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Appendix

Study Context

Malawi is a low-income country located in southeastern sub-Saharan Africa, bordering Mozambique, Zambia, and Tanzania. It has a population of 18 million people, 83% of whom live in rural areas[1]. GDP per capita is $300, and annual health expenditure per capita is $29[2]. In 2010, 51% of the population lived below the national poverty line[3].

Malawi's health system is inadequate to manage a disproportionately high burden of trauma[4-9]. Malawi has 41 practicing surgeons, 11 of whom are orthopaedic specialists, yielding 0.24 surgeons per 100,000 people compared with 29 surgeons per 100,000 people in HIC[10,11]. Orthopaedic clinical officers (OCOs) - non-physician clinicians - manage up to 90% of orthopaedic workload, especially in rural areas[12,13].

The public hospital system in Malawi has 3 tiers: rural health centers, providing primary care; district hospitals, staffed by OCOs; and regional referral hospitals in urban centers staffed by OCOs and orthopaedic surgeons. Health centers do not have orthopaedic staff, x-ray equipment to diagnose musculoskeletal injuries or basic equipment for temporary stabilization or definitive treatment of fractures. Patients presenting to health centers with fractures are therefore typically referred to a district or a referral hospital for treatment. Many district hospitals, however, also lack sufficient resources and capacity to provide adequate fracture care[14], and must refer patients to a referral center for definitive treatment. Referred patients, therefore, are typically not given any treatment besides an improvised sling, bandages, or analgesia prior to arrival at orthopaedic clinic in any of the 4 hospitals included in this study.

Furthermore, there is no organized emergency response system in Malawi. Very few patients are brought to hospital from the site of injury by emergency medical services or by ambulance[6,8]. Ambulances are rarely, if ever used to transport patients to ambulatory facilities. Thus, although no data are available in the Malawi Fracture Registry on method of transportation to reach clinic, we expect very few if any patients presented by ambulance.

Outpatient orthopaedic clinics at all 4 hospitals included in this study were typically open from 0730 to 1600 every weekday and closed on weekends. Each hospital had an on-call OCO or a general clinical officer available to see patients who presented at night or on weekends in the Accident and Emergency (A&E) department. Clinical officers and data clerks allocated to the orthopaedic clinics entered all registry information for each patient during a patient's clinic visit and on the same day that treatment was provided.

Sensitivity Analysis

Methods

While injury severity is not specifically documented in the Fracture Registry, disposition from clinic (treated and sent home versus admitted) is recorded. Hypothesizing from a clinical perspective that more severe injuries were likely admitted and less severe injuries were likely treated in clinic and sent home, we took disposition from clinic as a proxy for injury severity. As disposition from clinic occurs after presentation, and thus could not be a prospective predictor of delayed presentation, we performed a separate sensitivity analysis repeating our bivariate and multivariate analyses for both cohorts including this twelfth covariate. We examined its association with delayed presentation and its influence on other variables in the multivariate models.

Results

12 percent of pediatric and 10% of adult patients were admitted to hospital from clinic, while all other patients were treated and sent home. We did not observe a significant association between disposition from clinic (treated and sent home versus admitted) and delayed presentation in the pediatric cohort (RR 1.03, 95% CI 0.75 to 1.42) (Table E-1). However, in the adult cohort, patients who were treated and sent home had a significant 63% increased risk of delayed presentation (RR 1.63, 95% CI 0.96 to 2.76) in the multivariable model. Inclusion of this covariate in the multivariable model resulted in minimal change to the associations observed for the other 7 covariates (Table E-2).

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Tables

Table E-1 Pediatric Cohort, Sensitivity Analysis with Inclusion of Disposition from Clinic; Bivariate and Multivariate Predictors of Delayed Presentation in Modified Poisson Regression Analyses

		Bivariate		Multivariate		Parsimonious Multivariate	
Variable	Rate of Delayed Presentation (>1 day)	*RR (95% CI)*	*P* Value	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value
Age group			**0.031**		0.236		
0 to 10 years[a]	25.9% (160/619)	1		1			
11 to 17 years	32.6% (102/313)	1.26 (1.02-1.55)		1.18 (0.90-1.56)			
Sex			0.167				
Female[a]	24.5% (68/278)	1					
Male	28.9% (181/626)	1.18 (0.93-1.50)					
Education level			0.083		0.418		
No Schooling[a]	22.7% (44/194)	1		1			
Primary 1-4	30.5% (106/348)	1.34 (0.99-1.82)		1.03 (0.86-1.24)			
Primary 5-8	25.8% (68/264)	1.14 (0.82-1.58)		0.86 (0.69-1.07)			
Secondary or above	40.5% (17/42)	1.78 (1.14-2.80)		1.00 (0.73-1.36)			
Unknown	32.1% (27/84)	1.42 (0.95-2.12)		1.24 (0.95-1.62)			
Mechanism of Injury			0.197		**0.030**		**0.032**
Road Traffic Accident[a]	22.5% (11/49)	1		1		1	
Assault	18.9% (14/74)	0.84 (0.42-1.70)					
Other	26.7% (8/30)	1.19 (0.54-2.62)					
Fall	28.6% (190/664)	1.27 (0.75-2.17)		1.44 (1.03-2.01)		1.40 (1.02-1.93)	
Sports	34.4% (32/93)	1.53 (0.85-2.77)		1.64 (1.08-2.49)		1.65 (1.09-2.49)	
Injury Type			**0.014**		**0.008**		**0.003**
Other upper extremity[a]	28.7% (143/498)	1		1		1	
Other lower extremity	24.7% (19/77)	0.86 (0.57-1.30)		0.95 (0.63-1.44)			
Unknown	27.6% (27/98)	0.96 (0.68-1.36)		0.78 (0.56-1.10)			

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Elbow	21.5% (38/177)	0.75 (0.55-1.02)		0.69 (0.51-0.94)		0.72 (0.54-0.97)	
Tibia/Fibula	42.7% (35/82)	1.49 (1.12-1.98)		1.35 (1.03-1.77)		1.36 (1.05-1.77)	
Season of Injury			0.074				
Dry[a]	33.3% (63/189)	1					
Rainy	26.8% (199/743)	0.80 (0.64-1.02)					
Day of Injury			**<0.001**		**<0.001**		**<0.001**
Weekday[a]	19.5% (127/650)	1		1		1	
Weekend	47.9% (135/282)	2.45 (2.01-2.99)		2.26 (1.85-2.76)		2.30 (1.88-2.80)	
Estimated Travel Time			**<0.001**		**<0.001**		**<0.001**
<20 mins [a]	24.9% (140/563)	1		1		1	
≥20mins	45.2% (89/197)	1.82 (1.47-2.24)		1.43 (1.14-1.79)		1.45 (1.16-1.81)	
Undetermined	31.1% (14/45)	1.25 (0.79-1.98)		1.33 (0.81-2.16)		1.30 (0.80-2.13)	
Unknown	15.0% (19/127)	0.60 (0.39-0.93)		0.60 (0.39-0.94)		0.57 (0.37-0.90)	
Referrals			0.151		**0.010**		**0.013**
Self-referred [a]	23.1% (33/143)	1		1		1	
Referred from other facility	28.9% (228/788)	1.25 (0.91-1.72)		1.48 (1.06-2.06)		1.46 (1.05-2.02)	
Hospital of presentation			**<0.001**		**0.009**		**0.013**
Queen Elizabeth Central Hospital [a]	23.8% (143/602)	1		1		1	
Mangochi District Hospital	34.9% (22/63)	1.47 (1.02-2.12)		1.39 (1.09-1.76)		1.34 (1.07-1.69)	
Nkhata Bay District Hospital	41.6% (37/89)	1.75 (1.32-2.33)					
Kamuzu Central Hospital	33.7% (60/178)	1.42 (1.10-1.82)					
Disposition			0.856				
Admitted[a]	27.5% (30/109)	1					
Treated and sent home	28.4% (228/804)	1.03 (0.75-1.42)					

Type III p-values are shown for categorical variables. Bivariate analysis was performed for each covariate with delayed presentation as the outcome measure. Categories with RR > 1.25, RR < 0.8, or p-value < 0.05 were included in the multivariable model. Parsimonious model was constructed by excluding covariates for with a p-value greater than 0.05. P-values < 0.05 are shown in bold. Abbreviations: CI, confidence interval; RR, relative risk. [a]Reference category.

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Table E-2. Adult cohort, sensitivity analysis with inclusion of disposition from clinic; bivariate and multivariate predictors of delayed presentation in modified Poisson regression analyses.

		Bivariate		Multivariate		Parsimonious Multivariate	
Variable	Rate of Delayed Presentation	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value	RR (95% CI)	*P* Value
Age group			**0.029**		0.052		
18 to 45 years[a]	30.4% (98/322)	1		1			
46 years and above	41.3% (52/126)	1.36 (1.04-1.77)		1.31 (1.01-1.70)			
Sex			0.269				
Female[a]	30.5% (54/177)	1					
Male	35.6% (96/270)	1.17 (0.89-1.53)					
Occupation			**0.032**		**<0.001**		**<0.001**
Farmer[a]	40.2% (41/102)	1					
Unemployed	36.4% (12/33)	0.90 (0.54-1.51)					
Office Worker	45.5% (10/22)	1.13 (0.68-1.89)		1		1	
Student	37.5% (12/32)	0.93 (0.56-1.55)					
Other	31.7% (65/205)	0.79 (0.58-1.08)					
Housewife	15.7% (8/51)	0.39 (0.20-0.77)		0.35 (0.18-0.69)		0.38 (0.20-0.72)	
Education level			0.975				
No Schooling[a]	37.0% (17/46)	1					
Primary 1-4	34.7% (17/49)	0.94 (0.55-1.61)					
Primary 5-8	32.7% (52/159)	0.88 (0.57-1.37)					
Secondary or above	32.6% (57/175)	0.88 (0.57-1.36)					
Unknown	36.8% (7/19)	1.00 (0.50-2.01)					
Mechanism of Injury			**0.018**		**<0.001**		**<0.001**
Road Traffic Accident[a]	24.4% (20/82)	1					
Assault	23.9% (16/67)	0.98 (0.55-1.74)		1		1	
Other	30.4% (17/56)	1.24 (0.72-2.16)					
Fall	39.5% (92/233)	1.62 (1.07-2.45)		1.65 (1.23-2.22)		1.85 (1.38-2.46)	
Injury type			0.602				
Upper extremity[a]	35.6% (74/208)	1					
Lower extremity	30.9% (60/194)	0.87 (0.66-1.15)					

Unknown	34.8% (16/46)	0.98 (0.63-1.51)				
Season of Injury			0.105		0.525	
Dry[a]	39.5% (47/119)	1		1		
Rainy	31.3% (103/329)	0.79 (0.60-1.04)		0.89 (0.62-1.27)		
Day of Injury			**<0.001**		**<0.001**	**<0.001**
Weekday[a]	24.2% (64/264)	1		1		1
Weekend	46.7% (86/184)	1.93 (1.48-2.51)		1.77 (1.34-2.33)		1.80 (1.38-2.36)
Estimated Travel Time			**0.003**		0.051*	**0.017**
<20 minutes [a]	27.8% (81/291)	1		1		
≥20mins	40.9% (47/115)	1.47 (1.10-1.96)		1.36 (1.01-1.84)		1.36 (1.03-1.80)
Undetermined	45.5% (10/22)	1.63 (1.00-2.68)		1.63 (0.94-2.81)		1.75 (1.04-2.94)
Unknown	60.0% (12/20)	2.16 (1.44-3.22)		1.83 (1.16-2.90)		1.86 (1.26-2.76)
Referrals			0.312			
Self-referred [a]	30.7% (54/176)	1				
Referred from other facility	35.3% (96/272)	1.15 (0.87-1.51)				
Hospital of presentation			0.121		**0.005**	**<0.001**
Queen Elizabeth Central Hospital [a]	28.6% (69/241)	1		1		1
Mangochi District Hospital	34.8% (8/23)	1.21 (0.67-2.20)		1.11 (0.58-2.13)		
Nkhata Bay District Hospital	41.2% (28/68)	1.44 (1.02-2.03)		1.14 (0.79-1.65)		
Kamuzu Central Hospital	38.8% (45/116)	1.35 (1-1.84)		1.94 (1.40-2.70)		1.74 (1.30-2.33)
Disposition			0.237		**0.044**	
Admitted[a]	25.0% (11/44)	1		1		
Treated and sent home	33.8% (133/393)	1.35 (0.80-2.30)		1.63 (0.96-2.76)		

Type III p values are shown for categorical variables. Bivariate analysis was performed for each covariate with delayed presentation as the outcome measure. Categories with RR >1.25, RR <0.8, or p value <0.05 were included in the multivariable model. Parsimonious model was constructed by excluding covariates for with a p value greater than 0.05. p values <0.05 are shown in bold. Abbreviations: CI, confidence interval; RR, relative risk. [a]Reference category.

* ETT with a borderline p value was provisionally retained in the model, and was found to regain significance with exclusion of Season of Injury from the multivariate model.

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