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RESEARCH ARTICLE

Hospitalization Costs for Diabetes Related Lower Extremity Amputation at a Referral Hospital in KwaZulu Natal, South Africa

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ARTICLE HISTORY

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Abstract: ***Background*:** Diabetes mellitus is a significant risk factor for lower extremity amputations (LEA), both alone and in combination with peripheral vascular disease and infection. Currently, in Africa, more than half of the cases do not meet the recommended blood glucose control levels to prevent complications suggesting that the risk of complications is high.

***Objective*:** The study aims to estimate hospitalization costs of diabetes-related lower extremities amputation for patients consulted at a referral hospital in 2015/16.

***Methods*:** The study was a retrospective analysis using a mixed costing approach and based on 2015/16 financial year data inflated to 2020 at a 32-bed vascular unit of a quaternary care health facility. Patient level data were extracted from the hospital information system for length of stay, medication provided, laboratory and radiological investigations, and other clinical services offered.

***Results*:** The total summative cost for managing all 34 patients amounted to $ 568 407 or a mean unit cost per patient of $ 16 718 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 728 997 or $ 21 441 per patient. The mean unit cost per patient for foot amputation was $ 12 598 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 16 157 per patient, whilst the mean cost per patient for lower limb amputation was $ 16 718 based on 2015/16 prices, and when adjusted to 2020 prices, amounted to $ 21 441 per patient.

***Conclusion*:** Hospital costs associated with diabetes related amputation varied by whether the patient was admitted to intensive care unit or not, and the major cost drivers were general ward costs, compensation of employees, and radiology services. A comprehensive audit of the referral process and care process at the facility level as well as technical efficiency analysis, is required to identify inefficiencies that could reduce hospital costs for managing diabetes complications.

Keywords: Hospital costs, cost per patient day, cost per capita, diabetes, lower limb amputation, complications.

1. INTRODUCTION

Diabetes mellitus is a significant risk factor for lower extremity amputations (LEA), both alone and in combination with peripheral vascular disease (PVD) and infection [1]. Previous studies indicate that approximately 40-60 % of all lower extremity non-traumatic amputations globally are diabetes related [2]. The progressive increase in the incidence of diabetes and its associated complications may lead to an increase in diabetic amputations [3, 4]. Furthermore, the lack of access to specialist care, especially in rural areas and inadequate diabetic foot care at primary health care level are potential contributors to the increased risk for diabetes-related LEA (DRLEA) [5, 6].

Lower extremity amputations account for a substantial economic burden to any healthcare system. In the United States of America, the estimated annual cost of LEA is 4.3 billion USD, with diabetic foot syndrome (DFS) responsible for 75 % of the cost [7]. In the United Kingdom, healthcare costs related to foot ulceration and amputation in diabetics in 2014–2015 were between £ 972 million to £ 1.13 billion, equivalent to 0.72–0.83 percent of the entire National Health Service budget [8]. In Germany, the annual mean cost incurred for treatment of a patient undergoing amputation was estimated at € 10,796, more than a 6-fold increase compared to patients with uncomplicated diabetes [9].

In South Africa, despite the high burden of disease attributable to communicable diseases, including Human Immune Deficiency Virus (HIV) and Tuberculosis (TB), diabetes is a major contributor to morbidity and mortality [10]. The estimated number of people living with diabetes in South Africa more than doubled from 2 million in 2009 [11]

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to an estimated 4.5 million in 2020 [12] and 6 million in 2030 and 8.1 million by 2045 [13].

The management of patients with diabetes requires long-term interaction for continuous clinical care and management. In addition, patients with diabetes are prone to micro-vascular and macro-vascular complications. A previous study (2009) indicated that there were 8,000 new cases of blindness and 2,000 new amputations annually caused by diabetes [11].

During the year of study (2015/16), there were 1638 LEAs performed in the province of KwaZulu-Natal (KZN), with regional hospitals 53 % (863) and tertiary hospitals 35 % (580) accounting for the bulk of LEA (Table **1**).

Table 1. KwaZulu-Natal DRLEA case in 2015/16.

Hospital Type	Year 2015/16
National Central Hospital	42
Regional Hospital	863
District Hospital	153
Provincial Tertiary Hospital	580
Total	**1 638**

In 2018, public sector costs of diagnosed people living with diabetes Type 2 were approximately ZAR2.7bn (193m USD) and ZAR21.8bn (156m USD) (if both diagnosed and undiagnosed patients are considered). In real terms, the 2030 cost of all diabetes cases is estimated to be ZAR35.1 billion (2.6bn USD). Approximately 51 % of these estimated costs for 2030 are attributable to the management of diabetes, and 49 % are attributable to its complications, including LEAs [14]. The cost of LEA in diabetics has been identified as the most expensive complication of diabetes, compared to other micro and macro-vascular complications [8].

Inkosi Albert Luthuli hospital is at the apex of the referral chain in the province of KZN. Patients with multi-morbidity and complications that lower-level hospitals do not have the resources or expertise to manage are referred to this hospital. The cost of DRLEA at this level of the facility has not been analyzed previously. This study aimed at estimating the cost of managing patients with DRLEA from their time of admission for the procedure to their discharge. Currently, in Africa, more than half of the cases do not meet the recommended blood glucose control level to prevent complications [1], suggesting that the risk of complications is high.

The intention is to obtain a reliable estimate of the costs to inform policymakers of the potential cost savings to be realized by strengthening primary and secondary preventive measures at lower levels to ensure better diabetes control in order to reduce the incidence of complications.

2. MATERIALS AND METHOD

2.1. Study Location and Site

The study was conducted at the vascular unit of Inkosi Albert Luthuli Central Hospital (IALCH), a quaternary care health facility. The vascular unit, a 32-bed facility, is the only unit in the province that ideally should operate complicated LEAs. The unit is resourced with 8 vascular surgeons and 26 nurses. The catchment area for IALCH is the whole of the KZN as well as part of the neighboring Eastern Cape Province.

2.2. Study Design

The study was a retrospective cost analysis that focused on direct patient activity costs, including laboratory services, medication, consumables, blood products, radiological services, and other related costs. The cost analysis was conducted from a health service perspective in order to establish supply-side costs and the financial burden posed by diabetes related lower extremity amputations on the healthcare system.

2.3. Study Population

Forty-one patients admitted at the vascular unit for DRLEA during the 2015/16 financial year were included in the study. Six patients were excluded as the patients had amputations post-surgery, which were not directly related to their diabetes and one patient had an upper limb amputation.

2.4. Data Collection

Cost data were extracted from the electronic hospital system. No physical records examination or patient interaction took place. Initially, a search for all patients admitted using the International Classification of Diseases 10 (ICD-10) with the following codes E11.5, E11.8 and Z89, was used for retrieving patient level data. The following information was then extracted from the database for each of the admitted patients: length of stay, medication provided, consumables supplied, laboratory and radiological investigations, number of operations, procedure performed, intensive care unit admission, and other clinical services offered.

Direct patient activity costs, including laboratory services, medication, consumables, blood products, radiological services, were mapped against each patient. Financial costs for each of these activities were obtained from the Financial Department and the business management system. The unit costs and volume consumed for each patient were multiplied to obtain the total cost at the patient level. Human resource costs were obtained from the Personnel and Salary system. Cost of operational expenses such as utilities, waste management, telephone expenses, *etc*., were obtained from the Basic Accounting system used for managing financial expenses.

2.5. Data Analysis

All extracted data were saved on a Microsoft Excel® (Microsoft Corp, Redmund WA) spreadsheet. Direct patient activity costs, including laboratory services, medication, consumables, blood products, radiological services, were calculated for each patient. The unit costs and volume consumed for each patient were multiplied to obtain the total cost for each cost item. Theatre costs were determined using average minutes the patient was in theatre from entry to exit and in-

cluded anesthesia cost, surgeon cost, and all surgical consumables utilized.

All human resources, goods, and services costs were apportioned to each patient based on the length of stay as a proportion of all patients in the vascular ward length of stay.

Six component costs: human resources, medication cost, theatre costs, radiology cost, laboratory cost, and general ward cost (goods and services) were calculated per patient.

The total cost per patient was summed up to arrive at a total cost for DRLEA at the hospital. The mean cost per DRLEA was then calculated by dividing the total cost for DRLEA across all 34 patients by the total length of stay for all the patients. The standard deviation was calculated for the total cost. Costs were further disaggregated for patients with intensive care admission *versus* patients without intensive care admission as well as foot amputation *versus* lower leg amputation. To test for any statistical difference between the mean costs for those admitted and not admitted in ICU, a t-test was used. The total cost and mean cost were adjusted for inflation for 2020 prices. The exchange rate of R15.23 per dollar was applied for 2015/16 and R14.25 for 2020 (Fig. **1**).

2.6. Ethics Approval

Ethical clearance was obtained from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal: Reference number: BE221/17. Provincial approval was obtained from the KwaZulu -Natal Department of Health.

3. RESULTS

3.1. Study Population

Thirty-four patients fulfilled the inclusion criteria from the forty-one patients that had amputations during the period under the study. Six patients, although living with diabetes, were excluded. The primary indication for the LEA was not due to a diabetes-related complication. One patient had an upper limb amputation. Of the 34 patients included in the study, eight patients (24 %) had foot amputations (toes & metatarsals), whilst 26 patients (76 %) had lower limb amputations (above and below the knee). Fifty three percent (18) of the population were males. The mean age of the study population was 64 years (SD: 9.58). Males were significantly younger than females, with a mean age of 61 (SD: 7.02) compared to 68 years (SD: 10.83). The total length of stay for all patients was 832 days, with a mean length of stay of 26 days per patient (SD: 18.37). Males had a longer duration of stay (mean = 28 days; SD 22.34) compared to females (mean=22 days; SD: 13.04). Eight patients (24 %) were admitted to the high care/intensive care units for some duration of their total admission.

3.2. Total Cost of Hospitalization for DRLEA

The total summative cost for managing all 34 patients amounted to $ 568 407 or a mean unit cost per patent of $ 16 718 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 728 997 or $ 21 441 per patient. Patient activity-related costs in this study represented 36 % ($ 183 892) of the total DRLEA. Goods and services (inclusive

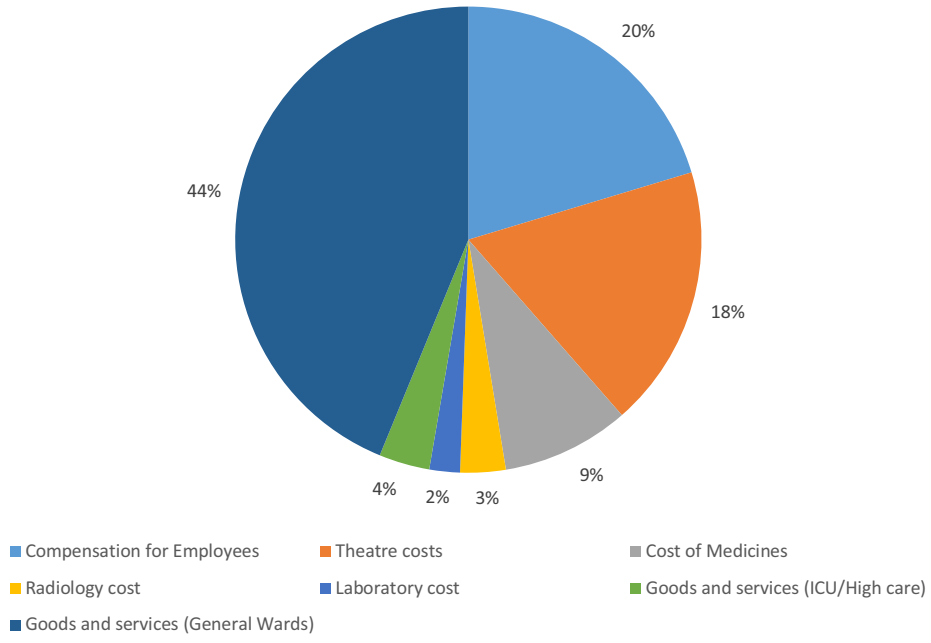

Fig. (1). Component cost of patients with DRLEA at IALCH (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

of equipment depreciation, maintenance, utilities, telephone, and other information communication equipment) accounted for 44 % of the total cost, followed by human resources cost (20 %). Theatre cost (18 %; $ 103 580) was the highest micro- costing component and included the cost for surgeon, anesthetist, and facility fees.

3.3. Hospitalization Cost for DRLEA with and without ICU Stay

Twenty-six (76 %) patients were not admitted into the high care/intensive unit during their admissions. The total summative cost for managing all 26 patients amounted to $ 406 338 or a mean unit cost per patent of $ 15 050 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 521 140 or $ 19 301 per patient. The summative cost for managing the eight patients that had intensive care unit admissions was $ 181 171 or a mean unit cost per patent of $ 22 646 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 232 357 or $ 29 044 per patient (Table **2**). There was no significant difference between the mean cost for patients admitted in ICU and those not admitted in ICU ($p = 0.18$)

3.4. Hospitalization Cost by the Level of Amputation

About 15 percent (5/34) patients had amputation of the foot that included toes and metatarsals. The total length of stay for these patients was 94 days, with a mean length of stay of 19 days per patient (SD: 13). The total summative cost for managing these five patients amounted to $ 62 988 or a mean unit cost per patent of $ 12 598 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 80 783 or $ 16 157 per patient.

Twenty-nine patients (85 %) received lower extremity amputations (above and below the knee). The total length of stay for these patients was 682 days, with a mean length of stay of 27 days per patient (SD: 20). The summative cost for managing the thirty patients was $ 568 407 or a mean cost per patient of $ 16 718 based on 2015/16 prices and $ 728 997 or $ 21 441 per patient when adjusted to 2020 prices (Table **3**).

4. DISCUSSION

The mean age of the study population was 64 years (SD: 9.58). This is in keeping with prior population-based studies that reported a mean age of 65 years in patients with LEA [15]. Males were significantly younger than females, with a mean age of 61 (SD: 7.02) compared to 68 years (SD: 10.83). This is in keeping with previous literature that has shown men to be younger at the time of amputation than women, regardless of the level of amputation [16].

As anticipated, the mean unit cost for all categories of amputations of $ 16 718 based on 2015/16 prices in our study is double the $ 8 302 per DRLEA shown at a tertiary hospital in KwaZulu-Natal based on 2019 prices when transportation costs, prosthesis cost, and down referral stay cost are excluded [6]. The unit cost per amputation in the current study is more than four times the cost obtained in a study of 140 patients that underwent LEA at a University Hospital in Jordan between 2012 and 2017. The mean cost for amputations was $ 4904.7 (SD± 429.3) [8].

Table 2. Hospitalization cost with/without intensive care unit stay.

Cost Analysis without ICU Stay				Cost Analysis with ICU Stay			
Cost Components	**2016/17**	**Mean Cost Per Patient**	**CPI Inflation Adjusted 2020**	**Cost Components**	**2016/17**	**Mean Cst Per Patient**	**CPI Inflation Adjusted 2020**
Compensation for Employees	$ 82 566	$ 3 058	$ 105 893	Compensation for Employees	$ 37 220	$ 4 653	$ 47 736
Theatre costs	$ 78 338	$ 2 901	$ 100 470	Theatre costs	$ 26 718	$ 3 340	$ 34 267
Cost of Medicines	$ 35 465	$ 1 314	$ 45 485	Cost of Medicines	$ 17 208	$ 2 151	$ 22 069
Radiology cost	$ 16 200	$ 600	$ 20 777	Radiology cost	$ 2 270	$ 284	$ 2 911
Laboratory cost	$ 8 122	$ 301	$ 10 417	Laboratory cost	$ 4 584	$ 573	$ 5 879
Goods and services (ICU/High care)	$ 0	$ 0	$ 0	Goods and services (ICU/High care)	$ 19 995	$ 2 499	$ 25 645
Goods and services (General Wards)	$ 185 647	$ 6 876	$ 238 098	Goods and services (General Wards)	$ 73 176	$ 9 147	$ 93 850
Total Cost	**$ 406 338**	**$ 15 050**	**$ 521 140**	**Total Cost**	**$ 181 171**	**$ 22 646**	**$ 232 357**
Total length of stay	630	23	630	Total length of stay	284	36	284
Cost per patient/day	**$ 645**	**$ 654**	**$ 827**	**Cost per patient/day**	**$ 638**	**$ 629**	**$ 818**

Table 3. Hospitalization cost by the level of amputation.

Type of Amputation	Cost Based on 2016/17	Mean Cost Per Patient (2016/17)	CPI Inflation Adjusted 2020	Mean Cost Per Patient (2020)
Foot amputations	$ 62 988	$ 12 598	$ 80783	$ 16 157
Lower extremity (above and below knee)	$ 568 407	$ 16 718	$ 728 997	$ 21 441

The cost of DRLEA in the current study is lower than many internationally published studies. Data obtained from the operating theatre database and medical records at Hamad General Hospital in Qatar for all patients who underwent upper extremity amputation and LEA between 2000 and 2014 estimated a mean cost per patient of $ 52 699 ($ 40 924 to $ 64 323). Direct amputation-related costs accounted for 13 % of the total cost, with the rest due to hospitalization costs [17].

The study findings of a mean unit cost of $ 16 718 based on 2015/16 prices and $ 21 441 per patient when adjusted to 2020 fall in the lower end of the bracket of estimates obtained from systematic studies published in the United States post 2000. The mean costs were estimated as $ 16 355 for minor amputations and $ 55 874 for major amputations with large standard deviations [18].

The mean unit cost per patient with intensive care unit admissions was $ 22 646 based on 2015/16 prices, and when adjusted to 2020, prices amounted to $ 29 044 per patient (Table **2**). This is 51 % more than the mean cost per amputation for a patient without intensive care unit admissions. Goods and services within the ICU contribute 33 % to the additional costs, with the additional costs associated with an increased length of stay in the general ward contributing an additional 30 %, followed by compensation of employees (salaries) (20 %) and additional medication (11 %).

The mean cost per patient (foot amputation) and the mean cost per patient (lower limb) compares favorably in relation to the study in Qatar that reported a mean cost of $ 36 773 for foot amputations and $ 88 997 for lower limb amputation (above and below the knee) [17]. In addition, the results are favorable when compared to the mean cost of care for patients with diabetes in US veterans with below knee amputations $ 71 067 (95 % CI $ 68 449 to $ 73 785) and above knee $ 82 758 ($ 78 063 to $ 87 736) [19].

A number of studies have been conducted in various settings to estimate the cost of diabetes-related amputations. However, due to variation in the process of care, differing cost structures, differences in the demographic characteristics of patients, and study designs for cost evaluation, comparison of costs across different countries is difficult [20]. The current study was conducted at the apex facility of the province that has modern medical technology, a specialised staff complement, and receives patients mainly as referrals from other facilities. This means that patients treated at this hospital are of a more complicated nature compared to patients treated at lower level facilities, and therefore, the cost is much higher than what obtains other lower level facilities in the province.

4.1. Study Limitations

The study had a number of limitations. First, it only focused on direct costs (excluding rehabilitation costs and prosthesis costs) and not indirect costs, which were likely to be significant given the public-private sector partnership at this hospital. Second, the study did not consider societal costs, which would have allowed for a broader understanding of the economic burden posed by DRLEA in society. Such information is important for informing referral policy and treatment and care interventions. However, the captured direct costs are important in demonstrating the need to decentralize treatment and care for patients with diabetes complications. Third, there was no integration of the length of stay and associated cost, and for some patients, length of stay could be extended whilst awaiting transport for down referral.

CONCLUSION

Hospital costs associated with DRLEA varied by whether the patient was admitted to ICU or not, and the major cost drivers were general ward costs, compensation of employees, and radiology services. Given the observed high costs of care for diabetes complications, adequate budgeting and resource allocation for hospital services are required to ensure that the patients are managed and amputated, preferably at the lower levels of service. It is therefore important that further cost analyses are conducted at regional and district level hospitals to inform the budgeting process. Part of the budgeting process for lower level hospitals should also consider a comprehensive audit of the referral process and care process at the facility level as well as technical efficiency analysis to identify inefficiencies that could reduce hospital costs. Prevention is more cost effective. Prevention of complications by strengthening the management of diabetes at the primary healthcare level in general and foot care, in particular, should not only be viewed for its clinical outcomes but also cost savings accrued.

LIST OF ABBREVIATIONS

LEA	=	lower Extremity Amputation
DRLEA	=	Diabetes Related Lower Extremity Amputation
USD	=	United States Dollars
KZN	=	KwaZulu Natal
ZAR	=	South African Rand
ICU	=	Intensive Care Unit

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance was obtained from the Biomedical Research Ethics Committee of the University of KwaZulu-Natal: South Africa, Reference number: BE221/17. Provincial approval was obtained from the KwaZulu-Natal Department of Health.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was waivered.

STANDARD OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

FUNDING

The study received funding support from the finance Department, Human resource Department, and the Business intelligence unit at IALCH.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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REFERENCES

[1] Sobngwi E, Ndour-Mbaye M, Boateng KA, *et al.* Type 2 diabetes control and complications in specialised diabetes care centres of six sub-Saharan African countries: The Diabcare Africa study. Diabetes Res Clin Pract 2012; 95(1): 30-6. http://dx.doi.org/10.1016/j.diabres.2011.10.018 PMID: 22071431

[2] Abbas ZG. Preventive foot care and reducing amputation: A step in the right direction for diabetes care. Diabetes Manage 2013; 3: 427-35. http://dx.doi.org/10.2217/dmt.13.32

[3] Kim TH, Chun KH, Kim HJ, *et al.* Direct medical costs for patients with type 2 diabetes and related complications: A prospective cohort study based on the Korean National Diabetes Program. J Korean Med Sci 2012; 27(8): 876-82. http://dx.doi.org/10.3346/jkms.2012.27.8.876 PMID: 22876053

[4] Rinonapoli GCP, Altissimi M, Caraffa A. Critical appraisal of foot and ankle amputations in diabetes. Clin Res Foot Ankle 2014; 3: 005. http://dx.doi.org/10.4172/2329-910X.S3-005

[5] 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. http://dx.doi.org/10.1007/s00268-019-05361-9 PMID: 31897692

[6] Thompson AT, Bruce JL, Kong VY, *et al.* 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? JEMDSA 2020; 25: 44-50. http://dx.doi.org/10.1080/16089677.2020.1782007

[7] Dillingham TR, Pezzin LE, Shore AD. Reamputation, mortality, and health care costs among persons with dysvascular lower-limb amputations. Arch Phys Med Rehabil 2005; 86(3): 480-6. http://dx.doi.org/10.1016/j.apmr.2004.06.072 PMID: 15759232

[8] Aljarrah Q, Bakkar S, Aleshawi A, *et al.* Analysis of the peri-operative cost of non-traumatic major lower extremity amputation in Jordan. Clinicoecon Outcomes Res 2020; 12(12): 13-21. http://dx.doi.org/10.2147/CEOR.S232779 PMID: 32021336

[9] Liebl A, Spannheimer A, Reitberger U, Görtz A. Costs of long-term complications in type 2 diabetes patients in Germany. Results of the CODE-2 Study. Med Klin (Munich) 2002; 97(12): 713-9. http://dx.doi.org/10.1007/s00063-002-1215-z PMID: 12491064

[10] Pillay-van Wyk V, Msemburi W, Laubscher R, *et al.* Mortality trends and differentials in South Africa from 1997 to 2012: Second National Burden of Disease Study. Lancet Glob Health 2016; 4(9): e642-53. http://dx.doi.org/10.1016/S2214-109X(16)30113-9 PMID: 27539806

[11] Bertram MY, Jaswal AV, Van Wyk VP, *et al.* The non-fatal disease burden caused by type 2 diabetes in South Africa, 2009. Glob Health Action 2013; 6: 19244. http://dx.doi.org/10.3402/gha.v6i0.19244

[12] International Diabetes Federation. IDF Africa Members: South Africa. 2020. Available from: https://idf.org/our-network/regions-members/africa/members/25-south-africa.html

[13] International Diabetes Federation. IDF Diabetes Atlas. (9th ed.), Brussels, Belgium: International Diabetes Federation 2019.

[14] Erzse A, Stacey N, Chola L, *et al.* The direct medical cost of type 2 diabetes mellitus in South Africa: A cost of illness study. Glob Health Action 2019; 12: 1636611. http://dx.doi.org/10.1080/16549716.2019.1636611

[15] Hussain MA, Al-Omran M, Mamdani M, *et al.* Efficacy of a guideline-recommended risk-reduction program to improve cardiovascular and limb outcomes in patients with peripheral arterial disease. JAMA Surg 2016; 151(8): 742-50. http://dx.doi.org/10.1001/jamasurg.2016.0415 PMID: 27050566

[16] Peek ME. Gender differences in diabetes-related lower extremity amputations. Clin Orthop Relat Res 2011; 469(7): 1951-5. http://dx.doi.org/10.1007/s11999-010-1735-4 PMID: 21161738

[17] Al-Thani H, Sathian B, El-Menyar A. Assessment of healthcare costs of amputation and prosthesis for upper and lower extremities in a Qatari healthcare institution: A retrospective cohort study. BMJ Open 2019; 9(1): e024963. http://dx.doi.org/10.1136/bmjopen-2018-024963 PMID: 30782746

[18] Nilsson A, Willis M, Neslusan C. A review of the costs of lower limb amputations in patients with diabetes in the US. Value Health 2018; 21: S73. http://dx.doi.org/10.1016/j.jval.2018.04.492

[19] Franklin H, Rajan M, Tseng CL, Pogach L, Sinha A, Mph M. Cost of lower-limb amputation in U.S. veterans with diabetes using health services data in fiscal years 2004 and 2010. J Rehabil Res Dev 2014; 51(8): 1325-30. http://dx.doi.org/10.1682/JRRD.2013.11.0249 PMID: 25625913

[20] Tchero H, Kangambega P, Lin L, *et al.* Cost of diabetic foot in France, Spain, Italy, Germany and United Kingdom: A systematic review. Ann Endocrinol (Paris) 2018; 79(2): 67-74. http://dx.doi.org/10.1016/j.ando.2017.11.005 PMID: 29544659

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