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Risk Factor Profile of Amputation in Diabetic Foot Patients in Dr. Soetomo General Academic Hospital, Surabaya, from 2019 to 2020

Aria Damarjiwo Adhibagio[1], Soebagijo Adi Soelistijo[2*], Arief Rakhman Hakim[3], Agung Prasmono[3]

[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Internal Medicine, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.
[3]Department of Thoracic, Cardiac, and Vascular Surgery, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.

ABSTRACT

Introduction: This study aimed to find the general distribution of certain variables as risk factors for lower extremity amputation among diabetic foot patients at the Inpatient Ward of the Department of Internal Medicine, Dr. Soetomo General Academic Hospital, Surabaya, from 2019 to 2020.
Methods: This was a descriptive-retrospective study using data from medical records. The International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) version 26 was used to calculate the distribution.
Results: The mean ± SD of age was 55.38 ± 7.503 years old and was slightly female-biased. The median (min-max) blood sugar level was 212.00 (85–446) mg/dL. Fifteen out of 16 patients had an HbA1c beyond 7.0%. The body mass index (BMI) of most patients was between normal and overweight, with a mean ± SD of 24.018 ± 4.1827. Fifteen percent of patients were smokers. Strokes were present in 3.9% of patients, cardiovascular diseases were present in 13.73% of patients, prior lower extremity amputation (LEA) history was present in 15.7% of patients, hypertension was present in 49% of patients, and dyslipidemia was present in 13 of 15 patients. The mean estimated glomerular filtration rate (eGFR) was 70.15 ± 34.498 mL/min/1.732.
Conclusion: Older age, high blood sugar, high HbA1c levels, nephropathy, dyslipidemia, and hypertension had a high prevalence. Smoking, cardiovascular diseases, strokes, and prior amputation had a low prevalence. Gram-negative bacterial infection was observed in almost all reported patients. ABI results were either mostly not assessable or abnormally high. Most of the patients' Wagner gradings were in the worst category.

Highlights:
1. Certain variables are known to be risk factors associated with the outcome of lower extremity amputation among diabetic foot patients.
2. The patient population was observed to be slightly female-biased, with a high prevalence of older age, abnormally high blood sugar and HbA1c, and a history of nephropathy, dyslipidemia, and hypertension. Prior history of vascular diseases, prior amputation history, and heavy smoking were observed but not as prevalent.

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* Correspondence: soebagijo.adi.s@fk.unair.ac.id

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Introduction

Diabetic foot ulceration (DFU) is a common major complication of long-standing diabetes. It is characterized by ulcers, infection, and musculoskeletal deformities caused by the combined vascular and neuromuscular dysfunctions associated with a constant state of hyperglycemia.[1] The aforementioned complex pathophysiological processes have steps, and each of the aforementioned risk factors may affect different parts of the process.

The International Diabetes Federation (IDF) stated in 2021 that diabetes mellitus (DM) affected around 19.5 million Indonesians between the ages of 20-79 years old and accounted for 236,711 deaths.[2] The availability of Indonesian national data regarding the rate of disabilities caused by DM is unfortunately lackluster. However, the IDF Atlas reported the prevalence of DFU ranging between 10-35% for African countries, 1-17% in Europe, up to 58% in the United States (US), 21% in Brazil, and around 15% in Southeast Asia regions. The prevalence of lower extremity amputation (LEA) varies by region, ranging from 3-35% in Africa, 0.2-60% and averaging 30% in the Middle East and North Africa regions, and 10-30% in Brazil.[3]

This study explored the correlation of certain variables as a risk factor for LEA in people suffering from diabetic foot to provide a clear picture of how the aforementioned risk factors increase the possibility of receiving an amputation as the outcome. Although the data might be limited to the recorded occurrence within a specific hospital, it would still show how certain variables make patients more susceptible to this grim outcome. This study aimed to create a descriptive overview of the general distribution of risk factors associated with amputation among diabetic foot patients in the Inpatient Ward at the Department of Internal Medicine, Dr. Soetomo General Academic Hospital, Surabaya, from January 2019 to December 2020, specifically in regards to the general distribution of age, gender, diabetes duration, body mass index (BMI), blood sugar levels, HbA1C levels, smoking, the presence of prior vasculopathies (cardiovascular diseases, stroke, nephropathy), dyslipidemia, hypertension microbacterial pattern, and Wagner grade.

Methods

This was a descriptive and retrospective study. Secondary data was obtained using medical records at Dr. Soetomo General Academic Hospital, Surabaya. The patients were first limited to the admission period between 1 January 2019 to 31 December 2020, then filtered by the result to ICD-10 code E11 (non-insulin-dependent DM), then further filtering was performed by the ICD-9-CM procedural code of 84.1 (LEA; further sub-numbering indicates level). The inclusion criteria were patients who underwent LEA due to DM, and the exclusion criteria were patients who underwent amputation for reasons aside from DM-related vascular and neurological complications. Patient data and its significant variables were then put into Microsoft Excel 2019[4] as a spreadsheet and imported into the International Business Machines Corporation (IBM) Statistical Package for the Social Sciences (SPSS) software version 26[5] for analysis via the Kolmogorov-Smirnov Test. The data were collected in distribution tables.

The data included regarding the general distribution of risk factors regarding amputations among diabetic foot patients between 1 January 2019 to 31 December 2020 were obtained through medical records. Data from 51 patients were accessible. Percentages were calculated with 51 patients as the default denominator unless stated otherwise.

The Kolmogorov-Smirnov test was utilized to determine the nature of the distribution of five scale-type variables (age, BMI, diabetes duration, estimated glomerular filtration rate (eGFR), and blood sugar), with normal represented by the mean (standard definition) and non-normal by the median (min-max).

Results

The ages of LEA patients of all amputation levels had a mean ± SD of 55.38 ± 7.503 years old, whereas those who underwent below-knee amputation had a mean ± SD of 56.89 ± 8.246 years old, and above-knee amputation at 53.11 ± 6.379 years old, showing minimal discrepancy in the age groups of patients in all amputation levels. The distribution between age groups showed that patients aged 51-60 years old made up a substantial fraction of diabetic foot patients who underwent LEA at all levels. However, this was substantially younger than the average 66.3 ± 13.6 years old found in a Taiwanese study (2019) observing diabetic foot complications among patients in 2014.[6]

The distribution of gender among all patients suggested a distribution of the two genders leaned slightly more towards females at 54.9%. When per-level amputation was concerned, the male-to-female ratio for below-knee amputation was 44:56, whereas the ratio for above-knee amputation was 50:50. The male-to-female amputation ratio in other studies varied vastly on a study-to-study basis. A study conducted at Gaziantep University in 2021 found that 70% of the 143 diabetic foot patients who underwent amputation from 2012 to 2017 were males.[7] A meta-analytic study in 2020 showed that LEA happened to 32.81% of male DFU patients and 28.08% of female patients.[8]

The analyzed median (minimum-maximum) of blood sugar levels among all patients was 212.00 (85-446) mg/dL, whereas those who had below-knee amputation were measured at 205.00 (85-446) mg/dL, and the mean ± SD among those who underwent above-knee amputation was measured at 238.94 ± 99.012 mg/dL.

Table 1. Characteristics of all patients who underwent LEA

Calculated Descriptives of Scale Type Variables	
Age	55.38 ± 75.03
BMI	24.018 ± 4.1827
eGFR	70.15 ± 34.498
Diabetes duration	8.00 (1-25)
Blood sugar	212.00 (85-446)

Age Group Distribution		
Age Group	**n**	**%**
≤40 years old	0	0
41-50 years old	12	23.5
51-60 years old	27	52.9
61-70 years old	10	19.6
>70 years old	2	3.92
Total	51	100

Gender Distribution		
Gender	**n**	**%**
Male	23	45.1
Female	28	54.9
Total	51	100

BMI Classification Distribution		
BMI Classification	**n**	**%**
Underweight	3	6.8
Normal	26	59.1
Overweight	11	25
Obese class I	2	4.5
Obese class II	2	4.5
Obese class III	0	0
Total	44	100

Distribution of Diabetes Duration		
Duration (Years)	**n**	**%**
1-5	19	43.2
6-10	12	27.3
11-15	4	9.1
16-20	6	13.6
21-25	1	2.3
>25	1	2.3
Total	44	100

HbA1c Levels Distribution	
HbA1c Levels (%)	**n**
<7.0	1
7.0-8.9	7
>9.0	8
Total	16

Smoking Distribution		
Smoking	**n**	**%**
No	45	88.2
Yes	6	15.7
Total	51	100

Ankle-Brachial Index Distribution			
Ankle-Brachial Index	**Side**		
	Right	**Left**	**Unknown**
Cannot be assessed	8	5	0
<0.5	0	0	0
0.5-0.79	0	1	0
0.8-0.89	2	1	0
0.9-0.99	6	4	1
1.0-1.4	10	15	0
>1.4	0	0	0

Amputation Level Outcome Distribution				
Levels	**n**			**%**
	Right	**Left**	**Both Sides Summed**	
Digital toe amputation	0	3	3	5.88
Below knee amputation	12	13	25	49
Above knee amputation	14	8	22	43.1
Hip disarticulation	0	1	1	1.96
Overall total	26	25	51	100

Cardiovascular Disease Distribution		
Cardiovascular Disease History	**n**	**%**
Stable angina	1	1.9
Cardiomegaly	2	3.9
Arrhythmia	1	1.9
Dilated cardiomyopathy	1	1.9
Left atrium enlargement	1	1.9
Acute decompensated heart failure	1	1.9
Myocardial infarction	1	1.9

Stroke History Distribution		
History of Stroke	**n**	**%**
No	49	96.1
Yes	2	3.9
Total	51	100

CKD Stage Distribution		
Nephropathy by CKD Stage	**n**	**%**
1	17	33.3
2	8	15.7
3a	7	13.7
3b	10	19.6
4	7	13.7
5	2	3.9
Total	51	100

Prior Amputation History Distribution		
History of Prior Amputation	**n**	**%**
Digital toe amputation	3	5.9
Lis Franc's amputation	1	2
Below knee	3	5.9
Below knee (opposite side)	1	2
Above knee	0	0

Dyslipidemia Distribution	
Dyslipidemia	**n**
No	2
Yes	13

Hypertension Distribution		
Hypertension	**n**	**%**
No	26	51
Yes (measured)	11	21.6
Yes (history)	14	27.5
Total	51	100

Lesion Bacteriology Distribution	
Reported Bacteriology Result	**n**
None	1
Achromobacter sp.	1
Candida rugrosa	1
Escherichia coli	3
Escherichia coli EBSL	3
KlebsieLEA pneunoniae	1
MorganeLEA morganii	1
Proteus mirabilis	5
Proteus vulgaris	1
Providencia rettgeri	2
Pseudomonas aeruginosa	1

Wagner Grading Distribution		
Wagner Grading	**n**	**%**
Unreported	6	11.8
0	0	0
1	0	0
2	0	0
3	1	2
4	20	39.2
5	24	47.1
Total	51	100

Source: Research data, processed

Discussion

It was unsurprising that most of the patients had been diagnosed with high blood sugar levels during admission due to the nature of the underlying pathophysiology. A study conducted in Saudi Arabia (2018) found that 57.1% of patients had blood sugar levels above 200 mg/dL and found a correlation between high blood sugar levels and the severity of DFU.[9] The analyzed median (minimum-maximum) of diabetes duration among all patients was 8.00 (1-25) years, 10.00 (1-25) years among patients who underwent below-knee amputation, and a mean ± SD of 7.94 ± 5.683 among patients who underwent above-knee amputation. While this does not take amputation levels into account, it is relatively consistent with an Australian study that showed the median diabetes duration of LEA patients at 8 (3-12.5) years.[10]

Findings regarding the lower average diabetes duration and age compared to studies from overseas may have been attributed to lower literacy levels. However, many overseas studies have concluded vastly different findings. A Chinese study utilizing questionnaires to measure

diabetic foot self-care practices among its correspondents found no correlation between educational status and their test scores.[11] Another study from Bangladesh comparing the risk of DFU between the urban and rural populations found that the urban population with a higher percentage of literacy had a much lower risk of ulceration than the rural population, though there might be other factors at play.[12]

Reports regarding the patients' HbA1C levels were unfortunately sparse at around 16 out of 51 studied patients who underwent LEA at all levels. When the aforementioned patients were categorized by their HbA1C percentage ranges, only 1 had levels below 7.0%, 7 patients at 7.0-8.9%, and 8 patients with HbA1c levels beyond 9.0%. Despite the low number of reported results among the studied patients, those who did show that a vast majority had an abnormal HbA1c value. This may be in line with a study in Pakistan (2020) that found a correlation between HbA1C levels and the patients' Wagner grading.[13] Another study conducted in Turkey found that HbA1C above 7.5% was mostly found in patients who underwent below-knee or higher-level amputations.[14]

The analyzed mean ± SD of BMI among LEA patients of all levels was 24.018 ± 4.1827, whereas it was measured at 23.242 ± 3.8345 among those who underwent below-knee amputation and 25.172 ± 4.4852 among above-knee amputation patients. Distributing the entire patient population based on their BMI classification showed that 59% of the patients were within the normal BMI range, whereas only 6.8% were underweight, 25% were overweight, and both obese class I and II were at 4.5%. When the population is split between below- and above-knee levels, the discrepancy in distribution from the overall distribution may be considered minor. It may seem counter-intuitive that a large majority of the DFU patients have a normal BMI in pathophysiologic terms, but there are a few studies conducted that imply such an observation. A meta-analytical study conducted in 2020 involving 6,505 subjects found a higher likelihood of diabetic foot-related amputation among patients within lower BMI ranges.[8]

Smokers comprised only about 15% of the study population, with only 6 out of 51 patients. This was quite noticeably lower than a study conducted in 2023 involving 134 patients, in which 10 of the 17 patients (58.8%) who underwent LEA were either active smokers or had a history of smoking.[15] It was thought that smoking might make DFU patients more likely to get LEA because breathing in cigarette smoke creates more reactive oxygen species (ROS) that make the diabetic peripheral vascular disease and neuropathy worse.[16]

As an indicator of pre-existing vasculopathy, the history of strokes and cardiovascular diseases was explored among the patients. A history of stroke attacks could be found in 2 of 51 (3.9%) patients, whereas cardiovascular disease could be found in 7 of 51 (13.73%) (see Results). Other studies that explore the correlation between the history of cardiovascular diseases and the likelihood of undergoing LEA among diabetic foot patients showed an associated increase as a risk factor. A study conducted on 589 patients in Italy found the presence of cardiovascular disease history as a substantial predictor of adverse DFU progression.[17] Another study conducted in Turkey found that among patients who underwent LEA, 16% had congestive heart failure, 41.4% had cerebral arterial disease, and 86.9% had coronary vascular disease.[18]

The analyzed mean ± SD eGFR among patients of all LEA levels was 70.15 ± 34.498 mL/min/1,732, a median (minimum-maximum) of 50.00 (16-112) mL/min/1,732 among below-knee amputation patients, and a mean ± SD of 79.78±36.596 mL/min/1,732 among above-knee amputation patients. Nephropathy seems to be prominent among diabetic foot amputation patients. However, in this study, the severity is not as high as in other studies. The previous study mentioned in the discussion of cardiovascular disease history also found low eGFR and the presence of micro/macroalbuminuria as predictive factors for adverse DFU progression.[17]

As per the case of the prevalence of dyslipidemia among diabetic foot amputation patients, the unfortunate lack of reported results (only 15 out of 51 patients) was due to the fact that cholesterol level measurement was not a standard test conducted in Dr. Soetomo General Academic Hospital, Surabaya. However, among the 15 patients with reported results, 13 patients did have dyslipidemia. This variable was brought up due to its association between abnormal lipid markers and the occurrence of atherosclerosis and was further suspected due to a study conducted in Pakistan (2019) that showed hyperlipidemia was present in 78.4% of 51 diabetic foot amputation patients.[19,20]

A history of prior amputation was observed in 8 of the 51 patients, or around 15.7% of the patient population. This is not far off from an Australian study in 2018, which showed that among 413 diabetic foot amputation patients, 17.9% had a history of minor amputation, and 2.7% had prior major amputation.[21] Meanwhile, a study conducted in Scotland (2022) between 2012 and 2017 showed that among 48,190 DM type 2 patients who underwent amputation or died, 1,257 (2.6%) patients had a prior history of amputation.[22]

Table 2. Characteristics of 25 patients who underwent below-knee amputation

Calculated Descriptives of Scale Type Variables	
Age	56.89 ± 8.246
BMI	23.242 ± 3.8345
eGFR	50.00 (16-112)
Diabetes duration	10.00 (1-25)
Blood sugar	205.00 (85-446)

Age Group Distribution		
Age Group	**n**	**%**
≤40 years old	0	0
41-50 years old	5	20
51-60 years old	12	48
61-70 years old	6	24
>70 years old	2	8
Total	25	100

Gender Distribution		
Gender	**n**	**%**
Male	11	44
Female	14	56
Total	25	100

BMI Classification Distribution		
BMI Classification	**n**	**%**
Underweight	2	9.52
Normal	13	61.9
Overweight	4	19.1
Obese class I	2	9.52
Obese class II	0	0
Obese class III	0	0
Total	21	100

Distribution of Diabetes Duration		
Duration (Years)	**n**	**%**
1-5	8	36.36
6-10	6	27.27
11-15	2	9.09
16-20	3	13.64
21-25	1	4.55
>25	2	9.09
Total	22	100

HbA1c Levels Distribution	
HbA1c Levels (%)	**n**
<7.0	1
7.0-8.9	4
>9.0	2
Total	7

Smoking Distribution		
Smoking	**n**	**%**
No	21	84
Yes	4	16
Total	25	100

Cardiovascular Disease Distribution		
Cardiovascular Disease History	**n**	**%**
Cardiomegaly	2	8
Arrhythmia	1	4
Dilated cardiomyopathy	1	4

Stroke History Distribution		
History of Stroke	**n**	**%**
No	23	92
Yes	2	8
Total	25	100

CKD Stage Distribution		
Nephropathy by CKD stage	**n**	**%**
1	5	20
2	4	16
3a	4	16
3b	8	32
4	3	12
5	1	4
Total	25	100

Prior Amputation History Distribution		
History of Prior Amputation	**n**	**%**
Digital toe amputation	2	8
Lis Franc's amputation	1	4
Below knee	0	0
Above knee	0	0

Dyslipidemia Distribution	
Dyslipidemia	**n**
No	2
Yes	7

Hypertension Distribution		
Hypertension	**n**	**%**
No	14	56
Yes (measured)	7	28
Yes (history)	4	16
Total	25	100

Lesion Bacteriology Distribution	
Reported Bacteriology Result	**n**
Achromobacter sp.	1
Escherichia coli	2
Escherichia coli EBSL	1
KlebsieLEA pneunoniae	1
MorganeLEA morganii	1
Proteus mirabilis	2
Proteus vulgaris	1
Providencia rettgeri	1
Pseudomonas aeruginosa	1

Ankle-Brachial Index Distribution			
Ankle-Brachial Index	**Side**		
	Right	**Left**	**Unknown**
Cannot be assessed	2	3	0
<0.5	0	0	0
0.5-0.79	0	1	0
0.8-0.89	0	0	0
0.9-0.99	3	2	0
1.0-1.4	6	6	0
>1.4	0	0	0

Wagner Grading Distribution		
Wagner Grading	**n**	**%**
Unreported	2	8
0	0	0
1	0	0
2	0	0
3	0	2
4	11	44
5	12	48
Total	25	100

Distribution of Reported Sides of Amputation		
Side	**n**	**%**
Right	12	48
Left	13	52
Total	25	100

Source: Research data, processed

The presence of hypertension was determined either through direct blood pressure measurement during hospital admission and/or through history-taking. It was found that 11 out of 51 patients had measured systole above 140 mmHg and/or diastole above 90 mmHg, and another 14 out of 51 patients were admitted to having a history of hypertension. With a total of 25 out of 51 amputation patients (49.02%) with hypertension, this is close to 57% of the 65 amputation patients involved in a study conducted in South Korea (2022).[23]

Table 3. Characteristics of 22 patients who underwent above-knee amputation

Calculated Descriptives of Scale Type Variables	
Age	53.11 ± 6.379
BMI	25.172 ± 4.4852
eGFR	79.78 ± 36.596
Diabetes duration	7.94 ± 5.683
Blood sugar	238.94 ± 99.012

Age Group Distribution		
Age Group	**n**	**%**
≤40 years old	0	0
41-50 years old	6	27.27
51-60 years old	13	59.09
61-70 years old	3	13.64
>70 years old	0	0
Total	22	100

Gender Distribution		
Gender	**n**	**%**
Male	11	50
Female	11	50
Total	22	100

BMI Classification Distribution		
BMI Classification	**n**	**%**
Underweight	1	5
Normal	11	55
Overweight	7	35
Obese class I	0	0
Obese class II	1	5
Obese class III	0	0
Total	20	100

Distribution of Diabetes Duration		
Duration (Years)	**n**	**%**
1-5	9	47.37
6-10	5	26.32
11-15	2	10.53
16-20	3	15.79
21-25	0	0
>25	0	0
Total	19	100

HbA1c Levels Distribution	
HbA1c Levels (%)	**n**
<7.0	0
7.0-8.9	2
>9.0	6
Total	8

Smoking Distribution		
Smoking	**n**	**%**
No	21	95.45
Yes	1	4.55
Total	22	100

Cardiovascular Disease Distribution		
Cardiovascular Disease History	**n**	**%**
Stable angina	1	4.55
Left atrium enlargement	1	4.55
Acute decompensated heart failure	1	4.55
Myocardial infarction	1	4.55

Stroke History Distribution		
History of Stroke	**n**	**%**
No	22	100
Yes	0	0
Total	22	100

CKD Stage Distribution		
Nephropathy by CKD stage	**n**	**%**
1	11	50
2	4	18.18
3a	2	9.09
3b	1	4.55
4	3	13.64
5	1	4.55
Total	22	100

Prior Amputation History Distribution		
History of Prior Amputation	**n**	**%**
Digital toe amputation	1	4.55
Lis Franc's amputation	0	0
Below knee	3	13.64
Below knee (opposite side)	1	4.55
Above knee	0	0

Dyslipidemia Distribution	
Dyslipidemia	**n**
No	0
Yes	4

Hypertension Distribution		
Hypertension	**n**	**%**
No	11	50
Yes (measured)	4	18.18
Yes (history)	7	31.82
Total	22	100

Lesion Bacteriology Distribution	
Reported Bacteriology Result	**n**
None	1
Candida rugrosa	1
Escherichia coli EBSL	2
Proteus mirabilis	2
Providencia rettgeri	1

Ankle-Brachial Index Distribution			
Ankle-Brachial Index	**Side**		
	Right	**Left**	**Unknown**
Cannot be assessed	2	2	0
<0.5	0	0	0
0.5-0.79	0	0	0
0.8-0.89	1	0	0
0.9-0.99	2	2	1
1.0-1.4	2	7	0
>1.4	0	0	0

Wagner Grading Distribution		
Wagner Grading	**n**	**%**
Unreported	4	18.18
0	0	0
1	0	0
2	0	0
3	1	4.55
4	6	27.27
5	11	50
Total	22	100

Distribution of Reported Sides of Amputation		
Side	**n**	**%**
Right	14	63.64
Left	8	36.36
Total	22	100

Source: Research data, processed

When bacteriology results among all 18 reported patients were concerned, *Proteus mirabilis* had the highest number of reported cases at around 5. Three cases of *Escherichia coli* and *Escherichia coli EBSL* were reported. There were 2 reports of *Providencia rettgeri* and only 1 case each of *Acromobacter sp.*, *Candida rugrosa*, *KlebsieLEA pneumoniae*, *MorganeLEA morganii*, *Proteus vulgaris*, and *Pseudomonas aeruginosa*. One patient did not seem to have any ongoing infection at the ulcer site. Oddly enough, most of those who were infected seem to have been infected by gram-negative bacteria, which does not seem to be in line with the 54.9% found in a study conducted in China.[24]

Another study conducted in India also found that a substantial number of bacteria types infecting DFU patients had different forms of antibiotic resistance, limiting the option for antibiotic treatments.[25] Patients who did not have bacteriology results in their medical records were not included, thus creating a bias that causes difficulty in drawing an accurate conclusion. Ankle-brachial index (ABI) values were unfortunately reported in only 27 of the 51 patients, and even then, a substantial number of patients were reported to have their ABI measurements concluded as “not accessible”. The generally known contraindication of the ABI measurement procedure is pain and the risk of dislodging an embolus or thrombus.[26]

Table 4. Characteristics of 3 patients who underwent digital mutilation

Variables	Patient 1	Patient 2	Patient 3
Age	50 years old	59 years old	64 years old
Gender	Female	Female	Female
BMI (classification)	35.4	19.5	22.5
Diabetes duration	N/A	3 years	4 years
Blood sugar	226 mg/dL	397 mg/dL	132 mg/dL
HbA1c levels	N/A	8.7%	N/A
Smoking	No	No	No
History of cardiovascular disease	None	None	None
History of stroke	None	None	None
eGFR (CKD stage)	32 mL/min/1.73^2 (3b)	47 mL/min/1.73^2 (3a)	100 mL/min/1.73^2 (1)
Prior amputation history	None	None	None
Dyslipidemia	N/A	N/A	Yes
Hypertension	Yes (history)	No	Yes (history)
Bacteriology of ulcer site	N/A	*Escherichia coli*	N/A
Ankle-brachial index	D: 0.9; S: 0.8	D: 1.1; S:1.0	N/A
Wagner grading	4	4	4
Final amputation level	Mutilation of digiti I pedis (left)	Mutilation of digiti I, II, IV pedis (left)	Mutilation of digiti IV-V pedis (left)

Source: Research data, processed

However, there are two additional reasons regarding the lack of reported results in ABI and the fact that a handful of reported cases of ABI are not accessible among the patient population, 1) Many of the patients presented in a state of foot necrosis that is advanced to the point of risking a pus rupture when pressure is applied to the ankle by the sphygmomanometer, 2) It is a more common practice in Dr. Soetomo General Academic Hospital, Surabaya, to check patients' foot circulation using a portable Doppler ultrasound device.

Table 5. Characteristics of 1 patient who underwent hip disarticulation

Variables	Results
Age	54 years old
Gender	Male
BMI (classification)	N/A
Diabetes duration	10 years
Blood sugar	105 mg/dL
HbA1c levels	N/A
Smoking	Yes
History of cardiovascular disease	None
History of stroke	None
eGFR (CKD stage)	122 mL/min/1.73^2 (1)
Prior amputation history	None
Dyslipidemia	Yes
Hypertension	Yes (history)
Bacteriology of ulcer site	*Proteus mirabilis*
Ankle-brachial index	D: 1; S: 1
Wagner grading	5
Final amputation level	Hip disarticulation (left)

Source: Research data, processed

Ankle-brachial index (ABI) values were unfortunately reported in only 27 of the 51 patients, and even then, a substantial number of patients were reported to have their ABI measurements concluded as "not accessible". The generally known contraindication of the ABI measurement procedure is pain and the risk of dislodging an embolus or thrombus.[26] However, there are two additional reasons regarding the lack of reported results in ABI and the fact that a handful of reported cases of ABI are not accessible among the patient population, 1) Many of the patients presented in a state of foot necrosis that is advanced to the point of risking a pus rupture when pressure is applied to the ankle by the sphygmomanometer, 2) It is a more common practice in Dr. Soetomo General Academic Hospital, Surabaya, to check patients' foot circulation using a portable Doppler ultrasound device.

It should be noted that the number of patients with seemingly high ABI values among those who did have such variables reported was quite high. High ABI values are commonly found in patients who have developed medial arterial disease, which is commonly found in long-term diabetics. A study in 2018 found that high ABI values double the likelihood of amputation among diabetic foot patients, but low ABI values carry an even higher risk.[27] The most common Wagner foot ulcer grade among the entire diabetic foot amputation patient population was its most severe grade of 5, standing at around 24 cases (47.1%), whereas grade 4 was reported at 20 cases (39.2%). Grade 3 was only reported once (2%), and there were no reported cases in grades 0-2. There were 6 (11.8%) patients that had unreported Wagner grading, most commonly through critical limb ischemia brought on by diabetic vasculopathy or was not assessable due to the patient presenting with a prior history of diabetic foot amputation beyond the ankle level.

Strength and Limitations

The Indonesian Ministry of Health does not appear to have information on the prevalence of disability, specifically amputations brought on by DFU as a result of DM. This study may be used as assistance to create a representation of the situation regarding the subject matter. This study may also be the first in Indonesia to be conducted regarding the subject matter, considering the difficulty in finding relevant local or national data surrounding the topic of amputations caused by DFU as a consequence of DM.

As a retrospective study, this study does have the common limitation of having many pieces of data missing due to being sourced from a clinical database instead of the research-specific input that has the rigid and specific requirements of a predesigned proforma. In addition to such limitations, data outside of the initially proposed medical records is off-limits, which results in the absence of a substantial amount of laboratory results that were excluded from the main medical record files due to the patient being discharged from the hospital by the time the laboratory results were completed.

Conclusion

When it comes to the implied societal benefits that could be provided from these findings, this study is expected to provide a better picture of the distribution of risk factors associated with LEA caused by DM. The probable usage of

the preceding findings in future public service announcements (PSAs) made by the Ministry of Health could help the general public understand that DM is certainly not a medical condition to be underestimated or reckoned with, especially for those who need to be fully able-bodied in their field of occupation. Health organizations may also utilize the findings in times when they may update guidelines regarding the management of DM and DFU in order to improve their effectiveness and efficiency, thus possibly reducing the rate at which the prevalence of disability caused by DM increases.

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Conflict of Interest

The authors declared there is no conflict of interest.

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Ethical Clearance

This study was ethically approved by the Health Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya (No. 0604/LOE/301.4.2/IX/2021) on 18-09-2021.

Authors' Contributions

Concepting and designing the study, gathering, analyzing, and interpretating data, creating tables and writing the manuscript: ADA. Reviewing and revising the manuscript: SAS, ARH, and AP. All authors contributed and approved the final version of the manuscript.

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