

Nontraumatic upper and lower-extremity amputation, an incidence-based Disability-Adjusted Life Years (DALY) approach

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Abstract: The aim was to estimate the odds ratio and burden of disease from nontraumatic upper and lower-extremity amputations attributable to diabetes and skin disorders in Arad County, Romania, from 2014 to 2018. A descriptive epidemiological study was chosen by calculating disability-adjusted life years (DALY). Odds ratio for amputations in diabetic patients was 21.7545 (95% CI 10,2969 to 45,9614; $P < 0,0001$) compared to non-diabetics ones. Burden of disease was high, 1,962 DALY in men and women, double for men compared to women, in cases with deaths related to amputation; burden of disease related with death caused by the main medical condition, mainly diabetes, was 21,964 DALY, with comparable Years Lost due to Disability (YLD) in men and women but with YLD component in women pushing this rate to 51.59% of total DALY, while in men represents 42.02%, meaning that women with diabetes in Arad are aging as diabetic ones and amputees more often than men. The burden of disease has to be evaluated every year and public health strategies must be tailored for improving glycemia control and avoid diabetic foot complications in all vulnerable patients.

Considering that almost 30,000 people in Arad County live with diabetes, with a five years hospital admissions of 21.45% of them and 696 amputations (10.81%), even if only 2,75% of the patients died during the index hospitalization, the burden of disease has to be evaluated every year and all strategies for prevention and health education for diabetic foot should be oriented according to vulnerability of these patients.

Key Words: amputation, diabetes, Years Lost due to Disability.

INTRODUCTION

Nontraumatic amputations are necessary mainly in peripheral artery disease (PAD) and diabetes, due to non-healing and infected ulcer and gangrene [1]. PAD affects 12%–14% of the general population and its prevalence increases with age affecting up to 20% of patients over the age of 75 [2]. Vascular specialist

recognition of personal risk factors in every patient for these severe conditions is needed. Chronic limb threatening ischaemia (CLTI) is a more difficult diagnosis than acute limb ischaemia for the non-specialist because the clinical features can be more subtle and gradual in onset [2]. Chronic limb ischemia (CLI) is pain in the lower extremity at rest or ulceration with and without tissue necrosis [3]. One classification of the PAD patient

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is: Asymptomatic PAD, Intermittent claudication (IC), Chronic limb ischemia (CLI), Acute limb ischemia (ALI) [4]. Patients with advanced vascular disease, diabetes, infections, or certain cancers are eligible candidates for nontraumatic amputations [5].

Nontraumatic upper and lower-extremity amputation is more frequent in diabetic patients than in non-diabetics [6], accounting for more than 70% of non-traumatic lower limb amputations [7].

Aim

Identification of all nontraumatic upper and lower-extremity amputations and their relation to diabetes and skin disorders in Arad inpatients between 2014-2018, without taking into account peripheral artery disease (PAD).

Hypothesis

Burden of disease from nontraumatic upper and lower-extremity amputation attributable to diabetes mellitus is higher compared to non-diabetics.

MATERIAL AND METHODS

A hospital-based descriptive epidemiological study was performed using DALY. From 2014 to 2018, lower and upper extremities amputations in inpatients were identified in the hospital database. The study included amputations due to all types of diabetes mellitus and skin disorders, unilateral or bilateral upper and lower extremity amputations in both sexes, for all levels of amputation, and in all age brackets. All codes for the surgical procedures related to upper and lower-extremity amputations were checked. All patients signed an Amputation Procedural Consent Form being also informed about the risks of an amputation.

Electronic hospital database was scanned for all DRG (Diagnosis Related Groups) cases [8] as listed in Romanian Tables of RO Diagnosis Related Groups related to upper and lower-extremity amputation (O08105, O16302, O11601, O16306, O16301, O16307, O13603, O16305, O11602, O08106, O16303) as well as nontraumatic diseases codes identified as causes for these procedures: L03.11 Cellulitis of lower limb, L98 Chronic skin ulcer NOS (not otherwise specified), L97 Lower limb ulcer NOS, I87.2 Chronic venous insufficiency, E14.52 Unspecified diabetes with diabetic peripheral angiopathy with gangrene, E10.69 Type 1 diabetes with other specified complications, E10.52 Type 1 diabetes with diabetic peripheral angiopathy with gangrene, E10.71 Type 1 diabetes with multiple microvascular complications, E11.69 Type 2 diabetes with other specified complications, E11.62 Type 2 diabetes with specified skin and subcutaneous tissue disorders, E11.8 Type 2 diabetes with NOS (not otherwise specified) complications, E11.73 Type 2 diabetes with lower

limb ulcer due to multiple causes. This Romanian [9] codification is different to ICD-11 for Mortality and Morbidity Statistics (December 2018) [10].

A hospital-based descriptive epidemiological study was performed by calculating disability-adjusted life years (DALY) according to Arad County population registered in the official demographic records [11]. Years of Life Lost due to premature mortality (YLL) was calculated by totalling the number of deaths at each age between 1-79 years for women and between 1-71.6 years for men, multiplied by the number of years of life remaining up to the age of 79 years for women and 71.6 for men, according to the Life Expectancy tables [12].

RESULTS

There were 10,518 electronic files of inpatients treated in Dermatovenereology (n= 4,083) and Diabetes, Nutrition and Metabolic Disease departments (6,435), with a mean age 61.10 (Standard Error 0.151; 95% Confidence Interval for Mean: Lower Bound 60.81 - Upper Bound 61.40; Median 63.00; Standard Deviation 15.440; Minimum 0, Maximum 96 years). Gender mean age was higher for women 62.80 years (n= 5,679) and 59.11 years for men (n=4,839). Gender ratio F:M was almost equal 1.17:1 (Fig. 1).

There were 6,435 diabetic patients (with amputation rate 10.18%, n=696) and 4,083 non-diabetic patients (amputation rate 0.17%, n=7). Death rate was 1.71% (n=180; F=89; M=91; 9 (0.22%) in non-diabetic and 171 (2.65%) in diabetic patients), in all patients and 0.23% (n=25; F=12; M=13) in amputated ones.

Of 10,518 cases, 7,472 (71.04%) were coded with medical conditions which led to amputation and/or death, excluding PAD, Table 1. There were 693 lower-extremity and 10 upper-extremity amputations.

Skin disorders such as cellulitis (Image 1, by the courtesy of Dr. Dan Goldis, surgeon in Clinical Emergency Arad Hospital), abscess, ulcer and chronic

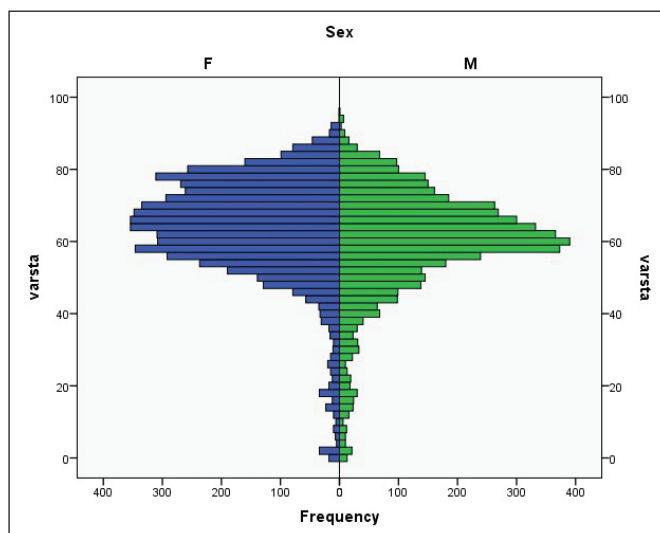


Figure 1. Inpatients age and gender distribution.

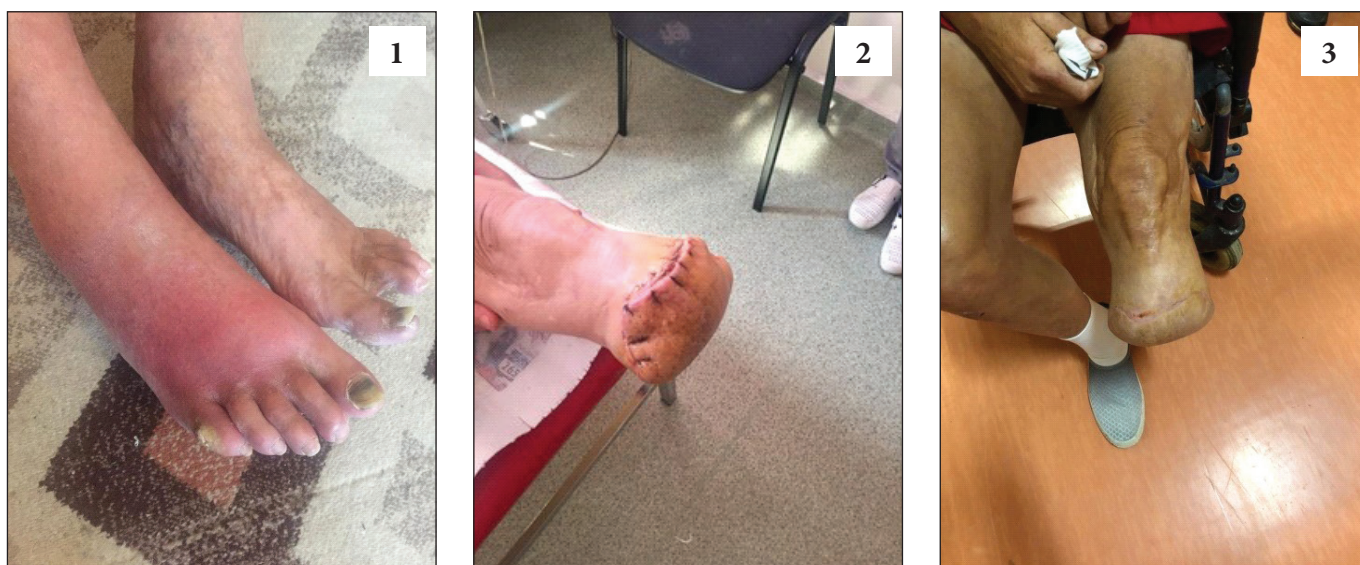


Image 1 - Foot cellulitis; Image 2 - Lower limb amputation; Image 3 - Healed amputation.

Table 1. Medical conditions which led to nontraumatic upper and lower-extremity amputations and/or death

ICD-10-AM	N	Deaths not related to amputation	Lower-extremity amputation	Upper-extremity amputation	Total amputation	Deaths related to amputation
L03.11 Cellulitis of lower limb	340	3	3	0	3	1
L02.2 Skin abscess, boil and boil anthracoid of torso	153	1	0	0	0	0
L02.4 Cutaneous abscess, furuncle and carbuncle of limb	250	2	0	0	0	0
I87.2 Chronic venous insufficiency	176	0	1	0	1	0
L98 Chronic skin ulcer, NOS	198	1	1	0	1	0
L97 Lower limb ulcer, NOS	200	1	2	0	2	0
E14.52 Unspecified diabetes with diabetic peripheral angiopathy with gangrene	3	0	3	0	3	0
E10.69 Type 1 diabetes with other specified complications	364	1	0	1	1	0
E10.52 Type 1 diabetes with diabetic peripheral angiopathy with gangrene	20	1	6	1	7	1
E10.71 Type 1 diabetes with multiple microvascular complications	2	1	1	0	1	0
E11.69 Type 2 diabetes with other specified complications	3,283	102	1	0	1	1
E11.52 Type 2 diabetes with diabetic peripheral angiopathy with gangrene	1,020	25	671	8	679	22
E11.62 Type 2 diabetes with specified skin and subcutaneous tissue disorders	1	0	1	0	1	0
E11.8 Type 2 diabetes with unspecified complications	143	4	2	0	2	0
E11.73 Type 2 diabetes with lower limb ulcer due to multiple causes	10	0	1	0	1	0
E11.9 Type 2 diabetes mellitus without complications	40	1	0	0	0	0
E10.42 Type 2 diabetes mellitus with diabetic polyneuropathy	1,103	1	0	0	0	0
E11.71 Type 2 diabetes mellitus with multiple microvascular complications	161	9	0	0	0	0
E11.12 Type 2 diabetes mellitus with ketoacidosis with coma	4	1	0	0	0	0
E11.15 Type 2 diabetes mellitus with ketoacidosis, lactic acidosis, without coma	1	1	0	0	0	0
Total	7,472	155	98.57(n=693)	1.42(n=10)	703	25

venous insufficiency were responsible for 0.53% of amputations (n=7), exclusively in lower limbs. The death rate not related to amputation was 0.6%, with a single case in which deaths occurred during the index hospitalization. Type 2 diabetes with diabetic peripheral angiopathy with gangrene has imposed lower-extremity amputations (Image 2 and 3, by the courtesy of Dr. Dan Goldis, surgeon in Clinical Emergency Arad Hospital) in 65.78% of cases (n=671) and upper-extremity amputations in 0.78% (n=8), being the most serious medical condition which represents the major risk for these extreme procedures.

Upper and lower-extremity amputations were performed on patients between 35 - 92 years of age, to 209 women and 494 men, gender ration M:F being 2.37:1.

Level of education of patients with amputations was dominated by elementary/Eighth grade school for 51.1% (n=401), Tenth grade for 17.7% (n=124), and Eleventh grade for 13.4% (n=94); Bachelor's level education was found in 1.6% (n=11) of the patients (P < 0,0001). Employment status of these patients indicated that 81,65% were retired (n=574) even if one third (31.35% ; n=180) of them was under 65 years old, Table 2.

Odds ratio for amputations in diabetic patients was 21.7545 (95% CI 10,2969 to 45,9614; P < 0,0001) compared to non-diabetics ones, with 696 amputations in diabetic and 7 in non-diabetic patients.

Years of life lost (YLL) take into account the age at which deaths occur by giving greater weight to deaths at younger age and lower weight to deaths at older age [13].

Disability-Adjusted Life Year (DALY) is quantifying the Burden of Disease from mortality and morbidity; DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences [14].

The Years of Life Lost due to premature mortality (YLL) is calculated by totalling the number of deaths at each age between 1-79.1 years for women and between 1-71.7 years for men, multiplied by the number of years of life remaining up to the age of 79.1 years for women and 71.7 for men, according to the Life Expectancy tables [15,16], added up to 1.962 years in men and women for 703 amputated cases. DALY was established using

Table 2. Employment status, study age groups and gender for patients with nontraumatic upper or lower-extremity amputations

Employment status	Study age groups						Total
	35-44	45-54	55-64	65-74	75-84	85+	
Amputations	35-44	45-54	55-64	65-74	75-84	85+	
F	2	9	49	85	52	12	209
Unemployed	1	3	10	2	0	0	16
Retired	1	3	39	82	52	12	189
Employee	0	3	0	1	0	0	4
M	4	54	181	180	68	7	494
Unemployed	2	13	22	4	1	0	42
Business owner	0	1	0	0	0	0	1
Retired	0	16	121	174	67	7	385
Employee	2	24	38	2	0	0	66

Table 3. YLL, YLD and DALYs in upper and lower-extremity amputation and deaths

YLL	Deaths	Deaths per 1000	Av. Age at death	Standard LE	YLLs	YLL per 1000
<i>Males</i>	13	0.06	68.3	10.4	113	0.5
<i>Females</i>	12	0	73.8	10.3	105	0.4
YLL in study age groups	Deaths	Deaths per 1000	Av. Age at death		YLLs	YLL per 1000
<i>Males</i>	13	0.1	68.3		113	0.5
<i>Females</i>	12	0	73.8		105	0.4
YLD	Incidence	Incidence per 1000	Age at onset	Duration (years)	Disability Weight	YLDs/ YLD per 1000
<i>Males</i>	494	2.1	65	5.4	0.5	1,180/5.1
<i>Females</i>	209	0.9	69.8	6.1	0.5	564/2.3
Total DALYS = YLL+YLD						
	<i>Males</i>		<i>Females</i>		<i>Persons</i>	
Age	DALYs	DALYs per 1000	DALYs	DALYs per 1000	DALYs	DALYs per 1000
0-4	-	-	-	-	-	-
5-14	-	-	-	-	-	-
15-29	-	-	-	-	-	-
30-44	-	-	0	0	0	0
45-59	40	0.8	0	0	40	0.4
60-69	904	34.8	406	12.8	1,310	22.7
70-79	288	22.8	204	10.4	492	15.3
80+	60	9.8	59	5.2	119	6.8
Total DALYS	1,293	5.6	669	2.8	1,961	4.1

YLL: Years of Life Lost due to premature mortality; LE: Life Expectancy; Av. Age: Average Age; YLD: Years Lost due to Disability; DALY: Disability-Adjusted Life Year; Total DALYS = YLL+YLD.

Table 4. YLL, YLD and DALYs in upper and lower-extremity amputation not related to deaths

YLL	Deaths	Deaths per 1000	Av. Age at death	Standard LE	YLLs	YLL per 1000
Males	78	0.34	68.6	10.4	670	2.9
Females	77	0	72.1	11.7	730	3
YLL in study age groups	Deaths	Deaths per 1000	Av. Age at death		YLLs	YLL per 1000
Males	78	0.3	68.6		670	2.9
Females	77	0.3	72.1		730	3
YLD	Incidence	Incidence per 1000	Age at onset	Duration (years)	Disability Weight	YLDs/ YLD per 1,000
Males	4,828	21	59.2	4.3	0.5	9,231/40.1
Females	5,669	23.3	62.9	4.5	0.5	11,333/46.7
Total DALYS = YLL+YLD						
Age	Males DALYs	DALYs per 1000	Females DALYs	DALYs per 1000	Persons DALYs	DALYs per 1000
0-4	-	-	-	-	-	-
5-14	-	-	-	-	-	-
15-29	-	-	0	0	0	0
30-44	21	0.4	0	0	21	0.2
45-59	188	3.9	196	3.9	384	3.9
60-69	7,204	277.5	7,446	234.8	14,650	254
70-79	2,052	162.2	3,553	181.8	5,605	174.1
80+	436	71.3	867	75.9	1,303	74.3
Total DALYS	9,901	43	12,062	49.7	21,964	46.4

existing calculation template available on World Health Organization site [17].

In these 5 years, the deaths due to diabetes mellitus and skin disorders which were followed by amputation reached a number of 25 and YLL (YLL=N x L where N= number of deaths and L = standard life expectancy at age of death in years) was 113 for men and 105 for women. Years Lost due to Disability induced by an amputation was 1,180 for men and 564 for women, total 1,744. DALYs, or burden of disease was 1,961 in men and women (1,293 in men and 669 in women). Years lost due to disability YLDs accounted for 88.93% of DALY for all patients. The burden in men, and the share of the years lost due to disability (YLD) component in men reached 60.17% of total DALY. For women the years lost due to disability (YLD) component reached 28.76% of total DALY, Table 3. Mortality accounted for 11.11% of DALY.

Analysing 155 deaths occurred in patients with no relation with amputation, YLLs reached 1,400 years (670 for men and 730 for women), YLD 20,564 (9,231 for men and 11,333 for women), DALY being 21,964 (9,901 in men and 12,062 in women), Table 4. YLD represented 93.62% from DALY.

CONCLUSIONS

The burden of disease from upper or lower-extremity amputations attributable to diabetes in Arad,

from 2014 to 2018 is high, 1,962 DALY in men and women, being double for men compared to women, in cases with deaths related to amputation; burden of disease related with death caused by the main medical condition, mainly diabetes, is huge, 21,964 DALY with comparable YLD in men and women but with years lost due to disability (YLD) component in women pushing this rate to 51.59% of total DALY, while in men represents 42.02%, meaning that women with diabetes in Arad are aging as diabetic ones and amputees more often than men.

Considering that almost 30,000 people in Arad County live with diabetes, with a five years hospital admissions of 21.45% of them and 696 amputations (10.81%), even if only 2.75% of the patients died during the index hospitalization, the burden of disease has to be evaluated every year and all strategies for prevention and health education for diabetic foot should be oriented according to vulnerability of these patients.

Amputations do not accelerate death but change the quality of life. Premature death, reflected in YLL as a component of burden disease does not have the biggest value, most of the burden being concentrated in YLD, which represented 93.62% from DALY. This result has to take into account that young amputees will age with physical irreversible limitations.

Conflict of interest. The authors declare that there is no conflict of interest.

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