medicines, etc.). Since we are simply using physical indicators in our study, even obstetricians can utilize them in low-resource situations where finding paediatricians is challenging.

The degree of training of the assessor determines the validity of a clinical examination. Few research included front-line healthcare workers, while the majority of studies named doctors, nurses, or midwives as assessors. The majority of research on newborn assessments has been conducted in hospital settings, with a small number of studies conducted at home with less successful outcomes. The assessor for this study was a front-line PGT working in a hospital. The timing of the examination—later after delivery—the more regulated atmosphere, and the illumination are some of the

elements that might increase the validity in the hospital setting.

The way that some traits emerge might differ depending on one's ethnicity. For instance, skin colour differs among ethnic groups, and different populations may perceive or score certain symptoms connected to skin colour differently. Additionally, the maturity evaluation may be impacted by gestational diabetes, which is more prevalent in certain ethnicities (African Americans and Asians). Lastly, the gestational age ranges in which an evaluation is performed, as in our study, may also have an impact on how well it performs.

Many of the scoring systems, for instance, were created and tested in NICU populations that had higher proportions of premature newborns. In the general community, where late preterm and near-term newborns are more prevalent, the validity and performance of the evaluations could change. When evaluating the newborn evaluation for gestational age dating in low- and middle-income countries (LMICs), feasibility and scalability are crucial considerations. A review paper found a favourable relationship between the accuracy of a gestational evaluation and the number of parameters.

However, the number of characteristics, especially neurological ones, is likely to have a negative association with usability. The Dubowitz examination has the same accuracy as newborn clinical exams, but it has more difficult-to-train neurologic criteria, is complex (21 signs), and may take 15 to 20 minutes to complete. In South Asia and Sub-Saharan Africa, around half of births occur outside of hospitals, and traditional birth attendants or community-based health providers may be the newborns' first point of contact. Probably, these medical personnel don't have the training, expertise, or time necessary to do the test properly.

A gestational age assessment technique's evaluation has to consider several crucial elements, such as the assessment's duration, the training method's viability, standardization, and quality control. A relatively simple instrument based on a single attribute, like foot size or similar anthropometric measure, might be effective in meeting these needs. Estimates of preterm birth rates and the epidemiologic connections with preterm birth at the population level can be distorted by imprecise and inaccurate gestational age dating. Selecting the right gestation age measuring technique for low- and middle-income countries (LMIC) requires figuring out the ideal precision (i.e., a 95 per cent confidence interval of +/-1, 2, vs. 3 weeks) and diagnostic accuracy.

Enhancing gestational age dating is essential for measuring the worldwide burden of preterm birth and SGA diseases and for delivering efficient treatments to enhance the development and survival of these high-risk groups.

5. Conclusion

According to the study's findings, newborns of varying gestational ages can benefit from using the Modified Dubowitz score as a valuable tool to predict fetal development. The study comes to the additional conclusion that the idea of the earlier maturation of the Asian population is valid in our community. This will help us make decisions about when to do iatrogenic premature delivery, particularly in complex instances.

INSTITUTIONAL REVIEW BOARD

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Contributions:

A, S.S.S, S.A - Conception of study
L.E - Experimentation/Study Conduction
H.B - Analysis/Interpretation/Discussion
A, H.N - Manuscript Writing
L.E, S.S.S, H.N - Critical Review

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