



## Original Research

### *Pedigree Analysis of Diabetes Mellitus in Minangkabau Ethnic*

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## Abstract

Diabetes Mellitus is a chronic metabolic disorder with multiple etiologies characterized by hyperglycemia accompanied by impaired carbohydrate, lipid and protein metabolism that occurs due to abnormal insulin secretion, insulin action, or both and has a tendency to be inherited. Province in Indonesia which has high prevalence of diabetes mellitus is West Sumatera. Minangkabau ethnic are an ethnic group indigenous to the Minangkabau highlands of West Sumatera. The study aim was to observed the tendency of the inheritance pattern of Diabetes mellitus in the Minangkabau ethnic group based on pedigree analysis. The result show that patients with Diabetes mellitus in the Minangkabau ethnicity have an equal distribution between men (47%) and women (53%). The patient generally know that suffer from diabetes mellitus in old age or after other complications arise, and 73% of patients have a family history of diabetes mellitus. It can be concluded that the inheritance pattern of Diabetes mellitus in the Minangkabau ethnic group follows the mitochondrial and autosomal inheritance pattern.

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## Introduction

The incidence and mortality rates due to diabetes mellitus are very high. In 2019, 463 million people in the world is estimate to have diabetes and this number is projected to rise into 578 million by 2030, and 700 million by 2045. The estimated number of people who died directly due to diabetes mellitus in the world in 2019 was 1.5 million (WHO, 2021). Over four million people aged 20–79 years are estimated to die from diabetes-related causes in 2019 (International Diabetes Federation, 2019). Every 10 seconds, one person dies due to complications of Diabetes mellitus, and at the same time, two new people with diabetes mellitus are found (Roglic, 2005). The prevalence of DM in the world is 8.8% while Indonesia is ranked seventh with prevalence 6.2% (International Diabetes Federation, 2019). It is projected that in 2030 the number of Diabetes mellitus cases in Indonesia will increase to 7.8% (21.3 million from 273,219,200 people) (Perdomo, 2005); (Wild sarah, 2004). While, the prevalence of Diabetes mellitus in West Sumatra in 2000 was 5.1% (S Syamsurizal et al., 2019).

The population of West Sumatra (ethnic Minangkabau) has a high enough potential to suffer from diabetes mellitus. The Minangkabau ethnic community has a diet that contains lots of carbohydrates, fat, salt, and a tiny part of fiber. The matriarchal lineage pattern that allows "pulang ka bako /marry with close relatives" increases the chance of growing diabetes mellitus. In addition, an unhealthy lifestyle increases the risk of people with diabetes mellitus (S Syamsurizal, 2019).

Clinically, diabetes mellitus is divided into four types, namely type I, II, III, and IV. Type 2 diabetes mellitus is the most common type, approximately 95% (S Syamsurizal, 2017). Type 2 diabetes mellitus occurs because the insulin hormone in the blood does not work effectively, even though the amount of insulin produced by the beta cells of the pancreatic islets of Langerhans is average. Glucose that enters the cell is reduced so that the cell lacks an energy source and makes the blood glucose increase. (International Diabetes Federation, 2019).

The risk factors of type 2 diabetes mellitus were poor diet (high in fat and sugar and low in fiber), obesity, and an unhealthy lifestyle (lack of physical activity/exercise, lack of rest, and stress), and genetic factors. The high number of Diabetes mellitus cases in India is related to the phenotype of individuals who have a high percentage of body fat and obesity (Joshi, 2006). Blood glucose levels were used to diagnose diabetes mellitus. Patients are diagnosed with Diabetes mellitus if their fasting blood glucose level is  $\geq 126$  mg/dL or blood glucose levels are  $\geq 200$  mg/dL 2 hours after being given a glucose load of 75 grams (Waspadji, 2005)

Diabetes mellitus has a strong familial pattern of inheritance. Olson (1981), reported that type 2 diabetes mellitus is inherited in an autosomal dominant pattern. In the ethnicity, he observed, 85% of the samples had parental diabetes mellitus and half of the parents had a sibling with diabetes mellitus. Pedigree analysis on 100 ethnic Minangkabau people with diabetes mellitus, it turns out that 57.63% of people with Diabetes mellitus follow an autosomal inheritance pattern (Halifah, 2009)

The role of genetic factors in the etiology of diabetes mellitus has been widely studied. From several studies, it is known that there is more than one inheritance pattern for diabetes mellitus. The WHO Study Group (1994) research demonstrated an autosomal hereditary pattern of type 1 diabetes mellitus in the Caucasian (United States) population. Olson (1981) also found the same result in his research, which showed an autosomal inheritance pattern of Diabetes mellitus. Meanwhile, in the case of type 2 diabetes mellitus, Tim Eijkman stated that the inheritance pattern follows the pattern of mitochondrial inheritance. However, research conducted by Olson (1981) noted that type 2 diabetes mellitus is inherited in an autosomal dominant pattern. Understanding the inheritance pattern of Diabetes mellitus is very important as a basis for understanding the role of genetic factors (including the role of particular genes) in the etiology of Diabetes mellitus.

The absence of factual data on the inheritance pattern of Diabetes mellitus in the Minangkabau population makes the authors interested in conducting the research. Based on the background, the authors are interested in researching with the title "Tendency of Inherited Patterns of Diabetes Mellitus in Minangkabau Population Based on Pedigree Analysis."

Based on the research background, the formulation of the research problem can be stated as follows: 1) Does diabetes mellitus in Minangkabau ethnic tend to be inherited? 2) What is the tendency of the inheritance pattern of Diabetes mellitus in the Minangkabau ethnic group as seen from the pedigree analysis?

The study's aims were 1) to see whether diabetes mellitus in the Minangkabau ethnic group has a tendency to be inherited. 2) Observing the tendency of the inheritance pattern of Diabetes mellitus in the Minangkabau ethnic group based on pedigree analysis.

## Method

This study was a descriptive study by taking data from the status of inpatients and outpatients with the diagnosis of diabetes mellitus at the General Hospital dr. M. Djamil Padang, Ibnu Sina Padang Islamic Hospital and Selasih Padang Hospital. The population in this study was the Minangkabau ethnic community with diabetes mellitus. The samples of this study were patients with diabetes mellitus at the General Hospital dr. M. Djamil Padang, Islamic Hospital Ibnu Sina Padang, and Selasih Padang Hospital who can be interviewed during the study with the following criteria: not a gestational type diabetes mellitus patient; and can remember and know the history of Diabetes mellitus in the family of at least one descent above it.

**Research Preparation.** Observed the General Hospital dr. M. Djamil Padang, Ibnu Sina Padang Islamic Hospital and Selasih Padang Hospital. Cooperated with internal medicine specialists who usually treat diabetes mellitus and nurses at the hospital. This collaboration aims to obtain complete data on patients with Diabetes mellitus who are hospitalized or outpatient. Prepared the instruments to collect the data. The question relates to the patient's family treemap (history of diabetes mellitus), and the number of family members who suffer from diabetes mellitus is included in the pedigree analysis.

**Research Implementation.** The sample was based on the criteria mentioned above. A total of 100 patients diagnosed with Diabetes mellitus (except gestational type) who were hospitalized or outpatient were chosen as the sample of this study.

**Data collection (interviews).** The data were collected by interview method. The sample was given several questions (research instruments) that had to be answered in order to trace the family history to do the pedigree analysis.

**Data Analysis.** The data was obtained from diabetes mellitus patients by interview. The expected value was determined by calculating the percentage.

### Results and Discussion

**Result.** The study was conducted on 100 samples of Diabetes Mellitus patients in the Minangkabau ethnic group. Some of the indicators observed are: Gender of Diabetes Mellitus Patient. The gender of the sample with d.mellitus in ethnic Minangkabau people can be seen in Figure 1:

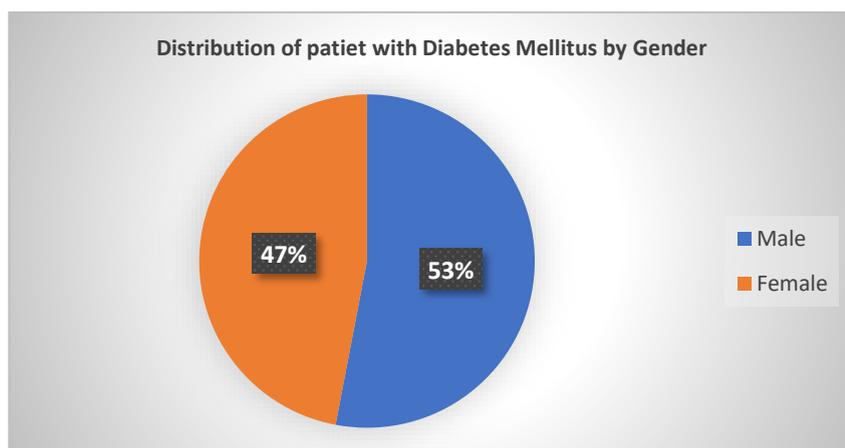


Figure 1. Distribution of Patients with Diabetes Mellitus by Gender

From Figure 1, it can be seen that the percentage of patients with Diabetes mellitus who are male is 53%, and 47% are female. There is not too much difference in this case. Age when Diabetes Mellitus First Diagnosed. In general, patients know that they had suffered from Diabetes mellitus when the disease symptoms appeared and the patient checked for glucose levels. The result study showed that the patients knew they had diabetes mellitus in the age range of 45 - 54 years as described in Figure 2:

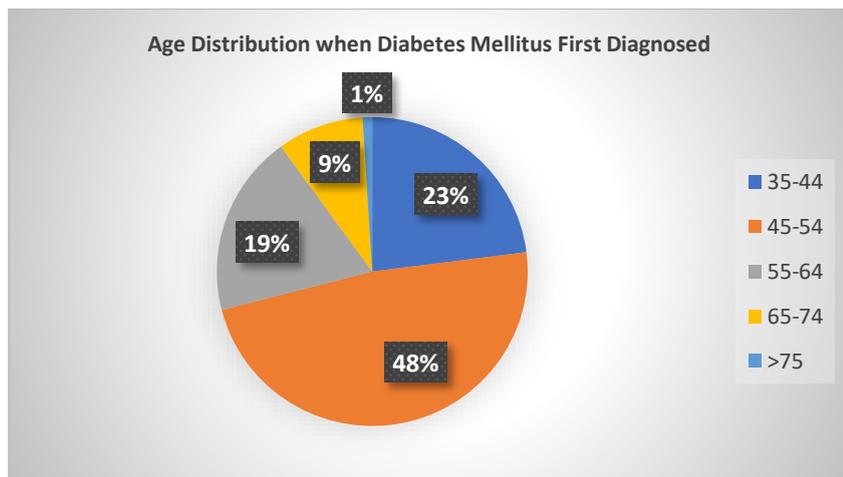


Figure 2. Age Distribution when Diabetes Mellitus First Diagnosed

Family History of Diabetes Mellitus and Inheritance Pattern. To find out how the patient suffer from diabetes mellitus, the patient is required to remember his family history. It turns out that 73% of patients have a family history of Diabetes mellitus, described in Figure 3:

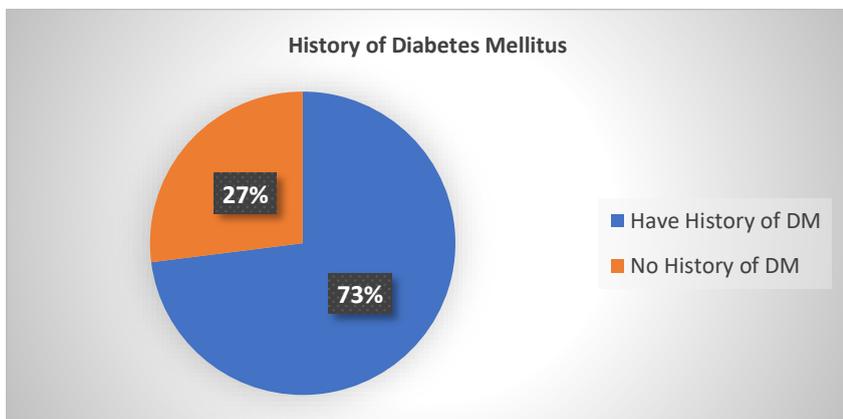


Figure 3. Patients with a history of Diabetes Mellitus

Furthermore, from the observations of patients who have a family history of Diabetes mellitus, it was found that the inheritance pattern tends to be described in Figure 4:

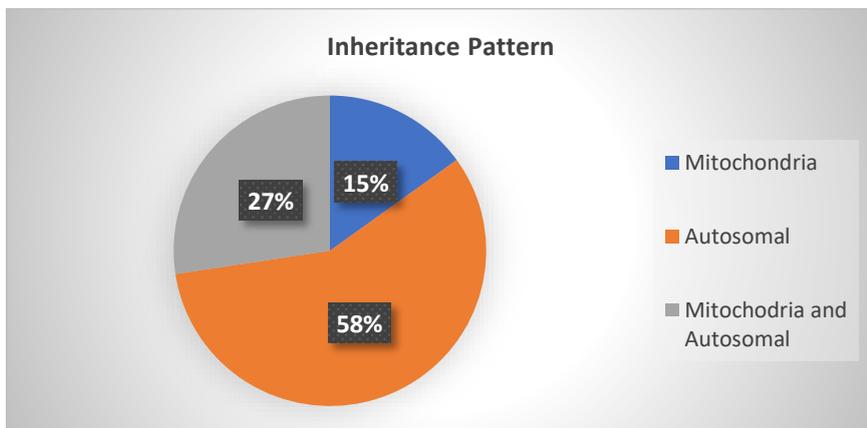


Figure 4. Percentage of Inherited Patterns of Diabetes Mellitus

From Figure 4, it can be seen that 15.06% of Diabetes mellitus patient in this study is suspected to be inherited following the mitochondrial inheritance pattern and 57.53% by the autosomal

inheritance pattern. Meanwhile, 27.39% of patients were suspected to follow both inheritance patterns (mitochondrial or autosomal).

**Discussion.** Diabetes mellitus is a disease that has a genetic component linkage that increases the risk of suffering for some families. In addition, environmental factors and lifestyle have almost the same role in causing this disease. To find out the description of the inheritance of Diabetes mellitus, the tool that can be used was a pedigree map (pedigree analysis) (Pai, 1992).

Diabetes mellitus is a disease that can be found in almost all people in the world. However, the relative distribution of Diabetes shows the main differences between countries and ethnic groups within a country (International Diabetes Federation, 2019). The Minangkabau ethnic population was selected as the sample in this study because of the diet and lifestyle that support the high prevalence of Diabetes mellitus (Syam Syamsurizal, 2018).

The distribution of diabetes mellitus sufferers in Minangkabau ethnicity shows no significant difference ( $p > 0,05$ ) between male and female patients as we know that diabetes mellitus is a disease that can happen in any age and gender (Waspadji, 2005). Of 100 samples of patients with Diabetes mellitus in the Minangkabau ethnic group, 53 samples were male patients (53%) and 47 samples were female patients (47%). The result is supported by other research by Deo (2006). Deo said that for type 2 diabetes mellitus (with a sample of 733), 53% of patients were male, and 47% of patients were female.

However, unlike Deo's research, the sample was not separated by their type of Diabetes Mellitus in this study. So the observations were only made for diabetes mellitus as a whole without differentiating the type of Diabetes mellitus suffered by the sample. The absence of data regarding the type of Diabetes mellitus sustained by the sample is a weakness in this study. This was caused by various factors, including the absence of a diagnosis regarding the type of Diabetes mellitus suffered by the samples, the inability of the samples to remember the type of Diabetes mellitus he suffered, or because of the samples' reluctance to provide information about the type of Diabetes mellitus he suffered.

Many people do not realize that they have diabetes mellitus or at risk of developing this disease. According to Nunung (2006), a study showed that people diagnosed with type 2 diabetes mellitus had actually been suffered from this disease since 8-12 years ago. So that half of those diagnosed with the disease have experienced serious complications. The facts obtained in this study stated that patients began to know that they had diabetes mellitus in the age range of 45-54 years with a percentage of 48%. Based on Nunung's statement (2006), 48% of patients have had diabetes mellitus since the age of 33-37 years. Factors that can affect these results were not having regular discussions with doctors, economic level, or having poor self-perceived health (Roche & Wang, 2014). At the same time, various methods and diagnostic criteria for diabetes mellitus have been found to help patient to diagnosed diabetes.

Tracing the background of the onset of Diabetes mellitus, the patient is required to remember his entire family history. This is intended to see whether the diabetes mellitus they suffer was inherited from the previous generation or acquired due to his unhealthy lifestyle. It turned out that most of the samples had a family history of Diabetes mellitus, with a percentage of 73%. From this percentage, it can be seen that diabetes mellitus in this population does have a tendency to be inherited.

According to Waspadji (2005), it is true that there are hereditary factors that influence the incidence of Diabetes mellitus. However, the environmental factors and lifestyle also contributed to the development of the disease. Therefore, many patients find out that they have diabetes mellitus at 45 years and over, as the data obtained from this study. In this study, 27% of the samples did not have a previous history of diabetes mellitus. In this case, genetic possibilities may exist but do not appear in the previous generation or due to lack of knowledge at that time in diagnosing diabetes mellitus.

Genetic investigation of the characteristics of diabetes mellitus requires observations about how these diseases are passed on from one generation to the next. Knowing how the disease is inherited is important to make it a marker for the other family members about the possibility of suffering Diabetes Mellitus. Nunung (2006) explained that the most common types of Diabetes mellitus are type 1 and 2 diabetes mellitus. For type 1 diabetes mellitus, several researchers have found possible inheritance patterns in families.

Studies in the Caucasian population in the United States (WHO Study Group, 1994) have shown that the main genetic predisposition is determined by genes located on the short arm of chromosome 6, either in or adjacent to the HLA (Human Leukocyte Antigen) region. Olson (1981) also supported this opinion that type 1 diabetes mellitus is due to DNA instability in chromosome 6. Researcher Ji-won Yoon (Anonymous, 1999) states that type 1 diabetes mellitus is caused by abnormalities in the cell nucleus. Mutations in the GAD gene cause this disorder. Due to mutations, when this protein is circulated in the body, the immune system will recognize it as a foreign object. As a result, T cells will attack the GAD gene's beta cells, and the body will lack insulin. These studies state that type 1 diabetes mellitus is inherited following an autosomal inheritance pattern (either dominant or recessive).

As for the case of type 2 diabetes mellitus, another researcher, the Eijkman team (Anonym, 1999), stated that type 2 diabetes mellitus follows the pattern of mitochondrial inheritance. They found that type 2 diabetes mellitus occurs due to mutations in the mitochondria (outside the cell nucleus). In this case, the beta cells are able to produce insulin but the hormone cannot be released because of the absence of energy (ATP is not formed). But according to Olson (1981), type 2 diabetes mellitus is inherited following an autosomal dominant inheritance pattern. In the population studied, 85% of the sample had parental diabetes mellitus and approximately half of these parents had a sibling with diabetes mellitus. From these two researchers, there are two possibilities about the inheritance pattern for type 2 diabetes mellitus, namely mitochondrial inheritance and autosomal dominant inheritance.

The patient's limitations (samples) in remembering the type of diabetes mellitus and remembering the entire family tree history became the weakness of this study. It could not determine the exact pattern of inheritance of Diabetes mellitus in the Minangkabau ethnic group. For this reason, researchers can only predict the inheritance pattern of Diabetes mellitus from the mitochondrial and autosomal patterns, ignoring the type of Diabetes mellitus. The results found that 57.63% of patients had diabetes mellitus through autosomal inheritance and 15.06% through mitochondrial inheritance. At the same time, 27.39% of patients are suspected of following one of the two patterns. These results show the same prevalence (as described previously) with the study conducted by the WHO Study Group, which showed a pattern of inheritance in autosomal for type 1 diabetes mellitus in the Caucasian population and similar results were also suggested by Ji-Won Yoon and Olson (1981). As for type 2 diabetes mellitus, researchers from Tim Eijkman mentioned the inheritance pattern that follows the mitochondrial pattern.

The tendency for inheritance patterns in the Minangkabau ethnic that follow mitochondrial and autosomal patterns can be a marker for other families who also have a family history of diabetes mellitus. Lewis (2007) stated that mitochondrial inheritance was obtained from maternal mitochondrial DNA. Mitochondrial DNA is wholly obtained from the mother (oocyte) because the father (sperm) never gave mitochondria when fertilization occurred in the oocyte. Sperm only enter the head (in which there is a nucleus, centrioles and acrosomes) while the neck (where there are mitochondria) and tail will be severed so that they do not enter the oocyte (Campbell, 2004).

## Conclusion

Diabetes mellitus in the Minangkabau ethnic group has a tendency to be inherited. The tendency of inheritance pattern of Diabetes mellitus in Minangkabau ethnic follows mitochondrial and autosomal inheritance pattern. Patients with Diabetes mellitus in the Minangkabau ethnicity have a relatively equal distribution between men and women. Patients with Diabetes mellitus in this ethnic group generally know that they suffer from diabetes mellitus in the elderly or after the complications arise due to diabetes mellitus.

## References

- Campbell , Reece and Mitchell. 1999. *Biologi*. Erlangga: Jakarta.
- International Diabetes Federation. (2019). International Diabetes Federation. In *The Lancet* (Vol. 266, Issue 6881). [https://doi.org/10.1016/S0140-6736\(55\)92135-8](https://doi.org/10.1016/S0140-6736(55)92135-8)
- Joshi , shashank R dkk. 2006. Family History and Pedigree Charting- A Simple Genetic Tool For Indian Diabetics. (<http://id.www.hindujahospital.com/IDCC2006>. diakses tanggal 10 september 2008 ).
- Lewis, Ricki.2007.Human Genetic, Concept and Aplikations. Mc Graw-Hill Companies.
- Nunung, N.dkk. 2006. Takhlukkan Diabetes Dengan Terapi Jus. Puspa swarna; Jakarta.
- Olson, charles. 1981. Diagnosis and Management of Diabetes Mellitus. Lea and Febiger: Washington.
- Pai, Anna C. 1992. Dasar-dasar Genetika. Erlangga: Jakarta.
- Perdomo, Rosa Perez. 2005. Epidemiology of Diabetes; Prevalence, Complications and Health Services Disparities. Centro de Diabetes: Para Puerto Rico.
- Roche, M. M., & Wang, P. P. (2014). Factors associated with a diabetes diagnosis and late diabetes diagnosis for males and females. *Journal of Clinical and Translational Endocrinology*, 1(3), 77–84. <https://doi.org/10.1016/j.jcte.2014.07.002>
- Syamsurizal, S. (2017). Sudut ATD sebagai Penanda Diabetes Mellitus Tipe-2 (DMT2). *BioScience*, 1(1), 1. <https://doi.org/10.24036/02017117162-0-00>
- Syamsurizal, S. (2019). *Jumlah Sulur sebagai Penanda Diabetes Mellitus Tipe-2 Etnis Minangkabau Ridge count as Type-2 diabetes mellitus marker in Minangkabau Ethnic. June 2018.*
- Syamsurizal, S, Handayani, D., Kadri, H., & Badriyya, E. (2019). Genotyping SNP rs7903146 TCF7L2 gene for detection T2DM in Indonesian melayu ethnic Genotyping SNP rs7903146 TCF7L2 gene for detection T2DM in Indonesian melayu ethnic. *Journal of Physics: Conference Series*, 1317, 1–8. <https://doi.org/10.1088/1742-6596/1317/1/012090>
- Syamsurizal, S. (2018). Type-2 Diabetes Mellitus of Degenerative Disease. *Bioscience*, 2(1), 34. <https://doi.org/10.24036/02018219980-0-00>
- Wild sarah, roglig gojka. (2004). Estimates for the year 2000 and projections for 2030. *World Health*, 27(5).
- Waspadji. 2005. Penyuluhan Diabetes. Balai Penerbit FKUI:Jakarta.
- World Health Organization.2021. Diabetes. <https://who.int/> Accessed December 27<sup>th</sup> 2021