

A case-control study of musculoskeletal impairment: association with socio-economic status, time use and quality of life in post-conflict Myanmar

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Abstract

Background: Musculoskeletal impairments (MSI) are a major global contributor to disability. Evidence suggests entrenched cyclical links between disability and poverty, although few data are available on the link of poverty with MSI. More data are needed on the association of MSI with functioning, socio-economic status and quality of life, particularly in resource poor settings where MSI is common.

Methods: We undertook a case-control study of the association between MSI and poverty, time use and quality of life in Myanmar. Cases were recruited from two physical rehabilitation service-centres, prior to the receipt of any services. One age (+/- 5 years) sex matched control was recruited per case, from their home community. 108 cases and 104 controls were recruited between July – December 2015.

Participants underwent in-depth structured interviews and functional performance tests at multiple time points over a twelve-month period. Baseline characteristics of participants are reported in this manuscript, using multivariate logistic regression analysis and various tests of association. **Results:** 89% of cases were male, 93% were lower limb amputees, and the vast majority had acquired MSI in adulthood. 69% were not working compared with 6% of controls (Odds Ratio 27.4, 95% Confidence Interval 10.6 – 70.7). Overall income, expenditure and assets were similar between cases and controls, with three-quarters of both living below the international LMIC poverty line. However, cases' health expenditure was significantly higher than controls' and associated with catastrophic health expenditure and an income gap for one fifth and two thirds of cases respectively. Quality of life scores were lower for cases than controls overall and in each sub-category of quality of life, and cases were far less likely to have participated in productive work the previous day than controls. **Conclusion:** Adults with MSI in Myanmar who are not in receipt of rehabilitative services may be at risk of increased poverty and lower quality of life in relation to increased health needs and limited opportunities to participate in productive work. This study highlights the need for more comprehensive and appropriate support to persons with physical impairments in Myanmar. **Key words:** musculoskeletal impairment, physical rehabilitation, quality of life, Myanmar

Background

One billion people, or 15% of the global population, is estimated to have a disability – 80% of whom live in low and middle income country (LMIC) settings(1).

Musculoskeletal impairments (MSI) – namely those that affect the physical functions, movements and structure of a person's body – are a major contributor to disability globally (2, 3). Musculoskeletal impairments include impaired functions, movements or structure of the joints, bones and muscles, and can be congenital, neurological or acquired through illness, injury or trauma(4). The global magnitude of MSI is unknown, in part due to the heterogeneity of conditions the term encompasses. However, studies conducted in Rwanda, Cameroon and India between 2005 and 2014 estimated the prevalence to vary between 3.4 -5.2% of the all-age population, increasing substantially with age (4, 5).

A growing body of evidence has identified pervasive cyclical links between disability and lower socio-economic status (SES), particularly in LMICs (6). Having a disability is associated with more frequent

health risks, and consequently greater risk of catastrophic health costs, exacerbating poverty (1, 7-9). Persons with disabilities also face greater barriers to work, leading to higher unemployment rates and lower SES of people with disabilities and their households (10-12). Conversely, poverty can heighten the risk of disability through exclusion from health and rehabilitative services and interventions, increased exposure to risk factors for poor health, and heightened environmental risks, such as from unsafe work environments (13-15).

Few data are available that disaggregate the relationship between disability and poverty by impairment type. One recent survey of MSI in Rwanda established that adults with MSI were over three times less likely to be working than adults without, but did not find differences in terms of SES (16). Moreover, limited data are available on the relationship between disability and time use, particularly by impairment type, which may help to unravel the relationship of disability with poverty and quality of life.

In 2011, the Republic of the Union of Myanmar elected a civilian government following fifty years of military rule (17). It is one of a small number of countries globally with continually high rates of landmine casualties following the lengthy conflict (18). In addition, unintentional injury related to road accidents, falls and mechanical force injuries remain common in the country, and are leading causes of MSI (19).

More data are urgently needed on the relationship between MSI, SES and quality of life and the effect of physical rehabilitation on quality of life in LMIC settings. This information is particularly needed in conflict and post-conflict affected settings, where increased risk of trauma and injury heighten the magnitude of MSI (20). This study therefore set out to assess the link between MSI with poverty, quality of life, and time use in Myanmar.

Methods

2.1 Study overview

We undertook a case-control study of the association between MSI and poverty, time use and quality of life in post-conflict Myanmar. Cases were recruited from two physical rehabilitation centres, prior to receipt of rehabilitation services. One age (\pm 5 years of the case's age) and sex matched control was recruited per case, living in the same community as the case and having no physical impairment. All cases and controls underwent in-depth interview using a structured questionnaire.

2.2 Sample Size Calculation

There is no existing data on the possible association between MSI and poverty on which to calculate a case-control study design sample size (21). Consequently, this study followed Norman et al.'s recommendation that a sample size of 64 per group would detect a medium effect size of 0.5 (22). Accounting for prospective drop out of up to 40% at one year post follow up, a sample of 100 cases and 100 controls were recruited.

2.3 Participant Recruitment

Cases were recruited from two physical rehabilitation centres in Myanmar, which were the main providers of prostheses in the country in 2015: The National Rehabilitation Hospital in Yangon (NRH, operated by the Myanmar Ministry of Health), and the Hpa-An Orthopaedic and Rehabilitation Centre in Hpa-An (HORC, operated by the Myanmar Red Cross Society in collaboration with the Ministry of Health and the International Committee of the Red Cross).

Participants were eligible for enrolment in the study if they:

- were ≥ 18 years old,
- had never previously been fitted with a prosthetic or orthotic assistive device,
- were determined by a trained physiotherapist to require either a prosthetic or orthotic device due to MSI,
- were able to communicate independently or via translator,
- did not plan to migrate outside of Myanmar within the following twelve months.

Clients at NRH and HORC meeting the above criteria were provided oral and written information about the study and requested to formally consent to participate. All clients were assured that they had the right not to participate and that this would not affect the services they received.

For each client who met the eligibility criteria and agreed to participate ("cases"), one matched control was identified from the same local community as the case. Controls were identified as follows: the same sex as the case, +/- five years of age, able to communicate independently or via translator, not planning to migrate outside of Myanmar within the following twelve months and did not have an MSI.

To identify controls, data collectors accompanied cases to their homes or were provided with information from the cases to identify their home independently. The data collector spun a bottle outside the case's house and walked in the direction of the bottle to the nearest house to identify a control matching the above criteria. If an eligible control was available, the data collector provided relevant study information and asked the control if they wished to participate before taking written consent and beginning the interview.

If no eligible control was identified within the household, or the eligible control chose not to participate, the data-collector returned to the case's household, re-spun the bottle and continued the process until an eligible control was identified.

2.4 Data Collection

Cases were assessed using the Rapid Assessment of Musculoskeletal Impairment (RAM) tool to identify MSI presence, severity and aetiology according to pre-validated algorithms (4, 23). The RAM was developed and validated for use in LMICs, and has been previously used in Kenya, Rwanda, Cameroon and India (23-25).

Physical functioning was assessed using two standardised tools: the Physical Performance Test (PPT) and the Two Minute Walk Test (TMWT (26)). The PPT comprises 9 items, scoring an individual based on the time it takes them to complete each task. A score of 0 relates to inability to complete a task, with higher scores for quicker completion rates. The PPT has not previously been used in low income settings. The TMWT is a widely validated test of aerobic capacity and endurance in post-stroke rehabilitation, spinal cord injury and amputation (27-29). The TMWT measures the distance ambulated in two minutes on flat ground.

Time use was measured using the 'Stylised Activity List' developed by the Living Standards Measurement Study (30). The tool contains thirteen broad activities comprising areas of personal care (e.g. sleeping, bathing/dressing and medical care), productive activities (both paid and non-paid activities including household tasks), leisure (in and outside the household) and time spent resting (no activity). The number of hours spent undertaking each activity on the previous day is recorded, alongside whether or not assistance was needed. This tool has previously been used in assessing the long term impact of cataract surgery in Bangladesh, Philippines and Kenya(31).

We used the WHOQOL-BREF, developed by the World Health Organisation (WHO) to assess quality of life. The WHOQOL-BREF comprises 26 items related to physical, psychological, social and environmental domains of quality of life, and uses Likert scale responses ranging between very poor/very dissatisfied/not at all, and very good/very satisfied/an extreme amount. The WHOQOL-BREF has shown excellent reliability and validity in more than 20 countries (32).

SES was measured in three different ways, each in accordance with World Bank recommendations of reliable and comparable collection of household SES data in LMICs(33): (i) Household income was measured directly as reported average monthly income in the household; (ii) Household expenditure was measured across 85 pre-validated, pilot-tested items related to expenditure on food (including value via home production, received in kind or as gifts), education, health, household and personal items and rent (34); and (iii) Asset ownership was measured using a pre-tested asset list (33 items) to assess the number and type of assets owned by the household (e.g. furniture, vehicles, cattle) and key characteristics of the household structure (e.g. building materials, number of rooms).

All questions related to socio-economic status were asked directly to the person in the household with primary responsibility for the household's finances.

2.5 Training and field work

Mid-level rehabilitation professionals (e.g. orthopaedic technicians, physiotherapists or physiotherapist assistants) at NRH and HORC were provided training to assist data collection through recruitment and physical assessment of eligible clients.

In addition, six full-time data collectors were recruited from local universities. A two-week training course was held in July 2015 incorporating modules on disability sensitisation (led by a local disabled persons'

organisation), project protocol and data collection tools, informed consent and ethics, study logistics and recruitment, safety and security.

Ten volunteers were recruited from NRH, alongside ten community volunteers as part of the training programme, to pilot-test the tools and study approach. Data was collected, stored and managed using a bespoke Android application, built on Python coding and deployed using Google Nexus tablets

2.6 Statistical Analysis

Data were cleaned and analysed in Stata 14.0 (35). Perfect matching between cases and controls was not achieved, excluding paired analysis approaches.

Chi-squared tests of association and age-sex adjusted logistic regression analyses were used to measure differences in socio-demographic characteristics between cases and controls, whilst descriptive statistics were used to describe case service-centre details.

PPT scores were divided into categories based on crude thirds (0-12, 13-24 and 25-36). PPT category and TMWT average distance were compared between cases and controls using Chi-squared and student t-tests of association/difference respectively.

Household monthly income was divided by household size to estimate Per Capita Income (PCY). Similarly, Personal Consumption Expenditure (PCE) was calculated by dividing household expenditure by household size. Both PCY and PCE were converted into US dollars for ease of interpretation. The assets list was used to derive a household-level relative index indicating SES, via Principle Components Analysis (PCA) and categorised into tertiles (36). PCA involves a statistical calculation of the relative weight of different assets, producing a total score per household.

Due to the skewed nature of income and expenditure variables, raw PCE and PCY results were logged, and exponentiated regression coefficients were derived using linear regression, accounting for age and sex. Age-Sex adjusted Logistic Regression was used to derive odds ratios for the proportion of cases and controls experiencing catastrophic health expenditure ($\geq 10\%$ monthly per capita expenditure(37)), below the international Lower Middle Income Country Poverty Line (3.20 USD, adjusted for Purchasing Power Parity), in each PCA tertile, and experiencing an income gap ($PCE > PCI$).

Time-use allocation was aggregated and any responses totalling less than 19 or greater than 29 hours were removed from the analysis. Age-sex adjusted logistic regression was used to compare participation in different activities amongst cases and controls. Logged linear regression was undertaken, accounting for age and sex, to assess differences in the proportion of time spent in different activities between cases and controls.

Quality of Life scores were aggregated and transformed into scores out of 100. Mean scores were compared using a student t-test.

Multivariate logistic regression analyses were undertaken amongst cases to ascertain associations between:

1. case quality of life scores (general quality of life score, general health quality of life score, physical health quality of life score and psychological health quality of life score respectively)
2. and age group, work status, proportion of the day spent resting, proportion of the day spent in productive activities, physical functioning score, PCA tertile, PCE quartile, PCI quartile and proportion experiencing income gap.

2.7 Ethical Approval

Ethical approval for the study was granted by the Research Ethics Committee (ref 9292) at the London School of Hygiene & Tropical Medicine and the Myanmar Ministry of Health Ethical Review Board (Ref 1/2015).

Results

Table 1 presents the socio-demographic characteristics of study participants. 108 cases were recruited, alongside 104 controls. Cases and controls were well matched on age and gender, although 89% of each were male.

There were no differences between cases and control in marital status, religion, ethnicity or literacy. However, cases were more likely than controls not to have a job (69% versus 6%, Odds Ratio 27.4, 95% confidence interval 10.6 – 70.7), and were also less likely to be the head of their household (57% versus 74%, OR 3.7, 95% CI 1.7 – 8.0).

Socio-demographics of study participants				
		Cases (n=108)	Controls (n=104)	Age-Sex adj OR (95% CI)
		%	%	
	Male	89%	89%	Ref. ^α
	Female	11%	11%	1.0 (0.4 - 2.5)
	18 - 39	43%	42%	Ref.
	40 - 59	44%	44%	1.1 (0.5 - 1.7)
	60+	14%	13%	1.0 (0.5 - 1.7)
status	Married	64%	72%	Ref.
	Not Married	36%	28%	1.6 (0.9 - 2.9)
	Theravada Buddhism	90%	93%	1.6 (0.6 - 4.3)
	Other	10%	6%	Ref.
	Bamar	76%	80%	Ref.
	Kayin	12%	10%	1.3 (0.6 - 3.2)
	Rakhine	6%	6%	1.0 (0.3 - 3.3)
	Other	7%	5%	1.4 (0.4 - 4.6)
	Reads well	77%	88%	Ref.
	Reads a little	16%	10%	1.9 (0.8 - 4.5)
	Does not read at all	7%	3%	3.1 (0.8 - 12.1)
status	In the field only	5%	36%	0.3 (0.1 - 0.8)
	Job other than in the field	26%	59%	Ref.
	No job and no work in the field	69%	6%	27.4 (10.6 - 70.7)
status	Yes	57%	74%	Ref.
	No	43%	26%	3.7 (1.7 - 8.0)

Reference group in odds ratio calculation throughout

Approximately half of the cases were recruited at each of the two sites (43% at HORC, 58% at NRH, Table 2). Only 2% reported that they had acquired MSI congenitally or in the first 15 years of life, with 46% acquired trauma and 23% related to non-acquired trauma. 98% of cases were lower limb amputees and over 90% were assessed to require an above or below knee prosthetic. (See Table 2)

Table 2: MSI-related information among cases		
		%
Service Centre	Red Cross Centre (HORC)	43%
	National Rehabilitation Centre (NRH)	58%
Age at which MSI acquired	Since birth	1%
	0 - 15 years old	1%
	16 - 39 years old	46%
	40+	52%
Origin of MSI	Congenital/ Genetic	2%
	Infection	10%
	Acquired Trauma	56%
	Neurological	8%
	Acquired Non Traumatic	23%
Amputee	Yes	98%
	No	2%
Device to be fitted	Below Knee (BK) prosthetic	53%
	Above Knee (AK) prosthetic	40%
	Knee Disarticulation (KD) prosthetic	4%
	Above Elbow (AE) prosthetic	3%
	Orthosis (AFO, KAFO or Milwaukee)	2%

Table 3 describes baseline physical functioning information for cases and controls. 100% of controls were categorised in the highest tertile of physical performance using the Physical Performance Test (PPT), compared with 44% of cases ($p < 0.001$). 95% of cases used an assistive device to perform the Two Minute Walk Test (TMWT). On average, cases were able to walk 65.6 metres in two minutes (standard deviation 29.5), compared with 133.5 metres on average for controls (sd 102.7, $p < 0.001$).

Table 3: Physical Functioning information				
		Cases (n=108)	Controls (n=104)	P-value (χ^2)
Physical Performance Test (PPT)	0-12 (lowest)	10%	0	<0.001
	13-24	46%	0	
	25-36 (highest)	44%	100%	
	Mean score	22.6	33.1	<0.001
	Standard deviation (sd.)	6.3	2.0	<0.001
Two Minute Walk Test (metres)	0	5%	0	<0.001
	1 - 50	24%	4%	
	51 - 100	62%	57%	
	101 - 200	9%	25%	
	201+	0	14%	
	Uses Assistive Device	95%	0	<0.001
	Mean Distance	65.6	133.5	<0.001
	Standard deviation (sd.)	29.5	102.7	

Socio-economic status is described in Table 4. There were no differences between cases and controls in overall per capita expenditure. Per capita expenditure on health care was significantly higher amongst cases compared to controls (a median monthly per capita expenditure of \$0.18 for cases compared with zero for controls) but there was no difference in per capita expenditure for the other categories. There were no differences in median per capita income between cases and controls, nor in the proportion of cases and controls below the international poverty line or the poorest per capita income quartile. However, cases were much more likely to experience catastrophic health expenditure (20.4% versus 1.9%, OR 15.2, 95% CI 3.3 – 69.8) and more likely to experience an income gap (65.7% versus 47.1%, 2.2, 1.2 – 3.8) than controls.

4: Socioeconomic status							
			Cases (n=108)		Controls (n=104)		Coefficient (95% CI) ^a
			Median (95% CI) ^a	(IQR) ^a	Median (95% CI) ^a	(IQR) ^a	
Expenditure (monthly)	Capita (US\$, monthly)	Total	35.03	34.72	32.07	35.50	11.8% (-8.6 - 32.2)
		Food	18.28	14.76	18.15	15.69	-6.0% (-21.0 - 8.9)
		Health	0.18	2.36	0.00	0.47	115.5% (51.3 - 179.8)
		Other ^b	12.57	19.18	11.52	17.72	9.2% (-19.5 - 38.0)
		Total minus health	32.41	27.14	31.06	33.54	2.2% (-16.9 - 21.2)
Proportion of Health Expenditure			20.4%		1.9%		15.2 (3.3 - 69.8)
Below International Poverty line			75.0%		76.9%		0.9 (0.5 - 1.7)
Capita Income (US\$, monthly)			3.1	0.8	3.4	0.9	-19.5% (-39.5 - 0.6)
Quintile 1 (poorest)			38.9%		26.2%		Ref.
Quintile 2			25.0%		25.2%		0.7 (0.3 - 1.4)
Quintile 3			15.7%		24.3%		0.4 (0.2 - 1.0)
Quintile 4 (richest)			20.4%		24.3%		0.6 (0.3 - 1.2)
Proportion experiencing an income			65.7%		47.1%		2.2 (1.2 - 3.8)
SES score	SES score		-0.2 (-0.7 - 0.2)	2.5	0.2 (-0.2 - 0.7)	2.4	Age-Sex adj OR (95% CI)
	Tertile 1 (poorest)		42.6%		33.7%		
	Tertile 2 (middle)		29.6%		33.7%		
	Tertile 3 (richest)		27.8%		32.7%		

Adjusted regression coefficient, using log transformed expenditure and income, which illustrates the percent difference in

ure/income per capita among case and control households, after taking into account age and sex.

xpenditure: personal, entertainment, education, taxes, occasional and other

st those reporting an income gap <0

Cases were much more likely to have allocated time to medical care in the previous twenty four hours than controls (88.5% versus 27.2%, 21.1, 10.0 – 44.8), and much less likely to have allocated time for either household, paid or non-paid work than controls in the previous 24 hours (Table 5). Median amount of time spent working the previous day was zero minutes amongst cases and six hours for controls, meaning that cases had spent 33.5% (95% CI 5.3% – 61.8%) less time on household work, and 88.5% (48.7% – 128.2%) less time on paid/non-paid work than controls in the previous 24 hours.

Table 5: Time Use among cases and controls					
	Cases (n=104) (%)*		Controls (n=103) (%) *		Age-Sex adj OR (95% CI)
<i>Participation</i>					
Personal/self care	100%		100%		-
Medical care	88.5%		27.2%		21.1 (10.0 - 44.8)
Household Work	58.7%		72.8%		0.5 (0.3 - 0.9)
Paid Work or Work for Own Use	17.3%		91.3%		0.02 (0.01 - 0.4)
Leisure out of the home	16.3%		33.0%		0.4 (0.2 - 0.8)
Leisure in the home	98.1%		98.1%		1.0 (0.1 - 7.4)
No specific activity	99.0%		95.2%		5.0 (0.5 - 46.1)
<i>Proportion of time</i>					
	Median (95% CI)	(IQR)	Median (95% CI)	(IQR)	Coefficient (95% CI) ^a
Personal/self-care	10:05	01:40	09:30	01:30	4.5% (0.6 - 9.3)
Medical care	03:00	04:00	0	00:15	90.6% (51.9 - 129.3)
Household Work	00:15	00:30	00:30	02:00	-33.5% (-61.8 - -5.3)
Paid Work or Work for Own Use	0	0	06:00	04:30	-88.5% (-128.2 - -48.7)
Leisure out of the home	02:30	02:45	04:00	00:30	-40.7% (-168.7 - 87.2)
Leisure in the home	04:00	01:30	03:00	02:00	39.6% (26.6 - 52.6)
No specific activity	04:00	02:00	02:00	03:00	52.3% (25.0 - 69.6)
^a Exponentiated regression coefficient, using log transformed time use in minutes, which illustrates the percent difference in time spent on activities the previous day after taking into account age and sex.					

*Time Use data was removed for four cases and one control due to missing values.

Quality of life scores were lower for cases than controls overall and for each category of quality of life (Table 6, Figure 1). The difference between mean scores was greatest in the domains of general (9.4,

p<0.001) and psychological (9.4, p<0.001) health. Multivariate logistic regression was undertaken to explore predictors of low quality of life amongst cases (Web table). Lower general health and lower psychological quality of life were noted amongst cases that were not working.

Table 6: Quality of Life

	Cases (n=108)		Controls (n=104)		Difference between means	P-value ^a
	Mean (95% CI)	SD	Mean (95% CI)	SD		
General QoL	59.6 (56.6 - 62.7)	16.0	66.0 (63.5 - 68.4)	12.4	6.4	<0.001
General Health	66.4 (52.5 - 70.2)	20.3	75.8 (72.9 - 78.7)	14.9	9.4	<0.001
Physical Health	38.1 (36.1 - 40.1)	10.4	44.7 (42.5 - 46.9)	11.3	6.6	<0.001
Psychological Health	55.1 (52.6 - 57.6)	13.0	64.5 (62.6 - 66.5)	10.1	9.4	<0.001
Social Relationships	69.5 (67.0 - 72.1)	13.4	76.9 (75.9 - 78.8)	10.2	7.4	<0.001
Environment	69.7 (66.9 - 72.4)	14.4	78.6 (76.1 - 81.0)	12.5	8.9	<0.001

Student T Test

Table 7: Quality of life MVA (web table)

		General QoL Rating	General Health	Physical Health	Psychological Health
		Average Score (95% CI)			
Age Group	18 - 49	57.6 (53.7 - 61.6)	64.7 (59.7 - 69.7)	37.7 (35.3 - 40.0)	56.0 (52.9 - 59.0)
	50+	63.1 (58.2 - 67.9)	69.2 (62.9 - 75.5)	38.9 (35.1 - 42.6)	53.7 (49.2 - 58.1)
	p for trend	0.3	0.3	0.7	0.5
Work	Yes	61.2 (56.2 - 66.2)	73.3 (67.3 - 79.4)	36.9 (34.3 - 39.5)	59.5 (55.7 - 63.3)
	No	58.9 (55.0 - 62.8)	63.2 (58.4 - 68.1)	40.9 (38.4 - 43.5)	53.1 (50.1 - 56.2)
	p for trend	0.6	<0.05	0.1	<0.05
Proportion of day spent resting (no activity)	Lowest	62.2 (56.8 - 67.6)	66.5 (59.8 - 73.2)	36.9 (34.1 - 39.7)	57.6 (53.9 - 61.2)
	Middle	57.1 (51.3 - 62.9)	68.0 (61.5 - 74.5)	39.3 (35.6 - 43.1)	53.5 (49.9 - 57.1)
	Highest	59.4 (54.3 - 64.6)	64.6 (56.9 - 72.2)	39.3 (35.8 - 42.8)	55.7 (50.9 - 60.5)
	p for trend	0.5	0.8	0.2	0.5
Proportion of day spent in productive activities	Lowest	58.4 (53.6 - 61.2)	67.3 (61.5 - 73.2)	39.1 (36.1 - 42.1)	56.1 (52.5 - 59.8)
	Middle	55.8 (58.7 - 69.5)	62.5 (54.5 - 70.5)	36.8 (32.2 - 41.3)	50.0 (46.4 - 53.6)
	Highest	61.1 (58.7 - 69.5)	67.4 (60.2 - 75.1)	38.8 (35.9 - 41.6)	58.8 (54.8 - 62.9)
	p for trend	1.0	1.0	0.8	0.4
Physical Functioning Score	Lowest	52.7 (43.7 - 61.8)	60.0 (45.3 - 74.7)	36.5 (31.2 - 41.9)	51.9 (41.2 - 62.4)
	Middle	59.2 (54.9 - 63.5)	64.0 (58.1 - 69.9)	38.6 (35.9 - 41.2)	55.5 (52.2 - 58.8)
	Highest	61.7 (56.6 - 66.9)	70.4 (64.7 - 76.1)	38.0 (34.4 - 41.5)	55.3 (51.4 - 59.5)
	p for trend	0.1	0.06	0.8	0.4
PCA ^a Tertile	Lowest	57.4 (52.1 - 62.6)	65.2 (59.3 - 71.1)	37.9 (34.9 - 40.9)	54.3 (49.9 - 58.8)
	Middle	60.6 (55.1 - 66.2)	67.7 (61.0 - 74.5)	39.1 (36.5 - 41.8)	57.4 (53.7 - 61.0)
	Highest	62.0 (56.7 - 67.3)	66.7 (58.0 - 75.3)	37.4 (32.4 - 42.5)	54.0 (49.5 - 58.5)

	p for trend	0.19	0.7	0.5	0.7
PCE ^b Quartile	Q1 (Lowest)	49.6 (42.3 - 56.9)	65.2 (56.5 - 74.0)	36.0 (31.8 - 40.3)	48.7 (44.4 - 52.9)
	Q2	64.6 (58.4 - 70.8)	68.5 (60.8 - 76.1)	35.0 (31.0 - 39.0)	55.2 (49.3 - 61.1)
	Q3	61.9 (56.5 - 67.4)	60.0 (52.7 - 67.3)	39.0 (35.7 - 42.1)	55.6 (50.7 - 60.6)
	Q4 (Highest)	60.7 (55.2 - 66.3)	72.6 (64.3 - 80.8)	42.1 (37.3 - 46.8)	59.8 (55.6 - 64.0)
	p for trend	<0.05	0.5	<0.05	<0.01
PCI ^c Quartile	Q1 (Lowest)	57.1 (52.1 - 62.2)	61.9 (55.8 - 68.0)	37.7 (35.3 - 40.2)	53.4 (49.9 - 56.8)
	Q2	60.8 (54.1 - 67.4)	66.2 (58.3 - 74.0)	36.0 (30.9 - 41.1)	54.7 (47.7 - 61.7)
	Q3	56.5 (49.9 - 63.0)	64.7 (52.9 - 76.5)	37.8 (33.4 - 42.2)	57.1 (51.4 - 62.7)
	Q4 (Highest)	65.5 (58.1 - 72.8)	76.4 (68.3 - 84.4)	41.6 (36.2 - 47.1)	57.4 (52.4 - 62.5)
	p for trend	0.14	<0.05	0.3	0.09
Income Gap	Yes	60.0 (56.34 - 63.7)	68.9 (62.3 - 75.4)	38.6 (36.5 - 40.7)	54.0 (49.0 - 58.9)
	No	58.9 (2.9 - 64.7)	65.1 (60.2 - 70.0)	37.2 (32.8 - 41.5)	55.7 (52.9 - 58.5)
	(χ^2)	0.3	0.7	0.3	0.6
Model P value	<0.001	0.14	0.2	<0.01	
Model R ²	29.8%	21.6%	19.5%	30.0%	

^aPrincipal Component Analysis; ^bPer Capita Expenditure; ^cPer Capita Income

Discussion

4.1 Summary of Key Findings

Almost all (89%) cases enrolled in this study were male, and the vast majority had acquired MSI in adulthood. 69% were not working at the time of enrolment (compared with 6% of controls), and 93% were amputees requiring below or above knee prosthetics and substantial physical.

Three quarters of both cases and controls lived below the international LMIC poverty line of \$3.20 per person per day. However, cases' expenditure on health was significantly higher than controls', and associated with catastrophic health expenditure and an income gap for one fifth and two thirds of cases respectively.

Cases were far less likely to have participated in work (either housework or paid/non-paid work) than controls the previous day, and the median proportion of time spent in productive activities was lower. Cases instead spent significantly more time engaged in medical care compared with controls (3 hours versus zero hours) and in resting with no specific activity (4 hours versus 2 hours).

Quality of life scores were lower for cases than controls in each domain, and particularly in terms of general and psychological health.

4.2 Socio-demographics and physical functioning

Most cases reported traumatic and non-traumatic acquisition of MSI in adulthood, suggesting that these were preventable both in terms of the prevention of trauma, and of acquired health conditions resulting in secondary amputation. These findings reinforce calls for the growing burden and exclusion related to MSI in LMICs to be addressed(38). The limited number of female cases compared to males may be a reflection of the fact that statistically, men are at higher risk of limb loss than women, particularly in cases of traumatic injury(39). Men may also exhibit higher rates of risk-taking behaviour associated with cardio-vascular conditions. For example, smoking is six times more prevalent among men than women in Myanmar.(40) However there may also be gender disparities in health-seeking behaviour and capacity to access appropriate services that contributed to this imbalance. Unsurprisingly, persons with MSI in the study had much lower physical functioning compared to controls – highlighting the physical impact of MSI on an individual's functionality.

4.3 Socio-economic status

A recent systematic literature review reported evidence of a positive association between disability and economic poverty in 81% of the 122 included studies (41). The review also established that the proportion of studies reporting a positive association was higher amongst middle income countries compared to lower income countries. This suggests that high levels of absolute poverty experienced across the population, as in Myanmar where three quarters of participants lived below the international LMIC poverty line, may mask disparities in relation to impairment.

However, despite similar per capita income and expenditure amongst people with and without MSI, people with MSI were far more likely to experience catastrophic health expenditure and an income gap than people without in the study. This finding reflects the prevailing literature on the “extra costs” of disability that are borne directly by households, often in direct relation to healthcare, and which exacerbate multi-dimensional poverty (42, 43).

Compounding the additional health expenditures related to impairment, the findings additionally highlight the substantial exclusion from income-generation experienced by people with physical impairments in Myanmar. Only 17% of cases reported that they had participated in paid work, or unpaid work otherwise for their own use, in the previous twenty four hours, compared with 91.3% of controls. The limited, but expanding, evidence base suggests that barriers to livelihoods are common amongst people with

disabilities in LMICs, and in particular for persons with physical impairments (44, 45). Evidence is needed on effective support and interventions to overcome these barriers, which may include policy change, social protection, health insurance and access to rehabilitation services and appropriate assistive devices(10).

4.4 Time Use and Quality of Life

The implications on wellbeing of the more vulnerable socio-economic situation of persons with physical impairments in the study and their households, compared to matched controls, are further highlighted by time use and quality of life metrics. Whilst the study is cross-sectional in nature, precluding comment on causality, poverty and vulnerability have previously been shown to be associated with poorer quality of life, and poorer mental health in a number of other studies (46, 47). Moreover, a recent review of psychosocial adjustment to lower-limb amputation emphasised the associations between limb loss, low mood and anxiety, particularly in the initial post-amputation phase (<2 years) (48). This may represent an adjustment reaction to limb loss and sudden disability, which subsequently improves(49). However there can be long lasting problems relating to amputation, including residual limb issues, phantom pain and pressure sores,(50) which may increase the likelihood and persistence of depression and anxiety(51).

4.6 Study Strengths and Limitations

This data is cross-sectional and therefore we are unable to ascribe causality to the associations between MSI, SES and quality of life identified. This study may potentially have been under-powered for certain stratified analyses. In addition, limited recent literature on the correlates of MSI exist with which to compare and contrast these findings. However, this is the first study to our knowledge to explore the impact of MSI in people's lives in Myanmar in a comprehensive and systematic way, and as such provides important preliminary evidence in this area.

Conclusion

This study highlights the negative link between MSI, socio-economic status, time-use and quality of life in post-conflict Myanmar. The interconnectedness of physical functionality, access to livelihoods, socio-economic vulnerability, time use and quality of life are apparent in the study findings, and highlight the need for more comprehensive and appropriate support to persons with physical impairments in Myanmar. In particular, the study highlights the need for further evidence generation of the impact of physical rehabilitation and other services to support inclusion of persons with physical impairments in the country.

List Of Abbreviations

AE	Above Elbow [Prosthetic]	NRH	National Rehabilitation Hospital
AFO	Ankle Foot Orthosis	OR	Odds Ratio
AK	Above Knee [Prosthetic]	PCA	Principal Component Analysis
BK	Below Knee [Prosthetic]	PCE	Personal Consumption Expenditure
CI	Confidence Interval	PCY	Per Capita Income
GPS	Global Positioning System	PPT	Physical Performance Test
HORC	Hpa-An Rehabilitation Centre	RAM	Rapid Assessment of MSI
IQR	Inter-Quartile Range	SD	Standard Deviation
KAFO	Knee Ankle Foot Orthosis	SES	Socio-economic status
KD	Knee Disarticulation	TMWT	Two Minute Walk Test
LMIC	Low or Middle Income Country	US	United States
MSI	Musculoskeletal Impairment	WHO	World Health Organisation
MVA	Multi-Variable Analysis	WHOQOL-BREF	WHO Quality of Life Brief Tool

Declarations

Ethics Approval and Consent to Participate

Ethical approval for the study was granted by the Research Ethics Committee (Ref 9292) at the London School of Hygiene & Tropical Medicine and the Myanmar Ministry of Health Ethical Review Board (Ref 1/2015). Participants were read an information sheet in the local language explaining the study purpose and design, confidentiality, risks and benefits and freedom to refuse. All participants provided witnesses, dated signature or fingerprint consent.

Consent for Publication

NA – no individual or identifiable person details are included in this manuscript

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

IM: Project coordination, training of data collectors, data cleaning and analysis, manuscript preparation and drafting

NSM: In-country project leadership, design of work, manuscript review

CTK: In-country project coordination, acquisition and analysis, manuscript review

HK: Expert input into study design, manuscript drafting and review

KB: Conception of work, design of work, manuscript review

All listed authors have read and approved this manuscript

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References

1. World Health Organization. World Report on Disability Geneva: World Health Organization; 2011.
2. Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2013;380(9859):2197-223.
3. Vos T, Allen C, Arora M, Barber RM, Bhutta ZA, Brown A, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*. 2016;388(10053):1545-602.
4. Atijosan O, Rischewski D, Simms V, Kuper H, Linganwa B, Nuhi A, et al. A National Survey of Musculoskeletal Impairment in Rwanda: Prevalence, Causes and Service Implications. *PLoS ONE*. 2008;3(7):e2851.
5. Mactaggart I, Kuper H, Murthy G, Oye J, Polack S. Measuring Disability in Population Based Surveys: The Interrelationship between Clinical Impairments and Reported Functional Limitations in Cameroon and India. *PLoS One*. 2016;11(10):e0164470.
6. Mitra S, Posarac A, Vick B. Disability and Poverty in Developing Countries: A Multidimensional Study. *World Development*. 2013;41(0):1-18.

7. Russell S. The economic burden of illness for households in developing countries: a review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. *The American journal of tropical medicine and hygiene*. 2004;71(2 suppl):147-55.
8. McIntyre D, Thiede M, Dahlgren G, Whitehead M. What are the economic consequences for households of illness and of paying for health care in low-and middle-income country contexts? *Social science & medicine*. 2006;62(4):858-65.
9. Mactaggart I, Kuper H, Murthy G, Sagar J, Oye J, Polack S. Assessing health and rehabilitation needs of people with disabilities in Cameroon and India. *Disability and rehabilitation*. 2015:1-8.
10. Mizunoya S, Mitra S. Is there a disability gap in employment rates in developing countries? *World Development*. 2013;42:28-43.
11. Trani JF, Loeb M. Poverty and disability: a vicious circle? Evidence from Afghanistan and Zambia. *Journal of International Development*. 2012;24(S1):S19-S52.
12. Banks LM, Keogh M. Inclusion counts: The economic case for disability-inclusive development. Bensheim, Germany: CBM; 2016.
13. Marmot M. Social determinants of health inequalities. *The Lancet*. 2005;365(9464):1099-104.
14. Beaglehole R, Bonita R, Alleyne G, Horton R, Li L, Lincoln P, et al. UN high-level meeting on non-communicable diseases: addressing four questions. *The Lancet*. 2011;378(9789):449-55.
15. Bhutta ZA, Sommerfeld J, Lassi ZS, Salam RA, Das JK. Global burden, distribution, and interventions for infectious diseases of poverty. *Infectious diseases of poverty*. 2014;3(1):21.
16. Rischewski D, Kuper H, Atijosan O, Simms V, Jofret-Bonet M, Foster A, et al. Poverty and musculoskeletal impairment in Rwanda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 2008;102(6):608-17.
17. Huang RL. Re-thinking Myanmar's political regime: military rule in Myanmar and implications for current reforms. *Contemporary Politics*. 2013;19(3):247-61.
18. Richard AJ, Lee CI, Richard MG, Shwe Oo E, Lee T, Stock L. Essential trauma management training: addressing service delivery needs in active conflict zones in eastern Myanmar. *Human resources for health*. 2009;7(1):19.
19. Institute for Health Metrics and Evaluation. Global Burden of Diseases Myanmar Country Profile 2015 [cited 2017 17.08.2017]. Available from: <http://www.healthdata.org/results/country-profiles>.
20. dos Santos-Zingale M, Ann McColl M. Disability and participation in post-conflict situations: the case of Sierra Leone. *Disability & society*. 2006;21(3):243-57.
21. Cohen J. *Statistical power analysis for the behavioral sciences*: Academic press; 2013.
22. Norman G, Monteiro S, Salama S. Sample size calculations: should the emperor's clothes be off the peg or made to measure? *BMJ*. 2012;345:e5278.
23. Atijosan O, Kuper H, Rischewski D, Simms V, Lavy C. Musculoskeletal impairment survey in Rwanda: design of survey tool, survey methodology, and results of the pilot study (a cross sectional survey).

- BMC musculoskeletal disorders. 2007;8(1):30.
24. Smythe T, Mactaggart I, Kuper H, Oye J, Lavy C, Polack S. Prevalence and causes of musculoskeletal impairment in Fundong District, North West Cameroon: Results of a population based survey Unpublished manuscript. 2017.
 25. Smythe T, Mactaggart I, O. A, Kuper H, Murthy GV, Lavy C, et al. Prevalence and causes of musculoskeletal impairment in Mabhugnagar District, Telangana State, India: Results of a population based survey Unpublished manuscript. 2017.
 26. Reuben DB, Siu AL. An objective measure of physical function of elderly outpatients. *J Am Geriatr Soc.* 1990;38(10):1105-12.
 27. Fulk GD, Echternach JL. Test-retest reliability and minimal detectable change of gait speed in individuals undergoing rehabilitation after stroke. *Journal of Neurologic Physical Therapy.* 2008;32(1):8-13.
 28. Jackson AB, Carnel CT, Ditunno JF, Read MS, Boninger ML, Schmeler MR, et al. Outcome measures for gait and ambulation in the spinal cord injury population. *The journal of spinal cord medicine.* 2008;31(5):487.
 29. Rau B, Bonvin F, De Bie R. Short-term effect of physiotherapy rehabilitation on functional performance of lower limb amputees. *Prosthetics and orthotics international.* 2007;31(3):258-70.
 30. Grosh M, Glewwe P. *Designing Household Survey Questionnaires for Developing Countries: Lessons from 15 Years of the Living Standards Measurement Study, Volume 1.* World Bank Publications. 2000.
 31. Polack S, Kuper H, Eusebio C, Mathenge W, Wadud Z, Foster A. The impact of cataract on time-use: results from a population based case-control study in Kenya, the Philippines and Bangladesh. *Ophthalmic epidemiology.* 2008;15(6):372-82.
 32. Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. *Quality of life Research.* 2004;13(2):299-310.
 33. Grosh M, Glewwe P. *Designing Household Survey Questionnaires for Developing Countries: Lessons from 15 Years of the Living Standards Measurement Study, Volume 3:* Washington, DC: World Bank; 2000.
 34. Kuper H, Polack S, Mathenge W, Eusebio C, Wadud Z, Rashid M, et al. Does cataract surgery alleviate poverty? Evidence from a multi-centre intervention study conducted in Kenya, the Philippines and Bangladesh. *PLoS One.* 2010;5(11):e15431.
 35. StataCorp Stata. Release, 14.0. 2015.
 36. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data—Or tears: An application to educational enrollments in states of India*. *Demography.* 2001;38(1):115-32.
 37. Wagstaff A, Doorslaer Ev. Catastrophe and impoverishment in paying for health care: with applications to Vietnam 1993–1998. *Health economics.* 2003;12(11):921-33.

38. Hoy D, Geere J-A, Davatchi F, Meggitt B, Barrero LH. A time for action: opportunities for preventing the growing burden and disability from musculoskeletal conditions in low-and middle-income countries. *Best Practice & Research Clinical Rheumatology*. 2014;28(3):377-93.
39. MacKenzie EJ. Limb amputation and limb deficiency: epidemiology and recent trends in the United States. *Southern Medical Journal*. 2002;August(1).
40. Policies APOoHSa. The Republic of the Union of Myanmar: Health System Review. *Health Systems in Transition* 2014;4(3).
41. Banks LM, Kuper H, Polack S. Poverty and disability in low-and middle-income countries: A systematic review. *PloS one*. 2017;12(12):e0189996.
42. Palmer M, Nguyen T, Neeman T, Berry H, Hull T, Harley D. Health care utilization, cost burden and coping strategies by disability status: an analysis of the Viet Nam National Health Survey. *The International journal of health planning and management*. 2011;26(3).
43. Saunders P. The costs of disability and the incidence of poverty. *Australian Journal of Social Issues*. 2007;42(4):461-80.
44. Mactaggart I, Banks LM, Kuper H, Murthy G, Sagar J, Oye J, et al. Livelihood opportunities amongst adults with and without disabilities in Cameroon and India: A case control study. *PloS one*. 2018;13(4):e0194105.
45. Trani J-F, Loeb M. Poverty and disability: A vicious circle? Evidence from Afghanistan and Zambia. *Journal of International Development*. 2012;24:S19-S52.
46. Lund C. Poverty and mental health: Towards a research agenda for low and middle-income countries. *Commentary on. Social Science & Medicine*. 2014;111:134-6.
47. Park J, Turnbull AP, Turnbull III HR. Impacts of poverty on quality of life in families of children with disabilities. *Exceptional children*. 2002;68(2):151-70.
48. Horgan O MM. Psychosocial adjustment to lower-limb amputation: A review. *Disability and Rehabilitation*. 2004;26(14-15):837-50.
49. Singh R HJaPA. The rapid resolution of depression and anxiety symptoms after lower limb amputation. *Clinical Rehabilitation* 2007;21(8).
50. Pezzin LE DTaME. Rehabilitation and the long-term outcomes of persons with trauma-related amputations. *Archives of Physical Medicine and Rehabilitation* 2000;81(3):292-300.
51. Bhuvanewar CG ELaST. Reactions to Amputation: Recognition and Treatment Primary Care Companion *J Clin Psychiatry*. 2007;9(4):303-8.

Figures

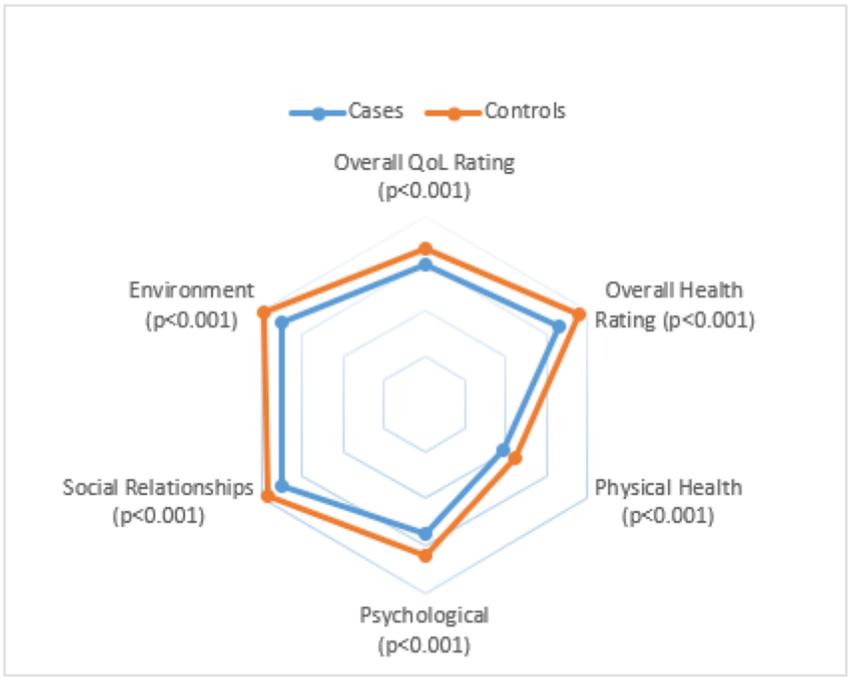


Figure 1

Baseline Quality of Life