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Risk Factors for Prediabetes among Women of Childbearing Age in DKI Jakarta (Analysis of SISKOHATKES Data 2023)

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Abstract

Background: *Prediabetes in women of childbearing age (15-49 years) is a serious health issue that can affect fertility, pregnancy, and long-term health. This study aims to identify the factors influencing the incidence of prediabetes among the Hajj pilgrims in DKI Jakarta.*

Method: *This cross-sectional study utilized data from the Integrated Hajj Health Information System (Siskohatkes) 2023, with a minimum sample size of 976. The study used Cox Regression analysis to determine the Prevalence Ratio (PR) and assess the association between independent and dependent variables at the multivariate level.*

Result: *In 2023, the prevalence of prediabetes among women of reproductive age in the Hajj pilgrims population in DKI Jakarta was 29.4%. Multivariate analysis indicated that High-Density Lipoprotein (HDL) cholesterol (Adjusted PR 1.33; 95% CI 1.00 – 1.78), triglycerides (Adjusted PR 1.38; 95% CI 1.08 – 1.77), and employment status (Adjusted PR 2.25; 95% CI 1.06 – 4.75) were associated with the incidence of prediabetes in this population.*

Conclusion: *These results underscore the necessity for special attention to risk factors such as HDL cholesterol, triglycerides, and job status in the prevention and management of prediabetes among women of childbearing age, particularly within the hajj pilgrim community.*

Keywords: *Hajj pilgrims, Prediabetes, Risk factor, Women of childbearing age*

INTRODUCTION

Prediabetes is defined by fasting blood glucose levels between 100–125 mg/dL or a two-hour postprandial glucose level between 140–199 mg/dL. Without appropriate intervention, prediabetes can progress to type 2 diabetes mellitus (T2DM) and increase the risk of cardiovascular diseases, including heart disease and stroke. Furthermore, prediabetes increases the risk of progression to type 2 diabetes mellitus.

The International Diabetes Federation (IDF) reported that in 2019, there were 373.9 million people worldwide with prediabetes (7.5% of adults aged 20–79 years), a figure projected to rise to 453.8 million (8.0%) by 2030 and 548.4 million (8.6%) by 2045. Indonesia ranks third globally in the prevalence of impaired glucose tolerance (IGT), with 29.1 million cases recorded in 2019.[2] Moreover, DKI Jakarta has the highest prevalence of diabetes in Indonesia, experiencing an increase to 3.4% between 2013 and 2018, making it the province most affected by diabetes.[3] The latest data from the 2023 Indonesia Health Survey shows that the prevalence of diabetes mellitus diagnosed by doctors among individuals aged ≥15 years in Indonesia remains highest in DKI Jakarta at 3.9%.[4] Futhermore, the prevalence among women (2.7%) is

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higher than among men (1.8%), indicating a greater burden of diabetes among women. Women have a greater likelihood of developing prediabetes due to physiological and hormonal factors that impact glucose metabolism. This suggest that individuals in Jakarta, particularly women, are at heightened risk.

Prediabetes in Women of Childbearing Age (WCA) (15–49 years) is a health concern that requires special attention due to its impact on fertility, pregnancy, and long-term health outcomes. Women with prediabetes have a higher risk of infertility and pregnancy complications, including preeclampsia, gestational diabetes, and low birth weight infants.[6] The estimated number of WCA in Indonesia reaches 72.7 million, making this demographic particularly relevant for public health interventions. Several risk factors contribute to the development of prediabetes and T2DM in WCA, such as age above 40 years, obesity (BMI >35), sedentary lifestyle, hypertension (>140/90 mmHg), low HDL cholesterol (<35 mg/dL), elevated triglycerides (>250 mg/dL), depression, and polycystic ovary syndrome (PCOS).[7] Given these risks, early detection and proper management of prediabetes are critical to maintaining the overall health of WCA.

Hajj pilgrims, particularly women, face unique health challenges due to lifestyle changes during the pilgrimage, including altered dietary patterns, changes in physical activity levels, and exposure to environmental stressors. Approximately two-thirds of Indonesian Hajj pilgrims fall into the high-risk category each year.[8] In 2023, the total number of Hajj pilgrims reached 221,000, with diabetes being among the ten most common diseases.[9] This condition poses a risk of exposure to complications, potentially affecting the pilgrims' ability to perform their religious duties optimally. Given these concerns, it is crucial to investigate further the factors influencing prediabetes among Hajj pilgrims in DKI Jakarta, enabling effective prevention and control measures to be implemented.

Although numerous studies have identified prediabetes risk factors in the general population, limited research has focused on specific subgroups, such as WCA, who are Hajj pilgrims. We hypothesize that metabolic (e.g., HDL cholesterol and triglycerides) and socio-demographic factors (e.g., employment status) are significantly associated with prediabetes among women of childbearing age in the Hajj pilgrim population of DKI Jakarta. Given these factors, this study aims to investigate the risk factors associated with prediabetes among WCA in the Hajj pilgrim population of DKI Jakarta. Understanding these risks will contribute to developing effective preventive measures and early interventions, particularly in populations with limited existing research. The study's novelty lies in its focus on a specific, high-risk population that has not been extensively examined in previous research.

METHODS

Participants and Study Design

This study used a cross-sectional design with secondary data sources from the Integrated Hajj Health Computerization System (SISKOHATKES) 2023, which is managed by the Ministry of Health of the Republic of Indonesia and is responsible for overseeing and managing the health information of pilgrims throughout Indonesia. Certified medical personnel at government-designated health facilities conduct routine health checks before Hajj departure, and data in this system are collected through these standardized medical examinations. Based on these conditions, the dataset appropriately addresses the study objectives. This study employed purposive sampling. Data completeness was checked from 5,615 records of DKI Jakarta pilgrims available in the SISKOHATKES database, after applying the inclusion criteria—female, aged between 15 and 49, and having complete fasting blood glucose test results—976 eligible samples were included in the analysis.

Measurements and Procedure

In this study, prediabetes was defined as fasting blood glucose levels between 100 and 125 mg/dL or 140 to 199 mg/dL two hours postprandial, according to the 2023 American Diabetes Association (ADA) standards. Metabolic factors such as blood pressure, high-density lipoprotein (HDL) levels, triglycerides, body mass index (BMI), low-density lipoprotein (LDL), and family history of diabetes mellitus were included in the independent variables analyzed in this study. The analysis also included socio-demographic elements, such as employment status and education level, and lifestyle elements, such as smoking and alcohol drinking habits.

High-density lipoprotein cholesterol was categorized as normal (≥40 mg/dL) or low (<40 mg/dL); triglycerides were categorized as normal (<150 mg/dL) or high (≥150 mg/dL); employment status was categorized as employed or unemployed; education level was categorized as high (senior high school or above) or low (below senior high school); body mass index (BMI) was categorized as obese (>27 kg/m²) or non-obese (≤27 kg/m²); central obesity was categorized as yes if waist circumference was ≥90 cm for women or ≥80 cm for men, and no if waist circumference was <90 cm for women or <80 cm for men; hypertension was categorized as no (if systolic blood pressure <140 mmHg and diastolic <90 mmHg) and yes (if diagnosed with hypertension by a doctor or having systolic blood pressure ≥140 mmHg and diastolic ≥90 mmHg); family history of diabetes mellitus was categorized as yes or no; LDL cholesterol was categorized as normal (<100 mg/dL) or high (≥100 mg/dL); smoking status was classified as smoker or non-smoker; and alcohol consumption was categorized as yes or no. To avoid bias in the study results, all variables with a p-value below 0.25 from the bivariate analysis were included in the multivariate analysis model to control for confounding factors.

Statistical Analysis and Ethical Clearance

The data were analyzed in three stages. First, the frequency distribution of sample characteristics was described through univariate analysis. Second, the Kaplan-Meier method was used to identify variables with a p-value below 0.25 for inclusion in the multivariate analysis model. Third, multivariate analysis was conducted using Cox Regression to determine the association between risk factors and prediabetes. This analysis aimed to estimate the Adjusted Prevalence Ratio (Adjusted PR) and its 95% Confidence Interval.

In this analysis, confounding tests were not performed, as the primary objective was identifying and predicting risk factors. Cox Regression was selected because it provides more precise estimates for outcomes with a prevalence greater than 10% compared to logistic regression. Additionally, the Prevalence Ratio (PR) is considered a more appropriate measure of risk than the Odds Ratio (OR) in cross-sectional studies. Although this study employed a cross-sectional design, Cox Regression remains applicable by assigning a constant value to the time variable (time = 1), thereby allowing for accurate estimation of PR. All statistical analyses were performed using statistical software. This study also obtained a letter of ethical review from the Health Research Ethics Commission (KEPK) of the Universitas Pembangunan Nasional "Veteran" Jakarta with letter number 2/I/2024/KEP.

RESULT

Table 1 shows that 689 women (70.6%) did not have prediabetes. The remaining 287 women (29.4%) had prediabetes. Based on Table 2, it is known that the family history of Diabetes Mellitus is 172 or 82.4%. It can be seen that women who suffer from hypertension are 25.3%, based on BMI who are not obese (≤27) by 42.5%, who do not smoke by 92.5%, do not consume alcohol by 92.5%, with normal LDL cholesterol (<100 mg/dl) by 18.6%, with normal HDL cholesterol (≥40 mg/dl) by 25.3%, with normal triglycerides (<150 mg/dl) by 27.9%, and with employment status, who work by 5.1%.

Table 1. Prevalence of Prediabetes

Variable	Frequency (N)	Percentage (%)
Prediabetes		
Yes	287	29.4
No	689	70.6

In Table 3, all independent variables were included in the multivariate model if the p-value was <0.25. The candidate variables for multivariate testing were BMI, hypertension, HDL cholesterol, triglycerides, education, and employment status. The variables tested in the multivariate analysis were BMI, hypertension, HDL cholesterol, triglycerides, education, employment status, and history of diabetes. The final modeling results of the multivariate Cox regression analysis are described in Table 4, showing that those with high triglycerides (≥150 mg/dl) had a 1.38 (95% CI 1.08-1.77) times higher risk of prediabetes

than those with normal triglycerides (<150 mg/dl), after controlling for HDL cholesterol and employment status.

Table 2. Frequency and Distribution of Prediabetes Risk Factors

Variable	Frequency (N)	Percentage (%)
Family History of Diabetes Mellitus		
Yes	172	82.4
No	804	17.6
Hypertension		
Yes	247	25.3
No	729	74.7
Body Mass Index (BMI)		
Obesity	561	57.5
No Obesity	415	42.5
Central Obesity		
Yes	976	100
No	0	0
Smoking Status		
Yes	73	7.5
No	903	92.5
Alcohol Drinking Status		
Yes	6	0.6
No	970	99.4
LDL-cholesterol		
Normal	182	18.6
High	794	81.4
HDL-cholesterol		
Normal	247	25.3
Low	729	74.7
Triglycerides		
Normal	702	71.9
High	274	28.1
Education Level		
High	272	27.9
Low	704	72.1
Employment Status		
Yes	50	5.1
No	926	949

Table 3. Bivariate Analysis Between Respondent Characteristics Prediabetics among Women of Childbearing Age

Variable	Prediabetes				Total		Crude PR (95% CI)	P-value
	No		Yes					
	N	%	N	%	N	%		
Family History of DM								
No	572	71.1	232	28.9	804	100	1.159	0.415
Yes	117	68	55	32	172	100	(0.813 - 1.653)	
Hypertension								
No	523	71.7	206	28.3	729	100	1.239	0.176
Yes	166	67.2	81	32.8	247	100	(0.908 - 1.690)	
Body Mass Index (BMI)								
Not Obese	308	74.2	107	25.8	415	100	1.360	0.033
Obesity	381	67.9	180	32.1	561	100	(1.025 - 1.804)	
HDL Cholesterol								
Normal	186	75.3	61	24.7	247	100	1.370	0.060
Low	503	69	226	31	729	100	(0.986 - 1.904)	
Smoking Status								
No	637	70.5	266	29.5	903	100	0.967	0.901
Yes	52	71.2	21	28.8	73	100	(0.571 - 1.637)	
Alcohol Drinking Status								
No	686	70.7	284	29.3	970	100	2.415	0.267
Yes	3	50	3	50	6	100	(0.485 - 12.039)	
LDL cholesterol								
Normal	126	69.2	56	30.8	182	100	0.923	0.654
High	563	70.9	231	29.1	794	100	(0.651 - 1.310)	
Triglyceride								
Normal	512	72.9	190	27.1	702	100	1.477	0.010
High	177	64.6	97	35.4	97	100	(1.096 - 1.990)	
Education Level								
High	200	73.5	72	26.5	272	100	1.221	0.211
Low	489	69.5	215	30.5	704	100	(0.893 - 1.671)	
Employment Status								
Working	43	86	7	14	50	100	2.663	0.014
Not Working	646	69.8	280	30.2	926	100	(1.183 - 5.991)	

Table 4. Final Model of Risk Factors for Prediabetics among Women of Childbearing Age

Variable	B	Standard Error	P-value	Adjusted PR	95% CI	
					Lower	Upper
HDL-cholesterol	0.287	0.146	0.049	1.333	1.001	1.775
Employment Status	0.809	0.383	0.035	2.245	1.060	4.754
Triglycerides	0.321	0.126	0.011	1.379	1.076	1.766

DISCUSSION

This study found that the prevalence of prediabetes based on fasting blood glucose levels among women of reproductive age among Hajj pilgrims in DKI Jakarta in 2023 was 29.4%. According to the 2023 Indonesia Health Survey.[4] The prevalence of prediabetes among individuals aged ≥15 years in Indonesia was 13.4%, while the prevalence among women in this age group was 11.5%. Another study conducted by Sari et al. found that the prevalence of prediabetes among young women in Denpasar, with an average age of 20.7 years and an age range of 18–25 years, was 38.1%. This indicates that the prevalence of prediabetes among women of reproductive age in Hajj pilgrims from DKI Jakarta is higher than both the national average and the prevalence among Indonesian women in general, but lower than the prevalence rate among young women in Denpasar.[10]

Based on multivariate analysis, HDL cholesterol levels were identified as a risk factor for prediabetes. This was demonstrated by an adjusted PR value of 1.33 (95% CI 1.00 – 1.78). Hajj pilgrims with low HDL cholesterol levels are 1.33 times more likely to develop prediabetes than those with normal HDL levels. These findings align with a study by Pratiwi et al., which reported a significant association between blood glucose and HDL cholesterol levels. Furthermore, Pratiwi et al. also demonstrated a significant negative association between blood glucose levels and HDL levels, indicating that higher blood glucose levels are associated with lower HDL levels.[11] Prediabetes and diabetes are complex conditions primarily involving dysfunction of pancreatic β-cells.[12] A decrease in HDL levels affects β-cells, which play a crucial role in the pathogenesis of prediabetes.[13] Pancreatic β-cell dysfunction due to dyslipidemia can lead to type 2 diabetes and serves as an independent risk factor for type 2 diabetes.[8]

Hajj pilgrims who are women of reproductive age with high triglyceride levels are at greater risk of developing prediabetes compared to those with normal triglyceride levels. This is evidenced by an adjusted PR value of 1.38 (95% CI 1.08 – 1.77), indicating that pilgrims with high triglyceride levels are 1.38 times more likely to develop prediabetes than those with normal triglyceride levels. This is consistent with a study by Hafid et al., which showed that prediabetes was most prevalent among individuals with high triglyceride levels.[14] Similarly, a study by Sumampouw also noted that prediabetes was more frequently observed in individuals with high triglyceride levels.[15] A study by Jasim et al. revealed that the triglyceride index increases the risk of prediabetes and diabetes progression, with an OR of 32.44 (95% CI: 4.43–237.54; P<0.001).[16] Several potential mechanisms may explain the association between the triglyceride/HDL ratio and prediabetes or type 2 diabetes. A recent study by Ma et al. identified a positive correlation between triglyceride levels and insulin resistance in individuals with standard glucose tolerance and a negative correlation with β-cell function in individuals with dyslipidemia.[17] This relationship may be mediated by the direct impact of triglycerides on insulin secretion and reduced levels of superoxide dismutase, a major antioxidant enzyme in the body, which increases oxidative stress and damages β-cells. When triglyceride/HDL levels are elevated, excessive triglycerides bind to insulin receptors, impairing receptor function, reducing insulin sensitivity, leading to insulin resistance, and eventually causing glucose intolerance and Diabetes.[18] Moreover, an increased TG/HDL-C ratio is associated with impaired glucose homeostasis and better predicts insulin sensitivity than classical lipid biomarkers. In this context, the TG/HDL-C ratio can serve as a valuable parameter linking four distinct conditions: inflammation, dyslipidemia, hyperglycemia, and atherosclerosis.[19]

In terms of employment status, women of reproductive age among Hajj pilgrims who are unemployed have a 2.25-fold higher risk of prediabetes than those who are employed. This is supported by an adjusted PR value of 2.25 (95%CI 1.06 – 4.75). A study conducted by Arania et al. found that unemployment is associated with reduced physical activity, leading to excess energy storage in the body, which may trigger obesity and subsequently increase the risk of prediabetes.[20] Another study by Funakoshi et al. reported that patients with type 2 diabetes who are unemployed have a higher likelihood of diabetes complications.[21] Research by Pazmino et al. also showed significant results for lower prediabetes risk among physically active individuals engaged in work and recreational activities between 18 and 64 years (OR = 0.33, 95% CI: 0.279 – 0.398).[22] Recently, it has been confirmed that physical activity reduces peripheral insulin resistance, particularly in trained prediabetic muscles.[23] These findings suggest integrating metabolic screening and socio-demographic assessments in pre-Hajj health evaluations. Public health interventions

should prioritize unemployed women of childbearing age for early prediabetes screening and lifestyle modification programs.

This study has several strengths. First, it focuses on identifying the determinants of prediabetes among women of reproductive age, a significant yet under-researched demographic group. Second, it highlights health aspects relevant to prediabetic conditions. Third, it provides novel insights into risk factors among women of reproductive age in the 2023 Hajj pilgrims from DKI Jakarta, a specific population rarely studied, emphasizing the prediabetes stage. This research can contribute to public health by enabling effective early interventions, potentially preventing the progression of type 2 diabetes. However, this study has limitations. The data are constrained by the availability of variables, leaving several other prediabetes risk factors unexamined.

Additionally, potential biases need to be considered. Selection bias may arise as the study sample consists solely of women of reproductive age who are Hajj pilgrims in DKI Jakarta, limiting generalizability to the broader population of women of reproductive age. Although the study population is specific to Hajj pilgrims in Jakarta, the findings may be relevant to other urban Muslim populations with similar demographic and health profiles. However, caution should be taken when generalizing results to non-pilgrim or rural populations. Information bias may occur in variables such as smoking status, alcohol consumption, and family history of diabetes mellitus, affecting the validity of the results. Recall bias may also compromise data accuracy if respondents provide incorrect information. Addressing these biases is critical, as they may lead to an overestimation or underestimation of the relationship between risk factors and prediabetes. Utilizing objective data from medical records can help mitigate these biases. Furthermore, the absence of missing values in data processing may result in overestimation or bias toward higher outcomes than actual conditions.

CONCLUSION

This study highlights that prediabetes is a significant health concern among WCA in the Hajj pilgrims of DKI Jakarta, with a prevalence of 29.4% in 2023. Key risk factors identified include low HDL cholesterol levels, high triglyceride levels, and employment status. These findings underscore the importance of targeted interventions that address both metabolic and socio-economic determinants of prediabetes in this high-risk population.

The implications of this study extend to public health strategies and policy-making. The findings suggest the necessity for routine metabolic screening, especially for HDL cholesterol and triglycerides, as part of the pre-Hajj medical assessment to identify at-risk individuals early. Additionally, integrating prediabetes prevention into community-based health programs, particularly those targeting WCA who are unemployed, can be an effective measure to mitigate disease progression. Future research should focus on longitudinal studies to track the progression of prediabetes in this population over time. Further exploration of lifestyle and dietary factors specific to the Hajj pilgrimage may provide deeper insights into additional risk factors. Strengthening health interventions before and after the pilgrimage is crucial to improving metabolic health outcomes for WCA in Indonesia.

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