

# Assessing Diabetes Screening Outcomes in Klang Valley, Malaysia: A Cross-Sectional Study

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**Abstract:** Diabetes mellitus, once primarily affecting the elderly, is now increasingly diagnosed in younger individuals due to poor lifestyle habits. Early detection through health screening is essential for effective management. A government agency that has conducted diabetes screening programs since 2013 launched its third initiative, aiming for an 80% detection rate among screened participants using HbA1c (cutoff  $\geq 6.3\%$ ), rather than reflecting national diabetes prevalence. This cross-sectional study evaluated the program's effectiveness in detecting diabetes among Malaysian adults aged 40 to 59 in Klang Valley. A total of 188 participants attended free screenings at registered clinics between September and December 2023. The cohort included 47.35% men and 52.65% women, with 41.5% Malays, 40.4% Chinese, 14.4% Indians, and 3.7% from other ethnic groups. HbA1c levels  $\geq 6.3\%$  were found in 27.12% of participants, with the highest prevalence among Indians (33.3%), followed by Malays (29%), Chinese (23.68%), and others (14.28%). Statistical analysis (ANOVA) showed no significant association between HbA1c levels and age, gender, or ethnicity ( $p = 0.188$ ). The program did not meet its 80% detection target, suggesting that alternative screening approaches, including revised diagnostic criteria or additional risk assessments, may be needed to improve diabetes detection and intervention efforts.

*Keywords:* health screening, diabetes, prevalence.

## 1. Introduction

### 1.1 Global and Regional Prevalence of Diabetes Mellitus

Diabetes mellitus (DM) is an increasing global public health challenge, affecting approximately 537 million people in 2021, with projections indicating a rise to 783 million by 2045 (Saeedi et al., 2019; International Diabetes Federation, 2021). In 2022, more than 800 million adults were living with diabetes, a fourfold increase since 1990 (World Health Organization, 2024). The global prevalence of diabetes among adults has risen from 7% in 1990 to 14% in 2022, primarily due to obesity, sedentary lifestyles, and unhealthy diets (Magliano et al., 2024).

Countries like China, India, and Pakistan have among the highest numbers of adults aged 20 to 79 years living with diabetes (International Diabetes Federation, 2021).

In the Southeast Asia region, approximately 90 million adults aged 20 to 79 had diabetes in 2021, representing 9.58% of the population. This number is projected to increase to 113 million by 2030 and 151 million by 2045 (International Diabetes Federation, 2021).

Among the Southeast Asian countries, Malaysia had the highest prevalence at 19% in 2021, significantly higher than the global average (14%) and the regional average (9.58%; The Global Economy, 2023). The diabetes prevalence in Malaysia emphasizes the urgent need for improved prevention, screening, and management strategies to control the rising burden of the disease. Given the rising prevalence trend, focused screening programs and early interventions are crucial to alleviate the long-term effects of diabetes in the nation (Institute for Public Health, 2020).

### 1.2 Diabetes Contributes to Financial Burden

The financial burden associated with diabetes is substantial, both in terms of direct and indirect healthcare costs, such as productivity loss (Bommer et al., 2017). In Malaysia, diabetes-related healthcare expenses accounted for a significant portion of healthcare spending, with USD3.6 billion spent in 2018 (Ministry of Health Malaysia, 2022). These costs primarily go toward managing complications arising from poorly controlled diabetes (Seuring et al., 2015). Preventive measures and early intervention programs are essential to alleviate this financial strain, as emphasized by the Malaysian guidelines on the management of type 2 DM (T2DM; Ministry of Health Malaysia, 2020). Due to the increasing costs associated with managing DM and its complications, countries worldwide have implemented measures to reduce healthcare expenses.

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### 1.3 A Comparison of Healthcare Interventions Pertaining to Diabetes

Countries worldwide have implemented various strategies to combat the diabetes epidemic. In the United Kingdom (UK), the National Health Service (NHS) launched the National Diabetes Prevention Program, which emphasizes lifestyle interventions, such as diet and physical activity (NHS England, 2019). In the United States (US), the Exercise is Medicine program integrates physical activity into the healthcare system (American College of Sports Medicine, n.d.). China has implemented the National Standardized Metabolic Disease Management Centre (MMC) to improve access to diabetes care (Li et al., 2020). In Singapore, the War on Diabetes campaign focuses on public awareness and early screening (Ministry of Health Singapore, 2021). In Malaysia, the Ministry of Health has introduced initiatives for glycemic control and medical nutrition therapy to reduce complications, as outlined in the *Clinical Practice Guidelines of Management of Type 2 Diabetes Mellitus* (6<sup>th</sup> ed.; Ministry of Health Malaysia, 2020).

### 1.4 The Role of Health Screening in Diabetes Detection

Screening for diabetes is critical in identifying undiagnosed cases and reducing long-term complications. The National Health and Morbidity Survey (NHMS) 2019 reported an 18.3% prevalence of diabetes among Malaysian adults, with 48.6% of these cases being undiagnosed (Institute for Public Health, 2020). The Malaysian guidelines on the management of type 2 DM emphasize routine screening for high-risk populations, particularly those aged 40 and above (Ministry of Health Malaysia, 2020).

### 1.5 The Health Screening Program (HSP)

The Malaysian Health Screening Program (HSP), introduced in 2013 (Social Security Organization, 2023), is an ongoing measure aimed at enhancing early detection of non-communicable diseases, including diabetes (Social Security Organization, 2023). The program is designed to identify individuals at high risk and encourage early detection of non-communicable diseases such as diabetes (Ministry of Health Malaysia, 2013). Targeting individuals aged 40 to 59, the HSP offers several screening services, including blood tests, urine analysis, and clinical evaluations (Mohamud et al., 2011). The program is designed to identify individuals at high risk and encourage early intervention, contributing to improved long-term health outcomes (Ministry of Health Malaysia, 2013). The success of the HSP is measured by its ability to identify cases of diabetes, with a particular focus on achieving an 80% prevalence of diagnosed cases using HbA1c screening criteria.

HbA1c is a widely accepted biomarker for diabetes screening, providing a three-month average of blood glucose levels (International Diabetes Federation, 2021). The Malaysian CPG recommends an HbA1c threshold of  $\geq 6.3\%$ , which is lower than the international standard of 6.5%, to improve early detection among Malaysians (Ministry of Health Malaysia, 2020).

The 80% detection target set by the HSP serves as an internal benchmark for program success. Since the screening program targets a high-risk working population, the expected detection rate should be higher than the national average (18.3%). A similar

high detection rate has been observed in previous health screening initiatives (Social Security Organization, 2023). If the program does not meet this target, it may suggest gaps in outreach, participant selection, or screening methods.

### 1.7 Study Objective

This study evaluates the effectiveness of the HSP in detecting diabetes among Malaysian adults aged 40 to 59, using HbA1c (cutoff  $\geq 6.3\%$ ). The study also investigates whether age, gender, and ethnicity influence diabetes detection rates.

## 2. Materials and methods

### 2.1 Study Design

This is a cross-sectional study that analyzed the HbA1c results of the health screening program using descriptive and inferential statistics to measure the prevalence of DM among the participants in Malaysia.

### 2.2 Sample and Setting

The sample size was not calculated as the researchers adopted the total population sampling method, a type of purposive sampling wherein the total population with specific characteristics was included. In this study, the specific characteristics were the inclusion criteria. The blood samples, which were processed by the MAHSA laboratory, were those of Malaysians aged 40 to 59 years who attended the screening conducted by a registered panel clinic in Klang Valley. In order to be eligible for this free HSP, the individuals had to fulfil certain criteria. The inclusion criteria were individuals who were Malaysians, aged between 40 and 59 years old, who were active employment insurance contributors with at least one (1) month of contribution in the year 2023, and at least a total of 12 months of total contributions. Exclusion criteria included individuals who did not fulfil the above criteria. The study procured ethical approval for secondary data procurement from the Research Management Centre of MAHSA University (RMC/OCTOBER/2024/EC07). Individual consent was not sought as the participant's information was not exposed at any point in the research. HbA1c data were generated by the laboratory from 1 September 2023 to 31 December 2023.

### 2.3 Data Analysis

The data was analyzed using SPSS version 27, while numerical data was entered into Excel version 2502 build 16. For all tests, a significance level of  $p < 0.05$  was set.

## 3. Results

Of a total population of 199 participants derived from the raw data, 188 were aged between 40 and 59 years. The predominant participants were Malay males aged 40 to 50 years, whereas Chinese ladies constituted the majority within the same age range.

Of the 188 participants between the ages of 40 and 59, 47.35% ( $n = 89$ ) were men and 52.65% ( $n = 99$ ) were women. The

**Table 1.** Demographic data (gender, age and ethnicity) of the 188 participants.

GENDER	ETHNICITY				
	MALAY	CHINESE	INDIAN	OTHERS	TOTAL
<b>MALE</b>	<b>N=47</b>	<b>N=26</b>	<b>N=13</b>	<b>N=3</b>	<b>N=89</b>
40 – 50 YEARS	n=37	n=21	n=8	n=3	69
51 – 59 YEARS	10	5	5	0	20
<b>FEMALE</b>	<b>31</b>	<b>50</b>	<b>14</b>	<b>4</b>	<b>99</b>
40 – 50 YEARS	18	40	12	3	73
51 – 59 YEARS	13	10	2	1	26

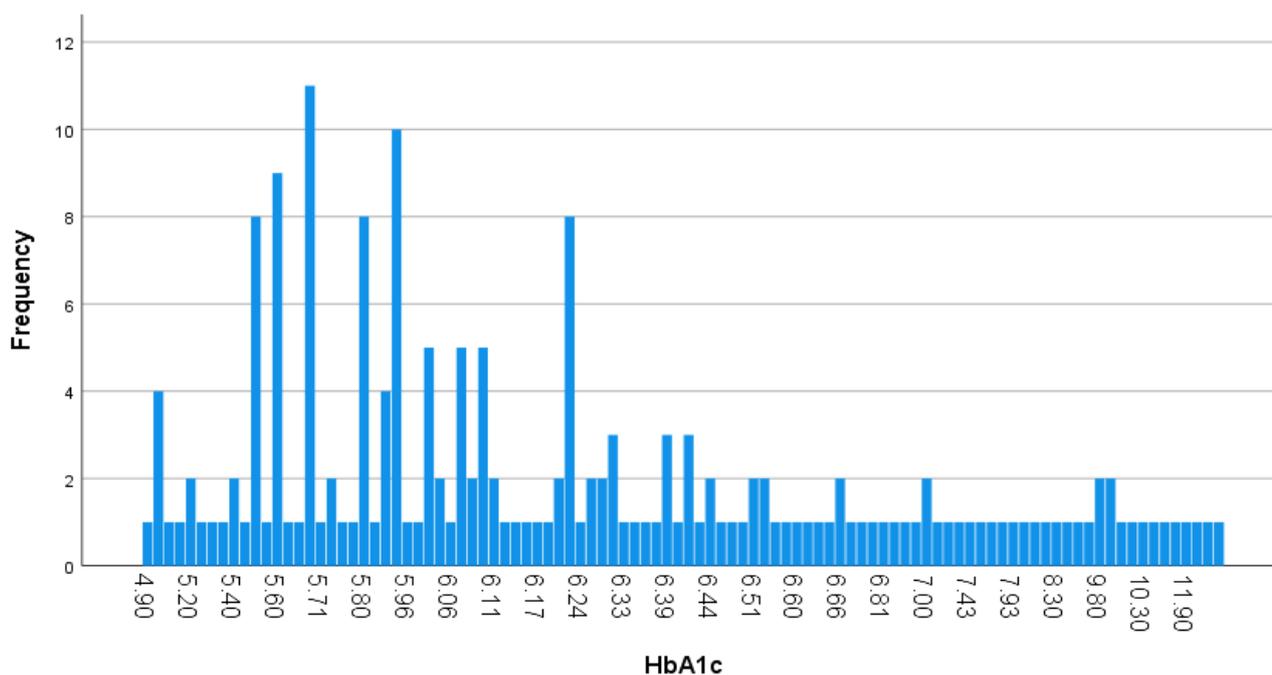
ethnicity of the participants was as follows: 41.5% Malays (n=78), 40.4% Chinese (n=76), 14.4% Indians (n=27), and 3.7% others. Of the 188 individuals, 51 (27.12%) had a HbA1c level of  $\geq 6.3\%$ .

When disaggregated by ethnicity, 29% of Malays (23 of 78), 23.68% of Chinese (18 out of 76), 33.33% of Indians (9 of 27), and 14.28% of other ethnic groups (1 of 7) exhibited HbA1c levels exceeding 6.3. Table 1 provides the distribution of the 188 participants aged 40 to 59 years, categorized by ethnicity and further divided into two age groups: 40 to 50 years and 51 to 59 years.

The descriptive analysis revealed that only 27.12% of the participants had HbA1c levels within the diabetic range ( $\geq 6.3\%$ ), as defined by the *Malaysian Clinical Practice Guidelines on the Management of Type 2 Diabetes Mellitus* (6th ed.).

Table 2 presents the gender distribution of participants undergoing HbA1c testing, detailing the number and percentage of male and female participants included in the study. The overall mean HbA1c level among participants was 6.56% (N = 188). The findings indicate that while fewer than 80% of individuals had an HbA1c level of  $\geq 6.3\%$ , the prevalence was highest among Indians, at 33.3%. The mean HbA1c level among male participants was 6.5%, encompassing nearly all individuals classified within the diabetes group. In contrast, the mean HbA1c level for female participants was 6.6%, only 0.1% higher than that of males.

As the data followed a normal distribution, the mean HbA1c levels between male and female participants were compared using an independent t-test. Levene’s test for equality of variances yielded an F-statistic of 0.155 with a non-significant p-



**Figure 1.** Distribution of HbA1c values among the participants.

**Table 2.** Mean HbA1c according to gender

HbA1c	Gender	N (%)	Mean	Std. Deviation	Std. Error Mean
HbA1c	Female	99 (52.66)	6.5877	1.71964	0.17283
	Male	89 (47.34)	6.5222	1.50832	0.15988

value of 0.694, indicating homogeneity of variances. The t-test for equality of means produced a t-statistic of 0.276, with 186 degrees of freedom and a p-value of 0.783, suggesting no statistically significant difference in HbA1c levels between genders. The mean difference was 0.06543, with a 95% confidence interval ranging from -0.40230 to 0.53316, further confirming the absence of a significant gender-based variation in HbA1c levels.

The ANOVA analysis of the model, with HbA1c as the dependent variable, and age, gender, and race as independent variables, indicates that the regression model accounts for some variation in HbA1c levels. Nevertheless, the F-statistic of 1.613 is associated with a p-value of 0.188, which is not statistically significant ( $p > 0.05$ ). This suggests that the model does not effectively explain the variation in HbA1c levels based on the selected predictors.

#### 4. Discussion

This study aims to evaluate the effectiveness of Malaysia's health screening program in identifying the prevalence of type II diabetes within the target population. Although the program aimed to detect diabetes in 80% of participants as an internal benchmark for success, findings from this study indicate that it fell significantly short of this target, with only 27.12% of participants having HbA1c levels  $\geq 6.3\%$ . This limitation may be attributed to the study's relatively small sample size, which was confined to a single geographic area, the Klang Valley. Nonetheless, implementing a nationwide screening program is highly relevant given Malaysia's alarming diabetes rates. The country has one of the highest diabetes prevalence rates in the Western Pacific region and ranks among the highest globally. Between 2011 and 2019, diabetes prevalence in Malaysia surged by 68.3%. In 2019, an estimated 3.6 million Malaysians aged 18 and above had been diagnosed with diabetes, while an additional 3.7 million remained undiagnosed. By 2025, the number of Malaysians with diabetes is projected to reach 7 million, translating to a prevalence rate of 31.3%. Reported prevalence rates in Malaysia vary significantly, ranging from 7.3% to 23.8%, depending on the study population and methodology (Ganasegeran et al., 2021).

According to the Demographic Data for Malaysia's fourth quarter of 2022, published by the Department of Statistics Malaysia (DOSM), the country's total population was 33 million. The ethnic composition comprised 17.6 million Malays (57.8%), 6.9 million Chinese (22.7%), 2.0 million Indians (6.6%), 3.7 million Other Bumiputera (12.2%), and 0.2 million individuals classified under other ethnicities (0.7%; Wan Nazaimoon et al., 2013). In this study, the majority of participants were of Malay ethnicity, accounting for 40.4% ( $n = 76$ ). However, among the Indian participants, 33% ( $n = 9$  of 27) had HbA1c levels exceeding the cutoff point. A 2013 study conducted in Malaysia among 4,341 subjects reported a diabetes prevalence of 22.9%. Consistent with our findings, the study showed that diabetes was most prevalent among Indians (37.9%), followed by Malays (23.8%), and was the lowest among the Chinese (Wan Nazaimoon et al., 2013).

Studies have examined the associations between ethnicity, age, gender, and HbA1c levels among non-diabetic adults across

various populations. For example, a community-based cross-sectional study conducted in Northern and Eastern Sudan found significantly higher HbA1c levels in Eastern Sudan compared to Northern Sudan. The study identified ethnicity and body mass index (BMI) as significant factors influencing HbA1c levels, whereas age and gender did not show statistically significant correlations in these regions. These findings highlight the influence of ethnic and regional variations on HbA1c levels, underscoring the importance of considering these factors in diabetes management and prevention strategies in Sudan (Ahmed et al., 2023).

A cross-sectional study in Shenzhen, China, analyzed 18,265 adults without a prior diabetes diagnosis to examine the association between HbA1c levels, age, and gender. The study found that HbA1c levels increase with age and are significantly higher in males compared to females. These findings suggest that both age and gender should be considered when using HbA1c as a diagnostic criterion for diabetes in Chinese populations (Ma et al., 2016).

The finding that Malaysian females and males had similar mean HbA1c levels suggests that gender may not be a significant determinant of blood glucose control in this population. This could be due to similar lifestyle habits, dietary patterns, and levels of physical activity among both genders. Additionally, equal access to healthcare, diabetes awareness, and workplace health programs may contribute to comparable glycemic control. Since the study focused on employed individuals aged 40–59, the participants likely shared similar socioeconomic backgrounds and occupational health support, which may have minimized gender-based differences. While hormonal differences can influence diabetes risk, they may not have had a substantial impact on HbA1c levels in this sample. Therefore, other factors such as age, ethnicity, and lifestyle choices may play a more significant role in influencing blood glucose levels.

Another study involving 8,665 participants from two cohorts (SHIP-0 and SHIP-Trend) aimed to prevent diabetes misdiagnosis in the elderly by establishing age-dependent HbA1c reference intervals. The study found that HbA1c levels increase with age, with the upper reference limit (URL) rising from 42.1 mmol/mol (6.0%) in individuals aged 20 to 39 to 47.5 mmol/mol (6.5%) in those aged 60 and above. These age-dependent reference values for HbA1c, derived from healthy populations, are crucial for improving diabetes diagnosis and care in elderly patients, helping to avoid misdiagnosis and overtreatment (Masuch et al., 2019).

A Malaysian study by Ismail et al. (2000) investigated the factors influencing glycemic control in young diabetic patients across Peninsular Malaysia. The study analyzed various sociodemographic variables, such as age, gender, ethnicity, educational background, and socioeconomic status, to determine their impact on patients' ability to manage blood sugar levels effectively. The findings suggest that socioeconomic and educational factors play a significant role in determining glycemic control among these patients, highlighting the need for targeted interventions to improve diabetes management based on these determinants (Ismail et al., 2000).

However, in this study, the ANOVA analysis of the model, which examines HbA1c levels based on age, gender, and race, is not statistically significant. The p-value of 0.188 (greater than 0.05) suggests that this explanation is likely due to chance. Therefore, the model may not effectively capture how age, gender, and race impact HbA1c levels, indicating that other factors may be more relevant in explaining the variation.

Another issue that may arise is whether HbA1c is the correct test to do instead of fasting blood glucose (FBG) or random blood glucose (RBG). HbA1c is usually preferred for prevalence studies because it indicates long-term glucose control and is straightforward to use. However, FBG or RBG may be chosen instead in certain scenarios. FBG is often used for immediate diabetes or prediabetes diagnosis, especially in clinical settings requiring precise measurements, in resource-limited environments, or when conditions like anemia affect HbA1c accuracy. RBG is beneficial for rapid confirmation of high glucose levels, especially in emergencies or community screenings where fasting is not possible. Thus, while HbA1c is favored for long-term monitoring, FBG and RBG are selected for immediate, specific, or practical reasons (NCD Risk Factor Collaboration [NCD-RisC], 2023; Ghazanfari et al., 2010).

As an overall prevalence, this study highlights the increase in the prevalence of diabetes in Malaysia, regardless of the diagnostic criteria used (Wan Nazaimoon et al., 2013). It has also elucidated that the HbA1c threshold of  $\geq 6.3\%$  as a diagnostic criterion may underestimate the burden of this disease, and the HbA1c with a cutoff point of  $\geq 6.3\%$  together with FBG or RBG, is found to give maximal sensitivity (Wan Nazaimoon et al., 2013).

## 5. Conclusion

The health screening program aimed to assess diabetes mellitus incidence and/or prevalence among the participants. Despite being accessible and free, the program achieved only a 27% diabetes detection rate, falling short of expectations. Contributing factors included the program's short duration, which did not account for aging and increasing life expectancy, self-selection bias, leading to underrepresentation of higher-risk individuals, and its focus on health-conscious individuals, potentially excluding a more diverse population. The social media campaign probably failed to reach the elderly effectively, and the lack of non-fasting tests limited opportunistic screening.

### Limitations of this study:

Though the study employed the total population sampling method, the sample was not sufficient to achieve the intended target. It is suggested to conduct this study at various locations with a larger sample size in the future. Alternatively, a study focusing on high-risk individuals would also yield a higher prevalence rate.

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## 7. References

- Ahmed, S. F., Hassan, A. A., Eltayeb, M. M., Omar, S. M., & Adam, I. (2023). Ethnicity, Age, and Gender Differences in Glycated Hemoglobin (HbA1c) Levels among Adults in Northern and Eastern Sudan: A Community-Based Cross-Sectional Study. *Life (Basel, Switzerland)*, 13(10), 2017. <https://doi.org/10.3390/life13102017>
- American College of Sports Medicine. (n.d.). *Exercise is medicine: About*. Retrieved from [https://www.exercisemedicine.org/support\\_page.php/about/](https://www.exercisemedicine.org/support_page.php/about/)
- Bommer, C., Heesemann, E., Sagalova, V., Manne-Goehler, J., Atun, R., Bärnighausen, T., & Vollmer, S. (2017). The global economic burden of diabetes in adults aged 20–79 years: a cost-of-illness study. *The Lancet Diabetes & Endocrinology*, 5(6), 423–430. [https://doi.org/10.1016/s2213-8587\(17\)30097-9](https://doi.org/10.1016/s2213-8587(17)30097-9)
- Ganasegeran, K., Hor, C. P., Jamil, M. F. A., Suppiah, P. D., Noor, J. M., Hamid, N. A., Chuan, D. R., Manaf, M. R. A., Ch'ng, A. S. H., & Looi, I. (2021). Mapping the Scientific Landscape of Diabetes Research in Malaysia (2000–2018): A Systematic Scientometrics Study. *International journal of environmental research and public health*, 18(1), 318. <https://doi.org/10.3390/ijerph18010318>
- Ghazanfari, Z., Haghdoost, A. A., Alizadeh, S. M., Atapour, J., & Zolala, F. (2010). A Comparison of HbA1c and Fasting Blood Sugar Tests in General Population. *International journal of preventive medicine*, 1(3), 187–194.
- Institute for Public Health. (2020). *National Health and Morbidity Survey (NHMS) 2019: Non-communicable diseases, healthcare demand, and health literacy*. Ministry of Health Malaysia. <https://iku.moh.gov.my>
- International Diabetes Federation. (2021). *IDF Diabetes Atlas (10th ed.)*. International Diabetes Federation. <https://diabetesatlas.org>
- Ismail, I. S., Nazaimoon, W. M., Mohamad, W. B., Letchuman, R., Singaraveloo, M., Pendek, R., Faridah, I., Rasat, R., Sheriff, I. H., & Khalid, B. A. (2000). Sociodemographic determinants of glycaemic control in young diabetic patients in peninsular Malaysia. *Diabetes research and clinical practice*, 47(1), 57–69. [https://doi.org/10.1016/s0168-8227\(99\)00104-7](https://doi.org/10.1016/s0168-8227(99)00104-7)
- Li, Y., et al. (2020). China's response to diabetes: A comprehensive review of China's diabetes burden, programs, and policies. *Journal of Diabetes Research*, 2020, Article ID 9654934. <https://doi.org/10.1155/2020/9654934>
- Ma, Q., Liu, H., Xiang, G., Shan, W., & Xing, W. (2016). Association between glycated hemoglobin A1c levels with age and gender in Chinese adults with no prior diagnosis of diabetes mellitus. *Biomedical reports*, 4(6), 737–740. <https://doi.org/10.3892/br.2016.643>

- Magliano, D. J., Boyko, E. J., IDF Diabetes Atlas Writing Group, & Shaw, J. E. (2024). *The global burden of diabetes and risk factors: 1990–2022. The Lancet Diabetes & Endocrinology*, 12(2), 89–102. [https://doi.org/10.1016/S2213-8587\(24\)00021-9](https://doi.org/10.1016/S2213-8587(24)00021-9)
- Masuch, A., Friedrich, N., Roth, J., Nauck, M., Müller, U.A., & Petersmann, A. (2019). Preventing misdiagnosis of diabetes in the elderly: age-dependent HbA1c reference intervals derived from two population-based study cohorts. *BMC Endocrine Disorders*, 19.
- Ministry of Health Malaysia. (2013). *Health facts 2013*. Ministry of Health Malaysia. <https://www.moh.gov.my/moh/resources/Penerbitan/Penerbitan%20Utama/HEALTH%20FACTS/HEALTH%20FACTS%202013.pdf>
- Ministry of Health Malaysia. (2013). *National Strategic Plan for Non-Communicable Diseases (NSPNCD)*. Putrajaya: Ministry of Health Malaysia.
- Ministry of Health Malaysia. (2020). *National Health and Morbidity Survey 2020: Diabetes prevalence report*. Ministry of Health Malaysia.
- Ministry of Health Malaysia. 2021. National Diabetes Registry Report 2020
- Ministry of Health Malaysia. (2020). *Management of Type 2 Diabetes Mellitus* (6th ed.).
- Ministry of Health Malaysia. [https://www.moh.gov.my/moh/resources/Penerbitan/CPG/Endocrine/CPG\\_T2DM\\_6th\\_Edition\\_2020\\_13042021.pdf](https://www.moh.gov.my/moh/resources/Penerbitan/CPG/Endocrine/CPG_T2DM_6th_Edition_2020_13042021.pdf)
- Ministry of Health Malaysia. (2022). *The direct healthcare cost of non-communicable diseases in Malaysia*. MOH. [https://www.moh.gov.my/moh/resources/Penerbitan/Rujukan/NCD/NCD\\_Laporan/HEALTH-COST\\_of\\_NCDs-7a-WEB.pdf](https://www.moh.gov.my/moh/resources/Penerbitan/Rujukan/NCD/NCD_Laporan/HEALTH-COST_of_NCDs-7a-WEB.pdf)
- Ministry of Health Singapore. (2021). *War on diabetes: Singapore's response to tackling diabetes*. <https://www.healthhub.sg/programmes/180/war-on-diabetes>
- Mohamud, W. N., Musa, K. I., Khir, A. S., Ismail, A. A., Ismail, I. S., Kadir, K. A., Kamaruddin, N. A., Yaacob, N. A., Mustafa, N., Ali, O., Isa, S. H., & Bebakar, W. M. (2011). Prevalence of overweight and obesity among adult Malaysians: an update. *Asia Pacific journal of clinical nutrition*, 20(1), 35–41.
- NCD Risk Factor Collaboration (NCD-RisC) (2023). Global variation in diabetes diagnosis and prevalence based on fasting glucose and hemoglobin A1c. *Nature medicine*, 29(11), 2885–2901. <https://doi.org/10.1038/s41591-023-02610-2>
- NHS England. (2019). *NHS Diabetes Prevention Programme: Information for health care professionals*. Retrieved from <https://www.england.nhs.uk/diabetes/diabetes-prevention/>
- Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A., Ogurtsova, K., Shaw, J. E., Bright, D., & Williams, R. (2019). Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Research and Clinical Practice*, 157, 107843. <https://doi.org/10.1016/j.diabres.2019.107843>
- Seuring, T., Archangelidi, O., & Suhrcke, M. (2015). The Economic Costs of Type 2 Diabetes: A Global Systematic Review. *Pharmacoeconomics*, 33(8), 811–831. <https://doi.org/10.1007/s40273-015-0268-9>
- Social Security Organization (SOCISO). (2023). *Health Screening Program (HSP 3.0)*. Retrieved from <https://www.perkeso.gov.my/en/perkhidmatan-kami/perkhidmatan-lain/belanjawan-2023/program-saringan-kesihatan-hsp3-0.html>
- The Global Economy. (2023). *Diabetes prevalence in Southeast Asia: Country rankings 2023*. [https://www.theglobaleconomy.com/rankings/diabetes\\_prevalence/South-East-Asia](https://www.theglobaleconomy.com/rankings/diabetes_prevalence/South-East-Asia)
- Wan Nazaimoon, W. M., Md Isa, S. H., Wan Mohamad, W. B., Khir, A. S., Kamaruddin, N. A., Kamarul, I. M., Mustafa, N., Ismail, I. S., Ali, O., & Khalid, B. A. (2013). Prevalence of diabetes in Malaysia and usefulness of HbA1c as a diagnostic criterion. *Diabetic medicine : a journal of the British Diabetic Association*, 30(7), 825–828. <https://doi.org/10.1111/dme.12161>
- World Health Organization. (2024). *Urgent action needed as global diabetes cases increase fourfold over past decades*. <https://www.who.int/news/item/13-11-2024-urgent-action-needed-as-global-diabetes-cases-increase>