



ANALYSIS OF DETERMINANTS OF TYPE 2 DIABETES MELLITUS: A LITERATURE REVIEW

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is a global health issue, with 537 million cases reported in 2021 and projected to increase to 783 million by 2045. Indonesia ranks fifth globally, with T2DM prevalence rising to 8.5% in 2018. The high number of cases and the risk of severe complications, such as heart disease, stroke, and kidney failure, underline the need for an in-depth study of risk factors to mitigate the disease's impact. Objective to further examine the determinants of Type 2 Diabetes Mellitus. This study employed a literature review approach using search engines such as Google Scholar, PubMed, ScienceDirect, and BMC with the keywords "Risk Factor" AND "T2DM." The reviewed articles are reputable and accredited, published within the last five years. From a total of 20 reviewed articles, the findings indicate that Type 2 Diabetes Mellitus is significantly associated with factors such as age, gender, hypertension, physical activity, family history of diabetes, obesity, smoking, cholesterol levels, fruit and vegetable consumption, and sweet food consumption. The determinants of Type 2 Diabetes Mellitus include physical activity, dietary patterns, family history of diabetes, BMI, smoking, age, gender, hypertension, and cholesterol levels.

Keywords: diabetes mellitus; determinants; type 2 diabetes mellitus

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INTRODUCTION

Along with the advancement of time, numerous changes have occurred in the structure of society, including industrialization, which has significantly influenced people's physical activity and dietary patterns. A simple reflection of this shift in physical activity can be seen in the tendency of individuals to use motorized vehicles for even short-distance travel instead of walking. Moreover, modern work routines often force individuals to spend most of their time indoors, thereby limiting opportunities for physical movement. In terms of dietary habits, fast food has become increasingly popular due to its practicality, taste, and affordability. Similarly, the consumption of sugar-sweetened beverages has also risen as part of current lifestyle trends. These behavioral changes collectively contribute to a greater risk of developing degenerative or non-communicable diseases in the future, one of which is diabetes mellitus.

Diabetes mellitus is a non-communicable disease characterized by impaired insulin utilization or insufficient insulin production. Insulin plays a crucial role in maintaining homeostasis by regulating blood glucose levels. Therefore, an inadequate amount of insulin results in impaired glucose metabolism, leading to glucose accumulation in the bloodstream, characterized by elevated blood sugar levels above the normal threshold (Astutisari et al., 2022). Based on its classification, diabetes mellitus is divided into two main types, Type 1 and Type 2. Type 1 Diabetes Mellitus occurs when pancreatic β -cells, which are responsible for insulin production, are destroyed by the body's immune system, a condition known as autoimmunity. In contrast, Type 2 Diabetes Mellitus arises from a decreased sensitivity of body tissues to insulin, leading to insulin resistance. Globally, Type 2 Diabetes Mellitus is more prevalent and represents the majority of diabetes cases (Priyanto et al., 2022).

Diabetes mellitus is one of the most prevalent non-communicable diseases worldwide. According to data from the International Diabetes Federation (IDF) in 2021, this chronic disease affected approximately 537 million adults globally. Notably, this number is projected to increase by 45%, reaching 783 million cases by 2045 (Santoso & Nurdiansyah, 2024). In the Southeast Asian region, there were an estimated 82 million cases in 2017, and the figure is expected to rise to 151 million by 2045 (Yunarlin et al., 2024). In addition, data from Infodatin indicate that diabetes mellitus cases are more prevalent in developing countries, including Indonesia.

In 2021, the International Diabetes Federation (IDF) ranked Indonesia fifth among the ten countries with the highest number of diabetes cases. The national prevalence increased from 6.9% in 2013 to 8.5% in 2018, indicating a continuing upward trend. With the number of people living with diabetes projected to reach 16 million, the risk of developing various comorbid conditions, such as stroke, cardiovascular diseases, kidney failure, and blindness, is also expected to rise. Moreover, vascular changes in the lower extremities may lead to diabetic foot complications caused by arteriosclerosis. Although genetic factors contribute to approximately a 4.6-fold increase in diabetes risk, several modifiable risk factors must also be addressed to prevent the onset of diabetes mellitus (Sari et al., 2024). According to Sanjaya and Setiawan (2024), the risk factors for Type 2 Diabetes Mellitus can be categorized into two groups: modifiable and non-modifiable factors. The non-modifiable factors include age, parity, and sex. In this context, parity refers to the presence of a family history of diabetes mellitus among first-degree relatives.

Although there is no clear consensus regarding which gender has a higher risk, studies conducted in the United States have suggested that women are more likely to develop diabetes mellitus compared to men. Furthermore, age is recognized as a significant risk factor, with individuals aged 45 years and above being more susceptible. However, an increasing number of cases have also been reported among younger adults aged 20–30 years, reflecting a concerning shift in the age distribution of the disease. Although there is no clear consensus regarding which gender has a higher risk, studies conducted in the United States have suggested that women are more likely to develop diabetes mellitus compared to men. Furthermore, age is recognized as a significant risk factor, with individuals aged 45 years and above being more susceptible. However, an increasing number of cases have also been reported among younger adults aged 20–30 years, reflecting a concerning shift in the age distribution of the disease.

Meanwhile, modifiable risk factors for Type 2 Diabetes Mellitus include Body Mass Index (BMI), smoking habits, hypertension, alcohol consumption, physical inactivity, and other lifestyle-related factors. Along with the increasing availability of various types of processed foods, dietary patterns have shifted toward meals high in sugar, fat, and salt. When such dietary habits are combined with insufficient physical activity, they can lead to obesity, particularly among individuals with a BMI greater than 23, who are classified as a high-risk group for diabetes mellitus (Rohmatika et al., 2024). Obesity and hypertension contribute to the development of insulin resistance, thereby increasing the risk of diabetes mellitus. Considering these issues, assessing the determinants of type 2 diabetes mellitus is essential for designing appropriate interventions across all age groups. Therefore, this article aims to further explore the determinants and risk factors of type 2 Diabetes Mellitus through a literature review of both national and international scientific publications.

METHOD

This study was conducted using a literature review design. According to Ridwan et al. (2021), a literature review is a research method that involves identifying, evaluating, and synthesizing relevant literature or written sources related to a specific topic or research problem. The reviewed sources may include various forms of written materials, such as articles, books, journals, and previously published documents, both national and international. The article search process was conducted using Google Scholar, ScienceDirect, PubMed, and BMC as search engines, with the

keywords “Risk Factor” AND “T2DM.” The inclusion criteria consisted of articles published in Indonesian or English within the past five years (2020–2024). For national publications, only journals indexed in SINTA (up to SINTA 4) were included. The exclusion criteria were articles with discussions deemed irrelevant to the study objectives. In total, 20 articles were analyzed, comprising 12 national and 8 international publications.

RESULT

Table 1.
Article Analysis

No	Title	Author	Year	Method	Sampel	Result
1.	Determinants of Type 2 Diabetes Mellitus in Hospitalized Patients at UPTDK Haji General Hospital Medan	Haryanti Sinaga, Rapotan Hasibuan, Nofi Susant	2024	case control unmatching	100 hospitalized patients at Haji General Hospital Medan: 50 cases and 50 controls	Age ($p = 0.044$, $OR = 2.471$), sex ($p = 0.005$, $OR = 3.500$), hypertension ($p = 0.009$, $OR = 3.160$), physical activity ($p = 0.016$, $OR = 2.912$), family history of DM ($p = 0.000$, $OR = 8.099$), BMI ($p = 0.045$, $OR = 2.447$), smoking status ($p = 0.054$, $OR = 2.087$), and cholesterol ($p = 0.021$, $OR = 2.923$) were found to be significantly associated with the incidence of T2DM.
2.	Determinants of Diabetes Mellitus at Sumberker Public Health Center, Biak Numfor Regency.	Febry Istyanto, Sophian Aswar, La Jumu	2024	Case control.	70 residents living in the working area of Sumberker Public Health Center: 35 cases and 35 controls	Anxiety (very strong, $r = 0.8219$), sleep quality (strong, $r = 0.6626$), and physical activity (moderate, $r = -0.5962$) were significantly associated ($p < 0.001$), contributing to 73.28% of the variance in the occurrence of Diabetes Mellitus ($F < 0.001$)
3.	Determinants of Diabetes Mellitus Among Residents in the Working Area of the Perdamaian Village Sub-Health Center.	Virgian Giranza, Ar Rum Nur Fachira, Rafiqoh Hasibuan, Tia Zahra Khairunnisa, Anasya Prananda, Romiza Atika	2024	cross-sectional.	379 residents of Perdamaian Village, Langkat Regency.	sweet food consumption ($p=0.000$; $POR=1.146$) and physical activity ($p=0.000$; $POR=1.076$) were significantly associated with the incidence of Diabetes Mellitus, whereas smoking habits ($p=0.883$; $POR=0.832$) demonstrated no significant association.
4.	Risk factors of early onset type 2 diabetes mellitus in young adults ≤ 40 years old	Burhan Gunawan, Soesilowati Soerachmad, Liana Dewi Hendrawan, Johana Titus, dan Vira Cendana	2024	cross-sectional	100 individuals registered at the Diabetes and Endocrinology Clinic of Sumber Waras Hospital	Smoking ($p=0.025$, $aOR=3.17$), hypertension ($p=0.000$, $aOR=2.48$), obesity ($p=0.000$, $aOR=5.11$), a history of excessive caloric intake ($p=0.000$, $aOR=3.40$), poor stress management ($p=0.025$, $aOR=2.33$), depression ($p=0.000$, $aOR=5.17$), short sleep duration ($p=0.023$, $aOR=2.72$), lack of physical activity ($p=0.000$, $aOR=6.14$), family history of T2DM ($p=0.000$, $aOR=6.29$), and family history of hypertension ($p=0.000$, $aOR=5.26$) were significantly associated with the

No	Title	Author	Year	Method	Sampel	Result
						incidence of prediabetes or Type 2 Diabetes Mellitus, with a family history of T2DM being identified as the most influential risk factor.
5.	Burden of type 2 diabetes mellitus and its risk factors in North Africa and the Middle East, 1990–2019: findings from the Global Burden of Disease study 2019	Nazli Namazi, Sahar Saeedi Moghaddam, Shahnaz Esmacili, Maryam Peimani, Yeganeh Sharifnejad Tehrani, Fatemeh Bandarian, Parnian Shobeiri, Ensieh Nasli-Esfahani, Mohammad-Reza Malekpour, Negar Rezaei, Nazila Rezaei, Babak Arjmand, Bagher Larijani, dan Farshad Farzadfar	2024	Population study	Residents from 21 countries included in the Global Burden of Disease (GBD) 1990–2019 database, stratified by age group, sex, and geographic location	Based on age-standardized analysis, there was an increase in the incidence and prevalence of T2DM per 100,000 population during the period 1990–2019. In addition, several modifiable risk factors were identified as major contributors to T2DM-related mortality, including high body mass index (56.4%), low physical activity (15.5%), and ambient particulate air pollution (20.9%).
6.	Determinants of type 2 diabetes mellitus in agricultural community	Fitria Saftarina, Dian Isti Angraini, Diana Mayasar	2023	case control	81 farmers in the working area of Gedong Tataan Public Health Center: 41 cases and 40 controls.	The determinants of T2DM among farmers in the working area of Gedong Tataan Public Health Center were family history of T2DM ($p=0.000$, $OR=16.03$), physical activity ($p=0.000$, $OR=4.154$), and pesticide exposure level ($p=0.027$, $OR=2.708$)
7.	Determinants of Type 2 Diabetes Mellitus at the Non-Communicable Disease Integrated Health Post (Posbindu PTM) of Pegandon Public Health Center, Central Kendal Regency.	Mar'atul Sarifah, Nur Siyam	2023	cross-sectional	95 participants of the Non-Communicable Disease Integrated Health Post (Posbindu PTM) in the working area of Pegandon Public Health Center from January to December 2021	Family history of diabetes ($p < 0.01$, $OR = 6.577$), physical activity ($p < 0.01$, $OR = 5.546$), fruit and vegetable consumption ($p < 0.01$, $OR = 6.889$), waist circumference ($p < 0.01$, $OR = 8.032$), obesity ($p < 0.01$, $OR = 4.547$), and hypertension ($p < 0.01$, $OR = 5.851$) were significantly associated with the incidence of Diabetes Mellitus in the working area of Pegandon Public Health Center, Kendal Regency, with hypertension identified as the most dominant risk factor.
8.	Determinants of Diabetes Mellitus in Young Adult	Nur Wahidah, Sri Ratna Rahayu	2022	cross-sectional	97 individuals aged 18–44	Total cholesterol level ($p = 0.01$, $PR = 0.21$), LDL level ($p = 0.04$, $PR = 0.25$), smoking status ($p =$

No	Title	Author	Year	Method	Sampel	Result
	Population				years who participated in the Indonesian National Basic Health Research (Riskesdas).	0.03, PR = 3.16), smoking intensity (p = 0.03, PR = 4.68), and sweetened beverage consumption (p = 0.04, PR = 2.87) were significantly associated with the incidence of Diabetes Mellitus among young adults in Indonesia.
9.	Determinant Factors of Diabetes Mellitus	Holis Tiawati, Thresya Febrianti	2022	Case control	138 participants of the Posbindu PTM at UPT Puskesmas Parung in 2019: 69 cases and 69 controls	smoking habits (p=0.778) and fruit and vegetable consumption (p=0.088) were not significantly associated with the incidence of Diabetes Mellitus, whereas physical activity (p=0.004; OR=2.947) showed a significant association with Diabetes Mellitus in the working area of Parung Health Center.
10.	Risk Factors For Diabetes Mellitus in Men of Productive Age In India (National Family Health Survey 2015-2016)	Maya Fernandya Siahaan, Trias Mahmudiono, Mahmudah, Soenarnatalina Melaniani, dan Syahfitri Wulandari	2023	cross-sectional	35,282 men in India who participated in the National Family Health Survey (NFHS-4).	Age (p=0.000), smoking habits (p=0.002), and economic status (p=0.000) were significantly associated with the occurrence of diabetes mellitus. Economic status in the wealthy category was the most dominant factor, with a higher risk of developing diabetes mellitus compared to other economic groups.
11.	Determinants of Type 2 Diabetes Mellitus Among Adults in Dill-Chora Referral Hospital, Dire Dawa, East Ethiopia	Tewodros Getnet Amara, Yibekal Manaye Tefera, Tameru Menberu, dan Aminu Mohammed Yassin	2022	unmatched case control	331 patients aged 18 or above who sought clinical care at DCRH outpatient departments: 113 cases and 218 controls	Smoking (p=0.015, AOR=3.15), frequency of physical activity (p=0.002, AOR=3.72), fruit consumption (p<0.001, AOR=5.28), additional salt use (p<0.001, AOR=5.52), waist-to-hip ratio (p<0.001, AOR=18.88), and serum triglyceride levels (p=0.007, AOR=2.93) were significantly associated with T2DM.
12.	The Risk Factors for Development of Type 2 Diabetes: Panasonic Cohort Study 4	Yuto Saijo, Hiroshi Okada, Masahide Hamaguchi, Momoko Habu, Kazushiro Kurogi, Hiroaki Murata, Masato Ito, dan Michiaki Fukui	2022	retrospective cohort conducted from 2008 to 2018.	46,001 Panasonic employees who underwent routine medical check-ups, of whom 3,208 developed diabetes mellitus during the observation period.	In the population with a BMI $\geq$ 25.0 kg/m ² , the risk factors contributing to diabetes mellitus were age, obesity, hypertension, hyperlipidemia, fasting plasma glucose (FPG) level, and smoking status. Similarly, in the population with 22.0 $\leq$ BMI < 25.0 kg/m ² , the risk factors were largely the same. However, in the population with BMI < 22.0 kg/m ² , the determinants were age, HDL cholesterol level, FPG level, smoking status, and eating speed.
13.	The risk factors of type 2 diabetes in hypertensive subjects	Yingqun Chen, Jiner Ma, Donghui Lu, dan Yefei Fang	2022	Case control matching based on age and sex	886 individuals with HTN and T2DM from the Department of Geriatrics	Creatinine (p=0.004, OR=1.013), duration of hypertension (p=0.024, OR=1.025), and a family history of T2DM (p<0.001, OR=5.119) were identified as risk factors for T2DM among hypertensive

No	Title	Author	Year	Method	Sampel	Result
					in Yuyao People's Hospital, Zhejiang, China: 443 cases and 443 control	subjects. In addition, respondents with diastolic blood pressure (DBP) ≥ 110 mmHg ($p=0.031$) had a 1.757-fold higher risk of developing diabetes mellitus, modified by sex ($p=0.037$).
14.	Incidence and Risk Factors for Progression to Diabetes Mellitus: A Retrospective Cohort Study	Min Kyung Hyun, Jong Heon Park, Kyoung Hoon Kim, Soon-Ki Ahn, and Seon Mi Ji	2022	Retrospective cohort	4,205,006 participants in the HEALS study who did not meet the exclusion criteria	The group with newly diagnosed diabetes mellitus tended to consist of older participants, females, active smokers, high-risk alcohol consumers, and participants with impaired fasting glucose (IFG), hypertension, dyslipidemia, and metabolic syndrome (p -values <0.0001).
15.	Assessment of the risk factors associated with type 2 diabetes and prediabetes mellitus: A national survey in Vietnam	Duong Huong Phan, Trang Thu Vu, Vu Tuan Doan, Toan Quang Le, Thanh Duc Nguyen, Minh Van Hoang	2022	cross-sectional	5244 vietnamese people aged 30-69 tahun	In the prediabetes group, the risk factors included sex, age, hypertension, and waist-to-hip ratio. In the diabetes group, the risk factors were sex, age, occupational status, and hypertension. Additionally, education level and BMI directly influenced the occurrence of both prediabetes and diabetes in both groups.
16.	Determinant Factors Associated with Type 2 Diabetes Mellitus in South Kalimantan: Analysis of the 2014 Indonesia Family Life Survey (IFLS 5) Data	Husda Oktavianoor, Ahmad Hidayat, St. Hateriah	2021	cross-sectional	588 residents aged ≥ 15 years living in South Kalimantan from the 2014 Indonesia Family Life Survey (IFLS) data	Age and occupational status ($p<0.001$, $POR=1.84$) were identified as risk factors for the occurrence of Diabetes Mellitus in South Kalimantan. Participants aged ≥ 45 years, 35–44 years, and 25–34 years were at higher risk of developing diabetes compared to those aged 15–24 years.
17.	Spatial Analysis and Risk Factors for Diabetes Mellitus Type II in Banjarbaru City	Hadrianti H D Lasari, Musafaah, Noor Laila Afifah, Yulia Mutmainnah, Jayanti Fitriyanti	2021	cross sectional	156 individuals with diabetes mellitus within the working area of the Banjarbaru City Health Office	There was a significant association between age and Diabetes Mellitus ($p=0.0001$). Whereas sex, marital status, occupation type, educational history, smoking status, BMI, waist circumference, and fruit and vegetable consumption were not significantly associated with Diabetes Mellitus.
18.	Evaluation of predominant risk factors for type 2 diabetes mellitus among out-patients in two Nigerian secondary health facilities	Chinonyerem O Iheanacho, Doyin O Osoba, Uchenna IH Eze	2021	cross-sectional	300 outpatients' department of two secondary health institutions in Ogun State	Sex, lifestyle factors such as physical activity and fruit and vegetable consumption, history of hypertension, family history of T2DM, education level, and BMI were influential risk factors for diabetes mellitus.

No	Title	Author	Year	Method	Sampel	Result
19.	Determinants of Type 2 Diabetes Mellitus at the Mawar Kuning Gambir Posbindu (Integrated Non-Communicable Disease Post)	Rofikoh, Sarah Handayani, Izza Suraya	2020	cross sectional	91 participants at the Mawar Kuning Posbindu PTM	Age ($p=0.017$, $PR=4.397$), physical activity ($p=0.000$, $PR=4.583$), history of diabetes mellitus ($p=0.000$, $PR=8.375$), and history of hypertension ($p=0.004$, $PR=3.298$) were significantly associated with the occurrence of diabetes mellitus.
20.	The Prevalence and Risk Factors of Type 2 Diabetes Mellitus (DMT2) in a Semi-Urban Saudi Population	Mohammed Abdullah Al Mansour	2020	cross sectional	353 Patients who attended primary health care centers (PHCCs) in Majmaah City	Age ($p<0.001$, $AOR=0.536$), BMI ($p=0.013$, $AOR=0.667$), HDL cholesterol ($p=0.012$, $AOR=1.540$), triglyceride levels ($p=0.004$, $AOR=0.654$), and total cholesterol ($p=0.016$, $AOR=2.109$) were significantly associated with diabetes mellitus.

DISCUSSION

The Association of Age, Sex, and Family History of Diabetes Mellitus with Type 2 Diabetes Mellitus

Among the determinants of diabetes mellitus, several factors fall into the non-modifiable category, namely age, sex, and family history of diabetes. According to Haryanti et al. (2024), age is significantly associated with the occurrence of diabetes. Individuals over 40 years of age are at higher risk, as glucose intolerance tends to increase at this stage. The β -cells of the pancreas, which are responsible for insulin production, decrease in number during the aging process. Baek and Kim (2021) reported that insulin resistance in older adults also occurs due to a 30% reduction in muscle cells affecting mitochondrial activity. This finding was similarly reported by Hadrianti et al. (2021) in Banjarbaru City. Meanwhile, sex appears to influence susceptibility, with females being more at risk. Hormonal decline during menopause leads to insulin resistance due to increased fat reserves. Females generally have a higher body fat composition, approximately 20–25% of total body weight, compared to males, who have 15–20%. In a study conducted in Nigeria, Chinonyerem et al. (2021) found that sex significantly affects the occurrence of diabetes mellitus.

Diabetes mellitus also frequently arises due to genetic factors transmitted through family history. Fachirah and Sari (2021) reported a significant association between family history of diabetes and the occurrence of DM. According to additional information from the CDC, individuals with a family history of diabetes have a 2–6 times higher risk of developing the condition. This finding aligns with the study by Rofiqoh et al. (2020) at the Mawar Kuning Gambir Posbindu. Recessive genes present in families with a history of DM are homozygous and associated with familial aggregation (Sinaga et al., 2024).

The Association of Physical Activity with Type 2 Diabetes Mellitus

Based on the literature review analysis, physical activity was identified as the most frequently reported risk factor significantly associated with the occurrence of diabetes mellitus. According to the study on determinants of DM in Eastern Ethiopia, individuals with low levels of physical activity had a 3.72-fold higher risk of developing diabetes compared to those who engaged in regular or frequent physical activity (Tewodros et al., 2022). In relation to sex, higher-intensity physical activity is generally more common among males, resulting in a lower risk of diabetes in men. Individuals with insufficient physical activity expend less energy than they consume, leading to positive energy balance stored in adipose tissue, which contributes to insulin resistance. Conversely, individuals who engage in regular physical activity benefit from enhanced glucose and fat metabolism and improved insulin efficacy, leading to reduced blood glucose levels and improved circulation. Holis and Thresya (2022) reported that individuals with low physical activity

have a 2.94-fold higher risk of developing diabetes mellitus compared to those with adequate physical activity. According to WHO recommendations, the suggested frequency of physical activity is 10 minutes per day for one week at moderate intensity, or 50 minutes per day for five days at higher intensity.

The Association of Body Mass Index (BMI) with Type 2 Diabetes Mellitus

Body Mass Index (BMI) is a simple method used to assess ideal body weight relative to height and is commonly applied to detect obesity risk. A BMI of less than 18.5 kg/m² is classified as underweight, a BMI of 25 kg/m² or higher is considered overweight, and a BMI of 30 kg/m² or higher is defined as obesity (Aprisuandani et al., 2021). In the study by Sarifah and Siyam (2023), individuals with obesity had a 4.547-fold higher risk of developing diabetes mellitus compared to non-obese individuals. Obesity is also associated with increased waist circumference, as waist circumference serves as a marker of fat distribution, particularly visceral fat, characterized by abdominal protrusion and a wider waist. Excessive fat accumulation can affect blood glucose levels, thereby contributing to insulin resistance.

The Association of Cholesterol Total and Hypertension with Type 2 Diabetes Mellitus

According to Mansour (2020), individuals with high cholesterol levels have a 2.109-fold higher risk of developing diabetes mellitus compared to those with normal cholesterol levels. Excess body fat can induce insulin resistance in muscle and adipose tissue through increased free fatty acids (Ahmed et al., 2021). Moreover, excessive fat resulting from an imbalance between caloric intake and energy expenditure is associated with obesity, which is also a risk factor for diabetes mellitus. Regarding cholesterol, elevated low-density lipoprotein (LDL) levels further increase the risk of developing diabetes mellitus. The arterial walls are more prone to damage when LDL adheres to the arteries. When lipoproteins are glycosylated by glucose, LDL coated with sugar remains longer in the bloodstream, leading to plaque formation and blood flow obstruction. Consequently, insulin action in the pancreas and muscle is impaired, ultimately contributing to diabetes (Rahayu et al., 2020).

In type 2 diabetes mellitus, hypertension and diabetes share similar pathogenic pathways, such as insulin resistance and oxidative stress, which interact and influence each other, making hypertension closely associated with the occurrence of diabetes. Additionally, metabolic syndrome components, including dyslipidemia, obesity, and hyperglycemia, are manifestations of hypertension and are strongly related to an increased risk of cardiovascular disease. According to Zefyang et al. (2022), hypertension is one of the causes of microvascular and macrovascular complications in diabetes mellitus. Individuals with hypertension have a 3.160-fold higher risk of developing diabetes mellitus compared to those without hypertension (Haryanti et al., 2024).

The Association of Dietary Patterns and Smoking Status with Type 2 Diabetes Mellitus

The dietary patterns examined in this study include fruit and vegetable consumption as well as intake of sweet foods and beverages. In a study by Sarifah and Siyam (2023) in Kendal Tengah Regency, individuals with low fruit and vegetable intake had a 6.889-fold higher risk of developing diabetes mellitus compared to those with adequate consumption. Regular intake of 300 grams of fruit per day can reduce the risk of DM by up to 8.2%, and similarly, consuming up to 300 grams of vegetables daily can lower DM risk by 9% (Li et al., 2022; Sarifah and Siyam, 2023). Sugar plays a role in maintaining the body's energy balance; however, excessive and frequent sugar consumption can be harmful. Individuals who habitually consume sweet foods have a 1.146-fold higher risk of developing diabetes compared to those who do not (Giranza et al., 2024). When glucose intake exceeds the body's requirements, blood glucose levels increase, serving as a marker of prediabetes or diabetes mellitus. Furthermore, smoking status is considered a determinant of DM occurrence. Smokers have a 3.16-fold higher risk of developing diabetes compared to non-smokers (Wahidah and Rahayu, 2022). Several mechanisms explain this association. First, active smokers experience

systemic effects such as systemic inflammation, oxidative stress, and endothelial dysfunction (Kotlyarov, 2023). Second, nicotine in cigarettes exerts toxic effects on pancreatic β -cells (Pitoy et al., 2024). Third, central adiposity, associated with inflammation and insulin resistance, is more common among smokers (Wahidah and Rahayu, 2022). According to Nurjannah and Asthiningsih (2023), active male smokers may experience a 10–40% reduction in glucose absorption function, which results from cellular functional impairment.

CONCLUSION

Based on a review of several national and international articles, it can be concluded that the determinants of diabetes mellitus occurrence include age, sex, family history of diabetes mellitus, physical activity, cholesterol levels, hypertension, body mass index (BMI), dietary patterns, and smoking status.

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