



# Diabetic Foot Deformity Examination in Diabetics at Surabaya, Indonesia

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**Abstract. Background:** Uncontrolled diabetic blood sugar can lead to chronic complications of motor neuropathy. Changes in foot shape (deformity) result in changes in foot biomechanics, so there is a high risk of developing diabetic foot ulcers.

**Aim:** This study aimed to identify diabetic foot deformities in diabetics.

**Methods:** The research design used descriptive quantitative observational categories. The population in this study were all patients suffering from type 2 diabetes mellitus at the Kebonsari Health Center Surabaya, which was examined in April – May 2020. The sampling technique used was incidental sampling with a sample size of 120 respondents. The research instrument used was an observation sheet to observe the anatomical deformity of the foot. The research analysis uses the frequency of each category (n) and the presentation of each category (%).

**Results:** The results showed that 96 people were Kallus (80%), Corn 66 people (55%), Burning 51 people (42.5%), Hammer toe 27 (22%), and Charcot foot 60 people (50%).

**Conclusion:** Diabetic foot deformities in diabetic are callus, corn, burnion, hammer toe, and Charcot foot caused by the duration of suffering from diabetes mellitus and inappropriate shoes. It is recommended that periodic examinations of diabetics need to be carried out to determine the deformity of the diabetic foot to prevent diabetic foot ulcers.

**Keywords:** Examination · Foot Deformity · Diabetes Mellitus

## 1 Introduction

Diabetes mellitus (DM) is an important priority public health problem and is one of the four non-communicable diseases. The number of cases and prevalence of diabetes have continued to increase over the last few decades and have become the target of follow-up by world leaders [1]. *American Diabetes Association* (2016) states that diabetes mellitus is a complex chronic disease that requires continuous treatment by reducing various risk factors to control blood sugar in people with diabetes mellitus. DM is also called the *silent killer* because it is often not realized by the sufferer until complications occur [2]. One of the most common complications of diabetes mellitus is peripheral neuropathy.

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Peripheral neuropathy in patients with diabetes mellitus is the first predisposing factor to appear. These disorders include autonomic disorders, motor disorders, and sensory disorders (Hobizal & Wukich, 2012; Farida *et al.*, 2021). According to data from RSUP Dr. Cipto Mangunkusumo Jakarta (RSCM) in 2011, the highest DM complication was foot neuropathy. Neuropathy in the feet can increase the occurrence of diabetic foot ulcers, infections, and even the need for amputation (Kemenkes RI, 2014). Early examination of neuropathic disorders such as examination of foot anatomical deformities for the prevention of DFU (*Diabetic Foot Ulcer*) in patients with type 2 DM (*Diabetes Mellitus*) at the Kebon Sari Health Center is still not explained.

According to *International Diabetes Federation* (IDF) in 2019, there were around 463 million people with diabetes in the world. This number will increase in 2030 by 578 million people and is expected to continue to increase by 51%, namely 700 million people in 2045. The prevalence of diabetes mellitus in Asia in 2019 is around 88 million people, in 2030 it is estimated to increase to 115 million people and will continue to increase by 74%, namely 153 million people in 2045 [6]. Patients with diabetes mellitus in Indonesia have increased from year to year. In 2013 DM patients were 6.9% and this increased to 8.5% in 2018 [7]. The prevalence of diabetes mellitus in East Java Province diagnosed by all ages in 2018 was 2.02% and in the city of Surabaya was 3.5%. The city of Surabaya is ranked 3rd after Madiun and Mojokerto (Risksedas Jatim, 2018). According to the PERSI (Indonesian Hospital Association) data and information center, the prevalence of type 2 diabetes mellitus patients with neuropathic complications in Indonesia is more than 50%. This statement is reinforced by the Basic Health Research (RISKESDAS) in 2011 which showed that the most diabetes complications were neuropathy experienced by around 54% of patients treated at Cipto Mangun Kusumo Hospital (Kemenkes RI, 2014, Farida, Arini, & Mardayati, 2018). Based on a preliminary survey conducted by researchers, all 5 diabetes mellitus patients, or 100% experienced foot deformities in the form of callus, burnion, and hammer toe.

Patients with DM if blood glucose levels are not controlled will occur chronic complications in the form of nerve disorders called neuropathy [10, 11]. Neuropathy causes changes in nerve tissue due to the accumulation of sorbitol and fructose, resulting in loss of axons, decreased speed of induction, paresthesias, decreased muscle reflexes, muscle atrophy, excessive sweating, dry skin, and loss of taste. to a diabetic ulcer [12]. Peripheral neuropathy includes autonomic, sensory, and motor nerves, which mostly affect the distal area [13]. Motor neuropathy causes muscle weakness so that it becomes abnormal biomechanics of the foot and causes deformities such as hammer toes, claw toes, and charcot, together with the presence of neuropathy facilitating callus formation [3].

DM patients remember that neurological disorders are at high risk of developing diabetic foot ulcers. *Screening* needs to be done to determine whether the diabetic patient is at low or high risk of experiencing DFU so that preventive measures can be taken immediately. Examination of neuropathic disorders is useful for preventing diabetic foot ulcers, one of which is the examination of foot deformities in patients with diabetes mellitus. This study aims to identify the anatomical deformity of the foot and its causes in patients with type 2 diabetes mellitus.

## 2 Methods

Design of this research was descriptive quantitative observational category. The population in this study were all patients suffering from type 2 diabetes mellitus at the Kebonsari Public Health Center Surabaya, who carried out examinations in April – May 2020. The sampling technique used is *incidental sampling* with a sample size of 40 respondents. The research instrument used was an observation sheet to observe the anatomical deformity of the foot, in patients with type 2 diabetes mellitus. The research analysis used statistical methods for each category (n) and the presentation for each category (%). This research has been carried out at the STIKES Hang Tuah Surabaya with no PE/17/VI/2022/KEPK/SHT on 10<sup>th</sup> June 2022.

## 3 Results

Table 1. Shows the majority of respondents are female, as many as 75 people (62.5%), aged 56 - 61 years, as many as 69 people (57.5%), working as housewives, as many as 48 people (40%), having high school education as many as.

Sixty-three people (52.5%) have used shoes/sandals with high heels for a long time, 63 people (52.5%) have used shoes with a narrow toe for a long time, 72 people (60%) have used shoes that fit on the feet for a long time 87 people (72.5%), DM patients doing foot care were 84 people (70%), DM patients with more than 5 years old were 93 people (77.5%).

Table 2 shows that the majority of foot anatomical deformities with callus were found in the right foot in as many as 96 people (80.0%), the left foot in as many as 9 people (7.5%), who experienced both as many as 3 people (2.5%) and did not experience callus/calluses. as many as 12 people (10.0%). Anatomical deformity of the foot with corns, the majority were on the right foot as many as 66 people (55%), left foot as many as 24 people (20%) who experienced both as many as 6 people (5%), did not experience corn as many as 24 people (20%). Anatomical deformities of the foot with burnion, the majority were in the right foot as many as 51 people (42.5%), the left foot as many as 21 people (17.5%), who experienced both as many as 21 people (17.5%) and 27 people did not experience burnion (22.5%). Anatomical deformities of the foot with a hammer toe, on the right foot of as many as 27 people (22.5%), in the left foot of as many as 18 people (15%), and those who experienced both were 15 people (12.5%) and 60 people who did not experience hammer toe (50%). Anatomical deformities of the foot with Charcot's foot, the majority were in the right foot as many as 60 people (50%), the left foot in as many as 18 people (15%), who experienced both as many as 15 people (12.5%) and did not experience the foot Charcot as many as 18 people (22.5%).

**Table 1.** Characteristics of Respondents in Type 2 DM patients at the Kebonsari Health Center Surabaya May - June 2020 (n = 120).

<b>Foot Anatomy Examination</b>		<b>n</b>	<b>%</b>
Gender	Male	45	37.5%
	Female	75	62.5%
Age	49–55 yrs	27	22.5%
	56–61 years	69	57.5%
	62–67 years	24	20.%
work	Domestic	48	40%
	Government employed	9	7.5%
	Private	24	20%
	Entrepreneur	9	7.5%
	Pension	30	25%
Education	Elementary	33	27.5%
	Junior high school	21	17.5%
	Senior high school	63	52.5%
	Higher Education	6	5%
Have used shoes/sandals with high heels for a long time	Yes	63	52.5%
	No	57	47.5%
Have worn shoes with narrow toes for a long time	Yes	72	60%
	No	48	40%
Have you worn shoes that fit your feet for a long time	Yes	87	72.5%
	No	33	27.5%
Foot care	yes	84	70%
	no	36	30%
Duration of DM	< 5 years	27	22.5%
	> 5 years	93	77.5%

## 4 Discussion

Table 2 shows that anatomical deformities of the feet with the majority of callus being on the right foot in as many as 96 people (80%), 9 people (7.5%), the left foot in as many as 3 people (2.5%) and not having callus/calluses. as many as 12 people (10%). These data indicate that there is a high prevalence in patients with diabetes mellitus who experience foot anatomical deformities with callus.

A callus is a thickening of the skin and hardening of the pads of the soles of the feet or the outer side of the big toe due to friction and pressure that is often repeated and lasts

**Table 2.** Data on Observation of Foot Anatomical Deformities in Type 2 DM Patients at Kebonsari Health Center Surabaya May – June 2020 (n = 120)

Foot Anatomy Examination		n	%
Callus/Calluses	Not Experiencing	12	10%
	Right	96	80%
	Left	9	7.5%
	Experiencing Both	3	2.5%
Corn/Fish Eye	Not Experiencing	24	20%
	Right	66	55%
	Left	24	20%
	Experiencing Both	6	5%
Burnions	No Experiencing	27	22.5%
	Right	51	42.5%
	Left	21	17.5%
	Experiencing Both	21	17.5%
Hammer Toes	Not Experiencing	60	50%
	Right	27	22.5%
	Left	18	15%
	Experiencing Both	15	12.5%
Feet Charcot	Unexperience d	27	22.5%
	Right	60	50.0%
	Left	18	15.0%
	Experiencing Both	15	12.5%

a long time [14]. Thickening of the skin often occurs on the soles of the feet, especially in the protruding areas caused by repeated friction/pressure on the same area, and also due to unbalanced weight distribution, the use of inappropriate shoes (narrowness), or skin disorders. Callus can develop into an infection if manipulated (scraped and cut). (Suyono 2009 dalam Fajriyah, 2018).

Calluses usually appear on the feet, heels, hands, or fingers, but calluses generally occur on the soles of the feet, because when we are walking, this is the part that supports the weight of the body. Callus often occurs in diabetic feet, as a result of neuropathy and decreased blood circulation, and repeated friction or pressure on certain areas of the foot. Callus if not known and treated appropriately, will cause injury to the underlying tissue, which continues with infection and then becomes an ulcer [16].

Based on the results of research conducted by Fazriyah (2018), shows that most of the respondents' diabetic feet experience dry scaly skin, cracked heels, thinning hair, and callus [15]. Tandra's research (2014) says that the callus on the soles of the feet is 11 times more prone to ulcers and amputations [17]. The foot deformity results from

increased pressure on the diabetic foot which can form a callus. Callus can develop into diabetic foot ulcers and recurrent diabetic foot ulcers (Fujiwara, 2011, Safruddin & Hidayat, 2018).

Based on the results of the study, the researchers assumed that the occurrence of calluses was due to the duration of diabetes mellitus patients who were more than 5 years as evidenced in Table 1, which shows 93 people (77%). This is because the longer you suffer from diabetes, the higher the risk of complications. The callus is one of the complications of diabetes mellitus due to neuropathy, decreased blood circulation, and repeated friction in the foot area.

The callus is also caused by the use of inappropriate and inappropriate shoes. This is evidenced by Table 1 that respondents who have used shoes with high heels for a long time are 63 people (52.5%), respondents who have used shoes with narrow front ends for a long time are 72 people (60%) and respondents have using shoes that fit on the feet for a long time is 87 people (72.5%). so that there will be friction and pressure that is continuous and excessive for a long time, irritates the feet, and becomes ulcers.

Table 1 shows that women suffer from diabetes mellitus more than men with 75 women (62.5%) and 45 men. People (37.5%). This is because women with diabetes mellitus are at high risk of experiencing foot anatomical deformities with callus. Women more often use shoes with high heels, shoes with a narrow front end, using shoes that fit on the feet.

Table 2 shows the anatomical deformity of the foot with corns, the majority of which were in the right foot of as many as 66 people (55%), the left foot of as many as 24 people (20%), who experienced both as many as 6 people (5%) and did not experience corn as many as 24 people (20%). These data indicate that there is a high prevalence in patients with diabetes mellitus who experience an anatomical deformity of the foot with corns.

Corn/Heloma/fish eye is a thickening of the skin on the back of the toes due to prolonged and excessive pressure and friction, round in shape, hard in the middle, and soft at the edges (Sutedjo, 2010; Fajriyah, 2018). Corns form when the skin is often under pressure or friction. Corn appears because of the body's way of trying to protect itself from further damage. Corns usually appear on the skin tissue closest to the bone. When this area is subjected to friction and pressure, the skin will produce more cells to protect the area. This is what causes the accumulation of cells to protect it so that excessive and dense skin thickens and grows, which then presses on the nerves and causes pain. Corn feels painful, especially when pressed [15].

Corn causes abnormalities in the skin, in the form of thickening, hardening, and protrusion of the skin. The skin can become scaly, dry, or oily. Corn with callus, the difference is that the corn causes inflammation and pain in the affected area. External factors that also play a role in causing corn are the type of shoes or footwear used. The most common location where corns form is on the soles of the feet, especially areas affected by friction [15].

Based on the results of the study, researchers assumed that the occurrence of corn was caused by the selection of shoes, types of shoes, and footwear used in patients with diabetes mellitus that were not appropriate and appropriate. This evidenced by Table 1 explained that respondents who have used shoes with high heels for a long time are

63 people (52.5%), respondents who have used shoes with narrow front ends for a long time are 72 people (60%) and respondents have using shoes that fit on the feet for a long time is 87 people (72.5%) so that continuous and excessive friction and pressure will irritate the feet and become diabetic ulcers.

Based on the results of the study, the researcher assumed that the occurrence of corn was due to the duration of diabetes mellitus patients who were more than 5 years as evidenced in Table 1 showing 93 people (77%). This is because the longer you suffer from diabetes, the higher the risk of complications. Corn is one of the complications of diabetes mellitus due to neuropathy disorders, decreased blood circulation, and repeated friction in the leg area.

Corn is also caused by the use of inappropriate and inappropriate shoes. This is evidenced by Table 1 that respondents who have used shoes with high heels for a long time are 63 people (52.5%), respondents who have used shoes with narrow front ends for a long time are 72 people (60%) and respondents have using shoes that fit on the feet for a long time is 87 people (72.5%). so that there will be friction and pressure that is continuous and excessive for a long time, irritates the feet, and becomes ulcers.

Table 1 shows that women suffer from diabetes mellitus more than men with 75 women (62.5%) and 45 men. People (37.5%). This is because women with diabetes mellitus are at high risk of experiencing an anatomical deformity of the foot with corns. Women more often use shoes with high heels, shoes with a narrow front end, using shoes that fit on the feet.

Table 2 shows the anatomical deformity of the foot with burnion, the majority of which were in the right leg of as many as 51 people (42.5%), the left foot in as many as 21 people (17.5%), who experienced both as many as 21 people (17.5%). And 27 people who did not experience burnion (22.5%). These data indicate that there is a high prevalence in patients with diabetes mellitus who experience foot anatomical deformities with burnion.

Burnion or Hallux Valgus or hallux abducto valgus or hallux rigid or stiff big toe is a lump at the base of the big toe (hallux). This lump is formed due to deformity of the big toe joint (first metatarsal). The big toe grows abnormally and is tilted towards the other toes [20]. Burnion is a condition where the medial metatarsal capitulum experiences an abnormal protrusion accompanied by the formation of a bursa or fluid-filled sac that can cause a shift in the big toe [21]. Bornion causes limited mobility of the foot so that it can increase the plantar pressure of the foot and ulcers are easy to occur [22].

The cause of burnion is Behavioral Factors. This factor is influenced by the habit of using shoes. The use of shoes is 48% of the causes of bunions. The causes that often occur are the use of high-heeled shoes, shoes with narrowed front ends, and the use of shoes that fit too well on the feet. The use of these shoes will cause the toes to press against each other which ultimately disrupts the balance of the joint of the thumb and little foot because the two fingers are in direct contact with the shoe so that both of them receive direct pressure (Fitria, 2015;Pramana et al., 2019).

Based on the results of the study, the researchers assumed that the occurrence of Burnion was due to the duration of diabetes mellitus patients who were more than 5 years as evidenced in table 1, which showed that 63 people (77%). This is because the longer you suffer from diabetes, the higher the risk of complications. Burnion is one

of the complications of diabetes mellitus due to neuropathy disorders, decreased blood circulation, and repeated friction in the foot area.

Bornion is also caused by the use of inappropriate and inappropriate shoes. This is evidenced by table 1 that respondents who have used shoes with high heels for a long time are 63 people (52.5%), respondents who have used shoes with narrow front ends for a long time are 72 people (60%), and respondents have used shoes that fit on the feet for a long time is 87 people (72.5%). so that the toes are pressing against each other which ultimately disrupts the balance condition of the thumb and little toe joints, because the two fingers are in direct contact with the shoes, both of them receive direct pressure, the longer it will become irritated and become diabetic ulcers.

Table 1 shows that more women suffer from diabetes mellitus than men with 75 women (62.5%) and 45 men (37.5%). This is because women with diabetes mellitus are at high risk of experiencing foot anatomical deformities with burnion. Women more often use shoes with high heels, shoes with a narrow front end, using shoes that fit on the feet.

Table 2 shows the anatomical deformity of the foot with hammer toes on the right in as many as 27 people (22.5%), on the left as 18 people (15%), experiencing as many as 15 people (12.5%), and not experiencing as many as 60 people (50%). These data indicate that those who experience hammer toe and those who do not have hammer toe have the same prevalence.

The anatomical deformity of the foot with hammer toes was found on the right in as many as 27 people (22.5%), on the left in 18 people (15.0%), and experiencing both in as many as 15 people (12.5%). The total number of patients who experienced hammer toe was 60 people (50%). Hammer's toe is a deformity that causes the toe to bend down like a hammer, resulting from an imbalance in the surrounding muscles, tendons, or ligaments that normally keep the toe straight, a deformity that often occurs in the second, third, or fourth toe [23]. The risk factor for hammer toe is that people with diabetes mellitus have a callus, burnion, and corn in which the skin layer is thickened due to prolonged and repeated friction. Hammer toe in people with diabetes mellitus is usually caused by the weakening of the intrinsic muscles so that the toes cannot be stable when they step on the ground. This deformity can cause increased pressure on the metatarsal heads [24].

The use of improper footwear and shoes that are too small for a long period makes the big toe bend. The big toe bends for a long time resulting in an imbalance between the muscles and ligaments, causing stiffness in the toes. The joint loses its flexibility and the big toe remains in a bent position. The use of high-heeled shoes makes the pressure move to the big toe so that the toe bends for a long time. People with diabetes mellitus who continue to use inappropriate shoes are at risk of irritating the skin over the joints and allowing the appearance of warts and blisters on the feet. Hammer's toes are usually very painful, especially when trying to stretch the joint. If this condition is left unchecked, friction between the big toe and the shoe will cause skin irritation which not only adds to the pain but can also become an infection, over time (American orthopaedic foot & ankle society, 2020).

Based on the results of the study, the researchers assumed that the occurrence of hammer toe was because of 63 respondents (77.5%). This is because the hammer toe arises as a complication of DM related to muscle imbalance, the surrounding tendon



ligaments cause foot deformity which has the potential to cause diabetic foot ulcers. Hammer's toe is also caused by risk factors that occur in respondents such as toes experiencing callus, corn, and burnion. This deformity causes the skin layer to thicken due to prolonged and repeated friction. This is evidenced in Table 2 which shows that in 96 people (80%), the left foot had to callus in 9 people (7.5%) and both 3 people (2.5%). Corn on the right leg 66 people (55%), left leg 24 people (20%), both 6 people (5%). Burnion on the right leg 51 people (42%), left leg 21 people (17.5%) and both 21 people (17.5%).

Hammer's toe is caused by people with diabetes mellitus in choosing shoes, the type of shoes that are not appropriate and appropriate. This is evidenced by Table 1 that respondents who have used shoes with high heels for a long time are 63 people (52.5%), respondents who have used shoes with narrow front ends for a long time are 72 people (60%) and respondents have using shoes that fit on the feet for a long time by 87 people (72.5%) so that the toes bend for a long time because it adjusts to the shape of the shoes used and the pressure shifts to the toes if using shoes with high heels makes the toes bend in old time. As a result of the conditions above the toes are jostling and getting direct pressure and the longer it will become irritated the more it becomes a diabetic foot ulcer.

Table 1 shows that more women suffer from diabetes mellitus than men with 75 women (62.5%) and 45 men (37.5%). This is because women with diabetes mellitus are at high risk of experiencing an anatomical deformity of the foot with a hammer toe. Women more often use shoes with high heels, shoes with a narrow front end, using shoes that fit on the feet.

There were 60 patients with diabetes mellitus who did not experience hammer toe (50%). This is because people with diabetes mellitus undergo foot care as evidenced in Table 1 that 84 people with diabetes mellitus (70%). Hammer toe foot care is done by choosing suitable and comfortable shoes by not using high-heeled shoes or sandals. Choose shoes with a wide toes. Ice pack on the inflamed hammer toe. Using special footwear for hammer toes serves as a cushion to protect the affected finger, provide support and relieve pain [26].

Respondents did not experience hammer toe because respondents did not use high-heeled shoes or sandals, did not use narrow front shoes, and did not use shoes that fit the feet. Evidenced by the data in Table 1, namely, the respondents who did not use high-heeled shoes or sandals for a long time by 57 people (47.5%), did not use shoes with narrowed front ends for a long time by 48 people (40%), and respondents who did not 33 people (27.5%). The respondents who did not experience hammer toe were because the duration of diabetes mellitus patients was less than 5 years, as evidenced in Table 1, which showed that there were 27 people with diabetes mellitus who had less than 5 years of age (22.5). Diabetic complications were lower than those with diabetes who were more than 5 years old.

Table 2 shows the anatomical deformity of the foot with Charcot's foot, the majority of which were in the right foot of as many as 60 people (50%), the left foot of as many as 18 people (15%), who experienced both as many as 15 people (12.5%) and did not experience Charcot's foot. as many as 27 people (22.5%). These data indicate that there

is a high prevalence in patients with diabetes mellitus who experience foot anatomical deformities with Charcot's foot.

Charcot's foot is a condition affecting the bones, joints, and soft tissues of the foot and ankle, where the initial phase is characterized by inflammation. Charcot's foot is a progressive condition characterized by joint dislocations, pathological fractures, and severe destruction of the foot architecture that can exacerbate the deformity [27]. Diabetic Charcot's foot is one of the complications of microangiopathy of diabetes mellitus, namely neuropathy of diabetes mellitus. Progressive dislocation and/or fracture results in severe deformity of the foot and ankle. This condition has the potential for ulceration with or without infection and increases the risk of amputation [28].

Based on the results of the study, the researchers assumed that the occurrence of Charcot's foot was caused by the fact that 63 respondents (77.5%). This is because Charcot's foot is caused by complications of DM in the form of neuropathic disorders related to pressure imbalances in the feet which result in foot deformities that have the potential to cause diabetic foot ulcers.

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**Authors' Contributions.** Imroatul Farida and Uzlifatul Khizbiyatul Khasanah. Conceived of the presented idea. Christina Yuliasuti and Didik Dwi Winarno developed the theory and verified the analytical methods. Nur Muji Astuti wrote the manuscript. All authors discussed the results and contributed to the final manuscript.

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