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Incidence, severity and time course of pressure injuries over the first two years following discharge from hospital in people with spinal cord injuries in Bangladesh

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DESIGN: Cohort study embedded in a clinical trial.
SETTING: Community, Bangladesh.
OBJECTIVES: To determine the incidence, severity and time course of pressure injuries over the first two years following discharge from hospital in people with spinal cord injuries (SCI) in Bangladesh.
METHODS: Participants ($n = 186$) were contacted by telephone 39 times and assessed face-to-face 4 to 6 times over the two years following discharge. At each point of contact the presence and severity of pressure injuries were determined using the Pressure Ulcer Scale for Healing (PUSH). Survival analyses were conducted to determine the time course of development of pressure injuries and recovery from pressure injuries. Lasso regression was used to construct multivariable prediction models.
RESULTS: Seventy-seven participants (41%; 95% CI 34% to 49%) developed at least one pressure injury in the first two years after discharge (incidence rate 0.27 per person-year, 95% CI 0.22 to 0.34). Most pressure injuries were on the sacrum (23%). Pressure injuries took a median (IQR) of 40 (29 to 57) days to heal. The median (IQR) peak PUSH score was 11.0/17 (8.0 to 13.5). The multivariable prediction models had poor predictive properties (maximum c-statistic 0.75).
CONCLUSION: Pressure injuries impose a large health burden on people with SCI in Bangladesh. However, they are difficult to predict, treat and prevent. Further research is needed to identify who is at most risk and to find solutions for the treatment and prevention of pressure injuries in Bangladesh and other low-middle income countries.

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INTRODUCTION

Pressure injuries are a serious complication of spinal cord injury (SCI), especially in low-and middle-income countries (LMICs) [1, 2]. Pressure injuries cause disability and functional limitations, reduce quality of life [3, 4], and are a leading cause of premature death. For example, our previous cohort study from Bangladesh found that one in five people with SCI who were wheelchair dependent at the time of discharge had died within two years of discharge from hospital, most frequently from pressure injuries [5].

Despite the problems pressure injuries pose for people with SCI in LMICs, there are few accurate data from these countries about the incidence or severity of pressure injuries after discharge from hospital. Two systematic reviews [6, 7] have sought to quantify the burden of pressure injuries in high-income countries (HICs) and LMICs. However neither review adequately considered the sampling techniques of the included studies, so the strength of the evidence provided by these reviews is low. Many of the studies included in the reviews used small or non-representative samples [8–12], or only focused on the period of initial hospitalisation [13–20].

The largest studies on the incidence or prevalence of pressure injuries after discharge from hospital were conducted in the USA in the 1990s. One study of 4,926 participants using data from the USA SCI Models System [21] found that 15% of participants had a pressure injury one year after discharge. The response rate in this study was 73%. Two other studies from the same decade and country reported similar findings: between 10% and 13% of participants experienced a pressure injury within one or two years of injury [22, 23]. One of these studies ($n = 357$) sampled participants from the National Spinal Cord Injury Database of nine Model Spinal Cord Injury Systems, and had a response rate of 42% [22]. The other ($n = 3,361$) sampled participants registered on a database between 1986 and 1995, and had a response rate of 49% [23]. A more recent study, again from the USA, examined incidence of pressure injuries in a cohort of participants ($n = 169$) from the Northwest Regional Spinal Cord Injury System included in a randomised controlled trial in 2017 [24]. Participants were telephoned 3, 6, 9, and 12 months after discharge from hospital and asked whether they had experienced a pressure injury since the last time they were contacted. This study reported a much higher incidence of pressure injuries than earlier studies: over the

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first year after discharge 41% of participants experienced a pressure injury. Similarly, a more recent study from the Netherlands reported an incidence of 36% over the first year since discharge [25].

There are few comparable studies from LMICs, although it is generally assumed that the incidence and prevalence of pressure injuries are much higher in LMICs than in HICs. A survey from Thailand ($n = 129$) looked at the prevalence of pressure injuries in wheelchair-dependent people with SCI living in the community [26]. Twenty-six percent of participants reported a pressure injury at the time of the survey. This estimate of prevalence is difficult to interpret because it is not clear how the population was sampled. Another study from Afghanistan [27] had similar methodological limitations. It found that 32% of 311 people discharged from two hospitals had a pressure injury at the time of assessment (mean (SD) of 8 (5.1) years since injury). Other smaller studies from LMICs provide additional estimates of incidence and prevalence but their estimates may not be accurate [28–34].

We recently completed a large ($n = 410$) randomised trial (the "CIVIC" trial) of the effectiveness of a community-based intervention for people with SCI in Bangladesh [35]. The intervention included regular telephone contact with participants and a limited number of home visits by a healthcare professional over the two years after discharge from hospital. The trial provided detailed longitudinal data on pressure injuries in the participants from the Intervention group. The Intervention participants were considered to be representative of participants from both groups and representative of those discharged from a hospital in Bangladesh because the intervention did not reduce mortality or affect any of the secondary outcomes, including the prevalence of pressure injuries two years after discharge. Consequently, we sought to use these data to determine the incidence, severity and time course of pressure injuries over the first two years following discharge from hospital in people with SCI in Bangladesh. The term first pressure injury is used in this study to refer to the first pressure injury since discharge from hospital.

MATERIALS AND METHODS

This study was a longitudinal cohort study embedded in a randomised controlled trial. Participants were 186 people from among the 204 participants randomised to the Intervention group of the CIVIC trial (18 participants were randomised to the Intervention group but were excluded from this study because they had a pressure injury at the time of discharge from hospital). People were eligible to participate in the trial if they had sustained a recent SCI in the preceding two years, were about to be discharged from the Centre for the Rehabilitation of the Paralysed (CRP), were at least 16 years of age, and were wheelchair-dependent. This included 81% of the wheelchair-dependent people with a SCI who were discharged from CRP between June 2015 and March 2018. The trial was completed in February 2020.

As part of the CIVIC trial intervention, participants in the Intervention group were telephoned by healthcare professionals every two weeks in the first year and every month in the second year (sometimes more often if a participant had problems). On each call, participants were asked if they had a pressure injury. If they had a pressure injury, they were asked to indicate the size of the pressure injury and the extent of exudate, and to describe the appearance of the pressure injury. Participants used different terms to describe the size, appearance and extent of exudate from their pressure injuries. The terms they used were recorded, and later used to derive a score out of a total of 17 points on the Pressure Ulcer Scale for Healing version 3 (PUSH) where a higher score indicates a more severe pressure injury. In addition, participants were visited in their homes at least four times; three times as part of the CIVIC intervention (up to five times if a participant had problems) and once as part of the two-year assessment. At each home visit, the assessor visually checked the participant's skin to determine the presence of pressure injuries. A PUSH assessment was completed at the same time. In all, data on pressure injuries were available from an average of 43 points of contact for each participant over two years. Some participants contributed less data because they died before the end of the trial.

Ethical approval for all aspects of the CIVIC trial was attained from the ethics committees of CRP, Bangladesh, and the University of Sydney, Australia. All participants provided written informed consent. The trial was prospectively registered (ACTRN.12615000630516, Universal Trial Number U1111-1171-1876).

Validity of the telephone self-report data

The validity of data self-reported by telephone was evaluated by comparison with data collected by the assessors during home visits. The home visit data were considered to be the reference standard. Only self-report data obtained over the telephone in the 14 days immediately preceding the first three home visits and the final two-year assessment were used. As a result, most participants contributed four pairs of observations (each pair consisting of a telephone assessment and the subsequent home visit) to the analysis of the validity of self-reported pressure injury. A subset of those data, consisting only of those pairs of observations in which there was a pressure injury at both the telephone call and home visit, contributed data to the analysis of the validity of self-reported PUSH scores. The validity of self-reported pressure injury was expressed in terms of sensitivity, specificity, and likelihood ratios. As most individuals contributed multiple pairs of observations, non-parametric (percentile) confidence intervals (CI) for sensitivity, specificity, and likelihood ratios were obtained by bootstrapping in a way that respected the clustering of observations by participant. The validity of self-reported PUSH scores was measured with an intraclass correlation coefficient (ICC) and percent close agreements.

Incidence, severity, and time course of the pressure injuries

The time from discharge to the onset of the first pressure injury after discharge was determined. Data from all points of contact were used for these analyses. Contacts included all telephone calls and home visits, as well as the two-year assessment. The date of pressure injury onset was considered to be the mid-point between the date of the last contact on which the participant did not have a pressure injury and the first date of contact at which the participant did have a pressure injury. Those who never developed a pressure injury were censored at the last point of contact (the two-year assessment). Two participants died without developing a pressure injury and were censored at the last point of contact prior to their deaths. The incidence rate of first pressure injuries was determined by dividing the number of first pressure injuries by the total person-time at risk (i.e., total time observed prior to first pressure injuries). The time course of development of participants' first pressure injury was described with the Kaplan–Meier survival function. The survival function was modelled with a Weibull model.

The time from the onset of the first pressure injury after discharge to its resolution (healing) was also determined. Only those participants who developed a pressure injury ($n = 77$) were included in this analysis, and if the participant had more than one pressure injury only the first was analysed. The date on which a pressure injury healed was assumed to be the mid-point between the date of the last contact on which the participant had a pressure injury and the date of the first contact on which the participant no longer had a pressure injury. Those participants whose pressure injuries did not heal before the two-year assessment were censored at the time of the two-year assessment. Five participants died with their first pressure injury and were therefore censored at the last point of contact prior to their deaths. The incidence rate of healing of first pressure injuries was determined by dividing the number of first pressure injuries that healed by the total person time at risk (i.e., total time observed with first pressure injuries). The time course of healing of first pressure injuries was described with the Kaplan–Meier survival function. The survival function was modelled with a Gompertz model.

To estimate the overall burden of all pressure injuries, the proportion of the first two years after discharge that participants spent with a pressure injury was calculated by dividing the total person-time with a pressure injury by the total person-time under observation in the two years after discharge. To quantify the severity of participants' pressure injuries, the peak and mean PUSH scores of all pressure injuries were determined.

Prediction of pressure injuries

A multivariate prediction model was developed to identify at discharge those who are at high risk of developing a pressure injury within two years. The following 15 variables collected at discharge were considered as potential predictors (see [35, 36] for details about each predictor): gender

Table 1. Characteristics of the 186 participants included in the analysis of time to first pressure injury and the 77 participants included in the analysis of time to healing of first pressure injury.

	Included in the analysis of time to first pressure injury (*N* = 186)	Included in the analysis of time to healing of first pressure injury (*N* = 77)
Age in years, median (IQR)	32.9 (25.4 to 43.4)	35.8 (27.9 to 44.9)
Time since injury in months, median (IQR)	5.9 (4.6 to 8.2)	5.9 (4.4 to 9.5)
Sex (male:female), *n* (%)	163:23 (88%:12%)	69:8 (90%:10%)
Neurological level of lesion, *n* (%)		
C1 to C4	53 (29%)	23 (30%)
C5 to C8	23 (12%)	7 (9%)
T1 to T7	30 (16%)	14 (18%)
T8 to T12	74 (40%)	28 (36%)
L1 to L5	6 (3%)	5 (7%)
ASIA impairment scale, *n* (%)		
A	130 (70%)	69 (90%)
B	21 (11%)	–
C	30 (16%)	7 (9%)
D	5 (3%)	1 (1%)
Total motor score/ 100, median (IQR)	50 (29 to 50)[a]	50 (20 to 50)

[a]One motor score was missing.
ASIA American Spinal Injuries Association, *IQR* interquartile range, *n* number.

(male or female), age (years), marital status (married, not married, separated, widowed), literacy level (good, limited, illiterate), working prior to injury (yes, no), combined family income prior to injury (Bangladeshi Taka), main income earner for family (yes, no), severity of injury (paraplegia, tetraplegia), completeness of injury (American Spinal Injury Association Impairment Scale, A-D), assessor's perception of likelihood of participant's survival at 2 years (100-point scale anchored with "certain the person will be alive at 2 years" and "certain the person will be deceased at 2 years"), depression (Center for Epidemiologic Studies Depression Scale revised version), independence (Spinal Cord Independence Measure III), complications (SCI Secondary Conditions Scale), mental wellbeing (mental subscore of the Short Form Health Survey-12), and participation (World Health Organization Disability Assessment Schedule version 2). Lasso regression was used to find a parsimonious logistic prediction model. Cross-validation was used to optimise the penalty for model complexity. Bootstrapping techniques were used to obtain an internally validated estimate of the c-statistic (i.e., the area under the receiver-operator curve).

All analyses were conducted using Stata 16. Two authors (RDH and LAH) independently conducted the analyses to ensure coding accuracy.

RESULTS

Participant characteristics are given in Table 1. Overall, participants were contacted 8,094 times either through home visits ($n = 556$), telephone calls ($n = 7{,}364$) or as part of the two-year assessments ($n = 174$). Twelve participants died: five died with their first pressure injuries, three died with their second pressure injuries, two died after a pressure injury had healed and two died without ever experiencing a pressure injury. The median (IQR, interquartile range) age of the 12 participants who died was 40.9 years (31.8 to 52.3 years).

Validity of the telephone self-report data

Five hundred and five telephone calls were made within 14 days prior to one of the 725 face-to-face assessments (see Supplementary File 1 for more details). The median (IQR) time between a telephone call and subsequent face-to-face assessment was 7 days (4 to 10 days). The sensitivity (95% CI) and specificity (95% CI) of self-reported pressure injury were 75% (62% to 85%) and 99% (97% to 100%), respectively. The positive and negative likelihood ratios (95% CI) were 66 (27 to 160) and 0.26 (0.17 to 0.39), respectively (see Table 2 for more details). This indicates that there was a strong concordance between telephone self-reports of the presence of a pressure injury. It also shows that a telephone self-report of no pressure injury provides strong evidence that there is no pressure injury and a telephone self-report of pressure injury provides strong evidence that there is a pressure injury.

PUSH scores were recorded during both the telephone call and the face-to-face assessment in 41 telephone calls made in the 14 days prior to a face-to-face assessment. The median (IQR) time between a telephone call and subsequent face-to-face assessment with PUSH data was 8 days (5 to 11 days). The ICC reflecting the agreement between self-reported PUSH scores and PUSH scores measured during the subsequent home visit was 0.76. An ICC of 0.75 to 0.9 indicates good validity. The PUSH scores attained over the telephone were the same as those attained from home visits in 15% of measurements, and within 1 point and 5 points of each other in 44% and 93% of measurements, respectively.

Incidence, severity, and time course of the development of pressure injuries

Data about the presence or absence of pressure injuries were missing from the records of 56 points of contact. Hence data were available from 8,038 points of contact, including 555 home visits, 7,309 telephone calls and 174 two-year assessments. These data, 91% of which were self-reported, were used in the subsequent analyses.

Seventy-seven (41%; 95% CI 34% to 49%) participants developed at least one pressure injury, 21 developed two pressure injuries, and 18 developed three or more pressure injuries (see Fig. 1). Collectively, participants had one or more pressure injuries for 10.8% of the time they were under observation (Fig. 1). The most common sites of pressure injuries were over the sacrum (23%), gluteal region (23%), greater trochanter (17%), and ischial tuberosity (17%). Only 8% of participants developed pressure injuries on the heel and the remaining 15% of pressure injuries were located over other areas including the elbow and various parts of the leg. In those who developed a pressure injury, PUSH data were available from 773 points of contact, 88% of which were self-reports. The medians (IQRs) of participants' mean and peak PUSH scores (/17) were 7.7 (6.3 to 10.2) and 11.0 (8.0 to 13.5), respectively, indicating that pressure injuries were typically of moderate severity.

The total person-time at risk of developing a first pressure injury was 272.9 person-years, and the total person-time under observation with a first pressure injury was 18.7 person-years. Thus the incidence of first pressure injuries was 0.27 per person-year (95% CI 0.22 to 0.34). The Kaplan–Meier estimate of the survival function, indicating the evolution of risk of a first pressure injury, is shown in Fig. 2. Twenty-one participants (11%) developed their first pressure injury within three months of discharge. A Weibull model fitted the survival function well. The model indicates that the probability of developing a first pressure injury within t days of discharge is $1 - e^{(-0.0036 \times t^{0.76})}$. A sensitivity analysis showed that the policy of defining the onset of a pressure injury as the mid-point between two assessments yielded very similar estimates to an interval-censored Weibull model and, as the two approaches yielded similar estimates, we have reported the simpler estimates obtained with mid-points.

Table 2. Validity of assessments self-reported by telephone.

Time	Median (IQR) days between telephone and face-to-face assessments	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	−LR (95% CI)
Home visit 1	6 (3 to 10)	71% (48% to 85%)	99% (96% to 100%)	58 (14 to 235)	0.29 (0.15 to 0.57)
Home visit 2	6 (3 to 10)	77% (55% to 92%)	99% (96% to 100%)	61 (15 to 246)	0.23 (0.11 to 0.50)
Home visit 3	7 (3 to 11)	71% (42% to 92%)	100% (96% to 100%)	NA	0.28 (0.12 to 0.65)
2-year assessment	11 (8 to 13)	83% (36% to 100%)	97% (84% to 100%)	27 (4 to 190)	0.17 (0.03 to 1.03)
All assessments	7 (4 to 10)	75% (62% to 85%)	99% (97% to 100%)	66 (27 to 160)	0.26 (0.17 to 0.39)

+LR positive likelihood ratio, *−LR* negative likelihood ratio, *CI* confidence interval, *IQR* interquartile range, *NA* insufficient data to calculate +LR.

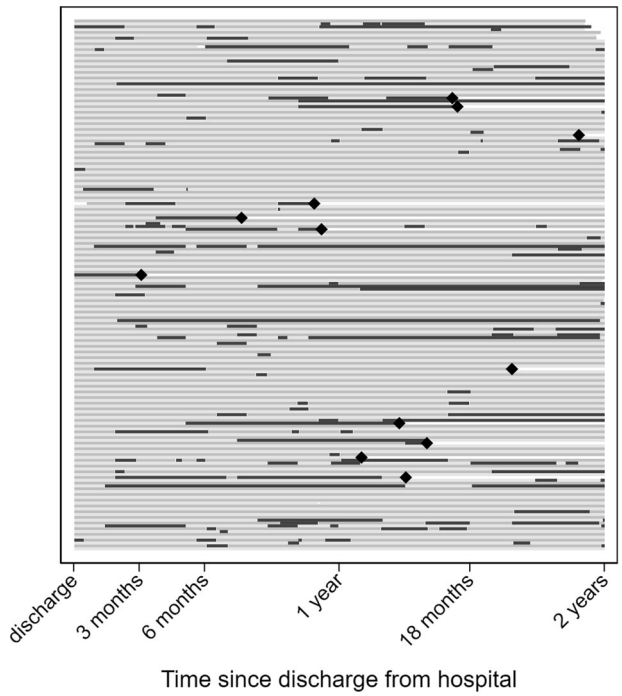

Fig. 1 A graphical representation of the overall time participants spent with a pressure injury. The width of the image reflects time and the height reflects the 186 participants. Each faint horizontal grey line represents a single participant. (There are two shades of grey lines to make it easier to see the individual lines.) The heavy black lines indicate the presence of a pressure injury. The black diamonds indicate deaths ($n = 12$).

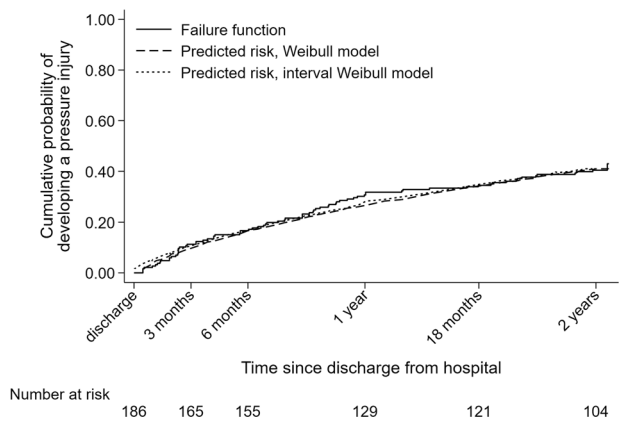

Fig. 2 Time to develop first pressure injury ($n = 186$). The Kaplan–Meier survival estimate and two Weibull models are shown. Seventy-seven people developed a pressure injury.

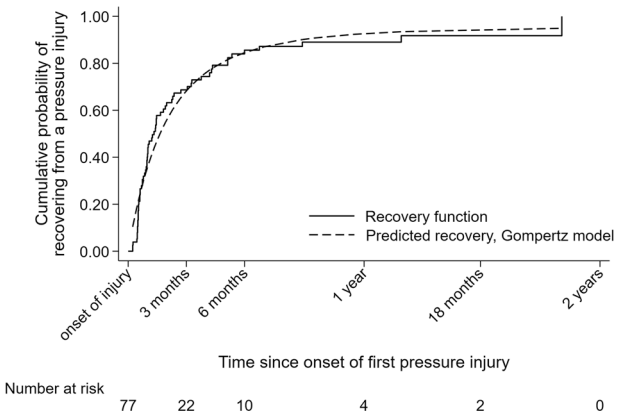

Fig. 3 Time to healing of first pressure injury ($n = 77$). The Kaplan–Meier survival estimate and a Gompertz model are shown.

Incidence, severity and time course of recovery from first pressure injuries

Seventy-seven participants who experienced a pressure injury contributed data to the analysis of time to healing. Sixty-six (86%) of the 77 first pressure injuries had healed before the participant was censored by death or the two-year follow-up, leaving a total person-time for which participants were at risk of recovery from their first pressure injuries of 18.7 person-years. The incidence of healing of first pressure injuries was therefore 3.5 recoveries per person-year. Pressure injuries took a median (IQR) of 40 (29 to 57) days to heal. The Kaplan–Meier estimate of the survival function, indicating the evolution of the risk of recovery from first pressure injury, is shown in Fig. 3. A Gompertz model fitted the data well. The model indicates that the probability of a first pressure injury healing within t days of onset is $1 - e^{(3.07 \times e^{-0.0052 \times t} - 1)}$.

Prediction of pressure injuries

The multivariate prediction model retained seven predictors with non-zero regression coefficients, but the model had poor discrimination. The naive (probably optimistic) estimates derived from the data used to develop the prediction model were that sensitivity was 62% and specificity was 72%. The internally validated estimate of the area under the receiver-operator curve was 0.75.

DISCUSSION

This study is the first to provide accurate data on the incidence and severity of pressure injuries from a representative sample of people discharged from a hospital in a LMIC. The data provide a quantitative estimate of the magnitude of the problem that pressure injuries pose for people with SCI in LMICs. An unsurprising finding is that the incidence of pressure injuries is high: 41% of participants in this study developed at least one pressure injury within two years of discharge from hospital, and 21% developed at least two pressure injuries. Typically, the first pressure injury was moderately serious and lasted

for 40 days. A small proportion (7%) of first pressure injuries did not resolve within one year.

Twelve participants died. While it was difficult to accurately determine the cause of death, the observation that eight participants had pressure injuries at the time of death, and those who died were quite young (median age was 40.9 years), suggests that pressure injuries contributed to some deaths.

Ninety-one percent of the data used to determine the presence of pressure injuries was self-reported over the telephone; the remaining 9% was collected during a face-to-face assessment. While self-report is less reliable than face-to-face assessment, the data indicate that participants provided quite accurate assessments of whether they did or did not have a pressure injury. However, participants provided more accurate assessments when they did not have a pressure injury (specificity 99%) than when they did (sensitivity 75%). These findings give us confidence in our estimates of the incidence of pressure injuries and should also give clinicians more confidence in the value of telephoning people with SCI to determine the presence of pressure injuries. Self-reported assessments of the severity of pressure injuries (ICC 0.76) appear to be less satisfactory than self-reports of the presence or absence of a pressure injury. However, this finding is provisional because it is based on only 41 pairs of observations. Another reason to be cautious of this finding is that up to 14 days elapsed between participants' self-report over the telephone and the ensuing face-to-face assessment. Therefore at least some of the differences in PUSH scores may reflect real changes in pressure injury severity. Nonetheless, telephone assessment of PUSH scores was more difficult than telephone assessment of the presence of pressure injuries. Participants had difficulties articulating the three aspects of the PUSH scores: the size, amount of exudate and type of tissue. We tried to provide participants with strategies to both assess and articulate each of these three features. For example, we asked participants to gauge the size of pressure injuries by comparing them to objects such as coins and jam jar lids. Often pressure injuries were located at a site (such as on the buttocks or sacrum) that the participant could not see, so they needed to either use a mirror or ask for assistance from carers to assess the pressure injury. Consequently, the PUSH scores reported in this study provide an imperfect estimate of the severity of the pressure injuries.

While we found a high incidence (41%) of pressure injuries over the first two years after discharge, the incidence rate may be lower than some readers might have expected. Moreover, the incidence rate of pressure injuries observed here is lower than that reported in the two most comparable studies from HICs: studies from the USA and the Netherlands reported incidence proportions of first pressure injuries of 41% and 36% in the first year after discharge from hospital [24, 25] (compared to 32% over the first year in our study). This may reflect differences between our cohort and the cohorts from the USA and Netherlands. In Bangladesh, elderly people and people who experience severe SCI may be more likely to die before reaching CRP. Had they survived and been included in our study, we might have observed a higher incidence of pressure injuries than is reported here. It is also difficult to make direct comparisons between studies because neither study from the USA or Netherlands reported the severity of the pressure injuries. So, while the incidence of pressure injuries may be similar, it is possible that the problems posed by pressure injuries in LMICs are greater than in HICs. The observation that 6% of participants in our cohort died within two years of discharge from hospital suggests that this may be the case. This mortality rate is high for a young cohort (median age 32.9 years).

The current study provides data on the incidence, severity, and time course of pressure injuries in wheelchair-dependent people with SCI discharged from a specialised SCI hospital in Bangladesh. The situation may be worse for patients discharged from non-specialised hospitals in Bangladesh and other LMICs, and worse again for people who never make it to a hospital. Detailed and accurate data on these subgroups are urgently needed to fully understand the problem that pressure injuries pose in LMICs.

We attempted to build a prediction model to identify those at high risk of developing pressure injuries within two years of discharge from hospital. We reasoned that if we could identify those at risk then resources and attention could be directed to those people. However, the model lacked sufficient discrimination to recommend it for clinical use (c-statistic 0.75). This was despite the inclusion of a wide range of potential predictor variables, including a subjective rating by assessors of participant's risk of premature death. This subjective rating potentially captures nuances of a person's situation that can be discerned by clinicians but are not readily measured with other types of scales. The obvious omission from our prediction model was the presence of pressure ulcers prior to discharge. However, these data were not available because they were not collected as part of the CIVIC trial. Nonetheless, our failure to identify a good prediction model from the large range of variables that were collected as part of the CIVIC trial highlights the difficulties of identifying those at risk of developing pressure injuries.

A weakness of our study is that we did not know the exact date at which the pressure injuries ($n = 77$) commenced or healed, because participants were only contacted every two weeks in the first year and every month in the second year. We assumed that the pressure injuries commenced and resolved at the mid-points between assessments. This left a potential for error of between one and two weeks. There was also the potential for error with the PUSH scores. The PUSH scores at the time of contact may not have been a reasonable reflection of the PUSH scores over the time period since the last point of contact. However, there was no other feasible way to follow up 186 participants in the community in Bangladesh over a two-year period. A sensitivity analysis conducted using interval-censored regression indicated that the use of mid-points did not appreciably bias estimates of the survivor functions.

We were only able to include participants from the Intervention group of the CIVIC trial. These participants received regular telephone contact and a limited number of home visits by a healthcare professional over the two years after discharge from hospital. There was, however, no evidence of any difference in the outcomes of participants in the Intervention and Control groups of the trial two years after discharge. This suggests the study sample is representative of those discharged from CRP.

In summary, this study is the first to provide robust data on the incidence, severity, and time course of pressure injuries in a LMIC. The incidence of pressure injuries is high but not as high as some might expect. Nonetheless, pressure injuries are clearly a major problem for this population.

DATA ARCHIVING

De-identified individual participant data will be made available in response to reasonable requests.

REFERENCES

1. Zakrasek EC, Creasey G, Crew JD. Pressure ulcers in people with spinal cord injury in developing nations. Spinal Cord. 2015;53:7–13.
2. Hossain MS, Islam MS, Rahman MA, Glinsky JV, Herbert RD, Ducharme S, et al. Health status, quality of life and socioeconomic situation of people with spinal cord injuries six years after discharge from a hospital in Bangladesh. Spinal Cord. 2019;57:652–61.
3. Arora M, Harvey LA, Glinsky JV, Chhabra HS, Hossain MS, Arumugam N, et al. Cost-effectiveness analysis of telephone-based support for the management of pressure ulcers in people with spinal cord injury in India and Bangladesh. Spinal Cord. 2017;55:1071–8.
4. Regan MA, Teasell RW, Wolfe DL, Keast D, Mortenson WB, Aubut JA, et al. A systematic review of therapeutic interventions for pressure ulcers after spinal cord injury. Arch Phys Med Rehabil. 2009;90:213–31.

5. Hossain MS, Rahman MA, Herbert RD, Quadir MM, Bowden JL, Harvey LA. Two-year survival following discharge from hospital after spinal cord injury in Bangladesh. Spinal Cord. 2016;54:132–6.
6. Chen HL, Cai JY, Du L, Shen HW, Yu HR, Song YP, et al. Incidence of pressure injury in individuals with spinal cord injury: a systematic review and meta-analysis. J Wound Ostomy Cont Nurs. 2020;47:215–23.
7. Shiferaw WS, Akalu TY, Mulugeta H, Aynalem YA. The global burden of pressure ulcers among patients with spinal cord injury: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2020;21:334. https://doi.org/10.1186/s12891-020-03369-0.
8. Raghavan P, Raza WA, Ahmed YS, Chamberlain MA. Prevalence of pressure sores in a community sample of spinal injury patients. Clin Rehabil. 2003;17:879–84.
9. Hu X, Zhang X, Gosney JE, Reinhardt JD, Chen S, Jin H, et al. Analysis of functional status, quality of life and community integration in earthquake survivors with spinal cord injury at hospital discharge and one-year follow-up in the community. J Rehabil Med. 2012;44:200–5.
10. Madasa V, Boggenpoel B, Phillips J, Joseph C. Mortality and secondary complications four years after traumatic spinal cord injury in Cape Town, South Africa. Spinal Cord Ser Cases. 2020;6:84 https://doi.org/10.1038/s41394-020-00334-w.
11. Garber SL, Rintala DH. Pressure ulcers in veterans with spinal cord injury: a retrospective study. J Rehabil Res Dev. 2003;40:433–42.
12. Saladin LK, Krause JS. Pressure ulcer prevalence and barriers to treatment after spinal cord injury: comparisons of four groups based on race-ethnicity. NeuroRehabilitation. 2009;24:57–66.
13. Irgens I, Hoff JM, Jelnes R, Alexander M, Stanghelle JK, Thoresen M, et al. Spinal cord injury and development of pressure injury during acute rehabilitation in Norway: a national retrospective cross-sectional study. Spinal Cord. 2020;58:1069–79.
14. Gour-Provencal G, Mac-Thiong J-M, Feldman DE, Begin J, Richard-Denis A. Decreasing pressure injuries and acute care length of stay in patients with acute traumatic spinal cord injury. J Spinal Cord Med. 2020 Feb:1–9. https://doi.org/10.1080/10790268.2020.1718265.:1-9.
15. van der Wielen H, Post MWM, Lay V, Glasche K, Scheel-Sailer A. Hospital-acquired pressure ulcers in spinal cord injured patients: time to occur, time until closure and risk factors. Spinal Cord. 2016;54:726–31.
16. Joseph C, Nilsson, Wikmar L. Prevalence of secondary medical complications and risk factors for pressure ulcers after traumatic spinal cord injury during acute care in South Africa. Spinal Cord. 2016;54:535–9.
17. Verschueren JHM, Post MWM, de Groot S, van der Woude LHV, van Asbeck FWA, Rol M. Occurrence and predictors of pressure ulcers during primary in-patient spinal cord injury rehabilitation. Spinal Cord. 2011;49:106–12.
18. Scheel-Sailer A, Wyss A, Boldt C, Post MW, Lay V. Prevalence, location, grade of pressure ulcers and association with specific patient characteristics in adult spinal cord injury patients during the hospital stay: a prospective cohort study. Spinal Cord. 2013;51:828–33.
19. Ash D. An exploration of the occurrence of pressure ulcers in a British spinal injuries unit. J Clin Nurs. 2002;11:470–8.
20. DeJong G, Hsieh CHJ, Brown P, Smout RJ, Horn SD, Ballard P, et al. Factors associated with pressure ulcer risk in spinal cord injury rehabilitation. Am J Phys Med Rehabil. 2014;93:971–86.
21. McKinley WO, Jackson AB, Cardenas DD, DeVivo MJ. Long-term medical complications after traumatic spinal cord injury: a Regional Model Systems Analysis. Arch Phys Med Rehabil. 1999;80:1402–10.
22. Johnson RL, Gerhart KA, McCray J, Menconi JC, Whiteneck GG. Secondary conditions following spinal cord injury in a population-based sample. Spinal Cord. 1998;36:45–50.
23. Chen Y, DeVivo MJ, Jackson AB. Pressure ulcer prevalence in people with spinal cord injury: age-period-duration effects. Arch Phys Med Rehabil. 2005;86:1208–13.
24. Stillman MD, Barber J, Burns S, Williams S, Hoffman JM. Complications of spinal cord injury over the first year after discharge from inpatient rehabilitation. Arch Phys Med Rehabil. 2017;98:1800–5.
25. Haisma JA, van der Woude LH, Stam HJ, Bergen MP, Sluis TA, Post MW, et al. Complications following spinal cord injury: occurrence and risk factors in a longitudinal study during and after inpatient rehabilitation. J Rehabil Med. 2007;39:393–8.
26. Kovindha A, Kammuang-Lue P, Prakongsai P, Wongphan T. Prevalence of pressure ulcers in Thai wheelchair users with chronic spinal cord injuries. Spinal Cord. 2015;53:767–71.
27. Deconinck H. The health condition of spinal cord injuries in two Afghan towns. Spinal Cord. 2003;41:303–9.
28. Lofvenmark I, Wikmar LN, Hasselberg M, Norrbrink C, Hultling C. Outcomes 2 years after traumatic spinal cord injury in Botswana: a follow-up study. Spinal Cord. 2017;55:285–9.
29. Lofvenmark I, Hasselberg M, Nilsson Wikmar L, Hultling C, Norrbrink C. Outcomes after acute traumatic spinal cord injury in Botswana: from admission to discharge. Spinal Cord. 2017;55:208–12.
30. Onigbinde AT, Ogunsanya GI, Oniyangi SO. Pressure ulcer incidence among high risk inpatients in Nigeria. Br J Nurs. 2012;21:S4–10.
31. Wannapakhe J, Arrayawichanon P, Saengsuwan J, Amatachaya S. Medical complications and falls in patients with spinal cord injury during the immediate phase after completing a rehabilitation program. J Spinal Cord Med. 2015;38:84–90.
32. Scovil CY, Ranabhat MK, Craighead IB, Wee J. Follow-up study of spinal cord injured patients after discharge from inpatient rehabilitation in Nepal in 2007. Spinal Cord. 2012;50:232–7.
33. Kawu AA, Alimi FM, Gbadegesin AAS, Salami AO, Olawepo A, Adebule TG, et al. Complications and causes of death in spinal cord injury patients in Nigeria. West Afr J Med. 2011;30:301–4.
34. Nogueira PC, Caliri MHL, Haas VJ. Profile of patients with spinal cord injuries and occurrence of pressure ulcer at a university hospital. Rev Lat Am Enferm. 2006;14:372–7.
35. Hossain MS, Harvey LA, Islam MS, Rahman MA, Muldoon S, Biering-Sorensen F et al. A community-based intervention to prevent serious complications and death 2 years after discharge in people with spinal cord injury in Bangladesh (CIVIC): a randomised trial. Spinal Cord. 2021;59:649–58.
36. Hossain MS, Harvey LA, Rahman MA, Muldoon S, Bowden JL, Islam MS, et al. Community-based interventions to prevent serious complications (CIVIC) following spinal cord injury in Bangladesh: protocol of a randomised controlled trial. BMJ Open. 2016;6:e010350.

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AUTHOR CONTRIBUTIONS

PDC, LAH, RDH, and MSH conceived the study. LAH, MSH, RDH, SJ, and IDC secured funding. PDC, MSI, and MAR collected data. MSI, MAR, and PDC managed or contributed to the management of the site. LAH, RDH, and PDC conducted the statistical analyses. LAH, RDH, and PDC interpreted the results. PDC, LAH, and RDH wrote the first draft of the manuscript. MSH, MSI, MAR, JVG, HL, SJ, and IDC reviewed the manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ETHICS STATEMENT

Ethical approval was obtained from the ethics committees of CRP, Bangladesh and the University of Sydney, Australia. Written consent was obtained from all participants involved in the study. Institutional and governmental regulations concerning the ethical use of human volunteers were followed.

ADDITIONAL INFORMATION

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