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ORIGINAL ARTICLE

Epidemiology of Surgical Amputations in Tamale Teaching Hospital, Ghana

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The current study aimed to explore the details of surgical amputations in Tamale, Ghana. This was a retrospective descriptive study. We analyzed case files of 112 patients who underwent surgical amputations between 2011 and 2017. Demographics, site of amputation, indication for amputation, and outcomes were retrieved from case files. Descriptive statistics were used to report the means and frequencies. Associations between variables were assessed using Chi-Square, ANOVA, and Student's t-test. The mean age of the participants was 43.6±23.1 years (range 2 to 86). Most (64.3%) were males. Lower limb amputations accounted for most (78.6%) cases. Diabetic vasculopathy was the most prevalent indication (44.6%), followed by trauma (36.6%). The mean hospital stay was 30.1±22.4 days (range 5 to 120). Surgical site infection (17.9%) was the main complication. In our study setting, there is thus far limited capability for proper management of diabetes mellitus, which needs to be improved. There is also an urgent need for multidisciplinary foot care teams that will help patients receive comprehensive care to reduce complications from diabetes and other vasculopathies.

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INTRODUCTION

Amputations are generally done to remove a part or an entire limb to restore function or as a life-saving procedure. This, however, may be done surgically, or in some unfortunate instances, it occurs traumatically. In the former's case, a surgical procedure is done by a team of professionals to remove an entire limb or a part of it due to malfunction (Agu & Ojiaku, 2016; Obalum & Okeke, 2009). Following amputation, patients and family could suffer devastating psychological and emotional challenges as they attempt to adjust to this new way of life. In less-resourced countries such as Ghana, limited availability of prosthesis and psychological support heightens the physical disability and psychological burden of amputees and their families (Onuminya,*et al*, 2000; Sié Essoh *et al,* 2009; Yinusa & Ugbeye, 2003). Amputation is a significant contributor to disability and morbidity globally (Godoy et al, 2009; Smith, 2006; Ziegler-Graham *et al,* 2008). The indications for surgical amputation vary based on geographical locations. Studies have reported that peripheral vascular diseases and limb ischemia account for most surgical amputations (Kelly *et al,* 2017; Ziegler-Graham *et al*., 2008). However, in Africa and other developing countries, the most typical

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indications for amputations vary. For example, studies conducted among subgroup populations in Nigeria reported that trauma (Agu & Ojiaku, 2016; Nwosu *et al*, 2017; Obalum & Okeke, 2009) and complicated diabetes (Dabkana *et al,* 2018) are the most typical indications for amputations of limbs. However, other studies conducted in Ethiopia (Gebreslassie *et al*, 2018), Ghana (Kuubiere *et al*, 2015), and Kenya (Ogeng'O et al, 2009) reported trauma as the most common cause. In Tanzania (Phlilipo. *et al.,* 2012) and India (Unnikrishnan, 2017), diabetic complications were reported as the most common indication. Aside from these geographical differences that influence the different indications for amputation, the body part is also significant. For instance, lower limb amputations are more likely to result from both diabetic complications and trauma, than upper limb, which rarely are as a result of diabetic complications (Agu & Ojiaku, 2016). Data from Ghana and other countries in sub-Saharan Africa are highly sparse, making it difficult to determine the trends and epidemiology of amputations. Therefore, it is necessary for more studies such as this to be conducted, which will contribute to the growing body of literature on amputations in Ghana and sub -Saharan Africa. This current study aims to analyze the characteristics and epidemiology of surgical amputations in a major referral hospital.

MATERIALS AND METHODS

The current study retrospectively analyzed the indications for surgical amputations at the Tamale Teaching Hospital (TTH), a major referral center in Tamale, northern Ghana, with a bed capacity of 800. Aside from serving as a referral center for the entire region, the center also provides services to patients from neighboring regions (Savannah, North East, Upper East, and Upper West Regions) and countries such as Togo and Burkina Faso. TTH is affiliated with the University for Development Studies as a teaching hospital for the School of Medicine and Health Sciences. We retrieved case files of 213 patients of all age groups and gender who underwent amputation surgeries between August 2011 and January 2017 from the general surgery theatre master list for assessment. In the end, 112 case files were found to contain complete patient records and included in this study. One hundred and one (101) case files were excluded because they did not contain relevant patient information necessary for this review (i.e., demographics, causes of amputation, anatomic site of amputation, and duration of stay). The included patients were treated in the trauma/ orthopedics and general surgery units. We determined the age and sex distribution of the study population, the indications for amputation, the site of amputation, and the length of hospital stay. The retrieved data were analyzed using the Statistical Package for Social Sciences for Windows, version 24.0 (SPSS, Inc., Chicago, Illinois). Descriptive statistics were used to determine the means and frequencies. Associations between variables were determined using Chi-Square, ANOVA, and Student's t-test. The statistical tests' significant level was considered at $p \leq 0.05$, and a confidence interval of 95%. This study was granted ethical approval from the Ethical Review Committee of Tamale Teaching Hospital, and the approval was ID TTHERC/17/11/16/04.

RESULTS

Demographics

A total of 112 patients underwent surgical amputations during the study period. There were 72 (64.3%) males and 40 (35.7%) females, a male to female ratio of 1.8:1.0 (Table 1). The overall mean age of all the studied participants was 43.6±23.1, range 2 to 86 years

Site of amputation

For the site of amputation, upper limb amputations accounted for 23 (20.5%) cases, lower limb -88 (78.6%), and both lower and upper limbs – 1 (0.9%). Among the 23 upper limb amputations, 15 (65.2%) were above-elbow amputations, 6 (26.1%) - below elbow, and 2 - (8.7%) hand amputations. With regards to the lower limb amputations, there were 42 (47.7%) above-knee, 44 (50.0%) below-knee, and 2 (2.3%) digital amputations. For the single case of both upper and

Table 1. Age and sex distribution of patients who underwent surgical amputations by indication

Indication			Sex		Total(%)
			Male	Female	
Trauma	Age Group	19 years and below	15	1	16(39.0)
		20-40 years	13	2	15(36.6)
		41-60 years	4	0	4(9.7)
		61-70 years	2	0	2(4.9)
		71-90 years	2	2	4(9.7)
	Total		36	5	41(100)
Infection	Age Group	19 years and below	1	1	2(40.0)
		20-40 years	1	1	2(40.0)
		41-60 years	1	0	1(20.0)
	Total		3	2	5(100)
Tumour	Age Group	19 years and below	3	1	4(36.4)
		20-40 years	3	2	5(45.4)
		41-60 years	0	1	1(9.1)
		71-90 years	0	1	1(9.1)
	Total		6	5	11(100)
Diabetic Vasculopathy	Age Group	19 years and below	1	0	1(2.0)
		20-40 years	1	5	6(12.0)
		41-60 years	13	9	22(44.0)
		61-70 years	3	5	8(16.0)
		71-90 years	7	6	13(26.0)
	Total		25	25	50(100)
Vasculopathy of Unknown cause	Age Group	41-60 years	0	1	1(20.0)
		71-90 years	2	2	4(80.0)
	Total		2	3	5(100)
Total	Age Group	19 years and below	20	3	23(20.5)
		20-40 years	18	10	28(25.0)
		41-60 years	18	11	29(25.9)
		61-70 years	5	5	10(8.9)
		71-90 years	11	11	22(19.6)
	Total		72	40	112(100)

lower limb amputations, the patient had one toe and one hand amputated (Table 2). All the 50 (44.6%) recorded cases of diabetic vasculopathy had lower limb amputations.

Indications

Diabetic vasculopathy was the most typical cause for limb amputation with 50 cases (44.6%), followed by trauma (41 cases, 36.6%), tumors (11 cases, 9.8%), infection (fasciitis or osteomyelitis) (5 cases, 4.5%), and vasculopathy of unknown causes (5 cases, 4.5%). Of the 41 trauma cases, there were 36 (87.8%) males and 5 (12.2%) females. The 71 non-trauma cases were balanced regarding sex, with 36 males (50.7%) and 35 females (49.3%). The age group of 19 years and below accounted for the highest number of cases in the trauma category (such as road traffic accidents, falls, or violence) with 16 (39.0%) cases, followed by the 20-40-year age group, with 15 (36.6%) (Table 1). Still, within the trauma group, 24 (58.5%) were recorded as primary trauma, 16 (39.0%) were complications from bonesetters, and 1 (2.4%) diabetic foot injury. A breakdown of individual mean ages per each indication is presented in Table 3. The age group with the highest number of cases of diabetic vasculopathy was 41-60 years, followed by 71-90 years representing 22 (44%) and 13 (26%), respectively (Table 1). The study population's ages were further classified into two main categories: ≤ 40 years and ≥ 41 years, being 51 (45.5%) and 61 (54.5%), respectively. Trauma accounted for a significantly higher proportion of cases among the younger patients (31 cases, 60.8%) than among the older patients (10 cases, 16.4%) ($p < 0.005$). Participants aged ≤ 40 years were thus found to be 3.7 times more likely to undergo amputation due to trauma than ≥ 41 years. Vasculopathy (diabetic and unknown cause) accounted for a significantly higher proportion of cases among the older patients (48 cases, 78.7%) than among the younger patients (7 cases, 13.7%) ($p < 0.001$). Participants aged > 41 years were thus found to be 5.7 times more likely to undergo amputation due to vasculopathy than those who were < 40 years. The association between gender and the major indications (trauma and non-trauma) was measured and found to be significant. Five females (12.5% of all females) and 36 males (50.0% of all males) had trauma-related amputations ($p<0.001$). Per the risk estimate, females were thus 1.75 times more likely to have non-trauma related amputations than males. In contrast, males are four times more likely to have trauma-related amputations than females. The association between the age classification (≤ 40 years and ≥ 41 years) was measured against the site of amputation (upper and lower limbs); for ages ≤ 40 years, upper limb 22 (43.1%), for those ≥ 41 years, upper limb 2 (3.3%) ($p<0.001$). Also, the association between gender and site of amputation was measured; for females, upper limb 3 (7.5%), males, upper limb 21 (29.2%) ($p=0.007$). Considering upper and lower limb amputations, participants aged ≤ 40 years were found to be 13.1 times more likely to undergo upper limb amputations than those who were ≥ 41 years. On the other hand, the category of ≥ 41 years was 1.67 times more likely to undergo lower-limb amputations than their counterparts who were ≤ 40 years. An Independent-sample t-test was done for mean ages of trauma and non-trauma related amputations. The difference in the mean ages of the two groups was found to be significant ($p < 0.001$), similarly for gender, a significant mean age difference was observed ($p < 0.005$).

Outcome: hospital stay and infection

The overall average length of hospital stay of all indications for amputation was 30.1±22.4 days, range 5 to 120 days. For the broad category of trauma and non-trauma cases, the average hospital stay was 27.8 ±18.7 and 32.6 ± 24.3, respectively, which was not statistically significant. The average duration of hospital stay before surgery was performed was 13.4±16.1, and after surgery 17.1±14.9 days. The mean duration of hospital stay for the various indications was: trauma 27.8 ±18.7, infection 28.2±15.9, tumor 42.5±25.0, diabetic vasculopathy 29.9±24.9, and vasculopathy of unknown cause 42.0±20.1. The difference was not statistically significant – (Table 4). Surgical site infection was the main complication among 20 (17.9%) of the entire study population. This resulted in four re-amputations and six surgical

Table 2. Details of the site of amputations*

		Frequency	Percentage
Upper limb		23	20.5%
	Above elbow	15	65.2%
	Below elbow	6	26.1%
	Hand	2	8.7%
Lower Limb		88	78.6%
	Above knee	42	47.7%
	Below knee	44	50.0%
	Digit	2	2.3%
Upper and lower limb		1	0.9%
	Digit	1	50.0%
	Hand	1	50.0%

*113 sites of amputation are listed, as one of the 112 patients had an amputation in two sites.

Table 3. Mean ages of participants per each indication of amputation

	N	Percent-age	Mean	Std. Deviation			Mini-mum	Maxi-mum
					Lower Bound	Upper Bound		
Trauma	41	36.6%	30.0	22.5	22.9	37.1	2	83
Infection	5	4.5%	30.4	15.9	10.6	50.2	15	53
Tumor	11	9.8%	30.1	16.9	18.8	41.4	10	71
Diabetic Vasculopathy	50	44.6%	56.2	15.4	51.8	60.6	17	82
Vasculopathy of unknown cause	5	4.5%	72.8	12.9	56.8	88.8	52	86
Total	112	100%	43.6	23.1	39.3	47.9	2	86

Table 4. The average duration of hospital stay in days

	N	Mean	Std. Deviation			Minimum	Maximum
				Lower Bound	Upper Bound		
Trauma	39	27.8	18.7	21.8	33.9	7	103
Infection	5	28.2	15.9	8.4	48.0	12	47
Tumor	11	42.5	25.0	25.6	59.3	12	81
Diabetic Vasculopathy	48	29.9	24.9	22.7	37.1	5	120
Vasculopathy of Unknown cause	5	42.0	20.1	17.1	66.9	18	68
Total	108*	30.9	22.4	26.6	35.2	5	120

*Data on length of stay missing in 4 of the 112 patients.

debridements. The remaining ten were managed with antibiotics.

DISCUSSION

The current study explored the epidemiology of amputations at a major referral hospital in Ghana. Various indications and patterns of surgical amputations have been highlighted. Limb amputations are a public health concern due to the economic, social, and psychological burden on patients and their caregivers (Phlilipo *et al.,* 2012). In sub-Saharan Africa and other low-and middle-income countries (LMICs), the resulting burden on this group of patients is high. Our findings revealed that most individuals aged ≤ 40 were more likely to have an amputation due to trauma-related factors than non-trauma. The main factor contributing to non-trauma related amputations was diabetic vasculopathy, which was mostly associated with those aged ≥40 years. This finding is consistent with previous studies' , which emphasized the importance of age on the onset and progress of diabetes and its related complications (Dabkana *et al*., 2018; Leone, 2012). This is not surprising since younger people are more likely to get trauma-related injuries leading to amputations than older adults. Generally, older adults are more likely to have a limb amputated due to diabetes or vasculopathy or other non-trauma related causes, especially in this current study population. In this study, males outnumbered females, as reported by other studies (Gebreslassie *et al*., 2018; Ndukwu & Muoneme, 2016; Phlilipo. *et al.,* 2012; Sié Essoh *et al.,* 2009). This disparity could be attributed to the fact that males are often involved in trauma-prone activities, which increases their chances of sustaining catastrophic injuries that could result in amputations (Gebreslassie *et al*., 2018). Therefore, it was not surprising to find that males were four times more likely to have amputations of the limbs carried out due to trauma than non-trauma related causes. The most common indication for amputations was diabetes-related amputations; this agrees with the findings of similar studies in the literature (Ndukwu & Muoneme, 2016; Phlilipo. *et al*., 2012; Unnikrishnan *et al*., 2017). Others however, hold a contrary view to this (Agu & Ojiaku, 2016; Gebreslassie *et al.,* 2018; Nwosu *et al.,* 2017; Sié Essoh *et al*., 2009). Although diabetic foot amputations have reportedly decreased in the wake of modern medicine (Markatos *et al*, 2018), they remain of public health concern in this part of the world due to their complications and the economic strain on sufferers. Patients in this part of the country often report late or are diagnosed late in a rather bad state. A situation that leads to the untoward effect of amputations, leaving in its wake the added morbidity to the patient, suffering for the family, increased cost to government and society as a whole. In most other LMICs, the burden of diabetes mellitus is on the rise (Dunbar *et al,* 2015). There is therefore, the need for strict adherence to the multidisciplinary approach to the management of diabetes and its

complications. Also, the poor management of this disease condition from the inadequate number of health professionals treating the condition could lead to this observed trend. Furthermore, if expertise in vascular services improves in this part of the country, there could be a reduction in diabetes-related amputations and other undesirable complications. In their study, Dunbar and colleagues suggested the development and implementation of foot care programs to reduce the financial burden associated with lower limb amputations (Dunbar *et al*., 2015). We believe this could as well benefit populations living around this study area. There were more non-trauma related amputations than those that were trauma-related. This finding is similar to other studies from Tanzania and Nigeria (Ndukwu & Muoneme, 2016; Phlilipo *et al.,* 2012) but at variance with others from other parts of Nigeria, Ethiopia, Cote d' Ivoire, and Iran (Gebreslassie *et al.,* 2018; Nwosu *et al*., 2017; Sarvestani & Azam, 2013; Sié Essoh *et al.,* 2009). Also, in our study, it was observed that there was a gradual increase in trauma-related amputations over the years. This trend could be due to the increasing urbanization and motorization within Tamale and the region as a whole (Karg *et al.,* 2019). However, it could also be due to bias resulting from missing data in the study. Within the broader category of non-trauma amputations, diabetic vasculopathy emerged as the highest indication, followed by tumors. This finding is consistent with previous studies that assessed the epidemiology of non-trauma amputations in Nigeria and other regions in Ghana (Dabkana *et al.,* 2018; Kyei *et al*, 2016). This, however, can change with time as people are becoming increasingly enlightened about diabetes treatment and its related complications. The total recorded lower-limb amputations were higher than that of upper limb amputations. With the high incidence of non-trauma amputations resulting from diabetes, it is not surprising that the lower limb amputations surpassed upper limb amputations. This finding is consistent with a previous study in Ghana (Kyei *et al.,* 2016). Also, with 54.5% of the study population being adults over 40 years of age, this outcome agrees with findings of previous studies that postulated that the incidence of lower limb amputations is higher among older adults and in diabetic populations (Narres *et al*., 2017). Regarding the length of hospital stay, we found that patients who had limbs amputated as a result of non-trauma causes stayed longer after surgery compared to those with trauma-related amputations. This could have resulted from non-trauma-related amputations being prone to infections due to prolonged stay in the hospital or due to causes such as diabetic vasculopathy predisposing them to infections, which further increased their length of hospital stay. This is similar to findings of a study conducted in Turkey by Tabur and colleagues; they reported that for patients who underwent non-trauma amputation surgeries, the patients' length of stay in hospitals was positively correlated to infection severity (Tabur et al., 2015). Grosset and colleagues posited that the dynamism of a traumatic injury and the need for specialized care such as reconstruction are essential determinants of surgical amputations' outcomes (Grosset *et al*., 2019). Extended hospital stays can increase the financial and caregiver burden and place undue pressure on the already limited health facilities, especially in LMICs where these facilities are mostly overstretched (Çamur *et al*, 2020; Ojaowo *et al,* 2017). This current study has some limitations, which the authors would like to acknowledge. First, we obtained the data for this study from one center with a small sample size, limiting the findings' generalizability. Second, a good number of potential cases within the study period were left out due to the case files' incompleteness; these cases could have provided a different dimension to the results presented herein. Third, we did not gather information on the amputation side (left or right) for the upper extremity or whether which dominant side was affected. Regardless of these limitations, the study serves as a basis for future studies. Further prospective and randomized studies will be needed to provide a clearer picture of surgical amputations in the country.

CONCLUSION

Despite the evidence gathered worldwide that

suggests that trauma due to uncurbed motorization accounts for most surgical amputations in LMICs, our findings show otherwise. Diabetic and other vasculopathies were the leading causes of surgical amputations. Below-knee amputations were the most common surgeries done, and males were most likely to have amputations carried out on them due to one condition or the other. Proper management and patient adherence to the treatment of diabetes mellitus would significantly reduce its associated complications. There is an urgent need for multidisciplinary foot care teams to help patients receive comprehensive care. This will reduce the in -hospital stay days that translate into a financial burden for patients, caregivers, and society.

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Informed consent
This is a retrospective study of patients' files and did not involve patients; an IRB approval was obtained from the Ethical Review Committee of Tamale Teaching Hospital.

Conflict of interest
The authors declare that they have no conflict of interest.

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