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Lower Extremity Amputation Rates in People With Diabetes Mellitus: A Retrospective Population Based Cohort Study in Zwolle Region, The Netherlands

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WHAT THIS PAPER ADDS

This paper shows, using exact data, the lower extremity amputation rate in people with diabetes in a region where the diabetic footcare is organised at all three levels following the international guidelines with the diabetes podiatrist functioning as a case manager. In most countries, organisation of diabetic footcare is challenging due to professions missing from the team.

Objective: Lower extremity amputations are a major complication of diabetes mellitus (DM). In a previous Dutch study, the incident rate of major amputations was 89.2 per 100 000 person years. The primary aim of this study was to describe the lower extremity amputation rates in people with DM in the Zwolle region, where preventive and curative footcare is organised according to the guidelines of the International Working Group of the Diabetic Foot (IWGDF). The secondary aim was to evaluate outcomes and underlying characteristics of these people.

Methods: This was a retrospective regional population based cohort study. Data from all people with DM treated in primary and secondary care, living in the region Zwolle were collected. All amputations in the period 2017 to 2019 were analysed. Comparisons were made between those with and without an amputation.

Results: In the analysis 5 915 people with DM were included, with a mean age of 67.8 (IQR 57.9, 75.9) years. Of those people, 47% were women and the median HbA1c was 53 (IQR 47, 62) mmol/mol. Over the three year study period 68 amputations were performed in 59 people: 46 minor, 22 major. This translated into an average annual crude amputation incidence rate of non-traumatic major and minor amputations of 41.5 and 86.9 per 100 000 person years among people with diabetes. Compared with those not undergoing amputations, those who underwent an amputation were more often men, older, mainly had T2DM, were treated in secondary care, had higher diastolic blood pressure, worse diabetic footcare profile, longer DM duration and higher HbA1c. At the end of the follow up, 111 people died: 96 (1.6%) without and 15 (25.4%) with amputations ($p < .001$).

Conclusions: This retrospective study provides detailed insight into the rate of amputations in Dutch people with diabetes in the region Zwolle. Compared with previous Dutch estimates, these data suggest a considerable decrease in the major amputation incidence rate.

Keywords: Amputations, Diabetic foot, Lower extremity amputation, Podiatry, Preventive care
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INTRODUCTION

Diabetic foot ulcers (DFUs) are common, have a major impact on healthcare costs, and negatively affect the quality of life of people with diabetes mellitus (DM).[1] Across Europe, DFUs lead to lower extremity amputation(s) (LEA) in 20% of all cases.[2] Major amputation (proximal to the ankle) carries a poor prognosis; the mortality rate is high, with a 22% 30 day mortality rate after amputation and a one year mortality rate of 44%.[3] Preventive footcare that aims to reduce the risk of DFU is essential to lower the number of major and minor non-traumatic amputations.

In 2013, Fard *et al.* reported a reduction in the incidence of amputations among people with DM from 142.6 major amputations per 100 000 person years in the period 1991 – 1992 to 89.2 per 100 000 person years among people with

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DM in the period 2012 — 2013.[4] However, this was before the introduction of a new structured multidisciplinary approach (started in 2015), expected to improve the care for DFUs.[5] More recent data from The Netherlands are lacking.

In The Netherlands all disciplines necessary to provide adequate (preventive) footcare, as described in the IWGDF guideline, are available and therefore (potentially) deployable. According to these guidelines there are three levels of diabetic footcare. In level 1, the podiatrist, general practitioner, and diabetes nurse are working together in preventive footcare. In level 2 the (vascular) surgeon, internist, rehabilitation doctor, podiatrist, shoe technician, and orthopaedic (plaster) technician are working together as a multidisciplinary foot team, and in level 3 a level 2 team has several experts on the diabetic foot from different disciplines acting as tertiary reference centre.

In 2020, an update of the IWGDF guidelines was published,[6] emphasising the importance of a well organised team, that uses a holistic approach in which the ulcer is seen as a sign of multi-organ disease.[6]

In The Netherlands a podiatrist is a paramedical professional, who is trained to actively treat DFU and to assess the biomechanical and offloading aspects of the diabetic foot. In The Netherlands all three levels are part of the standard of care with financial coverage by the healthcare system. In contrast, in neighbouring countries such as Belgium, France, or Germany, preventive diabetic footcare is not covered or only minimally covered by insurance (Belgium, France),[7] or a podiatrist is not part of the preventive care (Germany[8]). Other countries have problems with implementation of the current guidelines because recommended disciplines are missing.[9,10]

Care for people with type 2 diabetes mellitus (T2DM) in The Netherlands is concentrated in primary care, with an important role for trained primary care practice nurses ("Praktijk Ondersteuner Huisarts" = POH). Care for people with type 1 diabetes mellitus (T1DM) is concentrated in secondary care. According to current standards of care in DM, annual foot evaluation and a multidisciplinary approach to footcare are essential.[11]

All people with DM receive a yearly foot check to determine risk factors for foot ulceration based on presence of neuropathy, peripheral arterial disease (PAD), pressure points, a history of foot ulcers, amputations, Charcot foot, or end stage renal failure.[12] Every person receives a Sims score (0 — 3) (see Supplementary Table S1) and a care profile (0 — 4). Depending on their risk, follow up checks are done by primary care nurses/DM nurses (Sims 0, 1) or (DM specialised) podiatrists (Sims > 1) (see Supplementary Fig. S1 for schematic representation). Care profiles are scored from zero (no risk, yearly check up) to four (highest risk, four to six weekly check up).[12] From 2010 onwards, DM footcare was further professionalised by introducing DM specialised podiatrists. From 2015, preventive podiatric footcare was included in the basic insurance reimbursements package in the Netherlands. Since then, people with Sims 1 — 3 have visited podiatrists and pedicures with minimal personal financial burden.

In this study the primary aim was to evaluate the major and minor amputation rates in people with DM in a region where preventive and curative footcare is organised according to IWGDF principles. The secondary aims were to evaluate outcomes and characteristics of the people undergoing amputations and compare the present outcomes with previous literature.

METHODS

Study design

This was a retrospective regional population based cohort study in people with DM treated in 2017 — 2019 in primary and secondary care in the Zwolle region (Northeast of the Netherlands), within the confines of specific postal code regions. The time frame 2017 — 2019 was chosen because it took some time before the agreed care paths were fully implemented after the start in 2015, and because of the influence of COVID-19 pandemic lockdowns during which time structured and timely footcare was severely hampered in 2020. The total populations in this region each year were 138 208, 138 900, and 140 290 people in 2017, 2018, and 2019, respectively. Combining data of primary and secondary care registries, all people known to have DM were identified. The primary aim in the study was to calculate the number of minor and major amputations in people with DM within the Zwolle region. Secondary outcomes included an in depth analysis of characteristics of people who underwent an amputation compared with people who did not undergo an amputation, and their outcomes. Finally, data were compared with previous (Dutch) studies towards amputation rates.

Footcare in the Zwolle region

In the Zwolle region, > 85% of people with DM receive a yearly foot check.[13] High risk foot problems (DFU with infections or necrosis, ingrown toenails with infection, Charcot foot syndrome) are seen at short notice five days a week by a hospital based DM podiatrist and or wound expert. In really severe cases, presentations will be at the emergency department, often followed by hospital admission. A multidisciplinary team for complex foot disorders (vascular surgeon, internist, rehabilitation doctor, dermatologist, DM podiatrist, wound nurse specialist, wound nurse, orthopaedic [plaster] technician, and shoe technician) examines all people with DFU with impaired wound healing once a week. DM podiatrists and wound nurse specialists are available on a daily basis in the hospital for people with DFU and may consult the individual specialists of the multidisciplinary foot team as needed. In the region under study, all three levels of diabetic footcare are in place with the podiatrist as the coordinating discipline.

Data collection

Data were collected from primary (GPs) and secondary (Isala hospital) care registries. The Isala hospital is the only secondary care hospital in the Zwolle region, with a

catchment area of approximately 350 000. To ensure that referrals from primary care (GPs) would have taken place to the Isala Hospital, all people with DM living in the zip code areas with a > 95% primary referral rate to Isala in 2017 – 2019 were identified and included. Primary care data were extracted from the chain information system (Portavita Health management platform, Amsterdam, The Netherlands) as used by the regional primary care group. Secondary care (hospital) data were extracted from Cognos (IBM, Canada). In The Netherlands, physicians in secondary care are required to document a "Diagnose Behandel Combinatie" (DBC) code (Dutch for diagnosis treatment combination [DTC] and Dutch representation of the Diagnosis Related Groups [DRG] system: the DBC is used for reimbursement of hospital care by the health insurance companies). Each DBC contains information about the specialty of the treating physician, the diagnosis, and type of treatment provided. Secondary care treated people with DM were identified within Cognos with the DBC codes (for specification see Supplementary Table S3).

Traumatic amputations were excluded from this study. Amputations were categorised into minor (below ankle level) and major (above ankle level) amputations.[14] The group of major amputations was subdivided into transtibial amputation (TTA) and transfemoral amputation (TFA).

All podiatry and pedicure visits are extracted from the podiatric care systems in use (Prosoftware, Dordrecht; PodoFlow, Utrecht, Innofeet Diabetes Portal, Zwolle).

All extracted data were linked using date of birth, four numbered zip code, and house number in the coupling procedure. After combining these data by an independent trusted third party (Sycade Group, Zwolle, The Netherlands), the database was fully anonymised.

For the whole group the following information was collected: gender, weight, height, systolic and diastolic blood pressure, DM type, date of DM diagnosis, DM duration, HbA1c, Sims classification, smoking status, presence or absence of neuropathy, and date of death. For the subgroup of people with amputation, additional parameters were collected (see also Supplementary Table S3).

Statistical analysis and ethical considerations

All statistical analyses were done with SPSS version 23 (IBM Corporation, version 23, Somers, NY, USA). For those with more than one amputation in a single year, the highest level of amputation was included in the analysis. For those with more amputations in different years, the amputation was counted for each year. The amputation rate was calculated as the number of amputations per 1 000 and 100 000 person years. For each person, the days from the start of the study until the first amputation date during the study period were calculated; for those patients who underwent more than one amputation during the study, the first amputation date was used to calculate the person days. Differences in outcomes were tested with the Fisher's exact test for categorical data. For continuous data, Student *t* test or Mann–Whitney *U* test were used if data were distributed normally or skewed, respectively. Q-Q plots and histograms were used to determine whether the tested variable had a normal distribution. To visualise the survival rate after amputation, a Kaplan–Meier curve was constructed. The log rank test was used to test for significance of the survival rate. In The Netherlands, Dutch law exempts retrospective studies with anonymised databases from ethical review; therefore, this study was exempt from medical ethical approval. The Medical Ethical Committee was consulted and consented to the proposed approach. This manuscript was written in accordance with the STROBE checklist.[15]

RESULTS

A total of 5 915 people with DM, 53% men, with a median age of 67.8 (IQR 57.9, 75.9) years, were included in the analysis (Table 1). Most people (93%) had T2DM, and the majority of these were treated in primary care (83%). Median HbA1c was 53 (IQR 47, 62) mmol/mol. Forty three (43%) per cent of people had a low risk diabetic footcare profile (Sims 0), while 13% had a high risk diabetic footcare profile (see Supplementary Table S1 for Sims' classification).

During the follow up period of three years, 68 amputations were performed in 59 people (Table 2). As already mentioned, nine people underwent two amputations during the study period.

The annual crude incidence rate of non-traumatic amputations in people with DM in the Zwolle region was 45.3 (2017), 51.0 (2018), and 28.3 (2019) per 100 000 person years for major amputations and 62.4 (2017), 107.7 (2018), and 90.7 (2019) per 100 000 person years for minor amputations. Over the whole study period, the average annual incidence of non-traumatic major and minor amputations was 41.5 and 86.9 per 100 000 person years, respectively; most amputations (78%) were minor amputations.

Compared with people who did not undergo an amputation, those who did were more often men, older, were less often smokers, had higher diastolic blood pressure, had a worse diabetic footcare profile, longer DM duration, and higher HbA1c (Table 1).

Detailed characteristics of all amputations are presented in Table 3. The majority was men, had T2DM, and were treated in secondary care for their DM. Most amputations (80%) were preceded by DFU. People who underwent a major amputation had more often had PAD without any available treatment options for revascularisation compared with people with minor amputations (55% *vs.* 5%). All major amputation were transtibial amputations. There were no knee disarticulations or transfemoral amputations in the studied population. Of those with a major amputation, 75% had undergone a vascular intervention before the amputation took place. The most frequently applied method for revascularisation was an endovascular procedure (70%, see Table 3). In the major amputation group, more people (20% *vs.* 2.6%, see table 3) were in need of dialysis. People with major amputations had more previous amputations, and or gangrene of minimally one toe (wound classification

Table 1. Baseline characteristics of 5 915 people with diabetes mellitus treated in primary and secondary care, living in the region Zwolle

	Total (n = 5 915)	No amputation during follow up (n = 5 856)	Amputation during follow up (n = 59)	p*
Clinical characteristic				
Gender – male	3 133 (53)	3 091 (52.8)	42 (71.2)	.005
Age – y	67.8 (57.9, 75.9)	67.8 (57.6, 75.8)*	70.7 (61.4, 80.9)	.040
BMI – kg/m^2 †	28.9 (25.7, 32.8)	28.9 (25.7, 32.8)	27.8 (25.4, 33.6)	.97
Smoking	885 (14.8)	879 (15.0)	6 (10.2)	< .010
Systolic blood pressure – mmHg ‡	138.4 ± 17.2	137.0 ± 17.7	137.3 ± 17.2	.51
Diastolic blood pressure – mmHg ‡	78.3 ± 10.3	77.6 ± 10.5	78.4 ± 10.2	.010
Highest care profile §				
0	2 542 (43)	2 542 (43.4)	0	< .010
1	196 (3.3)	196 (3.3)	0	< .010
2	297 (5.0)	292 (5.0)	5 (8.5)	< .010
3	1 548 (26.2)	1 543 (26.3)	5 (8.5)	< .010
4	765 (12.9)	736 (12.6)	28 (47.5)	< .010
Diabetes characteristics				
Treatment setting DM				<.010
Primary care	4 887 (82.6)	4 874 (83.2)	13 (22.0)	
Secondary care	1 007(17.0)	978 (16.7)	29 (49.2)	
Nursing home care	18 (0.3)	2 (<0.1)	16 (27.1)	
DM type				.28
DM type 1	396 (6.7)	390 (6.7)	6 (10.2)	
DM type 2	5 519 (93.3)	5 466 (93.3)	53 (89.9)	
DM duration – y	9.8 (6.5, 13.5)	9.8 (6.5, 13.5)	11.6 (6.7, 17.5)	.030
HbA1c – mmol/mol	53 (47, 62)	53 (47, 62)*	65 (54, 72.5)	< .010
HbA1c – %	7 (6.5, 7.8)	7 (7.5, 7.8)	8.1 (7.1, 8.8)	< .010

Data are presented as n (%), mean ± standard deviation, or median (interquartile range). BMI = body mass index; DM = diabetes mellitus.
* $p < .050$ considered statistically significant.
† Missing values: n = 1 743 for the total group, n = 1721 for people without an amputation during follow up, and n = 22 for people with an amputation.
‡ Missing values: n = 529 for the total group, n = 525 for people without an amputation during follow up, and n = 4 for people with an amputation.
§ Missing values: n = 568 for the total group, n = 547 for people with an amputation during follow up, and n = 21 for people with an amputation.

Wagner stages 4 and 5 (see Supplementary Table S2). Furthermore, the DFUs of amputees were more often infected with Gram negative pathogens (Table 3).

At the end of the follow up period, 111 (1.9%) of the studied population had died: 96 (1.6%) from the group without amputations and 15 (25.4%) from the group with amputations ($p < .001$) (see Fig. 1 for Kaplan–Meier survival curve after amputation).

DISCUSSION

The aim of this study was to assess the amputation rates and the possible influence of structured preventive footcare on amputation rates in people with DM in the region of Zwolle. Over the three year study period the average annual incidence of non-traumatic major and minor amputation was 41.5 and 86.9 per 100 000 person years, respectively. Compared with those who did not undergo amputations, people who underwent an amputation were more often men, older, mainly had T2DM, were treated in secondary care, had a higher diastolic blood pressure, a worse diabetic footcare profile, longer DM duration, and higher HbA1c. The majority (70%) of people with a major amputation underwent an endovascular revascularisation procedure before amputation was performed. In 11 cases (55%), the vascular intervention was not (totally) successful and these cases were labelled as having no more vascular treatment options by the collaborating vascular surgeons. In these cases, major amputation was the only available option.

Earlier available Dutch data concerning amputations in people with DM in 2012 – 2013 used (partly estimated)

Table 2. Distribution of minor and major amputations over time in people with diabetes mellitus treated in primary and secondary care, living in the region Zwolle

	Amputations in total diabetes population (n = 5 915)	Percentage of all people with amputation (n = 59)
Amputations 2017	19 (0.3)	32.2
Major	8 (0.1)	13.6
Minor	11 (0.2)	18.6
Amputations 2018	28 (0.5)	47.5
Major	9 (0.2)	15.3
Minor	19 (0.3)	32.2
Amputations 2019	21 (0.4)	35.6
Major	5 (0.1)	8.5
Minor	16 (0.3)	27.1

Data presented as n (%), unless otherwise indicated.

Table 3. Characteristics of people with diabetes mellitus treated in primary and secondary care, living in the region Zwolle, who underwent an amputation during the follow up period

	Total group amputations (n = 59)	Minor amputations (n = 39)	Major amputations (n = 20)
Characteristic			
Gender – male	42 (71.2)	28 (71.8)	14 (70.0)
Age – y	70.7 (61.4, 80.9)	67.3 (60.7, 81.3)	74.0 (66.9, 79.6)
BMI – kg/m^2	27.5 (24.8, 33.4)	27.4 (24.5, 32.0)	31.2 (27.1, 36.0)
Smoking	6 (10.2)	4 (10.3)	2 (10)
Systolic blood pressure – mmHg	138.50 (124, 156)	139, 5 (128.6, 156.5)	128.50 (118.3, 155.3)
Diastolic blood pressure – mmHg	72, 50 (65.75, 82.50)	73.0 (68.0, 84.8)	72.5 (63.8, 79.5)
Neuropathy	43 (72.9)	30 (76.9)	13 (65)
Retinopathy	11 (18.6)	8 (20.5)	3 (15)
DBC Cardiology	5 (8.5)	2 (5.1)	3 (15)
Treatment setting			
Primary care	13 (22)	10 (25.6)	3 (15)
Secondary care	29 (49.2)	23 (59.0)	6 (30)
Nursing home	16 (27.1)	5 (12.8)	11 (55)
Diabetes characteristics			
DM type 1	6 (10.2)	4 (10.3)	2 (10)
DM type 2	53 (89.8)	35 (89.7)	18 (90)
Duration – y	11.6 (6.7, 17.5)	10.5 (6.4, 17.1)	12.3 (9.2, 18.0)
HbA1c around amputation date	58.5 (52.5, 71.0)	62.0 (53.0, 71.0)	54 (51.0, 76.0)
Insulin	17 (79.7)	32 (82.1)	15 (75)
Oral blood glucose lowering medication	33 (55.9)	22 (56.4)	11 (55)
Insulin and oral blood glucose lowering drug	21 (35.6)	15 (38.5)	6 (30)
GLP-1 receptor agonist	2 (3.4)	2 (5.1)	–
Laboratory values at date of amputation			
CRP – mg/L	48.0 (19.3, 108.0)	43.0 (10.0, 96.0)	78.0 (40.0, 146.0)
eGFR, CKD EPI – mL/min/1.73m^2	56.5 (33.0, 92.0)	55.0 (34.0, 92.0)	60.0 (29.0, 92.0)
Serum creatinine – µmol/L	104.5 (69.0, 172.5)	110 (69.0, 150.0)	92 (69.0, 179.0)
Albumin – g/L	39.0 (35.0, 43.0)	40.0 (37.0, 53.5)	36.8 (34.0, 41.0)
Patient died during follow up	15 (25.4)	8 (20.5)	7 (35)
Vascular status			
PAD without any options for revascularisation	13 (22)	2 (5.1)	11 (55)
Underwent vascular intervention before amputation	35 (59.3)	20 (51.3)	15 (75)
Underwent endovascular intervention	33 (55.9)	19 (48.7)	14 (70)
Underwent open reconstruction	6 (20.2)	2 (5.1)	4 (20)
Underwent thrombolysis	4 (6.8)	0 (0)	4 (20)
Ulcer characteristics			
Ulcer before amputation	47 (79.7)	32 (82.1)	16 (80)
Amputation in medical history	25 (42.4)	11 (28.0)	14 (70)
Texas ulcer classification			
B3	9 (15.3)	9 (23.1)	0
C2	2 (3.4)	2 (5.1)	0
C3	8 (13.6)	3 (7.7)	5 (25)
D3	31 (52.5)	20 (51.3)	11 (55)
No ulcer	2 (3.4)	0	2 (10)
Unknown	7 (11.9)	5 (12.8)	2 (10)
Wagner ulcer classification			
1	0	0	0
2	13 (22)	12 (30.8)	1 (5)
3	22 (37.3)	19 (48.7)	3 (15)
4	9 (15.3)	3 (7.7)	6 (30)
5	6 (10.2)	1 (2.6)	5 (25)
Unknown/no ulcer	9 (15.3)	4 (10.3)	5 (25)
Gangrene	39 (66.1)	23 (59)	16 (80)
Gram negatives in wound	34 (57.6)	21 (53.8)	13 (65)
Osteomyelitis	39 (66.1)	27 (69.2)	12 (60)
Dialysis	5 (8.5)	1 (2.6)	4 (20)
Diagnosed with mental disorders	20 (33.9)	13 (33.3)	7 (35.0)
Medication use			
Anticoagulation	27 (45.8)	20 (51.3)	7 (35)
Beta blockers	20 (33.9)	17 (43.6)	3 (15)
Calcium antagonists	11 (18.6)	8 (20.5)	3 (15)
ACE blocking medication	18 (30.5)	13 (33.3)	5 (25)

Continued

Table 3-*continued*

	Total group amputations (n = 59)	Minor amputations (n = 39)	Major amputations (n = 20)
Statins	26 (44.1)	21 (53.8)	5 (25)
Immunosuppressive medication	4 (6.6)	2 (5.1)	2 (10)
Insulin	10 (16.9)	2 (5.1)	3 (15)
Oral blood glucose lowering medication	19 (32.2)	13 (33.3)	6 (30)
GLP-1 receptor agonist	2 (3.4)	2 (5.1)	–

Data are presented as n (%) or median (interquartile range). BMI = body mass index; DBC = "Diagnose Behandel Combinatie" (Dutch for diagnosis treatment combination); DM = diabetes mellitus; GLP = glucagon like peptide; CRP = C reactive protein; eGFR = estimated glomerular filtration rate; CKD EPI = Chronic Kidney Disease Epidemiology; PAD = peripheral arterial disease; ACE = angiotensin converting enzyme.

data from the Northern part of The Netherlands and reported a crude annual incident rate of first ever major amputations of 89.2 per 100 000 person years.[4] Only the most proximal located amputation in people with DM and PAD was counted once in this study. As the present study also contains amputations without PAD (e.g., osteomyelitis and non-healing ulcers), the amputation rate in the previous Dutch study is higher than the amputation rate found in the present study and would suggest a decrease over time. In Belgium, the estimated major amputation rate decreased from 42.3 per 100 000 person years in 2009 to 29.9 per 100 000 person years in 2013.[16] It should be noted that the authors reported a higher percentage of transfemoral amputations compared with the present results. Transfemoral amputations are associated with less mobility than after transtibial amputations.[17]

Obviously, comparisons between amputation rates between studies should be interpreted with caution and study design differences should be taken into account. Firstly, previous studies used estimates to calculate amputation rates,[4,16] while in the present study actual observed rates were used. Secondly, the approach towards peripheral vascular disease in DM seems to differ between countries, with some apparently enacting a maximum leg preserving approach while others do not. A retrospective analysis from the Danish National Patient register[18] showed a crude major amputation rate of 1.25 per 1 000 person years among people with T2DM in 2017, and a rate of 0.78 per 1 000 person years for TFA and 0.4 per 1 000 person years for TTA, while in the region under study no TFA were observed in the study period. Also, the ratio of endovascular revascularisation to bypass surgery appears to be different between Denmark and The Netherlands. In the Danish study 100% of patients with a major amputation, who underwent a vascular intervention beforehand, had undergone bypass surgery. In the present study, 70% underwent endovascular surgery and only 20% bypass surgery.

Notably, differences in populations, healthcare systems, and reimbursement options in, for example, preventive care are unaccounted for, thus hampering reliable comparisons. The Organisation for Economic Co-operation and Development (OECD) reported the average major amputation rates

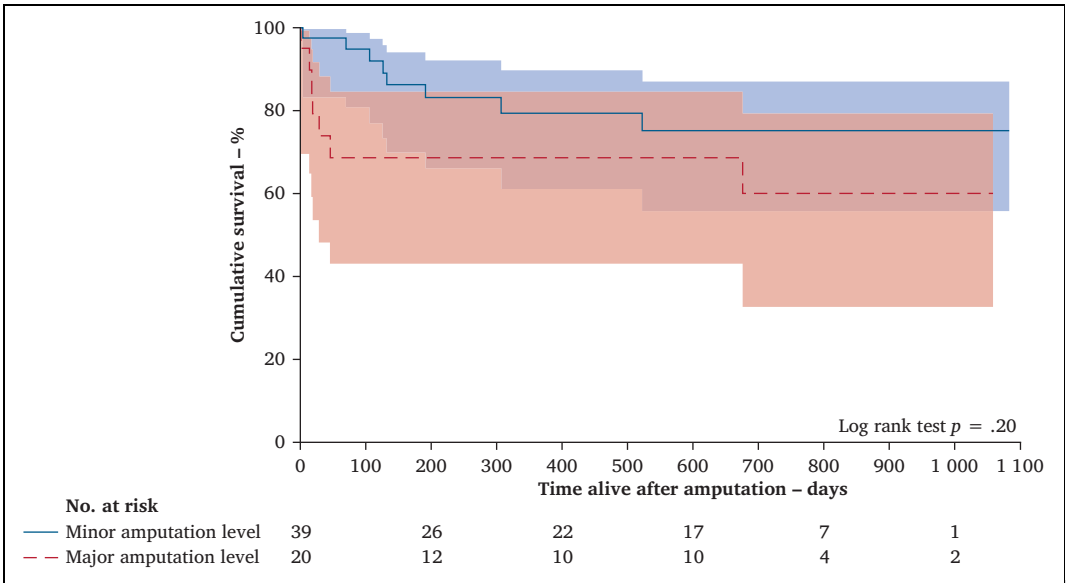

Figure 1. Cumulative Kaplan–Meier analysis of survival after amputation: minor *vs.* major amputation. Shaded areas represent 95% confidence intervals.

among people with DM for 21 high income countries. They reported an average amputation rate of 128.3 per 100 000 people with DM.[19] With a major amputation rate in the year 2019 of 84.5 per 100 000 people with DM, the present study compares favourably with this OECD rate. The decrease in major amputation rates in the present study is in line with the decrease observed in other T2DM related complications in The Netherlands, such as renal failure,[20] and it is speculated that the implementation of structured footcare, with a role of case manager for the DM podiatrist, may have contributed to the observed decrease in amputation rates.

When searching for more studies on amputation in DM, a reliable comparison of international data with the present study data is hampered by differences in population characteristics, in type of amputations reported (major *vs.* minor), and in reports differing in selection of first amputations only or including re-amputations. The already mentioned 2021 OECD report contains data on major amputations in DM from 22 European countries, although the exact definition of major amputation is lacking.[21]

Study limitations

In The Netherlands, data on the number of people with DM living in a nursing home are not as well documented as is the case for people with DM treated in primary and secondary care. Therefore, the total number of people with DM in the study region could have been slightly under reported. The number of all amputations among people with DM living in a nursing home is not known because the amputations are all performed in the hospital.

This study presents results for the Zwolle region, encompassing nearly 6 000 patients with DM, and results found in this rather small population cannot be extrapolated to the whole country. The study region has a largely homogeneous Caucasian population, with a higher living standard compared with other regions in The Netherlands. Also, there are no language barriers in healthcare.

Also, it is remarkable that relatively few smokers were reported within the group of people with an amputation. This might be explained partly by there being more ex-smokers in the amputation group, but unfortunately in the group of people who underwent an amputation more often information about former smoking behaviour was missing.

Limitations include missing data, and lack of data before and after the study period for the population, thus not permitting any assessment of trends. Even so, when comparing the present data with the earlier report from the northern part of The Netherlands,[4] the present findings do suggest an improvement in diabetic footcare with lower major amputation rates. However, given the limitations of this work and previous literature, it is hard to draw firm conclusions.

As an alternative approach, the present authors will analyse data from the national health insurance all payer claims registry managed by the Vektis Healthcare Information Centre, covering over 99% of the Dutch population. This will allow analysis of the complete Dutch population with uniform methods of assessment over consecutive years. Importantly, if these additional analyses do demonstrate a decrease in the amputation rate, underlying factors should be investigated, in particular the effect of organising DM footcare according to IWGDF guidelines. If it can be concluded that organising DM footcare according to IWGDF is the major determinant for the decrease in amputations — which could well be the case given previous literature,[6,22] strong arguments can be put forward that this integrated approach should become the standard of care, at least in the Dutch context.

Conclusion

This study presents the amputation rates in people with DM in a region where preventive and curative diabetic footcare is organised following the international guidelines for the treatment of people with diabetic foot disease. Although caution is needed when comparing these outcomes with previous data, the present findings suggest a decrease in the incidence rate of major amputations in the Zwolle region.

CONFLICT OF INTEREST

None.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejvs.2023.05.030

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