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Bibliometric Analysis of Factors Associated with the Incidence of Type 2 Diabetes Mellitus

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ABSTRACT

Diabetes mellitus is a chronic disease caused by the pancreas's inability to produce sufficient insulin or the body's inability to use the insulin produced effectively (insulin resistance). The onset of diabetes mellitus is caused by several factors, including age, physical activity, genetic factors, metabolic factors, obesity, diet, smoking, alcohol consumption, and psychological factors. The purpose of this literature review is to identify factors associated with the incidence of type 2 diabetes mellitus. This literature review was conducted by searching published results in the Google Scholar, ProQuest, and PubMed databases from 2022 to 2026 using the PRISMA method. The search terms used were "factors AND incidence AND Type 2 Diabetes Mellitus." The search identified 15 articles that met the inclusion criteria. In conclusion, factors influencing the incidence of type 2 diabetes include age, gender, occupation and socioeconomic status, family history of diabetes, Body Mass Index (BMI) and obesity, dietary patterns, physical activity, hypertension, dyslipidemia and cholesterol levels, blood glucose and metabolic factors, sleep duration, smoking, alcohol consumption, knowledge, and psychological factors/depression.

KEYWORDS: factors, incidence, type-2 diabetes mellitus

ARTICLE DETAILS

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A. INTRODUCTION

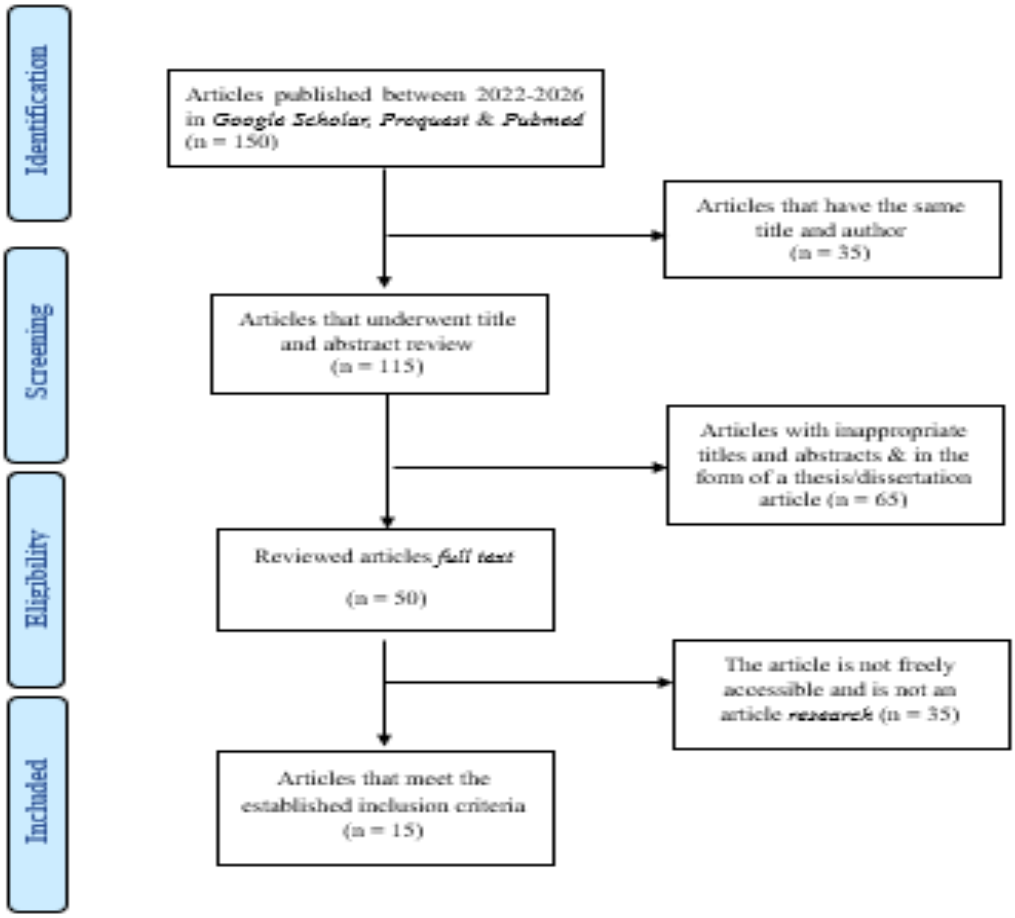
Diabetes Mellitus (DM) is a chronic disease that occurs because the pancreas cannot produce sufficient amounts of insulin or the body cannot use the insulin produced effectively (insulin resistance) (Sibony *et al.*, 2024). DM is one of the main health problems in the world with a prevalence that continues to increase and has an impact on high rates of morbidity, disability and mortality (Ariyani *et al.*, 2024). DM also has a negative impact on life productivity, requires lifelong care, high treatment costs, and reduces the patient's quality of life (Dyanneza, Ardyanto and Prabowo, 2022). The prevalence of DM reaches 830 million people in the world and causes 2 million deaths every year (WHO, 2025). The prevalence of DM in Indonesia will reach 11.7% in 2024 (Perkeni, 2024).

DM is a public health problem that is of concern because it requires lifelong care, high treatment costs, reduces productivity and quality of life of patients, and increases morbidity and mortality (Dyanneza, Ardyanto and Prabowo, 2022). The increase in the incidence of DM is influenced by various factors, such as unhealthy eating patterns, lack of physical activity, obesity, family history, age, and psychological stress conditions (Febriani *et al.*, 2023). Type II diabetes mellitus affects 90% of all DM sufferers. The primary indicator of successful management of type 2 DM is stable blood sugar levels, as elevated blood glucose levels (hyperglycemia) indicate suboptimal disease control (Gayatri *et al.*, 2021). Hyperglycemia is characterized by a random blood glucose level of ≥200 mg/dL or a fasting blood glucose level of ≥126 mg/dL (Syokumawena, Mediarti and Agustini, 2024). Long-term hyperglycemia will increase the risk of various complications, such as cardiovascular disease, nephropathy, retinopathy, neuropathy, and even increase the risk of death (Andriani and Hasanah, 2023b). This shows that controlling blood sugar levels is the main goal in managing DM (Suryanti *et al.*, 2025). Factors that influence blood sugar levels include age, physical activity, body mass index, diet, adherence to medication, and psychological factors such as stress levels (Ekasari and Dhanny, 2022).

B. METHOD

This literature study uses the Literature Review (LR) method, a systematic and clear literature study that collects, identifies, and evaluates existing research data. The purpose of this literature review is to identify factors associated with the incidence of type 2 diabetes. The literature review process was conducted by searching electronic databases such as Google Scholar, Proquest, and PubMed. The search was limited to articles published between 2022 and 2026. The keywords used by the author were "factors," "incidence," and "Type 2 Diabetes Mellitus."

The inclusion criteria established in this literature review process were: 1) articles focusing on factors related to the incidence of type 2 diabetes in Indonesia and globally, 2) full-text articles published between 2022 and 2026, 3) articles written in both Indonesian and English, and 4) research articles. Exclusion criteria: 1) articles in the form of theses or dissertations, 2) articles that are not freely accessible. Journal selection in writing this literature review used the Preferred Reporting Items For Systematic Reviews And Meta-Analyses (PRISMA) method, which is presented in the following diagram:



Picture 1. Alur *Literatur review* with the PRISMA method

C. RESULTS

A literature review was conducted on 15 articles. The publication years were between 2022-2026. The results of the journal analysis are presented in Table 1 as follows:

Tabel 1. Hasil Analisis Jurnal

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
1	Farhadipour *et al* (2022)	*Evaluation of the Risk Factors for Type 2 Diabetes Using the Generalized Structure Equation*	Iran	Exploratory research with *cross-sectional* design	The research sample consisted of 9975 residents aged ≥ 35 years (1,736	The results showed that risk factors such as BMI (impact coefficient 0.010), triglycerides (0.005), hypertension (0.086), and high cholesterol levels (0.005) directly affected DM status (P < 0.001). Meanwhile,

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
		Modeling in Iranian Adults based on Shahedieh Cohort Study			respondents suffering from type 2 diabetes mellitus & 74,431 non-type 2 diabetes mellitus respondents).	BMI and triglycerides acted as mediators in this case, while high-density lipoprotein (HDL) cholesterol, physical activity (-0.23), and diet (0.001) indirectly affected DM status.
2	Duan *et al.*, (2022)	Lifestyle Patterns and Incident Type 2 Diabetes in the Dutch Lifelines Cohort Study	Belanda	Research *cohort-retrospective*	The research sample was 61,869 people aged 35-65 years.	The study results showed that of the 61,869 participants analyzed, 900 cases of type 2 diabetes were identified during the follow-up period (205,696 person-years; incidence rate 4.38 per 1,000 person-years). The unhealthy lifestyle group had the highest risk of type 2 diabetes (HR 1.51 [95% CI 1.24; 1.85]), followed by the "poor diet and low physical activity group" (HR 1.26 [95% CI 1.03; 1.55]). The "high-risk alcohol drinkers" and the "physically inactive/sedentary group" (characterized by excessive TV viewing) did not show a significantly increased risk.
3	Lasmawati, Putri and Nuryani (2023)	Analysis of Factors Associated with the Incidence of Type 2 Diabetes Mellitus	Indonesia	Analytical quantitative research with *cross-sectional design*	The research sample consisted of 180 respondents.	The results showed a significant association between family history of diabetes (p-value 0.000), knowledge (p-value 0.000), nutritional status (p-value 0.000), and physical activity (p-value 0.000) with the incidence of type 2 diabetes. There was no significant association between fruit and vegetable consumption (p-value 0.186) and smoking (p-value 0.219). The most dominant variable influencing the incidence of type 2 diabetes was family history of diabetes with an OR of 21.393, followed by obesity with an OR of 16.3.

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
4	Darmawanti, (2024)	Determinants of Type 2 Diabetes Mellitus Cases in the Seribu Islands Regency, Jakarta Province, in 2023	Indonesia	Analytical observational research with a *case-control study design*	The research sample consisted of 658 respondents (329 respondents in the case group and 329 respondents in the control group)	The results of the study showed that the determinant factors that have the potential risk of causing Type 2 DM are age, occupation, body mass index, history of diabetes and sugar consumption excessive. The variable with the highest risk was a history of diabetes (odds ratio [OR] 49.346 [95% CI 25.2–96.3]). The variable with the highest risk was a history of diabetes (odds ratio [OR] 49.346 [95% CI 25.2–96.3]).
5	Kurniawan *et al* (2024)	*Lifestyle and Clinical Risk Factors in Relation with the Prevalence of Diabetes in the Indonesian Urban and Rural Populations : The 2018 Indonesian Basic Health*	Indonesia	Analytical quantitative research with *cross-sectional design*	Respondents aged ≥15 years with available blood glucose data (n urban = 17,129, n rural = 16,585)	Urban residents in Indonesia have lower levels of physical activity, a lower proportion of adequate fruit and vegetable intake, and a higher prevalence of obesity than rural residents. The prevalence of diagnosed diabetes is twice as high in urban residents as in rural residents (3.8% compared to 1.9%). Physical activity is associated with a lower risk of diabetes, especially in urban residents [prevalence OR (95% CI): 0.91 (0.85; 0.98) for urban residents and 0.94 (0.89; 1.00) for rural residents]. Obesity, hypertension, and dyslipidemia are risk factors for diabetes in both population groups.
6	Maskarinec *et al* (2024)	*Risk Factors for Type 2 Diabetes in the Multiethnic Cohort*	America	Prospective *cohort study*	The research sample consisted of 172,230 respondents aged 45-75 years	The results showed that overall, 46,500 (27%) participants were diagnosed with type 2 diabetes (T2D) after a mean follow-up period of 17.1 ± 6.9 years. All predictors were significantly associated with T2D: overweight (HR=1.74), obesity (HR=2.90), red meat intake (HR=1.15), short (HR=1.04) and long (HR=1.08) sleep duration, and smoking (HR=1.26) predicted a significantly higher incidence of T2D; conversely, coffee (HR=0.90) and alcohol (HR=0.78) consumption,

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
						physical activity (0.89), and diet quality (0.96) were associated with a lower incidence of T2D.
7	Yahya, Arsunan and Ayu (2024)	Risk Factors for Type II Diabetes Mellitus in Adolescents at Layang Community Health Center and Antara Community Health Center	Indonesia	Case Control Study	The research sample consisted of 132 adolescents (66 in the case group, namely adolescents with DM & 66 in the control group, adolescents who did not have DM)	The results showed that risk factors for diabetes mellitus were BMI (OR 2.38, 95% CI 1.11-5.08), diet (OR 4.96, 95% CI 1.98-13.2), physical activity (OR 5.14, 95% CI 1.90-15.2), and family history (OR 5.89, 95% CI 2.54-13.9), while gender was not a risk factor (OR 1.06, 95% CI 0.51-2.23).
8	Crowther, Ramsay and Norris (2025)	*Incident Type 2 Diabetes and its Risk Factors in Men and Women Aged 40–60 Years from Four Sub-Saharan African Countries: Results from the AWI-Gen Study*	Africa	This study uses a longitudinal/prospective design.	The research sample consisted of 6,553 participants aged 40–60 years.	The results showed that during the observation period, the overall incidence of type 2 diabetes mellitus among study participants was 14.6 cases per 1,000 people/year, with a 95% CI of 13.4–16.0. There were significant differences in incidence based on the study region. South Africa had the highest incidence of type 2 diabetes, at 21.8 cases per 1,000 person-years (95% CI 19.5–24.4). Conversely, West Africa had the lowest incidence, at 5.5 cases per 1,000 person-years (95% CI 4.4–6.9). These findings suggest that the incidence of type 2 diabetes in sub-Saharan African populations varies across regions. The analysis results showed several factors associated with an increased incidence of diabetes, namely random glucose levels (aOR 1.37), male gender (1.32), family history of diabetes (1.22), hypertension (1.21), unemployment (1.19), BMI (1.03), and waist

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
						circumference (1.02). Conversely, sufficient physical activity was associated with a lower risk (aOR 0.87). Thus, metabolic factors, individual characteristics, social factors, and lifestyle factors play a role in the incidence of type 2 diabetes in the 40–60 year old population.
9	Sirait *et al.*, (2025)	*Analysis Determinants of Type 2 Diabeters Mellitus : A Case Control Study*	Indonesia	Analytical observational research using a *case-control design*	The research sample of DM 2 sufferers was 138 respondents (case group: 46 respondents, control group: 92 respondents)	Chi-square test results showed that factors significantly associated with the incidence of type 2 diabetes included diet (p-value = 0.001 with an OR = 4.7 (95% CI: 2.231–10.154), knowledge (p-value = 0.033 and an OR = 2.3 (95% CI: 1.129–4.785), physical activity (p-value = 0.010 and an OR = 2.8 (95% CI: 1.342–6.032), and hypertension (p-value = 0.000 and an OR = 4.9 (95% CI: 2.089–11.784). Logistic regression analysis showed that hypertension was the most dominant factor associated with the incidence of type 2 diabetes, with a p-value = 0.000 and an OR = 7.3 (95% CI: 2.581–20.680).
10	Seleky *et al.*, (2025)	Risk Factor Analysis for Type 2 Diabetes Mellitus in the Miroto Community Health Center Work Area, Semarang City	Indonesia	Analytical quantitative research with *cross-sectional design*	The research sample consisted of 107 patients aged ≥30 years.	A history of hypertension is the factor with the highest Prevalence Odds Ratio (POR) value, namely 11.389, making it the factor with the strongest relationship to the incidence of type 2 diabetes. Physical activity of less than 30 minutes has a POR value of 8.167, while smoking habits have a POR of 2.688.
11	Wang *et al.*, (2025)	*Predicting Incident Type 2 Diabetes in a Japanese Cohort : an 8-Year Analysis of the NAGALA Database*	Jepan	This study uses a longitudinal/prospective design.	The research sample was 15,464 people (with a male proportion of 54.5% and an average age	The results showed that during a mean follow-up period of 2207.82 ± 1379.73 days, 262 patients (1.7%) experienced the onset of type 2 diabetes mellitus. After accounting for confounding variables, we

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
					of 43.71 ± 8.90 years)	found that age (HR=1.03; 95% CI 1.01–1.04; P=0.001), waist circumference (HR=1.05; 95% CI 1.03–1.06; P<0.001), alanine transaminase (HR=1.01; 95% CI 1.00–1.01; P=0.045), glycated hemoglobin (HbA1c) (HR=24.30; 95% CI 15.69–37.63; P<0.001), fasting plasma glucose (HR=1.10; 95% CI 1.07–1.12; P<0.001), fatty liver disease (HR=1.86; 95% CI 1.37–2.53; P<0.001), current smoking (HR=1.61; 95% CI 1.16–2.23; P=0.004), and heavy alcohol consumption (HR=1.79; 95% CI 1.06–2.99; P=0.028) were identified as independent risk factors for type 2 diabetes. High-density lipoprotein cholesterol (HDL-C) showed a protective effect (HR=0.98; 95% CI 0.97–1.00; P=0.010).
12	Thahara and Iriani (2026)	*Factors Associated with Diabetes Mellitus among Adults Aged ≥ 25 Years in DKI Jakarta : Analysis of the Indonesian Health Survey 2023*	Indonesia	Analytical quantitative research with *cross-sectional design*	The research sample consisted of 6,185 respondents aged ≥25 years who resided in DKI Jakarta.	The results showed that several factors were significantly associated with the incidence of diabetes mellitus (DM) in adults in Jakarta. Age had the strongest association in the initial analysis, with an OR of 21.99 (95% CI: 13.13–36.85; p<0.001). Gender was also significantly associated with the incidence of DM, with an OR of 1.63 (95% CI: 1.23–2.15; p=0.001). Education level showed an OR of 1.86 (95% CI: 1.20–2.90; p<0.001). Respondents with depression had an OR of 3.71 (95% CI: 1.81–7.58; p<0.001). Respondents with a history of hypertension had an OR of 5.05 (95% CI: 3.83–6.66; p<0.001). The results of the multiple logistic regression test showed that age remains the most dominant factor associated with the incidence of DM with an

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
						aOR of 16.081 with a 95% CI of 9.24–27.98 and p<0.001.
13	Rahmawati *et al.*, (2026)	Risk Factors for Type 2 Diabetes Mellitus in the Age Group ≥ 15 Years in DKI Jakarta Province: Analysis of 2023 SKI Data	Indonesia	Analytical quantitative research with *cross-sectional design*	The sample size was 24,454 respondents aged 15 years and above in DKI Jakarta Province	The results showed that factors significantly associated with the incidence of type 2 diabetes were age (p = 0.000, adjOR = 12.60; 95%CI: 5.83 – 27.22) and hypertension (p = 0.000, adjOR = 2.97; 95%CI: 2.05 – 4.30). Gender (p = 0.178, adjOR = 1.34; 95%CI: 0.87 – 2.06), central obesity (p = 0.237, adjOR = 1.28; 95%CI: 0.85 – 1.92), and physical activity (p = 0.760, adjOR = 1.06; 95%CI: 0.74 – 1.51) did not show a significant association with the incidence of type 2 diabetes. The results showed that factors significantly associated with the incidence of type 2 diabetes were age (p = 0.000, adjOR = 12.60; 95%CI: 5.83 – 27.22) and hypertension (p = 0.000, adjOR = 2.97; 95%CI: 2.05 – 4.30). Gender (p = 0.178, adjOR = 1.34; 95%CI: 0.87 – 2.06), central obesity (p = 0.237, adjOR = 1.28; 95%CI: 0.85 – 1.92), and physical activity (p = 0.760, adjOR = 1.06; 95%CI: 0.74 – 1.51) did not show a significant association with the incidence of type 2 diabetes.
14	Prasetya, Wardani and Isnaeni (2026)	Risk Factors for Type 2 Diabetes Mellitus in Patients in the Ampenan Community Health Center Work Area	Indonesia	Analytical observational study with *Case Control design.*	The sample size was 24 respondents from the Community Health Center patients (22 case groups and 22 control groups)	The results of this study showed that the risk factors associated with the incidence of Type 2 DM were family history (p=0.034; OR 4.667; 95% CI 1.229-16.761), obesity (p=0.034; OR 4.667; 95% CI 1.229-16.761), history of hypertension (p=0.032; OR 4.911; 95% CI 1.325-18.205) and age (p=0.047; OR 5.278; 95% CI 1.203-23.158). Factors not associated with the incidence of type 2 diabetes were gender (p = 0.759; OR 0.686; 95% CI 0.205-2.295)

No	Researcher name and year	Research title	Country	Research design	Sample	Research result
						and total cholesterol levels (p = 1.000; OR 1.275; 95% CI 0.324-5.013). Obesity was the dominant risk factor (p = 0.005; OR 43.051; 95% CI 3.060-605.675) for the incidence of type 2 diabetes mellitus.
15	Marlina *et al.*, (2026)	Sociodemographic and Lifestyle Risk Factors for the Incidence of Type 2 Diabetes Mellitus at the Jakabaring Community Health Center	Indonesia	Analytical quantitative research with a *cross-sectional* approach	The research sample consisted of 95 patients at the Community Health Center.	The results of the study showed that respondents with low physical activity had a higher risk of developing type 2 diabetes compared to those with moderate/high physical activity, with PR = 1.8; 95% CI: 1.3–2.4 p < 0.05. Respondents who did not work were also shown to be significantly associated with the incidence of type 2 diabetes, with PR = 2.4; 95% CI: 1.4–4.0; p < 0.05, in respondents who smoked had a significant association with the incidence of type 2 diabetes with PR = 1.5; 95% CI = 1.0–2.0; p < 0.05.

D. DISCUSSION

Based on a review of several previous studies, it has been shown that the incidence of type 2 diabetes is influenced by several factors, including demographic, genetic, anthropometric, clinical, lifestyle, and psychosocial factors. The factors influencing the incidence of type 2 diabetes are as follows:

1. Age

Age is one of the factors that is often found to be associated with the occurrence of type 2 diabetes. Increasing age is associated with an increased risk of glucose metabolism disorders due to physiological changes, decreased insulin sensitivity, and changes in body composition and physical activity (Suci and Ginting, 2023). Penelitian Thahara *and* Iriani (2026) showed that age is the most dominant factor associated with the occurrence of diabetes mellitus in adults, with older adults having a 16.081 times higher risk of developing diabetes compared to younger adults. These results indicate that increasing age significantly increases the likelihood of developing diabetes. This finding is supported by research Rahmawati *et al* (2026) which shows that age is significantly related to type 2 DM. Similar results were also found by Prasetya *et al* (2026) which states that age is significantly related to the incidence of DM 2. The consistency of the results in several studies shows that age is an important factor in the incidence of type 2 DM. The increased risk of type 2 DM at an older age may be related to decreased pancreatic beta cell function, increased insulin resistance, as well as a tendency towards obesity and decreased physical activity (Yameny, 2024). This implies that older age groups need attention in early detection and prevention efforts for type 2 DM (Tejasari, 2024).

2. Gender

Gender shows relatively inconsistent results as a factor associated with type 2 DM. Research Thahara *and* Iriani (2026) found a significant relationship between gender and the incidence of type 2 diabetes. Research by Crowther et al. (2025) also found that men have a 1.32-fold increased risk of developing type 2 diabetes compared to women. This relationship may be influenced by differences in biological and behavioral characteristics between men and women (Harmilah, Palestin and Ratnawati, 2021). Men tend to have a higher distribution of visceral fat, while visceral fat is closely related to insulin resistance and impaired glucose metabolism (Fajriyah *et al.*, 2024). In addition, differences in physical activity patterns, diet, smoking habits, alcohol consumption, and work characteristics can also influence the risk of type 2 diabetes in each gender (Sulfikar, Abu and Restika, 2024).

3. Occupation and social status

Occupational factors also show a relationship with the incidence of type 2 DM (Agustini *et al.*, 2025). Penelitian Darmawanti (2024) shows that work is one of the determining factors of type 2 DM. Crowther *et al* (2025) found that unemployment was associated with an increased incidence of type 2 diabetes mellitus. Marlina *et al* (2026) The study also showed that unemployed respondents had a 2.4 times higher risk of developing type 2 diabetes compared to employed respondents. The relationship between employment and type 2 diabetes can be related to socioeconomic conditions, physical activity levels, diet, stress, and access to health services (Andriani and Hasanah, 2023b). Certain types of work can also cause a person to sit more or have low physical activity (Maria, Ingrosso and Samvelyan, 2023). This implies that occupation may be a factor that indirectly influences the risk of DM through changes in lifestyle and socioeconomic conditions (Irman and Saridewi, 2024).

4. Family history of diabetes

Family history of DM is a factor that is strongly associated with the occurrence of type 2 DM (Marselin, Hartanto and Utami, 2021). Penelitian Lasmawati, Putri *and* Nuryani (2023) found a significant relationship between a family history of DM and the incidence of type 2 DM. This finding indicates that people with a family history of DM are much more likely to develop type 2 DM than people without a family history. This finding is supported by Darmawanti (2024) which shows that a history of diabetes is the factor with the highest risk of developing type 2 DM, where someone with a family history of DM is 49.346 times more likely to suffer from DM than someone who does not have a family history of DM. Study Yahya *et al* (2024) also found that family history is a risk factor for type 2 diabetes in adolescents, where adolescents with a family history of diabetes have a 5.89% greater risk of developing diabetes compared to adolescents with no family history of diabetes. This relationship can be explained by a genetic predisposition to impaired glucose metabolism and insulin resistance (Febriani *et al.*, 2023). This implies that family history can be an important indicator to identify individuals who need early prevention and monitoring for the occurrence of type 2 DM (Naningsih *et al.*, 2021).

5. Body Mass Index (BMI) and obesity

Nutritional status, especially obesity, is a factor that is consistently associated with the incidence of type 2 diabetes (Harmilah, Palestin and Ratnawati, 2021). Penelitian Lasmawati *et al* (2023) found a significant relationship between nutritional status and the incidence of type 2 diabetes. Obesity is the second dominant factor after family history, where someone who is obese has a 16.3 times greater risk of suffering from diabetes compared to people with normal body weight. Penelitian Darmawanti (2024) also shows that body mass index is one of the determining factors of type 2 DM. Research Yahya *et al* (2024) found that BMI is a risk factor for type 2 diabetes in adolescents, with obese adolescents having a 2.38 times greater chance of developing type 2 diabetes compared to adolescents with normal weight. These results are supported by research Prasetya *et al* (2026) which shows that obesity is associated with the incidence of type 2 diabetes and is a dominant risk factor. Physiologically, obesity, especially abdominal obesity, can increase insulin resistance through increased adipose tissue and the release of free fatty acids and inflammatory mediators (Marselin, Hartanto and Utami, 2021). This condition causes insulin to become less effective in controlling blood glucose levels (Febriani *et al.*, 2023). If it lasts for a long time, the increased need for insulin can cause disruption of pancreatic beta cell function, thereby increasing the risk of developing type 2 diabetes (Astuti, Sari and Merdekawati, 2021).

6. Eating patterns

Diet is a lifestyle factor that plays a role in the development of type 2 diabetes (Harmilah, Palestin and Ratnawati, 2021). Duan *et al* (2022) shows that unhealthy lifestyles have the highest risk of experiencing type 2 diabetes. Groups with poor diets and low physical activity also have an increased risk of type 2 diabetes. Penelitian Yahya *et al* (2024) found that diet is a risk factor for type 2 diabetes in adolescents with a risk 4.96 times greater than adolescents with a good diet. Study Darmawanti (2024) shows that excessive sugar consumption is one of the determining factors of type 2 diabetes. Unhealthy eating patterns, especially consumption of foods high in sugar, energy, fat and low in fiber, can cause excess energy intake and weight gain (Suryati, 2021). In the long term, this condition can increase insulin resistance and interfere with the control of blood glucose levels (Cao *et al.*, 2024). Improving the quality of diet is an important strategy in preventing type 2 diabetes (Jayedi *et al.*, 2022).

7. Physical activity

Physical activity is a lifestyle factor that is often associated with the occurrence of type 2 diabetes. Research Lasmawati *et al* (2023) showed a significant relationship between physical activity and type 2 DM. The study Yahya *et al* (2024) also found that physical activity is a risk factor for type 2 diabetes in adolescents. This finding is supported by evidence that groups with poor diets and low physical activity have an increased risk of developing type 2 diabetes. The study Kurniawan *et al* (2024) found that physical activity was associated with a lower risk of diabetes, especially in urban populations. The study Crowther *et al* (2025) also found that adequate physical activity was associated with a lower risk of diabetes. The study Seleky *et al* (2025) found that physical activity of less than 30 minutes has a risk of 8.167 times that of causing type 2 diabetes compared to people with good physical activity. The study Marlina *et al* (2026) also showed that respondents with low physical activity had a higher risk of developing type 2 diabetes. Overall, most studies show a tendency that low physical activity increases the risk of type 2 diabetes. Physical activity can increase glucose use by

muscles, improve insulin sensitivity, and help maintain body weight (Suci and Ginting, 2023).

8. Hypertension

Hypertension is a factor that is consistently found to be associated with the occurrence of type 2 diabetes (Wang *et al.*, 2025). Farhadipour *et al* (2022) found that hypertension has a strong influence on the incidence of DM. This research Sirait *et al* (2025) showed a significant relationship between hypertension and type 2 diabetes, with hypertension being the most dominant factor, with a risk 7.3 times greater than for individuals without hypertension. The relationship between hypertension and type 2 diabetes may be related to shared metabolic mechanisms, such as insulin resistance, inflammation, endothelial dysfunction, and impaired fat metabolism (Farhadipour *et al.*, 2022). Insulin resistance can lead to compensatory increases in insulin levels, impaired vascular function, inflammation, and changes in the neurohormonal system, all contributing to increased blood pressure. Conversely, hypertension and vascular stiffness can exacerbate insulin resistance, increasing the likelihood of developing impaired glucose tolerance and type 2 diabetes (Mancusi *et al.*, 2021). Hypertension also often occurs together with obesity and dyslipidemia, thus increasing the risk of glucose metabolism disorders (Jayedi *et al.*, 2022). This implies that hypertension is an important factor that needs to be considered in the screening and prevention of type 2 DM (Astuti, Sari and Merdekawati, 2021).

9. Dyslipidemia and Cholesterol

Lipid metabolism disorders have also been found to be associated with type 2 DM (Agustriana *et al.*, 2025). Farhadipour *et al* (2022) showed that high triglycerides and cholesterol levels have an influence on DM status. This research Kurniawan *et al* (2024) also showed that dyslipidemia is a risk factor for diabetes in both urban and rural Indonesian populations. Dyslipidemia is a condition characterized by disturbances in blood lipid levels, such as increased triglycerides (TG), increased LDL, and/or decreased HDL (Agustriana *et al.*, 2025). This condition is closely related to insulin resistance. Insulin resistance can increase the release of free fatty acids into the liver, thereby stimulating VLDL and triglyceride production and causing changes in LDL and HDL profiles (*atherogenic dyslipidemia)* (Hirano, 2023). When insulin resistance occurs, fat metabolism changes, leading to increased triglycerides and lipoprotein changes. Conversely, increased free fatty acids and impaired lipid metabolism can further exacerbate insulin resistance. This condition creates a metabolic cycle that can ultimately lead to increased blood glucose levels and the development of type 2 diabetes (Syokumawena, Mediarti and Agustini, 2024).

Wang *et al* (2025) also found that HDL-C has a protective effect against the occurrence of type 2 DM. Low HDL levels, often accompanied by increased triglycerides, are a common dyslipidemia pattern in patients with type 2 DM (ADCES7, 2021). HDL is often referred to as "good cholesterol" because it functions in reverse cholesterol transport, namely transporting excess cholesterol from the tissues to the liver (Zhang and Vorst, 2024). The relationship between HDL and type 2 DM tends to be inverse (inverse relationship). This result means that low HDL levels are generally found in individuals who have a higher risk of developing type 2 DM. HDL plays a role in the function of pancreatic beta cells. Pancreatic beta cells are responsible for producing insulin. HDL and its main component, namely apolipoprotein A-I (ApoA-I), are known to help maintain beta cell function and support insulin secretion. On the other hand, low HDL or impaired function can cause reduced protection of beta cells (Tak *et al.*, 2024).

10. Blood glucose and metabolic factors

Metabolic factors are important predictors of the incidence of type 2 diabetes mellitus (Vedantam *et al.*, 2022). Study Crowther *et al* (2025) found that random glucose levels are one of the factors associated with increased incidence of type 2 DM. Wang *et al* (2025) also showed that fasting plasma glucose was associated with an increased risk of type 2 diabetes, while HbA1c had a very strong association with the incidence of diabetes. Waist circumference, ALT, and fatty liver disease were also independent risk factors for type 2 diabetes (Wang *et al.*, 2025). These findings imply that impaired glucose metabolism, abdominal obesity, and impaired liver metabolism are interrelated in the development of type 2 DM (Suryanti *et al.*, 2025). Blood glucose is one of the main indicators of metabolic disorders that are closely related to the development of type 2 Diabetes Mellitus (DM). Increased blood glucose levels, especially fasting plasma glucose (FPG), glucose 2 hours after glucose load (2hPG), and HbA1c, indicate a disturbance in glucose regulation that can develop from normoglycemia to prediabetes and then type 2 DM (Meads *et al.*, 2026). Increased blood glucose is not only a sign of metabolic disorders, but can also be an early indicator of an increased risk of type 2 diabetes (Hu *et al.*, 2025).

Insulin resistance causes the body to require greater amounts of insulin to maintain normal glucose levels. If this condition persists, the ability of pancreatic beta cells to produce adequate insulin can decline. As a result, glucose cannot be optimally utilized by tissues and begins to increase in the blood (Hirano, 2023). This condition can develop into prediabetes and then type 2 DM. Exposure to repeated elevated glucose levels has a dose-response relationship with the risk of type 2 DM (Marlina *et al.*, 2026). Individuals with persistent or recurrent impaired fasting glucose (IFG) have a higher risk of developing diabetes than individuals who remain normoglycemic. Therefore, not only the glucose level at a single test is important, but also the duration and cumulative exposure to elevated blood glucose (Masrouri *et al.*, 2024).

11.Sleep duration

Sleep duration is a lifestyle factor that has been found to be associated with the incidence of type 2 diabetes (Suryati, 2021). Penelitian Maskarinec *et al* (2024) showed that sleep duration was too short (OR=1.04) or too long (OR=1.08). This relationship indicates that not only sleep deprivation, but also excessive or suboptimal sleep patterns can be associated with metabolic disorders (Cao *et al.*, 2024). Sleep disturbances can affect the regulation of hormones that regulate appetite, insulin sensitivity, and glucose metabolism (Dyanneza, Ardyanto and Prabowo, 2022). This implies that healthy sleep patterns can be part of a lifestyle approach in preventing type 2 DM (Sibony *et al.*, 2024).

Physiologically, sleep deprivation can affect glucose regulation and insulin sensitivity. Insufficient sleep can increase sympathetic nervous system activity and stress hormones, such as cortisol, which can further impair insulin function (Maria, Ingrosso and Samvelyan, 2023). Lack of sleep can also affect the hormones that regulate appetite, making a person more susceptible to increased hunger and changes in food preferences. This condition can encourage the consumption of high-calorie foods and increase energy intake (Irman and Saridewi, 2024). If it occurs in the long term, increased energy intake can lead to weight gain and obesity, which is one of the main risk factors for type 2 diabetes. Excessive sleep duration has also been found to be associated with an increased risk of type 2 diabetes (Haryono, 2023). These findings imply that sleep quality and regularity may be as important as the amount of sleep. Disruption of circadian rhythms and irregular sleep patterns can impair glucose metabolism, insulin sensitivity, and hormone regulation. Someone who gets enough sleep but has a very irregular sleep pattern may not necessarily experience the same metabolic benefits as someone with a regular sleep pattern (Naningsih *et al.*, 2021).

12. Smoking

Smoking has also been found to be associated with the incidence of type 2 diabetes (Minarti, Supriyanto and Adinata, 2025). Maskarinec *et al* (2024) found that smoking was associated with an increased incidence of type 2 DM. Wang *et al* (2025) also showed that current smoking habits are an independent risk factor for type 2 diabetes. Exposure to chemicals from cigarettes can increase oxidative stress and inflammation and affect insulin sensitivity (Astuti, Sari and Merdekawati, 2021). Nicotine can increase insulin resistance by affecting insulin action in peripheral tissues. Nicotine can also stimulate the release of catecholamines, thereby increasing circulating free fatty acid levels (Andriani and Hasanah, 2023a). Elevated free fatty acids can interfere with insulin function and increase glucose production by the liver. If this condition persists for a long time, the body will have difficulty maintaining glucose homeostasis (Sharma *et al.*, 2022). Chronic inflammation can also disrupt insulin signaling pathways, further decreasing insulin sensitivity. This condition can accelerate the progression from insulin resistance to impaired glucose tolerance and ultimately type 2 diabetes (Pitoy *et al.*, 2024).

13. Alcohol consumption

The relationship between alcohol consumption and type 2 DM shows complex results. (Tejasari, 2024). Maskarinec *et al* (2024) found that overall alcohol consumption was associated with the incidence of DM. Wang *et al* (2025) also showed that heavy alcohol consumption is an independent risk factor. Heavy alcohol consumption can cause metabolic disorders, weight gain, and liver dysfunction, potentially increasing the risk of glucose disorders (Siringo and Tondang, 2024).

14. Knowledge

Knowledge about DM and health behavior were also found to be associated with the incidence of type 2 DM (Harmilah, Palestin and Ratnawati, 2021). Lasmawati *et al* (2023) found a significant relationship between knowledge and the incidence of type 2 DM. The study Sirait *et al* (2025) also found a significant relationship between knowledge and type 2 DM. Knowledge can influence a person's ability to recognize risk factors, choose food, do physical activity, control body weight, and carry out health checks (Sugiharto, 2021). Individuals with better theoretical knowledge have a greater chance of implementing preventive behaviors (Husna and Mumtaz, 2025).

15. Psychological factors/depression

Depression was found to be associated with the incidence of type 2 DM (Friska *et al.*, 2025). The study Thahara *and* Iriani (2026) showed that depression carries a 3.71 times greater risk of developing type 2 diabetes compared to someone who does not experience depression. This finding implies that psychological conditions may be a factor associated with the occurrence of diabetes (Himawan *et al.*, 2023). Depression can be associated with changes in health behavior, such as decreased physical activity, changes in eating patterns, sleep disturbances, and difficulty maintaining healthy lifestyle behaviors (Sugiharto, 2021). Long-term psychological stress can be associated with hormonal changes and glucose metabolism (Irman and Saridewi, 2024).

E. CONCLUSION

Factors related to the occurrence of type 2 DM include age, gender, occupation and social status, family history of DM, BMI and obesity, diet, physical activity, hypertension, dyslipidemia and cholesterol, blood glucose and metabolic factors, sleep duration, smoking, alcohol consumption, knowledge about DM, and psychological factors/depression.

F. SUGGESTION

Prevention of type 2 diabetes should focus on lifestyle modifications and early detection, through a healthy diet, regular physical activity, weight management, smoking cessation, alcohol restriction, and maintaining good sleep

quality. At-risk individuals, especially those with a family history of obesity, hypertension, or dyslipidemia, are advised to undergo regular blood glucose screening and health check-ups.

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