The Incidence Rate of Lower Extremity Amputation in Amman, Jordan

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Abstract

Background: The incidence of Lower Extremity Amputation (LEA) is increasing worldwide. In the developing countries incidence data is lacking. The present study was conducted to determine the incidence rate of LEAs in Amman, Jordan.

Methods: The methodology used to conduct this study was based on the Global Lower Extremity Amputation (GLEA) study protocol for data collection and analysis. Data was collected on all amputations for adult Jordanians of 20 years and older at seventeen health centers in Amman city. Patients were identified from two data sources within each center and "Capture-recapture" technique was used to adjust for undercount.

Results: The total number of cases included in the analysis was 371 with a mean age of 59.6 years, SD= 13.8. The overall incidence rate was 23.6/100.000/year (95% CI 21.2, 26.1). Males had a higher incidence rate than females (32.5 with 95% CI (28.5, 36.3) vs. 13.6 with 95% CI (11, 16.5)). The ratio of males to females was 2.7:1. The incidence rate of major amputations was higher than minor amputations. Analysis of age-specific rates showed that the highest incidence rate was among those from the 60-79 years of age. The ascertainment level varied between 73.1%-83.3%. Comparing the present study with the GLEA study, age adjusted rates for males and females were the second highest after the U.S for both types of LEAs.

Conclusion: Lower extremity amputations represent a significant health concern in Jordan.

Keywords: Incidence rate, lower extremity, amputation, Amman.

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Introduction

Lower Extremity Amputation (LEA) is a common surgical treatment, which is usually performed for the removing of diseased or dead tissues, relieving pain, promoting healing, and rehabilitating the amputee for better quality of life. A limb amputation is also considered the most devastating choice for treatment in any health situation. Amputees have to face redefined body and self, distorted body image, social isolation, greater dependency on others, anxiety and depression, financial difficulty due to unemployment, and high health care costs. The total cost of amputation is dramatic; it is associated with hospitalization, rehabilitation,

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and artificial limbs (which may be a life-time obligation since the artificial limb has to be changed at least yearly to adjust to the stump). [1]

Based on a literature review, lower extremity amputations in the developing countries are poorly studied; therefore, incidence data are scarce. Incidence data are crucial to assess the magnitude of the problem for the purpose of reduction and /or primary prevention. To our knowledge, there has been no previous research relating to the incidence of LEAs among Jordanians. In general, there is limited data published about amputations for the Middle-Eastern Arabic countries. Research related to LEAs in the Arabic countries (which could be compared with Jordan) was conducted in Saudi Arabia. [2-5]

The present research was designed as a retrospective population-based study between Dec. 1996 and Dec. 1998, following the Global Lower Extremity Amputation Study's protocol (GLEA Study). The GLEA study protocol was designed specifically for finding the incidence rate of LEA in different countries. The purpose of the protocol is to provide a standardized method for data collection and analysis to make comparisons of incidence rates possible within and between countries. In addition, this study utilized the "Capture-recapture" technique to assess levels of ascertainment and ensure accurate data collection.

Significance and Background

Amputation is an old surgical procedure, which has been practiced since Neolithic times for therapy (as with leprosy), poisoning, and as a punishment in some societies. At that time, it was a very crude procedure due to unavailability of anesthesia, and as the high mortality rate was caused by hemorrhage, gangrene, and sepsis. [6, 7] The field of amputation surgery changed in the late eighteenth century when anesthesia became available, as well as the use of antisepsis in surgery (in 1867). After the First World War (1914-1918), primary amputation was performed due to a high incidence of anaerobic gangrene with compound fractures. Then, the concept of debridement rather than amputation was introduced at the time of the Spanish Civil War and was practiced through the Second World War to reduce the number of military amputees. In 1942, penicillin came into medical practice and brought a new dimension to the control of infection and allowed the development of more complex amputation surgery. [6]

Lower Extremity Amputation (LEA) is defined as the complete or partial loss of any part of the lower extremities, for any reason. [8] In addition, in this study a distinction between 'major' and 'minor' amputations are defined; major amputation is defined as amputation through or proximal to, the tarsometatarsal joint (which includes toe, ray and metatarsal amputation); minor amputation is defined as amputation distal to the tarsometatarsal joint (which includes above knee and below knee amputations).

Typically, LEAs are indicated in different conditions such as: in Peripheral Vascular Diseases (PVD), Diabetes Mellitus (DM), severe cases of limb threatening ischemia caused by injuries or fractures, tumors, and congenital deformities. Despite the advances that have been achieved lately in vascular, plastic, and orthopedic surgery, as well as the development of modernized medical technology and intensive therapy, LEAs are still the only alternative treatment in many situations. Over the years, epidemiological studies have been conducted to look at the incidence and prevalence of LEAs in many countries. In the developed countries, it is reported that the main factor contributing to LEAs is chronic diseases as PVD and DM. [9, 10] Therefore, in the last few years, attention has been focused on reporting the incidence and prevalence of LEAs as a significant complication of DM. It has been reported in the U.S that the incidence of LEAs as a consequence of DM is about 59.7/10,000 (about 67,000 cases/yr). [10] Other statistical data also indicates that there are approximately 400,000 persons with amputations in the U.S., with about 43,000- 50,000 new cases performed each year. [11]

Moreover, statistical information has revealed a marked variation among different countries, or even regions in the same country or geographical location. The incidence rate ranged between 6.8 and 241.0 per 10,000 depending on diabetes prevalence, ethnic background, lifestyle, accessibility to health care resources, and regional variation. [12] Unfortunately, in the developing countries epidemiological data regarding the incidence of amputations and underlying causes are scarce. In a few studies, percentage rates are reported from single health institutions, or results may be based on limited cases and/or rates derived from the general conclusions of various studies. A study conducted in Nigeria by Yakubu [13] looked at the different indications of major limb amputation. Results are expressed in percentages of cases in a hospital rather than incidence rates in the total population, e.g. 6.8% of the total amputation cases are related to diabetic complications. However, sometimes percentage rates are meaningful in creating a general assessment of the problem when prevalence and incidence rates are unavailable. In Khartoum, Sudan, a figure of 24% of LEAs related to DM was reported by Mohamed. [5] Another interesting study that was conducted in Western Saudi Arabia by Al Zahrani and colleagues [2] examined the pattern of limb amputation and risk factors. This study showed that diabetic foot ulcer complications constituted about 49.6% of the total amputation surgery in five years.

In general, the burden of LEA (traumatic and non-traumatic) is huge, and is more likely to increase throughout the years. Perhaps, an increased population burden of DM, PVDs, and other diseases and related complications of LEAs in many countries may reflect insufficient or ineffective health care or disease management. Therefore, data describing the impact of this problem is essential to increasing public awareness of the magnitude of the problem, identifying high risk groups, formulating health care policy, and developing strategies to reduce the disease and its complications. Results from many epidemiological studies were encouraging as far as prevention or incidence reduction was concerned. For example, epidemiological studies that had focused on diabetes research and related complications had shown a significant reduction of DM-related complications after implementing specific preventive measures. Furthermore, Rith-Najarian[14] found a significant decline in the incidence of LEA from 21/1000 to 6/1000 (P<.0001) after implementing of specific practice guidelines for improved diabetic foot care. In any country, successful and effective intervention strategies are always necessary to achieve significant health improvements and economic savings.

Research Design and Methods

Study design

The present research was designed as a 2-year retrospective study. Case definition, classification of amputations into first, all major and minor amputations, as well as data collection and analysis were based on the protocol designed by the GLEA study group. The protocol was explained previously elsewhere. [8]

Study Population

The study population included only Jordanian citizens 18 years and older, who are Amman city residents, and who underwent their first LEA (minor or major) within the period of Dec 1st, 1996 to Dec 31st, 1998. Citizenship is documented in the medical records as part of the demographic data. Data were collected from different surgical hospitals that performed LEA in Amman city (Table 1.). Some hospitals were excluded, e.g. the Italian,[1] Al-Moashar, [2] Al-Shmasani, Al-Rahma, and Ibn-Alhythem. [3]

The participation rate reached approximately 78% (about seventeen hospitals). Two sources were used for data collection: source 1 includes the Operating Records (OR), and source 2 includes the Discharge Records (D/C). These sources were found to be the most reliable sources for amputation procedures.

[1] Refused to cooperate and access medical records
[2] Closed for maintenance
[3] Denied performing LEAs during the specified study period

A data abstraction form was completed for each eligible case of LEA. Information included demographic data, date of first LEA, history of LEA, site and level, diabetes history, smoking information, and underlying causes.

Table (1): Participating health centers in Amman city.

No.	*Centers*	*Bed Capacity*
1	*Abu-Daya Hospital*	*68*
2	*ACHVS Hospital*	*148*
3	*AL-Bashir Hospital*	*874*
4	*Al-Hilal Hospital*	*64*
5	*Alkhaldi Hospital*	*160*
6	*Amman Surgical*	*65*
7	*Farah Rehabilitation center*	*130*
8	*Islamic Hospital*	*276*
9	*J. University Hospital*	*506*
10	*Jordan Hospital.*	*161*
11	*Luzmilia Hospital*	*67*
12	*Malhas Hospital*	*58*
13	*Palestine Hospital*	*50*
14	*Queen Alia Hospital*	*200*
15	*Queen Zein Hospital*	*67*
16	*Royal-Jordanian Medical Center*	*613*
17	*Specialty Hospital*	*88*
18	*Italian Hospital∗*	*47*
19	*Al-Moasher Hospital∗*	*94*
20	*Al-Shmeisani Hospital∗*	*60*
21	*Al-Rahma Hospital∗*	*41*
22	*Ibn-Alhytham Hospital∗*	*57*

∗ Hospitals that did not participate.

Data Analysis

Descriptive data analysis was done for the total number of cases by using the statistical package SPSS. The approach taken was similar to that recommended in the GLEA study. The crude incidence rates were counted by dividing the number of cases ascertained (n) as the numerator by the Amman city population data as the denominator (which is 785,815 based on the last statistical report, 1994) expressed by 100,000 population/year. Age and sex specific data for the Amman city population were taken from the last statistical report, 1994[4] (which is 785,815). In addition, the standard European population was used for direct age standardization (World Health Organization, 1993).

The two source "Capture-recapture" was used to estimate the ascertainment corrected rate and to evaluate the level of ascertainment of cases. The number of patients in each age-specific group was too small to provide meaningful results from "Capture-recapture" method. It is noteworthy that cases with missing age information (about 94 cases) were excluded from the analysis to obtain age-sex specific rates and age-adjusted rates. In addition, 95% CI was constructed based on the Poisson distribution to determine the confidence limits of the observed estimates.

Results

A total of 371 eligible cases were ascertained, with a mean age of 59.6 years, SD= 13.8 (range 20-85 years). The number of males included was 272 (73.3 %) with a mean age of 59.6 years, and the number of females was 99 (26.7 %) with a mean age of 62 years (Table 2). The ratio of males to females was approximately 2.7:1.

Table (2): Population size with mean ages.

Gender	*Number (%)*	*Age (years)*	
		Mean	***SD***
Males	*272 (73.3)*	*59.6*	*15.8*
Females	*99 (26.7)*	*62*	*12.3*
Total	*371*	*59.6*	*13.8*

Based on the GLEA study group classification, types of LEAs were grouped into major and minor. There were 233 (62.8%) cases that had major LEAs and 138 (37.2%) cases that had minor LEAs. In addition, history of LEAs (previous LEA) was examined and the analysis showed that of the 371 cases, 80 (21.3%) cases had a history or went through different types of amputations after their first amputation experience. However, 133 hospital records (about 35.4% cases) from the OR source did not include sufficient information regarding surgical history of previous types of LEAs. Therefore, the status

[4] Cases 18 and 19 years of age were excluded from the analysis because of the unavailability of the denominator data for this particular age group.

of those with missing information was "unknown" for the purpose of statistical analyses.

The most frequent amputation level in the lower extremity was the transtibial or Below Knee Amputation (BKA), followed by the transfemoral level or Above Knee Amputation (AKA). The crude incidence rate for the total population was 23.6/100,000/year, with the 95% CI (21.2, 26.1). However, by examining the crude incidence rate for the males (n=272) and females (n=99) separately, results showed that males had a considerably higher incidence rate than females: 32.5 with 95% CI (28.5, 36.3) vs. 13.6 with 95% CI (11, 16.5) /100,000/year respectively, with non-overlapping confidence intervals.

Table (3) summarizes the overall crude incidence rates for types of LEAs in both genders. The results indicated that a total of 371 cases (206 first major and 165 first minors) underwent 449 amputations (262 for all majors and 187 for all minors) amputations within the two-year period. The crude incidence rates for the types of LEAs were: for first LEAs, 23.6 /100,000/yr with 95% CI (21.2, 26.1); and for all LEAs, 28.6/100,000/yr with 95% CI (25.4, 30.7). As expected, the number and incidence rate for all LEAs were slightly higher than first LEAs. Furthermore, the crude incidence rates for first and all major LEAs were: 13.1 (95% CI 11.6, 15.3) and 16.7 (95%CI 14.6, 18.7) /100,000/year, and for first and all minor LEAs, 10.5 (95% CI 9, 12.2) and 11.9 (95% CI 10.3, 13.7)/100,000/year, respectively. Interestingly, there was not a big difference in the incidence rates between the two types of LEAs.

Table (3): Crude incidence rate for types of LEAs (1996-1998).

Types of LEAs		***Observed LEAs (n)***	***Incidence rate/ 100,000/yr (95% CI)***
Major LEAs	*First*	*206*	*13.1 (11.6, 15.3)*
	All	*262*	*16.7 (14.6, 18.7)*
Minor LEAs	*First*	*165*	*10.5 (9, 12.2)*
	All	*187*	*11.9 (10.3, 13.7)*
Total	*First*	*371*	*23.6 (21.2, 26.1)*
	All	*449*	*28.6 (25.4, 30.7)*

Data analysis for types of amputations in males and females separately revealed that males underwent 272 first major and minor LEAs (combined) with an incidence rate of 32.5/100,000/year. Females underwent 99 first majors and minors LEAs (combined) with an incidence rate of 13.6/100,000/year. Moreover, the analysis showed that the number of first major or minor LEAs, as well as related crude incidence rates in males compared to females, were higher (152 vs. 54) with an incidence rate of 18.1 CI (15.4, 21.3) vs. 7.4 CI (5.6, 9.7); the difference was more than two fold (Figure 1).

Age and sex specific incidence rates

Age was classified into four categories (Table 4); amputee's ages 18 and 19 years old (about 5 males cases) were excluded from the analysis because of the unavailability of the denominator specified for this age group. Moreover, 94 cases of males and females were excluded because of missing age information. Therefore, results will be presented here based on 277 cases only (mean age 59.6, SD= 13.7). Table 4 presents the number of first and all major and minor LEAs with the related crude incidence rate for males and females combined and separately. Based on the statistical analysis, the lowest incidence rate for combined genders was found among the youngest age group (20-39) to rise gradually and reach the peak at 60-70 years of age. Indeed, at the oldest age group (80+) major and minor LEAs took different directions, i.e. major LEAs continued to rise (76.2/100.000/yr) and minor LEAs declined (24.4/100,000/yr) (Figure 2).

In addition, examination of the crude incidence rate for males and females separately revealed that incidence rates for males were different than their counterparts. For major LEA in the males, the incidence rate rose steeply with age, but minor LEAs declined after the age 60+. Whereas, for the female participants, the incidence rate for both major and minor LEAs rose steeply after age 40+, then declined gradually after the age 60+ years old (Figures 3 and 4).

In fact, the rise in the crude incidence rate for first major LEAs in males compared to their counterparts was higher than expected. Another observation noted is that the incidence rates for major LEAs in males increased more than the expected after the age of 60+, minor LEAs had somewhat declined. This could be explained by the gradual progression of the pathological effect of the disease process (such as DM or PVDs) which makes it impossible to perform minor amputation to save the limb.

Ascertainment Corrected Incidence Rate

Based on a review of available records, the total number of eligible cases ascertained by the two sources was 371 cases. Figure (5) shows the total amputee population ascertained by each individual source and the recaptured cases, i.e. cases that were found in both sources. Source 1 (OR) identified 137 cases (36.9%) only, source 2 (D/C) identified 110 cases (29.7%) only, and the recaptured (overlap) cases accounted for 124 (33.4%) cases (i.e. total of 261 cases from source 1, and 234 cases from source 2). Although all amputations are done within hospitals, it may not be accurate to relay only on OR records, (i.e. a single data source) as the results showed. The number of cases identified in each individual source and for each hospital varied depending on the size of the hospital and the accuracy of patients' records.

While for the majority of hospitals, records keeping was the responsibility of the operating room (OR) staff, in few hospitals the surgeons or the anesthesiologists kept their own case records in addition to the main OR records as a backup. Nevertheless, our experience indicated that there is no single place where all amputation cases recorded can be counted accurately.

1- Estimated number of Cases and Ascertainment Corrected Rate for the study population

Statistical analyses indicated that the estimated (N) accounting or adjusting for undercount (for the total number of amputees identified) was about 491 cases for the two years with 95% CI of (448, 534) resulting in an estimated 120 missing cases (about 24.4%) with ascertainment rate of approximately 76%. The overall ascertainment corrected incidence rate for the amputees was about 31.3/100,000 population per year with 95% CI (28.5, 34). However, ascertainment rates for males were lower that than for females (73.5 vs. 81.8), indicating that more males were missed than females (Table 5).

The ascertainment corrected rates for males and females were 44.2/100000/year (95% CI 39.4, 49) and 16.6/100000/year (95% CI 14.4, 18.8), respectively. It is worthwhile to mention that the higher estimates of incidence rate obtained by the two sources "Capture-recapture" method may reflect the maximum estimates of the number of missing cases. Nevertheless, the 95% CI represents the lowest and likely the highest limits of the incidence value, and the true incidence rate is expected to be within the confidence interval boundaries.

2-Estimated number of cases and Ascertainment Corrected Rates for Types of LEA

The primary analysis of "Capture-recapture" method included the estimated N for first and all major and minor LEAs for males and females combined (Table 6). The results showed that for first major LEAs estimated cases were 273 vs. an observed 206 (with a difference of 68 cases), and for all major LEAs the estimated numbers were 332 vs. 262 (with a difference of 70 cases). For first minor LEAs, the combined estimated cases were 211 vs. an observed 165 (with a difference of 46 cases), and for all minors, it reached 233 vs. 187 (with a difference of 46 cases). Overlap cases (recaptured) were also presented which reflect the number of cases obtained from the two sources. These numbers were not very big compared to the numbers ascertained from each individual source or from the two sources (e.g. 65 cases were recaptured from the two sources while the observed number was 206 cases).

Further analysis examined the ascertainment corrected rate for types of LEA. The results are summarized in table (6). Although the ascertainment corrected rate showed different numbers than crude incidence rates, results were still higher for major LEAs as expected (Figure 6). Ascertainment levels were checked and ranged between approximately 75.5%-80.3%, which were good for this type of study.

Table (4): Age sex-specific incidence rate (per 100,000/yr) for first and all major and minor LEAs in males and females separately and combined.

age Group (years)		Males		Females		Totals	
		Major Number LEAs Crude incidence rate (95% CI)	Minor Number LEA Crude incidence rate (95% CI)	Major Number LEA Crude incidence rate (95% CI)	Minor Number LEA Crude incidence rate (95% CI)	Major Number LEA Crude incidence rate (95% CI)	Minor Number LEA Crude incidence rate (95% CI)
20-39	First	14	8	2	2	16	10
		2.5 (1.4, 4.2)	1.4 (0.6, 2.8)	0.4 (0.05, 1.5)	0.4 (0.1, 1.5)	1.5 (0.8, 2.5)	0.9 (.5,1.8)
		15	9	2	2	17	11
	All	2.7 (1.5, 4.4)	1.6 (0.7, 3)	0.4 (0.05, 1.5)	0.4 (0.1, 2.3)	1.6 (0.9, 2.6)	1.1(0.5,3.8)
40-59	First	30	29	8	16	38	44
		14.4 (9.7, 20.5)	13.9 (9.3, 20)	4.2 (1.8, 8.3)	8.4 (3.6,16.5)	9.5 (6.5,12.8)	11 (8,14.8)
		39	34	14	17	53	49
	All	18.7 (13.3, 25.5)	16.3 (11.3, 22.8)	7.3 (2.9,15)	8.9 (3.6,16.5)	13.3 (10, 17.4)	12.3 (9.1,16.2)
60-79	First	44	62	31	18	76	80
		71 (51.5, 95.2)	100(76.6,128.1)	57.6 (33.8,96.2)	33.4 (15.3,63.5)	62.7 (49.4, 78.4)	66 (52.3,82.1)
		63	72	43	22	106	94
	All	101 (76.6,128.1)	116 (90.7, 146.2)	80 (57.8, 107.6)	40.8 (25.6, 62)	87.4 (71.6, 105.7)	77.5 (62.6, 94.8)
80+	First	6	1	3	2	9	3
		120 (44, 261.2)	20 (0.6,111.4)	44 (9.1, 128.7)	29.3 (3.5, 105.6)	76.2 (34.8, 144.5)	25.4 (5.2, 74.2)
		7	2	5	7	12	9
	All	140 (56.2,288.4)	40 (4.8, 144.4)	73.4 (23.8, 171.7)	102.7 (41.2, 211.3)	101.6 (52.5, 177.4)	76.2 (34.8, 144.6)

Figure (1): Crude incidence rate for first major and minor amputation in males and females separately.

Figure (2): Age sex-specific incidence rate for LEA in males and females combined.

Figure (3): Age sex-specific crude incidence rate for major and minor LEA in males

Figure (4): Age sex-specific crude incidence rate for major and minor LEA in females.

Figure (5): "Capture –recapture" Technique.

Table (5): Observed and estimated number of cases with ascertainment corrected rate using the two-source Capture-recapture method.

Gender	Observed n with 95% CI	Crude incidence rate (100,000/yr) with 95% CI	Estimated N with 95% CI	Overlap (%)	Ascertainment corrected rate (100,000/yr) with 95% CI	Ascertainment rate (%)
Male	272 (238.8,304)	32.5 (28.5,36.3)	370 (330, 410)	85 (31.2)	44.2 (39.4, 49)	73.5
Female	99 (80.5,120)	13.6 (11, 16.5)	121 (105, 137)	39 (39.4)	16.6 (14.4, 18.8)	81.8
Total	371 (333.3,409.7)	23.4 (21.2, 26)	491 (448, 534)	124 (33.4)	31.3 (28.5, 34)	76

Table (6): Ascertainment corrected rates and ascertainment rates for types of LEAs using "Capture-recapture" method for males and females combined.

LEAs Type	Number identified from overlap	Estimated N with 95% CI	Total number identified from sources	Ascertainment corrected rate with 95% CI	Ascertainment Rate (%)
Major/First	65	273 (241, 307)	206	17.4(25.4,19.6)	75.5
All	95	332 (302, 362)	262	21.2 (19.2,23)	78.9
Minor/First	59	211 (186, 236)	165	13.3 (11.7,15)	78.2
All	70	233 (209, 257)	187	14.6(13.3,16.4)	80.3

Figure (6): Crude incidence rate and the ascertainment corrected rate for types of LEAs in males and females.

Our final "Capture-recapture" analysis evaluated ascertainment rate and ascertainment corrected rate for the types of LEAs in males and females separately. Table (7) summarizes the results obtained for both methods as well as ascertainment levels for different types of LEA in males and females separately. It is obvious that "Capture-recapture" method identified about 56 major LEA cases in males and 11 cases in females that could be missed or under-counted. Figure (6) illustrates both rates.

As shown, the highest incidence rate was for first and all major LEAs in males (crude incidence rate 18.1, and 22.4/100,000/year, and corrected rate about 24.8, and 29.1/100,000/yr, respectively) and the lowest rate was for first and all minor LEAs in females (crude incidence rate about 6.2 and 6.9 /100,000/year, and for corrected rate about 7.5/100,000/year, and 8.2/100,000/yr). Therefore, this confirms that the incidence rate of major LEAs in males was the highest, whether it was based on observed or estimated (N).

Finally, it is worth to remember that although the estimated ascertainment corrected rates were higher than the crude incidence rates, the differences between them were not very high (ranged between 1.3-6.7). In addition, the crude incidence rates will be closer to the lower bounds of the constructed 95% CI(s) than to the upper bounds. For example, the incidence rate for first major LEAs in males was about 18.1/100,000/year, which was almost close to the lower bound of the 95% CI corrected rate (which is 21.1/100,000/year), and for first major LEAs in the females it is the same (7.4 and 7.4).

Overall, ascertainment was quiet good and adjustment for ascertainment has little effect on the crude incidence rate.

Table (7): Summary of the analysis results of incidence rates using observed and estimated numbers of first major and minor LEA, and ascertainment levels by applying Capture-recapture method for males and females separately.

Sex/ Type of LEA	*Total number identified from both sources*	*Estimated N with (95% CI)*	*Number identified from overlap*	*Crude incidence rate for observed Cases/100,000/year (95%CI)*	*Ascertainment corrected rate 100,000/yr with (95% CI)*	*Ascertainment Levels (%)*
Males/ major						
First	*152*	*208 (177, 239)*	*43*	*18.1 (15.4, 21.3)*	*24.8 (21.1, 28.5)*	*73.1*
All	*188*	*244 (216, 272)*	*63*	*22.4 (19.4, 25.9)*	*29.1(25.8, 32.5)*	*77.2*
Males/ minor						
First	*120*	*155 (133,177)*	*42*	*14.3 (11.9, 17.1)*	*18.5 (15.9, 21.1)*	*77.4*
All	*137*	*173 (151, 195)*	*50*	*16.4 (13.7,19.3)*	*20.7(18, 23.3)*	*79.2*
Females/major						
First	*54*	*65 (54, 76)*	*22*	*7.4 (5.6, 9.7)*	*8.9 (7.4, 10.4)*	*83*
All	*74*	*87 (76, 98)*	*32*	*10.1 (8, 12.7)*	*11.9(10.4,13.4)*	*87*
Females/minor						
First	*45*	*55 (44, 66)*	*17*	*6.2 (4.5, 8.3)*	*7.5 (6,9.1)*	*81.8*
All	*50*	*60 (50, 70)*	*20*	*6.9 (5.1, 9.1)*	*8.2 (6.9, 9.6)*	*83.3*

Discussion

In the following discussion, the study findings will be compared to the previous studies that have examined the incidence rates of LEAs in the developing and the developed countries, taking into consideration population size, ethnic background, and geographical location. In addition, the results will be compared to the findings reported by the GLEA study centers in Europe, North America, and Asia. Comparison will be possible since these studies utilized similar methodology for data collection and analysis (The GLEA study group, 2000).

Incidence Rate

The main findings of the present study include the annual incidence rate for limb amputation in Jordan (which was 23.6/100,000), and the higher incidence rate for males than females (32.5 vs. 13.6). Moreover, our results indicated that the overall age adjusted incidence rates for first major and minor LEAs were 19.3 and 13.2/100,000/yr, respectively. These results were consistent with other studies that had been done in the Middle East and other developing countries. [2, 15]

Furthermore, in comparing the LEA crude incidence rate to some European studies, it appeared that our results were lower than those reported from Germany [16] which showed that the overall incidence rates for major and minor LEAs were 33.8 and 22.5/100,000/year, respectively. However, the German study showed that the women's incidence rates were higher than the males (36.3 vs. 31.2), which is not consistent with our results. Other studies from Denmark reported slightly higher incidence rate for major LEAs: about 25/100,000 (not adjusted). [17] The study from Sweden reported a lower overall incidence rate of 19.1/100,000, as well as a lower incidence rate for major LEAs (16/100,000). [18]

Finally, the U.S. Feinglass [9] reported an incidence rate of 24.95/100,000/year for major LEAs during 1979-1996 (adjusted to the U.S population), which may be close to our results.

Nevertheless, the above comparisons are difficult due to methodological variations. The best comparison is with the GLEA study (due to standardized methodologies as mentioned previously). Based on our results, for major and minor LEAs in men, the Amman center was ranked as the third highest rate following the U.S and the U.K. This means that the amputation rate in Jordan for males was still higher than those reported from Italy, Japan, Taiwan, and Spain. In women, Amman center ranked as the fifth highest among these centers for first major LEAs, and the fourth highest for all minor LEAs. In other words, crude incidence rates for males and females were higher than Spain, Taiwan, Japan, and Italy.

Age Factor and Age - Sex Specific Rates:

In the majority of LEA studies, age appeared to be a crucial risk factor for amputation. In other words, incidence rates varied with age. Mean age variations were found to range from the higher 30's in the developing countries to the higher 70's in the developed countries. [15, 19, 2, 13, 5, 20- 22] The results from the present study were consistent with other studies were amputee's mean age was found to be in the 50's.

Furthermore, the overall crude incidence rate for males and females, separate and combined, varied based on the age group and type of LEAs. The incidence rate continued to rise with age until age 80+ where minor LEAs started to decline. Interestingly, the crude incidence rate for males and females separately were remarkably different; in the males, major LEAs rose steeply with age but minors declined gradually after age 60 years and older. In females, major and minor LEAs raised gradually until 40 years of age, then declined after the age of 60 years and older. Our explanation for this phenomenon could be related to the increased incidence of PVDs in males more than the females and the severity, or the progression of the underlying diseases in males might be very severe at this age, which leaves no alternative treatment except for major LEAs. On the other hand, it could be related to the accuracy of the numerators and the denominators for males and females. However, this is unlikely as the data was collected from reliable sources and the denominator was accurate since it was based on formal official statistical reports. Therefore, based on the present conclusion, we believe that the probability of major LEAs in the elderly, particularly males, is very high. Another observation noted by examining the number and incidence rate of amputations in the elderly population, despite the lowest number of LEAs is that incidence rates were higher than other age groups as has been demonstrated in most other studies.

It is worth to mentioning that the number as well as the incidence rate of amputations at the younger ages in males and females was very similar and not very high compared to other age groups. This observation makes sense, since at the younger ages the probability of getting amputation or reamputations is low due to the fact that the underlying diseases have not progressed severely, and the health status as well as the ability to heal is usually better in the younger age groups. The key point here is that providing primary prevention and follow up as early as possible will be crucial in lowering the possibility of amputations.

Generally, however, our results were not any different from other studies that have looked at LEAs in elderly population. The amputation rate was found to increase with age by three fold in those aged 45-74 years and seven fold over 75 years. [23] Condie [29] reported that 80% of Scottish new amputees were elderly over 60 years old and more than 20% were over 80 years old. Other research from Germany by Traunter [16] Eastern Finland by Sittonen [25] Sweden by Kald [22] Spain by Calle-Pascual [1] and U.K by Morris [26] showed also a gradual incline in the incidence rate associated with increased age. In fact, the German study showed that the incidence rate for first major and minor LEAs increased steeply with age; for males it rose from 2.5 at 40 –59 years to 120 at the age of 80+, and for females, it rose from 0.4 at the age 40-59 years to 44 at the age of 80+. [16] Houtum and Lavery from the Netherlands [27] found also that age and incidence rates increased accordingly: from <45 year with an incidence rate of 11.2/10,000 to 75 years with an incidence rate of 107.9/ 10,000.

Finally, it is noteworthy the predominance of males over females in the present study (ratio 2.8:1), which is comparable with the majority of LEA studies in developing countries. [2, 13, 5] The effect of gender on LEA morbidity was explained in previous literature [28, 21, 29] and can be summarized by the differences in the activity levels, degree of compliance, level of denial, strength of social support mechanisms, and quality of education. Furthermore, other researchers rationalized this phenomenon by the female's effect of hormonal protection, which will lessen with advancing age [30, 31] and EDC study. Furthermore, in the developing countries the exposure of women to the occupational hazards, as well as road traffic accidents, may be much lower than men due to cultural and social restraints imposed on women.

Comparing age-adjusted rate (per/100,000/year) with the GLEA study

The GLEA study reported that the age adjusted rates for males varied between 2.8- 43.9. Generally, the highest rate for first major LEAs in the males was found in the USA (Navajo area), and the lowest was reported in Spain (Madrid). For all major LEAs, rates varied between 3.7 (for Madrid) to 58.7 (for the Navajo area). Based on our analysis, the age-adjusted rate for first and all major LEAs among Jordanians was found to be 22.8 and 30.7, respectively. Thus, Amman center ranked the third highest rate after the USA (Navajo area and Montgomery). Comparing the first and all minor LEAs, the rate varied dramatically between the lowest and the highest (0.6 - 61.8 for first minor and 2.5-98.8 for all minor LEAs). The highest age-adjusted rate was for the USA (Navajo area), and the lowest rate was for Japan. Considering our results, Jordan ranked in the second place (the rate for first and all minor LEA was 25.1 and 29.6, respectively). Therefore, it appeared that the age adjusted rates for Jordanian males were the highest rates after the USA (Navajo area) for both types of amputations.

Comparisons of age-adjusted rates for both types of LEAs in the females indicated that for the first and all major and minor amputations females in Amman had similar ranking as those for males. In other words, they had the second highest age adjusted rate among those participating centers (17.8 and 25.2, for first and all major LEAs, respectively, and 12.3 and 18 for first and all minor, respectively). It is noteworthy to mention that the range of age adjusted rates for first major LEAs was between 0.5-22.4, and for first minor was between 0.2- 25.1. The highest rates reported were for the USA (Navajo area) and the lowest rates for Spain (Madrid).

Conclusion

Our study was successful in accurately determining the incidence rate of LEA in Jordan. The conclusions of present study appeared to be reasonable and consistent with other studies that have been focused on the epidemiology of LEA. Our results were also consistent with those from Saudi Arabia. To our knowledge, studies related to the incidence rates in the Middle-Eastern neighboring countries such as Iraq, Syria, Lebanon, Kuwait, Egypt, etc (which share cultural and ethnic background) have not done to be able to compare the present results among these communities.

This research highlights a public health concern that has not received adequate attention. An understanding of major or minor health problems must incorporate accurate incidence information, if health administrators or public health leaders are to make health policies focused on prevention and reduction of chronic disease complications.

It is noteworthy to mention several potential limitations that may have influenced our results. These include:

1. It was virtually impossible to count every case of limb amputation which might create a source of underestimation. It must be recognized, however, that monitoring systems designed to capture all cases is not existed.
2. We were not positively sure that all participants included were from Amman city.
3. It was not easy to validate the information obtained from the operating theatre records, and discharge records. Each center employed different process of keeping these records
4. Some important information was missing from the medical records such as age, and smoking status.

Our future recommendations are repeating the study prospectively instead of retrospectively, this way in each center someone would be in charge of keeping the records of all amputees. In addition, it would be easier and possible to verify the information. Another point worth mentioning is the emphasis on physicians, surgeons, and other medical personnel in reporting or documenting accurate patient's information. It would be a good idea to explain the study to the medical staff as well as providing copies of data abstraction forms to make sure that all the data are collected accurately. Lastly, the study should include a complete analysis as to the economic benefit of preventing or reducing amputations in the country.

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معدل بتر الأطراف السفلية في عمان– الأردن

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الملخص

الهدف: الخلفية العلمية: تزداد نسبة بتر الأطراف السفلية في العالم باستمرار، و لا توجد إحصائيات أو بيانات في الدول النامية لتوضح مدى حجم المشكلة. أجريت هذه الدراسة في مدينة عمان (الأردن) لمعرفة معدل بتر الأطراف السفلية.

طريقة البحث: اعتمدت طريقة البحث وجمع العينات و تحليلها على بروتوكول عالمي يسمى Global Lower Extremity Amputation study protocol (**GLEA**).

وشملت العينة حالات البتر للمرضى الأردنيين الذين تتراوح أعمارهم بين 20 سنة و أكثر، و جمعت المعلومات من سبعة عشر مركزاً صحياً واستعمل على الأقل مصدران لاستخلاص المعلومات.

النتائج: بلغ عدد أفراد العينة حوالي 371 شخصاً، و معدل أعمارهم حوالي 56.6 سنة (التنمية المستدامة =13.8) وبلغت النسبة السنوية الكلية لبتر الأطراف السفلية حوالي 23.6/ 100,00 ، وكانت النسبة في الذكور أعلى منها في الإناث علما بان نسبة الذكور إلى الإناث في العينة هي 1 : 2.7 ، كما كانت نسبة البتر الكامل أعلى من البتر الجزئي. وعند النظر إلى العمر وجد ان نسبة البتر عند المسنين أعلى وخصوصا بين هؤلاء الذين تتراوح أعمارهم ما بين 60 – 79 سنة، علما بأن درجة التأكد من صحة جمع المعلومات تراوحت ما بين 73.1 -83.3 %. وبمقارنة نسبة البتر في عمان مع المدن الأخرى المشمولة في الدراسة العالمية احتلت عمان المركز الثاني بعد الولايات المتحدة الأمريكية في البتر الشامل و الجزئي.

الخلاصة: يعتبر بتر الأطراف السفلية مشكلة صحية مهمة في الأردن و يجب اتخاذ الإجراءات لمنعها أو الحد منها.

الكلمات الدالة: بتر، الأطراف السفلية،عمان.