Relation of Apgar Score to Neonatal Mortality among Preterm Newborn

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Abstract

Background: Gestational age is the major determinant of neonatal death in preterm infants. Preterm birth is the leading cause of neonatal death, and the risk of neonatal death increases with the degree of preterm birth. The Apgar score consists of five components (heart rate, respiratory effort, muscle tone, reflex irritability, and color), each given a value from 0 to 2. Thus, total scores range from 0 to 10, with higher scores indicating a better physical condition. A low Apgar score, commonly defined as less than 4 or less than 7. The aim of this study was to assess between apgar score and mortality in preterm neonate in Zagazig university. **Methods:** This was a prospective cohort study carried out in Neonatal intensive care unit in Zagazig University Children Hospitals for 6 months. The estimated sample was 58 neonates. **Results:** The present study revealed that females represented 55.2% of patients. Concerning causes of preterm delivery, 51.7%, 20.7%, 13.8% and 10.3%, 3.4% had PROM, preterm contraction, hypertension, antepartum hemorrhage and Preeclampsia. Our study showed that regarding outcome of the studied patients, 65.5% died and 34.5% discharged alive. There is statistically significant relation between outcome and APGAR score at 1 minute, 5 minutes and at 10 minutes. The best cutoff of APGAR at 1 minute in prediction of mortality is ≤6.5 so if APGAR score 6 or less can predict mortality with area under curve 0.961, with sensitivity 92.1%, specificity 90%, positive predictive value 94.6%, negative predictive value 85.7% and accuracy 91.4% ($p<0.001$) . The best cutoff of APGAR at 5 minutes in prediction of mortality is ≤7.5 so if APGAR score 7 or less can predict mortality with area under curve 0.944, with sensitivity 84.2%, specificity 95%, positive predictive value 97%, negative predictive value 76% and accuracy 87.9% ($p<0.001$).The best cutoff of APGAR at 10 minutes in prediction of mortality is ≤8.5 so if APGAR score 8 or less can predict mortality with area under curve 0.914, with sensitivity 84.2%, specificity 90%, positive predictive value 94.1%, negative predictive value 75% and accuracy 86.2% ($p<0.001$)**. Conclusion:** Low Apgar score was associated with increased mortality in premature neonates.

Key words: Apgar Score - Neonatal Mortality - Preterm Newborn

Introduction:

Gestational age is the major determinant of neonatal death (death within the first 28 days of life) in preterm infants [(1).]

Preterm birth (≤36 completed gestational weeks) is the leading cause of neonatal death, and the risk of neonatal death increases with the degree of preterm birth [(1).]

However, other factors also influence the risk of neonatal death. In a systematic review of studies involving very preterm infants (≤31 completed gestational weeks), the risk of death was lower among infants with a normal birth weight for gestational age, female infants, infants receiving glucocorticoids prenatally, and infants with higher 5-minute Apgar scores [(1).]

Dr. Virginia Apgar developed a score to assess the physical condition of the newborn and the need for resuscitation.Initially, the score was measured at 1 minute, but the Apgar score at 5 minutes was later shown to be a better predictor of neonatal survival [(1).]

Apgar score was devised with the aim to standardize the assessment of newborns. It has been used worldwide to evaluate infants' condition immediately after birth, to determine their need for resuscitation, and to evaluate the effectiveness of resuscitation [(2).]

The Apgar score consists of five components (heart rate, respiratory effort, muscle tone, reflex irritability, and color), each given a value from 0 to 2. Thus, total scores range from 0 to 10, with higher scores indicating

a better physical condition. A low Apgar score, commonly defined as less than 4 or less than 7. Apgar score was developed primarily to assess term infants during a time when neonatal mortality was very high among preterm infants. The frequency of low Apgar scores increases with decreasing gestational age and may reflect biologic immaturity in preterm infants. Extremely preterm infants (<28 weeks) and very preterm infants (28 to 31 weeks) in particular may seem less vigorous and be assigned a lower score because of an immature breathing drive and lower muscle tone. The value of the Apgar score to assess the condition of the preterm infant has therefore been questioned.Previous studies involving preterm infants, which used broad categories of Apgar score values (0 to 3, 4 to 6, and 7 to 10, or 0 to 3 and 4 to 10), showed increased relative risks of neonatal death with decreasing 5-minute Apgar score. A low Apgar score (0 to 3) has also been associated with a substantially increased risk of death among extremely preterm infants [(1)].

Neonatal infections, asphyxia related complications, respiratory distress, and neonatal hypoglycaemia were higher among infants with lower Apgar scores, especially at 5 and 10 minutes [(3)].

The aim of this study was to assess between apgar score and mortality in preterm neonate in Zagazig university.

Patients and Methods

I. Technical design:

Site of the study:

This study was carried out in Neonatal intensive care unitin Zagazig University Children Hospitals.

Sample size:

Assuming neonatal death's at apgar score 8 vs apgar score 2 was 8.2% vs 42.6%. At 80 power and 95% CI The estimated sample was 58 neonates Open epi.

Target population :

Preterm newborn <37 wk

Duration of study : 6 months

Inclusion criteria :

- **Preterm Newborn <37 weeks**
- **Lives in SHARKIA Governorate .**
- **Delivered to Neonatal Intensive Care Unit in Zagazig University Children Hospital.**

Exclusion criteria :

Full term newborn >37 weeks

II. Operational design:

Type of study: prospective cohort study.

Steps of performance:

All neonates included in the study were subjected to the following :

(1) **Detailed history taking:**

With special focus on gestational age (fullterm- preterm) , full maternal history, delivery history (antenatal, natal, postnatal). Gender, age, birth order, history of multiple pregnancy and social class, mode of delivery , maternal age. Antenatal history of maternal risk factors, cause of admission, need for oxygen, length of hospital stay and need for MV

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 07, 2021

Assessment of the gestational age in most of the neonatal units in sick infants or those in incubators by The New Ballard score (NBS) [4].

Preterm birth was stratified into extremely preterm (fewer than 28 weeks), very preterm (28 to 32 weeks), moderate to late preterm (32 to 37 weeks).

(2)**Full clinical examination:**

General examination: With special focus on vital signs (temperature, HR, RR ,BP). anthropometric measurements

Local examination to chest, heart, abdomen.

(3)**APGAR Score:**

At 1,5,10 minutes.

Examine scoring of:

- Breathing effort
- Heart rate
- Muscle tone
- Reflexes
- Skin color

Each category was scored with 0, 1, or 2, depending on the observed condition. [5].

Breathing effort:

- If the infant was not breathing, the respiratory score was 0.
- If the respirations were slow or irregular, the infant scores 1 for respiratory effort.
- If the infant cried well, the respiratory score was 2.

Heart rate :

If there was no heartbeat, the infant scores 0 for heart rate.

- If heart rate was less than 100 beats per minute, the infant scores 1 for heart rate.
- If heart rate was greater than 100 beats per minute, the infant scores 2 for heart rate.

Muscle tone:

- If muscles were loose and floppy, the infant scores 0 for muscle tone.
- If there was some muscle tone, the infant scores 1.
- If there was active motion, the infant scores 2 for muscle tone.

Grimace response or reflex irritability :

- If there was no reaction, the infant scores 0 for reflex irritability.
- If was eas grimacing, the infant scores 1 for reflex irritability.
- If there was grimacing and a cough, sneeze, or vigorous cry, the infant scores 2 for reflex irritability.

Skin color:

- If the skin color was pale blue, the infant scores 0 for color.
- If the body was pink and the extremities were blue, the infant scores 1 for color.
- If the entire body was pink, the infant scores 2 for color.

Interpretation :

Infants in poor condition scored 0-2, infants in fair condition scored 3-7, while scores 8-10 were achieved by infants in good condition**.** [(6).]

4. Laboratory investigations :

- **ABG**
- **CBC**

Complete blood count (CBC) which include white blood cells count, red blood cells count (millions/ml), hemoglobin (g/dl), platelets count.

- **CRP**

Quantitative C-reactive protein (CRP) using Latex agglutination test, Rapitex CRP kit.

(5)Follow up till discharge from NICU.

III. Administrative Design:

- The study protocol was submitted for approval by Zagazig University Institutional Review Board (IRB).
- Consent was obtained from patient's parents.

Statistical analysis

All data were statistically analyzed by statistic package for science software (version16), calculate every continuous variable in the study

To compare between the two groups, t-test,x^2 and Fischer exact test was applied appropriate.

A P-value ≤ 0.05 was consider statically significant.

- **The used tested were:**
- **1-chi-square test:** For categorical variables, to compare between different groups.
- **2-pearson and spearman rank correlation** coefficient analysis
- Correction between two groups
- **3- Receiver operating characteristic curve (ROC):** To permit the selection of threshold values and comparison of different test strategy allowing the calculation of sensitivity and specify positivity and negativity.

- **4- Regression analysis:** Logistic and linear regression analyses were used for prediction of risk factors.
- N.B: p is significant if <0.05 at confidence interval 95%.

Results:

This table shows that females represented 55.2% of patients. About 93% of patients had been delivered by singleton pregnancy. Regarding order in family, 32.8%, 32.8%, 15.5%, 12.1%, 3.4% and 3.4% were first, second, third, fourth, fifth and sixth respectively. Concerning socioeconomic status, 65.5%, 29.3% and 5.2% came from low, mild and moderate SES. Weight ranged from 0.95 to 2.8 kg with mean 1.71 kg. Length ranged from 37 to 50 cm with mean 40.62 cm. head circumference ranged from 27 to 33 cm with mean 30.15 cm **Table (1).**
This table shows that 3.4%, 36.2% and 60.3% were extremely preterm, very preterm and moderate to late preterm. About 17% of mothers had hypertension and 8.6% had vaginal bleeding. Concerning causes of preterm delivery, 51.7%, 20.7%, 13.8% and 10.3% had PROM, preterm contraction, hypertension, and antepartum hemorrhage. Maternal age ranged from 16 to 32 years with mean 24.62 years and 74.1% of patients had been delivered by CS **Table (2).**

Concerning cause of admission, 60.3%, 58.6%, 25.9%, 5.2%, 5.2%, 1.7%, and 1.7% had low birth weight, RD III, RD II, IUGR, RD IV, sepsis, down syndrome. About 62% need only suction and 37.9% need ambu bag and suction. Duration of hospitalization ranged from 4 hours to 40 days with median 10 days. Concerning respiratory support, 60.3% needed MV, 56.9% needed NCPAP, 37.9% needed nasal oxygen, 19% needed HFNC and 5.2% needed CPAP. About 93% of patients received unasyn and gentamycin, 53.4%, 46.6%, 44.8%, 37.9%, 17.2%, 10.3% and 5.2% received tazocin, meronem, amikacin, vancomycin, tigecycline, ciprofloxacin, zovirax respectively **Table (3)**.
APGAR score at 1 minute ranged from 2 to 9 with mean 5.52 with 20.7% had scores from 0 to 3, 43.1% had scores from 4 to 6 and 36.2% had scores from 7 to 10.

APGAR score at 5 minutes ranged from 3 to 10 with mean 6.62 with 6.9% had scores from 0 to 3, 39.7% had scores from 4 to 6 and 53.4% had scores from 7 to 10.

APGAR score at 10 minutes ranged from 3 to 10 with mean 7.21 with 1.7% had scores from 0 to 3, 39.7% had scores from 4 to 6 and 58.6% had scores from 7 to 10 **Table (4)**.

PH non-significantly changed from 7.31 to 7.314, CO2 non-significantly increased from 33.64 to 35.02, HCO3 non-significantly increased from 16.56 to 16.91. Hemoglobin significantly decreased from 16.01 g/dL to 14 g/dL. Platelet non-significantly decreased from 224.6 to 213.96 ($10^3/mm^3$). White blood cells non-significantly increased form 9.7 to 11($10^3/mm^3$) **Table (5).**
Concerning outcome of the studied patients, 65.5% died and 34.5% discharged alive **Table (6).**
This table shows that there is statistically significant relation between outcome and APGAR score at 1 minute. About 32% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 10% win the group discharged alive had APGAR score (0 – 3). About 8% among those who died versus 90% win the group discharged alive had APGAR score (7 – 10) **Table (7).**
This table shows that there is statistically significant relation between outcome and APGAR score at 5 minutes. About 11% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 29% among those who died versus 100% win the group discharged alive had APGAR score (7 – 10) **Table (8).**
This table shows that there is statistically significant relation between outcome and APGAR score at 10 minutes. About 3% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 0% win the group discharged alive had

APGAR score (0 – 3). About 37% among those who died versus 100% win the group discharged alive had APGAR score (7 – 10) **Table (9).**
The best cutoff of APGAR at 1 minute in prediction of mortality is ≤6.5 so if APGAR score 6 or less can predict mortality with area under curve 0.961, with sensitivity 92.1%, specificity 90%, positive predictive value 94.6%, negative predictive value 85.7% and accuracy 91.4% (p<0.001)

The best cutoff of APGAR at 5 minutes in prediction of mortality is ≤7.5 so if APGAR score 7 or less can predict mortality with area under curve 0.944, with sensitivity 84.2%, specificity 95%, positive predictive value 97%, negative predictive value 76% and accuracy 87.9% (p<0.001)

The best cutoff of APGAR at 10 minuteس in prediction of mortality is ≤8.5 so if APGAR score 8 or less can predict mortality with area under curve 0.914, with sensitivity 84.2%, specificity 90%, positive predictive value 94.1%, negative predictive value 75% and accuracy 86.2% (p<0.001) **Table (10).**

Table (1) Baseline data of the studied patients:

	N=58	%
Gender:		
Male	26	44.8%
Female	32	55.2%
Multiple pregnancy:		
No (singleton)	54	93.1%
Twins	3	5.2%
Triplet	1	1.7%
Order in family:		
First	19	32.8%
Second	19	32.8%
Third	9	15.5%
Fourth	7	12.1%
Fifth	2	3.4%
Sixth	2	3.4%
SES:		
Low	38	65.5%
Mild	17	29.3%
Moderate	3	5.2%
	Mean ± SD	Range
Weight (kg)	1.71 ± 0.46	0.95 – 2.8
Length (cm)	40.62 ± 2.48	37 – 50
Head circumference	30.15 ± 1.52	27 – 33

Table (2) Prenatal data of the studied patients:

	N=58	%
Gestational age (week):		
Mean ± SD	32.29 ± 2.7	
Extremely preterm	2	3.4%
Very preterm	21	36.2%
Moderate to late preterm	35	60.3%
Mode of delivery:		
NVD	15	25.9%

CS	43	74.1%
Maternal age (year): Mean ± SD Range	 24.62 ± 3.93 16 – 32	
Antenatal history: No MRF Anhydramnios Hypertension PE and diabetes Cord abnormalities Placenta previa Tender scar Vaginal bleeding	 35 3 10 2 1 3 2 5	 60.3% 3.4% 17.2% 1.7% 1.7% 5.2% 3.4% 8.6%
Cause of preterm delivery: Antepartum hemorrhage Cord problem Hypertension Multiple pregnancy PROM Preeclampsia Polyhydramnios Anhydramnios Multiple pregnancy IUFD IUGR Preterm contraction Tender scar	 6 1 8 3 30 2 1 2 2 1 1 12 4	 10.3% 1.7% 13.8% 5.2% 51.7% 3.4% 1.7% 3.4% 3.4% 1.7% 1.7% 20.7% 6.9%

Table (3) Distribution of the studied patients according to cause of admission and need for oxygen in resuscitation:

	N=58	%
Cause of admission Low birth weight RD II RD III RD IV Sepsis Down syndrome IUGR	 35 15 34 3 1 1 3	 60.3% 25.9% 58.6% 5.2% 1.7% 1.7% 5.2%
Need for O2: Suction only Suction and ambu bag	 36 22	 62.1% 37.9%
Antibiotic: Unasyn and gentamycin Tazocin Meronem Amikacin Cipro Zovirax	 54 31 27 26 6 3	 93.1% 53.4% 46.6% 44.8% 10.3% 5.2%

Vancomycin Tigecycline	22 10	37.9% 17.2%
Duration of hospitalization: Median Range	 10 days 4 hours – 40 days	
Respiratory support: Nasal O2 HFNC NCPAP CPAP MV	 22 11 33 3 35	 37.9% 19.0% 56.9% 5.2% 60.3%

Table (4) APGAR score of the studied patients:

		Mean ± SD	Range
APGAR 1 minute		5.52 ± 2.11	2 – 9
APGAR 5 minutes		6.62 ± 2.14	3 – 10
APGAR 10 minutes		7.21 ± 2.22	3 – 10
	1 minute	5 minutes	10 minutes
0 – 3	12 (20.7%)	4 (6.9%)	1 (1.7%)
4 – 6	25 (43.1%)	23 (39.7%)	23 (39.7%)
7 – 10	21 (36.2%)	31 (53.4%)	34 (58.6%)

Table (5) ABG and laboratory data of the studied patients:

	First visit	Follow up	t	p
	Mean ± SD	Mean ± SD		
PH	7.31 ± 0.129	7.314 ± 0.115	-0.298	0.767
CO2	33.64 ± 10.47	35.02 ± 11.35	-0.761	0.45
HCO3	16.56 ± 3.96	16.91 ± 5.04	-0.714	0.479
Hemoglobin	16.01 ± 2.48	14 ± 2.53	4.97	<0.001**
Platelet	224.6 ± 66.59	213.96 ± 83.36	1.699	0.095
	Median(range)	Median(range)	Z	p
WBCs	9.7 (2 – 60)	11 (2.6 – 43)	-0.296	0.767

t Paired sample t test Z Wilcoxon signed rank test **p≤0.001 is statistically highly significant

Table (6) Distribution of the studied patients according to outcome:

	N=58	%
Outcome: Died Discharged alive	 38 20	 65.5% 34.5%

Concerning outcome of the studied patients, 65.5% died and 34.5% discharged alive

Table (7) Relation between outcome and APGAR at 1 minute of the studied patients:

Parameter	Outcome		χ^2	p
	Died	Discharged		
	N=38(%)	N=20(%)		
APGAR: 0 – 3 4 – 6 7 – 10	 12 (31.6%) 23 (60.5%) 3 (7.9%)	 0 (0%) 2 (10.0%) 18 (90.0%)	30.544	<0.001**
Mean ± SD	4.32 ± 1.51	7.8 ± 0.77	t-11.655	<0.001**

χ^2Chi square for trend test t independent sample t test **p≤0.001 is statistically highly significant

Table (8) Relation between outcome and APGAR at 5 minutes of the studied patients:

Parameter	Outcome		χ^2	p
	Died	Discharged		
	N=38(%)	N=20(%)		
APGAR: 0 – 3 4 – 6 7 – 10	 4 (10.5%) 23 (60.5%) 11 (28.9%)	 0 (0%) 0 (0%) 20 (100%)	22.16	<0.001**
Mean ± SD	5.5 ± 1.74	8.75 ± 0.79	-9.789	<0.001**

χ^2Chi square for trend test t independent sample t test **p≤0.001 is statistically highly significant

Table (9) Relation between outcome and APGAR at 10 minute of the studied patients:

Parameter	Outcome		χ^2	p
	Died	Discharged		
	N=38(%)	N=20(%)		
APGAR: 0 – 3 4 – 6 7 – 10	 1 (2.6%) 23 (60.5%) 14 (36.8%)	 0 (0%) 0 (0%) 20 (100%)	19.926	<0.001**
Mean ± SD	6.11 ± 1.91	9.3 ± 0.8	-8.911	<0.001**

χ^2Chi square for trend test t independent sample t test **p≤0.001 is statistically highly significant

Table (10) Performance of APGAR score at 1, 5 and 10 minutes in prediction of mortality among the studied patients:

APGAR	Cutoff	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy	p
1 minute	0.961	≤6.5	92.1%	90%	94.6%	85.7%	91.4%	<0.001**
5 minutes	0.944	≤7.5	84.2%	95%	97%	76%	87.9%	<0.001**
10 minutes	0.914	≤8.5	84.2%	90%	94.1%	75%	86.2%	<0.001**

**p≤0.001 is statistically highly significant NPV negative predictive value PPV positive predictive value AUC area under curve

Discussion

The present study revealed that females represented 55.2% of patients.
This was agreement with an Egyptian study **Mona et al., [7]** which reported that male ratio were (42.7%) less than female's ratio (57.3%).
The present study revealed that, concerning causes of preterm delivery, 51.7%, 20.7%, 13.8% and 10.3%, 3.4% had PROM, preterm contraction, hypertension, antepartum hemorrhage and Preeclampsia.
Abdelhady & Abdelwahid [8] reported that maternal morbidity, especially anemia was associated with the development of PTBs because it interferes with intra-uterine fetal growth. The same result may be obtained if blood supply of the fetus was interfered with by any cause as hemorrhage or hypertension.
In the current study about 17% of mothers had hypertension, 8.6% had vaginal bleeding and 5.3% had Placenta previa.
Abdelhady & Abdelwahid [8] reported that fetal and placental abnormalities appeared more frequently among PTBs than Full-term ones. This can be attributed to concomitant conditions as intrauterine fetal retardation. If placenta was not properly functioning, the fetus may not grow as well as it should [9].
This study showed that, Head circumference ranged from 27 to 33 cm with mean 30.15 cm
Algameel et al. [10] reported that LPT neonates had significantly lower birth weight and head circumference, which agrees with some earlier reports [11].
The present study showed that regarding order in family, 32.8%, 32.8%, 15.5%, 12.1%, 3.4% and 3.4% were first, second, third, fourth, fifth and sixth respectively.
This coincidence with **Abdelhady & Abdelwahid [8]** reported that as regards relation between obstetric history and development of PTBs, it was found that parity had an effect, where (PTBs) were more likely to be the first baby rather than the second or more. Some studies considered that the small pregnant uterus in case of the first baby may not be yet well prepared to receive the coming baby and primi parity may be the most important contributing factor to preterm labor.
This study showed that, 74.1% of patients had been delivered by CS.
This is in similarity with **Algameel et al. [10]** who found that LPT neonates were more likely to be delivered by cesarean section than FT neonates. The most frequent indications for cesarean sections in LPT neonates were breech presentation and previous cesarean section. None of the CS was elective or indicated for maternal comorbidities. Cesarean sections in preterm deliveries are known to pose increased risks of neonatal morbidity and mortality [12].
Our study showed that regarding outcome of the studied patients, 65.5% died and 34.5% discharged alive.
This agreed with **Shrestha et al., [13]** who aimed to identify the indications for admission, complications, co-morbid conditions and outcome of those neonates in terms of survival. He found that there were 17 survivors (33.3%) and 34 non-survivors (66.7%).
This study showed that, There is statistically significant relation between outcome and APGAR score at 1 minute. About 32% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 10% win the group discharged alive had APGAR score (0 – 3). About 8% among those who died versus 90% win the group discharged alive had APGAR score (7 – 10)
Prematurity is associated with birth weight and, among those low-weight NB, there are the premature and the malnourished, who are children at risk of death, even in the absence of asphyxia, which is in agreement with the findings of this present study. The premature NB may be born vigorous and with an adequate Apgar score, but manifests worsening of its clinical condition and later dies. This fact may be explained perhaps because the association of mortality occurred more intensely with the low birth weight than with the low 1-minute Apgar scores, as was found in **Oliveira et al. [14]** study,

considering the significant association between the low Apgar and low weight with mortality. Although an Apgar > 3 does not mean absence of anoxia, its association with mortality shows that it identifies risk of early death in all classes of birth weight [(15).]

This agrees with **Razaz et al.** [(3)] who aimed to investigate associations between Apgar scores of 7, 8, and 9 (versus 10) at 1, 5, and 10 minutes, and neonatal mortality and morbidity. They reported that Pregnancy and delivery related factors, such as pre-eclampsia, chorioamnionitis, placental abruption, induced onset of labour, vaginal instrumental delivery, and meconium aspiration were associated with Apgar scores of 7 to 9 (versus 10), suggesting that low Apgar scores in the normal range represent early prognostic indicators highlighting the effects of pregnancy and delivery complications on neonatal morbidity.

Mu et al. [(16)] reported that it is necessary to note that neonatal mortality related to Apgar score is influenced by gestational age and that the effect of gestational age is different between the low and intermediate Apgar score groups. There is no doubt that the decreased Apgar score is related to the increased risk of neonatal mortality in both gestational age groups. However, the relative risk of an intermediate Apgar score for neonatal mortality decreased after 40 completed weeks of gestational age; conversely, the relative risk of a low Apgar score for neonatal mortality subsequently increased. In their study, no neonatal death was recorded when the Apgar score was 4–6 or 7–10 at 1 min.

Razaz et al. [(3)] found that only 11% of infants had an Apgar score of 10 at 1 minute, which is typically attributable to a reduction in score for skin colour. This finding warrants attention as our results show that an Apgar score of 9 at 1 minute was associated with higher risk of neonatal morbidity.

There is statistically significant relation between outcome and APGAR score at 5 minutes. About 11% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 29% among those who died versus 100% win the group discharged alive had APGAR score (7 – 10)

Oliveira et al. [(14)] reported that the 5-minute Apgar score below 7 may be considered an indicator of asphyxia and thus, would measure risk of death. The high frequency of deaths by asphyxia and malformations among NB with 5-minute Apgar < 7 showed a significant association with early mortality, although the greater number of deaths due to malformations occurred after seven days.

Mu et al. [(16)] who aimed to examine the association between the Apgar score and neonatal mortality over gestational age in China and to explore whether this association changed when Apgar scores were combined at 1 and 5 min. They reported that the neonatal mortality rates, in both the low- and intermediate-Apgar score groups, are much higher in our study (524 per 1000 live births and 132 per 1000 live births, respectively) than those of high-income countries [(15).]

According to **Getachew et al.** [(17),] prolonged duration of labor is significantly associated with low fifth minute Apgar score.

This study showed that, There is statistically significant relation between outcome and APGAR score at 10 minutes. About 3% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 61% among those who died versus 0% win the group discharged alive had APGAR score (0 – 3). About 37% among those who died versus 100% win the group discharged alive had APGAR score (7 – 10)

Razaz et al. [(3)] found that a lower Apgar score within the normal range at 1, 5, and 10 minutes is strongly associated with increased risks of neonatal mortality and morbidity. Their study expands on these findings by showing that even “normal” Apgar scores (7 to 9) are strongly associated with higher risks of neonatal mortality and neonatal morbidity, and neonatal morbidity is associated with risks of long term neurological disorders [(18).]

This study showed that, This study showed that, The best cutoff of APGAR at 1 minute in prediction of mortality is ≤6.5 so if APGAR score 6 or less can predict mortality with area under curve 0.961, with sensitivity 92.1%, specificity 90%, positive predictive value 94.6%, negative predictive value 85.7% and accuracy 91.4% ($p<0.001$) . The best cutoff of APGAR at 5 minutes in prediction of

mortality is ≤7.5 so if APGAR score 7 or less can predict mortality with area under curve 0.944, with sensitivity 84.2%, specificity 95%, positive predictive value 97%, negative predictive value 76% and accuracy 87.9% (p<0.001).The best cutoff of APGAR at 1*0* minutes in prediction of mortality is ≤8.5 so if APGAR score 8 or less can predict mortality with area under curve 0.914, with sensitivity 84.2%, specificity 90%, positive predictive value 94.1%, negative predictive value 75% and accuracy 86.2% (p<0.001)

Soliman, [19] found 5-min Apgar score were found to be independent predictor of neonatal mortality.

Conclusion:

Low Apgar score was associated with increased mortality in premature neonates.

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