



A REVIEW OF PHYSIOLOGICAL CHARACTERISTICS AND THEIR RESULTANT EFFECT ON THE JAUNDICE LEVEL.

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ABSTRACT: *Early delivery of neonates and reduction in birth weight, according to researchers, are mostly caused by jaundice in neonates, while yellowish color of the skin, yellowness of the eyes, and fingertips are its most common clinically visible symptoms as the age after birth increases. Jaundice results from high bilirubin levels and is a common condition particularly among neonates and persons with hepatic dysfunction. This paper reviews some physiological characteristics (e.g., yellowish color of the skin, gestation period, yellowness of the eyes, age of the child, weight of the child, etc.) and establishes if the level of jaundice would have a negative effect on them. Statistical analysis shows the significant inverse correlation between bilirubin levels and both birth weight and gestation duration and suggests that a lower infant birth weight is associated with a high jaundice level. A regression analysis establishes the gestational age and chronological age as significant predictors of birth weight, with the bilirubin's effect, though inversely related, having no statistical significance. Longer gestation and older age predict higher birth weight. Although bilirubin negatively impacts weight, it's not a strong predictor in the model. Finally, the bilirubin level may not be clinically revealed immediately after delivery and may also result in low birth weight and preterm delivery, and their relationship, if properly analyzed with hybrid machine learning tools, mathematical modeling and object-oriented programming language, can serve as a building block for a model that would diagnose jaundice non-invasively. These findings from this research provide a fundamental basis for clinicians in the prediction and management of jaundice risk based on physiological characteristics.*

KEYWORDS: Jaundice, Birth weight, Gestational period, Age.



INTRODUCTION

In West Africa, jaundice in childhood is a very rampant pediatric issue leading to a high morbidity and child mortality rate (Effiong & Ikpe, 1975). Within the past few years, research has significantly made progress in the understanding of the epidemiology of neonatal jaundice. On the part of statisticians and social scientists, they have analyzed the cultural and behavioral aspect of the epidemic as well as its impacts on families, communities and nations. It was also concluded that infant jaundice is a reoccurring pediatric case in different parts of the world. Most children born before their due date develop jaundice; this is as a result of not fully developed liver to aid in the excretion of excess bilirubin produced in the baby's blood and the liver is not mature enough to excrete it when necessary (Folorunso et al., 2015).

Over the years, visual examinations have been used to screen patients and are still important in clinical situations. Visual features are, however, subjective to the observer, and objectively quantifiable methods to support optical diagnosis are frequently used in the medical community. But this method cannot be totally relied upon because they lack bases and are done manually, separately and individually.

In this research, we are going to analyze those physiological characteristics that stand out when jaundice is mentioned, with respect to the jaundice level obtained from blood tests and state how the level of jaundice affects their stability or vice versa.

REVIEW OF RELATED LITERATURE

Neonatal jaundice is a condition caused as a result of elevated serum bilirubin levels, which affects 60% of term and 80% of preterm infants globally within the first week of life (Maisels et al., 2022). Different studies have identified the physiological variables such as birth weight, gestation period, bilirubin level and post-delivery age as key predictors of jaundice risk and severity. In a study to determine the prevalence and predisposing factors of neonatal jaundice done by Joseph, Helen and John (2011) in a health care facility in Delta State, two hundred and seventy-two (272) babies of age 1–30 days old born between June 2009 and June 2010 were examined daily for evidence of jaundice. After analyzing the data gathered, it was observed that children with low birth weight and Glucose-6-Phosphate Dehydrogenase (G6PD) deficiency were at high risk of having jaundice.

Seema and Shead (2011) established in their research that jaundice is a problem in babies in the first week of their existence. Almost 60 % of newborn children with jaundice show up in the first week of life but most of them begin to show clinical signs two days after birth, with 5–10% needing medical intervention or health care services. Muhammad et al. (2016) also did a clinical Review on neonates, which shows that jaundice might not be clinically visible at the birth of an infant. Brits et al. (2018) also stated in their research that jaundice might not have physical signs to make it easily detectable on the first day of delivery but many gradually develop within 48 hours after delivery.

Jangaard (2014) did an estimation of bilirubin level using BiliChek™, a transcutaneous bilirubin measurement device. The studies gave the effects of gestational age and the use of phototherapy devices. They concluded that most children born before their due date develop jaundice. Thomas et al. (2000) plotted a regression plot that revealed that preterm neonates are

at high risk of developing hyperbilirubinemia. Folorunso et al. (2015), in their study in which 232 neonates were examined for jaundice cases, also concluded that gestational age was a clear factor causing neonatal jaundice.

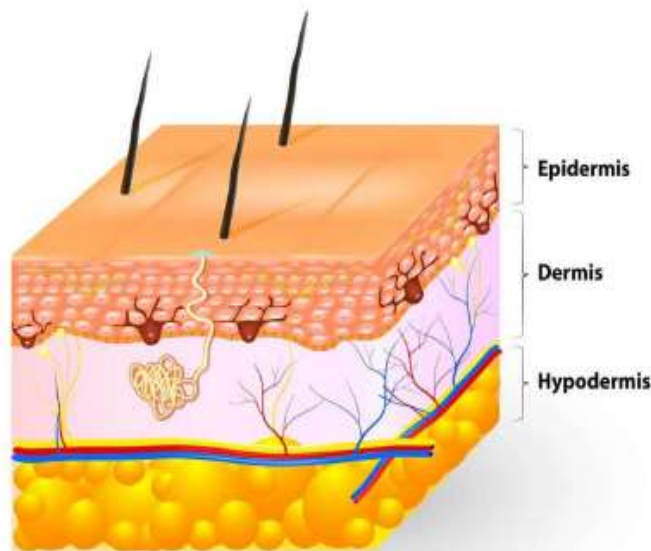
Hamid et al. (2003), who also conducted research, found a higher number of male jaundice neonates than female and stated that the high rate of jaundice in male neonates is a result of the presence of a lower enzyme level of the activities of G6PD in the male babies than in female babies. Louise et al., 2005 analyzed a data set of 869 children that went for phototherapy and came up with the 1:1.3 ratio of boys to girls. Kolawale et al. (2015) also during his research concluded that though the number of female children delivered was more during the period of his work, the number of male children diagnosed with jaundice was a little higher still.

Physiological Characteristics Review

Skin

Skin is divided into different layers that help to protect the human system from environmental disorders, such as high temperature, radiation, and infectious organisms. It consists of particles that can absorb light rays, and the skin's visual appearance is attributed to both its reflection and absorption properties. The yellowish discoloration of the skin forms a major part of our basics in this research for jaundice detection. Due to the absorption of green and blue light by bilirubin, it displays a yellow color underneath the skin. These absorption properties are today used to estimate bilirubin concentration via skin reflectance measurements (Ali et al., 2015). A diagram of the skin is given in Figure 1.1.

Figure 1.1: A Diagram of Human Skin. (Source: Designia)



Eye

The high concentration of the bilirubin content in the blood of a baby, if not excreted, can be seen in the eyes also; the color of the eyes gradually turns yellowish as the bilirubin level increases and this gradually leads to conjugated bilirubin, which is popularly known as jaundice (Gartner et al., 2003).



Gestation Age

During the gestation period, as a child grows inside the womb, the placenta gets rid of unconjugated bilirubin from a fetus. Because of this, the bilirubin-conjugating enzymes are actively shut off during the pregnancy (Maisels et al., 2006). Gestational age determines the neonatal physiological maturity. Preterm infants that are born before 37 weeks of gestation may show a less developed glucuronosyltransferase activity, which is a key enzyme in bilirubin clearance (Kassa et al., 2024). In Ethiopia, Preterm infants had six times the likelihood of developing jaundice when compared to term infants. A study by Ramesh et al. (2021) found that jaundice in late preterm neonates was 22.4% higher than the 6.5% reported among term neonates. However, the enzymes need time to become fully active. For babies born prematurely, the liver needs more time before it can fully take responsibility and this can result in a rise in the bilirubin level.

Weight

Low birth weight (LBW) infants are particularly susceptible to jaundice as a result of immature hepatic pathways that are responsible for bilirubin conjugation and excretion. A study done in Saudi Arabia on 1,855 neonates found that LBW was strongly found with hyperbilirubinemia, mostly among infants born to hypertensive mothers (Al Qahtani et al., 2024). Similarly, a retrospective cohort study by Chen et al. (2024) in China showed that preterm infants with birth weights below the 10th percentile had an increased risk of bilirubin complications. Children with low birth weight and Glucose 6 Phosphate Dehydrogenase (G6PD) deficiency were also at high risk of having the illness. This was the conclusion of Joseph et al. (2011) after examining 272 babies of age 1–30 days old born between June 2009 and June 2010 daily for evidence of jaundice in a health care facility in Delta state, Nigeria.

Age of the Neonate

Brits, Adendorff, Huisamen, Beukes, Botha, Herbst and Joubert (2018) stated thus: jaundice might not have physical signs to make it easily detectable on the first day of delivery but may gradually develop within 48 hours after delivery. Beyond neonatal physiology, a maternal and perinatal factor influences the bilirubin metabolism. Advanced maternal age (≥ 35 years) has been connected to an increased risk of neonatal jaundice, with complications such as gestational diabetes and preeclampsia (Abdella et al., 2024). Additionally, perinatal events such as prolonged labor, birth trauma, and infections have been cited as contributing factors (Demelash et al., 2024).

RESEARCH METHODOLOGY

The methodology used is the research methodology; a concentrated review of the different physiological characteristics was done, and then a clinical Review of 26 neonates was done in the Special Care Baby Unit (SCBU) of the Federal Medical Center Yenagoa. The weight, sex, gestational period, and age of the neonate were observed alongside the transcutaneous serum bilirubin level of every baby brought to the SCBU to see if there is any visible relationship between the physiological characteristics and the level of bilirubin in the neonate. All data was accurately collected and filed, respectively.

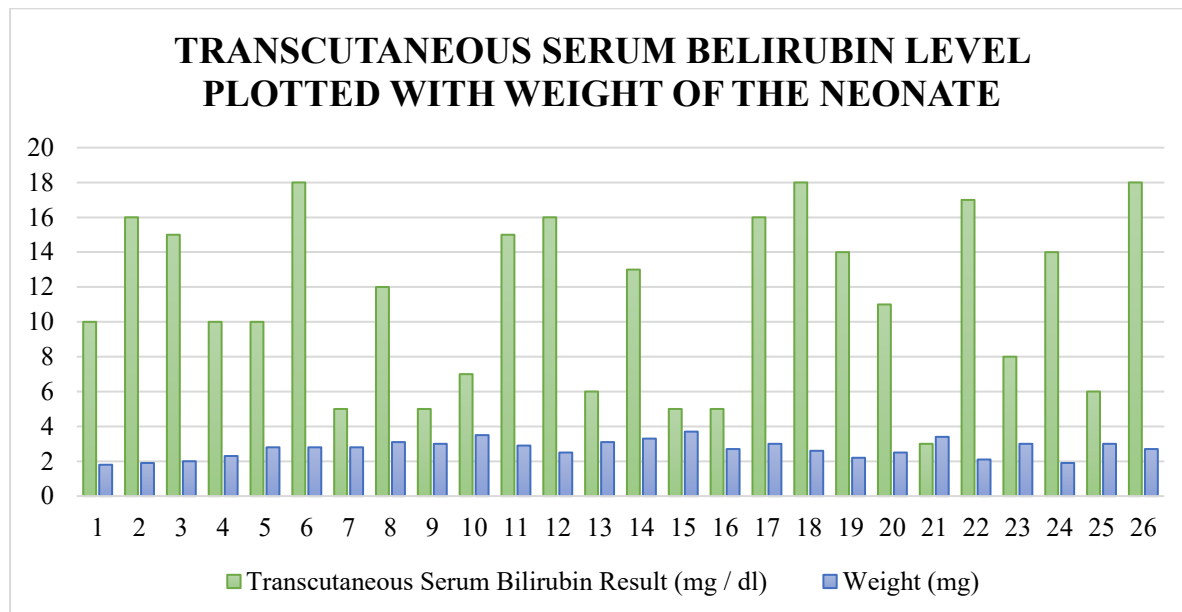


RESULTS AND DISCUSSION

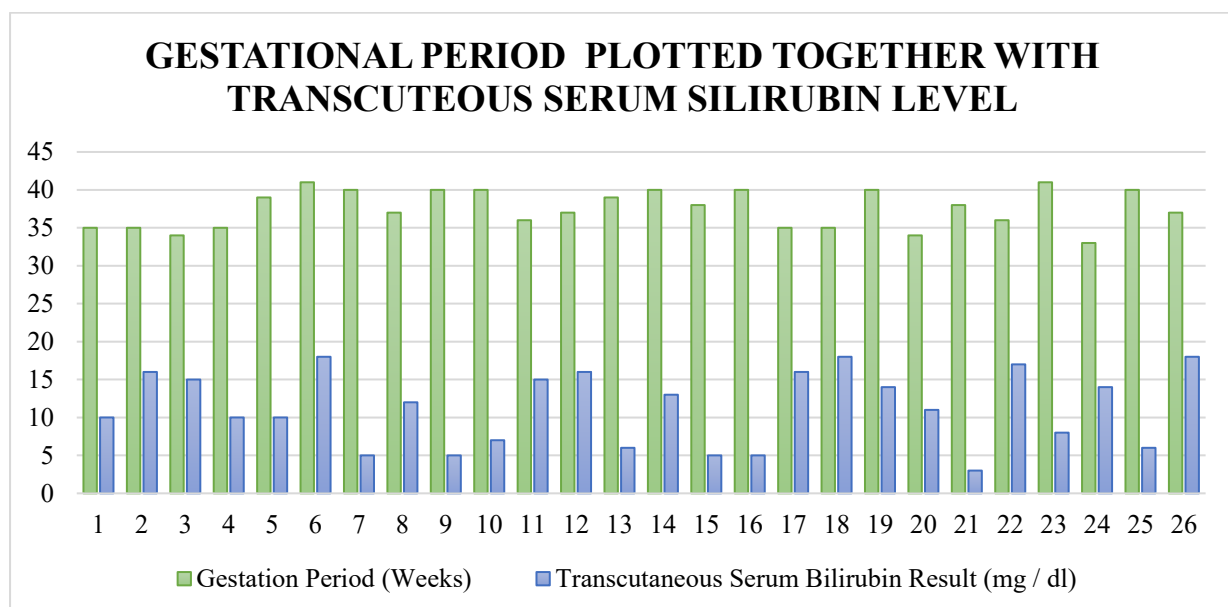
Table 4.1 gives the data gathered during this investigation. Plotting the transcutaneous serum bilirubin level against the weight as shown in Figure 4.1 gives a clear notion that the weight of the child after birth is a vital factor to be considered when clinically examining neonates after birth.

Table 1.1: Table of the TSB results, Weight, Sex, Gestational age, and Age after Birth of Neonates

Weight (mg)	Sex	Gestation Period (Weeks)	Age (Days)	Transcutaneous Serum Bilirubin Result (mg / dl)
1.8	F	35	1	10
1.9	M	35	2	16
2	M	34	2	15
2.3	M	35	1	10
2.8	M	39	2	10
2.8	F	41	1	18
2.8	F	40	0	5
3.1	M	37	2	12
3	F	40	3	5
3.5	F	40	3	7
2.9	F	36	2	15
2.5	M	37	2	16
3.1	F	39	5	6
3.3	F	40	3	13
3.7	M	38	5	5
2.7	M	40	2	5
3	F	35	2	16
2.6	M	35	2	18
2.2	M	40	3	14
2.5	M	34	4	11
3.4	F	38	6	3
2.1	F	36	4	17
3	F	41	3	8
1.9	M	33	2	14
3	F	40	1	6
2.7	M	37	3	18

Figure 1.2: TSB test Result Plotted together with Weight.

The weight of a baby can also be used to predict the likelihood of jaundice presence in neonates. Figure 1.2 confirms it, as most neonates seen to have birth weights less than 2.5 have high jaundice levels. Joseph et al. (2011) examined two hundred and seventy-two (272) babies and observed that children with low birth weight were at high risk of having jaundice.

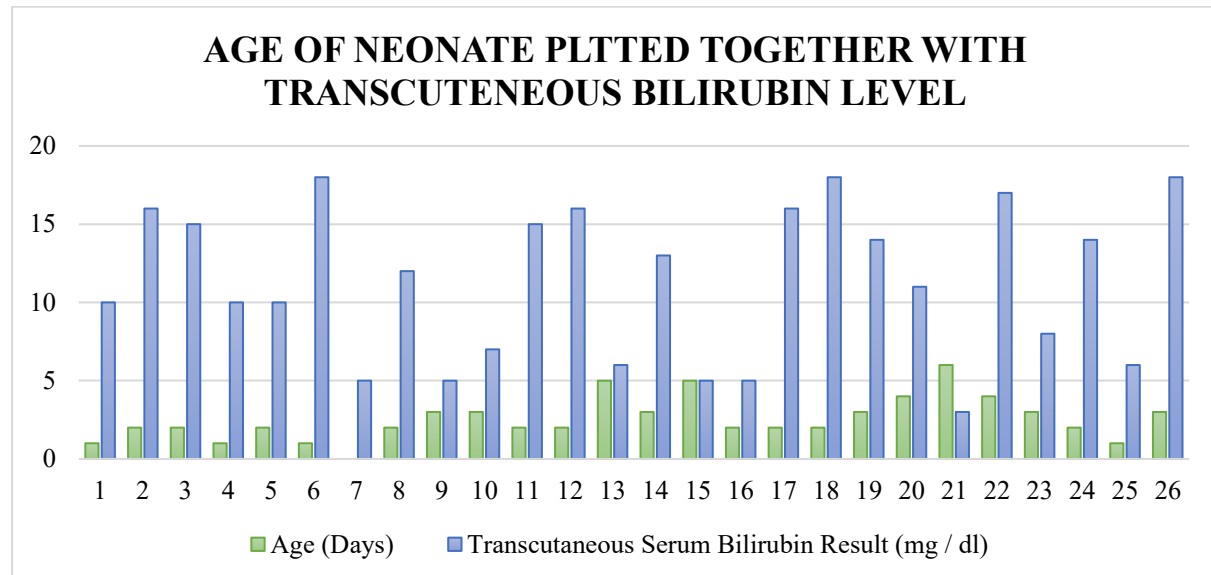
Figure 1.3: TSB Test Result Plotted together with Gestation Period.

The duration of the gestational period can also contribute to the jaundice rise in a neonate; Figure 1.3 confirms this statement. Shu-Shu-Chiung et al. (2003) and Jangaard (2014) also stated in their research that the risk of developing hyperbilirubinemia is directly proportional to low gestational age. Thomas et al. (2000) regression plot revealed that preterm neonates are



at high risk of developing hyperbilirubinemia. Folorunso et al. (2015), in their study, also concluded that gestational age was a clear factor causing neonatal jaundice.

Figure 1.4: TSB Test (TSB) Result (mg/dl) Plotted together with Neonatal Age after Birth.



In Figure 1.4, it is clear that the age of a child after birth is of high importance to the ease of jaundice detection non-invasively, as clearly seen in all the neonates of age less than a day, who did not show an abnormal level of jaundice but those that are 2 days and above in age, their jaundice level is clinically visible. This is in line with the study of Brits et al. (2018), which stated thus: jaundice might not have physical signs to make it easily detectable on the first day of delivery but many gradually develop within 48 hours after delivery.

Table 1.2 gives the male-to-female ratio of the jaundice level of the first 10 sampled neonates and Figure 1.5 gives its graphical representation.

Table 1.2: Male vs Female Ratio Table

Male Ratio (Jaundice Level mg/dl)	Female Ratio (Jaundice Level mg/dl)
16	10
14	19
10	5
10	5
12	7
0	15

Figure 1.5: Male/Female Test Result from the Developed Jaundice Detector (mg/dl) Plotted against Age

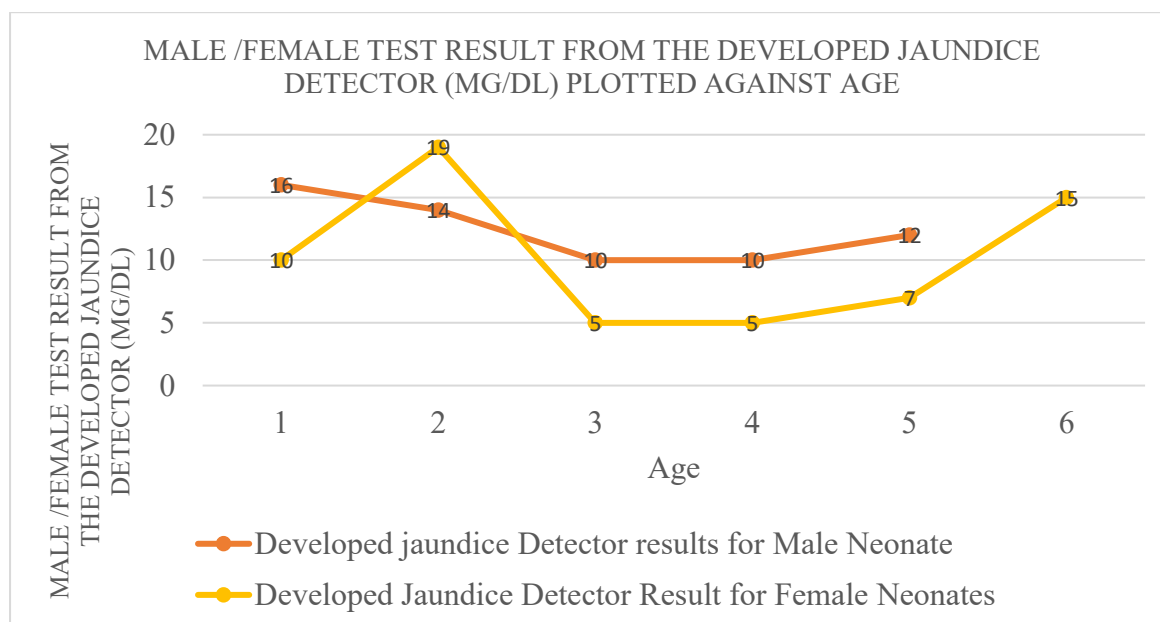


Figure 1.5 shows that the male children are at high risk of developing jaundice after birth and this confirms the result from Louise et al. (2005), who analyzed some data sets that had a 1:1.3 ratio of boys to girls. Kolawale et al. (2015) also proved this fact during his research and concluded that though the numbers of female children delivered were higher during the period of his work, the number of male children diagnosed with jaundice was a little higher still. Hamid et al. (2003) also had a higher number of male jaundice neonates than females in his research, from our graph, though, more of the male children develop jaundice but the severe cases are mostly associated with the female neonates.

Table 1.3 gives the descriptive statistics of the variables which include weight, age, gestation period and Bilirubin level

Table 1.3: Descriptive Statistics of the Variables

Descriptive Statistics		Variables			
		Weight	Gestation Period	Age	Bilirubin Result
Range	Statistics	1.9	8	6	15
Minimum	Statistics	1.8	33	0	3
Maximum	Statistics	3.7	41	6	18
Mean	Statistics	2.72	37.5	2.54	11.27
	Standard Error	0.1	0.49	0.27	0.96



Standard Deviation	Statistics	0.52	2.49	1.39	4.89
Variance	Statistics	0.27	6.18	1.94	23.87
Skewness	Statistics	-1.6	-1.69	0.73	-0.15
	Standard Error	0.46	0.46	0.46	0.46
Kurtosis	Statistics	-0.67	-1.4	0.55	-1.43
	Standard Error	0.89	0.89	0.89	0.89

From table 1.3 above, the mean **weight** was 2.72 kg with a range from 1.80 to 3.70, the mean gestation period was 37.5 weeks, the mean age was 2.54 days and the mean bilirubin was 11.27 mg/dL.

Table 1.4 gives the Root as R, Root Square value as R Square, and the Standard Error of the estimation

Table 1.4: The Root Square and the Standard Error of the Estimates

Model	R	R^2	Adjusted R^2	Standard Error of the Estimate	Change Statistics					Durbin-Watson
					R^2 Change	F Change	df 1	df2	Sig. F Change	
1	0.719	0.518	0.452	0.383	0.518	7.865	3.000	22.000	0.001	1.804

From table 1.4, the weight was considered as the dependent variable, while the independent variable includes gestation period, age and bilirubin level. The value was 0.518, indicating ~52% variance in the weight as explained by predictors and a significant F-statistic ($p = 0.001$). Significant predictors such as gestation period ($\beta = 0.484$, $p = 0.009$) showed Positive association with weight, Age ($\beta = 0.332$, $p = 0.043$) was positively associated; and Bilirubin ($\beta = -0.187$, $p = 0.295$) was inversely related but not statistically significant. Significant predictors such as gestation period ($\beta = 0.484$, $p = 0.009$) showed Positive association with weight, Age ($\beta = 0.332$, $p = 0.043$) was positively associated and Bilirubin ($\beta = -0.187$, $p = 0.295$) was inversely related but not statistically significant.

Furthermore, a correlation analysis showed a strong negative correlation ($r = -0.505$, $p = 0.004$) between weight and bilirubin, a negative correlation ($r = -0.472$, $p = 0.007$) between gestation period and bilirubin and a weak negative, not significant ($r = -0.269$, $p = 0.092$) correlation between age and bilirubin with the results suggesting that a lower birth weight and preterm birth are significantly associated with higher bilirubin levels.



CONCLUSION

After proper study of the neonates brought to the special care baby unit over a period of seven (7) months, and putting into cognizance the National Institute for Health and Clinical Excellence guideline, which also stated that the weight of the neonate and the age of the neonate should be highly considered. The influence of gestational and physiological maturity on bilirubin levels is reviewed in this study, with findings showing that a lower gestational age and weight will significantly increase the jaundice risk. Clinically, the findings support the need for improved monitoring of preterm and low-birth-weight infants. Physiological parameters which include weight and gestation period, are critical in understanding the variation of bilirubin level and neonatal assessment which will improve the management of jaundice. Also, a significant relationship between the weights, gestational age, age of child after birth, and skin color of every neonate, if properly analyzed with hybrid machine learning tools, object-oriented programming language, and mathematical modeling, can serve as a building block for a model that can be used to diagnose jaundice in neonates non-invasively. The resultant model can serve as a standalone kit for jaundice detection in infants. Recommendations include a regular bilirubin screening for neonates with low birth weight or preterm delivery and development of significant predictive models that will incorporate the physiological parameters for early intervention.

Conflict of Interest

I declare that there is no conflict of interest among authors.

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