Outcomes in socioeconomically disadvantaged patients with spinal cord injury: a systematic review

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OBJECTIVE Individuals with a spinal cord injury (SCI) in socioeconomically disadvantaged settings (e.g., rural or low income) have different outcomes than their counterparts; however, a contemporary literature review identifying and measuring these outcomes has not been published. Here, the authors' aim was to perform a systematic review and identify these parameters in the hope of providing tangible targets for future clinical research efforts.

METHODS A systematic review was performed to find English-language articles published from 2007 to 2017 in the PubMed/MEDLINE, EMBASE, and SCOPUS databases. Studies evaluating any outcomes related to patients with an SCI and in a low-resource setting were included. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed, and a flowchart was created. Of the 403 articles found, 31 underwent complete review and 26 were eligible for study inclusion. According to the current study criteria, any case studies, studies in less developed countries, studies including and not separating other types of neurological disorders, studies not assessing the effects of a low-resource setting on outcomes in patients with SCI, and studies evaluating the causes of SCI in a low-resource setting were excluded.

RESULTS In SCI patients, a lower income was a predictor of death (OR 2.1, 95% CI 1.7–2.6, $p = 0.0002$). Moreover, secondary outcomes such as pain intensities (OR 3.32, 95% CI 2.21–4.49, $p < 0.001$), emergency room visits (11% more likely, $p = 0.006$), and pressure ulcer formation (OR 2.1, 95% CI 1.5–3.0, $p < 0.001$) were significantly higher in the lower income brackets. Rurality was also a factor and was significantly associated with increased emergency room visits (OR 1.5, 95% CI 1.1–2.1, $p = 0.01$) and lower outpatient service utilization (incidence rate ratio [IRR] 0.57, 95% CI 0.35–0.93, $p < 0.05$).

CONCLUSIONS The authors showed that individuals in a low-resource setting who have suffered an SCI have significantly different outcomes than their counterparts. These specific outcomes are promising targets for future research efforts that focus on improving health conditions among this population.

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KEYWORDS spinal cord injury; socioeconomically disadvantaged; rurality

SPINAL cord injury (SCI) remains a concerning health problem throughout the world. With the aging of the population and the limited resources devoted to public health in certain socioeconomically disadvantaged populations, it is essential to investigate novel rehabilitation models and practices for patients suffering from SCI with either an acute or a chronic etiology.^{8,12} Besides the in-hospital rehabilitation interventions, increased support, and improved patient education in the acute phase of this disease, one of the emerging challenges of modern health systems is the long-term management of patients outside of high-resource healthcare structures.^{2,3} This is especial-

ly evident in settings such as rural areas and low-income neighborhoods.^{34,35}

In the United States, SCI has been reported to be prevalent among 250,000 persons, with an estimated 12,000 new cases per year.¹⁰ Most of these injuries are produced by trauma, accounting for approximately 10,000 of the new cases annually.¹ The mortality rate for this population is close to 1000 deaths per year, although this rate continues to decline with advances in SCI emergency care and rehabilitation.¹⁰ Well-known prognostic factors include age, SCI level, and neurological grade at the time of injury.⁴⁰ Moreover, the 1st year after injury is the most critical

ABBREVIATIONS IRR = incidence rate ratio; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SCI = spinal cord injury.

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FIG. 1. PRISMA flowchart of the included reviews.

period as mortality rates are the highest during this time. A considerable, but not well-studied, proportion of these events are distributed among persons in a low-resource setting. A series of studies completed in the recent past have demonstrated that income quartile and location (rural vs urban) are significant predictors of death.^{4,7,23}

The prognosis for recovery after SCI remains challenged by severe motor and sensory deficits, as well as the onset of secondary comorbidities. Certainly, some hurdles can be challenging to navigate in a low-resource setting and thus can negatively affect the patient. For example, the supply of rehabilitation therapists across the low-resource population has been shown to be a major factor in determining outcomes.¹⁶ Therefore, in this systematic review, SCI outcomes are highlighted with a particular focus on socioeconomically disadvantaged settings.

Methods

The PubMed/MEDLINE, EMBASE, and SCOPUS databases were searched using appropriate Medical Subject Headings (MeSH) and the following free subject terms in relation to SCI: 1) “rural,” 2) “low income,” 3) “low resource,” and 4) “income level.” The following terms were combined interchangeably with the aforementioned terms: 5) “management,” 6) “outcome,” 7) “treatment,” 8) “review,” and 9) “meta-analysis.” All search results were restricted to English-language articles published in the pe-

riod from 2007 to 2017. Moreover, we followed Preferring Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig. 1) in terms of eligibility criteria, study selection, summary measures, etc.³²

Of the 403 articles found, 31 underwent complete review and 26 were eligible for study inclusion. According to the study criteria, any case studies, studies in less developed countries, studies that included and did not separate other types of neurological disorders (e.g., stroke, traumatic brain injury), studies that did not assess the effects of a low-resource setting on outcomes in patients with SCI, and studies that evaluated the causes of SCI in this type of setting, were all excluded. Two authors (A.J. and M.D.W.) were involved in selecting relevant studies and following the PRISMA flow diagram. Disagreements were resolved by discussion with the third author (N.A.). We chose to limit our study to more developed countries because including the less developed countries could present a biasing effect in our results. Moreover, even in the more developed countries with efficient healthcare systems in place, we still see disparities in outcomes.

Results

Income

The majority of included articles supported the notion that income is related to outcomes after suffering from

TABLE 1. Income and SCI outcomes

Authors & Year	Study Type	Period Covered	No. of Subjects (injury type)	Main Finding(s)
Arnet et al., 2016	Cross-sectional survey	2005–2009	1,549	Middle- & high-income-tertile patients w/ SCI more prone to use handbike than low-income-tertile patients (24% & 29% vs 16%, respectively)
Brodell et al., 2015	Retrospective cohort	2003–2010	16,213 (only patients w/ central cord syndrome)	Overall inpatient mortality rate 2.6%; inpatient mortality in urban setting had OR 0.5 (95% CI 0.2–0.8, $p < 0.01$) vs that in rural setting; strangely, inpatient mortality for patients in \$40k–\$60k income level range had OR 3.4 (95% CI 1.8–6.6, $p < 0.01$) vs that for patients w/ income $< \$40k$
Cao et al., 2014	Cohort	1998–2008	434 across 3 hospitals	Both high- & low-income individuals experienced global satisfaction decline over the yrs; disparities in social isolation & income resources at injury onset remained unchanged over time; nonetheless, initial vocational disparities btwn the 2 groups disappeared over time
Dismuke et al., 2015	Cohort	1995–2010	1,408	Family income interval w/ highest rate of diabetes was \$15k–\$20k; diabetes associated w/ reduction of \$8,560 in family income
Fekete et al., 2015	Observational cross-sectional	2011–2013	1,549 (mixes traumatic & nontraumatic)	Financial hardships significantly associated w/ comorbidities (OR 2.88, 95% CI 1.83–4.53), pain intensity (OR 3.32, 95% CI 2.21–4.49), & participation in rehabilitation (OR 0.30, 95% CI 0.21–0.43)
Kim et al., 2013	Cross-sectional survey	2009	371 (any type of SCI)	Prevalence of obesity in patients w/ SCI not significantly different for various income subgroups ($p = 0.39$)
Krause et al., 2009	Prospective cohort	1997–2007	1,386 (traumatic injury)	Lower income associated w/ higher mortality risk (HR 1.76, $p < 0.0001$)
Krause et al., 2010	Prospective cohort	1997–2007	1,386 (traumatic injury)	Lower income significantly associated w/ higher mortality (OR 2.4, 95% CI 1.41–4.13)
Krause et al., 2011	Cohort	1995–2006	8,027 (traumatic injury)	Lower income significant predictor of mortality (OR 2.31, 95% CI 1.76–3.02)
Krause et al., 2012	Prospective cohort	1995–2006	7,955 (traumatic injury)	Lower income associated w/ higher mortality rate (OR 2.1, 95% CI 1.67–2.64)
Krause et al., 2015	Cross-sectional survey	2010–2013	1,579 (traumatic injury)	Patients w/ higher income 8%–11% less likely to visit ER ($p < 0.01$); however, income not a significant variable in determining hospitalization rates
Krause et al., 2016	Retrospective cohort	1973–2006	8,157 (traumatic injury)	Higher income resulted in lower HR for all-cause mortality (HR 0.55, 95% CI 0.46–0.66)
Lim et al., 2017	Retrospective cohort	1999–2008	3,556 (traumatic injury)	Patients w/ low economic status had significantly higher anxiety or depression incidence rate (IRR 1.29, 95% CI 1.04–1.61)
Phillips et al., 2012	Prospective cohort	2010–2012	111 (any injury)	Higher income significantly increased likelihood of returning to productive activities (median difference of 244 days, $p < 0.001$)
Saunders & Krause, 2011	Cross-sectional survey	1997–1998	1,549 (traumatic injury)	Higher income associated w/ heavy alcohol use ($p < 0.0001$)
Saunders et al., 2012 ³⁸	Cross-sectional survey	NR	2,549 (traumatic injury)	Lower income significantly associated w/ pressure ulcer formation after controlling for demographic & injury variables (OR 2.1, 95% CI 1.5–3.0)
Saunders et al., 2012 ³⁹	Cohort	2002–2008	801 (traumatic injury)	Income significant in development of depression (OR 2.27, 95% CI 1.48–3.48); however, it was not significant after controlling for behavioral factors
Yuen et al., 2009	Cross-sectional survey	2006–2007	192 (traumatic injury)	Lower income predictive of oral (tooth & gum) problems (OR 1.66, 95% CI 1.18–2.33)

ER = emergency room; NR = not reported.

SCI (Table 1). For example, a lower income was a significant predictor of death, as described in multiple cohort studies by Krause et al. (for example, OR 2.31, 95% CI 1.76–3.02 in 2011 study in over 8000 patients who suffered traumatic SCI).^{22–28} Moreover, a lower income was associated with secondary outcomes as well. In the hospital setting, a lower income was associated with pressure ulcer formation (OR 2.1, 95% CI 1.5–3.0), pain intensity (OR 3.32, 95% CI 2.21–4.49), and lower participation (OR 0.30, 95% CI 0.21–0.43).^{14,38}

Anxiety and depression rates in patients with a lower income were mixed. One cohort study reported a significantly higher incidence of anxiety and depression (incidence rate ratio [IRR] 1.29, 95% CI 1.04–1.61). An observational study had similar findings with lower overall mental health scores (based on a self-reported questionnaire, $p < 0.001$) associated with lower incomes.^{14,30} Contrastingly, another cohort study reported that although income was significant in the development of depression (OR 2.27, CI 1.48–3.48), it was not significant after controlling for behavioral factors

TABLE 2. Rurality and outcomes in patients with SCI

Authors & Year	Study Type	Period Covered	No. of Subjects (injury type)	Main Finding(s)
Bell et al., 2017	Retrospective cohort	2010 & 2012	243 (any SCI)	Decrease in outpatient services utilization w/ longer travel distances; one model showed 14% decreased participation rates per 2-fold increase in travel distance (RR 0.86, 95% CI 0.7–0.95); notably, no clear geographic patterns observed btwn rural & urban areas
Glennie et al., 2017	Cohort	2004–2012	338 (traumatic injury)	Perception of physical barriers (e.g., accessibility) & actual lack of services significantly more prevalent in rural group ($p=0.002$ & $p=0.042$, respectively); after 1 year, depression more prevalent in rural group (19% vs 35%, $p=0.015$)
Guilcher et al., 2010	Retrospective cohort	2003–2006	1,562 (traumatic & nontraumatic injuries)	More ER visits in rural setting (OR 1.5, 95% CI 1.1–2.1) & low-income population (OR 1.4, 95% CI 1.1–1.9)
Haddad et al., 2016	Retrospective cohort	2000–2013	1,872,327 (traumatic & myelopathic injuries)	Although incidence is around 1%, SSI incidence significantly higher in smaller hospital (OR 1.3, 95% CI 1.11–1.60) & in rural hospital (OR 1.4, 95% CI 1.04–1.74)
Hamilton et al., 2017	Cross-sectional survey	2016	142 (any SCI)	Visits to physiatrist significantly lower in patients living in rural area ($p=0.008$), w/o insurance ($p<0.001$), & w/ lower income ($p=0.01$)
Jaglal et al., 2009	Retrospective cohort	2003–2006	559 (traumatic injury)	Rehospitalization associated w/ patients living in rural areas (OR 1.94, 95% CI 1.18–3.17)
Ronca et al., 2017	Cross-sectional survey	2011–2013	492 (chronic SCI)	In urban areas, clinic visits 1.8 times more frequent than in rural areas (IRR 0.57, 95% CI 0.35–0.93)
Veeravagu et al., 2013	Retrospective cohort	1988–2008	37,593 (SCIs mixed w/ vertebral column fractures)	Surprisingly, patients w/ SCI &/or vertebral column fracture in rural hospital vs urban-academic hospital had lower chance (OR 0.54, 95% CI 0.46–0.61 $p<0.001$) of developing acute respiratory distress syndrome &/or acute lung injury; most notable hospital complications for this subpopulation were cardiac arrest (OR 14, 95% CI 11.8–16.7, $p<0.001$), sepsis (OR 8.6, 95% CI 7.7–9.7, $p<0.001$), & neurological dysfunction (OR 3.72, 95% CI 3.35–4.14, $p<0.001$)

SSI = surgical site infection.

such as pain medication use, hours in bed, and exercise.³⁹ Other comorbidities seen to be higher in patients with a low income included diabetes mellitus (higher rates in the \$15,000–\$20,000 income range, $p < 0.05$) and tooth and gum problems (OR 1.66, 95% CI 1.18–2.33).^{11,44}

As regards long-term outcomes, a study based on a questionnaire reported that the prevalence of obesity was not significantly different for various income groups ($p = 0.39$).²¹ Paradoxically, one recent cohort study reported a higher mortality rate among patients in the \$40,000–\$60,000 income range than that among patients with less than \$40,000.⁷ In addition, a higher income has been associated with heavy alcohol use.³⁷

Patients with a higher income were 10% less likely to visit the emergency room ($p < 0.01$); however, income was not a factor in hospitalization rates.²⁹ Moreover, a higher income was significantly predictive of an increased likelihood of returning to productive activities (return to work: 244 days earlier, $p < 0.001$) and an increased use of handbikes (29% vs 16%, $p < 0.001$).^{4,33}

Rurality

The majority of articles supported the idea that a rural setting is associated with poorer outcomes (Table 2). For example, a rural environment was significantly associated with two or more emergency room visits (OR 1.5, 95% CI 1.1–2.1) as compared to the urban counterpart.¹⁷ Rehospi-

tization was also significantly higher in the rural population (OR 1.94, 95% CI 1.18–3.17).²⁰ Although uncommon, the incidence of infection after spinal cord surgery was significantly higher in rural hospitals (OR 1.4, 95% CI 1.04–1.74).¹⁸ Contrastingly, the probability of developing an acute respiratory distress syndrome or acute lung injury was lower in a rural hospital than in an urban-academic hospital (OR 0.54, 95% CI 0.46–0.61).⁴³ Finally, a single study reported a higher prevalence of depression in the rural group (35% vs 19%, $p = 0.015$).¹⁵

One popular theme across multiple studies was accessibility. Three studies revealed significant differences in outpatient services utilization after hospital discharge. In a cross-sectional survey, urban areas demonstrated significantly higher clinic visits than rural areas (IRR 0.57, 95% CI 0.35–0.93).³⁶ Additionally, a cohort study found that visits to a physiatrist were significantly lower in patients living in a rural area ($p = 0.008$).¹⁹ One study reported a 14% decrease in participation rates for every twofold increase in travel distance.⁵ Finally, the perception of physical barriers (e.g., accessibility) and actual lack of services were significantly higher in the rural group ($p = 0.002$ and $p = 0.042$, respectively).¹⁵

Discussion

Unsurprisingly, the studies included in this review indicated that both rurality and disparities in income in

more developed countries lead to significantly lower life expectancies and significantly higher odds of secondary outcomes. Differences in outcomes were observed in the short term, after discharge, and in the long term, after several months to years. Although it is not surprising that a lower resource setting plays a role in outcomes, we can further analyze, based on the evidence presented, which specific factors are weighted more heavily.

Differences in income before an injury can affect an individual's capacity to return to work. Individuals with a higher income can more easily obtain transportation equipment to enable them to be mobilized. A higher income may place them in a higher socioeconomic stratum, which in turn can permit them to change careers to accommodate their specific deficits after injury. A patient with a lower income may be unable to acquire equipment or to change careers as easily.³³

Depressive symptoms and other psychological problems are highly prevalent in patients with SCI and can often compound with other variables such as age, severity of injury and pain, and social support.³⁹ In the case of patients in a lower income bracket, some studies have suggested they have even higher rates of mental health problems. In another study, after controlling for behavioral factors (such as pain medication use, hours out of bed, days out of the house, and exercise), income became nonsignificant.³⁹ These behavioral patterns may play a larger role and thus should be studied further.

Instead of stratifying patients based on income status, other researchers have proposed using perceived financial hardship and its relationship to outcomes to better model this population. In a large cohort study of Swiss patients who had suffered SCI, financial hardship was correlated with negative health outcomes in a univariate analysis.¹⁴ Moreover, after taking into account socioeconomic parameters such as education, income, and financial hardship, the authors found that only the latter factor was significant in determining outcomes such as comorbidities, mental health problems, and quality of life. Moreover, a recent cohort study concluded that financial hardship was "over and above" household income in determining death after an SCI.⁴² These findings suggest that, although financial hardship can be thought of as a function of income status, it may be completely independent of it in determining SCI outcomes. Therefore, further studies investigating patients in a low-resource setting would benefit from determining how financial hardship is perceived among their study population.

One proposed solution for tackling disparities in income and financial hardship is to increase telehealth efforts within this population. Telehealth, when conducted by an experienced physiatrist, can efficiently link underserved areas with SCI specialists while minimizing extraneous expenses.¹⁹ Unfortunately, motivating this population to participate in telehealth can prove challenging. Multiple studies have shown that lower participation rates in programs to improve health in the SCI population are correlated with lower incomes.^{9,13}

Patients in a rural setting can also benefit from telehealth services. Some regions simply lack the much-needed specialist care, leading patients with an SCI to rely

mainly on general practitioner expertise.³⁶ Our findings also suggest that limited access to experts in the field of SCI leads to increased visits to the emergency department.¹⁷ Increasing rates of emergency room visits, along with secondary complications as the leading cause of re-hospitalization, warrant further analysis into current practices and possible changes to prevent these outcomes.²⁰ There is already evidence suggesting that specialists, through the use of telehealth technologies, are efficiently improving outcomes within the SCI population.^{31,41}

Knowing that a return home is likely following rehabilitation after an SCI and that outcomes will be constant regardless of one's place of residence or financial status is positive information for individuals after a life-changing injury. Efforts after discharge should factor in financial status and rurality based on evidence that these variables play significant roles in patient care and related outcomes.¹⁵

Study Limitations

Outcomes observed in this study could have been influenced by factors such as different modalities or severities of injury (high-velocity traffic accident vs ground fall) and prehospital care that could not be accounted for in this study. The World Health Organization (WHO) and the International Spinal Cord Society (ISCoS) released an international report on SCI, stating that rollover traffic accidents are particularly common on rural roads, where high speeds and poorly maintained vehicles and infrastructure are risk factors.⁶ Additionally, it is known that individuals in rural settings experience longer transport times to medical centers than persons in urban areas.⁵ The inherent differences in the causes of SCI and prehospital care between rural and urban patients present some element of variability that could influence the observed outcomes. Although this study could not reliably account for these differences, it is important to note them.

Another limitation of this study is the lack of a standard global definition of what constitutes a rural setting. Although there was not a homogeneous definition for rurality across the included studies, frequent themes were present throughout. For example, we commonly observed population density (usually around 100–200 people per square mile) and travel distances to the appropriate healthcare center (usually about 2 times farther than urban dwellers) as variables to distinguish rural versus urban settings across the SCI population. The definition of a low-resource setting was another source of variability and was sometimes explicitly scaled to take into account household size and generally ranged from less than \$10,000 to \$25,000. At any rate, the 26 studies were chosen based on whether they made an explicit distinction between low- and high-income subgroups (or rural and urban settings) within their SCI cohort. Additionally, two-thirds of the studies were based in the United States, whereas the other third were based in various more developed countries, mainly in Europe. Differences in health systems within these countries are a potential source of variability as well.

Conclusions

Even in more developed countries, complications as

early as immediately after surgery are correlated to a low-resource setting and not entirely attributable to technical aspects.²² If income and rurality are indeed significant factors, as demonstrated here, then they would serve as promising targets to improve outcomes post-SCI. Resolving socioeconomic disparities would require changes in policies and regulations.

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Disclosures

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Author Contributions

Conception and design: Agarwal, Jorge. Acquisition of data: Jorge, White. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Agarwal. Statistical analysis: Jorge. Administrative/technical/material support: all authors. Study supervision: Agarwal, Jorge.

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