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# Association of Risk Factors with Type 2 Diabetes: A Scoping Review

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## ABSTRACT

The incidence of type 2 diabetes mellitus (type 2 DM) is one of the public health problems worldwide, with various factors as risk factors that can lead to high morbidity and mortality rates for people with type 2 DM. This study aims to identify, investigate, and summarize various scientific evidence related to risk factors for type 2 DM. The approach used in this study was a scoping review with the PRISMA protocol. The PICO framework was used as an early-stage strategy in conducting article searches. Databases such as Google Scholar, PubMed, Scopus, and ScienceDirect were used as literature search tools. The study inclusion criteria were journal articles published from 2016 to 2024 and English-language articles with open access. Of the 157 journal articles identified, only 11 were eligible for analysis after selection and eligibility. The data extraction stage was conducted by six people on 11 eligible articles and continued with the qualitative data analysis process. The study reported that age, education, duration of DM, gender and income, physical activity, obesity, consumption of sugary foods and beverages, and low fruit consumption are risk factors for type 2 DM.

**Keywords**: **risk factors, type 2 diabetes mellitus, obesity**

## INTRODUCTION

As a chronic non-communicable disease (NCD), diabetes mellitus (DM) is one of the major public health issues that negatively impact millions of people's lives globally (Cao et al., 2020). It is a complex and long-lasting disease affecting many of the Population. The World Health Organization (WHO) predicts that the number of adults living with diabetes will increase in the future (Artasensi et al., 2020). Complications of the metabolic disease known as type 2 diabetes mellitus (T2DM), such as kidney failure, amputation, cardiovascular disease, and cerebrovascular accident, can lead to high morbidity and mortality rates (Li et al., 2020).

Globally, about 1.5 deaths occur each year due to diabetes, affecting 422 million people worldwide with diabetes. The disease is most common in low- and middle-income countries (WHO, 2024). Data from the International Diabetes Federation (IDF) reported that in 2021,

536.6 million people (10.5% of the total Population) have type 2 diabetes. By 2045, an estimated 783.2 million people (12.2% of the total Population) will have the disease. Urban areas are projected to have a greater prevalence (12.1%) than rural areas (8.3%), while high-income countries (11.1%) have a higher prevalence than low-income countries (5.5%) (Sun et al., 2022).

Previous studies on risk factors for T2DM have been conducted, but until now, the dominant and significant risk factors for T2DM have yet to be consistently known. To strengthen efforts to detect risk factors for type 2 diabetes, followed up with education efforts, it is vital to have a thorough understanding of the differences between the risk factors for type 2 diabetes. Therefore, it is important to summarize and understand the literature on the dominant factors that influence the incidence of T2DM. As the prevalence of T2DM is increasing every year, it is essential to understand the risk factors of T2DM. Previous studies have reported that the increasing prevalence of type 2 diabetes with severe complications can cause significant economic and disease burdens (Naqshbandi et al., 2008; Zheng et al., 2018). Therefore, this study aims to investigate, summarize, and identify various scientific evidence related to risk factors of T2DM to enhance previous research on these factors.

## METHODS

The approach used in this study was a scoping review (Xiao & Watson, 2019). The PRISMA protocol will be used to accumulate and review the findings of previous studies on risk factors for T2DM. The strategy for the initial stage of searching for articles and the procedure for developing research questions using the PICO framework, namely Population (all patients and non-sufferers of T2DM), Intervention (variables with the application of intervention methods/not used), Comparison (variables as risk factors for T2DM), Outcome (incidence of T2DM). Article searches were conducted using Google Scholar, Scopus, ScienceDirect, and PubMed databases. A combination of MeSH (Medical Subject Headings) with keywords (risk factors OR affecting factors OR determinant) AND (type 2 diabetes mellitus OR type 2 DM OR T2DM) AND (crossectional OR case-control OR cohort) were used in this study. The inclusion criteria for this study are (1) journal articles published from 2016 to 2024 and (2) English-language articles with open access. Exclusion criteria are (1) journal articles in the form of reviews and not in English, (2) articles published before 2016.

The journal article selection procedure begins with identifying articles from 4 databases: Google Scholar, Pubmed, Scopus, and ScienceDirect. A total of 1.452 journal articles were

checked for duplicates with the Mendeley application, and 417 duplicate journal articles were found. Then, journal articles were selected after checking for duplicates, as many as 1.035 journal articles, excluding 821 articles that were not full text. 214 were reports sought for retrieval, and 179 were not retrieved. The next step is determining the eligibility of journal articles in the form of 35 full-text journal articles with 24 excluded journal articles because they are irrelevant, such as not according to design, journal articles in the acceptance stage, and the form of review articles. The final stage was an analytical study of 11 journal articles to synthesize the data qualitatively. Figure 1 below shows the article selection procedure.

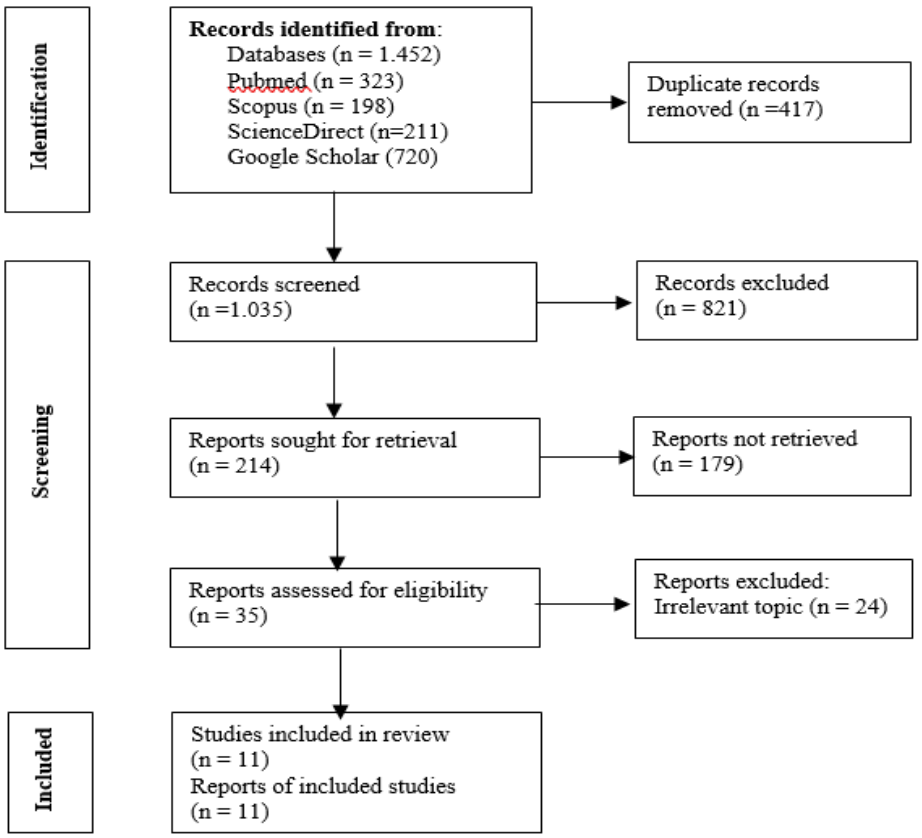


**Figure 1: Article Selection Procedure**

Six people carried out the data extraction stage on 11 eligible articles. The data extraction process began with selecting article titles, abstracts, study designs, measures, and data analysis. During the analysis phase, we performed a series of steps. The initial task was to summarize the content of the 11 selected articles, starting with identifying the author's name and year of publication, volume, journal title, research methodology used, research findings, and the specific journal database source. Subsequently, the summary was organized in a tabular synthesis matrix format. The next step was to categorize the questions relating to the issue of T2DM to facilitate the author's identification of the subject matter by examining the findings

from the research summaries of the eleven selected journal articles. The final step is to analyze and explain the empirical evidence, theoretical frameworks, and viewpoints relating to the study findings and the methodology used in the publications. The discussion section will provide a detailed explanation of the research findings, incorporating the appropriate theoretical framework.

## RESULTS

Table 1 shows that all articles in this study met the inclusion criteria and were published between 2016 and 2024 in various journal databases. These studies used cross-sectional, case-control, and cohort research designs from multiple countries (Figure 2).

**Table 1. Data Extraction Results**

| Author/Year | Country | Sample | Design study | Database |
|---|---|---|---|---|
| Lasari et al. (2020) | Indonesia | 156 | Cross-sectional | Google Scholar |
| Adhi et al. (2018) | Indonesia | 110 | Case-control study | Google Scholar |
| Putri et al. (2020) | Indonesia | 80 | Case-control study | Google Scholar |
| Safitri et al. (2021) | Indonesia | 6.754 | Cross-sectional | Google Scholar |
| Huang et al. (2016) | Taiwan | 111.670 | Cohort study | Pubmed |
| Chen et al. (2020) | Chinese | *3367* | Cross-sectional | Pubmed |
| Wu et al. (2021) | China | 39.259 | Cohort study | Scopus |
| Yan et al. (2022) | Wuhan, China | 376.702 | Cross-sectional | Scopus |
| Pasdar et al. (2024) | Western Iran | 9.283 | Cohort study | Scopus |
| Siregar et al. (2022) | Indonesia | 200 | Case-control | ScienceDirect |
| Gudjinu (2017) | Ghana | 136 | Case-control | ScienceDirect |

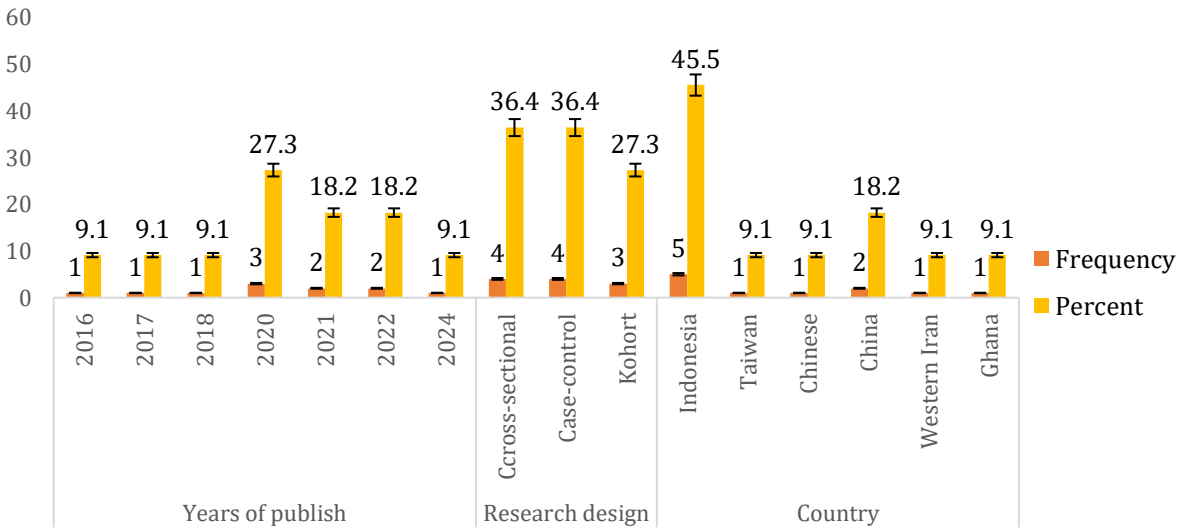


**Figure 2. General Characteristics for Study Selection (n=11)**

Table 2 reports that various variables are significant risk factors for T2DM. Seven of the eleven studies analyzed reported that respondent characteristics, including age, education, gender, income, residence, marital status, and income, were significant to the incidence of T2DM (Lasari et al., 2020; Safitri et al., 2021; Huang et al., 2016; Chen et al., 2020; Wu et al., 2021; Yan et al., 2022; Pasdar et al., 2024). In addition, four studies discussed physical activity, smoking, duration of DM >5 years, medication non-adherence, discomfort, and duration of alcohol intake (Siregar et al., 2022; Pasdar et al., 2024; Adhi et al., 2018; Putri et al., 2020). However, few studies have focused on food consumption, such as fruit consumption per week, the portion of fruit consumed, fast eating score and activity assessment for patients, cholesterol, waist-to-hip ratio, frequent consumption of sugary foods/beverages, waist-to-hip ratio, body fat percentage, visceral fat area, and intake of high-sugar beverages (Gudjinu, 2017; Siregar et al., 2022; Chen et al., 2020; Adhi et al., 2018), of the eleven studies analyzed, the dominant risk factors for the incidence of T2DM are still inconsistent between each study. Therefore, further research is needed to apply and develop complex methods to identify dominant risk factors consistent with the incidence of T2DM and can be used as a guideline in policymaking for the prevention and control of risk factors for T2DM.

**Table 2. Factors Associated with the Risk of T2DM**

| Significant Factors | Dominant Risk Factors | Main Empirical Sources |
|---|---|---|
| Age | Age (p = <0.001) | (Lasari et al., 2020) |
| Occupation, high sugar alcohol intake, duration of alcohol intake, obesity, high sugar beverage intake | High sugar drink intake (AOR = 39,57; 95%CI (4.00-391.8), obesity (AOR = 8,82; 95%CI 2.43-32.01) | (Adhi et al., 2018) |
| DM duration >5 years and medication non-adherence, uncomfortable condition | Duration of DM > 5 years (p = 0.01; OR = 3.46; 95% CI = 1.37 < OR < 8.69) and medication non-adherence (p = 0.02; OR = 3.15; 95% CI = 1.25 < OR < 7.93). | (Putri et al., 2020) |
| Age and level of education | Age over 35 years (p=0.01, PR=5.60, 95%Cl=3.64-8.62) and education level (p=0.01, PR=1.69, 95%Cl=1.22-2.34). | (Safitri et al., 2021) |
| Age, income, other catastrophic diseases, Charlson comorbidity index | Age (p<0,001), index comorbidities Charlson (p<0,001) | (Huang et al., 2016) |
| Gender, age, waist-to-hip ratio, body mass index, body fat percentage, visceral fat area. | Male gender (odds ratio [OR] = 1.68, 95%CI: 1.29-2.19), participants with waist-hip circumference ratio (OR = 1. 56, 95%CI: 1.18-2.07). | (Chen et al., 2020) |

| Significant Factors | Dominant Risk Factors | Main Empirical Sources |
|---|---|---|
| Age, gender, marital status, education, income, smoking, physical activity, body mass index | Gender was male with more alcohol consumption (p<0.05; OR 95CI: 1.68 (1.23, 2.30) compared to women. | (Wu et al., 2021) |
| Age, body mass index (BMI), central obesity, gender, education level, marital status, physical activity, alcohol consumption, and central obesity. | Older age, higher education level, physical activity, history of higher BMI, and obesity. | (Yan et al., 2022) |
| Age, residence, smoking, physical activity, abdominal obesity, general obesity, hypertension. | Abdominal obesity (p<0.001; OR: 1.58 (1.30, 1.93), General obesity (p<0.001; OR: 1.55 95%CI (1.31, 1.83), hypertension (p<0.001; OR: 1.08 (1.01, 1.20). | (Pasdar et al., 2024) |
| Waist-hip ratio, high diastolic blood pressure, lack of physical activity, frequent consumption of sugary foods/drinks. | High-risk waist-hip ratio (aOR = 2.86, 95% (CI): 1.12-7.30), frequent consumption of sugary foods/beverages (aOR = 1.83, 95% CI 1.00-3.39). | (Siregar et al., 2022) |
| Low socioeconomic status, body mass index above >35 kg/m2, fruit consumption per week, portion consumed, fast eating score and patient activity assessment, total cholesterol (mmol/L). | Fruit serving per meal (OR: 3.75 95CI 1.69-19.6), fast eating score, and patient activity assessment (OR: 5.45 95%CI 1.14-32.5). | (Gudjinu, 2017) |

## DISCUSSION

This scoping review provides evidence on risk factors for the incidence of T2DM. Of the 11 studies that met the inclusion criteria, various significant risk factors for the incidence of T2DM were found (Table 2). Multiple studies show that there still needs to be consistent research on risk factors for T2DM. According to the review in this study, characteristics such as age, gender, occupation, income, marital and earning status, obesity, and body mass index are associated with the incidence of T2DM. Previous studies reported that the characteristics of respondents were that they had an average age of 54.7 years and that about 75% of respondents were female. Men (9.0 ± 5.2 mmol/L) and women (8.1 ± 3.1 mmol/L) had similar fasting plasma glucose levels. However, women were more likely to be overweight (53%), obese (19%), have central adiposity (75%), and have increased body fat (54%, 56%) than men (p<0.001) (Danquah et al., 2012). Another study also reported that characteristics such as gender, age, marital status, education level, duration of T2DM, complications, and daily

activities of respondents were significantly associated with the incidence of T2DM ($p < 0.05$) (Zan et al., 2024). However, respondent characteristics are closely related to the quality of life of patients with T2DM (Zan et al., 2024). Previous studies have indicated that those with lower levels of education, being female, having a longer disease duration, and having complications are more likely to have a lower quality of life in T2DM patients (Kang et al., 2021; Godino et al., 2017; Zurita-Cruz et al., 2018). However, the 11 studies analyzed did not discuss the relationship between respondents' characteristics and the quality of life of patients with T2DM.

In addition to respondent characteristics, other variables were also significant to the incidence of T2DM. These variables were physical activity, smoking, duration of DM >5 years, medication non-adherence, discomfort, and duration of alcohol intake (Siregar et al., 2022; Pasdar et al., 2024; Adhi et al., 2018; Putri et al., 2020). Previous studies have indicated that regular physical activity and healthy body weight can aid in preventing and managing diabetes (Sigal et al., 2006). However, a major barrier to consistent physical activity is the health risks associated with diabetes and the concern that exercise can worsen these symptoms. Understanding these barriers and implementing effective strategies is essential to maintaining motivation and dedication in physical activity intervention programs for patients with T2DM (Ranasinghe et al., 2015). In addition to physical activity, the duration of DM >5 years also plays a role in the risk of T2DM. The duration of the disease is significant for the incidence of peripheral neuropathy in patients with T2DM. Disease duration ≥ five years tends to suffer from peripheral neuropathy in patients with T2DM compared to disease duration <5 years (Azmiardi et al., 2019).

In this study, consumption of sugary foods and beverages was also one of the significant risk factors for the incidence of T2DM. Daily consumption of granulated sugar was substantial for the incidence of DM ($p<0.001$; OR= 9.3 95%CI 2.914-30.163). Daily sugar consumption is 9.3 times more likely to have DM than weekly sugar consumption (Ramadhani & Mahmudiono, 2018).

Previous studies using the Systematic Review and Meta-Analysis method reported that consuming more sugar-sweetened beverages was associated with a higher risk of developing T2DM. The risk increased by 18% for each serving consumed daily, with a confidence interval of 9% to 28%. This association remained significant even after adjusting for adiposity, with a 13% increase in risk. Similarly, drinks with artificial sweeteners were also associated with a higher risk of T2DM, with an increased risk of 25% before adjustment and 8% after adjustment. Fruit juice consumption was associated with a more minor increase in risk, with a 5% increase

in risk before adjustment and 7% after adjustment (Imamura et al., 2015). Consumption of sugary foods and beverages is also closely linked to weight gain as a risk factor for T2DM. Previous studies using meta-analysis methods have also reported a positive correlation between increased body mass index and increased susceptibility to T2DM. The risk of T2DM is strongly and consistently associated with higher waist circumference, regardless of overall body fat (Jayedi et al., 2022). The researchers synthesized data from numerous cohort studies and performed statistical analysis to provide a complete picture of the link between anthropometric indicators and T2DM risk.

## CONCLUSION

Respondents' characteristics such as increasing age, low education, duration of DM >5 years, gender, and income are risk factors for DM that cannot be changed and have a significant correlation with the incidence of T2DM. Physical activity, sugary foods and beverages, obesity, and low fruit consumption are dominant risk factors for T2DM. Patients with T2DM need to maintain health by exercising regularly and routinely to help control blood sugar levels to be optimal. Avoiding sugary foods and drinks in patients with T2DM is very important to prevent sugar accumulation in the body. Still, frequent fruit consumption can help avoid complications and increase blood pressure in patients with T2DM. Policymakers, such as the Health Office and Universities, work together in making prevention and education efforts about T2DM to the entire community so that the risk factors for T2DM can be controlled, especially in the community group aged <40 years, can be significantly reduced. Therefore, future research should consider this study's results and assess the risk factors for type 2 diabetes in greater depth.

## LIMITATION

Due to resource constraints, studies published in periodicals other than English were not included, which could have resulted in selection bias. In addition, this study did not assess the quality of the 11 articles that met the inclusion criteria, as some studies needed to provide more information, such as under-reporting, making it difficult to review the quality of the studies fully.

## ACKNOWLEDGMENTS

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