Association of delivery procedure with APGAR scores among neonates born to healthy Pakistani mothers: a pilot study

Muhammad Ali Khalid, Rida Ghani, Muhammad Fahad Khalid, Muhammad Saad Malik, Ahmed Waqas

1CMH Lahore Medical College & Institute of Dentistry, Lahore, Cantt, Pakistan
2Rawalpindi Medical University, Rawalpindi, Pakistan

Abstract
Background: The present study explores the factors associated with poor APGAR scores among singletons born to healthy Pakistani mothers.
Methods: This cross-sectional study was conducted at a Tara Urea Medical Center, Iskandarabad Colony, district Mianwali, Pakistan from April 1 to August 30, 2017. Data was collected using a preformed proforma by a gynecologist and pediatrician during the birth procedure. The questionnaire comprised of two sections including neonatal and maternal characteristics. All data were analyzed in SPSS v.20.
Results: Regression analysis revealed that vaginal deliveries were associated with higher APGAR scores at five minutes than those delivered by cesarean section. However, maternal age and BMI and weight of the baby did not yield significant association with APGAR scores at five minutes. APGAR scores assessed at one minute were significantly associated with weight of the neonate.
Conclusion: APGAR scores of the neonates at birth are significantly associated with birth procedures. Therefore, birth procedure should be selected and managed effectively to reduce the risk of low APGAR scores.
Keywords
APGAR, neonate, factors, predictors
Corresponding author: Muhammad Ali Khalid (alikhalid1995@gmail.com)

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Introduction

In recent years, much has been published regarding the morbidity and mortality among newborns. However, most research studies are limited to the paradigm of Western countries. A limited contribution in terms of large scale prevalence studies, and culture and resource sensitive interventions have been made from the developing and third world countries. This is a major public health concern because the majority of newborn deaths occur in poorly resourced developing world. According to the World Health Organization (WHO), 2.6 million neonates died in 2016, accounting for a staggering 7,000 newborn deaths daily, with 1 million dying on the first day of life. Therefore, it is of paramount importance to assess the health status of the neonate during the birth procedure using validated methods such as the APGAR scoring system.

The APGAR score (AS) is validated, reliable and one of the most widely used clinical tools for evaluation of health status of the newborn immediately after birth. The APGAR scoring system was originally developed by Virginia Apgar (1953) based on five characteristics including heart rate of the newborn, respiratory effort, muscle tone, irritability, and color. Thus, APGAR scores provide a convenient method to recognize life threatening situations for the newborn and their subsequent response to resuscitation techniques. A low APGAR score is also a significant predictor of neonatal mortality, long term neurological development, IQ scores, motor impairment, cerebral palsy, mental retardation, epilepsy and poor academic performance.

Previous literature has shown that APGAR scores of neonates is dependent on a number of factors including maternal age, body mass index, education level, parity, previous miscarriages, emotional well-being, use of nicotine and antidepressants, gestational age, medical comorbidities, and multiple pregnancies. Method of delivery of the newborn has also been demonstrated as a significant predictor of APGAR scores among the newborns.

However, the evidence regarding the association between mode of delivery and APGAR scores is controversial. For instance, Kilsztajn and colleagues reported that compared to vaginal deliveries, neonates born through c-section had higher APGAR scores. However, they found that this association was spurious and driven by confounding with indication. A few studies also stratify the risk of low APGAR scores according to the urgency of birth procedure. For instance, Lai et al., reported that only emergency cesarean and instrumental vaginal deliveries are associated with low to moderate APGAR scores. Similar results have been corroborated by Johnson et al. and Prior et al. in their studies exploring predictive factors of neonatal outcomes. This variation in APGAR scores among neonates born through different birth procedures is likely due to oxidative stress experienced by them, however, studies exploring this hypothesis have also yielded mixed results.

In addition to delivery procedures, a number of other factors have been recognized as independent predictors of APGAR scores among neonates. These include non-cephalic presentation, intramuscular narcotic use, presence of meconium, nulliparity, preterm birth, body mass index, emotional distress, type of pregnancy, and antenatal healthcare.

Due to paucity of data, the present study explores the factors associated with poor APGAR scores among singletons born to healthy Pakistani mothers.

Methods

This cross-sectional study was conducted at Tara Urea Medical Center, Iskandarabad Colony, district Mianwali and Majid Medical Complex, Lahore, both in Pakistan from April 1 to August 30, 2017. Participants undergoing birth procedures at this center were recruited randomly using an online computer software. Only those women were found eligible who had a term birth, no previous history of comorbid medical disorders and antepartum complications were included. All participants provided written informed consent and they were ensured anonymity and that no individual data would be disclosed. Ethical review was sought and granted by the research committee at the Tara Urea Medical Center, Iskandarabad Colony, district Mianwali, Pakistan (Reference # IRB-001).

Data was collected using a preformed proforma by a gynecologist and pediatrician during the birth procedure. The questionnaire (Supplementary File 1) comprised of two sections including neonatal and maternal characteristics. Maternal characteristics included body mass index, age and the birth procedure used for delivering the newborn. Neonatal characteristics included gender, weight, admission to neonatal intensive care unit, complications during delivery, and APGAR scores at 1 and 5 minutes.

Using Gpower v3.1.7, a minimum sample size of 92 was considered to be appropriate for this study to achieve a power of 80% for an anticipated moderate effect size and five predictors. All data were analyzed using SPSS v.20 (IMB, Chicago, IL). Quantitative variables were presented as mean (SD) and categorical as frequency (%). Normality of quantitative variables was assessed by visualizing histograms. Thereafter, linear regression analysis was run to explore the predictors of APGAR scores at one and five minutes. Both maternal and neonatal characteristics were introduced as independent variables in these models.

Results

Out of 100 women undergoing birth procedures, a total of 98 (98%) agreed to participate in the study. There were 49 male (50%) and 49 female (50%) neonates. A majority of the neonates were born though supra-vaginal delivery (67, 68.4%) and episiotomy (9, 9.2%). A total of six (6.1%) neonates experienced complications during delivery and four (4.1%) were admitted to neonatal intensive care unit. Mean weight of mothers was 72.51 (6.32) kg, height 160.85 (4.64) cm, age 23.94 (2.81) years and BMI 28.06 (2.25). Mean weight of the neonates was 2.99 (0.25) kg, APGAR score at one minute 6.18 (1.37) and APGAR score at five minutes was 9.67 (0.69).
Linear regression analysis delineating predictors of APGAR scores at one minute explained only 5.3% variation. According to it, maternal age, BMI and type of delivery procedures were not associated with APGAR scores assessed at one minute after delivery. However, it was inversely associated with weight of the neonate.

Regression modelling for APGAR scores assessed at five minutes explained 70.60% of variation in it. According to it, vaginal deliveries and higher maternal BMI were associated with higher APGAR scores at five minutes than those delivered by cesarean section. However, maternal age and weight of the baby did not yield significant associations with APGAR scores at five minutes. Detailed results are presented in Table 1.

**Discussion**

In present study, delivery by cesarean section and low maternal BMI was associated with low APGAR scores assessed at five minutes. Whereas, the APGAR scores at one minute was significantly associated with weight of the neonate.

Our research evidence has several limitations and therefore, should be generalized with caution. The cross-sectional nature of the study design limits inferences regarding causality and temporality. Moreover, a small sample size (n=98) limits the statistical power of this study, therefore, future studies should include greater study samples.

In conclusion, a newborn’s health status is associated with the birth procedure as well as the birth-weight. These results have several implications for neonatal health in Pakistan on designing culture sensitive policies and educational interventions in antenatal care and preference for birthing procedures among expectant mothers as well as the practicing obstetricians and gynecologists. Expectant mothers should be delivered educational interventions during regular antenatal check-ups, aiming at improving overall health including an optimum weight of the fetus. Moreover, the rising preference of birth by cesarean sections among Pakistani expectant mothers should be discouraged.

**Data availability**

Dataset 1: APGAR factors 10.5256/f1000research.13784.d198118

Coding Scheme: Gender: 1= Male, 2= female; Mode of delivery: 1= C-section, 2= supra-vaginal delivery, 3= SVD with episiotomy; Admission to NICU= 1=yes, 2=no; Complications during delivery= 1=yes, 2=no. Mode of delivery binary= 1=C-section, 2=other

**Table 1. Predictors of APGAR scores assessed at one and five minutes (n=98).**

| Variables               | APGAR scores at five minutes | B     | Std. Error | T-value | P-value |
|-------------------------|------------------------------|-------|------------|---------|---------|
| Constant                | 0.847                        | 0.098 | 8.615      | < 0.001 |
| Maternal age            | -0.069                       | 0.048 | -0.095     | -1.437  | 0.154   |
| Weight of the neonate   | -0.068                       | 0.055 | -0.072     | -1.240  | 0.218   |
| Birth procedure         | 0.064                        | 0.005 | 0.794      | 11.941  | < 0.001 |
| Maternal BMI            | 0.105                        | 0.049 | 0.123      | 2.128   | 0.036   |

| Variables               | APGAR scores at one minute   | B     | Std. Error | T-value | P-value |
|-------------------------|------------------------------|-------|------------|---------|---------|
| Constant                | 1.121                        | 0.564 | 1.989      | 0.050   |
| Maternal age            | -0.016                       | 0.276 | -0.007     | -0.057  | 0.955   |
| Weight of the neonate   | -0.686                       | 0.315 | -0.227     | -2.176  | 0.032   |
| Birth procedure         | -0.047                       | 0.031 | -0.185     | -1.554  | 0.124   |
| Maternal BMI            | 0.062                        | 0.283 | 0.023      | 0.219   | 0.827   |

BMI= Body mass index
Std. Error= Standard Error

**Supplementary material**

Supplementary File 1 – Copy of study questionnaire

Click here to access the data.

**Competing interests**

No competing interests were disclosed.

**Grant information**

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