

Long-term (14-year) survival after discharge among people with spinal cord injury in Bangladesh

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Additional Declarations: There is no duality of interest

Abstract

Study design

Mixed retrospective and prospective cohort study.

Objectives

To quantify long-term survival after discharge among people with spinal cord injury (SCI) in Bangladesh.

Setting

Hospital, Bangladesh.

Methods

Medical records were used to identify people who were admitted to the Centre for the Rehabilitation of the Paralysed in Bangladesh in 2011 with a recent SCI and were wheelchair dependent on discharge. Participants or their family members were contacted 14 years later to determine vital status or date of death.

Results

222 people met the inclusion criteria. All (100%) were accounted for 14 years after discharge. The median follow-up time in those alive at the 14-year follow up was 14.2 years (IQR, 14.0 to 14.4 years). Of the initial cohort, 117 (53%) had died. Median survival time was 13.3 years. The mortality rate, averaged over the follow-up period, was 0.056 deaths/person-year. The standardised mortality ratio (SMR) amongst the males of the cohort aged 15–80 in 2011 was 13.8 in the first year of follow-up and declined progressively to 4.8 in the 15th year of follow-up. The most common cause of death was pressure injuries (57%).

Conclusion

This study provides robust estimates of long-term survival following SCI in a low-income country among those who survived to discharge. In this cohort of people who were wheelchair dependent at discharge, survival was poor.

INTRODUCTION

Long-term survival after spinal cord injury (SCI) in low- and middle-income countries (LMICs) is widely considered to be poor [1–4]. However, much of what is assumed about survival in these settings is inferred from limited or methodologically constrained data. Consequently, survival rates - particularly those beyond the early years after injury - should be considered uncertain.

The reporting of survival data from studies conducted in both high- and low-income countries is often suboptimal. The most comprehensive review identified 78 studies but found that only 16% provided adequate statistical detail [2]. Estimates of 10-year survival range from 81 to 93% [2] although these estimates are largely driven by data from high-income settings. Data from LMICs are sparse and inconsistent, but some evidence suggests survival rates may be lower in LMICs than in high-income countries. For example, a retrospective study of 422 patients with traumatic SCI admitted to two hospitals in Nigeria reported a six-month survival of just 66% from the time of admission [5, 6]. In contrast, studies from Southern India (n = 490) and Brazil (n = 343) reported more favourable five-year survival rates of approximately 86% [7] and 83% [4], respectively. However, these estimates are difficult to interpret because both studies were based on selected samples of individuals who could be followed up, with no accounting for those lost to follow-up. As a result, they are exposed to a risk of selection bias. As with other studies from LMICs, including a recent Brazilian study in which the survival status of 30% of the cohort was unknown [4], such methodological limitations make it difficult to determine the true magnitude of long-term mortality after SCI. Taken together, the limited evidence from LMICs suggests that survival rates may be poor, but the true magnitude of long-term survival remains uncertain.

We had the opportunity to obtain accurate long-term survival data from a cohort of people with SCI admitted in 2011 to the Centre for the Rehabilitation of the Paralysed (CRP), a specialised rehabilitation hospital in Bangladesh. CRP provides specialised care including rehabilitation for people with SCI. It admits approximately 390 individuals with recent SCI each year, most within a few days of injury, as well as a few from other hospitals up to six months after injury. CRP tends to admit a younger cohort than similar hospitals in high income countries, reflecting differences in the causes of SCI between low- and high-income settings. In low-income countries, SCI are frequently caused by falls from trees, falls while carrying heavy loads, and motor vehicle accidents, so they commonly affect younger adults. In high income countries, SCIs are frequently caused by low-level falls, so they more commonly occur in older people. These differences in aetiology and age at injury are important to consider when comparing survival rates across countries.

In 2014, we retrospectively identified all individuals (n = 371) admitted in 2011 to CRP with SCI. We are confident this represents a complete cohort due to the detailed analysis of medical records and extensive cross-checking undertaken at the time. Of the 371 people admitted, 21 died prior to discharge and 350 were discharged alive. These people were followed up approximately two years and five years after discharge. Follow-up was exceptionally high: 97% of the cohort was accounted for at two years and 99% was accounted for at five years. Those data were reported in 2016 and 2019 [8, 9]. Two-year survival was 87% (95% CI 83–90%) for the whole cohort, 98% (95% CI 94–100%) for those who were ambulant at discharge, and 81% (95% CI 76 to 86%) for those who were wheelchair dependent at discharge [8]. At five years, the corresponding figures were 78% (95% CI 74 to 82%), 96% (95% CI 90 to 98%), and 69% (95% CI 62 to 75%) [9].

This well-characterised cohort provides a unique opportunity to examine longer-term outcomes with minimal loss to follow-up. In the present study, we extend follow-up to a median of 14 years. For the

long-term follow-up we focussed on those who were wheelchair dependent at discharge (n = 222) as this group is at greatest risk of poor outcomes. Wheelchair status at discharge was used as a pragmatic surrogate for injury severity because it was consistently recorded in the medical records, was subsequently confirmed at the 2 year and 5 year follow-ups, and was considered more reliable than AIS classification in this context. The aim of this long-term follow-up study was to quantify survival rates and, where possible, document causes of death.

METHODS

The study was a mixed retrospective and prospective longitudinal cohort study [8]. Ethical approval was received from the Centre for Rehabilitation of the Paralysed Ethics Committee (approval number CRP-ERC-R&E-0401-0480) prior to the commencement of the study. Informed consent was received from participants or, if the participant had died, from next of kin. The study was conducted in accordance with the Declaration of Helsinki Ethical Principles for Medical Research Involving Human Participants.

The cohort has previously been described [8]. In brief, the cohort included all patients admitted with SCI to CRP in 2011 who survived until discharge and who were wheelchair dependent at that time. People who could walk at discharge, or who had sustained their injuries more than one year prior to admission, were excluded. The cohort was initially identified in 2014 from three sources that were cross-checked. The first source was hospital admission records, the second was the social welfare department's records, and the third was the detailed day-to-day medical files of admitted patients. Ability to walk at discharge was sourced in 3 ways also: initially from the medical records, then by asking all patients (both walkers and non-walkers) 2 years and 5 years after discharge. At these times they were asked (in Bangla): *"On discharge, did you require a wheelchair for mobility on a daily basis?"*

All participants who met the inclusion criteria and were known to be alive at the 5-year follow-up (n = 222) were then telephoned between Dec 2025 and May 2026 (approximately 14 years after discharge). If a participant could not be contacted by telephone, immediate family members were telephoned to either obtain the contact information of the participant or to verify that the participant had died and to ascertain the date of death (the date of death for one participant was retrieved from CRP medical records as it was not known by the family). Family members were asked the cause of death (if known) and a series of questions to ascertain whether the participant had a serious pressure injury at the time of death, whether the participant died suddenly and unexpectedly, and whether the participants had other symptoms related to common causes of death in this population. These data were used to identify the most likely cause of death. Four members of the cohort whose vital status was unknown could not be contacted by telephone. Research staff visited the last known place of residence of these people and attempted to identify someone in the community who knew how the person could be contacted. These efforts were successful and all four participants were subsequently contacted by telephone or visited in person.

Data analysis

Cumulative probabilities of survival and death were calculated using the Kaplan-Meier method, first for the cohort as whole and then for subgroups stratified by sex and age (< 35 years, 35 to 50 years, > 50 years).

Mortality rates were compared to those in the Bangladeshi population. This analysis was restricted to males aged 15–80 years in 2011. The age distributions of the male population in the years 2011–2025 were obtained from the Bangladesh Subnational Population and Housing Data Tables with Administrative Boundaries, Based on National Censuses and Surveys, downloaded from the Humanitarian Data Exchange (HDX; <https://data.humdata.org/>). Age-specific survival probabilities in the years 2011–2025 were obtained from The Human Life-Table Database (HLD), downloaded from <https://www.lifetable.de/Home/Index>. Survival probability data were not available for 2012 or 2023–2025, so the 2011 data were used in 2012, and 2022 data were used for the years 2023–2025. Survival probability data were not available for 80–85 year olds or 85–90 year olds in 2011 and 2015–2020, as data for those aged 80 + were combined in those years. Consequently, these survival probabilities were imputed from the most adjacent year. The population age structures and survival probabilities were used to construct life tables from 2011–2025 for males aged 15–80 years in Bangladesh in 2011. The population age structure in 2011 was used to calculate inverse probability weights for males aged 15–80 years in our cohort. Those weights were applied to estimation of life tables for the cohort. The standardised mortality ratio in each year of follow-up was calculated as the ratio of the cumulative risks of death in the inverse probability weighted cohort and the Bangladeshi population.

RESULTS

Survival

Of the initial cohort of 368 people admitted to CRP with recent SCI in 2011, 345 survived until discharge and 222 were wheelchair dependent at discharge. Our previous report of the same cohort indicated that 350 survived to discharge and 223 were wheelchair dependent [8]. The discrepancy of five people who survived to discharge is because two people who we had been unable to find in our previous publication were found to have died prior to discharge, and three people who were previously included were found to have not met the inclusion criteria (their injuries occurred more than one year prior to admission to CRP). The discrepancy of one person who was wheelchair dependent on discharge is because one person had been wrongly categorised as wheelchair dependent at the 2-year and 5-year follow-up.

The baseline characteristics of the cohort are shown in Table 1. All 222 participants were accounted for at the 14-year follow-up and contributed survival data until they died or were followed up. Median follow-up time in those alive at the 14-year follow up was 14.2 years (IQR, 14.0 to 14.4 years) and total person-time of follow-up was 2070.8 years.

Table 1
Characteristics of participants included in the study.

Count, n (%)	All participants	Dead at 14 years	Alive at 14 years
	222	117 (53%)	105 (47%)
Gender, n (%)			
Female	21 (9.5%)	11 (9.4%)	10 (9.5%)
Male	201 (90.5%)	106 (90.6%)	95 (90.5%)
Diagnosis, n (%)			
Tetraplegia	84 (37.8%)	57 (48.7%)	27 (25.7%)
Paraplegia	138 (62.2%)	60 (51.3%)	78 (74.3%)
Cause of SCI			
Traumatic	214 (96.4%)	111 (94.9%)	103 (98.1%)
Non-traumatic	8 (3.6%)	6 (5.1%)	2 (1.9%)
Age (years), median (IQR) ¹	33 (23 to 44)	40 (30 to 50)	25 (20 to 35)
Time from injury to admission (days) median (IQR)	13.0 (4.0 to 44.0)	11.0 (4.0 to 40.0)	16.0 (6.0 to 48.0)
Length of hospital stay (months), median (IQR)	3.6 (2.7 to 5.2)	3.5 (2.5 to 5.1)	3.7 (2.9 to 5.2)
Cause of death, n			
pressure injury	-	67 (57%)	-
respiratory complications	-	18 (15%)	-
renal	-	8 (7%)	-
stroke	-	8 (7%)	-
cardiac	-	1 (1%)	-
autonomic dysreflexia	-	1 (1%)	-
miscellaneous or unknown	-	14 (12%)	-
¹ Age on admission to CRP collected from medical records.. Some participants' ages would have been an estimation because it is not uncommon for people not to know their year of birth.			

At the 14-year follow-up, 117 (53%) of the 222 participants had died. The Kaplan–Meier estimate of survival from the time of discharge was 87% (95% CI 82 to 91%) at 1 year, 69% (95% CI 62 to 75%) at 5

years, 57% (95 CI 50 to 63%) at 10 years, and 47% at 14 years (95% CI 40 to 54%) (Fig. 1). The mortality rate was 0.056 deaths per person-year (95% CI 0.05 to 0.07). Mortality rates were higher in the first year (0.144 deaths/person-year, 95% CI 0.100 to 0.207) than in subsequent years (0.059, 95% CI 0.043 to 0.080 in years 2–5; 0.039, 95% CI 0.027 to 0.057 in years 6–10; and 0.042, 95% CI 0.028 to 0.065 in years 11–14). Mortality rates were highest among those aged over 50 years and lowest among those aged < 35 years in 2011 (see Fig. 2A). There was not a clear difference in the mortality rates of females and males (see Fig. 2B).

The standardised mortality ratio (SMR) for males aged 15 to 80 years in 2011 is given for each year of follow-up in Table 2 and is shown graphically in Fig. 3. The SMR declined approximately exponentially from 13.8 in the first year of follow-up to 4.8 in the 15th year of follow-up. The most common causes of death were pressure injuries (57%), respiratory complications (15%), renal complications (7%), and stroke (7%) (Table 1).

Table 2
The standardised mortality ratio (SMR) for males aged 15–80 in 2011.

Follow-up year	SMR
1	13.3
2	11.1
3	9.2
4	7.9
5	7.4
6	7.1
7	6.7
8	6.4
9	6.0
10	5.6
11	5.3
12	5.0
13	5.0
14	5.1
15	4.8

DISCUSSION

This study provides robust estimates of long-term survival rates following spinal cord injury (SCI) in a low-income country. In contrast to previous studies, which have been limited by incomplete follow-up and methodological inconsistencies [2, 4, 5, 7], this study had complete follow-up of a well-defined inception cohort and thereby provides more reliable estimates of survival. The data indicate that the long-term mortality rate is high: approximately one in two individuals who are wheelchair dependent at discharge die within 14 years. The long-term mortality rates were highest in those aged over 50 years in 2011. Although mortality rates appeared similar for females and males, only 9.5% of the cohort were female, limiting our ability to draw firm conclusions about sex-related differences in mortality.

The males aged 15 to 80 years in our cohort had much higher mortality rates than the age- and sex-matched part of the whole Bangladeshi population. This was most evident soon after discharge from hospital, but mortality rates were still very high 15 years after discharge. Taken together, these results suggest that survival rates following SCI in Bangladesh are poor, even within the relatively advantaged subgroup admitted to CRP. Our results also suggest that, while preventive strategies aimed at reducing mortality are likely to be most beneficial in the years immediately after discharge, preventive strategies may remain beneficial many years later.

The estimates reported here, however, need to be interpreted in light of important selection factors that influence both the composition of the cohort and the observed survival. First, the cohort was restricted to individuals who were wheelchair dependent at discharge. Inclusion of individuals who regained ambulation would almost certainly have resulted in higher survival estimates. Second, the cohort included only those admitted to CRP, thereby excluding individuals who never accessed specialised rehabilitation services. Third, the analysis excluded individuals who died prior to discharge. Although 23 deaths during admission were recorded, it was not possible to classify these individuals by ambulatory status at discharge and therefore they could not be included in this cohort. For these reasons, survival was estimated from the point of discharge. Collectively, these factors mean that the cohort represents a selected group of individuals who accessed specialist care and survived the acute phase of injury. While some of these features may inflate survival estimates, others - such as restriction to those who were wheelchair dependent - may have the opposite effect. These competing influences need to be considered when comparing the findings with those from other studies.

Comparisons with other studies are inherently challenging because of differences in study design, case mix, and follow-up. In addition, most studies from low and middle income countries examine mortality rates during hospital stay because these data are generally readily accessible from medical records [10, 11]. Nonetheless, recent reviews report one- and five-year survival rates following SCI ranging from 79% to 100% across a range of countries [2, 12]. A study of a representative hospital-based cohort in Israel reported a 15-year survival rate of 77% [13], while a similar study from Australia reported a 10-year survival rate of 86% [14].

The most common cause of death was sepsis arising from pressure injuries, accounting for over half of all deaths. This finding highlights a substantial and well recognised contributor to mortality following SCI [3, 4, 17, 18]. While pressure injuries are a known complication, there are limited data quantifying their contribution to death, particularly in low- and middle-income countries [1, 19, 20]. The prominence of this cause of death suggests that long-term survival is influenced not only by injury characteristics but also by the adequacy of ongoing care and support. Individuals treated at CRP receive education, equipment, and follow-up services that are not widely available elsewhere in Bangladesh, and it is likely that the burden of pressure injury-related mortality is even greater among those without access to such services. These findings indicate that a substantial proportion of deaths may be related to potentially preventable complications and point to gaps in long-term management and community-based care, or limited finances, family support and social networks.

We have previously attempted to address this issue in a randomised trial evaluating a programme of ongoing support for the first two years following injury [21]. However, that study found no evidence that enhanced post-discharge care improved survival or reduced complications. Taken together, the findings from both studies suggest that the causes of death following SCI in this setting are complex and unlikely to be addressed by relatively simple post-discharge care alone.

A full understanding of survival following SCI in low- and middle-income countries will ultimately require population-based data. However, obtaining such data is challenging in settings like Bangladesh where there are no comprehensive medical record systems or national registries. Many individuals with SCI, particularly those with more severe injuries who are at highest risk of early death, never present to hospital or reach specialised rehabilitation services. As a result, existing studies, including this one, likely underestimate the true risk of premature death. Future research will need to explore alternative approaches to capturing outcomes, including community-based surveillance and improved data systems, to better characterise the full trajectory of survival following SCI.

This study has limitations. The accuracy of recorded dates of death relied on reports from family members, which may have introduced bias in survival estimates. In addition, the selection factors described above limit the generalisability of the findings to the broader population of people with SCI in Bangladesh. Nonetheless, the study is strengthened by its near-complete follow-up and clearly defined cohort, which provide a level of robustness that is rarely achieved in similar contexts.

In summary, long-term mortality following SCI in Bangladesh is high amongst those who are wheelchair dependent, even among individuals who survive to discharge from specialist rehabilitation. The prominence of pressure injury-related deaths highlights the importance of long-term care and support, and suggests that a substantial proportion of mortality may be preventable. These findings underscore the need for improved systems of care to reduce the burden of SCI, alongside better data to guide policy and service development in low-resource settings.

Declarations

DATA AVAILABILITY STATEMENT

The authors will consider all reasonable requests for data sharing.

ACKNOWLEDGMENTS

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ETHICAL APPROVAL

Ethical permission was received from the Centre for Rehabilitation of the Paralysed Ethics Committee prior to the commencement of the study in 2013 (approval number CRP-R&E-0401-218), and then again for the 14-year follow-up (approval number CRP-ERC-R&E-0401-0480). We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers/animals were followed during the course of this research.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION STATEMENT

RMA conceived the research question, designed the study, collected the data, interpreted the data and contributed to the write-up of the manuscript.

MSH conceived the research question, designed the study, interpreted the data and contributed to the write-up of the manuscript.

LAH conceived the research question, designed the study, analysed the data (except the SMRs), interpreted the data and wrote the first draft of the manuscript.

MFA and ST collected the data, interpreted the data and contributed to the write-up of the manuscript.

RDH conceived the research question, designed the study, calculated the standardised mortality ratios, independently repeated and confirmed all statistical analyses, interpreted the data and contributed to the write-up of the manuscript.

SJ contributed to the write-up of the manuscript.

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Figures

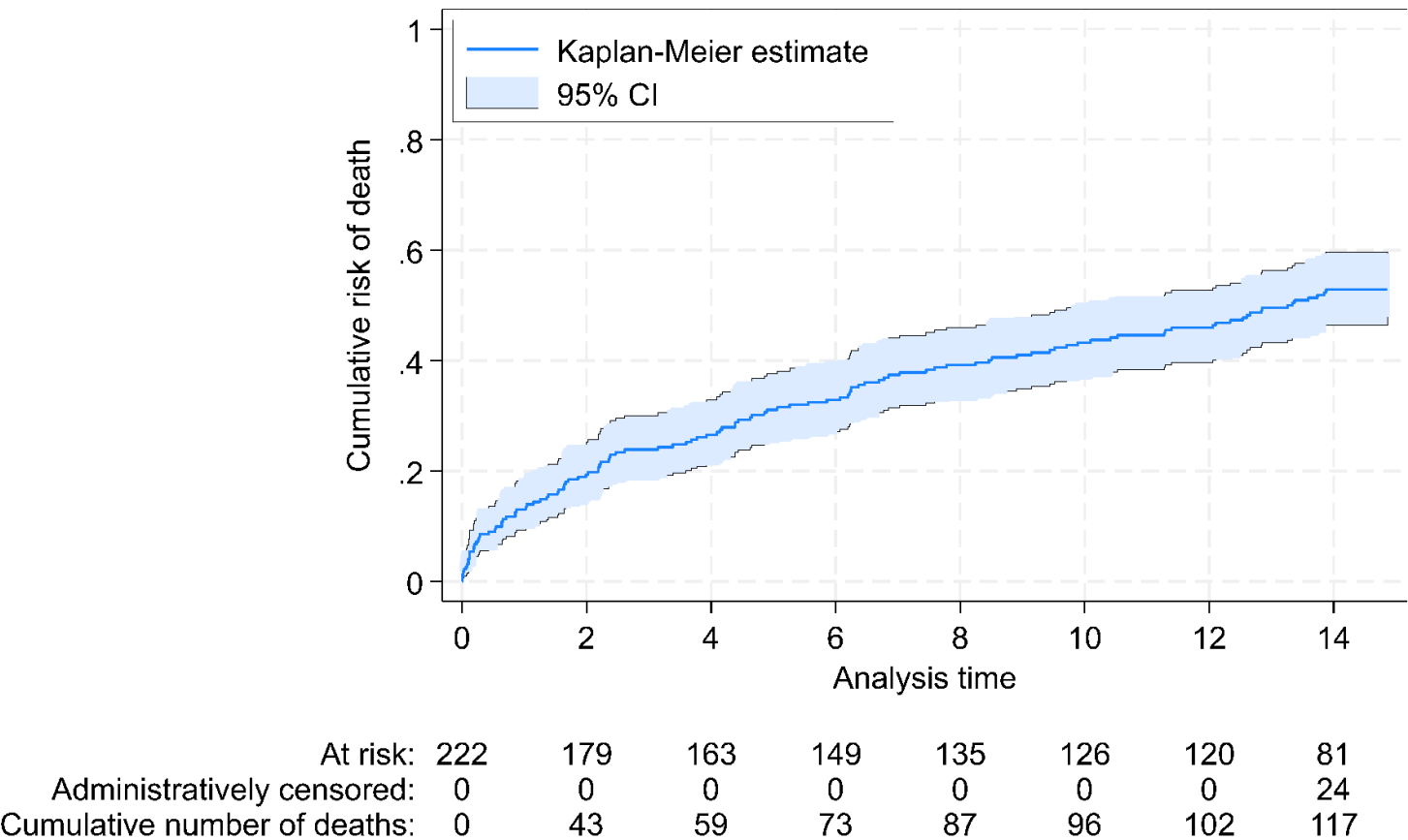


Figure 1

Cumulative risk of death over 14 years among people admitted to CRP in 2011 who were discharged alive and wheelchair dependent.

Kaplan-Meier estimate of the cumulative risk of death over 14 years among people admitted to CRP in 2011 who were discharged alive and wheelchair dependent. The shaded area indicates the 95% confidence interval. Numbers at risk, administratively censored participants, and cumulative deaths are shown below the x-axis.

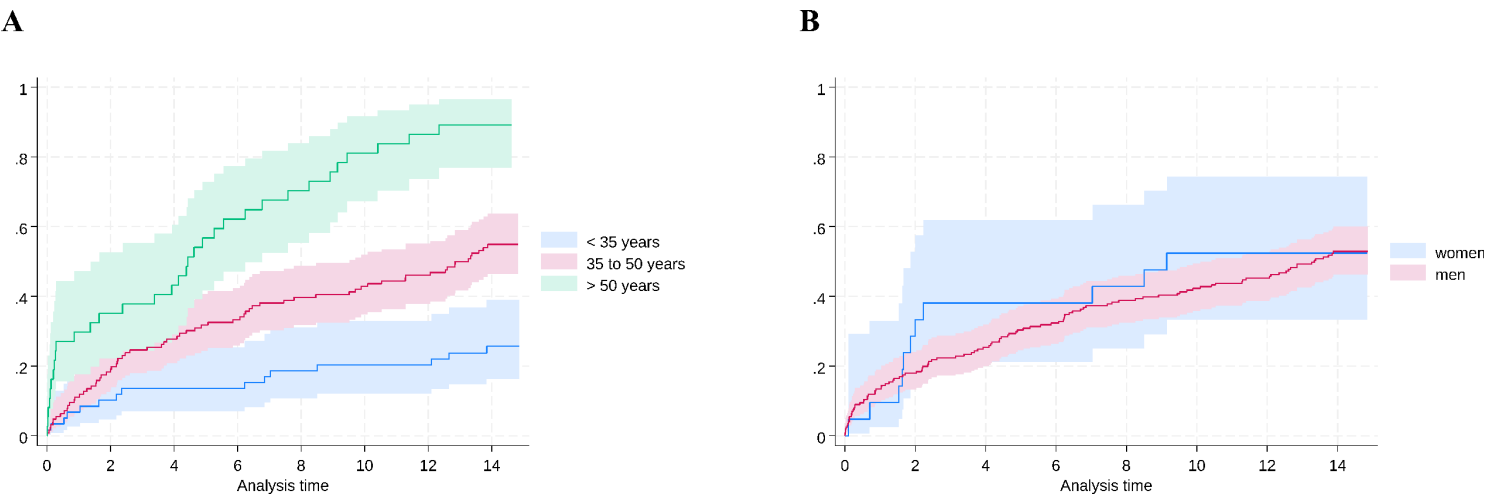


Figure 2

Cumulative risk of death over 14 years among people admitted to CRP in 2011 who were discharged alive and wheelchair dependent, stratified by age group (A) and sex (B).

Kaplan-Meier estimates of the cumulative risk of death over 14 years among people admitted to CRP in 2011 who were discharged alive and wheelchair dependent. (A) Stratified by age group (<35 years, 35 to 50 years, and >50 years). (B) Stratified by sex (women, men). Shaded areas indicate 95% confidence intervals around the estimates for each stratum.

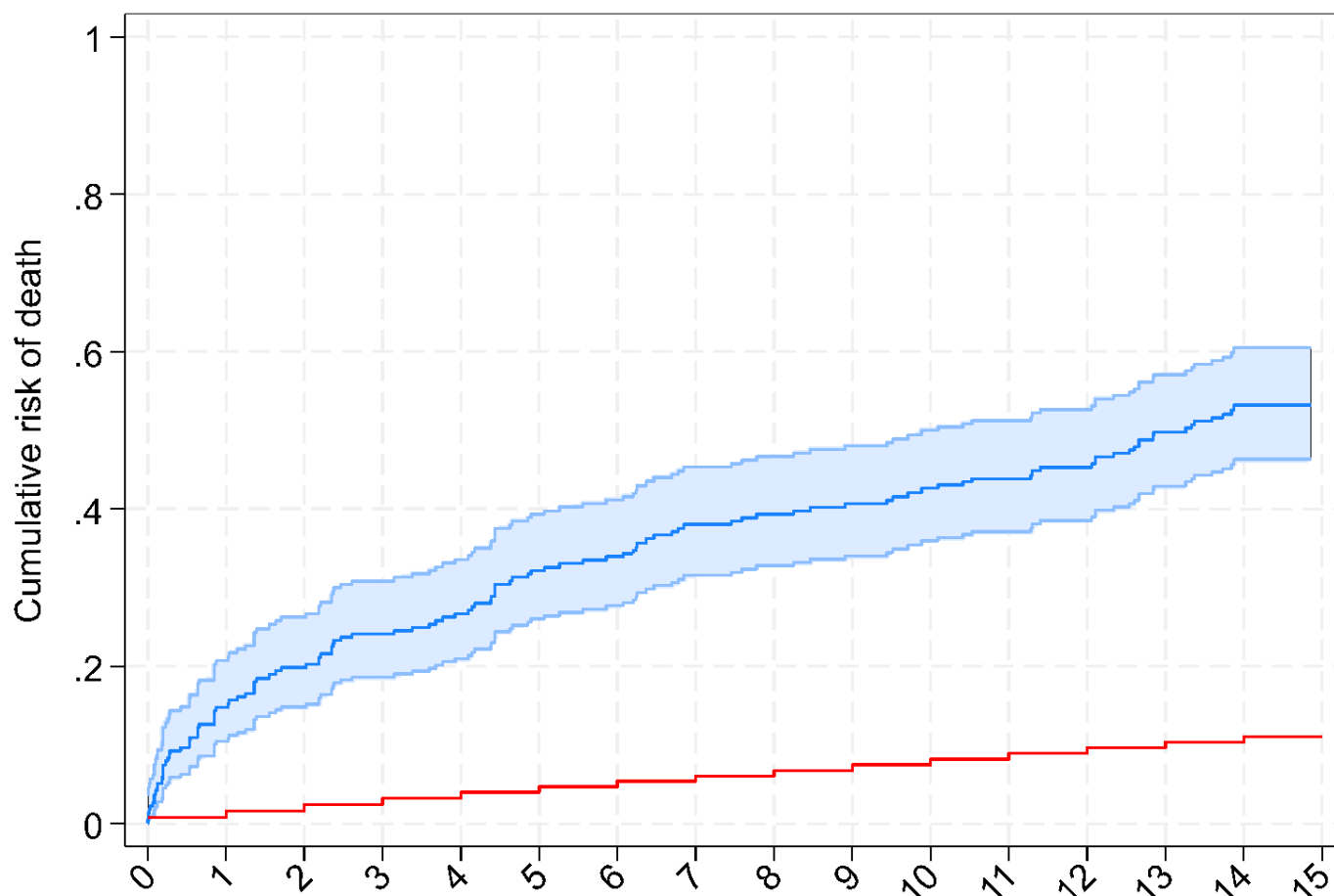


Figure 3

Cumulative risk of death over 14 years among wheelchair-dependent males discharged alive from CRP compared with age-matched males in the general Bangladeshi population.

Kaplan-Meier estimate of the cumulative risk of death over 14 years among males aged 15 to 80 years who were admitted to CRP in 2011 and subsequently discharged alive and wheelchair dependent, compared with the cumulative risk of death expected among age-matched males in the general Bangladeshi population. The shaded area indicates the 95% confidence interval around the estimate for the CRP cohort.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [STROBEchecklistcohort14yearfollowup.docx](#)