Research Article

The Effect of Environmental Deterioration and Demographic Pressure on Obstetric Complication Severity Amplified by Infectious Disease: Lessons Learnt from Lampung Province Public Choice Guided Policy

Aghesna Rahmatika Kesuma[1,8]*, Samsul Bakri[2], Ratna Dewi Puspita Sari[3] , Eko Kuswanto[4], Evi Kurniawaty[5], Dicky Budiman[6], and Arsyad Sobby Kesuma[7]

[1]Student in the Environmental Science Doctoral Study Program, Lampung University
[2]Lecturer in The Environmental Science Doctoral Study Program, Lampung University
[3]Lecturer in the Faculty of Medicine, Lampung University
[4]Lecturer in Tarbiyah and Teacher Training Faculty, Raden Intan Lampung State Islamic University
[5]Lecturer in the Faculty of Medicine, Lampung University
[6]Lecturer in School of Medicine and Dentistry, Griffith University, Brisbane, Australia
[7]Lecturer in Ushuluddin Faculty, Raden Intan Lampung State Islamic University
[8]Lecturer in Islamic Library and Information Science, Raden Intan Lampung State Islamic University

Abstract

Background: Environmental degradation and demographic pressures are increasingly recognized as important determinants of public health outcomes in low- and middle-income countries. Deforestation, declining sanitation, and rapid urban expansion exacerbate ecological pressures, while population density, poverty, and limited health resources intensify vulnerability among women of reproductive age. Infectious diseases such as malaria, dengue fever, and tuberculosis remain endemic in many regions of Indonesia, further complicating maternal health outcomes. Lampung Province, Sumatra, represents a microcosm of these intersecting challenges, making it a relevant locus for examining the combined effects of environmental and demographic stress on obstetric complications. Objective: This study aims to determine: (1) the direct effect of environmental deterioration (ENV) on pregnancy complications (COMP) and infectious diseases (DISEA); (2) the impact of demographic pressure (DEMG) on pregnancy complications and infectious diseases; (3) the effect of infectious diseases on pregnancy complications; and (4) the role of infectious disease mediation in amplifying the effects of environmental damage and demographic pressure on pregnancy complications. Methods: The study was conducted between January and April 2026 in Lampung Province. Data preparation and analysis were carried out at the Forest Inventory and Management Laboratory of the University of Lampung. Smart PLS-SEM is used for parameter optimization using 5,000 iterations of bootstrapping. ENV is measured through indicators such as declining forest quality, increased deforestation, deteriorating sanitation, barren land expansion, and housing growth. DEMG is reflected in increasing population density, concentration of modern sector workforce, increasing number of pregnant women, and declining disposable income. DISEA was measured by the number of occurrences of pneumonia, dengue fever, pulmonary tuberculosis, and acute respiratory infections. COMP is reflected in bleeding, anemia, preeclampsia/eclampsia and many obstetric complications. DEMG and ENV data were collected from www.bps.go.id (2019–2023), while DISEA and COMP data were obtained from the Lampung Provincial Health Office with a one-year gap (2020–2024). Results: Findings show that: (1) environmental deterioration (ENV) directly increases pregnancy complications (COMP) by about 0.231 cases per 10,000 population ($p = 0.139$) and infectious diseases (DISEA) by about 0.265 cases per 10,000 population ($p = 0.002$); (2) demographic pressure (DEMG) directly increases pregnancy complications (COMP) by about 0.144 cases per 10,000 population ($p = 0.563$) and infectious disease (DISEA) by about 0.660 cases per 10,000 population ($p = 0.000$); (3) the effect of infectious diseases (DISEA) on pregnancy complications was statistically significant ($p = 0.074$), with an estimated increase of 0.360 cases per 10,000 women of reproductive age .Conclusion: This study highlights the complex interplay between environmental degradation, demographic pressures, and infectious diseases in shaping maternal health outcomes. While environmental and demographic stress provide significant immediate effects, infectious diseases appear to play a limited mediating role. These findings underscore the need for integrated policies addressing ecological sustainability, demographic management, and infectious disease control to reduce obstetric complications in vulnerable populations.

Keywords: Environmental health; Demographic pressure; Maternal complications; Infectious disease; Lampung Province; Indonesia; Public health policy

1. Introduction

The global climate crisis has escalated from a distant ecological threat to a direct determinant of maternal and societal health outcomes. According to new research, environmental degradation, which includes deforestation, land degradation, and inadequate sanitation, acts in conjunction with sociodemographic forces to increase health risks rather than act alone (Zhang et al., 2025). In developing countries, where demographic transitions occur in tandem with rapid environmental shifts, the complexity of these interactions remains a critical gap in contemporary epidemiological research.

The high complications of pregnancy in developing countries, including Indonesia, show that global efforts such as the *Sustainable Development Goals* (SDGs) target 3.1 have not been fully effective in addressing this problem. Achieving the *Sustainable Development Goals* (SDGs), especially reducing the maternal mortality rate (MMR) to below 70 per 100,000 live births by 2030, remains a crucial challenge for the public health system in Indonesia (Ministry of Health, 2023). The Government of Indonesia has launched various strategic policy initiatives to reduce the prevalence of obstetric complications, which are the main cause of maternal mortality. However, the implementation of these policies is often hampered by geographic disparities and the complexity of risk factors that go beyond conventional clinical boundaries.

There has been a paradigm shift in the dynamic context of Indonesian public health, which recognizes that environmental factors and demographic pressures are important factors in maternal health. Pathological factors such as anemia, bleeding, and preeclampsia not only increase the risk of maternal death, but also negatively impact the health of the fetus and the future development of the child (Sulastri & Nurhayati, 2021). This condition exacerbates the burden on public health and creates additional pressure on the health service system which is often still limited in terms of access, quality, and equitable distribution of services (Panjaitan et al., 2024)

The intersection of ecological integrity and maternal health has become a focal point in global efforts to achieve the United Nations' Sustainable Development Goals (SDGs), specifically Goal 3 on health and Goal 13 on climate action. Along with the rapid economic shift by rapid low- and middle-income countries, the dual burden of environmental deterioration and demographic pressures have emerged as significant determinants of public health resilience (Haines & Ebi, 2019) Although maternal mortality has declined internationally due to clinical breakthroughs, obstetric problems are still severe in areas where social and environmental pressures coexist, resulting in endemic health risks (Barnabas & Eniola, 2025)

Conventionally, clinical interventions and access to healthcare have been used to determine maternal health, especially the severity of obstetric complications (COMP). On the other hand, environmental health perspectives claim that their physical environment and population density largely determine the biological resistance of pregnant women. Environmental deterioration (ENV) impacts microlocal climates and increases exposure to environmental pollutants and infections, especially in the development of infectious disease vectors such as Aedes mosquitoes (Bakri et al., 2024). Meanwhile, household adaptability is limited by demographic pressure (DEMG), which is characterized by high population density, poverty, and declining disposable income. This increases the physiological stress experienced by pregnant women.

Environmental deterioration (ENV), which is characterized by land-use changes, such as deforestation, land degradation, and sanitation disturbances, fundamentally alters the physiological and immunological landscape for pregnant women (Principi et al., 2025). Previous studies have shown that deforestation and the expansion of vacant land not only disrupt local ecosystem services, but also exacerbate heat stress and exposure to toxins, which are positively correlated with adverse pregnancy outcomes such as *stillbirth*, preeclampsia and maternal bleeding (Bonell et al., 2023). In addition, the rapid expansion of settlements into previously wild habitats often degrades local sanitation systems, further leaving populations vulnerable to systemic health risks.

This environmental degradation is often exacerbated by demographic pressures (DEMG). In areas such as Lampung, Indonesia, rapid changes in industrial and demographic aspects bring their own challenges, such as high population density, systemic poverty, and declining disposable income, which act as a multiplier of vulnerability levels (Rylander et al., 2013). This shift creates sociodemographic stress that can affect the health of pregnant women (Sriyani et al., 2020). These sociodemographic factors limit households' adaptive capacity to reduce environmental risks, creating a cycle in

which limited economic resources and dense living conditions amplify the biological impacts of ecological stress (Dewi, 2018). However, there is still a need for thorough empirical quantification of the exact mechanism by which this stress indicates the severity of obstetric complications (COMP), especially when mediated by the incidence of infectious disease (DISEA).

Infectious diseases, such as malaria, pneumonia, and acute respiratory infections, are endemic in many provinces in Indonesia and serve as an important biological pathway between a degraded environment and maternal health. Environments characterized by poor sanitation and land-use change provide an ideal breeding ground for vectors and pathogens (Myers et al., 2013). These diseases can serve as mediators that exacerbate the incidence of pregnancy complications. Infections, for example, can lead to anemia and systemic inflammation, which significantly reduces a woman's physiological threshold to fight obstetric emergencies such as hemorrhage (COMP).

Despite the clinical importance of this relationship, there has not been an integrated structural modeling that takes into account the simultaneous effects of ecological stress and demographic pressure on pregnancy complications (COMP) through infectious disease mediation (DISEA). Lampung Province, Sumatra, provides a unique locus for this research due to its shifting topography and diverse demographic challenges, which represent a microcosm of Indonesia's broader public health landscape.

This study aims to determine: (1) the direct effects of environmental deterioration (ENV) on pregnancy complications (COMP) and infectious diseases (DISEA); (2) the impact of demographic pressure (DEMG) on pregnancy complications and infectious diseases; (3) the effect of infectious diseases on pregnancy complications (COMP); and (4) the role of infectious disease mediation in amplifying the effects of environmental damage and demographic pressure (DEMG) on pregnancy complications.

The findings of this study are expected to provide strategic recommendations and evidence-based insights for policymakers to integrate ecological conservation and infectious disease control as fundamental components of maternal health infrastructure.

2. Methods

The research was conducted between January and April 2026 in Lampung Province. The measurement units are all districts and cities within Lampung Province. Data preparation and analysis were carried out at the Forest Inventory and Management Laboratory (IPH) of the University of Lampung. The evaluation of the measurement model was carried out by testing the reliability of the composite using Cronbach's Alpha, Rho_A, and Rho_C, as well as the validity of the instrument through the AVE (Average Variance Extracted) criteria as recommended (Hair et al., 2022). The evaluation of structural models uses t-statistics (t-statistic) to test each hypothesis put forward (Hair et al., 2022). Smart PLS-SEM version 4.0 is used for parameter optimition using 5,000 bootstrapping iterations. ENV is measured through indicators such as declining forest quality, increased deforestation, deteriorating sanitation, land expansion, and housing growth. DEMG is reflected in increasing population density, concentration of the modern sector workforce, increasing number of pregnant women, and declining disposable income. DISEA was measured by the incidence rate of pneumonia, dengue fever, pulmonary tuberculosis, and acute respiratory infections. COMP is reflected by incidence bleeding, anemia, preeclampsia/eclampsia, and many obstetric complications. DEMG and ENV data were collected from *www.bps.go.id* with a *one-year time lag (2019–2023), except for forest quality degradation, increased deforestation, bare land expansion, and housing growth; data were extracted from* Google Search Engine*, while DISEA and COMP data were obtained from the Service Office of Healthcare Affairs of Lampung (2020–2024).*

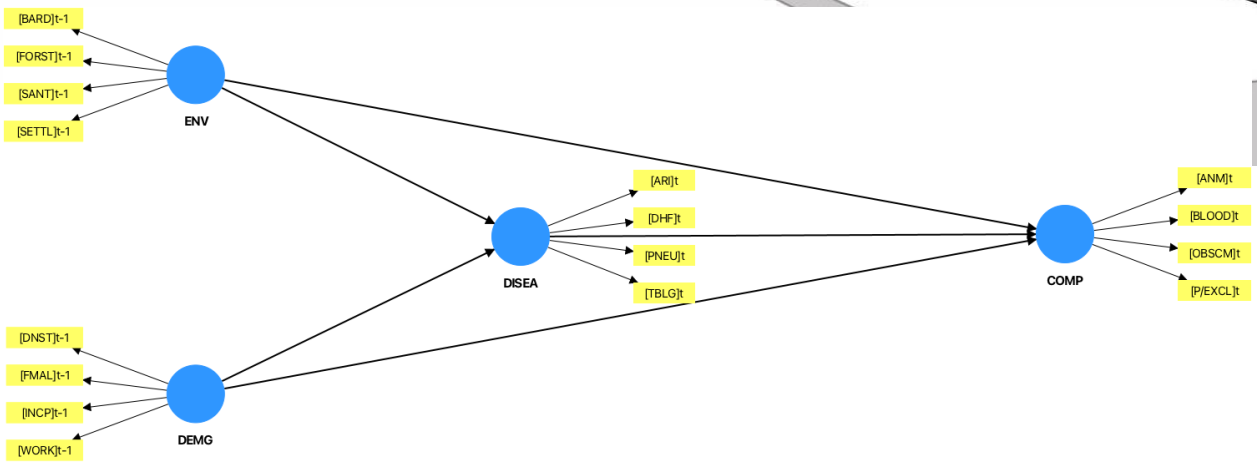

Figure 1. Structural Model of variable and indicator (Structural Equation Modeling Analysis)

3. Result

Land Cover

The identification of land cover in this study was carried out at the district/city level in Lampung Province using *Google Search Engine* from 2019 to 2023 (Figures 2 to 6). The land cover classes identified are state forests, community forests, bare land, plantations, settlements, mixed agriculture, rice fields, and others. Changes in land use continue to occur along with the development process.

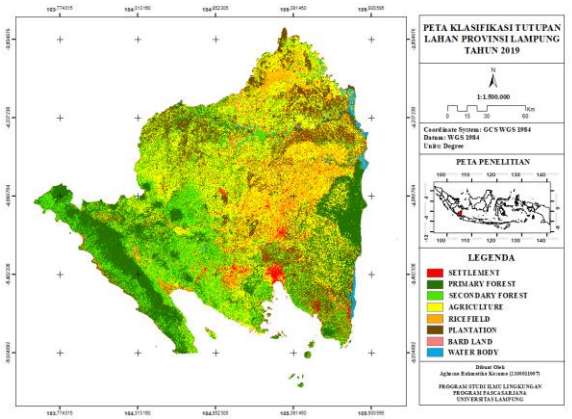

Figure 2 . Land Cover in Lampung Province 2019

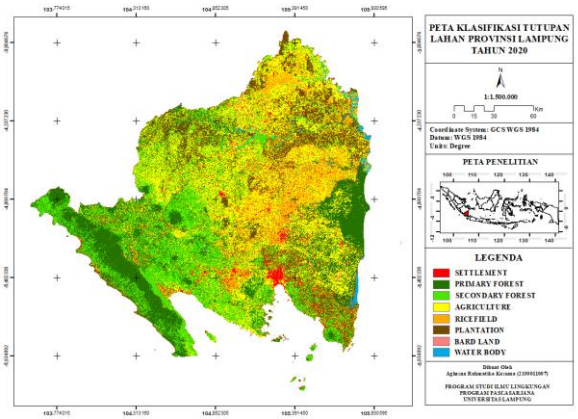

Figure 3 . Land Cover in Lampung Province 2020

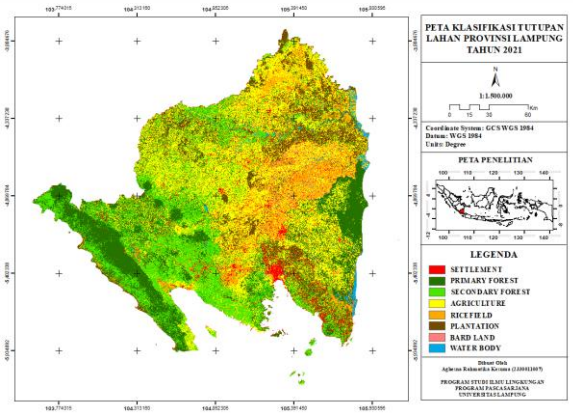

Figure 4. Land Cover in Lampung Province 2021

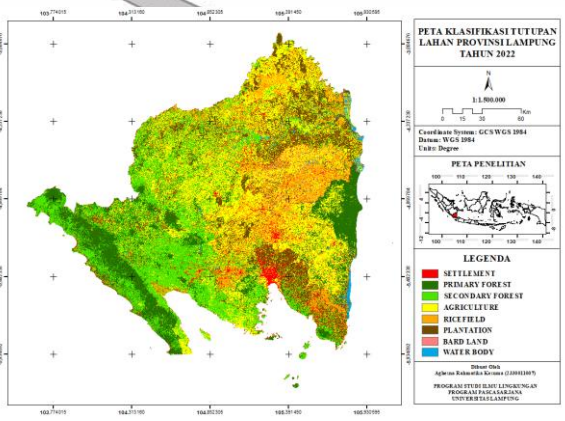

Figure 5. Land Cover in Lampung Province 2022

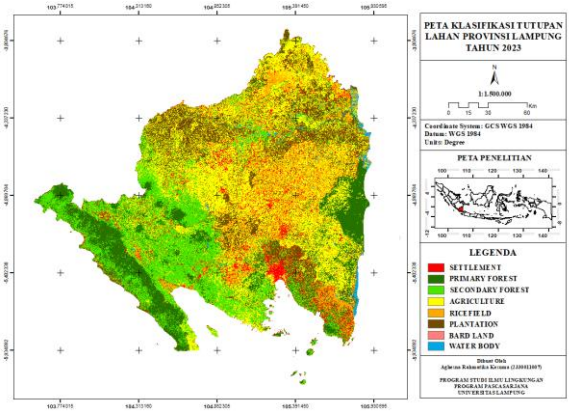

Figure 6. Land Cover in Lampung Province 2023

4. Outer Model

Before evaluating the inner model, it is necessary to check the reliability and validity of the measurement for each latent variable. Likewise, the loading factor for each indicator was used to compile the latent variables in this study. In addition, it is also important to check the results of the latent variable autocorrelation test (VIF). In Table 1, the composite reliability and average variance extracted (AVE) values are presented. From this table, it can be proven that all latent variables used are reliable (Rho_A > 0.700) and valid (AVE > 0.500). The loading factor value for each indicator for each latent variable is shown in Figure 1. From this image, all indicators used reflect each latent variable well, particularly the DEMG indicator of the density of modern-sector workers, which has a loading factor of 0.942. In addition, Table 2 shows that between latent variables, there is no real multicollinearity (VIF < 5,000).

Tabel 1. The composite reliability and average variance extracted

Laten Variabel	**Composite Reliability (Rho_A)**	**Average variance extracted (AVE)**
	Critical value = 0,700	Critical = 0,500
Demography [DEMG]	0.827	0.562
Environment [ENV]	0.727	0.522

Infection Disease [DISEA]	0.850	0.671
Obstretrict Complications [COMP]	0.821	0.633

Tabel 2. Multicollinearity Test

Indicator	Inner VIF
	Critical value = 5.000
ANM	1.715
ARI	1.908
BARD	1.673
BLOOD	2.489
DHF	2.000
DNST	1.422
FMAL	1.862
FORST	1.496
INCP	1.468
OBSCM	1.281
P/EXCL	2.465
PNEU	2.048
SANT	1.303
SETTL	1.673
TBLG	2.273
WORK	3.054

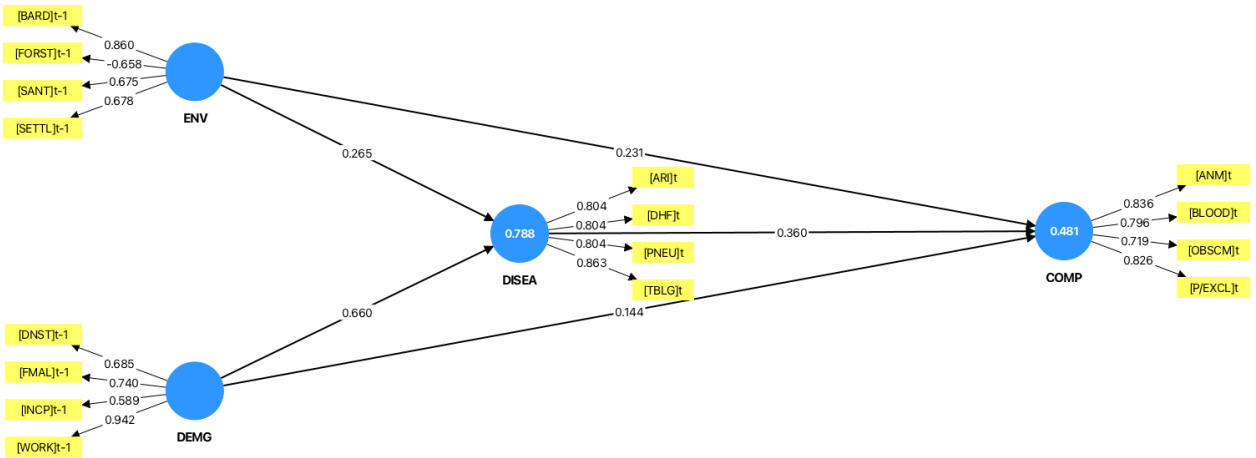

Figure 7: The output of the SEM Algorithm

5. Inner Model

To test the fine-tuning of the algorithm's SEM model, it is necessary to check the value of R2. As seen in Figure 1, the R2 value between the mediating variables for the two exogenous variables is 0.788. Meanwhile, the R2 value of the endogenous variable against the other three latent variables is 0.481. These two values of R^2 are seen as sufficient values to represent the causal relationship between exogenous variables and the endogenous variable, and through the mediating variable used. Furthermore, a bootstrapping test was carried out using 5,000 iterations, and the significance of the two types of causality relationships was obtained. In Figure 2, the results of the bootstrapping test are presented. Table 3 presents the results of the direct effect hypothesis test, and Table 4 presents the results of the indirect effect

hypothesis test.

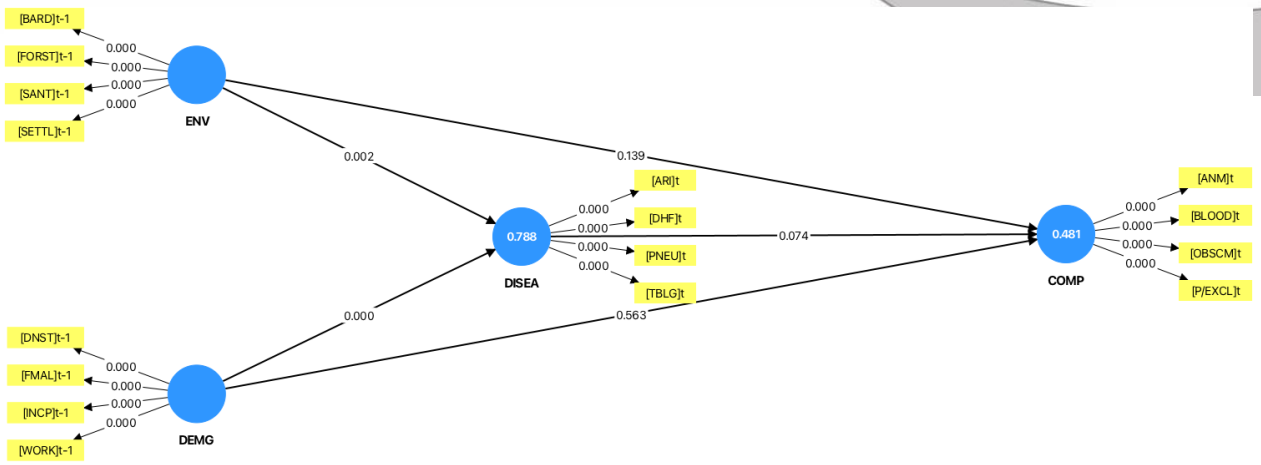

Figure 8. The final SEM model after bootstrapping uses 5,000 units of resampling

Table 3. The Direct Effect Hypotheses Testing Result

Hypotheses	Symbol in Model	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Env. Det. influence to Complication	ENV →COMP	0.231	0.254	0.156	1.479	0.139
Env. Det. influence to Infectious Disease	ENV → DISEA	0.265	0.265	0.084	8.248	0.002
Demg. Press. influce to Complication	DEMG → COMP	0.144	0.168	0.249	3.312	0.563
Demg. Press. influce to Infectious Disease	DEMG → DISEA	0.660	0.659	0.080	5.555	0.000
Infect. Disease influence to Complication	DISEA →COMP	0.360	0.335	0.202	0.613	0.074

In Table 3, for every time there is an increase of 1 unit of environmental deterioration (ENV), there will be an increase in complications (COMP) directly of around 0.231 units. But this increasement is not significant (P value = 0.139). And there will be an increase in infectious diseases (DISEA) directly around 0.265 units. The increase occurs in real terms (P value = 0.002). Then, every time there is a 1-unit demographic depression (DEMG) there will be a direct increase in complications (COMP) of about 0.144 units, although the increase is not real (P value = 0.563). And also directly there will be an increase in direct infectious diseases of around 0.660 units, the increase occurs significantly (P value = 0.000). Furthermore, every time there is an increase of 1 unit of infectious disease incidence (DISEA), it will directly increase the incidence of complications (COMP) by around 0.360 units, and the increase occurs significantly (P value = 0.074).

Tabel 4. The Indirect Effect Hypotheses Result

Hypotheses	Symbol in Model	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Influence of Env.Det.on Comp. Amplied by Inf,Disease	ENV →DISEA → COMP	0.095	0.087	0.060	1.594	0.111
Influence of Demg. Prss. on Comp. Amplied by Inf,Disease	DEMG → DISEA →COMP	0.238	0.223	0.142	1.677	0.094

In Table 4, the variable (DISEA) plays a significant role (P value = 0.094, α = 0.10) in amplifying the effect of demographic pressure (DEMG) in increasing pregnancy complications (COMP). In this case, for every increase in demographic depression by 1 unit, the complications will indirectly increase by 0.238 units. But conversely, the role of DISEA in mediating (ENV) deterioration can positively increase (COMP) but not significantly (P value = 0.111).

6. Discussion

Findings showed that: (1) environmental damage (ENV) directly increased pregnancy complications (COMP) by about 0.231 cases per 10,000 population (p = 0.139) and infectious diseases (DISEA) by about 0.265 cases per 10,000 population (p = 0.002); (2) demographic pressure (DEMG) directly increases pregnancy complications (COMP) by about 0.144 cases per 10,000 population (p = 0.563) and infectious disease (DISEA) by about 0.660 cases per 10,000 population (p = 0.000); (3) the effect of infectious diseases (DISEA) on pregnancy complications was statistically significant (p = 0.074), with an estimated increase of 0.360 cases per 10,000 women of reproductive age.

1. The Direct Impact of Environmental Deterioration on Obstetric Complications

According to the perspective of health ecology, human health cannot be separated from the condition of its ecosystem. Environmental variables are very important as determinants of social and ecological health that directly affect the prevalence of infectious diseases and the risk of pregnancy complications. Environmental quality (forest cover, air pollution) affects pathogen exposure as well as the body's physiological response (Nahian et al., 2023).

The results of structural analysis showed that environmental deterioration (ENV) had an influence coefficient of 0.231 on pregnancy complications (COMP), with a significance value (P value = 0.139). This means that every increase in environmental deterioration of 1 unit will directly increase pregnancy complications by about 0.231 units, although the increase is not real. The results of the analysis showed that the deterioration in environmental quality did not have a significant direct effect on the rate of pregnancy complications in Lampung Province. This phenomenon shows that environmental variables are distal or distant and have a structural impact on maternal health (Sari et al., 2024).

The absence of this significance states that environmental biophysical factors such as land cover, settlements, and sanitation rarely cause pregnancy complications if they are not accompanied by biological intermediate factors (Meherali et al., 2024). This shows that pregnancy complications such as bleeding or preeclampsia are not directly caused mechanically by environmental damage in Lampung, such as decreased sanitation or land cover changes, but rather through more complex transmission pathways. Therefore, the lack of direct links observed to these pathways confirms the importance of investigating intermediate biological pathways, especially infectious diseases, in order to fully understand how environmental stress impacts maternal clinical risk.

2. The Direct Effect of Environmental Deterioration on Infectious Disease

Vector-borne infectious diseases are greatly influenced by environmental performance variables. Changes in land use that have been linked to disease transmission include deforestation or forest fragmentation, habitat fragmentation, agricultural and irrigation development, and urbanization and suburbanization (Bakri et al., 2024). Environmental

degradation and the risk of infectious diseases can be exacerbated by massive land-use changes that cause flooding. The data analysis carried out showed that there was an increase in flood cases in Sumatra from 126 in 2019 to 193 in 2024, thus increasing the number of post-disaster infectious diseases (Budiman & Chu, 2026).

It is projected that climate change will have a major impact on human health, with waterborne diseases being one of the most significant. The spread of microbial agents is influenced by weather through rainfall and runoff, as well as survival and growth factors such as temperature. This condition is combined with air and water pollution, so that it has a significant impact on life (Sudarso, 2017).

There are concerns that dengue infection during pregnancy may have negative consequences for both mother and baby (Isna & Sjamsul, 2021). However, research on this issue is very limited. A total of 52 pregnant women infected with dengue fever were examined for infection severity, clinical course, and obstetric outcomes. Of the 52 women, 34 (65.3%) suffered from severe dengue fever or showed some warning signs, and 4 maternal deaths (7.7%) (Sutharsika et al., 2020). Over the past decade or so, a large number of studies have studied the negative effects of ambient air pollution on birth outcomes. Particulates appear to be the leading cause of infant mortality in terms of exposure to certain pollutants such as the effects of polycyclic aromatic hydrocarbons related to fetal growth retardation (IUGR) (Šrám et al., 2005).

The results showed that environmental deterioration (ENV) was a very strong predictor, had an influence coefficient of 0.265 and was real with a significance value (P-value = 0.002). Statistically, it shows that each unit increases environmental deterioration, contributing directly to the addition of infectious diseases by about 0.265 units. This illustrates that in areas experiencing environmental deterioration, the spread of diseases through water-borne and respiratory diseases triggers an increase in the prevalence of infectious diseases (DISEA) in Lampung Province. As indicated by the significance at the p< level of 0.01, the increased deterioration of the environment directly facilitates the spread of pathogens. These results provide strong empirical evidence that environmental deterioration is an important factor for public health, not just a conservation issue.

3. The Direct Impact of Demographic Pressure on Obstetric Complications

Demographic factors such as increased population density, concentration of modern sector labor, increasing number of pregnant women, and declining disposable income that are part of socio-economic pressures are often associated with pregnant women's health risks and even the risk of pregnancy complications (Iskandar & Sofia, 2019). Demographic variables such as income and type of employment, based on the framework of social determinants of health, affect access to quality health services (Apriliani, 2024) and women's reproductive health (Kaplan, 2006). Demographic depression affects the quality of maternal health services, access to health facilities, and the psychosocial condition of pregnant women (Shapiro et al., 2013).

Structural modeling results showed that demographic depression (DEMG) had a positive but not statistically significant effect on pregnancy complications (COMP). Every time there is an increase in demographic depression by 1 unit, it will increase pregnancy complications by 0.144 units. This increase is not significant with a P-value = 0.563, indicating that demographic factors are often passive to individual health if not accompanied by mediating factors. Or in other words, demographic depression rarely has a significant direct pathway to the incidence of pregnancy complications.

Demographic depression plays a role as a distant determinant or indirect risk factor in pregnancy complications. The increase in the number of pregnant women in areas with high demographic pressure (densely populated) such as urban areas or rural areas is often closely correlated with limited access to health services and minimal infrastructure, thus creating an excessive burden on health facilities, resulting in a decrease in the quality of maternal health services (antenatal care) which can increase the risk of pregnancy complications due to delayed early detection of complications (Rosidati, 2023).

4. The Direct Impact of Demographic Pressure on Infectious Disease

High population density is one of the demographic factors that mechanically shortens the distance of contact between individuals, which can increase the rate of transmission of pathogens, both through airborne routes and through intense social contact, especially in closed environments or slums (Nurjannah, 2025). Demographic depression faces challenges

in terms of health infrastructure that is unable to keep pace with the pace of population growth, increasing the risk of persistent infection transmission (Baker et al., 2022).

The findings of this study show that demographic depression (DEMG) has a statistically significant positive effect on infectious diseases (DISEA). If there is an increase in demographic depression of 1 unit, it will directly increase the incidence of infectious diseases by around 0.660 units. And the increase is very noticeable with a P-value = 0.000. This coefficient is the highest influence value in the structural model, which indicates that in Lampung Province, demographic pressure factors such as population dynamics are the more dominant determinants in triggering the burden of infectious diseases. This confirms that population density functions as a trigger for the circulation of pathogens in the social environment, especially at the community level.

When population density exceeds the carrying capacity of the environment, there is a degradation of quality of life, which contributes to an increase in infections diseases such as tuberculosis, pneumonia, and other acute respiratory diseases (Tsabitah Aulia et al., 2024). This condition accelerates the transmission of pathogens through the air due to close physical distances (overcrowding) and inadequate air ventilation (Mujiono et al., 2025). Infectious diseases in this case play a role as a mediator for the incidency of obstetric complications. The magnitude of the coefficient of 0.660 explains that infectious diseases are a very crucial variable. Demographic depression, such as a decline in quality of life, including lack of access to good nutrition, can affect the quality of the body's immune system, thus making individuals more susceptible to infection (Kurniawati et al., n.d.). Population pressure is an amplifier of the risk of a large set of diseases, then triggers a systemic inflammatory response in pregnant women and leads to severe pregnancy complications (Hunter et al., 2020).

5. The Direct Impact of Infectious Disease on Obstetrict Complications

Infectious diseases such as dengue, pneumonia, and tuberculosis can cause systemic infections, resulting in vascular endothelial dysfunction which is the main precursor to preeclampsia and eclampsia (Subandrate et al., 2017). This mechanism can lead to earlier uterine contractions and disrupt the flow of nutrients and oxygen to the fetus (Sultana et al., 2023). In tropical regions with a high burden of infection such as Sumatra, chronic infections often manifest into severe anemia in pregnant women, which significantly increases the risk of bleeding (Ramadan et al., 2023).

The results showed that infectious diseases (DISEA) had a significant positive effect on the severity of pregnancy complications (COMP), with an influence coefficient of 0.360 and a significance value of 0.074. This confirms that infectious diseases play a role as a direct biological trigger that amplifies the risk of complications in pregnant women. These findings confirm that infectious diseases (DISEA) are a significant factor in the incidence of pregnancy complications (COMP), so pregnant women's health policies must be directed at the prevention and handling of maternal infections.

Pregnancy causes physiological changes in the body and immune system that make the mother more susceptible to bacterial, viral, and parasitic infections (He et al., 2024), , thus triggering chronic systemic inflammation that can have an impact on the occurrence of anemia in pregnant women, thereby interfering with the function of the placenta and blood flow to the fetus (U. I. Sari et al., 2024). One of the infectious diseases caused by Mycobacterium tuberculosis (MTB) can cause anemia in patients. Anemia caused by tuberculosis infection is included in the category of chronic anemia (Anemia of Chronic Disease), which is anemia caused by the development of chronic diseases in patients (Dasaradhan et al., 2022). When compared to normal pregnant women, pregnant women with anemia have a higher risk of complications. Anemia negatively affects pregnant women, postpartum patients, and fetuses. Miscarriage, prematurity, prolonged labor due to uterine inertia, shock, infection, severe anemia, postnatal bleeding due to uterine atonia, and babies with BBLR (Low Birth Weight) can have an impact on labor (Obeagu & Obeagu, 2025).

6. The Indirect Effect of Environmental on Obstetricst Complications Amplifying by Infectious Diseases

The role of infectious diseases (DISEA) in mediating the occurrence of environmental deterioration (ENV) on pregnancy complications was positive but not statistically significant, with an influence coefficient value of 0.095 and a significance P-value of 0.111. These findings indicate that although environmental damage has been shown to increase the prevalence of infectious diseases (P-value 0.002), the risk pathway does not appear to be strong enough to consistently cause noticeable pregnancy complications over the time period of this study. The insignificance of this environmental

mediation indicates that pregnancy complications in Lampung may be more sensitive to the burden of infection derived from social dynamics (such as TB transmission or ISPA in densely populated areas) (Aulia et al., 2024), compared to the burden of infection derived purely from land degradation. Environmental factors often require a more extreme damage threshold or a longer duration of exposure to be able to manifest as a medical emergency through biological mediation pathways (Isna & Sjamsul, 2021).

Positive relationships with environmental variables (ENVs) remain relevant, as poor environment is often a predisposing factor for maternal infections. Environmental deterioration increases the risk of exposure to pathogens (Tambunan et al., 2023), but its effect on pregnancy complications may vary depending on other protective factors (e.g. access to health services). These findings reinforce the evidence that maternal infections are a key factor that worsens the environment on pregnant women's health (Giudice et al., 2021).

7. The Indirect Effect of Demographics Pressure on Obstetrict Complications Amplifying by Infectious Diseases

The findings showed that infectious diseases (DISEA) significantly amplified the influence of demographic depression (DEMG) on pregnancy complications (COMP) with a significance P-value of 0.094 (α = 0.10). Quantitatively, every increase in one unit of demographic depression will indirectly increase the severity of complications by 0.238 units through the mediation of infectious diseases. Demographic factors such as population density are the main drivers that activate clinical risks for pregnant women through biological intermediaries (pathogens). High population density will accelerate the rate of transmission of pathogens (Joegijantoro, 2019), , which then triggers a systemic inflammatory response in pregnant women that leads to the occurrence of pregnancy complications such as anemia, bleeding, and preeclampsia/eclampsia (Sulastri & Nurhayati, 2021).

Rapid demographic transmission, such as the intensity of human-to-human interactions, is a more dominant factor in the spread of pathogens compared to static population environments. The increase in the coefficient of influence by 0.238 units illustrates how effective infectious diseases are in turning population pressure into an emergency medical need. The mediated burden of infectious diseases is always stronger in high-density populations due to the multiplier effect of intense community transmission (Adriyani, 2019).

Conclusion and policy recommendations

This study provides empirical evidence that neither environmental quality deterioration (ENV) nor demographic depression (DEMG) has a direct effect on the occurrence of pregnancy complications (COMP) in Lampung Province, Indonesia, but these two exogenous variables can increase infectious diseases, which further exacerbate pregnancy complications. (In other words, environmental degradation and demographic depression can increase complications when preceded by an increase in infectious diseases due to environmental deterioration and demographic pressure.

Policy recommendations from the results of this study confirm that infectious diseases (DISEA) are critical mediators in the relationship between demographic depression (DEMG), environmental deterioration (ENV), and pregnancy complications (COMP). Thus, maternal health policies should be directed at ecosystem-based preventive mitigation and demographic surveillance, not just on downstream clinical interventions. This approach is expected to be able to reduce the number of pregnancy complications in a sustainable manner and strengthen the resilience of the public health system.

Limitations and future research, although this study provides a high-fidelity model based on 5,000 iterations of bootstrapping, this study is limited by its regional scope. Although this study clarifies the structural pathway of maternal risk, future research requires further longitudinal investigation to determine whether seasonal variations or specific types of pathogens may produce different outcomes. Future research should explore whether certain types of obstetric complications (e.g., preeclampsia vs. bleeding) respond differently to environmental stressors.

References

1. Adriyani, R. (2019). *Pemanasan Global , dan Kesehatan*. 1–340.
2. Apriliani, A. P. (2024). *Peranan Level Kesejahteraan Dalam mereduksi Penyakit Tular Vektor Sebagai Dampak Dari*

Kemerosotan Kinerja Lingkungan dan Dinamika Demografi Di Provinsi Lampung: Pemodelan SEM (Structural Equation Modelling). 1–23.
3. Baker, R. E., Mahmud, A. S., Miller, I. F., Rajeev, M., Rasambainarivo, F., Rice, B. L., Takahashi, S., Tatem, A. J., Wagner, C. E., Wang, L. F., Wesolowski, A., & Metcalf, C. J. E. (2022). Infectious disease in an era of global change. *Nature Reviews Microbiology*, *20*(4), 193–205. https://doi.org/10.1038/s41579-021-00639-z
4. Bakri, S., Apriliani, A. P., Kurniawaty, E., & Mayaquezz, H. (2024). Environmental and Demographic Effects on Vector Borne Disease Incidence: Welfare Role on DHF Reduction. *Journal of Human, Earth, and Future*, *5*(1), 34–50. https://doi.org/10.28991/HEF-2024-05-01-03
5. Barnabas, B., & Eniola, J. (2025). *The Intersection of Climate Change and Maternal Health: Risks, Challenges, and Solutions*.
6. Bonell, A., Part, C., Okomo, U., Cole, R., Hajat, S., Kovats, S., Sferruzzi-Perri, A. N., & Hirst, J. E. (2023). An expert review of environmental heat exposure and stillbirth in the face of climate change: Clinical implications and priority issues. *BJOG: An International Journal of Obstetrics and Gynaecology*, *July 2023*, 623–631. https://doi.org/10.1111/1471-0528.17622
7. Budiman, D., & Chu, C. (2026). *Flood crisis , ecological degradation , and hospital resilience in Sumatra : A One Health perspective Sociality : Journal of Public Health Service*. *5*(1), 1–9.
8. Dasaradhan, T., Koneti, J., Kalluru, R., Gadde, S., Cherukuri, S. P., & Chikatimalla, R. (2022). Tuberculosis-Associated Anemia: A Narrative Review. *Cureus*, *14*(8), e27746. https://doi.org/10.7759/cureus.27746
9. Dewi, Y. L. R. (2018). Perubahan Iklim, Dampak Langsung, Dampak Tidak Langsung, Gangguan Kesehatan,. *Biologi Fakultas Kedokteran Universitas Sebelas Maret*, 440–446.
10. Giudice, L. C., Llamas-Clark, E. F., DeNicola, N., Pandipati, S., Zlatnik, M. G., Decena, D. C. D., Woodruff, T. J., & Conry, J. A. (2021). Climate change, women's health, and the role of obstetricians and gynecologists in leadership. *International Journal of Gynecology and Obstetrics*, *155*(3), 345–356. https://doi.org/10.1002/ijgo.13958
11. Haines, A., & Ebi, K. (2019). The Imperative for Climate Action to Protect Health. *The New England Journal of Medicine*, 263–273. https://doi.org/10.1056/NEJMra1807873
12. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (3rd ed.)*. Sage Publishing.
13. He, J.-R., Tikellis, G., Paltiel, O., Klebanoff, M., Magnus, P., Northstone, K., Golding, J., Ward, M. H., Linet, M. S., Olsen, S. F., Phillips, G. S., Lemeshow, S., Qiu, X., Hirst, J. E., & Dwyer, T. (2024). Association of common maternal infections with birth outcomes: a multinational cohort study. *Infection*, *52*(4), 1553–1561. https://doi.org/10.1007/s15010-024-02291-0
14. Hunter, E., Namee, B. Mac, & Kelleher, J. D. (2020). A model for the spread of infectious diseases in a region. *International Journal of Environmental Research and Public Health*, *17*(9). https://doi.org/10.3390/ijerph17093119
15. Iskandar, & Sofia, R. (2019). Hubungan Stresor Psikososial Pada Kehamilan Dengan Komplikasi Persalinan Di Wilayah Kerja Puskesmas Lapang Aceh Utara. *Jurnal Averrous*, *5*(1).
16. Isna, H., & Sjamsul, H. (2021). *Peran Nyamuk Sebagai Vektor Demam Berdarah Dengue (DBD) Melalui Transovarial*. http://digital.library.ump.ac.id/1066/
17. Joegijantoro, R. (2019). Penyakit Infeksi. In *Sustainability (Switzerland)* (Vol. 11, Issue 1). Intimedia. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI
18. Kaplan, G. A. (2006). Social Determinants of Health, 2nd Edition. M Marmot and R Wilkinson (eds). Oxford: Oxford University Press, 2006, pp. 376, $57.50file:///Users/macbookair/Downloads/raihanaalkaff,+Journal+manager,+1.+edit+B.+Catur (1).pdf. ISBN: 9780198565895. *International Journal of Epidemiology*, *35*(4), 1111–1112. https://doi.org/10.1093/ije/dyl121
19. Kemenkes, R. (2023). *Survei Kesehatan Indonesia (SKI) 2023 Dalam Angka*.
20. Kurniawati, L., Isnawati, & Santoso, I. (n.d.). *Impact of Housing Microclimate and Overcrowding on Pulmonary Tuberculosis in South Kalimantan , Indonesia*. 357–367.
21. Meherali, S., Nisa, S., Aynalem, Y. A., Kennedy, M., Salami, B., Adjorlolo, S., Ali, P., Silva, K. L., Aziato, L., Richter, S., & Lassi, Z. S. (2024). Impact of climate change on maternal health outcomes: An evidence gap map review. *PLOS Global Public Health*, *4*(8), 1–14. https://doi.org/10.1371/journal.pgph.0003540
22. Mujiono, F., Aini, G. A., & Nurikah. (2025). *Dampak Kepadatan Penduduk dan Kualitas Lingkungan Permukiman di Kelurahan Kasemen Kota Serang*. *9*(4).
23. Nahian, M. Al, Ahmad, T., Jahan, I., Chakraborty, N., Nahar, Q., & Streatfield, P. K. (2023). Air pollution and pregnancy

outcomes in Dhaka, Bangladesh. *Journal of Climate Change and Health*, *9*, 0–7. https://doi.org/10.1016/j.joclim.2022.100187
24. Nurjannah, S. (2025). *Pengaruh Faktor Sosial dan Lingkungan terhadap Kejadian Penyakit Infeksius di Kota Dumai*. *5*(2), 19195–19200.
25. Obeagu, G. U., & Obeagu, E. I. (2025). *Complications of anemia in pregnancy; An update overview for healthcare professionals*. *January 2024*.
26. Panjaitan, F. B., Wandra, T., & Sirait, A. (2024). Faktor-Faktor Berhubungan Dengan Kepatuhan Ibu Hamil Dalam Melakukan Kunjungan Antenatal Care Di Puskesmas Buhit. *Prepotif*, *8*(April), 382–391.
27. Principi, N., Campana, B. R., Argentiero, A., Fainardi, V., & Esposito, S. (2025). The Influence of Heat on Pediatric and Perinatal Health: Risks, Evidence, and Future Directions. *Journal of Clinical Medicine*, *14*(4), 1–14. https://doi.org/10.3390/jcm14041123
28. Ramadhan, A. K., Danianto, A., & Cholidah, R. (2023). Anemia in Pregnancy : Cause and Effect. *Jurnal Biologi Tropis*, *2*(1).
29. Rosidati, C. (2023). *Journal of Religion and Public Health Determinan Kejadian Komplikasi Persalinan Di Indonesia (Analisis Data Survei Demografi dan Kesehatan Indonesia Tahun 2017) Determinants of Delivery Complications in Indonesia (Analysis of Indonesian Demographic and Health Survey Data 2017)*. *5*(1), 1–14. https://doi.org/10.15408/jrph.v5i1.36713
30. Sari, R. D. P., Sutyarso, Wardani, D. W. S. R., Bakri, S., Tugiyono, & Busman, H. (2024). A Structural Equation Modeling-Based Maternal Mortality Prediction Model with Three Levels of Determinants. *Universal Journal of Public Health*, *12*(1), 167–178. https://doi.org/10.13189/ujph.2024.120118
31. Sari, U. I., Fujiko, M., & Ginayah, M. (2024). Characteristics Of Pregnant Women With Anemia. *Jurnal Eduhealth*, *15*(04), 154–168. https://doi.org/10.54209/eduhealth.v15i04
32. Shapiro, G. D., Fraser, W. D., Frasch, M. G., & Séguin, J. R. (2013). Psychosocial stress in pregnancy and preterm birth: Associations and mechanisms. *Journal of Perinatal Medicine*, *41*(6), 631–645. https://doi.org/10.1515/jpm-2012-0295
33. Šrám, R. J., Binková, B., Dejmek, J., & Bobak, M. (2005). Ambient air pollution and pregnancy outcomes: A review of the literature. *Environmental Health Perspectives*, *113*(4), 375–382. https://doi.org/10.1289/ehp.6362
34. Sriyani, A., Berawi, N., Bakri, S., & Kaskoyo, H. (2020). Development of Prediction Model for Childhood Diarrhea Based on Maternal Care Variables, Characteristics of Children, Demography and Sanitation in Study Environment Tulang Bawang Barat Regency. *International Journal of Progressive Sciences and Technologies (IJPSAT*, *23*(2), 354–365. http://ijpsat.ijsht-journals.org
35. Subandrate, Faisal, M. E., & Anggraini, N. W. (2017). *Peranan Stres Oksidatif pada Preeklamsia*. *44*(5), 353–355. http://www.who.
36. Sudarso. (2017). Pengaruh Variabiltas Iklim Terhadap Perkembangan Water-Borne Diseases. *Jurnal Ilmiah Kedokteran*, 8.
37. Sulastri, & Nurhayati, E. (2021). Identifikasi Faktor Risiko Ibu Hamil dengan Komplikasi Kehamilan dan Persalinan. *Higeia Journal of Public Health Research and Development*, *5*(2), 276–282.
38. Sultana, Z., Qiao, Y., Maiti, K., & Smith, R. (2023). Involvement of oxidative stress in placental dysfunction, the pathophysiology of fetal death and pregnancy disorders. *Reproduction*, *166*(2), R25–R38. https://doi.org/10.1530/REP-22-0278
39. Sutharsika, T., Sasirekha, R., & Saranya, R. (2020). Clinical Characteristics and Obstetric Outcome of Symptomatic Dengue Infection in Pregnancy from a Tertiary Care Center in South India. *Journal of Infectious Diseases and Epidemiology*, *6*(3), 1–5. https://doi.org/10.23937/2474-3658/1510133
40. Tambunan, H. N. R., Kahar, D. W. B., Mertha, I. M., Lenakoly, T. Y., Bakhri, S., Sahriyana, Darmawan, A. I. M. D. M., Cutwardani, K., Mikawati, Wiradana, P. A., & Sukesi, T. W. (2023). *Penyakit Berbasis Lingkungan*.
41. Tsabitah Aulia, K., Yuniati, S. K., & Seto, A. A. B. (2024). The Effect of Population Density on The Risk of Tuberculosis in Densely Populated Environments. *Journal of Divers Medical Research*, *1*(2), 7–12.
42. Zhang, X., He, Y., Liu, Y., Guan, J., Jiang, F., & Gu, W. (2025). *Mapping the Research Landscape of Climate Change and its Impact on Pregnancy and Neonatal Outcomes : A Bibliometric Analysis*. *9*, 1–13.