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RESEARCH

ASSOCIATION BETWEEN BIRTH WEIGHT, GESTATIONAL AGE AND SECONDARY DIAGNOSES IN THE HOSPITAL STAY OF PREMATURE NEWBORNS

ASSOCIAÇÃO ENTRE PESO AO NASCER, IDADE GESTACIONAL E DIAGNÓSTICOS SECUNDÁRIOS NA PERMANÊNCIA HOSPITALAR DE RECÉM-NASCIDOS PREMATUROS

ASOCIACIÓN ENTRE PESO AL NACIMIENTO, EDAD GESTACIONAL Y DIAGNÓSTICO SECUNDARIO EN ESTANCIA HOSPITALARIA DE RECIÉN NACIDO PREMATURO

Marina Dayrell de Oliveira Lima[1]
Thales Philipe Rodrigues Silva[2]
Ariene Silva do Carmo[2]
Lorena Medreiros de Almeida Mateus[3]
Juliana de Oliveira Marcatto[3]
Fernanda Penido Matozinhos[3]
Ana Cláudia Abreu[4]
Renato Camargo Couto[4]
Tânia Moreira Grillo Pedrosa[4]

[1]Universidade Federal de Minas Gerais - UFMG, Programa de Pós-Graduação em Enfermagem. Belo Horizonte, MG - Brazil.
[2]UFMG, Faculdade de Medicina, Pós-Graduação em Ciências da Saúde - Saúde da Criança e do Adolescente. Belo Horizonte, MG -Brazil.
[3]UFMG, Escola de Enfermagem - EE, Departamento de Enfermagem Materno-Infantil e Saúde Pública. Belo Horizonte, MG -Brazil.
[4]Instituto de Acreditação e Gestão em Saúde - IAG Saúde, Departamento Grupos Diagnósticos Relacionados - DRG. Belo Horizonte, MG - Brazil.

Corresponding Author: Fernanda Penido Matozinhos
E-mail: nandapenido@hotmail.com

Authors' Contributions:
Conceptualization: Marina D. O. Lima, Thales P. R. Silva, Ariene S. Carmo, Lorena M. A. Mateus, Juliana O. Marcatto, Fernanda P. Matozinhos, Ana C. Abreu, Renato C. Couto, Tânia M. G. Pedrosa; ***Methodology:*** Marina D. O. Lima, Thales P. R. Silva, Fernanda P. Matozinhos; ***Project Management:*** Fernanda P. Matozinhos; ***Resources Management:*** Ana C. Abreu, Renato C. Couto, Tânia M. G. Pedrosa; ***Statistical Analysis:*** Thales P. R. Silva; ***Writing – Original Draft Preparation:*** Marina D. O. Lima; ***Writing – Review and Editing:*** Thales P. R. Silva, Ariene S. Carmo, Lorena M. A. Mateus, Juliana O. Marcatto, Fernanda P. Matozinhos, Ana C. Abreu, Renato C. Couto, Tânia M. G. Pedrosa.

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Tânia Couto Machado Chianca
Bruna Figueiredo Manzo

ABSTRACT

Objective: to verify the association between birth weight, gestational age, and secondary medical diagnoses in the length of hospital stay of premature newborns. **Methods:** cross-sectional study, with 1,329 medical records of newborns from July 2012 to September 2015, in two hospitals in Belo Horizonte, which use the Diagnosis Related Groups Brasil system. To determine a cutoff point for birth weight and gestational age at birth that best determined the length of hospital stay, the Receive Operator Characteristic curve was used. Subsequently, the analysis of variance test and Duncan's test were used to compare the mean length of hospital stay. **Results:** prematurity without major problems (DRG792) was the most prevalent category (43.12%). The longest mean length of hospital stay was 34.9 days, identified among preterm infants or infants with respiratory distress syndrome (DRG 790). The combination of lower birth weight and lower GA at birth presented the highest risk of hospital stay, increased when compared to the other profiles formed for this DRG. **Conclusion:** the findings may direct assistance in relation to the mobilization of physical, human and consumer goods resources, in addition to the critical analysis of conditions that influence clinical outcomes. The possibility of optimizing the use of these hospital resources, allied to improving the quality of care and patient safety, is associated with minimizing the length of hospital stay and the burden of neonatal morbidity and mortality.

Keywords: Diagnosis-Related Groups; Infant, Newborn; Infant, Premature; Length of Stay.

RESUMO

Objetivo: *verificar a associação entre peso ao nascer, idade gestacional e diagnósticos médicos secundários no tempo de permanência hospitalar de recém-nascidos prematuros.* ***Métodos:*** *estudo transversal, com 1.329 prontuários de recém-nascidos no período de julho de 2012 a setembro de 2015, em dois hospitais de Belo Horizonte, que utilizam o sistema Diagnosis Related Groups Brasil. Para determinar um ponto de corte para o peso ao nascer e a idade gestacional no nascimento que melhor determinasse o tempo de internação, foi utilizada a curva Receive Operator Characteristic. Posteriormente, utilizou-se o teste de análise de variância e teste de Duncan para a comparação entre a média de tempo de permanência hospitalar.* ***Resultados:*** *a prematuridade sem problemas maiores (DRG792) foi a categoria mais prevalente (43,12%). O maior tempo médio de internação foi de 34,9 dias, identificado entre os recém-nascidos prematuros ou com síndrome da angústia respiratória (DRG 790). A combinação de menor peso ao nascer e menor IG ao nascimento apresentou o maior risco de permanência hospitalar, aumentada quando comparados aos demais perfis formados para esse DRG.* ***Conclusão:*** *os achados poderão direcionar a assistência em relação à mobilização de recursos físicos, humanos e de bens de consumo, além da análise crítica de condições que influenciam os desfechos clínicos. A possibilidade da otimização do uso desses recursos hospitalares aliada à melhoria da qualidade dos atendimentos e da segurança dos pacientes está associada à minimização do tempo de permanência hospitalar e da carga de morbidade e mortalidade neonatal.*

Palavras-chave: *Grupos Diagnósticos Relacionados; Recém-Nascido; Recém-Nascido Prematuro; Tempo de Internação.*

RESUMEN

Objetivo: *verificar la asociación entre el peso al nacer, la edad gestacional y los diagnósticos médicos secundarios en la duración de la estancia hospitalaria de los recién nacidos prematuros.* ***Métodos:*** *estudio transversal, con 1.329 registros de recién nacidos de julio de 2012 a septiembre de 2015, en dos hospitales de Belo Horizonte, que utilizan el sistema Diagnosis Related Groups Brasil. Para determinar un punto de corte para el peso al nacer y la edad gestacional al nacer que mejor determina la duración de la estadía, se utilizó la curva Receive Operator Characteristic. Posteriormente, se utilizó la prueba de análisis de varianza y la prueba de Duncan para comparar la duración media de la estancia hospitalaria.* ***Resultados:*** *la prematuridad sin mayores problemas (DRG792) fue la categoría más prevalente (43,12%). La estancia media más larga fue de 34,9 días, identificada entre los recién nacidos prematuros o aquellos con síndrome de dificultad respiratoria (DRG 790). La combinación de menor peso al nacer y menor IG al nacer presentó el mayor riesgo de estancia hospitalaria, que se incrementó en comparación con los otros perfiles formados para este DRG.* ***Conclusión:*** *los hallazgos pueden orientar la atención en relación con la movilización de recursos físicos, humanos y de bienes de consumo, además del análisis crítico de las condiciones que influyen en los resultados clínicos. La posibilidad de optimizar el uso de estos recursos hospitalarios, aliada a mejorar la calidad de la atención y la seguridad del paciente, está asociada a minimizar la duración de la estancia hospitalaria y la carga de morbilidad y mortalidad neonatal.*

Palabras clave: *Grupos Diagnósticos Relacionados; Recién Nacido; Recién Nacido Prematuro; Tiempo de Internación.*

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INTRODUCTION

Birth conditions directly influence the adaptation and evolution of postnatal life. Among the 130 million children born each year, approximately four million children die in the first four weeks of life.[1,2]

The newborn (NB), so called from birth to the 28th day of life, receives a classification based on its gestational age (GA), birth weight (BW) and the relationship between GA and birth weight.[3] The World Health Organization (WHO) defines as premature all births before 37 weeks of GA, with extreme prematurity as births occurring before 32 weeks and late prematurity as births occurring between 34 and 36 weeks of GA.[4]

The increasing and significant increase in premature births has been demonstrated. In 2014, there were 139.9 million live births in the world, of which 14.8 million were premature, generating a global rate of premature birth of 10.6% in that year.[5]

Worldwide, approximately 84.7% of all deliveries took place between 32 and 37 weeks of GA. In high-income countries, about 8% of births are premature, and in African countries, this proportion reaches between 11.2 and 13.4%.[5,6]

The WHO classifies birth weight into categories. Adequate birth weight is between 3,000 and 3,999 g, inadequate or insufficient weight between 2,500 and 2,999 g, and low birth weight (LBW) refers to weight below 2,500 g. The latter can be subcategorized into very low birth weight (< 1,500 g) and extremely low birth weight (< 1,000 g). This classification makes it possible to assess the progressive risk of morbidity and mortality in the short and long term. LBW is the main isolated factor associated with neonatal morbidity and mortality (zero to 27 days).[4-5]

Studies highlight that the lower the GA and BW, the greater the complexity of care demand and the increased consumption of resources and neonatal hospital costs, as well as the chances of death during the neonatal period.[1,7,8]

Prematurity and birth weight are a relevant health problem due to the immediate and late repercussions observed not only in the lives of affected individuals, but also in their families and in the social group responsible for organizing healthcare networks. It is noteworthy that the neonatal period is considered a moment of great vulnerability in the life of the NB, due to biological, environmental, social, and cultural risks.[9-11]

Given the above, it is necessary to develop tools that make it possible to predict the permanence of premature neonates in progressive neonatal care units and to develop a model that considers the particularities of different groups of birth weight, with different morbidities and associated problems.[12]

The analysis of the hospitalization period suggests a relationship with the demographic profile, prevalent complications and the trajectory of the population served during hospitalization, in addition to constituting an important indicator for the quality and cost of healthcare.[9,13]

The categorization of patients into homogeneous groups according to their characteristics and care complexity is proposed by the methodology of related diagnostic groups (DRG), being applicable to patients admitted in hospitals that treat acute cases, being an important resource for the generation of data that contribute to the reorganization of care for the newborn.[14]

The DRG methodology has been used by several countries for providing consistent information on factors related to care peculiarities and the period of stay of the patient in the health institution, contributing to the forecast of resources by hospitals, being considered a remarkable platform for decision making.[14]

Thus, this study aimed to verify the association between birth weight, gestational age, and secondary medical diagnoses in the length of hospital stay of premature newborns.

METHODS

This is a cross-sectional study carried out with the collection of data from 1,329 medical records of premature newborns between July 2012 and September 2015, in two hospitals in Belo Horizonte, Minas Gerais, using the Diagnosis Related Group (DRG) Brasil® system. The software used was version 9 of DRG Brasil®. The collected data were digitally recorded and organized for further analysis.

The data used were collected from the electronic medical records of all NBs who were discharged from the two hospitals in question, between January and July 2020, with registration of this information in the DRG Brasil® system, by coding nurses, dedicated to this function, under medical supervision. The variables collected refer to: main diagnosis at admission, secondary medical diagnoses, surgeries, and therapeutic interventions (need for mechanical ventilation) and patient characteristics (such as age, weight, and gestational age at birth). It is noteworthy that there was no sample loss.

It is emphasized that the difference in temporality between the years of data collection and the analyzes of the present study does not compromise the results presented, since there was no temporal dissociation in the variables, in the design of the study period and in the context inherent to the influence of the birth weight, gestational age and secondary medical diagnoses in the length of hospital stay of newborns.

The acute care provided in a hospital is characterized by the demand for a variety of human resources, physical structure, equipment, pharmaceuticals, and medical supplies. With the DRG methodology, care outcomes and resource consumption become comparable and predictable, since patients grouped into the same DRG (care product) have similar clinical and risk characteristics, determining the use of resources (length of stay and consumption of inputs) are also similar.[15]

Care complexity is established by the profile of patients treated in a hospital, in a given period of time (casemix index: index of the composition or mixture of different clinical cases). The term complexity by casemix is used to refer to a set of patient attributes that are interrelated but distinct, including disease severity, prognosis, treatment difficulty, need for interventions, and resource consumption intensity.[16] Each DRG is assigned a relative weight that expresses the minimum number of resources needed to treat a patient in that DRG.

In the case of neonates, there are specifics for the assignment of a DRG. Each neonate is assigned a DRG, considering, as the first requirement of the algorithms, birth weight (BW) and gestational age (GA). These two variables are the main markers of severity in the neonatal population. Birth weights below 1,500 grams or GA below 32 weeks determine more chances of complications and mortality associated with prematurity, demand a long hospital stay - practically the entire period in the intensive care unit - and consumption of resources significantly higher than those observed for neonates in higher weight and age ranges. The length variable, analyzed together with the previous ones, also influences the formation of the DRG in this population.[14,16]

Other variables classified as conditions originating in the neonatal period, such as congenital malformations, endocrine-metabolic diseases, genetic alterations, respiratory distress syndrome of the newborn, among many other comorbidities and complications of the perinatal period, add to the risk, increasing the severity of the disease. neonate.[1]

Although it does not fully explain the total cost of hospital treatment in extremely preterm infants, length of stay can be considered a marker of resource consumption.[17] In addition, the predictability of average length of stay helps manage family expectations and contributes to the allocation of resources in the neonatal intensive care unit (NICU).[8]

For the classification of cases in a given DRG, the following variables were considered: main diagnosis, age and gender of the patient, existence of comorbidities and complications (secondary diagnoses) and the procedures performed. And in the case of newborns, the variables BW, GA, and length.[18] For the description of the main and secondary diagnoses, the International Classification of Diseases-ICD10 was used. The procedures performed were coded according to the table of procedures used in the Unified Health System (*SUS*) and in supplementary health (Unified Terminology for Supplementary Health - *TUSS*). It should be noted that the algorithms for the classification of the DRG are in the public domain.

In this study, six DRGs that make up the major diagnostic category (MDC) of NBs and neonates with conditions originating in the perinatal period (MDC 15) were analyzed. The DRGs studied referred to extreme prematurity or respiratory distress syndrome of newborns (DRG 790), in which premature newborns from 23 to 26 weeks or newborns with respiratory distress syndrome were included, regardless of GA (this group was divided into two subgroups: one of those who progressed to death and another of those who progressed to hospital discharge).

Regarding prematurity with major problems (DRG 791), preterm NBs from 27 to 36 weeks of GA with major problems (health conditions with potential for serious harm, disability, or death of the neonate) were included. Prematurity without major problems (DRG 792), in turn, included preterm newborns from 27 to 36 weeks of GA without major problems.

The sample was described using absolute and relative frequencies. Regarding length of stay, birth weight and GA, the mean, the standard deviation (SD), the confidence interval (CI) of the means, minimum and maximum values, and the percentiles of interest (P_{10}, P_{25}, P_{50}, P_{75} and P_{90}), in addition to the coefficient of variation.

To determine a cutoff point for birth weight and GA at birth that best determined the length of hospital stay, the Receive Operator Characteristic (ROC) curve was used. In this study, we sought to define the cutoff points for birth weight and GA, considering each of the evaluated hospital stay percentiles (P_{10}, P_{25}, P_{50}, P_{75} and P_{90}).

After identifying the groups using the ROC curve, the analysis of variance test (ANOVA) and Duncan's test were used to compare the mean length of hospital stay between the groups.

The mean length of hospital stay was also compared according to the groups formed by the most frequent secondary diagnoses according to the ICD-10 for the DRGs studied, verifying whether these diagnoses would increase the length of hospital stay of neonates. For this procedure, analysis of variance was used.

After this phase, risk profiles of premature newborns were created, elaborating the forecast for hospital stay, considering birth weight and GA for each DRG studied. It is noteworthy that, in the analysis of secondary ICDs, there was an association with the length of hospital stay. DRG was stratified by secondary diagnosis and followed by profiling preterm newborns. ANOVA and Duncan tests were used to evaluate the statistical difference between the formed profiles.

A significance level of 5% was adopted in all statistical procedures. Data were processed and analyzed using free statistical software R.

The research followed guidelines expressed in Resolution MS 466/2012, which deals with research with human beings, and was approved by the Research Ethics Committee (COEP) of the *Universidade Federal de Minas Gerais* - UFMG, under number 34133814.5.0000.5149. The free and informed consent form was waived.

RESULTS

Among the preterm newborns analyzed, prematurity without major problems (DRG 792) was the most prevalent category (43.12%) - Table 1. Regarding the mean length of hospital stay, it was observed that the longest average length of stay was 34.9 days, identified among premature newborns or with respiratory distress syndrome (DRG 790) - Table 1.

Considering the P50 for the length of stay of neonates with extreme prematurity or newborn respiratory distress syndrome (DRG 790), prematurity with major problems (DRG 791) and prematurity without major problems (DRG 792), were identified as the best points. of cuts for birth weight the values of 1,580 grams, 2,097 grams and 2,250 grams, respectively. Regarding GA at birth, the best cutoff points for P50 for length of hospital stay were 32 weeks of gestation for DRG 790, 34.5 weeks of gestation for DRG 791 and 35 weeks for DRG 792 - Table two.

After identifying the groups using the ROC curve, the weight and GA at birth that best discriminated the patients belonging to the percentiles (P_{10}, P_{25}, P_{50}, P_{75} and P_{90}) of hospital stay in the progressive neonatal care unit were obtained (UCPN). Neonates with lower birth weight or lower GA at birth remained hospitalized for a longer period of time at the UCPN, with a statistical difference ($p<0.001$) when compared to the other groups of birth weight or GA at birth. Neonates belonging to the DRG 790 - high (extreme prematurity or respiratory distress syndrome) who were born with a birth weight of less than 1,120 grams - demonstrated greater permanence when compared to neonates belonging to other birth weight groups. Regarding GA at birth, for neonates belonging to the same DRG and with GA at birth less than 29 weeks, it was also found that the length of stay was longer in relation to neonates belonging to other groups formed, also with a statistically significant difference (Table 3).

After the formation of the groups of birth weight and GA at birth using the ROC curve, verification of the similarity of these groups by the ANOVA test and Duncan's test and evaluation of the impact of secondary diagnoses on the length of hospital stay, the profiles were formed of neonates (Tables 2 and 3).

For the DRG 790 (newborns with extreme prematurity or respiratory distress syndrome of the newborn), the formation of six risk profiles of premature newborns was inferred (profile A, profile B, profile C, profile D, profile E and profile F) that influence hospital stay, and the combination of lower birth weight (<1,120 grams) and lower GA at birth (< 29 weeks) presented the highest risk of increased hospital stay when compared to the other profiles formed for this DRG (Table 4).

Among the premature NBs belonging to the DRG 791 (prematurity with major problems), there was the formation of three risk profiles (profile A, profile B and profile C) for hospital stay, with preterm NBs belonging to the lower GA profile (< 33.5 weeks) and lower birth weight (<1,805 grams) were more likely to have increased hospital stay when compared to neonates belonging to the group with higher GA (≥ 33.5 weeks) and higher birth weight (≥ 1,805 grams) - (Table 4).

Neonates belonging to the DRG 790, when they had a secondary diagnosis of neonatal jaundice associated with premature birth or other NB apneas, showed an increase in hospital stay at the NICU when compared to those who did not have such secondary diagnoses, with a statistically significant difference (p-value=0.043).

Table 1 - Characterization of neonatal hospital stay of DRGs in the diagnostic categories related to MDC 15. DRG Brazil Database - 2015

	DRG	n(%)	Description	Results		
				n(%)	Mean±SD	CV
Primature	790	535(40.26)	Extreme prematurity or respiratory distress syndrome of the newborn - high	535(38.82)	34.9±29.1	83.8
	791	221(16.63)	Prematurity without major problems	221(16.04)	17.0±26.1	106.0
	792	573(43.12)	Prematurity without major problems	573(41.58)	8.4±8.4	102.4
	TOTAL	**1329**				

*Observation: Major issues are health conditions with the potential for serious harm, disability, or death to the neonate.; SD – standard deviation; CV - coefficient of variation.

Table 2 - Agreement and accuracy of birth weight and GA at birth in relation to hospital stay of neonates in progressive neonatal care units. DRG Brazil Database - 2015

Hospital Stay	Cutoff Point – ROC Curve	Sensitivity	Specificity	Area under the Curve
BIRTH WEIGHT				
DRG 790				
P_{10} = 8.2	2,030	0.830	0.828	0.886
P_{25} = 14.8	1,900	0.886	0.883	0.932
P_{50} = 28.5	1,580	0.865	0.870	0.945
P_{75} = 45.7	1,290	0.863	0.866	0.946
P_{90} = 71.5	1,120	0.873	0.870	0.941
DRG 791				
P_{10} = 3.5	2,171	0.682	0.693	0.737
P_{25} = 6.7	2,197	0.679	0.648	0.726
P_{50} = 10.6	2,097	0.721	0.664	0.765
P_{75} = 18.3	1,945	0.705	0.655	0.791
P_{90} = 31.6	1,805	0.784	0.636	0.762
DRG 792				
P_{10} = 1.9	2,400	0.655	0.643	0.698
P_{25} = 2.5	2,350	0.683	0.647	0.717
P_{50} = 6.0	2,250	0.715	0.670	0.750
P_{75} = 11.0	2,100	0.767	0.734	0.842
P_{90} = 18.5	1,950	0.843	0.804	0.870
GESTATIONAL AGE AT BIRTH				
DRG 790				
P_{10} = 8.2	34.0	0.792	0.898	0.915
P_{25} = 14.8	33.3	0.856	0.861	0.910
P_{50} = 28.5	32.0	0.842	0.877	0.926
P_{75} = 45.7	30.4	0.881	0.881	0.946
P_{90} = 71.5	29.0	0.889	0.889	0.946
DRG 791				
P_{10} = 3.5	35.0	0.982	0.653	0.718
P_{25} = 6.7	35.0	0.625	0.703	0.738
P_{50} = 10.6	34.5	0.793	0.618	0.748
P_{75} = 18.3	34.5	0.681	0.691	0.743
P_{90} = 31.6	33.5	0.829	0.727	0.741
DRG 792				
P_{10} = 1.9	35.5	0.690	0.687	0.729
P_{25} = 2.5	35.0	0.717	0.652	0.717
P_{50} = 6.0	35.0	0.880	0.613	0.808
P_{75} = 11.0	34.5	0.826	0.769	0.875
P_{90} = 18.5	33.8	0.895	0.625	0.875

Observation: P_{10}, P_{25}, P_{50}, P_{75}, P_{90} – percentile of actual hospital stay.
Roc - Receive Operator Characteristic.

Table 3 - Groups formed by the ROC curve of birth weight and GA at birth in relation to hospital stay of neonates in progressive neonatal care units. DRG Brazil Database - 2015

	Hospital Stay			
	n	Mean ± SD	CI (95%)	p
BIRTH WEIGHT (grams)				
DRG 790				<0.001
2,030 or more[A]	127	11.4 ± 5.9	(10.4 - 12.5)	
1,900 to 2,029[A]	39	17.3 ± 11.0	(13.8 - 20.9)	
1,580 to 1,899[B]	103	25.1 ± 15.9	(22.0 - 28.2)	
1,290 to 1,579[C]	101	33.8 ± 11.6	(31.5 - 36.1)	
1,120 to 1,289[D]	57	47.2 ± 14.7	(43.3 - 51.1)	
< 1,120[E]	108	72.9 ± 35.5	(66.1 - 79.7)	
DRG 791				<0.001
2,320 or more[A]	76	10.5 ± 13.8	(7.3 - 13.7)	
2,197 to 2,319[A]	20	10.3 ± 9.3	(5.9 - 14.7)	
2,097 to 2,196[A]	20	12.0 ± 7.7	(8.4 - 15.6)	
1,945 to 2,096[A]	19	15.5 ± 13.7	(8.9 - 22.1)	
1,805 to 1,944[A]	28	14.9 ± 12.1	(10.3 - 19.6)	
< 1,805[B]	57	25.8 ± 21.2	(20.2 - 31.5)	
DRG 792				<0.001
2,400 or more[A]	224	5.0 ± 5.5	(4.3 - 5.7)	
2,350 to 2,399[AB]	28	5.3 ± 3.7	(3.9 - 6.8)	
2,250 to 2,349[AB]	51	6.1 ± 5.3	(4.6 - 7.6)	
2,100 to 2,249[AB]	71	7.0 ± 5.2	(5.8 - 8.2)	
1,950 to 2,099[B]	78	7.9 ± 4.8	(6.8 – 9.0)	
< 1,950[C]	121	17.6 ± 11.0	(15.6 - 19.5)	
GESTATIONAL AGE AT BIRTH (weeks)				
DRG 790				<0.001
34 or more[A]	143	13.1 ± 8.4	(11.7 - 14.5)	
33.3 to 33.9[A]	35	18.7 ± 11.2	(14.8 - 22.5)	
32.0 to 33.2[B]	115	25.2 ± 12.0	(23.0 - 27.4)	
30.4 to 31.9[C]	80	35.1 ± 16.4	(31.4 - 38.7)	
29.0 to 30.3[D]	77	47.2 ± 17.6	(43.2 - 51.2)	
< 29.0[E]	85	80.2 ± 35.0	(72.6 - 87.7)	
DRG 791				<0.001
35 or more[A]	89	11.9 ± 14.6	(9.2 - 14.5)	
34.5 to 34.9[A]	11	11.1 ± 7.1	(7.0 - 15.2)	
33.5 to 34.4[A]	35	14.5 ± 7.9	(12.0 - 17.0)	
< 33.5[B]	51	33.9 ± 47.6	(19.9 - 47.8)	
DRG 792				<0.001
35.5 or more[A]	212	4.2 ± 5.1	(3.6 - 4.9)	
35.0 to 35.4[AB]	153	6.5 ± 5.0	(5.7 - 7.3)	
34.5 to 34.9[BC]	23	8.6 ± 4.7	(6.6 - 10.7)	
33.8 to 34.4[C]	96	10.5 ± 6.4	(9.2 - 11.8)	
< 33.8[D]	89	19.3 ± 11.2	(17.0 - 21.7)	

Notes: SD – standard deviation; 95% CI - confidence interval of 95%; p-value in bold < 0.05 in the analysis of variance (ANOVA); equal letters indicate similarities between groups, Duncan's test.

However, in neonates with transient tachypnea of the NB as a secondary diagnosis, a reduction in the length of hospital stay at the NICU was observed when compared to those without this diagnosis, with a statistically significant difference (p-value=0.013). Other comorbidities were evaluated (NB affected by oligohydramnios, transient tachypnea of the NB, NB affected by maternal hypertensive disorders, ABO isoimmunization of the NB, cyanotic crises of the NB and neonatal polycythemia), but they did not affect the length of hospital stay (data not shown in tables).

Among the neonates belonging to the DRG 791 (prematurity with major problems), secondary diagnoses did not significantly impact the length of hospital stay of neonates, and the comorbidities evaluated were: unspecified respiratory distress in the NB, neonatal jaundice, transient tachypnea in the NB and NB affected by oligohydramnios (data not shown in tables).

As for the neonates belonging to the DRG 792 (prematurity without major problems), the secondary diagnoses of unspecified respiratory distress in the newborn and other respiratory discomforts significantly impacted the increase in the length of hospital stay in the NICU of these neonates when compared to those who did not have these diagnoses. Other comorbidities (neonatal jaundice, transient tachypnea of the NB, ABO isoimmunization of the NB, NB affected by maternal hypertensive disorders and cyanotic crises of the NB) were evaluated but did not impact the length of stay (data not shown in tables).

For the DRG of prematurity without major problems (DRG 792), preterm NBs with a lower GA (< 33.6 weeks), lower birth weight (< 1,950 grams) and with secondary ICD 'other respiratory distress of the newborn' or 'unspecified respiratory distress of the newborn' formed the group with the longest expected hospital stay when compared to the other profiles. The group of neonates with at least 35.5 weeks of GA and with at least 2,100 grams of birth weight constituted, in turn, the group with the shortest expected hospital stay - Table 5.

DISCUSSION

This study made it possible to identify the profiles of combination of birth weight and GA, within each DRG evaluated, which interfered in the length of hospital stay of premature newborns.

The category that presented the longest period of hospitalization among the premature NB included in this study was that of NB with extreme prematurity or respiratory distress syndrome (DRG 790).

The need for an NB to remain hospitalized after birth may be related to multiple factors, from socioeconomic, biological, care and institutional, as a reflection of health actions that need to be improved. The repercussion of diseases in the perinatal period in an NB can generate negative impacts that last throughout their life, except for the adequate performance of professionals working in the obstetric and neonatology sectors and a good hospital structure.[19]

Table 4 - Profiles for DRG 790 and 791 of neonates formed by birth weight and GA at birth in relation to hospital stay of neonates in progressive neonatal care units. DRG Brazil Database - 2015

	Birth Weight (grams)	Gestational Age at Birth (weeks)				
		< 29	29.0 a 30.3	30.4 a 31.6	32.0 a 33.2	33.3 a 36.6
DRG 790	< 1,120	88.5 ± 35.3^{A}	52.6 ± 20.1^{B}	47.2 ± 10.9^{B}		
	1,120 a 1,289	56.2 ± 12.5^{B}	53.6 ± 14.9^{B}	35.4 ± 3.1^{C}		
	1,290 a 1,579		41.4 ± 15.6^{C}	32.9 ± 6.2^{C}	29.8 ± 9.2^{D}	27.1 ± 6.3^{D}
	1,580 a 1,899			33.9 ± 26.3^{C}	22.2 ± 7.9^{E}	20.1 ± 9.6^{E}
	1,900 or more				18.5 ± 10.3^{E}	10.5 ± 5.0^{F}
	Weight at Birth (grams)	**Gestational Age at Birth (weeks)**				
		< 33.5		33.5 a 36.6		
DRG 791	< 1,805	36.2 ± 25.2^{A}		18.9 ± 14.6^{B}		
	1,805 or more	19.1 ± 13.5^{B}		10.8 ± 11.9^{C}		

*Notes: the values presented in the table refer to the hospital stay (mean ± standard deviation); p < 0.001 (analysis of variance); equal letters indicate similarities between groups, Duncan's test.

Table 5 - Profiles for DRG 792 of neonates formed by birth weight, GA at birth and comorbidities in relation to hospital stay of neonates in progressive neonatal care units. DRG Brazil Database - 2015

	Birth Weight (grams)	Gestational Age at Birth (weeks)				
		< 33,6	33,6 a 34,4	34,5 a 34,6	35,0 a 35,4	≥ 35,5
Other or no comorbidities	< 1.950	20,5 ± 12,9[B]	16,2 ± 6,3[B]	5,7 ± 2,3[D]	9,6 ± 7,3[C]	6,7 ± 3,2[D]
	1.950 to 2.099	12,0 ± 6,6[C]	7,5 ± 5,0[C]		6,7 ± 4,9[D]	4,8 ± 2,8[D]
	2.100 to 2.399		8,1 ± 5,1[C]		5,3 ± 4,1[D]	3,4 ± 2,4[E]
	2.400 or more		6,5 ± 2,6[D]		5,6 ± 4,9[D]	3,7 ± 6,3[E]
Unspecified respiratory distress of the newborn	Weight at Birth (grams)	Gestational Age at Birth (weeks)				
		< 33,6		≥ 33,6		
	< 1950	24,4 ± 11,4A				
	1.950 ou mais			9,9 ± 5,3C		
Other respiratory distress in the newborn	Weight at Birth (grams)	Gestational Age at Birth (weeks)				
		< 33,6		≥ 33,6		
	< 1950	27,0 ± 11,8[A]				
	1.950 ou mais			12,4 ± 4,4[C]		

Notes: the values presented in the table refer to the hospital stay (mean ± standard deviation); $p < 0.001$ (analysis of variance); equal letters indicate similarities between groups, Duncan's test.

In cases where, in addition to prematurity, major problems occur - such as malformations, infections and comorbidities resulting from hospitalization -, this period can be even longer, as evidenced in the present study. For the same population profile (DRG 791 - prematurity with major problems - and DRG 792 - prematurity without major problems), in NBs with major complications, the mean hospital stay was 17 days and, in those without complications, 8-4 days. The systemic immaturity observed in premature newborns in isolation determines a series of possible complications, however, the course during hospitalization can determine the occurrence of unfavorable outcomes until the moment of hospital discharge. Therefore, the longer the period of hospitalization, the greater the exposure and, consequently, the higher the risks associated with care.[19,20]

The care model adopted in the prenatal and neonatal period, the morbidities developed during hospitalization and the different protocols of discharge criteria can directly interfere with the length of stay and increase exposure to the risk of complications, interfere with family dynamics and impact in costs related to care.[6] It is understood that, by avoiding complications associated with prematurity, it is possible to obtain better results and reduce the period of hospitalization, regardless of GA and birth weight.[21]

Studies highlight the importance of qualified prenatal care in the identification and prevention of conditions associated with prematurity and low birth weight. However, its multifactorial etiology requires that actions go beyond the health sector, requiring strategies aimed at improving the socioeconomic conditions of the population.[6,19]

In the present study, the longest hospital stay was associated with a birth weight of less than 1,120 g and a GA of less than 29 weeks for NBs classified as DRG 790; weight less than 1,805 and GA less than 33.5 weeks for NBs with DRG 791; and weight less than 1,950 and GA less than 33.6 weeks in patients with DRG 792. It is abstracted that in DRGs 791 and 792, the range of weight and GA that determined longer periods of hospitalization was similar, with no statistically significant difference.

It is known that birth weight is the variable that most interferes with the length of stay and is the main predictor of mortality in the hospital environment. Thus, the inverse relationship of length of stay with GA and birth weight is described in the literature and evidenced in clinical practice.[2]

In a study on models for predicting hospital discharge in preterm infants, it was concluded that the inverse relationship is weak if only perinatal factors are considered.[22] The present study also showed that major complications did not lead to a significant increase in the length of stay in DRGs 791 and 792.

However, the more premature and lower the weight, the longer the length of stay, which highlights the fact that perinatal data are important in defining the length of stay, since they can determine complications related to prematurity and low birth weight. at birth.

Research reports that prematurity and intrauterine growth retardation are among the main determinant conditions for low birth weight, however, several characteristics have been investigated as possible risk factors. Of the most frequently associated are socioeconomic, sociodemographic, maternal, obstetric, and prenatal care.[6,21] Other authors still suggest the relationship with environmental characteristics, such as atmospheric, water or soil pollution, and with the family, such as in cases of domestic violence during pregnancy.[21,22]

Regarding secondary ICDs, in NBs belonging to the DRG 790-discharge, jaundice and other apneas were related to longer hospital stays. A possible explanation for this finding is the relationship between hepatic immaturity and extreme prematurity.[23] Pulmonary immaturity often determines the need for ventilatory support and the higher incidence of apnea in this sample. Neuronal organization in premature newborns is characterized by few synapses and dendritic formations, depending on the quantity and quality of ascending sensory stimuli. In this way, disturbances of thermal regulation, tactile and sensorial stimuli, as well as metabolic disturbances, such as hypoglycemia and infections, can explain apnea.[24]

The increase in rib cage compliance associated with pulmonary immaturity in premature newborns results in a reduction in pulmonary functional residual capacity and increases the incidence of saturation drop events. A relationship between jaundice and apnea events in premature newborns was described by Amin *et al*., who showed that patients with hyperbilirubinemia were up to twice as likely to develop apnea as those who did not have this clinical entity.[25]

Patients belonging to the DRG 790 with a secondary diagnosis of transient tachypnea of the newborn (TTRN) had a shorter hospital stay when compared to those without this diagnosis. TTRN is a self-limiting disease resulting from delayed expulsion and absorption of pulmonary fluid. As this group is composed of extremely preterm infants and those with respiratory distress syndrome, clinical conditions were expected that would determine a greater need for interventions and ventilatory support (findings in relation to TTRN and shorter hospital stay).

It is essential that profiles and peculiar characteristics associated with the length of hospital stay of NB are considered, in order to investigate actions to improve the quality of care provided and avoid possible related complications, as well as to enable the development of an individual and comprehensive care plan, including continuous monitoring of assistance to this population.[5,7,18]

This study has as limitations the use of secondary data from medical records and the relatively low sample representativeness of the public sector, which could make it possible to compare public care and supplementary health. This, in turn, is justified by the implementation of the DRG methodology in a greater number of hospitals with this type of funding. It is important to highlight the potential of the work, such as its originality in Brazil and Latin America. To our knowledge, this is the first study to assess the need for risk adjustment for this population segment in developing countries.

This study showed that longer hospital stay was associated with birth weight below 1,120 and GA below 29 weeks for NBs classified as DRG 790; weight less than 1,805 and GA less than 33.5 weeks for NBs with DRG 791; and weight less than 1950 and GA less than 33.6 weeks in patients with DRG 792.

CONCLUSION

The present study provided data on length of hospital stay and indicators related to neonatal morbidity and mortality, which are remarkably important in assessing the quality of care provided.

The dynamics of neonatal units, the understanding of the profile of the population served and the identification of groups of homogeneous behaviors through the DRG methodology can direct the mobilization of physical, human and consumer goods resources, in addition to allowing the critical analysis of conditions that influence clinical outcomes.

The possibility of optimizing the use of these hospital resources, allied to improving the quality of care and patient safety, is associated with minimizing the length of hospital stay and the burden of neonatal morbidity and mortality.

The results of this investigation offer, therefore, important epidemiological information for the introduction of management tools for estimating the hospital stay of premature neonates, considering the particularities of different groups of birth weight and gestational age, with different morbidities and associated problems,

which can provide a broad understanding of the health needs of patients and their families and the understanding of likely strategies, in order to meet the demands taking into account the peculiarities and comprehensiveness of care.

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