

# Diabetic Foot Amputations at Central and Provincial Hospital in Gauteng. A Signpost for Inadequate Foot Health Services at Primary Healthcare Level in South Africa

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## Research

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# Abstract

## Background

Diabetic foot amputations are the most devastating outcome for any diabetic patient and could be associated with failure to risk stratify the diabetic foot and create individualised treatment plans to lower risk at the primary healthcare level (PHC). In South Africa (RSA), PHC clinics are the first entry point to the public healthcare system. Failure to correctly identify, risk categorise, and refer diabetic foot complications may lead to poor clinical outcomes for diabetic patients. There is a need to highlight poor clinical outcomes and link them to limited access to foot health services at the PHC level. This approach may help drive the strategic allocation and deployment of limited podiatry force in RSA. This study looks at the incidence of diabetic-related amputations at central and tertiary hospitals in Gauteng to argue the case of the needed foot health services at the PHC level.

## Methods

A cross-sectional retrospective study that reviewed theatre records. We reviewed records of all diabetic patients who had diabetic-related amputations between January 2017 and June 2019.

## Results

There were 1862 diabetic-related amputations; however, only 1565 accurately recorded and met the inclusion criteria for the study. The first amputation was a major amputation in 73% of the cases, and an infected foot ulcer was a primary amputation cause in 75% of patients. Males had the most amputations, 62%. The majority, 71% of amputations, were in patients younger than 65 years. Nearly all patients (98%) came from a poor socio-economic background and are state-dependent; they earned ZAR 0.00- 70 000.00 or USD (0.00- 4754.41) per annum.

## Conclusion

Amputations are a sign of poor clinical outcomes for diabetic patients and imply inadequate care of diabetic foot complications across the continuum of care, particularly at the PHC level in RSA. Due to the hierarchal nature of healthcare delivery in RSA, all patients in this study would have presented at a PHC facility to manage their diabetes and other chronic comorbidities. The findings show that most first amputations recorded in this study were major amputations. This finding is a significant signpost of the potential delay in recognising, treating and timely referral of diabetic-related foot complications. Arguably, a lack of access to structured foot health services at PHC levels impedes early identification of foot complication identification and appropriate referral resulting in the amputation in some of the patients.

# 1.1 Introduction

More than 19 million people have diabetes in the African continent, likely to rise to about 47 million by 2045. South Africa (RSA) has the highest number of people living with diabetes in Africa, accounting for about 4.6 million.[1] A percentage of people living with diabetes will inevitably have foot complications related to the disease, including peripheral neuropathy, foot infections and diabetic foot ulcers. These complications are a significant risk factor for disability, surgical amputation, and mortality among patients with diabetes.[2, 3] These complications are associated with significant morbidity and mortality, reduced quality of life, and increased financial burden on the individual and the state.[4, 5] In 2018, public sector costs for managing diagnosed and undiagnosed type 2 diabetes mellitus (T2DM) patients were approximately ZAR 2.7 bn and ZAR 21.8 patients.[5] However, despite this heavy capital outlay, the clinical outcomes for diabetic patients remains poor. Recent estimates show that as many as 80.6% of the population with DM (diagnosed and undiagnosed cases) in South Africa have an unmet need for care.[6, 7] One study estimated the annual incidence of diabetes-related amputations in RSA at 3311 amputations.[5] The number of diabetic foot complications (DFCs) presenting at the hospital level is an ominous sign that diabetic foot care remain inadequate or absent in diabetic patient care in RSA across the continuum of care. This omission comes at a high cost as one amputation can cost ZAR 320 000 or USD 21130 per amputation, which the state carries for all patients seen in public hospitals.[8]

Many factors contribute to the risk of amputation. These include chronic hyperglycaemia and poor vascular health over many years after the diagnosis of diabetes, resulting in peripheral neuropathy and peripheral vascular disease, which lead to diabetic foot ulcers (DFUs) and poor wound healing.[9] Poor access to podiatric or foot health services for foot screening and early identification of potential risk factors may further compound this problem.[10–12]

Most patients diagnosed with diabetes present at primary healthcare (PHC) facilities for their diabetic care. In most of these clinics, access to podiatry or organised foot health services is limited and, in most cases, absent.[13] Studies have found that some patients who present with a diabetic foot complication at a hospital might have never had a foot inspection at their local PHC facility. [14–16] The hierarchical nature of healthcare delivery in RSA requires all patients present first at the local PHC facility. At this level, patients receive routine care focusing primarily on prevention, health promotion for their presenting condition and referral if there are present or suspected complications. This approach should be helpful in the prevention of diabetic foot complications (DFCs) and early identification of potential risk factors. Evidence suggests that failure to access foot health services leads to poor foot care practices and eventually DFUs and amputations. There is evidence that DFU and amputation result from failure to access foot health services resulting in poor foot care practices. [17, 18] On the contrary, early access to effective foot health services and early identification of risks and providing adequate foot health education can prevent up to 50% of DFUs and resultant amputations. [19]

Therefore, the omission or poor accessibility of foot health services as a mandatory part of the primary healthcare package at the PHC level might be ill-advised and likely leading to poor health outcomes for

diabetic patients. Early recognition of diabetic foot complications (DFUs) is critical as the lifetime incidence rate of diabetic foot ulceration is 19–34%, with a yearly incidence rate of 2%<sup>[20, 21]</sup>, and 20% will require either minor or major amputation to achieve healing.<sup>[22, 23]</sup>

In RSA, podiatric or foot health services are primarily available in the tertiary and central hospitals, and mainly in Gauteng Province.<sup>[24, 25]</sup> Gauteng is the smallest of RSA's provinces, covering 18 178km<sup>2</sup> (approximately 1.4%) of the total surface area of RSA, but is also the most populous, home to 15,810,388 people – 26.3% of the national population. It is the economic engine room of the country and the subcontinent, responsible for over 34.8% of the country's GDP. Gauteng province has 27 hospitals (4 central, 3 tertiary, 11 district and 9 regional) and 373 PHC clinics.<sup>[26]</sup> These clinics and hospitals provide all health services to 85% of the 15 million people who live in Gauteng.<sup>[26, 27]</sup> Of the 15.8 million people, an estimated 1.9 million have diabetes mellitus.<sup>[27]</sup> The province is home to the only Podiatry training institution in RSA and the continent, the University of Johannesburg (UJ).

Most diabetic patients receive their monthly follow up appointments and their chronic medications at PHC facilities. In RSA, data are limited on the prevalence and management of diabetic foot complications at PHC facilities. However, the amputation rate in central and provincial tertiary hospitals might be a signpost of the care diabetic patient receive at lower levels of care. A few studies have in other provinces of RSA shown an increasing number of amputations.<sup>[8, 28–30]</sup> Therefore, this study investigated the prevalence of diabetic foot related amputations at the central and provincial hospitals in the province between January 2017 and June 2019. The main aim was to highlight the potential need for structured foot health services at the PHC level to prevent DFCs and improve health outcomes of diabetic patients.

## **1.2 Material And Methods**

### **Study Design and Population**

This retrospective quantitative theatre record review study at the three provincial tertiary and four central hospitals in the Gauteng province of RSA. The study population were records of all diabetic patients who had a foot or lower limb amputation. Data were collected from diabetic patient files with minor or major lower limb amputations between January 2017 and June 2019. The study received ethics clearance from the University of Johannesburg Faculty of Health Sciences (REC241112-35) and the Gauteng Department of Health (GDoH-GP\_2019\_046) Research Ethics Committees. After receiving the ethical clearance, the researchers reviewed theatre records of all amputations at the central and tertiary hospitals between January 2017 and June 2019. Data were collected using hospital theatre registers, diagnosis/procedure, and hospital numbers (all hospital patients receive a patient/ hospital number unique to them) to differentiate traumatic from non-traumatic diabetic-related amputations and the type/level of amputation. We excluded files of all patients who had a non-diabetic foot amputation and traumatic diabetic-related amputations.

### **Data Collection**

Detailed records of patients were retrieved and recorded. We collected data, including age, gender, population group, duration of diabetes, comorbidities, financial bracket, and type of amputation, from hospital administration systems for each patient. The definitions of amputations were based on the primary amputation and re-amputation classification by Larson and Apelqvist.[31] All amputations performed below the ankle were recorded as minor amputations and above ankle amputations as major. We recorded the number of patients who underwent multiple amputations, including those who had a second, third, and fourth amputation.

## **Data Analysis**

Data were analysed using the SPSS version 25 software (SPSS Inc., Chicago, IL, USA). Normally distributed variables were expressed as means  $\pm$  SD. Frequencies and percentages were used for statistical descriptions. Statistical significance was set at  $P < 0.05$ .

## **1.3 Results**

Out of the theatre registers search, we found 1862 records of diabetic patients who had undergone amputations during the study period. However, only 1565 theatre records had sufficient data for inclusion in the study. Most patients were males 62% (n=964), and the mean age of patients was 60 years (range 37–97 years), Table 1.

Table 1  
Demographics

Demographics		Frequency	Percentage
<b>Hospital classification (Income bracket)</b>	H0 (no fee patients)	719	45.9
	H1(R0- R70 000 per annum)	820	54.2
	H2 (> R70 000 - R250 000 per annum)	25	1.6
	Medical aid	1	0.1
<b>Population group</b>	Black	1058	68.3
	Mixed-Race	191	12.3
	Indian or Asian	83	5.4
	White	218	14.1
<b>Sex</b>	Male	964	62
	Female	601	38
<b>Type of diabetes</b>	Type 1	19	1.2
	Type 2	1544	98.7
	Gestational	1	0.1
<b>Duration of diabetes</b>	Less than 1 year	91	5.8
	1-5 years	204	13.0
	5-10 years	703	44.9
	10-15 years	251	16.0
	15- 20 years	67	4.3

### Comorbidities

Hypertension and high cholesterol were the most common comorbidities in patients who had a foot and lower limb amputation

### Number of amputations per year

There was a high number of amputations in 2018.

### Type of amputation

The findings show that 73% ( $n=1142$ ) who had the first amputation had a major amputation, and 27% ( $n=423$ ) of patients had a minor amputation.

### Diagnosis preceding amputation

Of most diabetic-related foot amputations, 75.3% resulted from an infected foot ulcer, followed by ischemia (Table 2). Wet gangrene, necrotising fasciitis, and gas gangrene are the other causes of amputations where the diagnosis was not one of the main three mentioned.

Table 2  
Diagnosis preceding amputation

	First amputation	Second amputation	Third amputation	Fourth amputation
Infected (foot) ulcer	75.3%	88.0%	75.6%	100%
Non-healing foot ulcer	1.5%	1.5%	0.0%	0.0%
Ischemia	17.3%	3.4%	17.8%	0.0%
Other	6.0%	7.9%	6.7%	0.0%

### Recorded Risk factors for amputation

The most recorded risk factor of diabetic foot amputation was uncontrolled diabetes.

Table 3  
Risk Factors

Risk Factor	Frequency	%
Smoking	$n=391$	25%
Uncontrolled diabetes	$n=1450$	93%
Obesity	$n=267$	17%
Peripheral vascular disease	$n=409$	26%
Peripheral neuropathy	$n=133$	8.5%
Previous amputation	$n=153$	9.7%
Other	$n=2$	0.13%

### Relationship between age, sex, and amputations

In this study, most amputations 44.7% were in the 55-64 age group; Table 4 presents the distribution.

Table 4  
Relationship between age, sex, and amputations

Sex	Younger than 55		55-64		65 and older	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Male	263	27.3%	426	44.2%	275	28.5%
Female	148	24.6%	274	45.6%	179	29.8%
	411	26.3%	700	44.7%	454	29.0%

## 1.4 Discussion

Of the 4.6 million people are diagnosed with type II diabetes mellitus in RSA, 3.2 out of 1000 live in Gauteng.[32] This study found 1565 amputations over 30 months (we excluded 297 records from the 1862 amputations) at the tertiary and central hospitals in Gauteng. We argue that each recorded amputation in this study represents a missed opportunity to implement basic preventative measures and limb salvage measures at the PHC level. Most importantly, though, each amputation represents a person and a family whose lives have changed completely.

Due to the nature of the healthcare delivery structure in RSA, most diabetic patients receive their care from a public healthcare system consisting of primary healthcare clinics, community healthcare centres, and hospitals.[33] The public sector healthcare system is structured around a strict hierarchical referral mechanism to stop patients from presenting at hospitals with minor ailments.[34, 35] In this system, the PHC facilities are the first point of contact for patients and, in some cases, the only available form of healthcare services. If the need arises, patients are referred from the PHC level to more advanced treatment levels of care. In this study, we submit that the incidence of diabetic-related amputations indicates poor or inadequate care of diabetic patients at PHC clinics. Therefore, additional studies need to interrogate the foot health services received by diabetic patients at the PHC level to identify potential failures or inadequacies at this level.

The PHC level focuses on health promotion, disease prevention, early recognition of complications, health maintenance, patient education, diagnosis, and treatment of acute and chronic illnesses.[36] The PHC was adopted post-1994 in RSA as the best-suited approach to attain better-quality public health outcomes and meet RSA goals of equitable healthcare service delivery for all its citizens.[37, 38] Therefore, the healthcare delivery system in RSA is ideal in the early recognition and management of DFCs, as the critical features of PHC include prevention, early recognition, and correct referral to a higher setting. However, despite the RSA government allocating 8.5% of gross domestic product (GDP) to healthcare, the health outcomes remain relatively poor compared to other middle-income countries with similar GDP percentage expenditure on health.[35, 39]

When considering clinical outcomes in diabetic patients, we should include our ability to deal with DFCs across the continuum of care and preventing amputations. The findings of this study suggest we may

still be a long way off from achieving improved health outcomes for diabetic patients. Foot ulcers precede 84% of amputations in diabetic patients; therefore, early recognition of DFCs that might predispose diabetic patients to DFUs is critical.[40] In this study, 73% of all first amputations were major amputations.

We suggest that this finding alone indicates insufficient diabetic foot care these patients receive at the PHC level. Moreover, it signifies delayed identification, recognition or referral to a hospital and insufficient care at PHC, among other factors. Therefore, there is a need to consider placing evidence-based prevention programmes at PHC facilities. These can include patient and carer education, risk stratification, early detection, foot ulcer treatment by a multidisciplinary team, and periodic observation, which can diminish the amputation rates. In areas where such measures exist, amputation rates are significantly decreased by 49–85%.[41, 42] In this study, the researchers could not find any record of foot assessments, risk stratification or interventions at the PHC level. Early identification and risk stratification of DFCs at the PHC level will ensure early referral to the hospital for swift treatment of DFCs. Such an approach will ensure that DFCs are managed appropriately, reducing the number and severity of diabetic-related foot amputations. We argue that by the time the patient arrives with a septic foot ulcer at a hospital, it is too late to consider and effectively implement limb salvage initiatives.

Therefore, it is time to consider early targeted interventions at lower levels of care. Such interventions can include integrating structured foot health services or measures at PHC directed at patient education, identifying risk and prevention of complication at this level. Adequately trained healthcare professionals (ideally podiatrists) can offer such services or train others to provide essential foot care services. Podiatrists at the PHC level can identify and treat pre-ulcerative risk factors known to be strong predictors of future ulceration, such as blisters, fissures, calluses, ingrown or thickened toenails, and fungal infections. Such a foot health service should occupy a central role in foot health and can take on a gate-keeping role to reduce the rate of DFCs and subsequent amputations seen in hospitals. Having these services at PHC facilities will ensure that the first step of identifying and quantifying the degree of risk for foot ulceration in all patients is accessible at the first point of entry (into the healthcare system) or contact (with healthcare professional).

This study does not intend to speak to the socio-economic impact of diabetic-related foot amputations. However, it is essential to highlight some of the factors we feel might influence the socio-economic outcomes of patients who had amputations. In this study, 71% of all amputations were in patients younger than 64 years, 26.3% younger than 55 and 44.7% between 55-64, respectively, which indicate a high proportion of amputations in the economically active group. Furthermore, it is essential to note that most patients 98% who had an amputation earn between ZAR 0.00 - 70 000.00 or USD 0.00-4754.41 per annum. The amputation of a foot or lower limb renders future employment prospects of most of these patients limited or non-existent. These findings have far-reaching socio-economic implications, requiring further studies to quantify this aspect.

South Africa has a shortage of podiatrists, as there is one institution in the country that trains these professionals, and most of the limited graduates work in the private sector. However, developing clinical practice guidelines (CPGs) can help direct the limited services and coordinate diabetic patient care in the interim. This approach can help define a standardised and efficient approach to prevention, treatment and referral of diabetic foot complications/ulceration and consequent amputations.

## 1.5 Conclusion

Despite the chosen PHC public health delivery system in RSA being ideal for delivering educational, screening, and preventative diabetic foot programmes, concerns about delivering foot health services at PHC persist. The number of amputations reported in this study signifies a failure or inadequacy in the continuum of care for diabetic patients in RSA. Amputations are a sign of poor clinical outcomes for these patients and are likely to have far-reaching effects. Most of these patients would have presented at a PHC facility to manage their diabetes and other chronic comorbidities. However, most recorded amputations in this study were major amputations, indicating a potential delay in recognising, treating and timely referral of diabetic-related foot complications. Arguably, a lack of structured foot health services impedes care to this patient population.

South Africa has limited resources in finance and human capital, which likely impacts resource allocation. In advocating for improved diabetic foot care, there is a need to identify specific areas of failure within the continuum of care and provide a detailed analysis of care currently available to highlight the need gaps. This approach will allow for strategic positioning and deployment of limited resources to improve clinical outcomes for diabetic patients. This study has identified amputations in diabetic patients as a signpost for inadequate care or access to appropriate services at PHC levels as this level remain the first point of entry.

## References

1. IDF. IDF Diabetes Atlas 9th edition 2019.. 2019.
2. Boulton AJ. The diabetic foot. *Medicine*. 2018.
3. Thorud JC, Plemmons B, Buckley CJ, Shibuya N, Jupiter DC. Mortality after nontraumatic major amputation among patients with diabetes and peripheral vascular disease: a systematic review. *The journal of foot ankle surgery*. 2016;55(3):591–9.
4. Sen P, Demirdal T, Emir B. Meta-analysis of risk factors for amputation in diabetic foot infections. *Diabetes Metab Res*. 2019;35(7):e3165.
5. Erzse A, Stacey N, Chola L, Tugendhaft A, Freeman M, Hofman K. The direct medical cost of type 2 diabetes mellitus in South Africa: a cost of illness study. *Global health action*. 2019;12(1):1636611.
6. Stokes A, Berry KM, Mchiza Z, Parker W, Labadarios D, Chola L, et al. Prevalence and unmet need for diabetes care across the care continuum in a national sample of South African adults: Evidence from the SANHANES-1, 2011-2012. *PLoS one*. 2017;12(10):e0184264.

7. Erzse A, Fraser H, Levitt N, Hofman K. Prioritising action on diabetes during COVID-19. *SAMJ: South African Medical Journal*. 2020;110(8):719–20.
8. Thompson AT, Bruce JL, Kong VY, Clarke DL, Aldous C. Counting the cost of preventable diabetes-related lower limb amputations at a single district hospital in KwaZulu-Natal: what does this mean, what can be done? *Journal of Endocrinology Metabolism Diabetes of South Africa*. 2020;25(2):44–50.
9. Gurney JK, Stanley J, York S, Rosenbaum D, Sarfati D. Risk of lower limb amputation in a national prevalent cohort of patients with diabetes. *Diabetologia*. 2018;61(3):626–35.
10. Joret MO, Osman K, Dean A, Cao C, van der Werf B, Bhamidipaty V. Multidisciplinary clinics reduce treatment costs and improve patient outcomes in diabetic foot disease. *J Vasc Surg*. 2019;70(3):806–14.
11. Khan MZ, Smith MT, Bruce JL, Kong VY, Clarke DL. Evolving indications for lower limb amputations in South Africa offer opportunities for health system improvement. *World J Surg*. 2020;44(5):1436–43.
12. Thompson AT. Red flags for potential diabetes-related foot disease: when you should refer to a podiatrist. *South African Journal of Diabetes*. 2018;11(3):23–5.
13. Ntuli S, Vincent-Lambert C, Swart A. Risk factors for diabetic foot ulceration in diabetic patients presenting at primary healthcare clinics in South Africa.. 2018.
14. Dikeukwu RA. The awareness and performance of appropriate foot self-care practices among diabetic patients attending Dr.Yusuf Dadoo Hospital, Gauteng Province, South Africa. *JEMDSA*; 2011.
15. Goie TT, Naidoo M. Awareness of diabetic foot disease amongst patients with type 2 diabetes mellitus attending the chronic outpatients department at a regional hospital in Durban, South Africa. *African journal of primary health care & family medicine*. 2016;8(1).
16. Manickum P, Ramklass SS, Madiba TE. A five-year audit of lower limb amputations below the knee and rehabilitation outcomes: the Durban experience. *Journal of Endocrinology Metabolism Diabetes of South Africa*. 2019;24(2):41–5.
17. Pourkazemi A, Ghanbari A, Khojamli M, Balo H, Hemmati H, Jafaryparvar Z, et al. Diabetic foot care: knowledge and practice. *BMC endocrine disorders*. 2020;20(1):1–8.
18. Haq NU, Durrani P, Nasim A, Riaz S. Assessment of Knowledge and Practice of Diabetes Mellitus Patients Regarding Foot Care in Tertiary Care Hospitals in Quetta, Pakistan. *Specialty J Med Res Health Sci*. 2017;2(4):35–43.
19. Boulton AJ. The diabetic foot. *Medicine*. 2015;43(1):33–7.
20. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA*. 2005;293(2):217–28.
21. Armstrong DG, Boulton AJ, Bus SA. Diabetic foot ulcers and their recurrence. *N Engl J Med*. 2017;376(24):2367–75.

22. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, et al. 2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. *Clinical infectious diseases*. 2012;54(12):e132-73.
23. Lavery LA, Armstrong DG, Wunderlich RP, Tredwell J, Boulton AJ. Diabetic foot syndrome: evaluating the prevalence and incidence of foot pathology in Mexican Americans and non-Hispanic whites from a diabetes disease management cohort. *Diabetes Care*. 2003;26(5):1435–8.
24. Bodernsten M. Annual report for podiatry statistics for 1 April 2018 to 31 March 2019.. 2019.
25. Ntuli SM. The Need for Podiatrists as Members of the Primary Health Care Team. University of Johannesburg (South Africa); 2016.
26. 2017-Gauteng-health-annual-report. 2016.
27. Africa SS. 2020 Mid-year population estimates | Statistics South Africa.
28. Manickum P, Ramklass SS, Madiba TE. A five-year audit of lower limb amputations below the knee and rehabilitation outcomes: the Durban experience. *Journal of Endocrinology Metabolism Diabetes of South Africa*. 2019;24(2):41–5.
29. Somasundram P, Davashni P, Deepak S, Romashan P. Diabetes-related amputations in the public healthcare sector in KwaZulu-Natal: a five-year perspective. Are we winning? *Journal of Endocrinology, Metabolism and Diabetes of South Africa*. 2019 Jan 2;;24(1):32–6.
30. Khan MZ, Smith MT, Bruce JL, Kong VY, Clarke DL. Evolving indications for lower limb amputations in South Africa offer opportunities for health system improvement. *World J Surg*. 2020;44(5):1436–43.
31. Larsson J, Apelqvist J. Towards less amputations in diabetic patients: incidence, causes, cost, treatment, and prevention—a review. *Acta Orthop Scand*. 1995;66(2):181–92.
32. Massyn N, Tanna G, Day C, Ndlovu N. District health barometer: district health profiles 2017/18. Durban: health systems trust. 2018.
33. Jobson M. Structure of the health system in South Africa. Khulumani Support Group; 2015.
34. Jobson M. Structure of the health system in South Africa. Johannesburg: Khulumani support group; 2015.
35. Rispel L. Analysing the progress and fault lines of health sector transformation in South Africa. *South African health review*. 2016;2016(1):17–23.
36. Bazemore A, Neale AV, Lupo P, Seehusen D. No title. Advancing the science of implementation in primary health care. 2018.
37. Baum F. Health for All Now! Reviving the spirit of Alma Ata in the twenty-first century: An Introduction to the Alma Ata Declaration. *Social Medicine*. 2007;2(1):34–41.
38. Department of Health. National health insurance in South Africa: Policy paper. *Government Gazette*. 2011;554:34523.
39. Kredo T, Cooper S, Abrams AL, Muller J, Schmidt B, Volmink J, et al. 'Building on shaky ground'—challenges to and solutions for primary care guideline implementation in four provinces in South

Africa: a qualitative study. *BMJ Open*. 2020;10(5):e031468.

40. Brem H, Sheehan P, Rosenberg HJ, Schneider JS, Boulton AJ. Evidence-based protocol for diabetic foot ulcers. *Plast Reconstr Surg*. 2006;117(7S):193S–209S.
41. Boulton AJ, Meneses P, Ennis WJ. Diabetic foot ulcers: a framework for prevention and care. *Wound repair regeneration*. 1999;7(1):7–16.
42. Monteiro-Soares M, Boyko EJ, Ribeiro J, Ribeiro I, Dinis-Ribeiro M. Risk stratification systems for diabetic foot ulcers: a systematic review. *Diabetologia*. 2011;54(5):1190–9.

## Figures

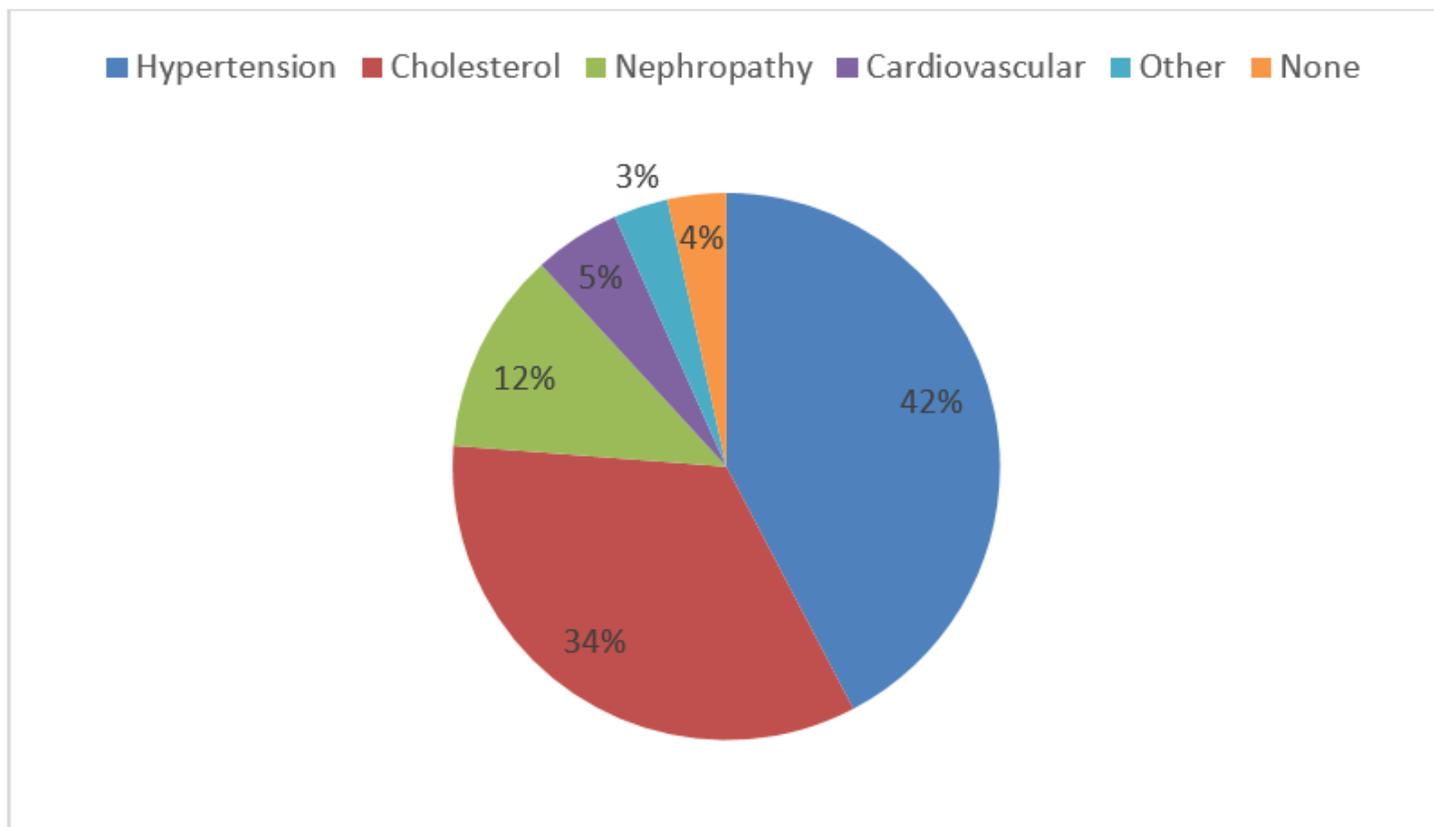
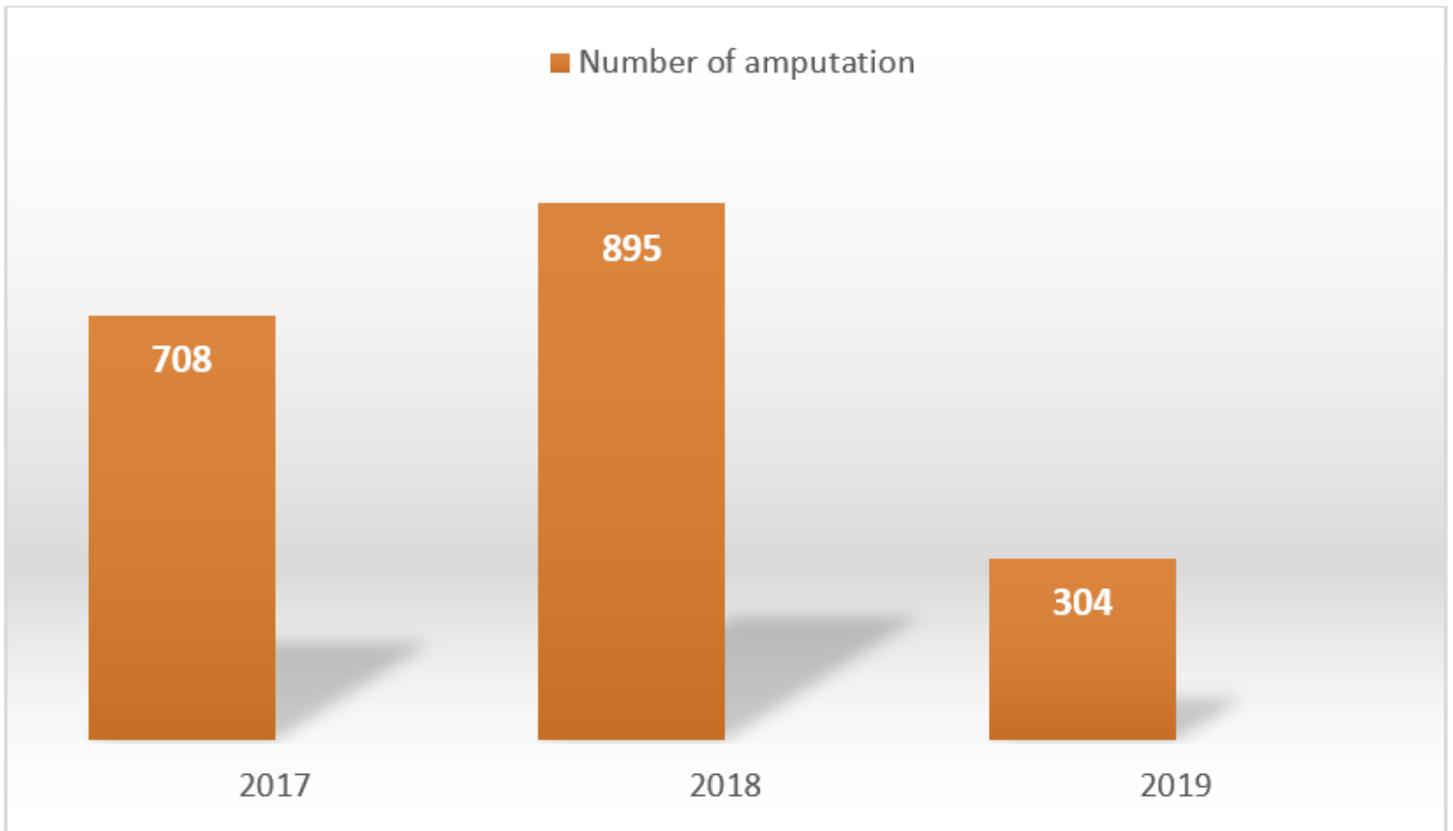


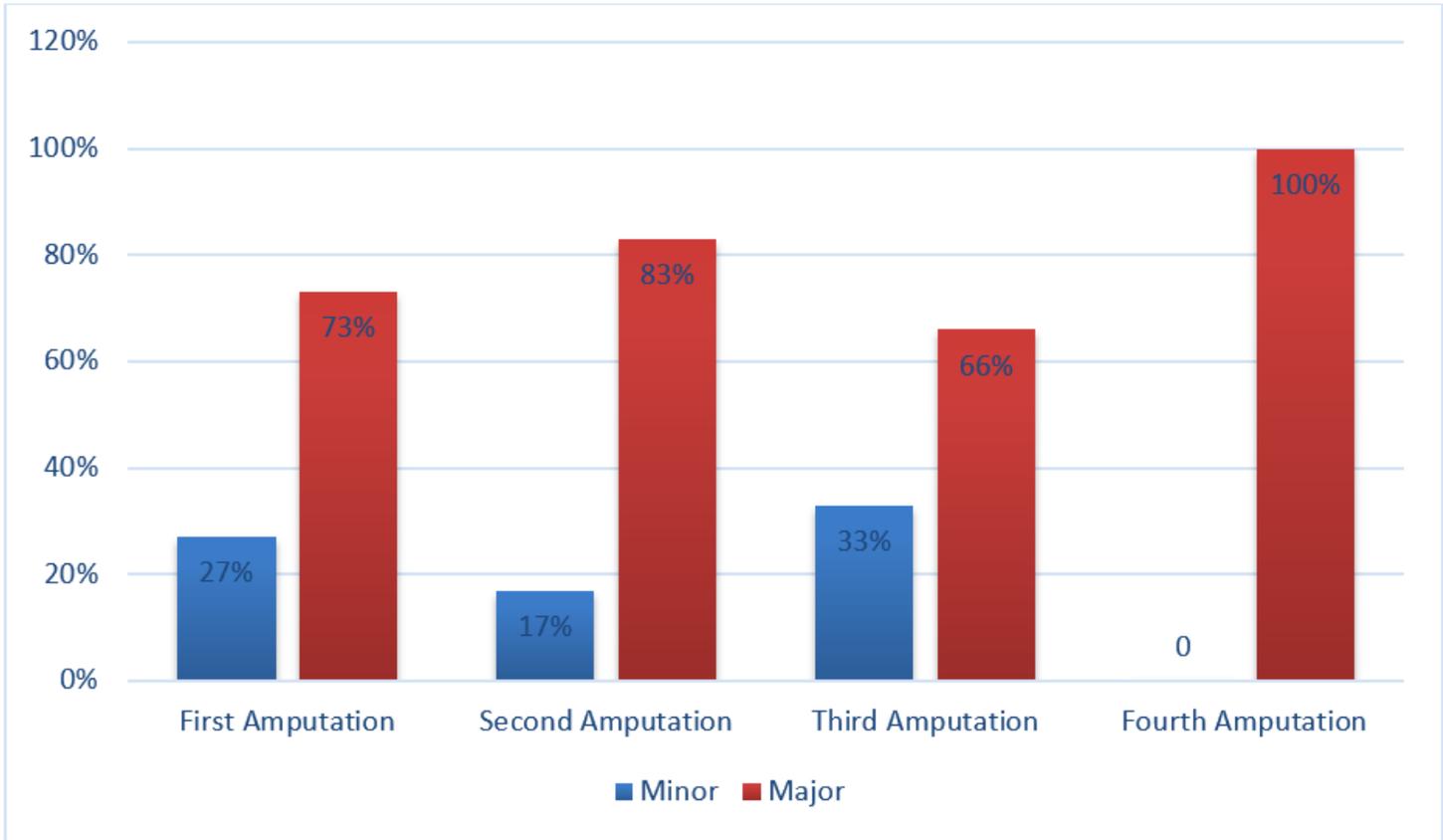
Figure 1

Comorbidities



**Figure 2**

Number of amputations per year.



**Figure 3**

Type of amputation