ORIGINAL ARTICLE

Non-stress test reactivity and its association with neonatal Apgar scores: a retrospective analysis

Luz Flores-Salcedo[1], Judith García-Cajaleón[1], Luis A. Orozco-Elizondo[2], Brandon E. Guillen-Calle[3]

[1] Universidad Nacional Mayor de San Marcos, Lima, Perú
[2] Universidad de Guadalajara, Guadalajara, México
[3] Universidad Científica del Sur, Lima, Perú

ABSTRACT

Objective: To evaluate the association between the non-stress test (NST) and the Apgar score of newborns (NB) in a public hospital in Peru.
Methods: A total of 634 NST records from pregnant women with corresponding neonatal Apgar scores from the same hospital in 2023 were included. Only singleton pregnancies of at least 34 weeks of gestation were considered. The NST was classified as "reactive" (Fisher test score ≥ 8) and "non-reactive or pathological" (Fisher test score < 8). Apgar scores were assessed at the first and fifth minutes and categorized as neonatal depression (ND) (Apgar < 7) or normal (Apgar ≥ 7). Associations were analyzed using the Chi-square test and Fisher's exact test ($p < 0.05$).
Results: A total of 6.31% (n = 40) of NSTs were classified as non-reactive or pathological. Neonatal depression was observed in 2.84% (n = 18) at the first minute and in 0.16% (n = 1) at the fifth minute. No significant association was found between overall NST reactivity and neonatal depression at the first minute ($p = 0.067$) or the fifth minute ($p = 0.063$). However, the absence of fetal movements was associated with neonatal depression at the first minute ($p = 0.028$), while the presence of accelerations and decelerations were associated with Apgar scores at the fifth minute ($p = 0.006$ and $p = 0.031$, respectively).
Conclusions: No statistically significant association was found between the NST and Apgar score. However, the absence of fetal movements, accelerations, and decelerations in the NST was associated with a higher prevalence of neonatal depression.

Keywords: Fetal hypoxia; Fetal Monitoring; Perinatology; Apgar Score; Infant Health (Source: MeSH)

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Corresponding author:
Brandon E. Guillen-Calle
Phone: +51 927 739 766
E-mail: emerson16cyesj@gmail.com

ORCID iDs
Luz Flores-Salcedo
https://orcid.org/0009-0005-8890-8615
Judith García-Cajaleón
https://orcid.org/0000-0002-9286-6674
Luis A. Orozco-Elizondo
https://orcid.org/0009-0006-8506-0388
Brandon E. Guillen-Calle
https://orcid.org/0009-0001-5161-266X

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Reactividad del test no estresante y su asociación con la puntuación Apgar neonatal: un análisis retrospectivo

RESUMEN

Objetivo: Evaluar la asociación entre el test no estresante y la puntuación de Apgar de recién nacidos (RN) en un hospital público peruano.
Métodos: Se incluyeron 634 registros de test no estresante (NST) de gestantes con registro de Apgar neonatal en el mismo hospital durante el año 2023. Se incluyeron embarazos únicos de al menos 34 semanas de gestación. El NST se clasificó como "reactivo" (puntuación del test de Fisher ≥ 8) y "no reactivo o patológico" (puntuación del test de Fisher < 8). Las puntuaciones de Apgar se evaluaron al primer y quinto minuto, clasificándose como depresión neonatal (DN) (Apgar < 7) y normal (Apgar ≥ 7). Se utilizaron las pruebas de chi cuadrado y exacta de Fisher para analizar las asociaciones ($p < 0,05$).
Resultados: El 6,31 % (n = 40) de los test no estresantes fueron no reactivos o patológicos. El 2,84 % (n = 18) mostró DN al primer minuto, y el 0,16 % (n = 1) al quinto minuto. No se encontró una asociación significativa entre la reactividad general del test no estresante y la depresión en la puntuación de Apgar al primer minuto ($p = 0,067$) ni al quinto minuto ($p = 0,063$). La ausencia de movimientos fetales estuvo asociada con depresión neonatal al primer minuto ($p = 0,028$). La presencia de aceleraciones y de desaceleraciones se asociaron con la puntuación de Apgar al quinto minuto ($p = 0,006$ y $p = 0,031$, respectivamente).

Conclusiones: No se halló asociación estadísticamente significativa entre el NST y la puntuación de Apgar. La ausencia de movimientos fetales, y de aceleraciones/desaceleraciones en el NST estuvo asociada con una mayor prevalencia de DN.

Palabras clave: Hipoxia Fetal; Monitoreo Fetal; Perinatología; Puntaje de Apgar; Salud del Lactante (Fuente: DeCS)

INTRODUCTION

TThe assessment of fetal and neonatal well-being is a crucial aspect of perinatal care, given its significant impact on immediate clinical decision-making and short-term neonatal health outcomes (1). Two of the most widely used tools in this assessment are the non-stress test (NST) and the Apgar score. The NST is a non-invasive prenatal test that monitors the relationships between heart rate and fetal movements, providing indirect evidence of fetal oxygenation and overall well-being (2). This test is critical in high-risk pregnancies, as it helps identify early signs of fetal hypoxia or possible complications, allowing for timely intervention to reduce perinatal risks (3).

The NST is based on the principle that a healthy and well-oxygenated fetal nervous system should exhibit an adaptive heart rate response to fetal movement (4). Specifically, an increase of at least 15 beats per minute lasting for at least 15 seconds (or 10 beats for pregnancies under 32 weeks) is expected during fetal movement (5); this type of response, called " acceleration," is a marker of fetal autonomic nervous system integrity and good oxygenation (6). The absence of accelerations or the presence of deceleration patterns in the heart rate may indicate hypoxia or neurological dysfunction. However, these abnormalities may also be caused by benign factors, such as fetal sleep (7). Thus, the NST provides indirect information on the neurological status and oxygen reserve of the fetus, allowing for early assessment of potential perinatal risks (8). The Apgar score, introduced in 1952 by Dr. Virginia Apgar (9), remains a standard tool for rapid assessment of the newborn immediately after delivery. This test, with a range of 0 to 10 points, measures five parameters: appearance, pulse, gesticulation, activity, and respiration, which reflect the overall physical condition of the newborn (10). Scores are assigned at the first and fifth minutes of life and are an initial measure of the newborn's vitality, guiding the need for immediate medical intervention (11).

Regarding these two assessment methods, previous studies have reported the utility of the NST in predicting perinatal outcomes; however, findings have been inconsistent. In some cases, a reactive NST, i.e., a result indicating preserved fetal well-being, has been associated with better Apgar scores. At the same time, other studies have found no direct relationship between NST reactivity and immediate neonatal status (12–15). These discrepancies may be due to differences in NST interpretation criteria, the gestational age of the fetuses evaluated, the presence of maternal comorbidities, or even variations in obstetric care between different hospitals (16–18). Specifically, in high-risk pregnancy populations, the NST has shown a higher correlation with adverse outcomes, while in low-risk pregnancies, its predictive value may be lower (19, 20). A "reactive" NST result is generally interpreted as an indicator of fetal well-being, suggesting a healthy state of oxygenation and good fetal neurological function. In contrast, a "non-reactive" result may indicate the presence of fetal hypoxia or other factors that warrant closer monitoring and potentially additional interventions (10). However, the NST is known to have a high false positive rate; that is, in many cases, fetuses that do not have any condition also show "non-reactive" results (16). This limitation, coupled with the influence of variables such as fetal sleep, maternal medication, and other external factors, can lead to the NST, suggesting problems in fetuses that are actually in good condition (17).

In this context, its usefulness as an exclusive predictor of perinatal outcomes is a matter of analysis and caution. In Peru, neonatal mortality is a significant challenge. In 2023, 289 fetal deaths and 369 neonatal deaths were recorded in the care network to which the target hospital belongs, a figure that underscores the urgent need to optimize perinatal assessment methods to effectively identify at-risk fetuses and improve health outcomes at birth (18). This is especially relevant given that the Apgar score, measured at one and five minutes of life, is a rapid and widely recognized assessment of an infant's initial condition and is crucial for identifying newborns who require immediate care. Given the above, the present study aims to analyze whether NST findings, especially "non-reactive" ones, can serve to predict low Apgar scores, which could help healthcare personnel anticipate and plan rapid and appropriate interventions.

METHODS

Study design

An analytical, observational, retrospective, and cross-sectional study was conducted. In this design, the Apgar scores at one and five minutes were the dependent variables, while the NST findings were the independent variable.

Population and sample

The study population consisted of newborns delivered by mothers whose NST registries were recorded within the Electronic Fetal Monitoring service, with deliveries conducted at the same facility that documented neonatal Apgar scores. A total of 1,625 NST records were identified for analysis, from which specific selection criteria were applied to determine the final sample size, as detailed in the results section. Inclusion criteria encompassed single pregnancy records with gestational ages exceeding 34 weeks, the most recent NST record (when multiple NSTs were performed), and records that were sufficiently legible for both variables. Conversely, records from fetuses with congenital malformations and those classified as post-term pregnancies were excluded (see Figure 1).

NST findings

NST findings were categorized as "reactive" (Fisher test score ≥ 8) and "non-reactive/pathological" (Fisher test score < 8) for those that did not meet the requirements to confirm a fetal well-being result. This score is obtained by analyzing the

parameters individually, where a score of 0 is assigned when the value is severely concerning, 1 when it falls outside the normal range, and 2 when it is within the normal range. The NST test is a recurring obstetric assessment tool in clinical practice, which is described in greater detail in the Clinical Practice and Procedures Guide in Obstetrics and Perinatology of the National Maternal Perinatal Institute (21).

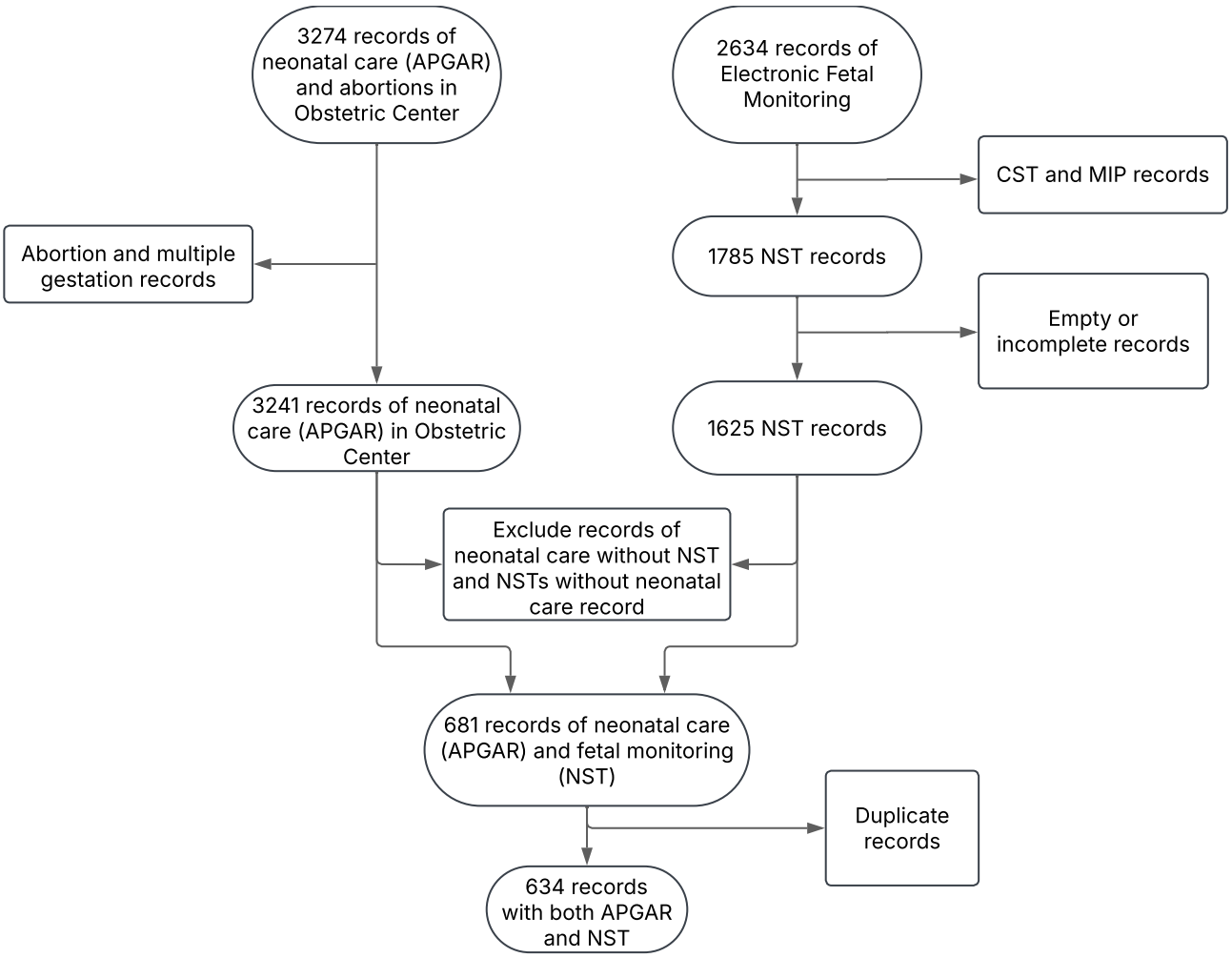

Figure 1. Flowchart depicting sample selection process
CST: Oxytocin Stress Test; MIP: Intrapartum Monitoring.

NST parameters

NST parameters evaluated included Baseline values, variability, accelerations, decelerations, and fetal movement.

Apgar score

The Apgar score was assessed at the first and fifth minutes of life of the newborn and classified as normal (7-10 points) or depressed (0-6 points). Data collection procedures.

Following approval by the facility's Research Ethics Committee, access was granted to the records of the Fetal Monitoring Service and the Obstetric Center. The information was linked into a single database that included the NST results and Apgar scores, along with sociodemographic and obstetric variables of the pregnant women. The data were consolidated in a Microsoft Excel 2019 format and then exported to STATA v.17 for statistical analysis. In cases where the NST was categorized as "non-reactive" or "pathological," clinical management followed institutional protocols, which may include repeating the NST or performing

additional tests such as the oxytocin stress test (CST) or the fetal biophysical profile. However, this study did not include an assessment of these interventions, so it was not possible to determine their impact on neonatal outcomes.

Data analysis

A descriptive analysis was performed to characterize the sample, reporting frequencies and percentages for categorical variables and measures of central tendency and dispersion for continuous variables. To evaluate the association between the final NST finding, its parameters, and the Apgar score, the chi-square test or Fisher's exact test was used, with a statistical significance level of 5% ($p < 0.05$).

Ethical considerations

The study was approved by the Institutional Ethics Committee of the institution where it was conducted. The principles of confidentiality and anonymity were respected to protect the identity of the participants and their newborns.

RESULTS

The sample included 634 newborns born to mothers who underwent NST, as recorded in the Electronic Fetal Monitoring service, with Apgar scores assessed in the Delivery Room (Figure 1). Most of the mothers were between 25 and 33 years of age (47.95%), and 4.57% (29) were Venezuelan nationals. Regarding the NST results, 6.31% (40) were non-reactive or pathological. Regarding the Apgar score at one minute, 2.84% (n = 18) showed depression, whereas this figure decreased to 0.16% (n = 1) at five minutes (Table 1). In the analysis of the relationship between NST findings and Apgar scores at one minute, no statistically significant association was found between NST reactivity and Apgar scores (OR = 3.12; p = 0.067; 95% CI = 0.5-75). Similarly, when evaluating the association between NST and Apgar score at five minutes, no statistically significant association was found (p = 0.063) (Table 2). When analyzing the parameters separately, a higher proportion of one-minute Apgar depression was observed among fetuses that showed absence of fetal movements during the NST, compared to those with a normal score (5.26% vs. 1.68%) (p = 0.028); in addition, the only case of depression in the Apgar score at five minutes was also observed to have no accelerations during the NST, compared to 8.69% (n = 55) that had a normal Apgar score (p = 0.006) and also presented decelerations, compared to 12.48% (n = 79) that showed a normal Apgar score (p = 0.031) (Table 3).

Table 1. Sample characteristics and non-stress test results with corresponding apgar scores at one and five minutes

Variable	n	%
Maternal age		
16 to 24 years	179	27.29
25 to 33 years	304	47.95
34 to 46 years	157	24.76
Maternal nationality		
Peruvian	605	95.43
Venezuelan	29	4.57
Neonatal sex		
Female	317	50.00
Male	317	50.00
Neonatal weight		
Low weight (< 2500 g)	11	1.74
Normal weight (2500 - 3999 g)	565	89.12
Macrosomic (≥ 4000 g)	58	9.15
NST result		
Reactive	594	93.69
Non-reactive/pathological	40	6.31
Apgar at first minute		
Normal	616	97.16
Depressed	18	2.84
Apgar at fifth minutes		
Normal	633	99.84
Depressed	1	0.16
Total	634	100.00

DISCUSSION

The results show that most newborns had a normal Apgar score, with no significant association between a non-reactive NST and a low Apgar score. However, the absence of fetal movements was associated with a low Apgar score at one minute, and the lack of accelerations and the presence of decelerations were associated with a low Apgar score at five minutes. This suggests that, although the overall NST may not be a good predictor, specific individual parameters could provide relevant information about fetal well-being.

Regarding the literature found, previous studies in various contexts have reported a significant relationship between an abnormal NST and low Apgar scores. In a study conducted in Nepal, Joshi and Dangal (8) found that a non-reactive NST was associated with the need for neonatal resuscitation in 62.1% of cases, an intervention aimed at neonates with poor Apgar scores. In contrast, only 5.4% of neonates with a reactive NST required resuscitation. This highlights the NST's capability to identify fetal hypoxia in patients with reduced fetal movement, suggesting that the NST may be more predictive in high-risk pregnancies or specific conditions, unlike the current sample, which primarily consisted of pregnancies without evident complications (7).

Similarly, studies in India by Rema et al. (15) and Deshmukh et al. (12) emphasize the effectiveness of NST in monitoring high-risk pregnancies. Both studies demonstrated that an abnormal NST was significantly associated with low Apgar scores and correlated with a higher probability of admission to the neonatal intensive care unit, as well as an increased risk of cesarean delivery.These findings are consistent with the usefulness of NST as a monitoring tool in high-risk obstetric situations (22); in contrast, its predictive utility was lower in the population considered in this study, probably

Table 2. Association between non-stress test results and apgar scores at one minute

NST Result	Apgar at first minute				OR	95% CI	p*
	Depressed		Normal				
At first minute	n=18	%	n=616	%			
Non-reactive/ pathological	3	16.67	37	6.00	3.12	0.55 - 11.75	0.066
Reactive	15	83.33	579	94.00			
At fifth minute	n=1	%	n=633	%			
Non-reactive/ pathological	1	16.67	39	6.16	-	-	0.063
Reactive	0	83.33	594	93.84			

**: Estimated using the Chi-square test*

Table 3. Association between non-stress test parameters and neonatal apgar scores

Parameters	Apgar at first minute				p[a]	Apgar at fifth minutes				p[a]
	Depressed		Normal			Depressed		Normal		
	n	%	n	%		n	%	n	%	
Baseline (bpm)										
100 - 119 or 161 - 180	0	0.00	23	3.86	0.389[b]	0	0.00	23	3.63	0.964[b]
120 - 160	38	100.00	573	96.14		1	100.00	610	96.37	
Variability (bpm)										
<5	1	2.63	6	1.01		0	0.00	7	1.11	
5 - 9 or > 25	10	26.32	163	27.35	0.647	0	0.00	173	27.33	0.820
10 - 25	27	71.05	427	71.64		1	100.00	453	71.56	
Accelerations										
Absent	6	15.79	50	8.39		1	100.00	55	8.69	
Periodic	3	7.89	27	4.53	0.170	0	0.00	30	4.74	0.006
Sporadic	29	76.32	519	87.08		0	0.00	548	86.57	
Decelerations										
Present	6	15.79	74	12.42		1	100.00	79	12.48	
Atypical	3	7.89	22	3.69	0.338	0	0.00	25	3.95	0.031
Absent	29	76.32	500	83.89		0	0.00	529	83.57	
Fetal movements										
Absent	2	5.26	10	1.68		0	0.00	12	1.9	
1 to 4	8	21.05	61	10.23	0.028	0	0.00	69	10.9	0.929
5 or more	28	73.68	525	88.09		1	100.00	552	87.2	
Total	38	100.00	596	100.00		1	100	633	100.00	

a : Estimated uisng Chi-square test
b: Estimated using Fisher's exact test

because both women with low-risk and high-risk obstetric pregnancies were included.

In the Peruvian context, studies by Alcedo (23) and Carhuamaca (14) found a significant association between NST and Apgar scores, indicating that a non-reactive NST is associated with an increased risk of Apgar scores less than or equal to 6 in lower-level healthcare facilities or populations with limited access to continuous pregnancy monitoring. However, the present study was conducted in a Level II-2 care institution; additionally, the Apgar score was analyzed as a categorical variable rather than numerically. This could have contributed to variations in the selection of the population in the context of obstetric-perinatal care and the measurement of the Apgar score, respectively.

Although a slight association was observed between the absence of accelerations and the presence of decelerations in NST parameters and Apgar scores at five minutes in this study, it was not robust enough to suggest a reliable predictive capacity of NST for low Apgar scores in this context. This finding aligns with the work of Cusihuamán (24), who identified a significant association between NST results and Apgar scores in pregnancies complicated by preeclampsia but not in the general population. In the current study sample, complications were not stratified, which could explain the lack of significant associations between NST and Apgar

scores, thereby limiting the predictive utility of this finding in this population (25).

A significant limitation of this study is the inclusion of a sample of both high and low obstetric risk, which may reduce the frequency of non-reactive NST findings and limit the ability to observe strong associations with Apgar scores. Additionally, the evaluation of NST and Apgar scores was subject to inter-observer variability among different healthcare professionals, which could have introduced bias into the results. These are prevalent limitations in retrospective studies, where it is not possible to have complete control over confounding variables since the data have already been collected (26). Finally, although the NST is widely used as a screening tool to detect alterations in fetal well-being, our results suggest that its predictive value for anticipating low Apgar scores in a low-risk population is limited (12).

While previous studies support its usefulness in high-risk settings, its effectiveness is likely to depend on the prevalence of specific conditions affecting the fetus. In this regard, evaluating not only the overall NST result but also its parameters could improve the identification of at-risk neonates and optimize clinical decision-making (27, 28). Therefore, it is recommended to consider other clinical factors in conjunction with the NST for a comprehensive perinatal assessment and more accurate planning of neonatal interventions.

Author contributions

LFS, BEGC, and JGC contributed to the conceptualization of the study. BEGC and LAOE curated the data; LFS and BEGC performed the formal analysis; LFS collected the data; LFS and JGC developed the methodology; LFS provided resources; JGC, LAOE, and BEGC supervised and validated the work. All authors contributed to writing and reviewing both the draft and the final version of the manuscript.

Conflicts of interest

The authors declare no conflicts of interest related with the material presented in the manuscript.

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