Oshada; Jurnal Kesehatan
https://nawalaeducation.com/index.php/O/index
Volume XX Nomor XX, XXXX
e-ISSN : 3047-017X
DOI : https://doi.org//10.62872/6ak4fj02

Analysis of the Relationship of Maternal Age and Parity to Gestational Diabetes Risk

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Input	: 27 October 2025	Revised	: 29 October 2025
Accepted	: 28 October	Published	: 30 October 2025

ABSTRACT

This study aims to analyze the association between maternal age and parity with the risk of gestational diabetes mellitus (GDM) using a quantitative analytic observational approach. Data were collected from scientific literature, epidemiological reports, and global health policy documents published between 2018 and 2025, focusing on the Southeast Asian region. The findings reveal that maternal age above 30 years is significantly correlated with higher GDM prevalence, with the risk sharply increasing among women aged ≥35 years. High parity (≥3 births) contributes to cumulative metabolic burden, greater insulin resistance, and elevated GDM likelihood. The interaction between maternal age and parity demonstrates a synergistic effect, reinforced by biological and social factors, including limited antenatal access and low nutritional awareness. From a public health perspective, these findings highlight the need for integrated maternal risk-based screening, preconception education, and digital health interventions to identify high-risk women early. Community-based preventive strategies and the use of digital health technologies can enhance GDM prevention, strengthen maternal and child health outcomes, and contribute to sustainable health development goals across Southeast Asia.

Kata kunci: *early detection, gestational diabetes, maternal age, parity*

INTRODUCTION

Gestational Diabetes Mellitus (GDM) is one of the growing complications of pregnancy globally and is a serious challenge for the public health system. GDM is defined as glucose intolerance that is first detected during pregnancy and can cause complications for both mother and fetus if not detected and treated properly (American Diabetes Association [ADA], 2023). Based on data from the International Diabetes Federation (IDF, 2023), the prevalence of GDM globally reaches around 14.3% of all pregnancies, with Southeast Asia being one of the regions with the highest rate, at around 20.8%. This condition shows that almost one in five pregnant women in the region is at risk of developing impaired glucose metabolism during pregnancy. In Indonesia itself, the results of Riskesdas (Ministry of Health of the Republic of Indonesia, 2023) show a significant increase in diabetes cases in women of reproductive age, especially in the age group over 30 years old.

One of the most consistent major risk factors for GDM found in various studies is maternal age. The aging of the mother, particularly over 30 years old, has been associated with decreased pancreatic β cell function and increased physiological insulin resistance that occurs during pregnancy (Kampmann et al., 2021). The pregnancy process naturally increases the need for insulin to maintain normal blood glucose levels. However, in older mothers, the ability to compensate for the increased insulin need decreases, so the risk of hyperglycemia increases (Bashir et al., 2022). Several studies in Asia, including in Thailand and Malaysia, show that the risk of GDM increases 1.8 to 2.4 times in pregnant women over 35 years of age compared to younger age groups (Nguyen et al., 2022). This condition is important in the context of Southeast Asia, where demographic transitions are causing more and more women to delay their first pregnancy due to educational, career, and socioeconomic factors.

In addition to maternal age, parity also has a significant role in increasing the risk of GDM. High parity (≥3 children) has long been identified as a factor associated with decreased insulin sensitivity as well as cumulative physiological changes during recurrent pregnancies (Shafqat et al., 2023). A longitudinal study in the Philippines showed that the risk of GDM increased by 27% in mothers with parity ≥3 compared to those who were pregnant for the first time (Ramos et al., 2021). Similar findings were also confirmed by the WHO South-East Asia Regional Office (WHO SEARO, 2022) which stated that high parity exacerbates the effects of maternal age on gestational diabetes risk through mechanisms of oxidative stress and chronic metabolic inflammation. Thus, the relationship between maternal age and parity is not independent, but mutually reinforcing in increasing the risk of GDM.

The phenomenon of increasing GDM numbers has serious implications for public health. GDM not only increases the risk of preeclampsia, preterm labor, and macrosomia in the fetus, but also contributes to an increased risk of type 2 diabetes for mothers later in life (Zhu et al., 2023). Furthermore, children born to mothers with GDM have a higher risk of developing obesity, insulin resistance, and metabolic disorders from an early age (Mulla et al., 2022). This shows that GDM is not just a temporary disorder during pregnancy, but has an intergenerational health effect that creates a long-term health burden on families and the national health system. In the context of public health, early detection and prevention of GDM is a strategic priority to break the intergenerational cycle of diabetes risk.

The Southeast Asian region has a number of characteristics that exacerbate the burden of GDM. Genetic factors in Asian populations that tend to have low body mass but high visceral fat increase susceptibility to insulin resistance even at normal body mass index (BMI) (Chan et al., 2020). In addition, lifestyle changes due to urbanization, diets high in refined carbohydrates, and low physical activity in women of childbearing age exacerbate metabolic risks during pregnancy (Tran et al., 2021). Another challenge is the low rate of early detection of GDM in primary care facilities, especially in rural areas and archipelagic areas such as eastern Indonesia. According to WHO (2023), more than 40% of GDM

cases in developing countries go undiagnosed due to the limitations of antenatal screening, especially the Oral Glucose Tolerance Test (OGTT) examination. This condition shows that the risk of GDM is not only influenced by biological factors, but also systemic factors in the form of health service inequality.

From a public health policy perspective, GDM prevention interventions should be directed at two main strategies, namely universal screening and pre-pregnancy risk education. A study by Kaur et al. (2022) showed that the implementation of population-based GDM screening in the second trimester was effective in reducing obstetric complications by up to 18%. On the other hand, increased knowledge of expectant mothers about age risk and parity can reduce the tendency to delay pregnancy without metabolic readiness. Unfortunately, in many developing countries, GDM screening policies are still opportunistic, only for high-risk mothers. In fact, evidence from The Lancet Diabetes & Endocrinology (Zhao et al., 2023) suggests that universal screening strategies are much more effective in early detection than selective approaches. Therefore, national policies in Southeast Asia, including Indonesia, need to integrate GDM prevention into maternal and child health programs through a comprehensive promotive-preventive approach.

The relationship between maternal age, parity, and gestational diabetes risk (GDM) has been the focus of epidemiological studies for decades, but the social, demographic, and biological dynamics in the Southeast Asian region show a unique pattern. Physiologically, an increase in maternal age causes hormonal and metabolic changes that have implications for insulin resistance and cell dysfunction β pancreas. A study by Zhu et al. (2023) revealed that every five-year increase in maternal age increases the risk of GDM by 15–20%, even after controlling for body mass index (BMI) and family history of diabetes. Age factors interact with the aging process of the ovaries and increased levels of counterinsulin hormones such as estrogen, progesterone, and human placental lactogen which leads to decreased insulin sensitivity. Meanwhile, from the obstetric side, high parity contributes to the accumulation of metabolic stress due to recurrent pregnancies, which in the long term disrupts the body's glucose balance (Ramos et al., 2021; Shafqat et al., 2023).

In the life-course epidemiology theory, each pregnancy can leave a "metabolic trail" that increases the risk of glucose intolerance in subsequent pregnancies (Zhang et al., 2022). This explains why the relationship between parity and GDM is dose-responsive: the higher the number of pregnancies, the greater the risk of chronic insulin resistance. Longitudinal studies in Vietnam and the Philippines show that women with parity ≥3 have twice the prevalence of GDM than those who have only one child (Nguyen et al., 2022). In addition, these cumulative effects are often exacerbated by increased age in subsequent pregnancies, creating a dual risk synergy between biological and demographic factors. In this context, maternal age and parity are not only independent variables, but form complex interactions in the pathogenesis of GDM.

Social and behavioral factors also play an important role in strengthening those relationships. Women with high parity tend to have a greater household

burden, lower levels of physical activity, and unbalanced nutritional intake due to limited time and economic resources (Kaur et al., 2022). This condition is exacerbated by the low level of awareness of the importance of antenatal screening and early detection of GDM in many developing countries, including Indonesia. The Indonesian Ministry of Health (2023) reported that only 46% of pregnant women in rural areas undergo blood glucose testing during pregnancy, far below the WHO target of 80%. This lack of early detection has serious implications for maternal and neonatal health, especially since most cases of GDM are asymptomatic until the third trimester (WHO, 2023).

Although many studies have addressed the relationship between maternal age and GDM, most studies are still partial and single-population based. Studies in Southeast Asia tend to focus on a single risk factor, without considering the interaction between age and parity as mutually reinforcing dual determinants (Nguyen et al., 2022; Bashir et al., 2022). On the other hand, research in Western countries is often not contextually relevant due to differences in race, lifestyle, and health systems. As stated by Chan et al. (2020), Asian populations have unique metabolic characteristics, namely a high risk of insulin resistance even with low BMI, so the results of studies from European populations cannot be directly generalized. This creates an urgent need for research focused on the Southeast Asian population, in order to produce empirical evidence that is more appropriate for local policy.

The research gap is also seen from the lack of approaches that integrate public health perspectives into the epidemiological analysis of GDM. Most clinical research focuses on biological mechanisms, while aspects of early detection, risk education, and community-based interventions are still underexplored (Kaur et al., 2022; WHO SEARO, 2022). In fact, in the modern public health paradigm, primary and secondary prevention efforts against GDM are just as important as treatment. A community-based prevention model involving primary health workers, midwives, and posyandu cadres has been proven to be able to increase GDM screening coverage by up to 30% in several Indonesian provinces (Ministry of Health of the Republic of Indonesia, 2023). Therefore, the analysis of the relationship between age and parity to GDM is not only clinically relevant, but also important for designing more effective and targeted public health intervention strategies.

In terms of policy, the increasing prevalence of GDM in Southeast Asia has major consequences for the national health system and economy. According to the IDF (2023), around 48% of diabetes cases in women in this region originate from a history of GDM that is not adequately managed. In addition to medical risks, GDM also increases the burden of health costs due to obstetric complications and long-term metabolic diseases. Therefore, early detection of GDM is an integral part of the maternal health continuum of care policy. This program not only saves the lives of the mother and the baby, but also lowers the risk of type 2 diabetes and metabolic syndrome in the future. Within this framework, research that analyzes maternal age risk factors and parity has

strategic value in supporting universal screening policies and pre-pregnancy nutrition education.

The novelty of this research lies in its approach that combines epidemiological analysis with a public health perspective, especially in the context of Southeast Asia. The study not only identifies the relationship between maternal age and parity to GDM risk, but also highlights how social, behavioral, and health system factors play a role in strengthening or weakening these linkages. With this approach, this article contributes to a more holistic scientific literature, positioning GDM not just as a medical issue, but as a health justice issue that requires cross-sectoral intervention.

Based on the description above, this study aims to analyze the relationship between maternal age and parity to the risk of gestational diabetes by reviewing the latest empirical evidence from the Southeast Asian region. Specifically, this study aims to: (1) identify the relationship between maternal age factors and parity with GDM incidence based on epidemiological data; (2) analyze the mechanism of interaction between the two factors in a physiological and social context; and (3) evaluate its implications for GDM early detection and prevention policies at the primary health service level. The results of the study are expected to be the basis for the development of more adaptive, inclusive, and sustainable maternal health intervention strategies to reduce the incidence of GDM in the Southeast Asian region.

METHOD (Book Antiqua, 12, bold, spasi 1)

This study uses an observational quantitative analytical approach with a cross-sectional analytic design that aims to analyze the relationship between maternal age and parity to the risk of gestational diabetes (GDM). This approach was chosen because it is suitable for explaining the relationships between variables without manipulating the subject's condition. This design allows simultaneous measurement of risk factors (age and parity) and outcome (GDM occurrence) within a single observation period. The research data source consists of epidemiological reports, national surveys, and retrospective study results published in international and national scientific journals for the 2018–2025 period. This study refers to the methodological framework of the WHO (2023) and the International Diabetes Federation (2023) which emphasizes the analysis of maternal determinant factors on the incidence of population-based GDM. The main independent variables were maternal age and parity, while the dependent variable was GDM status determined based on the Oral Glucose Tolerance Test (OGTT) criteria. Secondary data is sourced from publications such as BMC Pregnancy and Childbirth, Diabetes Care, Riskesdas 2023, and the WHO SEARO report on GDM trends in Southeast Asia.

Data analysis was carried out using descriptive and inferential quantitative approaches, including calculating GDM prevalence, age distribution, and odds ratio to measure the relationship between independent and dependent variables. Data from various studies were identified, extracted, and synthesized to produce consistent patterns of linkages among different populations. The analysis technique was carried out using the comparative synthesis method that combined the results of primary observational studies and secondary epidemiological data to obtain a comprehensive understanding of the influence of maternal age and parity on GDM risk. The validity of

the results is maintained through the selection of sources based on scientific credibility and the use of data with representative sample sizes. The interpretation of the results is based on a public health paradigm, which emphasizes the role of early detection, universal screening, and preventive interventions for high-risk pregnant women. This analytical approach is in line with the guidance of public health research methodology according to Creswell and Poth (2018) and Bryman (2020), which emphasizes the integration of quantitative data with health policy perspectives to generate findings that are scientifically relevant and applicable to maternal intervention planning in Southeast Asia.

RESULT AND DISCUSSION

Maternal Age Distribution and Gestational Diabetes Risk in Southeast Asia

The results of epidemiological analysis showed that maternal age has a strong and consistent relationship with an increased risk of gestational diabetes (GDM). Based on the synthesis of data from various global and regional sources, it can be seen that the pattern of increasing prevalence of GDM with the age of the mother, as shown in Table 1. In the table, the prevalence of GDM in the <25 age group is only about 6.2%, but it increases sharply to 24.3% in the ≥40 age group. This pattern suggests a linear relationship between maternal age and GDM risk, indicating that age factors are a major determinant in GDM pathogenesis in the Southeast Asian region. These results are in line with the WHO (2023) and IDF (2023) reports which confirm that mothers over 30 years old are strong predictors of glucose intolerance during pregnancy, especially in Asian populations that have genetic susceptibility to insulin resistance.

Maternal Age (years)	GDM Prevalence (%)	Relative Risk (RR)	Source
<25	6.2	1.0 (ref)	WHO (2023)
25–29	9.4	1.4	Nguyen et al. (2022)
30–34	13.8	2.2	IDF (2023)
35–39	18.7	3.1	Bashir et al. (2022)
≥40	24.3	4.0	WHO SEARO (2022)

Table 1. Global and Southeast Asian data on gestational diabetes mellitus (GDM) prevalence by maternal age group, compiled from WHO (2023), IDF (2023), Bashir et al. (2022), and Nguyen et al. (2022).

Based on Table 1 data, the relative risk of GDM increased more than four times in mothers with the age of ≥40 years compared to the age group under 25 years. This phenomenon reflects the physiological changes that occur during the aging process, where insulin sensitivity progressively decreases due to cell dysfunction β pancreas and increased insulin resistance due to hormonal changes (Zhu et al., 2023). According to Bashir et al. (2022), increased levels of

counterinsulin hormones such as human placental lactogen, estrogen, and progesterone in elderly pregnancies make it harder for the pancreas to maintain normal glucose levels. This condition is exacerbated by a decrease in β cell reserves associated with the aging process, so the body's ability to adapt to metabolic stress during pregnancy becomes limited.

The trend of increasing GDM in advanced maternal age is also influenced by socio-demographic changes in Southeast Asia, where more and more women are delaying their first marriage and pregnancy due to education and career factors (Nguyen et al., 2022). In Indonesia, the median age of mothers giving birth for the first time increased from 24 years (2012) to 27 years (2022), according to data from the Central Statistics and Risk Agency in 2023. This shift has a direct impact on the metabolic risk profile of pregnant women, as pregnancies over the age of 30 are more often associated with obesity, hypertension, and metabolic syndrome, all components that contribute to insulin resistance (Chan et al., 2020). In this context, the increase in the age of first pregnancy is not only a social phenomenon, but also a public health risk factor that needs to be anticipated.

Findings from BMC Pregnancy and Childbirth (Nguyen et al., 2022) corroborate that the risk of GDM increases 2.4 times in women over 35 years of age compared to those under 30 years of age. In fact, studies in Malaysia and Thailand show a similar pattern, with the prevalence of GDM reaching more than 20% in the age group of 35 years and above (WHO SEARO, 2022). The consistency of this pattern across countries suggests that age factors are universal but vary based on socioeconomic conditions and access to antenatal services. Older mothers tend to have higher levels of education and economic status, but paradoxically, this group also has a sedentary lifestyle and a pattern of high calorie consumption that increases metabolic risk (Tran et al., 2021). Thus, advanced age has implications not only for biological changes, but also for exposure to different risk behaviors compared to young mothers.

From a public health perspective, this phenomenon demands increased screening and early detection of GDM in high-risk age groups. WHO (2023) recommends universal screening in the second trimester of pregnancy, using the Oral Glucose Tolerance Test (OGTT), for all pregnant women regardless of risk factors. However, implementation in many Southeast Asian countries is still limited due to logistical and financing constraints. Kaur et al. (2022) found that the universal coverage of GDM screening in Southeast Asia has only reached 46%, far from the 80% target set by the WHO. As a result, most cases of GDM are only detected after the onset of obstetric complications such as preeclampsia, macrosomy babies, or premature delivery. This condition shows a serious gap between global policies and local practices in efforts to prevent GDM.

In addition, the age factor also has complex interactions with other variables such as obesity and family history of diabetes. A study by Zhao et al. (2023) in The Lancet Diabetes & Endocrinology showed that the risk of GDM increases exponentially when the maternal age >35 years is accompanied by a

body mass index of ≥25 kg/m². This means that age factors are not a single determinant, but rather part of a spectrum of metabolic risk that interact with each other. Therefore, in the design of GDM prevention programs, early identification of a combination of risk factors is an important step to reduce prevalence.

The policy implications of these findings are quite clear: increasing maternal age requires adjustments to maternal health care policies, especially at the primary service level. The implementation of pre-pregnancy education and nutrition counseling must be prioritized for women of childbearing age who are delaying pregnancy. Community-based interventions, such as the integration of GDM early detection with the Posyandu or antenatal class program, can expand the range of services without increasing the burden on the health system (Ministry of Health of the Republic of Indonesia, 2023). In addition, strengthening the capacity of health workers to conduct screening and follow-up examination results is the key to the success of early detection of GDM in the field.

Overall, data analysis from Southeast Asia shows that maternal age is the dominant risk factor for GDM, both biologically and socially. Consistent patterns of increased risk across age groups suggest the need for population-based policies for GDM screening and prevention. Taking into account the demographic context and the shift in the age of marriage in the region, maternal health programs should be geared towards primary prevention targeting women of young reproductive age before the first pregnancy. This effort is not only to reduce the incidence of GDM, but also to prevent the long-term metabolic impact on the mother and child resulting from the complications of gestational diabetes.

Interaction of Maternal Age and Parity on Gestational Diabetes Risk

The relationship between maternal age and parity with gestational diabetes risk (GDM) is not independent, but forms a mutually reinforcing dual interaction in influencing the metabolic susceptibility of pregnant women. A number of studies in the Southeast Asian region show that the combination of advanced maternal age and high parity significantly increases the likelihood of developing glucose intolerance during pregnancy. According to a study by Nguyen et al. (2022) involving 12,430 pregnant women in four Southeast Asian countries, the risk of GDM increased almost threefold in mothers over 35 years of age with parity of ≥3 compared to the age group under 30 years old who were pregnant for the first time. These findings are reinforced by Shafqat et al. (2023), who identified the cumulative effects of recurrent pregnancies on insulin sensitivity, especially in older women where pancreatic β cell function has physiologically declined.

Biologically, the interaction between age and parity can be explained through the mechanisms of cumulative metabolic stress. Each pregnancy triggers complex metabolic adaptations to meet the energy needs of the fetus, including a temporary increase in insulin resistance. However, in mothers with

high parity, this adaptation cycle repeats many times without a full recovery to glucose homeostasis, thus gradually degrading the compensatory ability of the pancreas (Zhu et al., 2023). When the condition occurs in advanced maternal age, the decline in β cell function becomes more pronounced due to aging processes and oxidative stress, resulting in synergistic effects that exacerbate the risk of GDM. WHO SEARO (2022) calls this phenomenon cumulative metabolic burden, which is a state in which the metabolic load of repeated pregnancies accelerates age-related endocrine dysfunction.

In addition to biological factors, social and behavioral dimensions also strengthen these interactions. Mothers with high parity often face economic challenges, chronic burnout, and limited access to health services, all of which can hinder early detection of GDM. In the Indonesian context, for example, data from Riskesdas (Ministry of Health of the Republic of Indonesia, 2023) shows that the coverage of blood glucose level checks is decreasing as the number of children increases. In mothers with three or more children, only about 41% underwent complete GDM screening, compared to 63% in mothers with one child. This condition indicates the presence of a structural dimension in which social factors reinforce the physiological effects of high parity and old age. Ramos et al. (2021) also found that in the Philippines, multipara mothers at the age of ≥35 years tend to consider blood sugar testing not a priority due to economic and cultural factors, especially in rural areas. As a result, many cases of GDM are only detected after obstetric complications appear.

Another factor that strengthens the age-parity interaction is the pattern of interpregnancy weight gain. Research by Yoo et al. (2022) in South Korea showed that women who experienced a weight gain of >5 kg between two pregnancies had a 2.3 times higher risk of GDM in subsequent pregnancies, especially at the age of over 35 years. These findings are relevant to Southeast Asian populations, where post-pregnancy weight gain tends to be poorly controlled due to a lack of nutrition education and physical activity. A similar pattern was also observed by Mulla et al. (2022), who explained that the accumulation of visceral fat due to repeated pregnancies strengthens insulin resistance and subclinical inflammation. Thus, the interaction between age and parity is not only hormonal, but also influenced by changes in body composition and post-pregnancy life behavior.

From an epidemiological perspective, the synergistic relationship between maternal age and parity with GDM shows a clear dose-response pattern. Bashir et al. (2022) reported that the prevalence of GDM increased from 9% in women aged 25–29 years with low parity to more than 22% in women aged ≥35 years with parity ≥3. This correlation remained significant even after controlling for BMI and family history of diabetes. A similar pattern was found by Nguyen et al. (2022) in Southeast Asia and WHO (2023) in their global report, which suggests that age and parity factors have an additive interaction effect, rather than simply independent. This means that the risk of GDM increases faster when both factors are present at the same time than if only one of them is present.

In the context of public health policy, these findings have important implications for early detection and prevention strategies for GDM. A universal screening approach needs to be balanced with a risk assessment mechanism based on a combination of maternal factors. Antenatal care programs in developing countries often still use a one-dimensional approach, i.e. only assessing age or parity separately. In fact, composite indicator-based risk prediction models that take into account age, parity, BMI, and family history of diabetes have been shown to be more effective. A study by Kaur et al. (2022) showed that the application of multiple risk-based screening models increased the early detection of GDM by up to 31% compared to conventional methods.

This approach also supports more preventive reproductive health policies. The Government of Indonesia through the Ministry of Health (2023) has integrated GDM screening into the Continuum of Care program for high-risk pregnant women, but its implementation is still limited in urban areas. To overcome this, WHO (2023) recommends the involvement of community midwives and health cadres in the implementation of simple blood glucose tests, especially in rural areas. By strengthening community-based screening networks, older multi-age mothers can be identified early and receive timely nutrition and education interventions.

Furthermore, the integration of age-parity analysis results into digital health information systems can help develop predictive analytics for GDM prevention. The use of data-driven maternal health apps allows for automatic detection of high-risk mothers based on age and the amount of parity registered in the system. This approach has been tested in Thailand and Malaysia with promising results (WHO SEARO, 2022). This strategy aligns with the trend of precision public health, where technology is used to personalize prevention and improve the efficiency of public health interventions.

Thus, the interaction between maternal age and parity with GDM risk must be understood as a multidimensional phenomenon, influenced by biological, behavioral, and structural factors. Age factors increase physiological susceptibility, while parity strengthens the cumulative metabolic load and weakens the body's readiness for pregnancy stress. The combination of the two forms a significant dual risk, especially in Asian populations with a genetic predisposition to insulin resistance. Prevention and early detection efforts must consider these two variables simultaneously, rather than separately, so that pre-pregnancy screening and education policies can be more targeted. In the context of Southeast Asia, which is facing a demographic and epidemiological transition, this holistic approach is key in reducing the burden of GDM and its long-term impact on maternal health and the next generation.

Public Health Implications and Maternal Risk-Based GDM Prevention Strategies

Research findings on the association between maternal age and parity on gestational diabetes risk (GDM) have strategic implications for public health policy, especially in the context of prevention and early detection of pregnancy

complications. In many developing countries, including in the Southeast Asian region, the rapidly increasing burden of GDM suggests that conventional clinical-based approaches have not been sufficiently effective in reducing incidence rates. Therefore, there is a need for a more proactive, maternal risk-based, and integrated public health approach in the service system for pregnant women. Based on a World Health Organization report (2023), around 40% of GDM cases in developing countries go undiagnosed, especially in rural areas with limited access to laboratory tests. This shows the importance of reformulating policies from a curative paradigm to a preventive paradigm that places early detection and health promotion as top priorities.

One of the key strategies in the prevention of GDM is comprehensive risk-based screening, which takes into account maternal age, parity, body mass index (BMI), and family history of diabetes. This approach has been shown to be more efficient in identifying high-risk mothers than universal screening in resource-constrained areas. A study by Kaur et al. (2022) shows that the implementation of risk-based screening can reduce the missed diagnosis rate of GDM by up to 27% in primary health facilities in India and Malaysia. Although the WHO (2023) recommends universal screening, many Southeast Asian countries are adopting a hybrid approach that combines universal screening in urban and risk-based screening in remote areas. In Indonesia, this policy began to be implemented in the High-Risk Pregnant Women Examination Program (PIHRT), where village midwives use simple indicators such as age >30 years and parity ≥3 as early markers for further examinations (Ministry of Health of the Republic of Indonesia, 2023).

In addition to early detection, pre-pregnancy education and nutrition interventions play a central role in lowering the risk of GDM. Research by Wang et al. (2023) in The Lancet Global Health confirms that pre-conception education regarding balanced nutrition and weight control can reduce the incidence of GDM by up to 19% in high-risk populations. Community-based education programs have also proven effective, especially if they are carried out by local health workers who understand the socio-cultural context of the community. In Indonesia, the Pre-Conception Posyandu model piloted in East Nusa Tenggara was able to increase the knowledge of expectant mothers about age risk and parity to GDM by up to 35% (Ministry of Health of the Republic of Indonesia, 2024). This kind of education is important because many women in the 3T area do not yet have an understanding that pregnancy at an advanced age or with high parity carries greater metabolic risks.

Healthy lifestyle interventions are also an important pillar in GDM prevention strategies. Diets with a low glycemic index, high fiber consumption, and restriction of refined carbohydrates have been shown to lower insulin resistance during pregnancy (Zhu et al., 2023). On the other hand, moderate physical activity such as walking 30 minutes per day during pregnancy can reduce the risk of GDM by up to 25% (Shah et al., 2021). However, the implementation of lifestyle interventions is often hampered by social and economic factors. Many elderly pregnant women in Southeast Asia work in the

informal sector or have large household dependents, making it difficult to implement healthy lifestyle recommendations. For this reason, health policies need to integrate social approaches such as prenatal leave, nutrition support programs, and incentives for routine pregnancy check-ups for high-risk mothers.

From a macro policy perspective, the increasing prevalence of GDM shows the need for cross-sectoral integration between health services, education, and the economy in addressing social determinants. UNICEF (2023) and the World Bank (2023) highlight that economic and educational inequality contribute to low early detection of GDM in middle-income countries. Therefore, preventive interventions should be seen not only as the responsibility of the health sector, but also as part of broader social welfare policies. For example, nutrition-based social protection programs such as the Free Nutritious Meal Program and Food Assistance for Pregnant Women can help increase the nutritional intake of elderly women in high-risk areas. The integration of this kind of policy has been proven to reduce the number of pregnancy complications related to GDM in several provinces in Indonesia (Bappenas, 2024).

In addition, digital transformation in the health system opens up great opportunities to strengthen early detection and monitoring of maternal risk-based GDM. The electronic health record system enables the integration of age, parity, BMI, and medical history data to automatically generate GDM risk prediction algorithms. WHO SEARO (2022) reported the successful implementation of a similar system in Thailand and Malaysia that was able to increase screening coverage by up to 20% in the first two years. In Indonesia, the e-Maternal Health application developed by the Ministry of Health has begun to adopt a blood sugar check reminder feature for mothers over 30 years old or high parity. This digital approach strengthens precision public health, which is the use of data to target health interventions more efficiently and on target.

Overall, the results of this study confirm that maternal age and parity factors are not only clinically relevant, but also have a strong social dimension in the context of public health. The increase in the age of first pregnancy and the high rate of multiparity in Southeast Asia create a combination of risks that need to be anticipated through multi-level policies. Efforts to prevent GDM must begin from the pre-conception period through nutrition education, weight control, and promotion of reproductive health checkups. Community-based approaches, digitization of health systems, and integration of national nutrition programs are strategic steps to realize equitable early detection and prevention of GDM.

Thus, the success of GDM control is not only measured by the decrease in incidence rates, but also by the increased awareness and capacity of the health system to detect risks early. Through a combination of promotive, preventive, and policy digitalization strategies, it is hoped that the complex interactions between maternal age and parity can be managed effectively, so that future

generations are born healthier and avoid the long-term effects of gestational diabetes.

CONCLUSION

The results of this study show that maternal age and parity are two main determinants that interact with each other in increasing the risk of gestational diabetes (GDM) in the Southeast Asian region. Increased maternal age over 30 years and high parity (≥3 children) have been shown to reinforce the cumulative metabolic load leading to insulin resistance and pancreatic β cell dysfunction during pregnancy. The interaction of these two factors is not only biological, but also influenced by social dimensions such as limited access to antenatal services, low nutritional awareness, and economic inequality. This phenomenon further confirms that GDM is not only a clinical problem, but also a public health challenge that requires a cross-sectoral approach. In the context of Indonesia and Southeast Asia, the increase in the number of pregnancies in the elderly and the high degree of multiparity must be anticipated through policies that place early detection, pre-conception education, and equitable distribution of services as national strategic priorities.

Based on the results of the analysis, it is recommended that governments and stakeholders strengthen maternal risk-based GDM prevention strategies by integrating age and parity factors in the national screening system. Nutrition and healthy lifestyle education programs need to be expanded through a community approach, especially in areas with a high prevalence of multiparity. In addition, the implementation of maternal health digital transformation can be an effective solution to identify and monitor high-risk mothers in real-time. Preventive efforts must begin in the pre-pregnancy period through education, counseling, and empowerment of women of reproductive age to be able to manage metabolic risks before pregnancy. With a promotive, preventive, and data-driven approach, public health policies can play a significant role in reducing the prevalence of GDM, strengthening maternal and child health, and breaking the intergenerational diabetes risk chain in the Southeast Asian region.

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