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Analysis of Factors Affecting Birth Weight Using Probabilistic Neural Network (PNN)

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Abstract. The hight mortality rate in newborns is caused by the fact that many babies are born with low birth weight. LBW is one of the factors of infant mortality in Indonesia. Mitra Medika hospital Bandar Kippa is one of the pregnant women who has a Low Birth Weight (LBW) baby. Prevention and treatment of pregnant women when they know that they will give birth to a baby withlow birth weight is very necessary, in order to minimize death during the bieth process. So it is hoped that the existence of a factor analysis that affects birth weight in babies cas help to identify the condition of the baby in pregnant women before the baby is born. In this study, *Probabilistic Neural Network* (PNN) method was used with 150 data and 7 features including maternal age, maternal weight, maternal height, maternal hemoglobin, gestational distance, parity and maternal education. To get the best accuracy results, training data and testing data are shared using *K-Means Clustering.* Furthermore, an analysis of the factors that affect BBL using the *Probabilistic Neural Network* method is carried out, therefore it can be obtained that the probability value affecting BBL is found in the mother's weight of 0,856 with the highest output layer value in the normal class of 6,741 and an accuracy value of 88,67.

Keyword: BBL, *Probabilistic Neural Network, K-Means Clustering.*

Abstrak. *Tingginya angka kematian pada bayi baru lahir disebabkan karena masih banyak bayi yang dilahirkan dengan berat badan bayi yang rendah. BBLR merupakan salah satu faktor dari kematian bayi di Indonesia. RSU Mitra Medika Bandar Klippa merupakan salah satu ibu hamil yang memiliki kelahiran bayi Berat Badan Lahir Rendah (BBLR). Pencegahan dan penanganan pada ibu hamil saat mengetahui akan melahirkan bayi kondisi BBLR sangat diperlukan, demi meminimalisir kematian saat proses kelahiran. Sehingga diharapkan dengan adanya analis faktor yang mempengaruhi berat badan lahir pada bayi ini dapat membantu untuk mengidentifikasi kondisi bayi pada ibu hamil sebelum bayi dilahirkan. Pada penelitian ini digunakan metode Probabilistic Neural Network (PNN) dengan 150 data dan 7 fitur diantaranya yaitu usia ibu, berat badan ibu, tinggi ibu, hemoglobin ibu, jarak kehamilan, paritas, dan pendidikan ibu. Untuk mendapatkan hasil akurasi terbaik dilakukan pembagian data training dan data testing menggunakan K-Means Clustering. Selanjutnya dilakukan analisis faktor yang mempengaruhi BBL menggunakan metode Probabilistic Neural Network, oleh karena itu dapat diperoleh nilai probabilitas yang mempengaruhi BBL terdapat pada berat badan ibu sebesar 0,856 dengan nilai output layer tertinggi pada kelas normal sebesar 6,741 serta diperoleh nilai akurasi sebesar 88,67%.*

Kata Kunci: *BBL, Probabilistic Neural Network, K-Means Clustering.*

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1. Introduction

The Infant Mortality Rate (IMR) is the first indicator in determining the health status of children. Most of the causes of infant and under-five mortality are problems that occur in newborns aged 0-28 days. Birth weight is the weight of the neonate weighed within one hour after birth. The weight of the neonate is an important tropometric measure and is often used in neonates, besides the weight of the neonate is used as a diagnosis of normal or LBW infants [1]. Problems that often occur in newborns are asphyxia (difficulty breathing at birth), Low Birth Weight Babies (LBW), and infections. The baby's weight at birth is one of the descriptions of the health condition of the baby and its good and bad nutrition during the womb [2].

A baby's weight at birth is the result of the interaction of various factors through a process that takes place while in the womb of pregnant women. In general, babies are born after being conceived for approximately 40 weeks in the mother's womb. In general, the weight of a normal born baby is between 3000 grams to 4000 grams, and if it is below or less than 2500 grams, it is said to be LBW [3].

The knowledge between birth weight in infants and the factors that influence it is important to overcome the problem of birth weight. The relationship does not only come from one factor, but can also come from other factors that influence it, namely internal factors that are influenced by the mother and external factors that are influenced by the environment [4].

The method used in this research is Probabilistic Neural Network (PNN). The Probabilistic Neural Network method is one of the Artificial Neural Networks which is generally used for classification and pattern recognition problems [5]. The Probabilistic Neural Network method is often used for classification with a fast process, and can map patterns to classes optimally, aka having high accuracy. The PNN structure consists of four layers, namely the input layer, pattern layer, summation layer, and output layer [6].

Based on the problem regarding newborns, the researchers analyzed the factors that influence birth weight by paying attention to the history of pregnant women at Mitra Medika Bandar Klippa General Hospital. Factors that affect birth weight are maternal age, maternal weight, maternal height, maternal hemoglobin, gestational age, parity, and maternal education. PNN consists of four layers, namely input layer, pattern layer, summation layer, and output layer. PNN is often used for classification with a fast process, and can map patterns to classes optimally, aka having high accuracy.

2. Materials and Methods

2.1. Data Sources and Research Variables

This research was conducted at RSU Mitra Medika Bandar Klippa located in Jl. Medan – Batang Kuis Dusun XI, Bandar Klippa, Kec. Percut Sei Tuan, Kabupaten Deli Serdang, Sumatera Utara 20371. This research was started from the preparation of the proposal in April to October 2020.

Table 1. Research Variable

Table	Description	Unit
Y	Brith Weight (BBL) BBL < 2500 gr = 1 BBL ≥ 2500 gr = 2	gr
X_1	Mother's Age	Year
X_2	Mother's Weight	Kg
X_3	Mother's Height	Cm
X_4	Hemoglobin	g/dL
X_5	Pregnancy distance	Year
X_6	Parity	Child
X_7	Mother's Education	Graduate

2.2. Research Procedure

The data analysis process used by this method:

1. Secondary data collection on birth weight at Mitra Medika General Hospital in 2018-2019.
2. Determine the initial centroid and then calculate the Euclidean Distance value to determine the cluster point using the K-Means Clustering method.
3. Determine training data and testing data.
4. Calculating the accuracy value on the Probabilistic Neural Network method.

3. Result and Analysis

3.1. Data Collection

In this study, the data used from the patient status book of pregnant women at Mitra Medika General Hospital obtained data of 150 patients. The data on pregnant women patients are obtained in Table 2.

Table 2. Patient Data for Pregnant Women at Mitra Medika Hospital

No	BB Born	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
1	1	32	75	155	13,1	0	1	SMA
2	1	22	69	156	11,3	0	1	SMA
3	1	37	55	155	13,3	4	2	SMA
4	1	26	73	152	10,5	4	4	SMA
...	...	...	...	...	...	...	...	...
147	2	37	69	155	12,1	4	3	SMA
148	2	36	68	158	11	7	4	SMA
149	2	27	67	154	11,7	3	2	SMA
150	2	32	69	154	11,6	0	1	SMA

3.2. Classification Using PNN

The application of the PNN method in this study was used to obtain the results of the analysis of factors that affect Birth Weight (BBL) using the Probabilistic Neural Network (PNN) at Mitra Medika General Hospital. The training data used amounted to 105 records and the testing data used for manual calculations amounted to 45 data which can be seen in Table 3 and Table 4.

Table 3. Data *Training* PNN

No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
3	0,857	0,208	0,700	1,000	0,333	0,250	0,600
4	0,333	0,547	0,640	0,429	0,333	0,750	0,600
...	...	...	...	...	...	...	...
105	0,333	0,623	0,800	0,755	0,000	0,000	0,800
106	0,333	0,434	0,720	0,612	0,000	0,000	0,800

Table 4. Data *Testing* PNN

No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
103	0,571	0,434	0,600	0,857	0,250	0,500	0,600
107	0,476	0,491	0,600	0,653	0,167	0,250	0,800
...	...	...	...	...	...	...	...
144	0,381	0,585	0,000	0,735	0,000	0,000	1,000
150	0,619	0,472	0,680	0,653	0,000	0,000	0,600

The PNN architecture consists of 4 layers, namely input layer, pattern layer, summation layer, and output layer. The description of the architecture in PNN is as follows:

3.2.1. Input Layer

The input layer is the input layer that contains testing data for which class existence will be searched, it can be seen in Table 5.

Table 5. *Input Layer* PNN

No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
103	0,571	0,434	0,600	0,857	0,250	0,500	0,600
107	0,476	0,491	0,600	0,653	0,167	0,250	0,800
...	...	...	...	...	...	...	...
144	0,381	0,585	0,000	0,735	0,000	0,000	1,000
150	0,619	0,472	0,680	0,653	0,000	0,000	0,600

3.2.2. Pattern Layer

The pattern layer is a pattern layer that calculates the distance between the test data (testing) and the training data. The results of the pattern layer calculation of the pattern layer can be seen in Table 8.

Table 6. Mean

Mean							
Class	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
Normal	0,601	0,498	0,714	0,604	0,229	0,369	0,655
low	0,284	0,444	0,712	0,614	0,055	0,050	0,646

Table 7. Standard Deviation

σ^2							
Class	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
Normal	0,165	0,153	0,102	0,178	0,138	0,179	0,169
low	0,172	0,160	0,085	0,204	0,165	0,119	0,169

Table 8. Pattern Layer

Normal Class *Pattern Layer*							
No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
103	0,995	0,974	0,880	0,698	0,997	0,908	0,982
107	0,910	1,000	0,880	0,987	0,972	0,924	0,883
...	...	...	...	...	...	...	...
119	0,835	0,769	0,811	0,934	0,972	0,908	0,982
123	0,835	0,999	0,896	0,880	0,858	0,924	0,495
Low Class *Pattern Layer*							
No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education
103	0,570	0,844	0,689	0,499	0,877	0,055	0,750
107	0,722	0,782	0,689	0,720	1,000	0,708	0,540
...	...	...	...	...	...	...	...
119	0,793	0,521	0,430	0,655	1,000	0,055	0,750
123	0,793	0,759	0,468	0,610	0,886	0,708	0,343

3.2.3. Summation Layer

The summation layer is a summation layer that will calculate the average per class so that it will get several possibilities for input to enter into another class. The results of the summation layer can be seen in Table 9.

Table 9. Summation Layer

No	Factors Affecting BBL	*Summation Layer*
1	Mother's age	0,731
2	Mom's BB	**0,856**
3	Mother's Height	0,728
4	Mother's HB	0,826
5	Pregnancy distance	0,775
6	Parity	0,654
7	Mother's Education	0,752

Based on Table 9, it can be seen that the highest probability value is in the mother's weight with a summation layer value of 0,856, while the lowest probability value is parity with a summation layer value of 0,654.

3.2.4. Output Layer

The output layer of the Probabilistic Neural Network method is the largest value compared to the other class values. From the calculation results of the summation layer. The results of the Output layer can be seen in Table 10.

Table 10. Output Layer

No	Normal Class	Low Class	Highest Grade
103	6,434	4,284	6,434
107	6,556	5,160	6,556
...	...	...	...
144	4,259	4,854	4,854
150	6,103	4,742	6,103

Table 11. Test Results

No	Mother's age	Mom's BB	Mother's Height	Mother's HB	Pregnancy distance	Parity	Mother's Education	Class	Information
103	0,571	0,434	0,600	0,857	0,250	0,500	0,600	1	Valid
107	0,476	0,491	0,600	0,653	0,167	0,250	0,800	1	Valid
...	...	...	...	...	...	...	...	...	...
127	0,381	0,491	0,780	0,612	0,000	0,000	0,800	1	Invalid
130	0,333	0,717	1,000	0,633	0,000	0,000	1,000	2	Valid

As for through this test, the accuracy value can be calculated and obtained an accuracy of 86.67% and resulted in the classification of Birth Weight (BBL) at RSU Mitra Media Bandar Klippa with the highest output layer of 6.741 in the Normal class.

4. Conclusion

The number of respondents was 150 samples consisting of 76 samples with cases of low birth weight and 74 samples with cases of normal birth weight. Therefore, there is the highest probability value that affects BBL the most, namely the mother's weight of 0.856 with the highest output layer value in the normal class of 6.741. In the Probabilistic Neural Network method, an accuracy of 86.67% is obtained from the test results of 45 test data and 105 training data with a failure percentage of 13.33%.

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