Impact of preeclampsia on the outcome

by Jonathan Kevin Djuanda

Impact of preeclampsia on the outcome of COVID-19 infection

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ABSTRACT

Backgrounds: The COVID-19 outbreaks began at 2020 and spreading fast throughout the world. Infection in pregnancy is associated with increasing number of mortality and morbidity reports as well as increasing reports of preeclampsia (PE) cases complicating the cases. This study aimed to analyze the impact of preeclampsia on the outcome of COVID-19 patients during pregnancy and determine the effect of these variables on maternal and neonatal morbidity and mortality.

Methods: A retrospective study was performed on 711 COVID-19 patients admitted at Dr. Soetomo Hospital during 2020 - 2021. Demographic, clinical, laboratory, complication, and patient outcomes data were collected. Patients were then classified as COVID-19 with preeclampsia and COVID-19 without preeclampsia. Data were collected from hospital medical records, and statistical analysis was carried out to analyze these variables.

Results: We reported 711 pregnant patients with COVID-19, of which 510 patients (72%) had no preeclampsia and 201 patients (28%) had preeclampsia. There were statistically significant differences in maternal age, referral status, gestational age at admission, comorbidities, complications, and symptoms of COVID-19. COVID-19 with PE had higher comorbidities and severe performance than COVID-19 without PE : > 50% were preterm pregnancy, oxygen saturation < 90% on admission reported on 5.9% cases, 35.8% had symptoms, 20.4 % cases suffered severity/ critical condition, 24.4% need ventilation support. However, there was no significant difference in maternal death cases between COVID-19 with and without PE. Risk analysis shows an increased risk of morbidity in pregnant patients with COVID-19 infection: pulmonary edema, critical condition, ICU admission, and Ventilation needed with OR 18.9, 12.5, 5.1, and 2.7, respectively.

Conclusion: Preeclampsia increases the risk of morbidity in COVID-19 pregnant patients.

INTRODUCTION

Pneumonia outbreaks due to the SARS-CoV-2 virus (Severe Acute Respiratory Syndrome Coronavirus-2) began in December 2019 which originated in the Wuhan area, China. The transmission of this virus was fast and claimed many lives and soon spread rapidly and until now in 2022, based on WHO decisions, the world is still in a pandemic status. Globally, as of 19 August 2022, WHO recorded 591,683,619 confirmed cases of COVID-19, with 6,443,306 deaths reported. In Southeast Asia (of which Indonesia is included), 59,807,693 cases were reported with 794,411 deaths. As of August 2022, Indonesia was ranked 19th in the world for total cases and ranked 9th in the world for total deaths, where 6,306,686 confirmed cases of COVID-19 were recorded and 157,343 deaths.[1]

Pregnant women are a population that is declared vulnerable to COVID-19 infection. Pregnant women experience physiological and immunological changes that increase the risk of infection with the SARS-CoV-2 virus with more severe clinical manifestations than those who are not pregnant.[2]

COVID-19 in pregnancy is also commonly found together with previously undiagnosed preeclampsia (PE), giving rise to the term preeclampsia like syndrome in pregnant women infected with COVID-19.[3] Until now the diagnosis of preeclampsia like syndrome is still a challenge in itself and its impact on the course of the disease as well as the severity of symptoms and the risk of maternal death is still not known with certainty. Preeclampsia is defined as a pregnancy complication with new onset of proteinuria and hypertension, occurring after 20 weeks of gestation, in which organ damage may occur. The clinical course of PE begins with abnormal trophoblastic infiltration, which occurs long before the appearance of clinical signs of the disease. Upon proper implantation, the trophoblast infiltrates the decidualized endometrium, causing spiral artery remodeling and obliteration of the tunica media of the myometrial spiral arteries which then facilitates increased blood circulation to the placenta. In PE, there are interferences with trophoblastic invasion and infiltration which, as a result, leads to inadequate spiral artery remodeling.[4]

Immunological factors, inflammation, infection, and genetic predisposition are some other factors that contribute to the manifestations of this disease. Placental hypoxia and ischemia are also other influential factors in the pathogenesis of PE, leading to the signs and symptoms of PE

due to release of vasoactive agents into the maternal bloodstream and concomitant endothelial cell dysfunction.[5,6]

The relationship between PE and COVID-19 infection must be evaluated holistically. First, COVID-19 infection can present signs and symptoms similar to PE. On the other hand, COVID-19 can facilitate the occurrence of PE through its own pathogenesis, besides that PE can also form a similar conducive environment which increase the susceptibility of COVID-19 infection.[7] The potential overlap between risk factors for PE and severe COVID-19 should be assessed as a confounding variable.[3,8] Many multinational studies reveal that pregnant women diagnosed with COVID-19 have higher rates of severe pregnancy complications than those who are not infected with COVID-19, including eclampsia and preeclampsia.[3,9,10]

This study aimed to analyze the impact of preeclampsia on the outcome of COVID-19 patients during pregnancy and determine the effect of these variables on maternal and neonatal morbidity and mortality.

METHODS

This is a retrospective study on pregnant patients with COVID-19 infection. All COVID-19 patient who admitted at dr Soetomo Hospital during 2020-2021 were recruited. Samples then categorized as maternal COVID-19 infection with and without preeclampsia. Demographic data, clinical characteristic and patient outcome were collected from hospital medical record. This study was conducted under the approval and supervision of the Ethics Committee of Dr. Soetomo hospital (Registration no. 2092/104/4/III/2023).

Definitions used for preeclampsia was patients diagnosed using AJOG criteria; hypertension (140 mmHg systolic and/ or 90 mmHg diastolic blood pressure) after 20 weeks of pregnancy which also included the presence of proteinuria, other maternal organ dysfunction, suspected IUGR (AJOG). COVID-19 patients are pregnant women who have been diagnosed with COVID-19 based on pre-defined COVID-19 symptoms, radiographic lung abnormalities that are indicative of COVID-19, or laboratory

Table 1. Demographic and clinical characteristics of maternal COVID-19 cases with and without preeclampsia.

Variables	Without Preeclampsia (n = 510)	Preeclampsia (n = 201)	p
Preeclampsia (PE) Onset, n (%)			0.000
Without PE	510 (100)		
Early onset PE		57 (39,6)	
Late onset PE		144 (60,4)	
Place of Origin, n (%)			0.002
Surabaya	400 (78,4)	135 (67,2)	
Outside Surabaya	110 (21,6)	66 (32,8)	
Age Group, n (%)			0.000
Age <19 years old	10 (1,9)	2 (0,99)	
Age 20-34 years old	402 (78,8)	128 (63,68)	
Age >35 years old	98 (19,3)	71 (35,32)	
Gestational Age upon Arrival, n (%)			0.002
Post partum	25 (4,9)	3 (1,49)	
<28 gestational weeks	37 (7,3)	12 (5,97)	
28-36 gestational weeks	149 (29,2)	88 (43,78)	
37-41 gestational weeks	298 (58,4)	98 (48,76)	
>42 gestational weeks	1 (0,2)	0 (0)	
Parity Status, n (%)			0.476
Primiparous	167 (32,75)	60 (29,85)	
Multiparous	343 (67,25)	141 (70,15)	
History of Hypertension, n (%)			0.000
No	503 (98,63)	162 (80,6)	
Yes	7 (1,37)	39 (19,4)	
History of Diabetes Mellitus, n (%)			0.000
No	504 (98,82)	185 (92,04)	
Yes	6 (1,18)	16 (7,96)	
History of Obesity, n (%)			0.000
No	424 (83,14)	92 (45,77)	
Yes	86 (16,86)	109 (54,23)	
Pulmonary Edema, n (%)			0.000
No	506 (99,22)	175 (87,06)	
Yes	4 (0,78)	26 (12,94)	
Eclampsia, n (%)			0.000
No	510 (100)	180 (89,6)	
Yes	0 (0)	21 (10,4)	
Referral Status, n (%)			0.001
Not referred	185 (36,3)	46 (22,9)	
Primary health care facility / midwife	38 (7,5)	13 (6,5)	
Hospital and Obstetrician	245 (48)	130 (65,1)	
Internal in the institution	42 (8,2)	11 (5,5)	
COVID-19 Associated Symptoms, n (%)			0.000
Not present	407 (79,8)	129 (64,2)	
Present	103 (20,2)	72 (35,8)	
COVID-19 Symptoms Severity, n (%)			0.000
No symptoms	407 (79,8)	129 (64,2)	
Mild	41 (8,04)	25 (12,44)	
Moderate	33 (6,47)	6 (2,98)	
Severe	27 (5,29)	32 (15,92)	

confirmation of COVID-19.[11]

Statistical analyzes was performed with Chi-Square and Mann-Whitney equation and conducted using SPSS ver. 26 (IBM Corp., Armonk, NY, USA).

RESULTS

There were 711 pregnant patients with COVID-19 during this period. Of these, 510 patients (72%) did not suffer from preeclampsia (PE) while the rest (201 patients, 28%) had preeclampsia (Table 1).

Maternal COVID-19 infection complicated with PE experiences higher complications compared to COVID-19 without PE. These complications included pulmonary edema (26 cases in the PE group and 4 cases in the non-PE group), eclampsia, and HELLP syndrome (21 cases and 16 cases) respectively, found in the PE group only)Most cases were referrals from other Hospitals and obstetricians who did not have isolation rooms. The majority of patients were asymptomatic (407 patients, 79.8% in the non-PE group, and 129 patients, 64.2% in the PE group). Among those who were symptomatic, most of the non-PE group had mild symptoms (41 patients, 8.04%). COVID-19 with PE had higher cases with severe symptoms (32 patients, 15.92%) and critical condition (9 patients, 4.48%).

Most cases were delivered by cesarean section (257 cases; 50.4% in the non-preeclampsia group and 165 cases, 82.2% in the preeclampsia group. There was no significant difference in maternal death cases—higher perinatal mortality in the PE group (16.4%).

Risk analysis of the the maternal clinical characteristics shows an increase of risks in several clinical findings in preeclampsia complicated groups (Table 2). Pulmonary edema risk is markedly increased in preeclampsia group (OR 18.79 (6.46 – 54.61), p 0.000) although this is might be associated with increased capillary permeability due to endothelial dysfunction which is a part of preeclampsia pathophysiology. The risk of COVID-19 symptoms manifestations are also increased in preeclampsia group, with critical COVID-19 symptoms are 12.52 time more likely to occur in the preeclampsia group ((2.67 – 58.69), p 0.000). Preeclampsia also increases the

Variables	Without Preeclampsia (n = 510)	Preeclampsia (n = 201)	p
Critical	2 (0,4)	9 (4,48)	
Initial Oxygen Saturation, n (%)			0.019
>95%	475 (93,14)	174 (86,57)	
90-94%	18 (3,53)	15 (7,46)	
<90%	17 (3,33)	12 (5,97)	
Admission to Intensive care, n (%)			0.000
No	447 (87,65)	117 (58,2)	
Yes	63 (12,35)	84 (41,8)	
Use of Ventilator, n (%)			0.000
No	456 (89,41)	152 (75,62)	
Yes	54 (10,59)	49 (24,38)	
Maternal Outcome, n (%)			0.679
Alive	460 (90,2)	179 (89)	
Deceased	50 (9,8)	22 (11)	
Mode of Delivery, n (%)			0.000
Not delivered	49 (9,6)	1 (0,5)	
Vaginal delivery	200 (39,2)	33 (16,4)	
Assisted vaginal delivery	4 (0,8)	2 (1)	
Cesarean section	257 (50,4)	165 (82,1)	
Fetal outcome, n (%)			0.000
Alive	411 (80,6)	167 (83,1)	
Deceased	50 (9,8)	33 (16,4)	
Not delivered	49 (9,6)	1 (0,5)	

*PE: Preeclampsia; COVID-19: Coronavirus disease-19

Table 2. Odds ratio analysis of each characteristics and its impact in preeclampsia cases compared with without preeclampsia in maternal COVID-19 infection.

Parameter	p	OR (95% CI)
Pulmonary edema	0.000	18.79 (6.46 – 54.61)
COVID-19 symptoms	0.000	2.205 (1.538 – 3.162)
COVID-19 symptoms severity		
Mild	0.392	1.25 (0.75 – 2.16)
Moderate	0.004	0.28 (0.12 – 0.66)
Severe	0.000	2.62 (1.55 – 4.42)
Critical	0.001	12.52 (2.67 – 58.69)
Initial O2 saturation	0.023	2.27 (1.12 – 4.61)
Intensive care admission	0.000	5.09 (3.46 – 7.48)
Ventilator use	0.000	2.72 (1.77 – 4.17)
Mode of delivery		
Assisted vag. delivery	0.016	24.5 (1.8 – 332)
Cesarean section	0.001	22.86 (2.60 – 201)

*COVID-19: Coronavirus disease-19

risk of intensive care admission, ventilator use as well as the risk of cesarean section in maternal COVID-19 infection cases.

DISCUSSION

Our study revealed that the incidence of COVID-19 cases in pregnancies was 28%. It is higher than global data. JAMA reported that the incidence of preeclampsia in pregnancy ranges from 4-5%.[2] The INTERCOVID study in October 2020 recorded 2,130 pregnant women in 18 countries, including Indonesia.[9] It is related to higher cases of PE in Indonesia, and our data recorded that the incidence of PE in Indonesia, mostly in our hospital, was more than 20% (Institution internal report data).

We found a relatively higher incidence of symptomatic patients, including severe and critical cases, in the COVID-19 with PE compared to those without PE. COVID with PE also has a higher fetal and maternal complication. This finding aligns with The INTERCOVID study, which presented that pregnant individuals with COVID-19 have a nearly two-fold higher risk of PE, with an increased risk of adverse outcomes, including maternal death, severe infection, and preterm birth.[9] This finding could be explained by the fact that COVID-19 initiates a cascade of endothelial dysfunction both directly and indirectly,[5] followed by hyperinflammation and an exaggerated body response against the virus, a known condition as a cytokine storm or cytokine storm.[6] During pregnancy, COVID-19 has been found to cause specific pathological vascular changes similar to those seen in preeclampsia. Mendoza et al. introduced the concept of "preeclampsia-like syndrome" in which a syndrome resembling preeclampsia was found in pregnant patients infected with COVID-19[3]. In other words, it is difficult to distinguish this syndrome clinically from "true" preeclampsia because both are characterized by severe endothelial dysfunction.[7,12]

SARS-CoV-2 infection reduces the availability of ACE2 on the cell surface through the degradation of ACE2 via the clathrin-mediated endocytic pathway.[12] There are two questions to be answered; are pregnant women infected with SARS-CoV-2 have a greater risk of developing preeclampsia; and whether preeclampsia can be a risk factor itself for increasing the risk of COVID-19 infection as well as severe COVID-19 clinical manifestation? Older age and more comorbidities are associated with an increased risk of developing severe COVID-19.[13] On the other hand, impaired regulation of the RAAS system is associated with poor pregnancy outcomes. This fact will generally manifest in PE and impaired fetal growth.[4,14]

Due to limited isolation room for COVID-19 patients, there was a paradigm shift at our institution during the pandemic; it was decided to carry out abdominal termination of pregnancy to minimize exposure to COVID-19

to medical personnel. In addition, abdominal delivery was also indicated for patients with moderate, severe, and critical symptoms who have no signs of labor and have a viable fetus. Indeed, this contradicts the initial recommendations of the Royal College of Obstetricians and Gynecologists (RCOG) and the International Federation of Gynecology and Obstetrics (IFGO), which suggest that termination of pregnancy in COVID-19 patients should still be following obstetric indications.[15] In some cases, termination can even be decided without an obstetric indication, provided that the gestational age is viable and the patient has a confirmed COVID-19 infection. The condition deterioration of COVID-19 patients is unpredictable. Therefore, termination without an obstetric indication in a viable pregnancy might be considered to prevent worse outcomes for both the mother and the fetus. The same thing was reported by various studies, such as that reported by Papapanou et al. in their systematic review, in which the reported abdominal delivery rate was very high (52.3-95.8%).[16]

The incidence of severe and critical symptoms increased significantly in the group with preeclampsia. The risk of developing severe symptoms increased 2.62 times, and the risk of developing critical symptoms increased 12.52 times in the preeclampsia group. We did not analyze whether the presence of preeclampsia will affect the severity of the COVID-19 infection symptoms; further analysis of each maternal mortality is crucial in further studies.

COVID-19 with PE was at risk of ending up in intensive care and using a ventilator; the risk of both increased by five and two times, respectively. Patients with preeclampsia risk more severe symptoms of COVID-19 infection and, thus, the risk of using a breathing apparatus and intensive care management; however, there is no significant difference in maternal death between the two groups. The PE patient had an inferior condition, which increased the risk of deterioration with infection. Qeadan et al. reported an almost fourfold increase in the use of mechanical ventilation in pregnant patients with COVID-19, especially in pregnant women aged over 35 years old.[17]

No study confirmed when the COVID-19 infection started and when the preeclampsia manifested itself, so it is difficult to determine the relationship and risk based on the onset of preeclampsia because of the confounding variables involved. Various studies have been carried out to determine biomarkers that can predict the onset of preeclampsia without being affected by the status of the COVID-19 infection; this is because sFlt-1, one of the most widely used biomarkers to determine the onset of preeclampsia, was also found to be increased in ongoing COVID-19 infection. This situation made it difficult to establish the diagnosis.[4,18-22] Several other biomarkers that were developed and are more specific for preeclampsia include ITGA5, IRF6, and P2RX7, all three of which are thought to be able to help establish the diagnosis of early onset preeclampsia without being affected by COVID infection status.[18] Interestingly, in a relatively new study, Serrano et al. found that as many as 50% of women who were infected with severe COVID-19 and met the criteria for the diagnosis of preeclampsia did not have preeclampsia but had PE-like syndrome. Serrano used the sFlt-1/PlGF ratio as a reference in determining this, and in patients with a ratio <38 who were treated until their COVID-19 negative, it was found that their PE symptoms subsided after their COVID-19 infection ended so that these patients' pregnancies could be continued.[19]

Our study was limited by the difficulty in identifying the exact timing of preeclampsia occurrence and the impact of COVID-19 infection as well as the impact of prior COVID-19 infection, especially the asymptomatic one. COVID-19 infection might lead to the development of preeclampsia-like syndrome that can manifest during the infection or after the infection resolved. Because we did not follow the patients without preeclampsia that were treated conservatively, we did not have the data regarding the preeclampsia development in these patients. We also did not analyze the onset of preeclampsia and its impact. Another limitation was many indications regarding pregnancy termination were made on the basis of immediate termination before maternal

deterioration occurs, so the risk of bias in the delivery method is still present. We recommend that in future study, resolved cases of maternal COVID-19 infection that were treated conservatively should be followed up until delivery to evaluate the development of any changes or complications in the fetus and the patient.

CONCLUSION

Preeclampsia increases the risk of morbidity in COVID-19 pregnant patients.

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None.

ETHICAL CONSIDERATION

This study was conducted under the approval and supervision of the Ethics Committee of Dr. Soetomo hospital (Registration no. 2092/104/4/III/2023)

CONFLICT OF INTEREST

The author reports no conflicts of interest.

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AUTHOR CONTRIBUTION

All authors have contributed equally from the conceptual framework, data acquisition, and data analysis until the study results are reported through publication.

References

1. Wójtowicz A, Zembala-Szczerba M, Babczyk D, Kołodziejczyk-Pietruszka M, Lewaczyńska O, Huras H. Early-and Late-Onset Preeclampsia: A comprehensive cohort study of laboratory and clinical findings according to the New ISHHP Criteria. Int J Hypertens. 2019;2019.

2. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and neonatal morbidity and mortality among pregnant women with and without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr. 2021;175(8):817–826.

3. Mendoza M, Garcia-Ruiz I, Maiz N, Rodo C, Garcia-Manau P, Serrano B, et al. Pre-eclampsia-like syndrome induced by severe COVID-19: a prospective observational study. BJOG An Int J Obstet Gynaecol. 2020;127(11):1374–1380.

4. Palomo M, Youssef L, Ramos A, Torramade-Moix S, Moreno-Castaño AB, Martinez-Sanchez J, et al. Differences and similarities in endothelial and angiogenic profiles of preeclampsia and COVID-19 in pregnancy. Am J Obstet Gynecol. 2022;227(2):277.e1-277.e16.

5. Agostinis C, Mangogna A, Balduit A, Aghamajidi A, Ricci G, Kishore U, et al. COVID-19, pre-eclampsia, and complement system. Front Immunol. 2021;12:1–20.

6. Sayad B, Afshar ZM, Mansouri F, Salimi M, Miladi R, Rahimi S, et al. Pregnancy, preeclampsia, and covid-19: susceptibility and mechanisms: A Review Study. Int J Fertil Steril. 2022;16(2):64–69.

7. Khalil A, Samara A, Chowdhury T, O'Brien P. Does COVID-19 cause pre-eclampsia? Ultrasound Obstet Gynecol. 2022;59(2):146–152.

8. Sathiya R, Rajendran J, Sumathi S. COVID-19 and preeclampsia: overlapping features in pregnancy. Rambam Maimonides Med J. 2022;13(1):1–10.

9. Papageorghiou AT, Deruelle P, Gunier RB, Rauch S, García-May PK, Mhatre M, et al. Preeclampsia and COVID-19: results from the INTERCOVID prospective longitudinal study. Am J Obstet Gynecol. 2021;225(3):289.e1-289.e17.

10. Wei SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: A systematic review and meta-analysis. Cmaj. 2021;193(16):E540–E548.

11. Shi H, Han X, Jiang N, Cao Y, Alwalid O, Gu J, et al. Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. Lancet Infect Dis. 2020;20(4):425–434.

12. Giardini V, Gambacorti-Passerini C, Casati M, Carrer A, Vergani P. Can Similarities between the pathogenesis of preeclampsia and COVID-19 increase the understanding of COVID-19?. Int J Transl Med. 2022;2(2):186–197.

13. Sokolowska M, Lukasik ZM, Agache I, Akdis CA, Akdis D, Akdis M, et al. Immunology of COVID-19: mechanisms, clinical outcome, diagnostics, and perspectives—a report of the European Academy of Allergy and Clinical Immunology (EAACI). Allergy Eur J Allergy Clin Immunol. 2020;75(10):2445–2476.

14. Robillard PY, Dekker G, Scioscia M, Saito S. Progress in the understanding of the pathophysiology of immunologic maladaptation related to early-onset preeclampsia and metabolic syndrome related to late-onset preeclampsia. Am J Obstet Gynecol [Internet]. 2022;226(2):S867–S875.

15. Vimercati A, De Nola R, Trerotoli P, Metta ME, Cazzato G, Resta L, et al. COVID-19 infection in pregnancy: obstetrical risk factors and neonatal outcomes—a monocentric, single-cohort study. Vaccines. 2022;10(2):1–11.

16. Papapanou M, Papaioannou M, Petta A, Routsi E, Farmaki M, Vlahos N, et al. Maternal and neonatal characteristics and outcomes of COVID-19 in pregnancy: An overview of systematic reviews. Int J Environ Res Public Health. 2021;18(2):1–20.

17. Qeadan F, Mensah NA, Tingey B, Stanford JB. The risk of clinical complications and death among pregnant women with COVID-19 in the Cerner COVID-19 cohort: a retrospective analysis. BMC Pregnancy Childbirth. 2021;21(1):1–14.

18. Sufriyana H, Salim HM, Muhammad AR, Wu YW, Su ECY. Blood biomarkers representing maternal-fetal interface tissues used to predict early-and late-onset preeclampsia but not COVID-19 infection. Comput Struct Biotechnol J. 2022;20:4206–4224.

19. Serrano B, Bonacina E, Garcia-Ruiz I, Mendoza M, Garcia-Manau P, Garcia-Aguilar P, et al. Confirmation of preeclampsia-like syndrome induced by severe COVID-19: an observational study. Am J Obstet Gynecol MFM. 2023;5(1):100760.

20. Wiyati PS, Adawiyah R, Dewantiningrum J, Pramono BA. Maternal and perinatal outcomes with covid-19: lesson learned from the tertiary hospital. Bali Med J. 2021;10(1):442-447.

21. Mega Putra IG, Surya IGP, Pratiwi ASIM. High level of soluble FMS-like tyrosine kinase-1 (sFlt-1) serum in pregnancy as a risk factor of preeclampsia. Bali Med J.;5(2):322-325.

22. Wantania JJ, Homenta C, Kepel BJ. Relationship of heme oxygenase-1 (HO-1) level with onset and severity in normotensive pregnancy and severe preeclampsia. Bali Med J.;5(1):105-109.

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GENERAL COMMENTS