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Original article

Life Expectancy Score in Lower Extremity/Limb Amputation: A Meta-Analysis

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Peripheral Artery Disease, Critical Limb Ischemia, Acute Limb Ischemia, Mortality Rate with Amputation Above Knee, Mortality Rate with Amputation Below Knee.

ABSTRACT

Lower limb amputations (LEA) are commonly performed to control pain and sepsis in non-viable limbs among patients with chronic limb-threatening ischemia secondary to peripheral arterial disease. Despite advances in surgical technique and perioperative care, LEA remains associated with high short- and long-term mortality. The objective of this research is to estimate pooled mortality rates following LEA and to develop a composite life expectancy stratification framework based on age, level of amputation, and diabetes mellitus. This meta-analysis was conducted using electronic searches of EMBASE, Scopus, CINAHL, the Cochrane Library, and Google Scholar. Mortality rates were analysed at 30 days, 1 year, 2 years, 3 years, and 5 years following amputation. Mortality was further stratified by patient age, amputation level, and diabetes status. These variables were integrated into a composite Life Expectancy Score to stratify mortality risk.. Thirty-day mortality ranged from 8.1% to 30.0%, with higher mortality observed after above-knee amputation (AKA) compared with below-knee amputation (BKA) (17.9% vs. 10.1%). One-year mortality approached 50% following AKA compared with approximately 33% after BKA, while five-year mortality exceeded 75% for AKA patients. Advanced age (≥85 years) and diabetes mellitus were consistently associated with increased mortality across all follow-up intervals. When combined into a Life Expectancy Score, patients could be stratified into low-, intermediate-, high-, and very high-risk groups, with estimated 1-year mortality ranging from approximately 15–20% in low-risk patients to ≥60% in very high-risk patients, and 5-year mortality reaching to 85–90% in the highest-risk group. Mortality following LEA remains substantial, particularly among elderly and diabetic patients undergoing major amputations. A composite Life Expectancy Score incorporating age, amputation level, and diabetes status provides a pragmatic framework for stratifying post-amputation survival and may assist clinicians in prognostic counselling and shared decision-making.

Introduction

Numerous studies report that lower limb amputations (LEA) are associated with a high risk of mortality [1-6]. Following LEA, perioperative mortality ranges from 9-16% [7-11], and one-year survival rates range from 86-53% (7-16). Vascular disease, diabetes, or a combination of the two, accounts for the majority of non-traumatic amputations (7-15). Even lower survival rates have been documented in other studies, and these have been linked to variables such as advanced age, diabetes, multiple co-morbidities, and above-knee amputation (AKA) [7, 9, 10, 12, 15-17]. Amputation levels and one-year morbidity [8] or death [9] do not differ, according to other research, and amputees with diabetes appear to have a lower one-year mortality rate than amputees with dysvascular disease [11].

The earliest record of amputation was by the Hammurabi tribe in Babylon, where it was used as punishment [17]. The first use of amputation for clinical practice was by Hippocrates [18]. Individuals with diabetes have a higher risk of developing LEA, and they account for 50% of non-traumatic amputations [19]. Since their peripheral artery disease (PAD) is significant and permanent, the remaining 50% of patients typically require amputations. Ischemia and sensory neuropathy are caused by long-term diabetes [20]. The most frequent reason for hospital stays brought on by diabetes is foot issues [21]. Diabetic patients are more likely to experience morbidity and death following amputation. Consequently, the two main causes of LEA are diabetes mellitus and PAD [22]. The extent of LEA can vary, encompassing the amputation of a toe, an above-knee amputation (AKA), and in certain cases, the amputation of the entire leg [23].

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Methods

Search Strategy

The electronic search approach utilized the databases Medline, EMBASE, Scopus, CINAHL, Cochrane Library, and Google Scholar. (Diabetes OR Diabetic OR Peripheral Artery Disease (PAD) OR peripheral vascular disease (PVD) OR critical limb ischemia OR acute limb ischemia AND (foot OR feet) AND (mortality OR death OR survival) AND amputation AND (AKA OR BKA OR toe OR metatarsal) is an example of the full electronic search for the PubMed database. No restrictions were placed on the date for this study.

Criteria for Study Selection

In the meta-analytical research, the following studies were eligible for inclusion:

1. Comparative
2. Cohort
3. Cross-sectional Studies.

Case studies were excluded. The term "Lower Extremity Amputation" (LEA) refers to the excision of one or more lower limb components for this study. The thigh (between the hip and knee joints), lower leg (between the knee and ankle), and foot (calcaneus and distally) are the three subdivisions of the lower limb.

Screening

Two reviewers went through each of the found citations. After being determined to be possibly relevant, citations were retrieved to conduct a full-text review. Every full-text article was evaluated independently by two reviewers to determine its eligibility and place in the body of research literature. The disagreement among the reviewers was settled through conversation. Two writers separately retrieved pertinent data, research details, and outcomes for each included study. From the included research, two authors retrieved the pertinent data and created an organized table. Independent records were kept of the first author, publication year, nation or region, research design, number of cases, incidence, possible risk factors, and related data.

Study Outcomes

The mortality rate at the following time intervals: 30 days, 1 year, 2 years, 3 years, and 5 years after surgery, was determined to be the main outcome of this study. A secondary outcome, categorised according to the site of amputation—hip, above-knee (AKA), below-knee (BKA), knee, ankle, foot, or toe—was death. Additionally, a life expectancy score was created to provide a standardized measure of predicted survival for patients undergoing lower limb amputation. Studies were categorised as "diabetic" with or without PAD to examine variations in the outcomes. Studies referring to "PAD" patients also include people who have diabetes as a comorbidity. The overall results are indicative of all patients with PAD, diabetes, or both.

Data Collection

Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) were adhered to during the data gathering process.

Data Extraction

Data was extracted into an Excel spreadsheet, and two reviewers confirmed the accuracy of the data.

Quality Assessment

Using the Prisma checklist, the peer review of electronic search strategies (PRESS) checklist, and systematic review criteria and quality standards, two researchers independently assessed the quality of the papers. Cochrane PRESS rated the quality of the systematic search, while PRISMA examined the degree of data reporting.

Statistical Analysis

Each of the checklists, PRESS and PRISMA, had its mean, standard deviation (SD), or median (interquartile range) determined for both normally distributed and non-normally distributed scores for the purposes of this meta-analysis. The final checklist scores were tested for normalcy using the K-S test.

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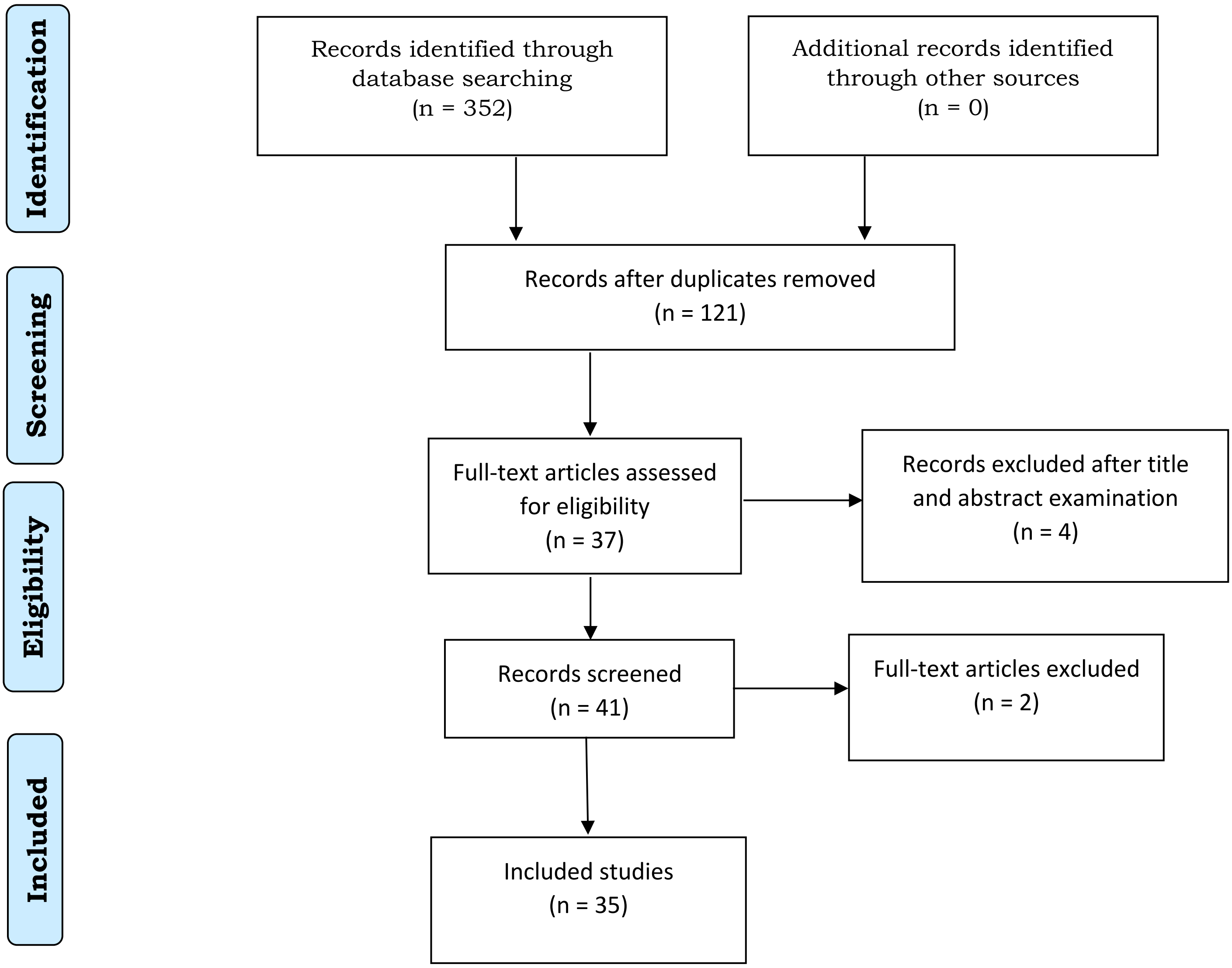
Results

Results of the Existing Research

There were 352 studies found at first. 121 full-text reports were reviewed following the removal of duplicates and the initial screening of titles and abstracts. 35 of the 121 papers met the predetermined inclusion criteria, as indicated by the PRISMA flow diagram (Fig. 1).

Fig. 1. PRISMA flow diagram illustrating study inclusions and exclusions



Demographic Results

There were 35 studies in all, totaling 17,325 people, as shown in Table 1 [1-34]. A total of 20 studies that were included disclosed the age of their sample, resulting in a pooled mean age of 66.6 ± 4.3 years. The follow-up duration had varied from 1 to 30 years (mean, 5.0 6 5.1 years), except for the three studies that had solely reported the 30-day death rate. The location of the minor LEA has been described in 13 studies overall. Furthermore, the percentage of diabetic individuals with or without PAD was reported in 23 investigations. Finally, the precise number of PAD patients had been provided by ten studies.

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Table 1. Demographic Characteristics of Studies

Author	Country	Patient No.	No. amputations	Age (years)	LEA Level n (%)					DM		
					Major				Minor			
					Hip	TFA(AKA)	Knee	TTA(BKA)	Ankle/Toe	Overall	AKA	BKA
Kidman et. al., 2004 [1]	Nigeria	87	94	44.5±21.1		46(49.9%)		BKA35(37.2%)		23(26.4%)		
Pernot et. al., 2000 [2]	Netherlands	153	180	NR		52(29%)	43(24%)	77(43%)	5(3.3%)	50.7%		
Chalya et. al., 2012 [3]	Tanzania	162		28.3±13.72		64(39.5%)	1(0.6%)	75(46.3%)		41.9%		
Ploeg et. al, 2005 [4]	Netherlands	97	122	73.4		45(36.9%)		77(63.1%)			17(39.5%)	24(44.4%)
Aljarrah et. al, 2019 [5]	Jordan	140		62.9±1.1		30(21.4%)		110(78.6%)		125(89.3%)		
Rosen et. al., 2014 [6]	Israel	188	198	72±0.0		91(46%)		107(54%)			16.8%	51.8%
Karam et. al., 2013 [7]	USA	6839				2838(41.5%)		4001(58.5%)		4209(61%)		

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Easterlin et. al., 2013 [8]	USA	9244		66±0.0		5740(62.1%)						
Jones et. al., 2013 [9]	USA	186338								37.4%		
Franchini et. al., 2021 [10]	Italy	286	310			257(82.9%)		53(17.1%)		185(59.7%)		
Fraglia et. al., 2006 [11]	Italy		32			3(9.4%)		13(40.6%)				
Wong et. al., 2013 [12]	USA	151		55.2								
Costa et. al., 2017 [13]	Brazil	499		63.1±12.20	0.8%	75(15.0%)		56(11.2%)	314(62.9%)			
Mayfield et. al., 2001 [14]	USA	5180		65.6±0		1565(30.2%		1381(26.7%)	2234(43.1%	61.4%		
Fortington et. al., 2013 [15]	Netherlands		299	74.1		101(34%)	27(9%)	146(49%)				
Soo et. al., 2020 [16]	UK	233		69				161(69.1%)	72(30.9%)			
Moulik et. al., 2003 [17]	UK	185	30	65.0±1.3						84%		

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Lee et. al., 1993 [18]	USA	875	156	51.6±10.8		3.6%		38.1%	58.4%			
Resnick et. al., 2004 [19]	USA	2108	134			1(0.7%)		53(39.6%)		100%		
Mandrup-Poulsen et. al., 1982 [20]	Denmark	310		70		103(33%)	66(21%)	141(46%)				
Subramaniam et. al., 2005 [21]	Israel		954	66.1±14.0		234(24.5%)		720(75.5%)				
Ebskov et. al., 1996 [22]				71.3		19%	6%	52%	23%			
Pohjolainen et. al., 1998 [23]	Finland		705							41%		
Nehler et. al., 2003 [24]	USA	154	172			78(45.3%)		94(54.7%)				
Kazmers et. al., 2000 [25]	USA	8696		68.1±14.0								
Basu et. al., 2008 [26]	UK	75				31(41.3%)		44(58.7%)			15(48.3%)	26(59.1%)

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Aulivola et. al., 2004 [27]	USA	788	951			233(26.6%)		704(73.4%)				
Kristensen et. al., 2012 [28]	Denmark		93	75.8		42%	9%	33%	16%			
Tentolouris et. al.,1996 [29]	UK		257							39.7%		
Schofield et. al., 2006 [30]	Scotland		390							119(30.5%)		
De Godoy et. al., 2005 [31]	Brazil	50		67.3								
Uzzaman et. al., 2011 [32]	UK	126								79(62.7%)		
López-Valverde et. el., 2018 [33]	Spain	230						87(42.9%)	116(57.1%)			
Icks et. al., 2011 [34]	UK	126		69.1±11.7		43%				58.3%		
Rosedi et. al., 2022 [35]	Malaysia	362	66									

Quality Appraisal

Using the Joanna Briggs Institute methodology, two studies received a score of 6, three received a score of 7, and the final study received a complete score of 8. Table 2 lists the specifics for every item score.

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Primary Outcomes

Mortality Rate: 30 days After Surgery

Thirty days following surgery, mortality rates varied from 8.1% to 30.0%. Out of the 19 studies that reported 30-day mortality, 10 reported a mortality of 10.67 ±1.127 [95%CI, 9.5%-11.8%] with a total population of 219 133. A mortality of 20.96 ±4.74 (±22.6%) [95%CI, 16.22 – 25.70] was recorded in four trials. There have been five studies on mortality after above-knee (AKA) and below-knee (BKA) amputations. Patients with AKA had a mean mortality of 18.93 ±4.91 (±25.9%) [14.02 – 23.84], while those with BKA had a mean mortality of 10.1 ±2.63 (±26.0%) [7.48 – 12.73].

Mortality Rate: 1 year After Surgery

The range of mortality rates at one year following surgery was 13.7% to 38.0%. Eight studies (with a total population of 188,399) found a mortality of 29.55 ±5.29 (±17.9%) [24.26 – 34.84], out of the 17 that reported mortality one year after surgery. 53.26 ±5.68 (±10.7%) was the death rate reported by five studies with a total population of 186 676 [47.58 – 58.94]. Following AKA, three studies found that the mean mortality ranged from 52.67 ±5.66 (±10.7%) [47.02 – 58.31], while four studies found that the mean mortality following BKA was 31.8 ±2.28 (±7.2%) [29.52 – 34.08].

Mortality at 2 years After Surgery

Two years after surgery, six studies reported on mortality, which ranged from 40.0 to 51%. 46 ±4.544 (±9.9%) was the mean mortality (41.456 – 50.544). According to one study, the death rate after AKA was 64 percent, and the death rate after BKA was 47 percent.

Mortality at 3 years After Surgery

After three years following surgery, the mortality rates across eight studies, totaling 192 444 participants, ranged from 25.4% to 70.9%. A mean mortality of 39.7 ±8.31 (±20.9%) was found in four investigations [31.39 – 48.011]. A mean mortality of 58.48 ±7.88 (±13.5%) was found in 4 further investigations [50.597 – 66.353].

Mortality at 5 years After Surgery

For a total population of 7,458, 14 studies reported mortality five years after surgery, with mortality ranging from 27% to 77%. A mean mortality of 36 ±7.87 (±21.9%) was found in four investigations [28.13 – 43.87]. A mean mortality of 64.22 ±4.40 (±6.8%) was found in nine investigations [59.82 – 68.62]. A mean mortality of 70 ±11.35 (±16.2%) was found in three investigations [58.65 – 81.35] after BKA. AKA had a mean mortality of 73.5 ±4.85 (±6.6%) [68.65 – 78.35] according to two investigations.

Mortality at 6 years After Surgery

At six years after amputation, two investigations involving a total of 283 participants revealed a mean mortality of 68 ±5.544 (±8.2%) [62.46 – 73.54].

Table 2. Outcomes of Individual Studies

Author	**Mortality, No (%)**				
	Mort_30days*	**Mort_1yr**	**Mort_2yrs**	**Mort_3yrs**	**Mort_5yrs**
Kidmas et. al., 2004 [1]	21 (13.1%)				
Pernot et. al., 2000 [2]					
Chalya et. al., 2012 [3]	8 (18%)	62%	50%		29%
Ploeg et. al, 2005 [4]					
Aljarrah et. al, 2019 [5]		43 (30.7%)			
Rosen et. al., 2014 [6]					

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Karam et. al., 2013 [7]	622 (9.1%)				
Easterlin et. al., 2013 [8]	744 (8.1%)				
Jones et. al., 2013 [9]	13.50%	48.30%		70.90%	
Franchini et. al., 2021 [10]	49 (15.8%)	36.60%		25.40%	
Fraglia et. al., 2006 [11]					
Wong et. al., 2013 [12]					
Costa et. al., 2017 [13]	12.00%				
Mayfield et. al., 2001 [14]				41.50%	55.50%
Fortington et. al., 2013 [15]	22.00%	44.00%			77%
Soo et. al., 2020 [16]		36.00%		50.00%	60%
Moulik et. al., 2003 [17]					47%
Lee et. al., 1993 [18]					60%
Resnick et. al., 2004 [19]					
Mandrup-Poulsen et. al., 1982 [20]	55 (18%)		43%	53.00%	65%
Subramaniam et. al., 2005 [21]					
Ebskov et. al., 1996 [22]					
Pohjolainen et. al., 1998 [23]		38.00%	51%		73%
Nehler et. al., 2003 [24]	10.00%	22.00%		45.00%	
Kazmers et. al., 2000 [25]					
Basu et. al., 2008 [26]	10 (10%)	13.70%			
Aulivola et. al., 2004 [27]	8.60%				
Kristensen et. al., 2012 [28]	30.00%	54.00%			
Tentolouris et. al.,1996 [29]					44%
Schofield et. al., 2006 [30]		29.00%	41%	46.90%	61%

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De Godoy et. al., 2005 [31]		22(44%)	3(50%)	5(60%)	2(68%)
Uzzaman et. al., 2011 [32]		58.00%			27%
López-Valverde et. el., 2018 [33]	25(12.3%)				
Icks et. al., 2011 [34]	10.00%	31.00%			59%
Rosedi et. al., 2022 [35]					

(Fig. 2) shows changes in mortality rates during the first five years following LEA. As shown in (Fig. 2), almost 50% occurs during the first 2 years post operation. This finding is confirmed by the Forest plot in (Fig. 3), which further indicates that by year 5, almost 70% mortality would have occurred.

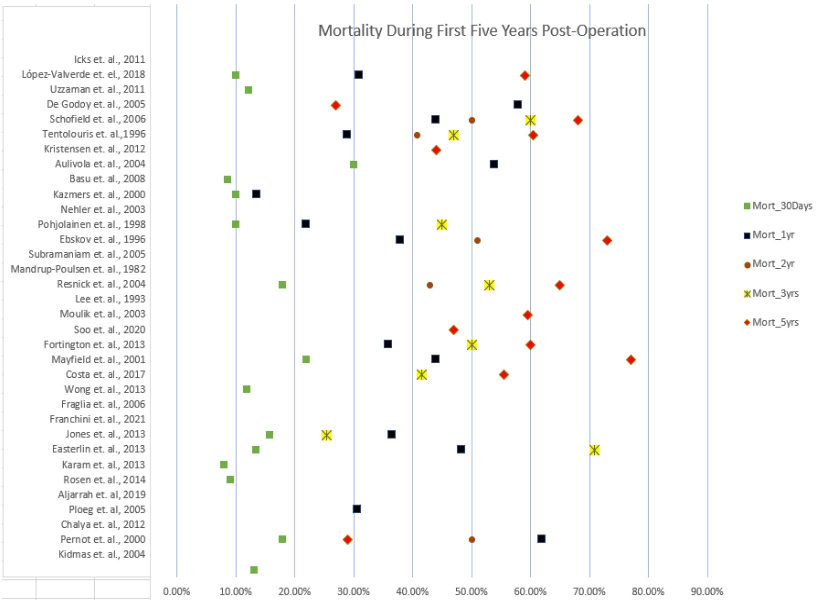

Fig. 2. An illustration of mortality rates for all the included studies during the first five years post-operation

Fig. 3. Forest plot of mortality during the first 5 years post-operation

Data were discovered for three predictors of mortality following LEA, including patient age group, degree of amputation, and diabetes mellitus, based on the papers included in this meta-analysis. With respect to the age of patients, (Table 3), shows that for each subsequent year following surgery for the first 5 years, mortality rates were higher for older patients above the age of 85 years. Patients younger than 65 years old

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had the lowest mortality rate for each year until 5 years post-LEA. Furthermore, (Table 3), shows that for patients older than 85 years old, 50% mortality occurred between 1st and second year, while for younger patients aged <65, 50% mortality occurred between 4 and 5-years post-surgery.
According to the study, AKA had an average mortality rate of 17.94±5.32% within the first 30 days after LEA, while BKA's mortality rate was just 10.1±2.63%. This difference in mortality rates was found to be statistically significant using an independent T-test. A comparable finding was made within the first year following LEA, as Table 3 illustrates: over 49.8% (±16.1%) of AKA deaths had occurred, compared to only 32.8% (±8.4%) of BKA deaths, and the difference was statistically significant. Nevertheless, AKA mortality was over 76% five years after surgery, and the difference was not statistically significant. As a result, this study showed that, in comparison to BKA, AKA had greater death rates for every year after surgery. One year after surgery, approximately 50% of cases with AKA result in death, whereas three years after BKA, almost 50% of cases result in death. Patients with diabetes had greater death rates than those without diabetes when it came to diabetic mellitus (DM).

Table 3. Investigating post-LEA mortality based on three mortality predictors

Age-group	**Mortality Rate (%)**				
	Year 1	Year 2	Year 3	Year 4	Year 5
<65	16	30	29	40	65
65-74	26.5	45	79	65	74
75-84	28	46.5	67	75	81
≥85	45	63	80	82	85
Level of Amputation	**Mortality Rate (%)**				
	Year 1	Year 2	Year 3	Year 4	Year 5
	Mortality rate	Mortality rate	Mortality rate	Mortality rate	Mortality rate
AKA	49.8±16.1	62.0±9.7	68.4±5.0	73.0±7.5	75.8±6.4
BKA	32.2±19.9	32.8±8.4	51.0±10.4	59.5±7.6	67.0±9.8
Minor	21.0±17.7	21.5±2.1	32.5±3.5	40.0±7.1	50.0±0.0
P-value	0.05	<0.001	0.01	0.04	0.13
Diabetes Mellitus	Mortality Rate				
	Year 1	Year 2	Year 3	Year 4	Year 5
	Mortality rate	Mortality rate	Mortality rate	Mortality rate	Mortality rate
No Diabetes	32.5±7.2	39.9±4.4	45.2±4.3	49.5±5.0	57.7±10.3
Diabetes	32.5±11.3	41.6±11.9	50.1±13.6	56.3±15.7	62.2±16.7
P-value	NS	NS	NS	NS	NS

P-values represent inter-group comparisons for each year (AKA vs BKA vs Minor; Diabetes vs No diabetes) using appropriate statistical tests. P-values <0.05 were considered statistically significant. (NS = not statistically significant)

Estimation of Mortality Probability Using the Life Expectancy Score

The Life Expectancy Score was developed as a composite prognostic framework based on three independent mortality predictors consistently identified in this meta-analysis: patient age, level of amputation, and presence of diabetes mellitus. Each predictor was assigned an ordinal point value reflecting its relative contribution to increasing mortality, as derived from pooled outcome trends across included studies. The components and point allocation used to calculate the Life Expectancy Score are detailed in Table 4. The cumulative score ranges from 0 to 6, with higher scores indicating progressively reduced post-amputation life expectancy.
Due to the absence of individual patient-level data, mortality probability was not calculated using multivariable regression or predictive modeling. Instead, estimated mortality probabilities were derived by mapping cumulative Life Expectancy Score categories to empirically observed pooled mortality rates stratified by age group, amputation level, and diabetes status at predefined follow-up intervals. This score-to-risk mapping approach allows clinically meaningful prognostic stratification based on aggregated outcome distributions and is consistent with accepted meta-analytic methodology.

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Estimated mortality probabilities at 1, 3, and 5 years following lower extremity amputation according to Life Expectancy Score categories are presented in Table 5, where increasing score ranges correspond to progressively higher short- and long-term mortality risk.

Table 4: Life Expectancy Score Components and Point Allocation

Prognostic Domain	Category	Score
Age (years)	<65	0
	65–74	1
	75–84	2
	≥85	3
Level of Amputation	Minor (toe/foot)	0
	Below-knee amputation (BKA)	1
	Above-knee amputation (AKA)	2
Diabetes Mellitus	Absent	0
	Present	1
Total possible score:		0–6

Table 5: Estimated Mortality Probability According to Life Expectancy Score

Total Score	Risk Category	1-Year Mortality	3-Year Mortality	5-Year Mortality
0–1	**Low risk**	15–20%	30–35%	45–50%
2–3	**Intermediate risk**	25–35%	45–55%	60–65%
4–5	**High risk**	45–55%	65–75%	75–85%
6	**Very high risk**	≥60%	≥80%	≥85–90%

Discussion

The study showed that mortality rates after 30 days post LEA ranged between 8.1-30.0%, with an average mortality of 14.03% (±0.5%). After one-year post-LEA, mortality rates reported by studies in this meta-analysis ranged between 13.7-38.0%, with an average mortality rate of 39.09% (±1.5%). Mortality rates after 2 years ranged between 40.0-51.0% with an average mortality rate of 47.0% (±2.5%). After 3 years, mortality rates ranged between 25.4-70.9%, with an average mortality rate of 49.09% (±3.5%). The study also showed that after 5 years, mortality rates ranged between 27-77.0%, with an average mortality rate of 55.8% (±4.5%). Furthermore, the studies included in this meta-analysis show that almost half of patients who underwent LEA had died by the fifth year after LEA.

Patients older than 85 years had a higher mortality than younger patients aged less than 65 years, one year after the operation. Nearly half of all patients aged >85 years had died after 1-year post-operation. Consistently over the five years post-operation, patients aged >85 years post-operation, had the highest mortality rates compared with younger age-groups. After 5 years, post-operation, almost 90% of patients >85 years had died compared with nearly half of patients <65 years that died after four years post-operation. AKA patients had the highest mortality rates compared with BKA and minor amputation patients. A year after LEA, nearly 50% of AKA patients had died compared with approximately 30% BKA and 21% minor amputation individuals. After 5 years, post-operation, nearly 75% of AKA patients had died compared with 67% and 50% of BKA and minor amputation patients, respectively.

Diabetic patients who underwent LEA had a higher mortality for each subsequent year post-operation compared with non-diabetic patients. After 5 years, diabetic LEA patients had a mortality rate of about 62% compared with 58% of patients without diabetes.

Conclusion

Lower limb amputations are common surgical procedures for patients with chronic limb-threatening ischemia following peripheral arterial disease. However, these procedures are associated with high mortality rates. This research aims to calculate the mortality rate of post-lower extremity amputation (LEA) in peripheral arterial disease and classify mortality based on amputation level, age, and relation to diabetes mellitus. Results show that above-knee amputation (AKA) has higher mortality rates during the first 30 days post-LEA compared to below-knee amputation (BKA). AKA mortality rates hit 76% after five years, and

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patients with diabetes mellitus had higher mortality rates. The study concludes that further measures should be taken to prevent limb ischemia, the leading cause of amputation in the population.

Conflict of interest. Nil

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