Effect of Birth Interval Upon Neonatal Deaths in Indonesia: 5-Year-Based Calendar Data

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DOI: 10.24252/al-sihah.v14i2.30127
Received: 10 July 2022 / In Reviewed: 30 September 2022 / Accepted: 3 December 2022 / Available online: 27 December 2022

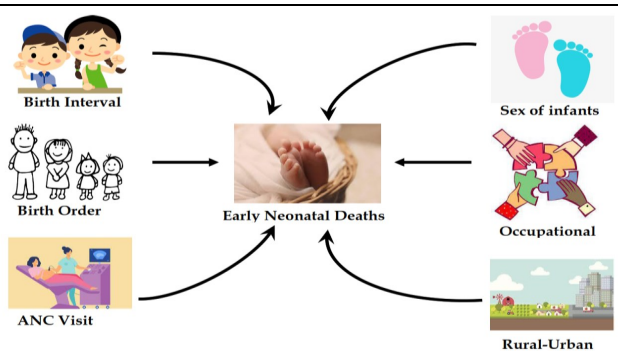
ABSTRACT

Early neonatal deaths, defined as deaths of newborn babies between zero and seven days, have undoubtedly triggered a big challenge in developing countries. This current analysis aimed to determine the effect of birth interval (i.e., the time between two successive live births) on adverse pregnancy outcomes such as early neonatal death by using reproductive calendar data containing information on birth history for five years preceding Indonesia Demographic and Health Survey 2017. Merely singleton and non-first live births were included in the analysis (n=11, 599). Logistic regression models for the complex sample were utilized to measure the associations between birth interval and early neonatal deaths after adjusting for potential confounders. Early neonatal mortality was associated with birth interval. Newborns with shorter birth intervals (< 24 months) and longer birth intervals (36 months or more) had 2.68 times (95% CI: 1.15-6.28) and 3.08 times (95% CI: 1.37-6.92), respectively, higher odds of early neonatal deaths compared with newborns birth spaced of 24-35 months. Among mothers who received at least one antenatal care visit, there was a decrease in the odds of early neonatal deaths for shorter and longer birth intervals. The results suggest that the promotion of optimal birth interval, the utilization of antenatal care services, and the improvement of contraceptive services are all important to prevent adverse pregnancy outcomes.

ABSTRAK

Kematian neonatal, kematian bayi baru lahir antara nol dan tujuh hari, merupakan tantangan besar di negara berkembang. Tujuan dari analisis ini adalah untuk mengetahui pengaruh jarak kelahiran (waktu diantara dua kelahiran hidup) terhadap hasil kehamilan yang merugikan seperti kematian neonatal dengan menggunakan data kalender reproduksi yang berisi riwayat kelahiran dalam lima tahun pada Survei Demografi dan Kesehatan Indonesia tahun 2017. Hanya kelahiran tunggal dan bukan bayi pertama yang dimasukkan dalam analisis (n = 11, 599). Model regresi logistik untuk sampel kompleks digunakan untuk mengukur hubungan antara interval kelahiran dan kematian neonatal. Kematian neonatal dikaitkan dengan jarak kelahiran. Bayi baru lahir dengan interval kelahiran yang lebih pendek (<24 bulan) dan interval kelahiran yang lebih lama (36 bulan atau lebih) masing-masing memiliki 2,68 kali (95% CI: 1,15-6,28) dan 3,08 kali (95% CI: 1,37-6,92), lebih tinggi kematian neonatal dibandingkan dengan bayi baru lahir yang lahir dengan jarak 24-35 bulan. Di antara ibu yang menerima setidaknya satu kunjungan perawatan antenatal, ada penurunan kemungkinan kematian neonatal dini untuk interval kelahiran yang lebih pendek dan lebih lama. Promosi untuk interval kelahiran yang optimal, pemanfaatan layanan pemeriksaan kehamilan dan peningkatan layanan kontrasepsi penting untuk mencegah hasil kehamilan yang merugikan.

GRAPHICAL ABSTRACT



Keyword
antenatal care
birth interval
calendar data
early neonatal deaths
neonatal in indonesia

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ISSN-P : 2086-2040
ISSN-E : 2548-5334

INTRODUCTION

Early neonatal death, defined as deaths of newborns between zero and seven days, occurs during the perinatal period and poses a big challenge in developing countries (Lehtonen et al., 2017; National Population and Family Planning Board et al., 2018; Sankar et al., 2016). About 73% of newborn deaths occurred globally within the first week of life, and about 36% of early neonatal deaths occurred on the first day of birth (Lawn et al., 2014; Lehtonen et al., 2017). Every year, it is estimated that more than 3 million cases of early neonatal mortality ensued (Liu et al., 2016). Moreover, during the crucial 48-hour encompassing deliveries, nearly 50% of stillbirth, early neonatal and maternal mortality appeared (Lehtonen et al., 2017). The neonatal mortality rate in Indonesia in 2017 was reported to be 15 per 1,000 live births (National Population and Family Planning Board et al., 2018).

Some prior studies have shown the effect of birth interval on adverse pregnancy outcomes for maternal, perinatal, infants and children (e.g., Jena et al., 2020; Nisha et al., 2019; Swaminathan et al., 2020; Yadeta et al., 2020). Birth intervals less than six months were associated with an increased risk of small gestational age, uterine rupture following the previous cesarean, low birth weight, preterm birth, spontaneous preterm birth, and infant mortality (Ahrens et al., 2019; Dhingra & Pingali, 2021; Kannaujiya et al., 2020; Ye et al., 2019). Stillbirths and early neonatal deaths are estimated to be reduced by 70% if there are investments in maternal and child health services (Migoto et al., 2018).

The most significant drain on human capital development is adverse pregnancy outcomes, especially in low-income countries (Lawn et al., 2014). Reducing neonatal and under-5 mortality has become one of the targets of the Sustainable Development Goals (SDGs). Target 3.2 SDGs states that by 2030, all nations should strive to reduce neonatal mortality by at least 12 per 1,000 live births and under-5 mortality by at least 25 per 1,000 live births. Safe and healthy babies are important for the nation's human capital development and economic progress in the future (Lawn et al., 2014). Based on earlier studies, the birth interval influences child mortality (including neonatal mortality) (Fotso et al., 2013; Molitoris, 2018). Early neonatal mortality, maternal mortality and stillbirth occur within the 48 hours following labour and delivery, accounting for nearly half of all early neonatal deaths, maternal deaths and stillbirths (Lehtonen et al., 2017). Reduction in neonatal mortality is needed to achieve maternal and child health targets. It is significant to strengthen the continuum of care in maternal and child health services to reduce early neonatal deaths.

Birth interval is the main exposure in this study because the birth interval is easier to intervene for prevention (such as with family planning services) in reducing child mortality compared to other variables. Postpartum family planning is a key strategy of childbirth care to reduce the risk of unintended pregnancy and high-risk pregnancy due to the very close duration period between pregnancies. Postpartum family planning provides counseling and contraceptive services as a continuum of care services for mothers before leaving the health facilities.

Indonesia is the fourth most inhabited country worldwide, comprising the largest archipelago and consisting of more than one thousand ethnic groups spreading across 13,000 islands. Indonesia is geographically located in Southeast Asia, with an estimated total population of 270 million, according to the 2020 census. Based on the Indonesia Demographic and Health Survey 2017, the perinatal mortality (including stillbirths and early neonatal deaths) rate in Indonesia was 21 deaths per 1000 pregnancies (National Population and Family Plan-

ning Board et al., 2018). It is needed an acceleration program to reduce early neonatal deaths in Indonesia.

Previous studies about early neonatal deaths stated that the determinants of early neonatal deaths were maternal factors (e.g., age, the number of children ever born, interpregnancy interval), infant factors (e.g., low birth weight, sex, prematurity, infections), sociodemographic factors (e.g., education, wealth status, occupation), health-related factors (e.g., antenatal care, postnatal care) (Kibria et al., 2018; Lehtonen et al., 2017; Migoto et al., 2018; Subedi et al., 2022). Some studies about early neonatal mortality in Indonesia (Hatt et al., 2009; Titaley et al., 2012). Those studies focus on examining the impact of the type of delivery attendant and place of delivery on early neonatal deaths in Indonesia (Titaley et al., 2012) and further explore the such association between professional attendance at home births and early neonatal mortality in Indonesia (Hatt et al., 2009). However, no study has been conducted on the impact of birth interval on early neonatal death in Indonesia. Therefore, this current analysis aimed to determine the effect of birth interval on adverse pregnancy outcomes, such as early neonatal death, by using further analysis of the Indonesia Demographic and Health Survey 2017.

METHODS

This research applied the latest version of the Indonesia Demographic and Health Survey (IDHS) in 2017. IDHS is a nationally representative survey that covers over 34 provinces in Indonesia. The analysis was limited to the information provided in the individual and birth records data. Data were obtained from the demographic and health survey website (www.dhsprogram.com) after receiving approval from DHS.

Women aged 15 to 49 years were interviewed using standard questionnaires. The Demographic and Health Survey (DHS) Program developed standard questionnaires to compare the demographic and health indicators across countries. The standard questionnaires have been reviewed and modified, so they can be applied in all countries which conducted demographic and health surveys. The country can adopt and modify the questionnaire to a specific interest that is relevant in the country. This study used woman's and children's questionnaires. The survey used multistage cluster sampling designs, stratified by urban and rural areas and ordered by household wealth status (National Population and Family Planning Board et al., 2018). A total of 49,627 women in reproductive-aged were interviewed, with a response rate of 97.8% (National Population and Family Planning Board et al., 2018). In the IDHS 2017, women were asked about their reproductive history in the last five years preceding the survey, such as their events of births or pregnancy loss (miscarriage, abortion or stillbirth), the duration of pregnancy and the duration of contraceptive used (USAID, 2018). The estimation of the birth interval was based on self-reported data including reproductive calendar data containing retrospective birth history in the previous five years.

The outcome in this analysis was early neonatal mortality as one of the indicators of adverse pregnancy outcomes. Early neonatal death was defined as neonatal death of infants during the first seven days of live births. The data on early neonatal death was obtained from birth history data, which provided detailed birth histories of all children born in the past five years. The estimation of early neonatal death was based on the mother's information on the infant's age at death in the birth history data. The history data was self-reported data based on the births and deaths of the infants over five years preceding the survey. Moreover, in the

birth records data, mothers were asked whether the child was a twin, the child was alive, the sex of the child, the age at death, the current age of the children, the birth order and whether the child lived with whom. For infants who died in the first month, the age at death was recorded in days. Infants who reported their age at death of 0-7 days would be coded as "1" (early neonatal deaths), and other infants were coded as "0" (live births for seven days or more).

Moreover, the main exposure was birth interval, defined as the interval between the last pregnancy and the current/recent pregnancy. Birth interval became an interesting factor in this analysis based on its impact on neonatal mortality in previous studies (Kibria et al., 2018; Nisha et al., 2019; Titaley et al., 2012). The birth interval information was collected from the calendar data in the individual record data of women aged 15-49 years. The information on pregnancy, births and termination was provided monthly in the reproductive history calendar data. The time of birth spacing was based on the gap (in months) between two pregnancies in five years preceding the survey. The period of birth was provided in the first column of the calendar (vcal_1 in the Stata file). Data in vcal_1 were extracted because each woman might have more than two pregnancies within the reproductive calendar period of 60 months. The birth intervals were collected after of the reproductive history calendar data extraction. The birth interval was categorized into three groups <24 months, 24-35 months and > 36 months. The categorization of the birth interval was based on some literature reviews in Indonesia (Titaley et al., 2012) and other countries (Kibria et al., 2018).

The potential confounders included in this analysis were socioeconomic, maternal and child-related variables. The potential confounders were determined based on the previous literature on neonatal mortality, including early neonatal mortality. Maternal and child-related variables included were birth order (Kibria et al., 2018; Titaley et al., 2012), sex of the infants (Kibria et al., 2018; Migoto et al., 2018; Nisha et al., 2019; Titaley et al., 2012), number of antenatal care visits (Kibria et al., 2018; Migoto et al., 2018; Titaley et al., 2012), and maternal desire for pregnancy (Kibria et al., 2018; Titaley et al., 2012). Birth order was categorized as "2-3" and "4 or more". The number of antenatal care visits was categorized as "none", 1-3 visits" and "4 or more". Maternal desire of pregnancy was categorized as "no" and "yes". Sex of the infants was dichotomized as "male and female". Socioeconomic factors included in the analysis were occupational status (Nisha et al., 2019) and place of residence (Kibria et al., 2018; Titaley et al., 2012). Occupational was dichotomized as "working" and "not working". Similarly, place of residence was dichotomized as "urban" and "rural". A total of 11,599 newborns were analyzed among live births who met the inclusion criteria: singleton live births, non-first live births, and factors variables and the most recent live births. The samples without birth or termination in the reproductive calendar data were excluded from the analysis.

For descriptive analysis, weighted frequencies for main explanatory variables and potential confounders were calculated. Table 1 describes the percentage of early neonatal death across the explanatory and confounders. The association between birth interval and early neonatal mortality were identified using binary logistic regression for the complex sample with dichotomous outcome after adjusting for potential confounders.

The main independent variable and all potential confounders were tested into the baseline logistic regression models to investigate the impact of each variable on the outcome. For multivariate analysis, the main predictor and potential confounder were assessed in a multi-

Table 1
The Characteristics of infants and their mothers by subsample (IDHS 2017)

Variables	Early neonatal deaths (n=141)	Total samples (n=11,599)
Birth Interval (in months)		
< 24	25.58	21.59
24-35	4.48	10.80
>35	69.93	67.61
Birth order		
2-3	72.86	80.54
4 or more	27.14	19.46
Number of antenatal care visits		
None	14.31	3.57
1-3	9.38	7.48
4 or more	76.31	88.95
Maternal desire for pregnancy		
No	53.56	67.65
Yes	46.44	32.35
Sex of infants		
Male	65.70	60.80
Female	34.30	49.20
Occupational status		
Not working	35.91	48.25
Working	64.09	51.75
Place of residence		
Urban	54.21	48.35
Rural	45.79	51.65

variate model to determine the simultaneous impacts of all variables on early neonatal deaths. Data analysis utilized Stata 15.1 (Stata Corp, College Station, Texas, USA). The analysis used a complex sample because IDHS used a multistage sample design. The "SVY" function in Stata was added to adjust the sampling design by including strata, primary sampling unit and sampling weights. In the inferential analysis, the unadjusted and adjusted odds ratios with 95 percent confidence intervals were observed based on the logistic regression models.

This study was based on existing data from Indonesia Demographic and Health Survey. The authors got the approval to download and use the IDHS 2017 dataset from the demographic and health survey website (www.dhsprogram.com). During the survey interview, all respondents provided informed consent (National Population and Family Planning Board et al., 2018). The confidential data of respondents, such as name and address, were not included while downloading the data.

RESULTS

Table 1 displayed descriptive statistics across the entire variables in the study. Information about basic infants and their mothers' characteristics and the birth interval was available for 11,599 children under five years old. About 68% of the births were from mothers with a birth interval of 36 months or more, 21% from mothers whose birth interval was less than two years and only 11% from mothers whose birth interval was between 24 and 35 months. Concerning antenatal care services, almost 89% of mothers visited antenatal services at least four times, and about 7% visited antenatal care services 1-3 times. In contrast, only 4% of mothers did not visit antenatal care during the pregnancy. Fifty-two percent of chil-

Table 2
Some Factors associated with early neonatal deaths in Indonesia (IDHS 2017)

Variables	Early Neonatal Deaths (n=17,171)	
	COR (95% CI)	aOR (95% CI)
Birth Interval (in months)		
< 24	2.88 (1.24-6.72)*	2.68 (1.15-6.28)*
24-35	1	1
>35	2.51 (1.12-5.62)*	3.08 (1.37-6.92)**
Birth order		
2-3	1	1
4 or more	1.55 (1.07-2.25)*	1.57 (1.04-2.36)*
Number of antenatal care visits		
None	4.86 (2.99-7.89)**	5.17 (3.06-8.73)**
1-3	1.47 (1.18-2.61)*	1.54 (1.63-2.78)*
4 or more	1	1
Maternal desire for pregnancy		
No	1	1
Yes	1.83 (1.31-2.55)*	1.17 (0.75-1.49)
Sex of infants		
Male	1.87 (1.32-2.65)**	1.86 (1.31-2.64)**
Female	1	1
Occupational status		
Not working	1	1
Working	1.67 (1.19-2.37)**	1.64 (1.16-2.33)**
Place of residence		
Urban	1.23 (1.19-1.77)*	1.58 (1.12-2.23)**
Rural	1	1

Note: *p < 0.05; **p < 0.01; COR : Crude Odds Ratio; aOR: adjusted Odds Ratio; CI: Confidence Interval

dren in the sample lived in rural areas, whereas only forty-eight percent lived in urban areas. Approximately 81 out of 100 children under five in this study were the second or the third children in the households, and only about 19% of the children were at least the fourth children. Based on the sample size, about 61% of the children in this study were male. Moreover, approximately 66 out of 100 infants who died in the first week of life were males (table 1).

Table 2 displayed test statistics tabulated by the characteristics of respondents, including Crude/unadjusted and adjusted Odds Ratio (OR) for the association between early neonatal mortality and birth interval. The main finding of this study was that early neonatal mortality was associated with a birth interval after being adjusted for confounders. Newborns with shorter birth intervals (< 24 months) had 2.68 times (95% CI: 1.15-6.28) higher odds of early neonatal deaths compared with newborns birth spaced at 24-35 months. The odds of early neonatal deaths among newborns with longer birth intervals (36 months or more) were greater (aOR=3.08; 95% CI: 1.37 – 6.92) than those with 24-35 months. Among mothers who received at least one antenatal care visit, there was a decrease in the odds of early neonatal deaths for shorter and longer birth intervals. Mothers who did not visit (aOR=5.17; 95% CI: 3.06-8.73) and mothers who visited the antenatal care services 1-3 times had higher odds of early neonatal mortality compared to those who visited antenatal care services more than four times, both for the shorter and longer birth interval.

DISCUSSION

This current study examines the association between birth interval and early neonatal deaths. The result suggests that the shorter (≤ 24 months) and longer ≥36 months) birth interval has a significant association with a higher risk

of early neonatal death as one of the adverse pregnancy outcomes. The findings on the association between birth interval and adverse pregnancy outcomes consolidate results from previous studies (Kibria et al., 2018). Globally, preterm birth complications (about 40%) and birth asphyxia (about 29%) are the main causes of early neonatal mortality. Preterm birth complications are common in the early neonatal period, which indicates preterm babies are poorly cared for (Lawn et al., 2014).

Birth interval is a proximate factor of child mortality (Ghimire et al., 2019; Kibria et al., 2018). The risk of neonatal mortality decreases with rising birth spacing lengths up to 24 months (Ezeh et al., 2019; Hossain et al., 2019). Shorter birth intervals related to a higher risk of infant and child mortality may indicate maternal depletion syndrome and sibling competition for parental resources, and infection transmission (Dhingra & Pingali, 2021; Molitoris, 2017; Nisha et al., 2019; Onwuka et al., 2020; Thomas et al., 2015). Moreover, birth spacing between two pregnancies allows mothers to prepare their physical and mental for the next pregnancy, such as the supply of essential nutrients, iron, and folic acid restoration (Afeworki et al., 2015). Because there is not enough time for mothers to recover from maternal psychological vulnerability from the previous pregnancy, the condition of the shorter birth interval and shorter period of breastfeeding may harm the mother's nutritional status, causing reproductive complications and adverse pregnancy outcomes (Chungkham et al., 2020; Dhingra & Pingali, 2021).

Moreover, shorter birth intervals may cause maternal folate depletion because the restoration of folate is not complete before the next pregnancy. Thus the risk of adverse birth outcomes can be increased (Chungkham et al., 2020). Shorter interpregnancy outcomes increase the risk of preterm birth, low birth weight, stillbirth, neural tube defects, uterine rupture, uteroplacental bleeding disorder and young gestational age (Conde-Agudelo et al., 2012; Swaminathan et al., 2020). Moreover, another study shows that the risk of neonatal and infant mortality and risk of undernutrition may have occurred among infants whose mother's birth interval is less than 36 months (Nisha et al., 2019). A prospective study from Nairobi and an international comparative study presented that shorter birth spacing may increase the risk of infant mortality and early childhood mortality (Fotso et al., 2013; Molitoris et al., 2018). Moreover, the risk of maternal mortality is higher among mothers with a birth interval of fewer than six months (Duclos et al., 2019).

The risk of adverse maternal and infant outcomes among mothers with long birth intervals is similar to primigravid mothers. Longer birth intervals of more than 59 months may increase the risk of low birth weight, preterm birth, small for gestational age, preeclampsia and labour dystocia (Conde-Agudelo et al., 2012). The findings reinforce the urgency to communicate the need for birth spacing for all women. The 'maternal depletion hypothesis' has clarified the association between short inter-pregnancy intervals and neonatal mortality as the result of depleted maternal nutritional stores due to insufficient recuperation time between pregnancies (Thoma et al., 2019). Therefore, the World Health Organization has recommended that mothers, particularly in developing countries, space their births at least three years apart by utilizing contraceptive methods and should be a part of communication strategies (Molitoris et al., 2018).

It is observed in the study that the risk of early neonatal deaths is higher among male infants compared with their counterparts regarding their birth interval. This finding is similar to other studies (Lawn et al., 2014; Migoto et al., 2018). Birth asphyxia, preterm birth and

intrapartum-related neonatal are the main causes of early neonatal deaths that more commonly occur among male babies who are more biologically vulnerable to neonatal complications than female babies (Lawn et al., 2014; Subedi et al., 2022). Moreover, the risk of respiratory and gastrointestinal illness or infections is higher among male infants than female infants, which is related to the testosterone level that influences the infant's immunity system. Based on the previous study, the sex hormone (testosterone) among male infants surprises their immune function. However, the risk of neonatal mortality may result from the difference in gender preference and the gap in health-seeking behaviour (Aghai et al., 2020; Subedi et al., 2022). Therefore, it is important to strengthen the strategy to improve gender equity especially related to health-seeking behaviour for pregnant women to access antenatal care services and postpartum women to access postnatal care services for increasing male and female early neonatal survival.

The strength of this study is based on nationally representative data that covered all provinces in Indonesia. However, some limitations are associated with estimating the impact of birth intervals on early neonatal deaths. First, the study does not consider the previous experience of child loss/miscarriages due to data limitations. Second, the estimation of birth spacing is based on self-reported data for the last five years, which can lead to recall bias and measurement error. Third, since the survey does not collect information on children whose mothers died, the estimation of early neonatal death is only based on information on children who live with their mothers.

A case-control study showed that poor socioeconomic condition, short duration of breastfeeding (< 24 months), and not using any contraceptive methods before the last pregnancy are the determinants of short birth intervals (Hailu & Gulte, 2016). Therefore, the integration of family planning and child survival programs is needed to meet reproductive needs, especially among women with unmet needs for contraception. Improving the promotion of birth spacing may contribute to women's empowerment and children's well-being because mothers have more time to take care of their selves and their children (Duclos et al., 2019). The promotion and counseling of birth intervals from health providers may impact improving maternal and child health. By integrating contraceptive services into maternal or newborn health services, new mothers can receive family planning services in the postpartum period for spacing or limiting their pregnancy. As a result, postpartum family planning can reduce early neonatal mortality and maternal mortality.

CONCLUSIONS

This study analyzes the association between birth interval and early neonatal deaths using the reproductive and birth histories according to the Indonesia Demographic and Health Survey 2017. After controlling for potential confounders of the mother and the child characteristics, the study found that the birth interval is significantly associated with early neonatal deaths. The odds of early neonatal deaths increase among women with a birth interval shorter than 24 months and longer than 36 months compared with those with 24-35 months birth spacing. The study, unfortunately, has the limitation of a cross-sectional study to describe the causality between exposure and neonatal mortality and the unavailability of the history of previous perinatal mortality and maternal medical records during pregnancy. The study's strength is that the study was based on a large nationally representative survey and used weighted data in analysis so that the results can be generalizable to the population of reproductive-age women in Indonesia. This study pro-

vides evidence that is promoting optimal birth interval, using antenatal care services and improving contraceptive services are associated with preventing adverse pregnancy outcomes in Indonesia. These findings will contribute to program planners and policymakers to formulate targeted interventions to increase birth intervals and contribute to achieving the SDGs target of reducing neonatal mortality in Indonesia.

ACKNOWLEDGEMENT

The authors would like to thank The DHS Program for providing the IDHS data.

FUNDING

The authors received no specific funding for this study.

AUTHORS' CONTRIBUTIONS

Maria Gayatri design the study, formal analysis, methodology, writing the original draft, review and editing article and approved the final version to be published. Dian K. Irawaty acquired data, critically review the article and approved the final version to be published.

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COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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