KORESPONDENSI ARTIKEL

Judul Artikel : The prediction model for Low Birth Weight in Batang District, Central Java, Indonesia

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Prediction Model for Low Birth Weight of Pregnant Women in Batang District, Central Java, Indonesia

Martha Irene Kartasurya1, Yudhy Dharmawan[2],Bagoes Widjanarko[3],

Novia Handayani[4]

Background

In Indonesia, the prevalence of low birth weight, is very high (10.7%).

Batang District had the highest low birth weight prevalence in Central Java. Maternal and environmental factors are the strongest,

therefore these risk factors were investigated and prediction model were designed based on data to facilitate the targeted intervention program.

Method

- This case control study was done on 163 low birth weight (<2500g) as cases and 163 normal weight (≥2500g) babies as controls.
- The cases were all of the low birth weight babies aged <6 months in Batang District, which were singleton births.
- The controls were normal birth weight and matched for gender, age and village.
- Data were collected by interviews and records of maternal and child health handbooks.
- The risk factors which are looking were: mother's characteristics, nutritional status, health condition, behavioral factors, environmental factors, and health service factor.
- Among the most important risk factors, then linear multiple regression were designed to find a prediction model.

Resut

	LBW	NBW
Variables	Mean±SD	Mean ±SD
Maternal age (years)	26.2±7.10	26.9±6.23
Parity	1.4±0.95	1.4±0.75
Education's years	8.4±2.93	8.4±2.93
Family income	1.8E6±0.9E6	2.1E6±1.2E6
MUAC (cm)	24.0±2.57	24.8±2.60
Weight gain (kg)	8.7±4.60	10.1±5.01
Hemoglobin levels(g/dL)	10.8±1.28	11.1±1.17
Disease during pregnancy	1.1±1.1	0.8±1.0
Hypertension	0.1±0.3	0.02±0.22
Energy adequacy levels(%)	82.5±26.36	89.3±35.20
Protein adequacy levels(%)	110.8±45.76	85.0±37.37
Iron adequacy levels(%)	25.9±12.26	30.7±19.15
Zn Adequacy levels(%)	10.6±5.02	12.0±6.14
Ante Natal Visits	2.5±0.5	2.7±0.5
Cigarettes'exposure	1.1±0.6	1.1±0.6

Result

Risk factors	p value	OR	CI
Maternal age	0.011	1.95	1.16 - 3.36
Low Family Income	0.060	1.57	0.98 - 2.55
Low education	0.885	1.03	0.59 -1.86
Low MUAC	0.050	1.59	0.99 - 2.55
Anemia	0.000	2.9	1.73 - 4.84
Disease during pregnancy	0.022	1.76	1.08 - 2.91
Hipertension	0.108	2	0.86 - 4.94
Low Energy adequacy	0.416	1.21	0.76 - 1.93
Low protein adequacy	0.289	1.29	0.81 - 2.08
Zn	0.254	1.30	0.83 - 2.07
Iron	>0.99	1	0.63 - 1.58
ANC completeness	0.000	2.42	1.51- 3.95
Cigarette exposure	0.519	0.84	0.50 -1.41
Housing condition	0.003	2.85	1.73 - 4.84

Result

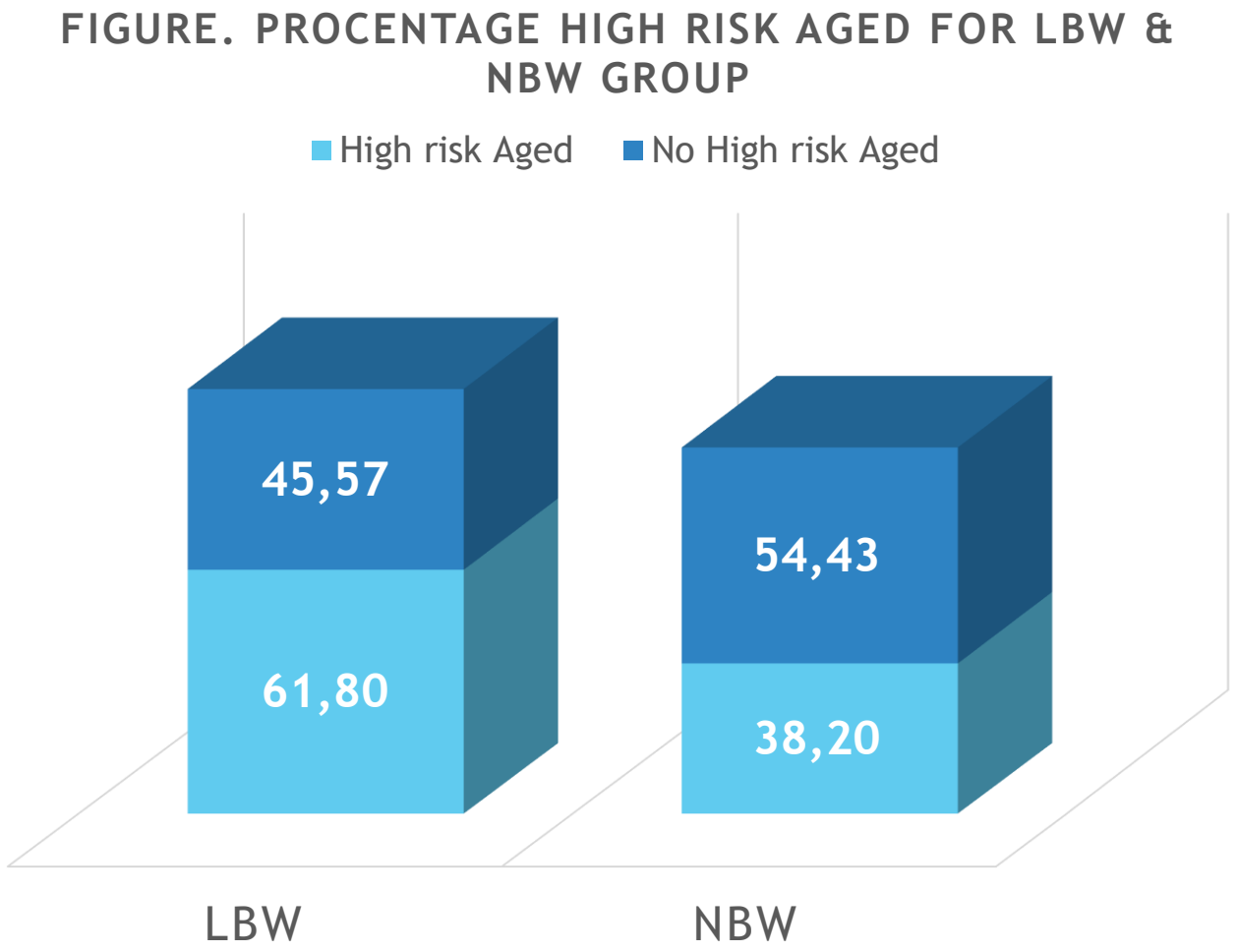
FIGURE. PROCENTAGE HIGH RISK AGED FOR LBW & NBW GROUP
High risk Aged
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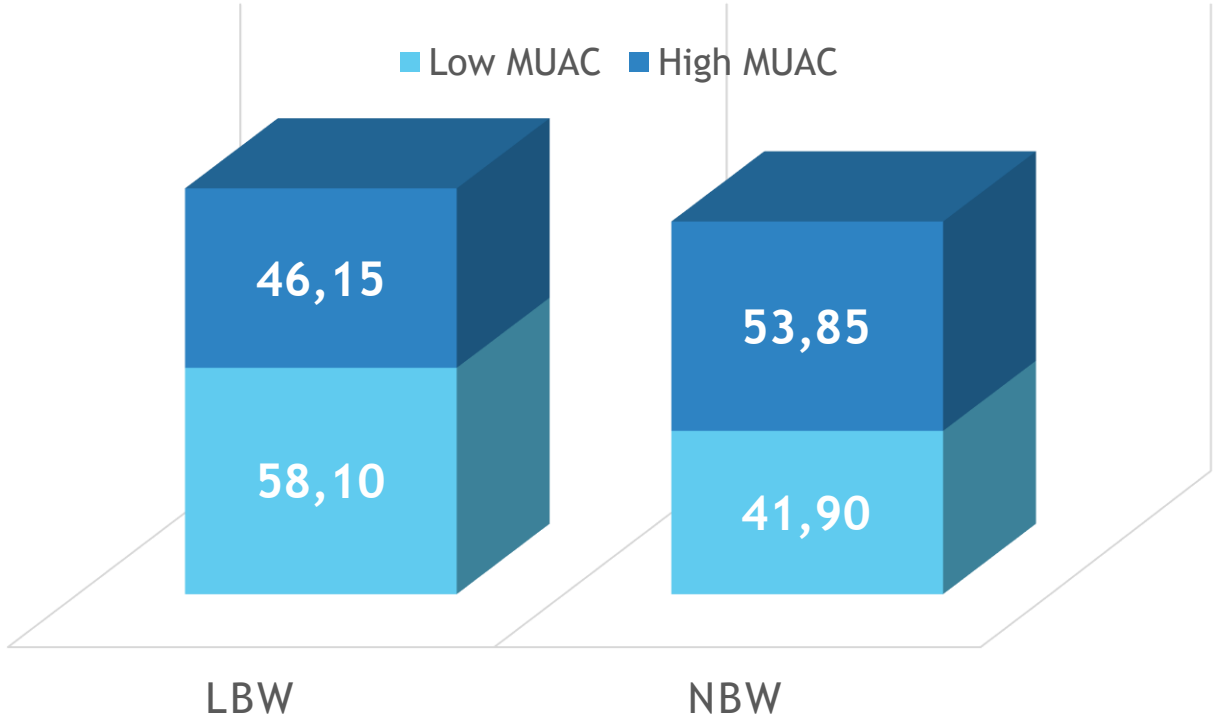
38,20
LBW
NBW

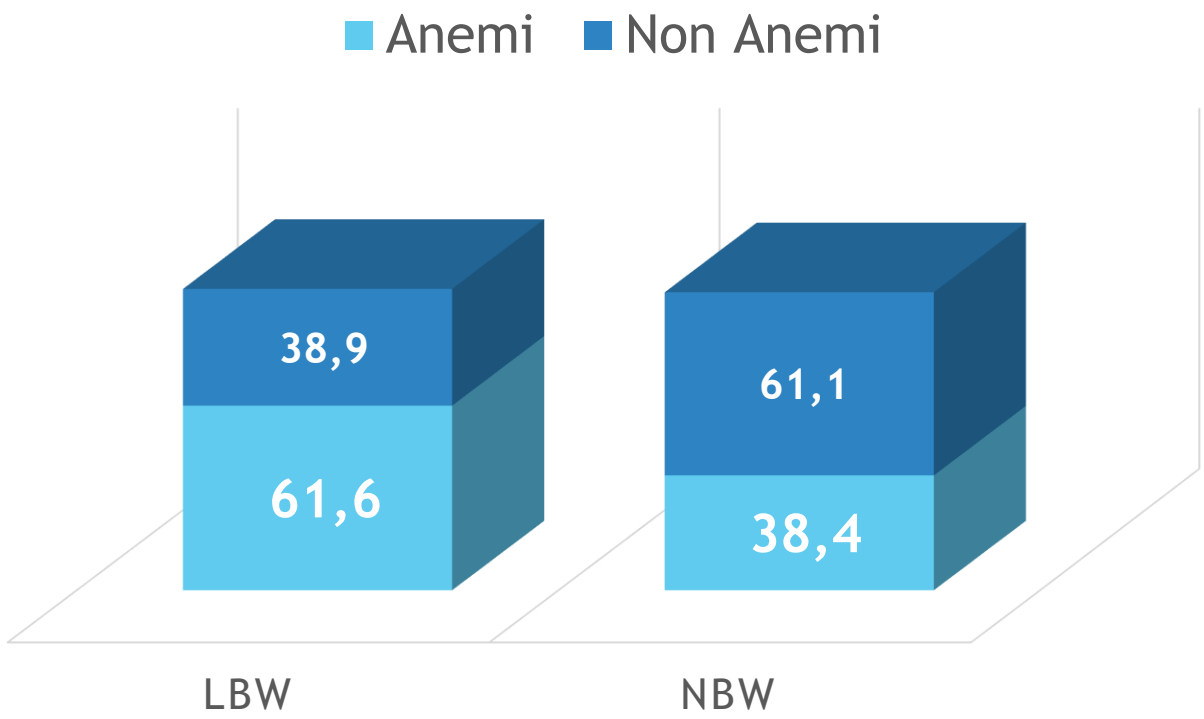
Result

FIGURE 3. PERCENTAGE OF MUAC AT LBW & NBW GROUPS



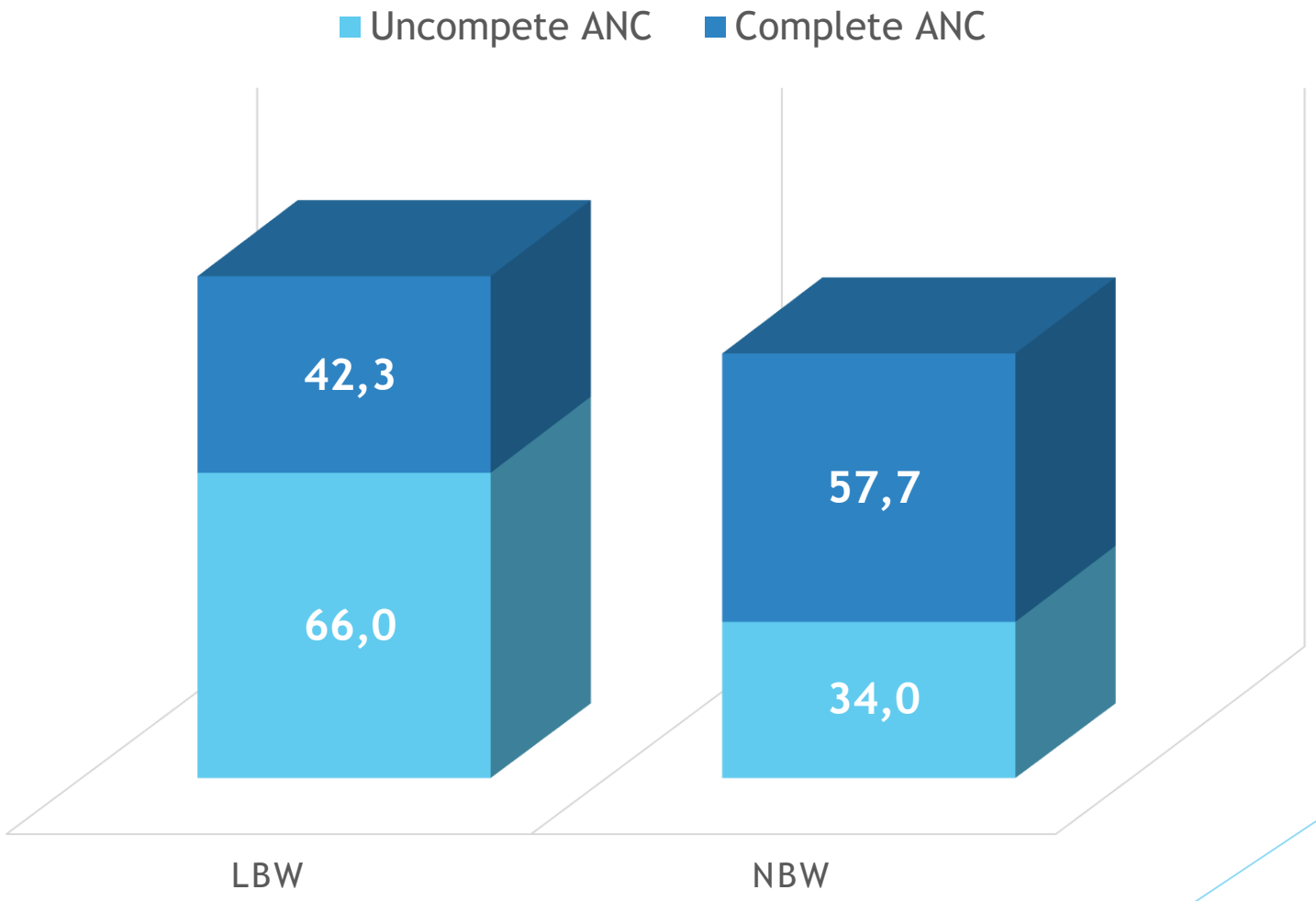
Result

FIGURE 2. PROCENTAGE ANEMI IN LBW & NBW GROUPS



Result

FIGURE 4. PROCENTAGE ANC IN LBW & NBW GROUPS



Result

Model Prediction :

Birth Weight : 741,33 + 268,122 (Pregnant Women Group)+ 24,732 (Hb) + 43,476 (MUAC) + 61,556 (Completness of ANC)

Conclusion

The pregnant women who have anemia, low MUAC, lack of ante natal visits and aged at risk age should be given nutrition intervention to prevent low birth weight

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Abstract

Background: In Indonesia, the prevalence of low birth weight, is very high (10.7%). Batang District had the highest low birth weight prevalence in Central Java. Maternal and environmental factors are the strongest, therefore these risk factors were investigated, and prediction model for birth weight was designed to target the intervention program.

Method: This case-control study was done on 163 low birth weight (<2500g) as cases and 163 normal weight (≥2500g) babies as controls. The cases were all of the low birth weight babies aged <6 months in Batang District, which were singleton births. The controls were normal birth weight and matched for gender, age, and village. Data were collected by interviews and records of maternal and child health handbooks. The risk factors which were investigated: mother's characteristics, nutritional status, health condition, behavioral factors, environmental factors, and health service factor. Among the most important risk factors, then the multiple linear regressions were run to find the best prediction model.

Results: The risk factors of birth weight were: anemia (OR= 2.85; 95%CI:1.713-4.743), lack of ante natal visits (OR=2.24; 95%CI: 1.523-3.305), hypertension (OR=2.09; 95%CI: 1.02-4.29), maternal age at <20 years or ≥ 35 years (OR=2.07; 95%CI: 1.328- 3.223), disease/maternal disorders during pregnancy (OR=1.85;95%CI: 1.221- 2.812), abortion history (OR=1.82; 95%CI: 1.081- 3.059), Low MUAC (OR=1.58; 95%CI: 1.060- 2.341) and low protein intake (OR=1.50; 95%CI: 1.015- 2.216). The best predictors for the birthweight were: hemoglobin levels, the completeness of ante natal visits, MUAC and mother's age at pregnancy.

Conclusion: The pregnant women who have anemia, low MUAC, lack of ante natal visits and aged at-risk age should be given nutrition intervention to prevent low birth weight.

Keywords: low birth weight, anemia, mid-upper arm circumference (MUAC), antenatal visit.

1. INTRODUCTION

Globally, 60 to 80% neonatal deaths were contributed to low birth weight (LBW), and 96.5% of them were from developing countries. [1] Based on 2012 Indonesian Demographic Health Survey, LBW direct contribution to neonatal mortality in Indonesia was 21.3%, while the rest problems are still related to LBW, such as intra-uterine fetal death, birth asphyxia, respiratory distress and neonatal sepsis.

In Central Java Province, LBW is the main cause of infant deaths (80%). Since 2006, the IMR of Central Java Province has increased over the years. Also, the absolute number of early neonatal deaths in Central Java Province was the highest in Indonesia.[2] Based on WHO reports and some other studies in Indonesia, factors related to mother's condition during pregnancy is the main cause of LBW. [3] Those factors could be classified into mother's

characteristics, nutritional status, health condition, behavioral factors, environmental factors, and health service factor.

Previous studies have been done on maternal factors: such as in Nigeria [4], India [5] and Pakistan[6] and even the history or maternal early life factor [7] and maternal genetics. [8] Maternal age was important factors as teenage pregnancy was also shown to be the second lead to low birth weight. [9] Another study includes smoking as the risk factor for low birth weight. [10] In this study, passive smoking was included as the risk factors, as smoking mothers rate was too low in this area of study, but the passive smoking rates were very high. However, not many studies have combined maternal and environmental factors at the same time.

The risk factors for low birth weight were different based on the areas of study. [11,12] In Indonesia, the risk for low birth weight in the northern part of Central Java, especially in Batang, which has the highest rate of low birth weight has never been studied before. This study needs to be done to plan the intervention that can be done to prevent low birth weight. [13]

Almost all of those factors are preventable, thus the knowledge of the most important factors are needed. Then, based on these important variables of pregnant mothers, the best regression model can be made to predict the birth weight. This prediction model for each pregnant mother will be important to target the intervention program to prevent low birth weight babies.

2. METHOD

The maternal risk factors for LBW were investigated in a case-control study conducted in Batang regency. Batang regency was selected as it has the highest prevalence of low birth weight in Central Java province. Central Java Province has the highest absolute number of low birth weight cases. Total sampling techniques were used for selecting the cases. The cases were 163 babies aged less than six months, who were born as low birth weight (<2500g) and the controls were 163 babies who were born at a normal weight (≥ 2500g). Cases and controls were matched for age and gender.

Data were collected by interviews using structured questionnaires to the mothers and secondary data from the records in maternal and child handbook of each baby. The food consumption data were collected by semi-quantitative food frequency questionnaires. The subjects were asked about their consumption during their pregnancies. The risk factors which were investigated: 1) Demographical characteristics: maternal age at risk (<20 years or ≥35 years), high parity, low income, 2) Nutritional status: low-mid upper arm circumference (MUAC), low weight gain during pregnancy, anemia, 3) Health conditions: infectious and non-infectious disease: hypertension, hyper-emesis gravidarum, 4) Behavioral: low nutrient intake, lack of antenatal care visit, 5) Environmental: cigarettes exposure in the household and 6) Health service factors: low quality of ante natal care.

Data analysis was conducted by cross tabulation and Odd Ratio calculation of each risk factor. The variables which show Odd Ratios > 2, then were included in the linear regression models as continuous variables, with birth weight as the dependent variable. The best prediction model was chosen based on the simplest models which have the highest R-squared.

This study has been approved by the Faculty of Public Health, Diponegoro University Ethical Committee (N0.194/EC/FKM/2015) and therefore been performed by the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All subjects gave their informed consent before their inclusion in the study.

3. RESULTS

The subjects were from all over the area of Batang regency. In this study, the subjects were generally of low socioeconomic status. Table 1 shows the characteristics of the subjects.

Table 1. Characteristics of the subjects

	LBW	NBW
Variables	Mean±SD	Mean ±SD
Maternal age (years)	26.2±7.10	26.9±6.23
Parity	1.4±0.95	1.4±0.75
Education levels (years)	8.4±2.93	8.4±2.93
Family income (thousand Rupiahs)	1.800±900	2.100±1.200
MUAC (cm)	24.0±2.57	24.8±2.60
Weight gain (kg)	8.7±4.60	10.1±5.01
Hemoglobin levels(g/dL)	10.8±1.28	11.1±1.17
Energy adequacy levels (%)	82.5±26.36	89.3±35.20
Protein adequacy levels (%)	110.8±45.76	85.0±37.37
Iron adequacy levels (%)	25.9±12.26	30.7±19.15
Zn Adequacy levels (%)	10.6±5.02	12.0±6.14
Ante Natal Visits (times)	2.5±0.5	2.7±0.5
Cigarettes'exposure (numbers of cigarettes/day)	1.1±0.6	1.1±0.6

The Odd Ratio for each risk factors was calculated and presented in Table 2. This table showed that maternal age a

Table 2. The Odd Ratios of the Risk Factors

Risk factors	p-value	OR	CI
Maternal ageat risk (<20 or > 35 years)	**0.011**	**1.95**	**1.16 - 3.36**
Low Family Income	0.060	1.57	0.98 - 2.55
Low education	0.885	1.03	0.59 -1.86
Low MUAC	0.050	1.59	0.99 - 2.55
Anemia	**0.000**	**2.9**	**1.73 - 4.84**
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ANC completeness	**0.000**	**2.42**	**1.51- 3.95**
Cigarette exposure	0.519	0.84	0.50 -1.41
Housing condition	**0.003**	**2.85**	**1.73 - 4.84**

The best prediction model for the birth weight of the babies: **Birth Weight = 741.33 + 268.122 (Maternal Age Group)+ 24.732 (Hemoglobin levels) + 43.476 (MUAC) + 61.556 (Completeness of ANC).**

Maternal age group= 0 if it is at risk (<20 or > 35 years) or 1 if not at risk (20-35 years).

Hemoglobin levels= as measured in g/dL.

MUAC = as measured in centimeters.

Completeness in Ante Natal Care = 1 if it has complete or 0 if it has not completed at the time of the prediction.

Ante Natal Care is considered complete if it is done once in the first trimester, once at the second trimester and twice at the third trimester, for the normal pregnancy, without any complications/problems.

4. DISCUSSION

Many studies showed that maternal characteristics associated with LBW. These features include, among many, maternal age less than 20 years old or older than 31 years old (OR = 1.74 & 1.80 respectively), low education (OR = 2.0), and low income (OR = 1.7).[14] This study used 35 years as the cut off for late maternal age and combine the two age groups as one. Thus, this maternal age factor shows a stronger risk factor compared to the other studies. The high prevalence of low birth weight among less than 20 years old could be due to teenage pregnancies when the maternal growth is not fully complete. On the other hand, pregnancies in women over 31 years old might have impaired intrauterine growth due to placental insufficiency or inadequate gestational duration. [15]

Maternal nutritional status, which can be measured by mid-upper arm circumference and weight gain during pregnancy, may have an effect on low birth weight. A study in Ethiopia showed that mothers with MUAC less than 23 cm have a higher risk of delivering an LBW infant (OR=1.6).[16] In this study, we used 23.5 cm as the cut off for low MUAC, thus the OR was slightly lower compared to the study in Ethiopia. Maternal MUAC is affected by maternal food intake during pregnancy. Similar to MUAC, weight and weight gain of pregnant women during pregnancy also associated with the birth weight of the infant. A study in India showed that pregnant women with low weight have a 7-fold higher risk of having an LBW infant. [15]

The environment may affect the risk of having an LBW infant. Second-hand smoking is very common in Indonesia as most men smoke tobacco. A study of maternal exposure to second-hand smoking reported that second-hand smoking during pregnancy was significantly associated with increased odds of LBW (OR = 1.56). [17] Nicotine exposure is associated with LBW. Carbon monoxide (CO) from the smoke forms carboxyhemoglobin (COHb), which results in the inhibition of oxygen transfer from maternal to fetal tissues. Nicotine also rises maternal blood pressure and heart rate, which followed by the decrease in uterine blood flow. These may affect the fetal growth and may result in low birth weight. [18,19] However, in this study, cigarette's exposure which was defined as passive smoking was not proven as the risk factor low birth weight. It could be that almost all of the subjects were exposed to cigarette's smoke.

Anemia has been found to be strong risk factors for low birth weight and prematurity based on previous studies.[20,21] The biological mechanism which may result in low birth weight is through hypoxia, which causes maternal and fetal stress and this condition leads to the production of Corticotropin-releasing Hormone (CRH). CRH then raise the fetal cortisol production which may constrain the fetal growth. [22]

The other study also showed that maternal MUAC could be used as a predictor of low birth weight. [23,24] MUAC indicates the maternal lean body mass and the adipose tissue, therefore will influence the fetal nutritional status.

The housing condition was not included in the model, as in practice, it is difficult to find the housing condition during the ante natal visits to the midwives. Having disease during pregnancy become non-

significant if the other variables included in the model, thus, we did not include in the final model. The best prediction model gives the best R-squared values compared to the other models.

5. CONCLUSION

It was concluded that the most important factors which can predict the birth weight of the babies are maternal age, hemoglobin levels, ANC frequency and Mid Upper Arm Circumference. On the mothers who have these risk factors, the intervention to prevent low birth weight baby deliveries should be done.

ACKNOWLEDGEMENTS

Special thanks to the students who collected data on the field, midwives, health workers, health cadres, and Local Health Office in Batang Districts. This study was funded by Indonesian Ministry of Research, Technology and Higher Education. The authors have no conflict of interest

REFERENCES

1. WHO. *Infant Mortality: Situation and trends*. WHO; 2013 Source: http://www.who.int/gho/child_health/mortality/neonatal_infant_text/en/
2. Ministry of Health, Indonesia. *Indonesia Demographic and Health Survey (IDHS) 2012*. Jakarta, Indonesia: Statistic Indonesia, National Population and Family Planning Board, Ministry of Health, Measure DHS, ICF International. 2013.
3. WHO. *Low Birth Weight: Country, Regional, and Global Estimates*. WHO 2009. http://whqlibdoc.who.int/publications/2004/9280638327.pdf, accessed on March 12 2014
4. Awoleke JO. Maternal risk factors for low birth weight babies in Lagos, Nigeria. *Arch Gynecol Obstet*. 2012;285(1):1-6
5. Mumbare S, Maindarkar G, Darade R, Yenge S, Tolani M, Patole K. Maternal Risk Factors Associated with Term Low Birth Weight Neonates : *Indian Pediatr*. 2012;49:25-28.
6. Khan N, Jamal M. Maternal risk factors associated with low birth weight. *J Coll Physicians Surg Pak*. 2003;13(1):25-28.
7. Gavin AR, Hill KG, Hawkins JD, Maas C. The role of maternal early-life and later-life risk factors on offspring low birth weight: Findings from a three-generational study. *J Adolesc Heal*. 2011;49(2):166-171.
8. Yaghootkar H, Freathy RM. Genetic origins of low birth weight. *Curr Opin Clin Nutr Metab Care*. 2012;15(3):258-264. doi:10.1097/MCO.0b013e328351f543.
9. Partington SN, Steber DL, Blair K a, Cisler R a. Second births to teenage mothers: risk factors for low birth weight and preterm birth. *Perspect Sex Reprod Health*. 2009;41(2):101-109.
10. Phung H, Bauman A, Nguyen T V., Young L, Tran M, Hillman K. Risk factors for low birth weight in a socio-economically disadvantaged population: Parity, marital status, ethnicity and cigarette smoking. *Eur J Epidemiol*. 2003;18(3):235-243.
11. Coutinho PR, Cecatti JG, Surita FG, Souza JP De, Morais SS De. Factors associated with low birth weight in a historical series of deliveries in Campinas, Brazil. *Rev Assoc Med Bras*. 2009;55(6):692-699.
12. Siza JE. Risk factors associated with low birth weight of neonates among pregnant women attending a referral hospital in northern Tanzania. *Tanzan J Health Res*. 2008;10(1):1-8.
13. Redding S, Conrey E, Porter K, Paulson J, Hughes K, Redding M. Pathways Community Care Coordination in Low Birth Weight Prevention. *Matern Child Health J*. 2014;19(3):643-650.
14. Dickute J, Padaiga Z, Grabauskas V, Nadisauskiene RJ, Basys V, Gaizauskiene A. *Maternal Socio-Economic Factors and The Risk of Low Birth Weight in Lithuania*. Medicina *(Kaunas)* 2004; 40 (5): 475-482
15. Thomre BA, Naik J and Rajderkar S. *Maternal Risk Factors Determining Birth Weight of Newborns: A Tertiary Care Hospital Based Study*. International Journal of Recent Trends in Science And Technology 2012; 5:1: 03-08.
16. Nega A, Berhane Y and Worku A. *Wealth Status, Mid Upper Arm Circumference (MUAC) and Antenatal Care (ANC) Are Determinants for Low Birth Weight in Kersa, Ethiopia*. Plos ONE 2012; 7(6): e39957. doi: 10.1371/journal.pone.0039957
17. Khader YS, Al-Akour N, Alzubi IM & Lataifeh I. *The Association between Second Hand Smoke and Low Birth Weight and Preterm Delivery*. Maternal and Child Health Journal 2011; 15:4: 453-459
18. Lambers DS, Clark KE. *The Maternal and Fetal Physiologic Effects of Nicotine*. Seminars in perinatology 1996; 20: 2:115-126
19. Salmasi G, Grady R, Jones J, Mc Donald S. *Environmental Tobacco Smoke Exposure and Perinatal Outcomes: a systematic review and*

meta-analyses. Acta Obstetricia et Gynecologica Scandinavica Scandinavica 2010; 89:4:423-441

20. Levy A, Fraser D, Katz M, Mazor M and Sheiner E. *Maternal anemia during pregnancy is an independent risk factor for low birthweight and preterm delivery*. European journal of obstetrics, gynecology, and reproductive biology 2005;122:2: 182-186.
21. Zhang Q, Ananth CV, Li Z and Smulian, JC. *Maternal anaemia and preterm birth: a prospective cohort study.* International Journal of Epidemiology 2009;38:1380–1389
22. Allen L. *Biological Mechanisms That Might Underlie Iron's Effects on Fetal Growth and Preterm Birth.* The Journal of Nutrition 2001;131: 581–589.
23. Assefa N, Berhane Y, Worku A (2012). *Wealth Status, Mid Upper Arm Circumference (MUAC) and Ante Natal Care (ANC) Are Determinants for Low Birth Weight in Kersa, Ethiopia*. PLoS ONE 7(6): e39957. doi:10.1371/journal.pone.0039957
24. Ricalde, AE, Velásquez-Meléndez G, Ana Tanaka AC d'A, de Siqueira AAF. Mid-upper arm circumference in pregnant women and its relation to birth weight. Rev. Saúde Pública, 32 (2): 112-7, 1998

Tulis

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Martha Kartasurya <mkartasurya64@gmail.com> Kam, 27 Okt 2016, 14.38
kepada Endang

Yth. Prof. Dr. Endang L. Achadi,
Seperti pembicaraan sebelumnya, kami mohon bantuan ibu untuk mereview beberapa paper yang telah dipresentasikan di International Conference of Public H
for Tropical and Coastal Development pada tanggal 15-17 Oktober 2016, untuk dimuat pada proceeding yang akan diterbitkan pada Advanced Science Letters
review terlampir dan dapat dicopy sebanyak yang dibutuhkan (satu untuk setiap manuskrip). Atas bantuan ibu, kami mengucapkan banyak terima kasih.

Salam,
dr. Martha Irene Kartasurya, MSc, PhD
Ketua Panitia ICOPH TCD 2016

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Tulis

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Endang Achadi <endang.achadi@gmail.com> Sen, 28 Nov 2016, 22.29
kepada saya

Dear Dr. Martha,

Sekali lagi mohon maaf atas keterlambatan dan terima kasih atas toleransinya ..
Terlampir form hasil review papers dan masukan khusus untuk paper Dr. Martha ya.
Semoga berkenan.

Best, EA

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Paper review for...


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RESEARCH ARTICLE

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Abstract

Background: In Indonesia, the prevalence of low birth weight, is ~~very~~ high (10.7%). Batang District had the highest low birth weight prevalence in Central Java. Maternal and environmental factors are the strongest, therefore these risk factors were investigated, and prediction model for birth weight was designed to target the intervention program.

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Conclusion: The pregnant women who have anemia, low MUAC, lack of ante natal visits and aged at-risk age should be given nutrition intervention to prevent low birth weight.

Keywords: low birth weight, anemia, mid-upper arm circumference (MUAC), antenatal visit.

1. INTRODUCTION

Globally, 60 to 80% neonatal deaths were contributed to low birth weight (LBW), and 96.5% of them were from developing countries. [1] Based on 2012 Indonesian Demographic Health Survey, LBW direct contribution to neonatal mortality in Indonesia was 21.3%, while the rest problems are still related to LBW, such as intra-uterine fetal death, birth asphyxia, respiratory distress and neonatal sepsis.

In Central Java Province, LBW is the main cause of infant deaths (80%). Since 2006, the IMR of Central Java Province has increased over the years. Also, the absolute number of early neonatal deaths in Central Java Province was the highest in Indonesia.[2] Based on WHO reports and some other studies in Indonesia, factors related to mother's condition during pregnancy is the main cause of LBW. [3] Those

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http://www.who.int/maternal_child_adolescent/topics/newborn/care_of_preterm/en/

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factors could be classified into mother's characteristics, nutritional status, health condition, behavioral factors, environmental factors, and health service factor.

Previous studies have been done on maternal factors: such as in Nigeria [4], India [5] and Pakistan[6] and even the history or maternal early life factor [7] and maternal genetics. [8] Maternal age was important factors as teenage pregnancy was also shown to be the second lead to low birth weight. [9] Another study includes smoking as the risk factor for low birth weight. [10] In this study, passive smoking was included as the risk factors, ~~as~~because even though smoking mothers rate was ~~too~~ very low in this area of study, ~~but~~ the passive smoking rates were very high. However, not many studies have combined maternal and environmental factors on LBW at the same time.

The risk factors for low birth weight were different based on the areas of study. [11,12] In Indonesia, the risk for low birth weight in the northern part of Central Java, especially in Batang, which has the highest rate of low birth weight has never been studied before. This study needs to be done to plan the intervention that can be done to prevent low birth weight. [13]

Almost all of those factors are preventable, thus the knowledge of the most important factors are needed. Then, based on these important variables of pregnant mothers, the best regression model can be made to predict the birth weight. This prediction model for each pregnant mother will be important to target the intervention program to prevent low birth weight babies.

2. METHOD

The maternal risk factors for LBW were investigated in a case-control study conducted in Batang regency. Batang regency was selected as it has the highest prevalence of low birth weight in Central Java province. Central Java Province has the highest absolute number of low birth weight cases. Total sampling techniques were used for selecting the cases. The cases were 163 babies aged less than six months, who were born as low birth weight (<2500g) and the controls were 163 babies who were born at a normal weight (≥ 2500g). Cases and controls were matched for age and gender.

Data were collected by interviews using structured questionnaires to the mothers and secondary data from the records in maternal and child handbook of each baby. The food consumption data were collected by semi-quantitative food frequency questionnaires. The subjects were asked about their food consumption during their pregnancies. The risk factors which were investigated were: 1) Demographical characteristics: maternal age at risk (<20 years or ≥35 years), high parity (berapa cut off pointnya?), low income defines as those having income lower than …?), education (?) 2) Nutritional status: low-mid upper arm circumference (MUAC < 23.5 cm)), low weight gain during pregnancy (berapa?), anemia (Hb < 11 g/L), 3) Health conditions: infectious disease and non-infectious disease: hypertension, hyper-emesis gravidarum, 4) Behavioral factors: low nutrient intake, lack of antenatal care visit, 5) Environmental factors: cigarettes exposure in the household and 6) Health service factors: low quality of ante natal care (not fulfilling National ANC program of 1, 1, and 2 visits during the 1st, 2nd and 3rd trimester).

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This study has been approved by the Faculty of Public Health, Diponegoro University Ethical Committee (N0.194/EC/FKM/2015) and therefore been performed by the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All subjects gave their informed consent before their inclusion in the study.

3. RESULTS

The subjects were from all over the area of Batang regency. In this study, the subjects were generally of low socioeconomic status. Table 1 shows the characteristics of the subjects.

Table 1. Characteristics of the subjects

	LBW	NBW
Variables	Mean±SD	Mean ±SD
Maternal age (years)	26.2±7.10	26.9±6.23
Parity	1.4±0.95	1.4±0.75
Education levels (years)	8.4±2.93	8.4±2.93
Family income (thousand Rupiahs)	1.800±900	2.100±1.200
MUAC (cm)	24.0±2.57	24.8±2.60
Weight gain (kg)	8.7±4.60	10.1±5.01
Hemoglobin levels(g/dL)	10.8±1.28	11.1±1.17
Energy adequacy levels (%)	82.5±26.36	89.3±35.20
Protein adequacy levels (%)	110.8±45.76	85.0±37.37
Iron adequacy levels (%)	25.9±12.26	30.7±19.15

Zn Adequacy levels (%)	10.6±5.02	12.0±6.14
Ante Natal Visits (times)	2.5±0.5	2.7±0.5
Cigarettes'exposure (numbers of cigarettes/day)	1.1±0.6	1.1±0.6

The Odd Ratio for each risk factors was calculated and presented in Table 2. This table showed that maternal age a …… lanjutannya?

Table 2. The Odd Ratios of the Risk Factors

Risk factors	p-value	OR	CI
Maternal ageat risk (<20 or > 35 years)	**0.011**	**1.95**	**1.16 - 3.36**
Low Family Income	0.060	1.57	0.98 - 2.55
Low education	0.885	1.03	0.59 -1.86
Low MUAC	0.050	1.59	0.99 - 2.55
Anemia	**0.000**	**2.9**	**1.73 - 4.84**
Disease during pregnancy	**0.022**	**1.76**	**1.08- 2.91**
Hipertension	0.108	2	0.86 - 4.94
Low Energy adequacy	0.416	1.21	0.76 - 1.93
Low protein adequacy	0.289	1.29	0.81 - 2.08
Low zinc consumption	0.254	1.30	0.83 - 2.07
Low iron consumption	>0.99	1	0.63 - 1.58
ANC completeness	**0.000**	**2.42**	**1.51- 3.95**
Cigarette exposure	0.519	0.84	0.50 -1.41
Housing condition	**0.003**	**2.85**	**1.73 - 4.84**

The best prediction model for the birth weight of the babies was **Birth Weight = 741.33 + 268.122 (Maternal Age Group)+ 24.732 (Hemoglobin levels) + 43.476 (MUAC) + 61.556 (Completeness of ANC).**

Maternal age group= 0 if it is at risk (<20 or > 35 years) or 1 if not at risk (20-35 years).
Hemoglobin levels= as measured in g/dL.
MUAC = as measured in centimeters.
Completeness in Ante Natal Care = 1 if it has complete or 0 if it has not completed at the time of the prediction.
Ante Natal Care is considered complete if it is done once in the first trimester, once at the second trimester and twice at the third trimester, for the normal pregnancy, without any complications/problems.

4. DISCUSSIONS

Many studies showed that maternal characteristics associated with LBW. These features include, among many, maternal age less than 20 years old or older than 31 years old (OR = 1.74 & 1.80 respectively), low education (OR = 2.0), and low income (OR = 1.7).[14] This study used 35 years as the cut off for late maternal age and combine the two age groups as one. Thus, this maternal age factor shows a stronger risk factor compared to the other studies. One explanation of the high prevalence of low birth weight among those aged less than 20 years old could be ~~due to teenage pregnancies when~~ that the maternal growth is not fully complete. On the other hand, pregnancies in women over 31 years old might have impaired intrauterine growth due to placental insufficiency or inadequate gestational duration. [15]

Maternal nutritional status, which can be measured by mid-upper arm circumference and weight gain during pregnancy, may have an effect on low birth weight. A study in Ethiopia showed that mothers with MUAC less than 23 cm have a higher risk of delivering an LBW infant (OR=1.6).[16] In this study, we used 23.5 cm as the cut off for low MUAC as the risk for LBW, ~~thus~~ which probably explained why the OR was slightly lower compared to the study in Ethiopia. Maternal MUAC is affected by maternal food intake during pregnancy. Similar to MUAC, ~~weight and~~ weight gain ~~of pregnant women~~ during pregnancy also associated with the birth weight of the infant. A study in India showed that pregnant women with low weight have a 7-fold higher risk of having an LBW infant. [15]

The environment may affect the risk of having an LBW infant. Second-hand smoking is very common in Indonesia as most men smoke tobacco. A study of maternal exposure to second-hand smoking reported that second-hand smoking during pregnancy was significantly associated with increased odds of LBW (OR = 1.56). [17] Nicotine exposure is associated with LBW. Carbon monoxide (CO) from the smoke forms carboxyhemoglobin (COHb), which results in the inhibition of oxygen transfer from maternal to fetal tissues. Nicotine also rises maternal blood pressure and heart rate, which followed by the decrease in uterine blood flow. These may affect the fetal growth and may result in low birth weight. [18,19] However, in this study, cigarette's exposure which was defined as passive smoking was not proven as the risk factor of low birth weight. It could be that almost all of the subjects were exposed to cigarette's smoke.

Anemia has been found to be a strong risk factors for low birth weight and prematurity based on previous studies.[20,21] The biological mechanism which may result in low birth weight is through hypoxia, which causes maternal and fetal stress and this condition leads to the production of Corticotropin-releasing Hormone (CRH). CRH then raise the fetal cortisol production which may constrain the fetal growth. [22]

Commented [I5]: Sebetulnya MUAC sangat lambat perubahannya, sehingga MUC saat pregnancy merupakan keadaan sebelum pregnancy, jadi ukuran MUAC saat hamil bukan karena pola makan saat kehamilan, tapi saat sebelum hamil. Jadi kalimatnya mungkin diubah: ***Maternal MUAC during pregnancy , which is representing the situation prior to pregnancy, is refecting the maternal storage of energy.***

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~~The~~ Other study also showed that maternal MUAC could be used as a predictor of low birth weight. [23,24] MUAC indicates the maternal lean body mass and the adipose tissue, therefore will influence the fetal nutritional status.

~~The~~ Housing condition was not included in the model, as in practice, it is difficult to find the housing condition during the ante natal visits to the midwives. Having disease during pregnancy become non-significant if the other variables included in the model, thus, we did not include in the final model. The best prediction model gives the best R-squared values compared to the other models.

5. CONCLUSION

It was concluded that the most important factors which can predict the birth weight of the babies are maternal age, hemoglobin levels, ANC frequency and Mid Upper Arm Circumference. On the mothers who have these risk factors, the intervention to prevent low birth weight baby deliveries should be done.

ACKNOWLEDGEMENTS

Special thanks to the students who collected data on the field, midwives, health workers, health cadres, and Local Health Office in Batang Districts. This study was funded by Indonesian Ministry of Research, Technology and Higher Education. The authors have no conflict of interest

REFERENCES

1. WHO. *Infant Mortality: Situation and trends*. WHO; 2013 Source: iiihttp://www.who.int/gho/cd hild_health/mortality/neonatal_infant_text/en/
2. Ministry of Health, Indonesia. *Indonesia Demographic and Health Survey (IDHS) 2012*. Jakarta, Indonesia: Statistic Indonesia, National Population and Family Planning Board, Ministry of Health, Measure DHS, ICF International. 2013.
3. WHO. *Low Birth Weight: Country, Regional, and Global Estimates*. WHO 2009. http://whqlibdoc.who.int/publications/2004/9280638327.pdf, accessed on March 12 2014
4. Awoleke JO. Maternal risk factors for low birth weight babies in Lagos, Nigeria. *Arch Gynecol Obstet*. 2012;285(1):1-6
5. Mumbare S, Maindarkar G, Darade R, Yenge S, Tolani M, Patole K. Maternal Risk Factors Associated with Term Low Birth Weight Neonates : *Indian Pediatr*. 2012;49:25-28.
6. Khan N, Jamal M. Maternal risk factors associated with low birth weight. *J Coll Physicians Surg Pak*. 2003;13(1):25-28.
7. Gavin AR, Hill KG, Hawkins JD, Maas C. The role of maternal early-life and later-life risk factors on offspring low birth weight: Findings from a three-generational study. *J Adolesc Heal*. 2011;49(2):166-171.
8. Yaghootkar H, Freathy RM. Genetic origins of low birth weight. *Curr Opin Clin Nutr Metab Care*. 2012;15(3):258-264. doi:10.1097/MCO.0b013e328351f543.
9. Partington SN, Steber DL, Blair K a, Cisler R a. Second births to teenage mothers: risk factors for low birth weight and preterm birth. *Perspect Sex Reprod Health*. 2009;41(2):101-109.
10. Phung H, Bauman A, Nguyen T V., Young L, Tran M, Hillman K. Risk factors for low birth weight in a socio-economically disadvantaged population: Parity, marital status, ethnicity and cigarette smoking. *Eur J Epidemiol*. 2003;18(3):235-243.
11. Coutinho PR, Cecatti JG, Surita FG, Souza JP De, Morais SS De. Factors associated with low birth weight in a historical series of deliveries in Campinas, Brazil. *Rev Assoc Med Bras*. 2009;55(6):692-699.
12. Siza JE. Risk factors associated with low birth weight of neonates among pregnant women attending a referral hospital in northern Tanzania. *Tanzan J Health Res*. 2008;10(1):1-8.
13. Redding S, Conrey E, Porter K, Paulson J, Hughes K, Redding M. Pathways Community Care Coordination in Low Birth Weight Prevention. *Matern Child Health J*. 2014;19(3):643-650.
14. Dickute J, Padaiga Z, Grabauskas V, Nadisauskiene RJ, Basys V, Gaizauskiene A. *Maternal Socio-Economic Factors and The Risk of Low Birth Weight in Lithuania*. Medicina *(Kaunas)* 2004; 40 (5): 475-482
15. Thomre BA, Naik J and Rajderkar S. *Maternal Risk Factors Determining Birth Weight of Newborns: A Tertiary Care Hospital Based Study*. International Journal of Recent Trends in Science And Technology 2012; 5:1: 03-08.
16. Nega A, Berhane Y and Worku A. *Wealth Status, Mid Upper Arm Circumference (MUAC) and Antenatal Care (ANC) Are Determinants for Low Birth Weight in Kersa, Ethiopia*. Plos ONE 2012; 7(6): e39957. doi: 10.1371/journal.pone.0039957
17. Khader YS, Al-Akour N, Alzubi IM & Lataifeh I. *The Association between Second Hand Smoke and Low Birth Weight and Preterm Delivery*.

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Maternal and Child Health Journal 2011; 15:4: 453-459
18. Lambers DS, Clark KE. *The Maternal and Fetal Physiologic Effects of Nicotine*. Seminars in perinatology 1996; 20: 2:115-126
19. Salmasi G, Grady R, Jones J, Mc Donald S. *Environmental Tobacco Smoke Exposure and Perinatal Outcomes: a systematic review and meta-analyses*. Acta Obstetricia et Gynecologica Scandinavica Scandinavica 2010; 89:4:423-441
20. Levy A, Fraser D, Katz M, Mazor M and Sheiner E. *Maternal anemia during pregnancy is an independent risk factor for low birthweight and preterm delivery*. European journal of obstetrics, gynecology, and reproductive biology 2005;122:2: 182-186.
21. Zhang Q, Ananth CV, Li Z and Smulian, JC. *Maternal anaemia and preterm birth: a prospective cohort study.* International Journal of Epidemiology 2009;38:1380–1389
22. Allen L. *Biological Mechanisms That Might Underlie Iron's Effects on Fetal Growth and Preterm Birth.* The Journal of Nutrition 2001;131: 581–589.
23. Assefa N, Berhane Y, Worku A (2012). *Wealth Status, Mid Upper Arm Circumference (MUAC) and Ante Natal Care (ANC) Are Determinants for Low Birth Weight in Kersa, Ethiopia.* PLoS ONE 7(6): e39957. doi:10.1371/journal.pone.0039957
24. Ricalde, AE, Velásquez-Meléndez G, Ana Tanaka AC d'A, de Siqueira AAF. Mid-upper arm circumference in pregnant women and its relation to birth weight. Rev. Saúde Pública, 32 (2): 112-7, 1998

ICOPH TCD 2016 PAPER REVIEW FORM TO BE INCLUDED IN "ADVANCED SCIENCE LETTERS"

Paper title: Prediction Model for Low Birth Weight of Pregnant Women in Batang District, Central Java, Indonesia

Martha Irene Kartasurya[1], Yudhy Dharmawan[2],Bagoes Widjanarko[3], Novia Handayani[4]

GUIDELINES FOR PAPER REVIEW

Parts of review	Guidelines	Yes	No	Reviewer's note for improvement
Title	- Title have less than 18 words	V		
	- Clear, specific, informative and interesting (eye catching), describe the content, include key words.	V		
	- Does not start with Research of, or An Analysis, or A study on, etc.	V (does not start with …)		
	- Suitable for its content	V		
Abstract	- A brief description of the paper	V		Penyampaian hasil tidak perlu terlalu detil dg 95% CI untuk semua variable sehingga tidak melebihi 250 kata
	- Should include: Background, Methods, Results and Conclusion in each paragraph.	V		
	- Informative, including main finding and significance?	V		
	- Maximum of 250 words		V	
	- Have keywords	V		
Background	- Sufficient (include the background problem and objectives)	V		
	- Informative	V		
Methods	- Adequate (including study design, location, subjects, data collection, data analysis)	V		
	- Clear	V		
	- Ethical	V		
Results	- Should answer the objectives	V		
	- Data analysis should be appropriate to the study design and objective	V		

	- Interpretation of the analysis, in relation to the problem and objective	V		
	- Tables, graphs and pictures are well presented	V		
	- Results are separated to the discussion	V		

Parts of review	Guidelines	Yes	No	Reviewer's note for improvement
Discussion	- In comparison to the relevant previous studies/ literatures	V		
	- Focus on the interpretation of the results	V		
	- Not a repetition of the results	V		
Conclusion	- From the analysis of the results and discussion/ hypothesis testing	V		
	- Not a summary	V		
	- Clear and not in the form of pointers, but a narration.	V		
	- A consistency between problems, objectives and conclusion.	V		
Recommendation (optional)	- Recommendation for the next study or program/action or policy application.	V		
Acknowledgment	- For the funding institution or other individual significant contributors in the study	V		
References	- A match between the references and the citation. - Sample of the reference: 3. Lin, F., Holt, P., Leung, S., Hogeboom, H., Cao, Y., A Multi-Agent and Service-Oriented Architecture for Developing Integrated and Intelligent Web-based Educational Systems, Center for Computing and Information Systems, 1 University Drive, Athabasca, Alberta, Canada, T9S 3A3, (2004). 4. Rodrigo, M. Mercedes T., Ryan S.J.d. Baker, Jenilyn Agapito, Julieta Nabos, Ma. Concepcion Repalam, Salvador S. Reyes Jr., Student Member, IEEE, and Maria Ofelia C.Z. San Pedro. The Effects of an Interactive Software Agent on Student Affective Dynamics while Using an Intelligent Tutoring System. IEEE Transactions on Affective Computing, Vol. 3, No. 2, April-June, (2012).	V		
Pictures or Tables	- Are numbered consecutively.	V		
	- The content is not duplicated with the narrative text or between			

	tables and pictures.			
Number of pages	- Maximum 5 pages (however more pages are accepted, but not exceeded 8 pages.)	V		

After reviewing this paper, please have some comments on:

(Please have a tick on your choice)

1. Does this paper add some new knowledge? Yes [V] or No [ ]
2. Do the title, problem, objectives, methods and conclusion are in line? Yes [V] or No [ ]
3. Does the content in this paper can be accepted academically? Yes [V] or No [ ]
5. Recommendation:
   1. Accepted in present form, [ ]
   2. Accepted with minor changes, [V]
   3. Accepted with major changes [ ]
   4. Rejected [ ]

6. Reason for rejection: _____

Reviewer's name : Endang L. Achadi, FKM UI

Date's return to the committee : **26 November 2015**

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Prediction Model for Low Birth Weight in Batang District, Central Java, Indonesia

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Abstract

Background: In Indonesia, the prevalence of low birth weight, is high (10.7%). Batang District had the highest low birth weight prevalence in Central Java. Maternal and environmental factors are the strongest, therefore these risk factors were investigated, and prediction model for birth weight was designed.

Method: This case-control study was done on 163 low birth weight (<2500g) as cases and 163 normal weight (≥2500g) babies and their mothers as controls. The cases were all of the singleton birth low birth weight babies aged <6 months in Batang District. The controls were normal birth weight and matched for gender, age and village. Data were collected by interviews and review of maternal and child health handbooks. The risk factors which were investigated: mother's characteristics, nutritional status, health condition, behavioral factors, environmental factors and health service factor. Among the most important risk factors, the multiple linear regressions were run to find the best prediction model.

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Conclusion: The most important factors which can predict the birth weight of the babies are maternal age, hemoglobin levels, ANC frequency and Mid Upper Arm Circumference.

Keywords: low birth weight, anemia, mid-upper arm circumference (MUAC), antenatal visit.

1. INTRODUCTION

Globally, 60 to 80% neonatal deaths were contributed to low birth weight (LBW), and 96.5% of them were from developing countries. [1] Based on 2012 Indonesian Demographic Health Survey, LBW direct contribution to neonatal mortality in Indonesia was 21.3%, while the rest problems are still related to LBW, such as intra-uterine fetal death, birth asphyxia, respiratory distress and neonatal sepsis.

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3. RESULTS

The subjects were from all over the area of Batang regency. In this study, the subjects were generally of low socioeconomic status. Table 1 shows the characteristics of the subjects.

Table 1. Characteristics of the mothers

	LBW	NBW
Variables	Mean±SD	Mean ±SD
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Family income (thousand Rupiahs)	1.800±900	2.100±1.200
MUAC (cm)	24.0±2.57	24.8±2.60
Weight gain (kg)	8.7±4.60	10.1±5.01
Hemoglobin levels(g/dL)	10.8±1.28	11.1±1.17
Energy adequacy levels (%)	82.5±26.36	89.3±35.20
Protein adequacy levels (%)	110.8±45.76	85.0±37.37
Iron adequacy levels (%)	25.9±12.26	30.7±19.15
Zn Adequacy levels (%)	10.6±5.02	12.0±6.14

Ante Natal Visits (times)	2.5±0.5	2.7±0.5
Cigarettes' exposure (numbers of cigarettes/day)	1.1±0.6	1.1±0.6

The Odd Ratio for each risk factors was calculated and presented in Table 2. This table showed that maternal age, anemia, disease during pregnancy, ANC completeness and housing condition are the risk factors for low birth weight.

Table 2. The Odd Ratios of the Maternal and Environmental Factors

Maternal and environmental Factors	p-value	OR	CI
Maternal age at risk (<20 or > 35 years)	**0.011**	**1.95**	**1.16 - 3.36**
Low Family Income	0.060	1.57	0.98 - 2.55
Low education	0.885	1.03	0.59 -1.86
Low MUAC	0.050	1.59	0.99 - 2.55
Anemia	**0.000**	**2.9**	**1.73 - 4.84**
Low weight gain	0.1573	1,4	0.88-2.24
Disease during pregnancy	**0.022**	**1.76**	**1.08- 2.91**
Hipertension	0.108	2	0.86 - 4.94
Low Energy adequacy	0.416	1.21	0.76 - 1.93
Low protein adequacy	0.289	1.29	0.81 - 2.08
Low zinc consumption	0.254	1.30	0.83 - 2.07
Low iron consumption	>0.99	1	0.63 - 1.58
ANC completeness	**0.000**	**2.42**	**1.51- 3.95**
Cigarette exposure	0.519	0.84	0.50 -1.41
Housing condition	**0.003**	**2.85**	**1.73 - 4.84**

The best prediction model for the birth weight of the babies was **Birth Weight = 741.33 + 268.122 (Maternal Age Group)+ 24.732 (Hemoglobin levels) + 43.476 (MUAC) + 61.556 (Completeness of ANC).** In this model, maternal age group was defined 0 if it was at risk (<20 or > 35 years) or 1 if not at risk (20-35 years) and completeness of ANC was 0 if it was not complete and 1 is it was complete. Hemoglobin levels were measured in g/dL and MUAC were measured in centimeters.

4. DISCUSSIONS

Many studies showed that maternal characteristics associated with LBW. These features include, among many, maternal age less than 20 years old or older than 31 years old (OR = 1.74 & 1.80 respectively), low education (OR = 2.0), and low income (OR = 1.7).[14] This study used 35 years as the cut off for late maternal age and combine the two age groups as one. Thus, this maternal age factor shows a stronger risk factor compared to the other studies. One explanation of the high prevalence of low birth weight among those aged less than 20 years old could be that the maternal growth is not fully complete. On the other hand, pregnancies in women over 31 years old might have impaired intrauterine growth due to placental insufficiency or inadequate gestational duration. [15]

Maternal nutritional status, which can be measured by mid-upper arm circumference and weight gain during pregnancy, may have an effect on low birth weight. A study in Ethiopia showed that mothers with MUAC less than 23 cm have a higher risk of delivering an LBW infant (OR=1.6).[16] In this study, we used 23.5 cm as the cut off for low MUAC as the risk for LBW, which probably explained why the OR was slightly lower compared to the study in Ethiopia. Maternal MUAC during pregnancy, which is representing the situation prior to pregnancy, is reflecting the maternal storage of energy.

The environment may affect the risk of having an LBW infant. Second-hand smoking is very common in Indonesia as most men smoke tobacco. A study of maternal exposure to second-hand smoking reported that second-hand smoking during pregnancy was significantly associated with increased odds of LBW (OR = 1.56). [17] Nicotine exposure is associated with LBW. Carbon monoxide (CO) from the smoke forms carboxyhemoglobin (COHb), which results in the inhibition of oxygen transfer from maternal to fetal tissues. Nicotine also rises maternal blood pressure and heart rate, which followed by the decrease in uterine blood flow. These may affect the fetal growth and may result in low birth weight. [18,19] However, in this study, cigarette's exposure which was defined as passive smoking was not proven as the risk factor of low birth weight. It could be that almost all of the subjects were exposed to cigarette's smoke.

Anemia has been found to be a strong risk factors for low birth weight and prematurity based on previous studies.[20,21] The biological mechanism which may result in low birth weight is through hypoxia, which causes maternal and fetal stress and this condition leads to the production of Corticotropin-releasing Hormone (CRH). CRH then raise the fetal cortisol production which may constrain the fetal growth. [22]

Housing condition was not included in the model, as in practice, it is difficult to find the housing condition during the ante natal visits to the midwives. Having disease during pregnancy become non-significant if the other variables included in the model, thus, we did not include in the final model. The best prediction model gives the best R-squared values compared to the other models.

5. CONCLUSION

It was concluded that the most important factors which can predict the birth weight of the babies are maternal age, hemoglobin levels, ANC frequency and Mid Upper Arm Circumference. It is recommended that the intervention to prevent low birth weight baby deliveries should be focused on increasing the age of first pregnancy, improving Hb level and nutritional status prior to pregnancy and improve ANC compliance.

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REFERENCES

1. WHO. Care of the preterm and/or low-birth-weight newborn. WHO 2016. http://www.who.int/maternal_child_adolescent/topics/newborn/care_of_preterm/en/
2. Ministry of Health, Indonesia. *Indonesia Demographic and Health Survey (IDHS) 2012*. Jakarta, Indonesia: Statistic Indonesia, National Population and Family Planning Board, Ministry of Health, Measure DHS, ICF International. 2013.
3. WHO. *Low Birth Weight: Country, Regional, and Global Estimates*. WHO 2009. http://whqlibdoc.who.int/publications/2004/9280638327.pdf, accessed on March 12 2014
4. Awoleke JO. Maternal risk factors for low birth weight babies in Lagos, Nigeria. *Arch Gynecol Obstet*. 2012;285(1):1-6
5. Mumbare S, Maindarkar G, Darade R, Yenge S, Tolani M, Patole K. Maternal Risk Factors Associated with Term Low Birth Weight Neonates : *Indian Pediatr*. 2012;49:25-28.
6. Khan N, Jamal M. Maternal risk factors associated with low birth weight. *J Coll Physicians Surg Pak*. 2003;13(1):25-28.
7. Gavin AR, Hill KG, Hawkins JD, Maas C. The role of maternal early-life and later-life risk factors on offspring low birth weight: Findings from a three-generational study. *J Adolesc Heal*. 2011;49(2):166-171.
8. Yaghootkar H, Freathy RM. Genetic origins of low birth weight. *Curr Opin Clin Nutr Metab Care*. 2012;15(3):258-264. doi:10.1097/MCO.0b013e328351f543.
9. Partington SN, Steber DL, Blair K a, Cisler R a. Second births to teenage mothers: risk factors for low birth weight and preterm birth. *Perspect Sex Reprod Health*. 2009;41(2):101-109.
10. Phung H, Bauman A, Nguyen T V., Young L, Tran M, Hillman K. Risk factors for low birth weight in a socio-economically disadvantaged population: Parity, marital status, ethnicity and cigarette smoking. *Eur J Epidemiol*. 2003;18(3):235-243.
11. Coutinho PR, Cecatti JG, Surita FG, Souza JP De, Morais SS De. Factors associated with low birth weight in a historical series of deliveries in Campinas, Brazil. *Rev Assoc Med Bras*. 2009;55(6):692-699.
12. Siza JE. Risk factors associated with low birth weight of neonates among pregnant women attending a referral hospital in northern Tanzania. *Tanzan J Health Res*. 2008;10(1):1-8.
13. Redding S, Conrey E, Porter K, Paulson J, Hughes K, Redding M. Pathways Community Care Coordination in Low Birth Weight Prevention. *Matern Child Health J*. 2014;19(3):643-650.
14. Dickute J, Padaiga Z, Grabauskas V, Nadisauskiene RJ, Basys V, Gaizauskiene A. *Maternal Socio-Economic Factors and The Risk of Low Birth Weight in Lithuania*. Medicina *(Kaunas)* 2004; 40 (5): 475-482
15. Thomre BA, Naik J and Rajderkar S. *Maternal Risk Factors Determining Birth Weight of Newborns: A Tertiary Care Hospital Based Study.* International Journal of Recent Trends in Science And Technology 2012; 5:1: 03-08.
16. Nega A, Berhane Y and Worku A. *Wealth Status, Mid Upper Arm Circumference (MUAC) and Antenatal Care (ANC) Are Determinants for Low Birth Weight in Kersa, Ethiopia.* Plos ONE 2012; 7(6): e39957. doi: 10.1371/journal.pone.0039957
17. Khader YS, Al-Akour N, Alzubi IM & Lataifeh I. *The Association between Second Hand Smoke and Low Birth Weight and Preterm Delivery.* Maternal and Child Health Journal 2011; 15:4: 453-459
18. Lambers DS, Clark KE. *The Maternal and Fetal Physiologic Effects of Nicotine*. Seminars in perinatology 1996; 20: 2:115-126
19. Salmasi G, Grady R, Jones J, Mc Donald S. *Environmental Tobacco Smoke Exposure and Perinatal Outcomes: a systematic review and meta-analyses*. Acta Obstetricia et Gynecologica Scandinavica Scandinavica 2010; 89:4:423-441
20. Levy A, Fraser D, Katz M, Mazor M and Sheiner E. *Maternal anemia during pregnancy is an*

independent risk factor for low birthweight and preterm delivery. European journal of obstetrics, gynecology, and reproductive biology 2005;122:2: 182-186.

21. Zhang Q, Ananth CV, Li Z and Smulian, JC. *Maternal anaemia and preterm birth: a prospective cohort study.* International Journal of Epidemiology 2009;38:1380–1389
22. Allen L. *Biological Mechanisms That Might Underlie Iron's Effects on Fetal Growth and Preterm Birth.* The Journal of Nutrition 2001;131: 581–589.