



# Analysis of diabetes mellitus foot sensitivity disorders in Magelang Regency

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**Abstract.** The increasing population of diabetes mellitus (DM) sufferers has an impact on increasing the incidence of diabetic ulcers as a chronic complication of DM, as many as 15-25% of DM sufferers will experience diabetic ulcers in their lives. Diabetic foot exercises are activities or exercises carried out by people who suffer from diabetes mellitus to prevent injuries and help improve blood circulation in the feet. The aim of this research is to analyze foot sensitivity disorders in people with diabetes mellitus in Magelang Regency. Quantitative descriptive is used in research based on Regional Health Research data Magelang Regency. The percentage of diabetes mellitus incidence in Central Java Province has increased from 0.9% based on the 2013 Riskesdas, and increased to 1.33 based on the 2018 Riskesdas. There was an increase of 0.43% compared to the 2013 Riskesdas results. Therefore, people who have diabetes mellitus are at risk of experiencing impaired foot sensitivity so it is recommended to provide health promotion and diabetic foot exercises to manage diabetes mellitus.

**Keywords:** Diabetic Mellitus, Foot Exercises, Foot Sensitivity.

## 1 Introduction

According to the International Diabetes Federation (IDF), in 2019 diabetes mellitus in the world is expected to increase threefold from the previous year, 463 million. The lowest prevalence is in the 20-24 years old age range, it is 1.4% in 2019 and in the 75-79 years old age range, the prevalence of diabetes is 19.9% in 2019 so it is predicted to increase to 20.4% and 20.5% in 2030 and 2045. The estimated prevalence of diabetes in women aged 20-79 years is slightly lower than in men, 9.0% versus 9.6%. In 2019 around 17.2 million more men than women had diabetes. China is the country with the most diabetes sufferers in the world, with 116.4 million patients, followed by India with 77 million patients, and 31 million patients in the United States. Indonesia ranks seventh with 10.7 million DM sufferers in the world and it is estimated that this will continue to increase every year. IDF estimates that DM patients in Indonesia in 2030 will be 13.7 million sufferers, then in 2045 there will be 16.6 million sufferers.

The results stated that the prevalence of diabetes in Indonesia based on doctor's diagnosis among those aged  $\geq 15$  years was 2% increase compared to the 2013 Riskesdas

results, 1.5% [3]. All provinces showed an increase in cases in 2013-2018, except for the province of East Nusa Tenggara (NTT). There are three provinces with the highest prevalence in 2013 and 2018, namely DI Yogyakarta, DKI Jakarta, North Sulawesi. Central Java Province is in 9th place in the 2013-2018 Riskesdas results [3].

The prevalence of diabetes mellitus cases in Central Java province in 2018 was 20.57%, an increase compared to cases in 2017, 19.22%. Based on gender, diabetes cases are more common in women, 1.97%, compared to men, 1.20% [29]. DM cases in Magelang Regency in 2018 were 1.33%. The proportion of types of Diabetes Mellitus (DM) treatment diagnosed by doctors in Magelang Regency at all ages is Anti-Diabetes Medication (OAD) from medical personnel at 73.04%, insulin injection at 5.98%, OAD from medical personnel and insulin injection at 12.38%, and untreated 8.61% [3]. Based on age categories, diabetes sufferers are predominantly in the age range 55-64 years and 65-74 years. Areas with many diabetes mellitus sufferers are in urban areas at 1.9% compared to rural areas which is only 1.0% [4]. The risk of vascular complications can increase if someone suffers from DM. A total of 15% of people with DM will experience DM wounds and 24% of people with leg ulcers will require amputation. As many as 54.74% did exercise, 7.87% did not comply with the doctor's advice [3]. Foot care is an effort to primary prevent wounds on diabetic feet as well as early symptoms of tingling or numbness which will cause a decrease in foot sensitivity. One of the actions that must be taken in foot care to detect foot abnormalities early is to massage the venous veins as well as diabetic foot exercises, in addition to cutting nails properly, wearing good footwear, and maintaining foot hygiene [20].

The basic treatment that can be carried out when complications occur is simply to control blood sugar levels as much as possible to prevent worse conditions from occurring, because neuropathy will continue as the diabetes mellitus disease progresses. Handling neuropathy can be done through three things, namely (1) counseling or providing advice; (2) pain treatment; and (3) foot care [24]. Foot care is an effort to primary prevent wounds on diabetic feet as well as early symptoms of tingling or numbness which will cause a decrease in foot sensitivity. One of the actions that must be taken in foot care to detect foot abnormalities early is to massage the venous veins as well as diabetic foot exercises, in addition to cutting nails properly, wearing good footwear, and maintaining foot hygiene [20]. Diabetes mellitus can be treated by managing several things that influence glucose reduction, namely activity, insulin levels, diet, education and therapy [11]. From a health science perspective, there is no doubt that exercise or physical exercise, if done properly, is beneficial for health and strength in general. A part from that, exercise has long been used as part of the treatment of diabetes mellitus, but not all exercise is recommended for people with diabetes mellitus (for normal people too), because it can cause unexpected things. The right exercise to do is exercise that is measurable, regular, controlled and sustainable. The recommended frequency is several times per week for 30 minutes or more regularly and not excessively [8]. The recommended intensity is 40-70%, light to moderate activity [25]. One type of exercise that is recommended, especially for elderly patients, is foot exercises [1].

Diabetic foot exercises are activities or exercises carried out by diabetes mellitus patients to prevent injuries and help improve blood circulation in the feet [17]. Meanwhile, according to [19], diabetic foot exercises are one of the therapies provided by a

nurse or health worker. This diabetic foot exercise aims to improve blood circulation so that nutrition reaches the tissues more smoothly, strengthen small muscles, calf muscles and thigh muscles, and overcome the limited joint movement that is often experienced by diabetes mellitus sufferers [21]. This diabetic foot exercise can be given to all diabetes mellitus sufferers of type 1 or 2. However, it should be given from the time the patient is diagnosed with diabetes mellitus as an early preventive measure against diabetic ulcers.

Diabetic foot exercises are highly recommended for diabetes sufferers who experience blood circulation disorders and neuropathy in the feet, but are adjusted to the condition and abilities of the sufferer's body. The power of venous massage and movements in diabetic foot exercises as presented in the 3rd National Diabetes Educators Training Camp in 2005 can help improve blood circulation in the feet so that it is hoped that they can overcome the occurrence of diabetic ulcers. Reduces complaints from sensory neuropathy such as: soreness, numbness or tingling in the feet. The benefits of foot venous massage and diabetic foot exercises are that it can strengthen small muscles, prevent foot deformities, increase the strength of the calf and thigh muscles (gastrocnemius, hamstring, quadriceps), and overcome limitations in joint movement, making the muscles in the which moves to contract [20]. This study aims to provide an overview of the percentage of diabetes mellitus cases that experience a risk of DM ulcers starting with a decrease in foot sensitivity (numbness) in Magelang Regency in 2018-2020.

## 2 Methods

Data collection used secondary data, 2018 Regional Health Research data and the Magelang District Health Service. The data is processed using Excel to get percentages. The results are then visualized using diagrams to make it easier to see the overall results. The percentage description was then analyzed qualitatively.

## 3 Results

The results of this research are depicted in diagram form, the percentage of people who experience diabetes mellitus in Central Java, the percentage of people who experience peripheral blood circulation disorders in the form of numbness (tingling) in Magelang district in 2013 and 2018. The percentage of diabetes mellitus incidents in Central Java Province has increased from 0.9% from the 2013 Riskesdas results, and increased to 1.33 based on the 2018 Riskesdas results. There was an increase of 0.43% compared to the 2013 Riskesdas results. This was also followed by an increase in the risk of diabetic ulcers which began with a decrease in foot sensitivity (numbness). Table 1 describes the population in Central Java who consume sweet foods, Table 2 looks at several characteristics.

**Table 1.** Proportion of population aged  $\geq 10$  years who consume sweet food/drinks by district/city, Central Java Province 2013

Regency/City	Sweet food/drinks.		
	$\geq 1$ times/ day	1 - 6 times/ week	$\leq 3$ times/ month
Cilacap	54,0	33,1	13,0
Banyumas	57,0	34,8	8,2
Purbalingga	47,3	40,6	12,1
Banjarnegara	58,6	29,4	12,0
Kebumen	61,3	30,0	8,6
Purworejo	57,3	38,6	4,1
Wonosobo	52,6	30,8	16,6
Magelang	56,9	32,6	10,5
Boyolali	68,3	24,5	7,2
Klaten	68,6	23,1	8,3
Sukoharjo	66,2	30,2	3,6
Wonogiri	80,3	11,4	8,3
Karanganyar	77,8	17,3	4,9
Sragen	54,9	34,5	10,7
Grobogan	43,8	45,6	10,6
Bloro	51,8	38,2	10,0
Rembang	35,1	53,7	11,2
Pati	53,3	37,6	9,1
Kudus	80,9	17,4	1,7
Jepara	55,5	40,1	4,4
Demak	48,5	43,1	8,4
Semarang	61,1	29,7	9,2
Temanggung	81,9	13,6	4,5
Kendal	60,0	34,8	5,2
Batang	79,1	15,6	5,3
Pekalongan	84,8	11,3	3,9
Pemalang	65,6	26,6	7,8
Tegal	66,2	27,0	6,8
Brebes	50,5	36,5	12,9
Kota Magelang	80,9	14,1	5,0
Kota Surakarta	77,7	17,6	4,8
Kota Salatiga	73,9	20,3	5,8
Kota Semarang	73,5	22,4	4,1
Kota Pekalongan	91,7	6,6	1,7
Kota Tegal	80,0	16,7	3,3
JAWA TENGAH	62,0	29,9	8,1

**Table 2.** Proportion of population aged  $\geq 10$  years who consume sweet foods/drinks according to characteristics, Central Java Province 2013

Characteristics	Sweet Food/Drinks		
	$\geq 1$ times/ day	1 - 6 times/ week	$\geq 3$ times/ month
Age group (years)			
10 – 14	57,1	35,5	7,4
15 – 19	56,5	35,7	7,9
20 – 24	61,0	32,5	6,5
25 – 29	61,0	31,0	8,0
30 – 34	63,4	29,3	7,3
35 – 39	64,3	28,0	7,7
40 – 44	63,9	28,2	8,0
45 -49	64,4	28,0	7,6
50 -54	64,7	26,7	8,6
55 -59	63,5	27,9	8,6
60 -64	63,5	25,9	10,6
65 +	64,5	24,1	11,5
Gender			
Man	66,3	27,5	6,2
Woman	57,8	32,2	10,0
Education			
No school	63,1	26,2	10,7
Not completed in primary school	60,4	30,9	8,7
Finished elementary school	59,9	31,3	8,8
Finished high school	61,7	30,2	8,2
Finished high school	66,4	27,9	5,7
Completed D1-D3/PT	67,7	26,2	6,1

## 4 Discussion

Based on the results above, between the results of the 2013 Riskesdas and the 2018 Riskesdas, regarding the prevalence of diabetes mellitus in Magelang Regency and Central Java Province, the sweet eating pattern of people who have diabetes mellitus, and suffer from peripheral blood circulation disorders (at the tips of the feet) is relatively enhancement, 56.9% of people's food patterns consume food/drinks  $\geq 1$  time per day. The sweet eating pattern is mostly done by those aged 50-54 years, as many as 64.7 people consume food/drinks  $\geq 1$  time per day. Based on 2018 Riskesdas data, people Only 48.1% of people with diabetes mellitus do sports or activities to overcome peripheral blood circulation disorders. This data shows the lack of community efforts to deal with the impact of diabetes mellitus with activities including diabetic foot exercises.

Blood circulation is the flow of blood pumped by the heart into the blood vessels and distributed by the arteries to all the body's organs, one of which is the leg organs [5]. Sensitivity measurements are carried out by comparing the results of sensitivity measurements between those using a needle, brush and cotton. The criteria for sensitivity at the tips of the feet according to [17] are a value of 0 which is no sensitivity, a

value of 1 is less sensitivity, a value of 2 is moderate sensitivity and a value of 3 is good (normal) sensitivity.

The cause of wounds or abnormalities in the feet of patients with diabetes is an abnormality in the nerves, an abnormality in the blood vessels and then an infection. Of these three things, the one that plays the most role is nerve abnormalities, while blood vessel abnormalities play a more significant role in wound healing, thereby determining the fate of the foot. Nervous disorders can affect sensory nerves, motor and autonomic nerves [23].

Sensory sensation becomes lost, which causes the inability to feel painful stimuli, thereby losing the ability to protect the feet against external stimuli. As a result, the feet are more susceptible to injury even from small impacts. If a wound occurs, it will make it easier for germs to enter and cause infection. If this infection is not treated properly, it will progress to decay (gangrene) and can even result in amputation [23].

Disorders of motor nerve fibers (nerve fibers that go to muscles) can result in atrophy of the interosseous muscles in the legs. As a further consequence of this situation, there is an imbalance in the leg muscles, there is a change in the form of deformity in the foot such as the fingers bending cock up toes, shifting of the luxation joints in the metatarsophalangeal joints of the forefoot and thinning of the fat pad under the area at the base of the toes of the metatarsal heads. This causes an expansion of the area under pressure, especially under the metatarsal heads [23].

Changes in the power of vasodilatation-vasoconstriction blood vessels in the lower leg area increase or decrease, resulting in the joints becoming stiff. In a further situation, there is a change in the shape of the charcot foot, which causes changes in new pressure areas of the foot and risks injury [23]. Blood vessel disorders result in blockage of blood vessels, thereby obstructing blood flow, disrupting the supply of oxygen, food or antibiotic drugs which can interfere with the wound healing process. If treatment for this infection is not perfect it can cause gangrene. Extensive gangrene can also occur due to extensive blockage of blood vessels, making it possible to amputation of the leg above the knee [35].

Diabetic foot exercises are physical exercises that are chosen and created in a planned manner, arranged systematically with the aim of forming and developing the person in harmony [26]. Based on its definition, gymnastics is a type of aerobic exercise that uses movement of some of the body's muscles, where the body's oxygen needs can still be met [27]. Physical exercise is one of the principles in managing diabetes mellitus. Daily physical activity and regular physical exercise (3-4 times a week for approximately 30 minutes) is one of the pillars in managing diabetes. The physical exercise in question is walking, cycling, jogging, gymnastics and swimming. This physical exercise should be adjusted to age and physical fitness status [11].

Diabetic foot exercises are activities or exercises carried out by diabetes mellitus patients to prevent injuries and help improve blood circulation in the feet [28]. Foot exercises can help improve blood circulation and strengthen the small muscles of the feet and prevent foot deformities. Apart from that, it can increase the strength of the calf muscles, thigh muscles, and also overcome limitations in joint movement [21]. Physical activity is body movement that substantially increases energy use and can take

the form of daily activities (walking, doing housework, gardening) as well as sports activities, namely swimming, cycling, gymnastics, fitness [2].

According to Lemon, et al. [10] with his activity theory states that successful aging depends on how satisfied the elderly feel in carrying out and maintaining activities. This is related to social interaction and involvement of the elderly in their environment so that losing their role will eliminate an elderly person's satisfaction. This is reinforced by the opinion of [30] who states that physical activity has a significant relationship with limb disorders where low physical activity, one of which is irregular exercise, is at risk of movement disorders. Exercises to maintain mobility and body posture in the elderly also aim to maintain and improve joint movement throughout the body, increase muscle strength, stimulate blood circulation, maintain functional capacity, prevent contractures and maintain good body posture [31].

Elderly people who participate in sports activities, even those who have stopped for a long time, have better postural control and reduced dependence on visual information compared to elderly people who are inactive [32]. This is reinforced by the opinion of [6] that in a state of immobilization approximately 3% of muscle strength decreases every day, which means that elderly people will experience deterioration more quickly due to disuse.

According to the benefits of exercise programs for the elderly, especially for the musculoskeletal system, are increased muscle strength, ROM (Range of Motion), flexibility, bone density and blood circulation [16]. This is in accordance with the opinion stated that activity training and high-intensity ROM training in elderly people with idiopathic Parkinson's disease carried out 3 times a week for 4 weeks can increase muscle strength and blood circulation [33]. Likewise, research conducted showed that elderly people who were given four square step training, which is a form of dynamic movement training for 4 weeks, had significantly better blood circulation than before training [34].

The goal obtained after doing these foot exercises is to improve blood circulation in the feet of diabetic patients, so that nutrients are distributed smoothly into the tissues [18]. The benefits of diabetes exercise on the heart organ, it becomes stronger and the heart chambers become larger, so that the beats are strong and have a large capacity. Both of these things will increase the efficiency of the heart's work. With high work efficiency, the heart does not need to beat too often [7]. In blood vessels, the elasticity of the blood vessels will increase, due to reduced fat deposits and increased contractility of the muscles of the blood vessel walls. High elasticity of blood vessels will facilitate the flow of blood and prevent the emergence of hypertension [7]. The elasticity of the lungs will increase, so that the ability to expand and collapse will also increase [7]. Flexibility and muscle endurance will increase. This is caused by an increase in the size of muscle fibers an increase in the energy supply system in the muscles. Ligaments and tendons will get stronger, as will the attachment of tendons to bones [7].

The indications for this foot exercise can be given to all people with diabetes mellitus type 1 or 2. However, it should be given from the time the patient is diagnosed with diabetes mellitus as an early preventive measure. This leg exercise is also contraindicated in clients who experience changes in physiological function such as dyspnea or chest pain. Circumstances like this need to be considered before doing leg exercises.

Apart from that, assess the patient's general condition and condition whether it is appropriate to do the leg exercises, check vital signs and respiratory status (is there dyspnea or chest pain), assess the patient's emotional status (mood, motivation), and pay attention to indications and contraindications in providing leg exercise [11].

## 5 Conclusion

The increasing number of people suffering from diabetes mellitus are at risk of impaired foot sensitivity, to overcome the risk of peripheral blood circulation disorders and even the risk of diabetic ulcers can be prevented with foot exercises.

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