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The socioeconomic impact of a femoral neck fracture on patients aged 18-50: A population-based study

Nathan N. O'Hara[a,b,*], Gerard P. Slobogean[a], David J. Stockton[c], Christopher C. Stewart[a], Niek S. Klazinga[b]

[a] Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, MD, USA
[b] Academic Medical Center, University of Amsterdam, Amsterdam, the Netherlands
[c] Department of Orthopaedics, University of British Columbia, Vancouver, BC, Canada

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ABSTRACT

Background: By linking health and census data, the objective of this study was to determine the effect of a femoral neck fracture on the household income of non-elderly patients.
Methods: All individuals aged 18–50 who underwent internal fixation for a femoral neck fracture during the years 2006–2012 in the Canadian Province of British Columbia were included in the study. Patient-level hospital data was linked with patient's after-tax household income decile, as estimated by Statistics Canada Postal Code Conversion Files. The primary endpoint was a decline of ≥2 income deciles following the index fracture. Kaplan-Meier analysis was performed to estimate the probability of income decline during the study period. A Cox regression model was used to study the association between a ≥2 income decline and patient age, sex, reoperation, and pre-injury income decile.
Results: Of the 391 femoral neck fracture patients included, the majority of patients were male (61.6%), with a median age of 43 years (IQR: 35–48), and a pre-injury median income in the fifth decile (IQR: decile 3–8). 27.0% of patients sustained a decline of ≥2 income deciles during the study period, with 16.3% declining ≥2 income deciles within 2-years of injury. A pre-injury household income in the top 4 deciles (mean of deciles: $57,000–170,500) was associated with an increased likelihood of a ≥2 drop in household income (HR: 1.38, 95% CI: 1.06–1.79, p = 0.02).
Discussion: Over a quarter of the femoral neck fracture patients in this study sustained a decline of ≥2 deciles in their household income following their injury. The income decline was disproportionately absorbed by patients with baseline incomes in the 6th decile or higher. This suggests that the available incapacity programs are limited in providing income protection to patients with higher incomes.

Introduction

Sudden health events, such as myocardial infarction, a cancer diagnosis, or a femur fracture, bear substantial medical costs. A principal objective of healthcare insurance is to pool the risk of these health events among individuals, and therefore providing financial protection for the patient against a catastrophic health expenditure [1]. In Canada, and as in most countries of the Organisation for Economic Co-operation and Development (OECD), health systems and financial risk-pooling mechanisms have been developed to protect patients from catastrophic health expenditures [1]. However, less attention is directed towards the economic impact of these health conditions beyond direct healthcare expenditures.

Following recommendations by the National Academy of Sciences in 1966 that stated trauma should be recognized as an important public health issue [2], trauma systems in OECD countries have observed rapid advances in improving access and quality of care [3]. Financial protection against emergency medical costs is generally included in countries with universal health insurance coverage or supported through additional forms of protection such as the Emergency Medical Treatment and Active Labor Act in the United States [4]. The coverage of post-acute medical costs can vary substantially among countries. Protecting individuals from employment income loss following a medical condition may include private disability protection, workers compensation for work-related injuries, or incapacity protection by a government welfare system that may consist of employment insurance and disability coverage [5].

* Corresponding author at: Department of Orthopaedics, University of Maryland School of Medicine, Suite 300, 110 S. Paca St. Baltimore, MD, 21201 USA.
E-mail address: nohara@som.umaryland.edu (N.N. O'Hara).

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Resuming economic activities after an injury is important to patients and predictive of future health [6,7]. However, there is a paucity of data on the long-term economic impact of an orthopaedic injury or the effectiveness of post-acute financial protection in mitigating economic loss. A recent study in Italy estimated that patients with a pelvis or acetabular fracture lost over 17,000 euros in income due to lost productivity [8]. This estimate was calculated as the monetary value of one lost working day multiplied by the gross domestic product of the country per day. However, the study failed to account for any long-term impairment in productivity or modifications in occupation. Rotondi et al investigated the impact on fragility fractures on return to work and work productivity in a Canadian cohort and found 86% of the sample returned to work within 6-months with no work modifications [9].

Understanding the long-term economic impact of orthopaedic injuries is essential to developing effective health and welfare policies that provide long-term financial protection to patients and their families. Knowledge of the economic consequences of injury is also of value to the treating surgeon, to not only prepare fracture patients for the financial challenges they may face during recovery but also to refer their patients to other services or programs equipped to support the patient's socioeconomic recovery.

Among orthopaedic injuries, femoral neck fractures in non-elderly adults are known to be associated with substantial health-care costs [10]. These fractures often are the result of high-energy trauma, and successful treatment is challenging due to difficulty in preserving the native hip joint [11–14]. Complications rates for femoral neck fractures in non-elderly adults likely exceed 20% and can substantially impact physical function [14–17]. Given the challenges in treating femoral neck fractures and high rate of complications for this injury, it is a valuable benchmark for future post-injury financial protection policy.

By linking health and census data, this study aimed to describe the associated effect of a femoral neck fracture on the household income of non-elderly patients. The secondary objective was to determine the independent associations between post-fracture income decline and patient sex, age, pre-injury income, and reoperation for bone-healing complications. Furthermore, we investigated if income loss within the first two-years of injury was sustained.

Methods and materials

Study design

This longitudinal cohort study linked patient-level hospital billing data from the Canadian Province of British Columbia with the patient's after-tax household income decile, as estimated by Statistics Canada Postal Code Conversion Files. The data linkage was performed by Population Data BC, a multi-university, data, and education resource facilitating interdisciplinary research on the determinants of human health, well-being, and development of British Columbian's 4.6 million citizens. The data sources from this study included the Medical Services Plan (MSP) Payment Information Files that capture data on medically necessary services provided by physicians to individuals covered by MSP, the province's universal insurance program [18]; the Discharge Abstracts Database (DAD) which contains demographic, administrative, and clinical data for all patients discharged from acute-care hospitals in British Columbia [19]; and Statistics Canada Postal Code Conversion Files that contain basic demographic information including geocoding that indicates location of residence [20]. These databases are held securely in a linked, de-identified format with Population Data BC (www.popdata.bc.ca). Clinical Research Ethics Board at the University of British Columbia approved by the study (H14-03413).

Study participants

All individuals aged 18 to 50 who underwent internal fixation for a femoral neck fracture (MSP code 55751 for closed reduction internal fixation and 55755 for open reduction internal fixation) between January 1, 2006 to December 31, 2012 in British Columbia were included in the study. Patients who concomitantly experienced femoral shaft fractures (MSP codes 55782, 55783, and 55785) were also included; however, those that had a pelvic or acetabular fracture (MSP code 55741, 55745, or 55746) were excluded. This type of fracture was selected as the injury of interest because of its relatively high complication rate, but its potential for good long-term functional recovery in the non-elderly population. Patients were also excluded if they moved out-of-province after their index surgery (identified by the Province of Patient code from the DAD). All patients had a minimum of 1-year follow-up.

Primary endpoint

Income mobility has an absolute and relative component [21]. Absolute mobility measures the change in income of an individual relative to their previous income. Whereas, relative mobility depends on both the income of the individual in question and the incomes of others within a given region or jurisdiction. The primary endpoint for the study was a decline of $\geq$2 income deciles following index fracture and is a measure of relative income mobility. Despite this being an individual patient-level analysis, the income level, as reported by the Statistics Canada Postal Code Conversion Files was determined by the adjusted mean after-tax family income for the patient's geographic code. The Statistics Canada Postal Code Conversion Files are based on enumeration areas with relatively homogeneous economic and social living conditions and has been previously validated [22,23]. Adjusted family after-tax income is defined as the sum of after-tax income earned by all family members in a household divided by the square root of the family size. All dollar figures were converted into 2006 constant dollars. For the 2006 census year, mean incomes ranged from $9000 in the lowest decile to $170,500 in the highest decile.

Study variables

In addition to income data, several additional variables of interest were included in our analysis. Age and sex variables were obtained from the DAD. Baseline income was determined based on the year prior to the index fracture. Reoperation was defined as a composite of procedures performed after the index surgery, including: hardware removal (MSP code 55,415 or 55420), proximal femur osteotomy (55,603), bone grafting (MSP code 55,651), non-union fixation (MSP code 55,633), hip hemiarthroplasty (55,662), and total hip arthroplasty (MSP code 55663).

Statistical analysis

Patient characteristics were described using medians with interquartile ranges for continuous variables and frequencies and proportions for categorical data. Kaplan-Meier analysis was performed to determine the incidence of income decline during the study period. Patients that did not experience the primary endpoint were censored at the end of the study period. A Cox proportional-hazards regression model was used to study the associations between a $\geq$2 income decline and patient age, sex, any reoperation, and pre-injury income decile in a bivariate analysis. Covariates with an association of $p < 0.2$ were included in a multivariable model. Finally, the proportion of annual income mobility between years 2–7 post-injury was compared between patients with income decline within 2-years to those without an

income decline in 2-years using a Chi-squared test. All statistical analysis was performed with SPSS Version 24 (Chicago, IL).

Results

Three hundred ninety-one femoral neck fracture patients were treated with internal fixation from 2006 to 2012, and included for analysis in this study. The majority of the patients were male (61.6%), with a median age of 43 years (IQR: 35–48), and a pre-injury median income in the 5th decile (mean income for 5th decile: $46,000; IQR: decile 3–8 ($28,000-$83,600)) (Table 1).

Twenty-seven percent (SE: 4.2) of the cohort sustained a decline of ≥2 income deciles during the study period, with 16.3% (SE: 2.5) of the cohort declining ≥2 income deciles within 2-years of injury (Fig. 1). There was significant variation in the proportion of the sample with a ≥2 income decile reduction in income when stratified by income decline at baseline ($p < 0.01$) (Table 2). A pre-injury household income in the top 4 deciles (mean of deciles: $57,000–170,500) was associated with an increased likelihood of ≥2 decile drop in household income (HR: 1.38, 95% CI: 1.06–1.79, $p = 0.02$) (Table 3). Patient age (HR: 1.00, 95% CI: 0.97–1.02, $p = 0.65$), sex (HR: 0.99, 95% CI: 0.62–1.59, $p = 0.96$), or requiring a reoperation (HR: 0.94, 95% CI: 0.71–1.20, $p = 0.63$) were not associated with a decline in household income following injury in our bivariate or multivariable analysis.

The income deciles remained relatively stable for both patients that experienced a ≥2 income decile decline in income within 2-years of their fracture, with 59–83% of the sub-group experiencing no change in annual income in the subsequent years (Table 4). Of those with the initial income decline, 8–24% declined further in the subsequent years. By contrast, 6–17% experience an annual increase in their incomes. Of the sub-group of patients that did not experience income decline within 2-years of injury, 79–87% did not experience a change in income in the subsequent years. No evidence of substantial economic recovery was observed in patients that experienced a ≥2 income decile decline in income within 2-years of their fracture. Moreover, we observed higher rates of income decline in years 3–5 for patients with income decline within two-years compared to those patients with no initial decline.

Discussion

Over a quarter of non-elderly femoral neck fractures in British Columbia injured between 2006–2012 sustained a decline ≥2 deciles in their household income following their injury. Depending on the pre-injury income decile of the patient (Table 2), a 2 decile decline in income translates to a 32–69% absolute reduction in annual income. Patients with a pre-injury household income in the top 4 income deciles were 38% more likely to experience this level of income decline. Age, sex, or a reoperation due to a bone-healing complication were not associated with post-injury income decline. Minimal income recovery was observed in the 5-years following injury in those patients that experienced a decline of ≥2 income deciles within 2-years of injury.

The findings suggest that while a hip fracture has substantial economic consequences to patients ages 18–50, the available social safety nets mitigate catastrophic income decline for patients on the lower end of the income spectrum. Current employment insurance protection in Canada provides income support up to a maximum of $51,300 [24], which is the 5th decile in 2006 dollars. Our findings suggest that this support effectively protects British Columbians with a baseline income in the 5th decile or lower from substantial income decline following injury. Expanding the income limits of welfare protection programs may guard fracture patients with higher incomes from their high rate of income decline following injury. Furthermore, additional financial protection and rehabilitation support may assist in long-term financial recovery for those patients that experienced substantial income loss within 2-years of injury.

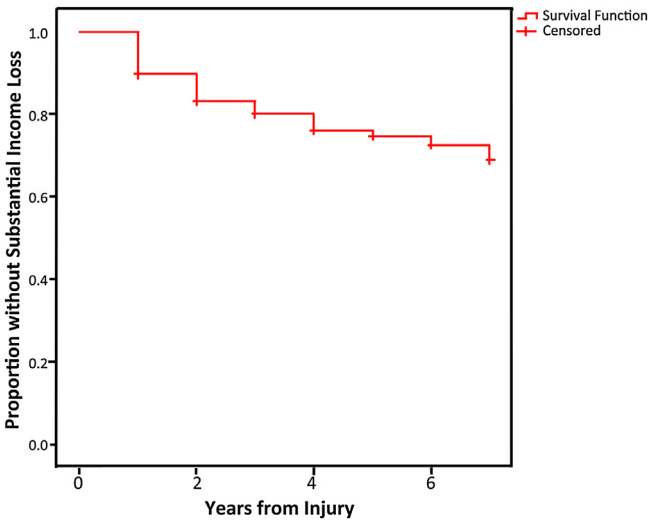

Fig. 1. Kaplan Meier curve representing the proportion of the sample that did not experience substantial income loss. Substantial income loss is defined as a ≥2 decile decline in income following their index fracture.

There is limited data on the long-term economic impact of orthopaedic injuries. Given the severity of these fractures, it is reasonable to assume the injury would impair short-term employment productivity. However, our data suggest that income loss in femoral neck fracture patients is sustained beyond two years. There are several possible explanations for this observed effect. Campenfeldt et al demonstrated that the majority of patients ages 20–69 years with healed femoral neck fractures due to return to their pre-injury physical function at 2 years from injury [25]. This persistent physically impairment is likely associated with some of the post-injury economic decline. Rogmark et al suggest that low bone mineral density is a common risk factor for non-elderly hip fractures regardless of the trauma mechanism [26]. This reduced bone strength may impede many patient's recovery to pre-injury levels of economic productivity. The sustained income loss observed in this study may also be linked with concomitant post-injury mental health challenges. A study by Whooley et al noted that depressive symptoms were associated with a significant loss in family income and higher rates of unemployment [27]. A recent meta-analysis estimated that over 30% of orthopaedic trauma patients have depressive symptoms, and over 25% demonstrate a moderate to severe post-traumatic stress disorder [28]. These data suggest that, in addition to physical impairment, the post-fracture mental health condition of a patient may play a role in long-term income decline.

Research by Zhang et al provides detailed information on income mobility in Canada during our study period [29]. Their paper details how income growth between 1982–2012 was mainly concentrated in individuals aged 25–44, highlighting the particular importance of this age group on the province's economic growth

Table 1
Patient characteristics. (n = 391).

Characteristic	
Age, median (IQR)	43 (35-48)
Sex, male, n (%)	244 (61.6)
Income decile at injury, median (IRQ)	5 (3-8)

Table 2
Canadian income statistics by after-tax income decile.

Income Decile	Mean Income (2006)	Proportion at Time of Injury	Proportion with Income ≥2 decile Decline
Lowest decile	9000	12.5	0
Second decile	20,100	9.2	0
Third decile	28,800	12.0	6.4
Fourth decile	37,600	10.0	25.6
Fifth decile	46,600	8.7	20.6
Sixth decile	57,000	12.0	29.8
Seventh decile	68,600	8.7	20.6
Eighth decile	83,600	11.3	34.1
Ninth decile	104,700	9.0	28.6
Highest decile	170,500	6.6	26.9

Table 3
Association between a ≥2 decile decline in income and patient age, sex, baseline income, and a reoperation.

	Bivariate			Multivariable		
	HR	95% CI	P-value	HR	95% CI	P-value
Reoperation	1.40	0.87 – 2.25	0.17	0.94	0.71 – 1.20	0.63
Sex, Male	0.99	0.62 – 1.59	0.96		–	
Age (continuous)	0.98	0.96 – 1.01	0.16	1.00	0.97 – 1.02	0.65
Baseline Income						
Decile (3-5)	Reference (1.00)			Reference (1.00)		
Decile (6-10)	1.40	1.08 – 1.80	0.01	1.38	1.06 – 1.79	0.02

Table 4
Comparison in the change in annual income decile, stratifying the cohort between patients that had a ≥ 2 decline in income within the first 2-years from injury with those patients that did not experience a ≥ 2 decline in income within the first 2-years from injury.

		≥ 2 Decile Decline within 2-Years of Injury				No ≥ 2 Decile Decline within 2-Years of Injury			
Years Post-Injury	N	Income Decrease	No Change	Income Increase	N	Income Decrease	No Change	Income Increase	P Value
Year 2-3	61	11 (18)	43 (70)	7 (11)	164	16 (10)	130 (79)	18 (11)	0.22
Year 3-4	46	11 (24)	27 (59)	8 (17)	139	6 (4)	119 (86)	14 (10)	<0.001
Year 4-5	36	8 (22)	24 (67)	4 (11)	108	9 (5)	92 (85)	7 (6)	0.04
Year 5-6	24	2 (8)	18 (75)	4 (17)	69	7 (4)	60 (87)	2 (3)	0.06
Year 6-7	18	2 (11)	15 (83)	1 (6)	37	3 (2)	31(84)	3 (8)	0.89

Note: Income decrease refers to ≥ 1 income decile decline. Income increase refers to a ≥ 1 income decile increase.

and the downward economic strain associated these fractures. Additionally, Zhang's paper reports individuals in income deciles 6–10 having the most substantial proportion transitioning downward in their income. This finding suggests that economic factors outside of an individual's fracture likely contributes to the income decline we observed in our cohort.

The strengths of this study include its province-wide data and substantial follow-up. Canada's government health expenditures, federally supported incapacity programs, and employment protection laws are similar to many other OECD countries, including the United Kingdom, Australia, and New Zealand [30–32], and similar effects may be observed under these similar parameters. Previous studies on the economic impact of health conditions commonly use a human capital method, which only investigates the income loss of the individual. This study's use of geocoded zone income data is considerably more inclusive of the effect of other household members who may reduce their labor productivity to support the care of the patient. The methods used to link the administrative data and analyze economic impact can be easily replicated for other fracture types and in other countries.

Despite these strengths, the findings must be interpreted within the context of the study design, which presents several limitations. Firstly, the income data is based on the mean after-tax adjusted family income of the geocoded zone for that individual. While this has been demonstrated as a reliable estimate in previous research [23], it lacks the precision of individual-level data. Income mobility, under these parameters, would be the result of a change in mean income for the geocoded zone or the individual relocating to a different geocode zone. Furthermore, given the limited variables available through the administrative database, we were restricted in our analysis of factors associated with income decline. The absence of data on the post-acute medical disposition of patients is particularly limiting, and further study should investigate post-acute care as a possible pathway to divergent economic outcomes. While a composite covariate for reoperation was not found to be a factor associated with an increased risk of income loss, the effect of components of that covariate, such as a non-union or avascular necrosis, may have been attenuated by the inclusion of hardware removals.

Conclusions

In this study, we observed substantial downward income mobility by over a quarter for the study patients. This economic hardship was compounded by a period of relative income rigidity following the initial decline in income after the injury. The income decline was disproportionately absorbed by patients with baseline incomes in the 6th decile or higher, suggesting that current incapacity programs in British Columbia have their limits in providing financial protection for fracture patients with higher incomes. With an understanding of these economic implications of femoral neck fractures in non-elderly patients, surgeons can better

prepare their patients for these challenges during their recovery, as well as advocate for the necessary resources and reimbursements to manage these injuries and mitigate these negative socioeconomic outcomes. Further study on an individual level that includes pre-injury occupation and work history might help to identify policies that could help this specific category of fracture patients to cope, not only with the short-term but also the long term, socioeconomic consequences of a femoral neck fracture.

Conflicts of interest statement

NNO reports stock options with Arbutus Medical Inc. GPS is a paid consultant with Zimmer Biomet and Smith & Nephew, and receives research support from the Patient-Centered Outcomes Research Institute and the US Department of Defense. The other authors have no disclosures to report.

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