JSES International 7 (2023) 743–750

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Social determinants of outcomes in nonoperatively treated proximal humerus fractures

Shaun Kai Kiat Chua [a], Qian Ying Soh [a], Chien Joo Lim, MSc[b], David Ring, MD, PhD, FAOA, FAAOS[c], Ivan Tjun Huat Chua, MBBS, MRCS(Edin), MMed(Ortho), FRCS(Ortho)[d], Ernest Beng Kee Kwek, MBBS, MRCS(Edin), MMed(Ortho), FRCS(Ortho)[b], Bryan Yijia Tan, MBBS, MRCS(Edin), MMed(Ortho), FRCS(Ortho)[b,*]

[a]*Nanyang Technological University, Lee Kong Chian School of Medicine, Singapore, Singapore*
[b]*Department of Orthopedic Surgery, Woodlands Health, National Healthcare Group, Singapore, Singapore*
[c]*Department of Surgery and Perioperative Care, Dell Medical School, Austin, TX, USA*
[d]*Department of Orthopedic Surgery, Tan Tock Seng Hospital, Singapore, Singapore*

ARTICLE INFO

Keywords:
Proximal humerus fractures
Social factors
Trauma
Social determinants of health
Nonoperative
Conservative

Level of evidence: Level I; Prospective Cohort Design; Prognosis Study

Background: Proximal humerus fractures (PHFs) are common fractures especially in the elderly, with most fractures being managed nonoperatively. Traditional biomedical factors such as radiological alignment have not been able to meaningfully predict comfort and capability after PHFs. Conversely, recent literature has increasingly recognized the role of psychological factors in determining comfort and capability after PHFs. Nonetheless, less is known about the impact of social factors. Additional study of these potentially modifiable social factors as targets for enhancing recovery from injury is merited. Among people recovering from a nonoperatively- treated proximal humerus fracture (PHF) we studied the social factors associated with patient-reported outcomes at 6 months and 1 year.

Methods: One hundred seventy-one patients who received nonoperative management of a PHF completed baseline measures of sociodemographic characteristics (age, gender, race, employment status, household income, educational level, presence of domestic workers, housing type, and smoking status). Six and 12 months after fracture, participants completed the Oxford Shoulder Score (OSS), Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) and EuroQol-5-Dimensions (EQ5D) measures of comfort and capability. The relationship between capability and social factors was assessed using linear regression modelling, accounting for potential confounding from age, fracture severity assessed using Neer classification, premorbid comorbidities measured by Charlson Comorbidity Index, and premorbid functional status measured by Parker Mobility Index and Barthel Index.

Results: Lower capability (higher QuickDASH scores) 6 months and 1 year after fracture were associated with being unemployed (coef: −5.02 [95% CI: −9.96 to −0.07]; $P = .047$) and having domestic workers at home (coef: 8.63 [95% CI: 1.39 to 15.86]; $P = .020$), but not with Neer classification. Both greater shoulder discomfort and magnitude of incapability (lower OSS scores) and worse general quality of life (lower EQ5D scores) were associated with having domestic workers (coef: −4.07 [95% CI: −6.62 to −1.53]; $P = .002$ and coef: −0.18 [95% CI: −0.29 to −0.07]; $P = .001$ respectively) or living in an assisted care facility (coef: −14.82 [95% CI: −22.24 to −7.39]; $P < .001$ and coef: −0.59 [95% CI: −0.90 to −0.29] $P < .001$).

Conclusions: The finding that people recovering from PHF experience less incapability in proportion to their social independence (employment, absence of a caregiver such as domestic workers at home and living outside care facilities) emphasizes the important associations of social factors to musculoskeletal health, and the utility of accounting for social factors in the development and assessment of care strategies.

Ethical approval for this study was obtained from the Institutional Review Board (IRB), National Healthcare Group (NHG) Domain Specific Review Board (DSRB) (reference number 2016/01241).
This work was performed at the Department of Orthopedics, Tan Tock Seng Hospital, Singapore.

*Corresponding author: Bryan Yijia Tan, MBBS, MRCS(Edin), MMed(Ortho), FRCS(Ortho), Department of Orthopedic Surgery, Woodlands Health Campus, National Healthcare Group, 11 Jalan Tan Tock Seng, Singapore 308433, Singapore.
E-mail address: btanyj@hotmail.com (B.Y. Tan).

https://doi.org/10.1016/j.jseint.2023.05.013

There is growing attention on the association of social factors and health. The International Classification of Functioning (ICF), Disability and Health framework of the World Health Organization (WHO) encourages the consideration of mental, social, and pathophysiological factors when developing strategies to help people get and stay healthy.[28] A number of studies link socioeconomic disadvantage with worse health.[6] In the musculoskeletal realm, psychosocial factors such as symptoms of anxiety or depression, and lack of family or friend support are associated with greater incapability in patients with conditions like rotator cuff tendinopathy, osteoarthritis, and persistent shoulder pain.[16,26,29]

PHFs are common fractures occurring especially in the elderly population and associated with diminished capability and limited independence.[13,23]. Comfort and capability after fracture of the proximal humerus have limited correlation with radiological alignment.[11,22] On the other hand, less fear of painful movement (kinesiophobia) and more effective coping strategies such as pain self-efficacy seem to have important associations with comfort and capability in patients recovering from a PHF.[4,13] Less is known about the impact of social factors.[5] While social health factors including age, gender, education level, family support, and socioeconomic status (SES) are associated with pain intensity and death after hip and distal radius fractures, the evidence regarding PHFs is sparse.[15,16] Clement et al studied people recovering from proximal humerus fractures (PHFs) and found that age, living alone, dressing oneself or engaging in recreational activities were associated with better Constant Scores.[4] Additional study of social factors as targets for enhancing recovery from injury, as well as the utility of accounting for social factors in the development and assessment of care strategies is merited.

The aim of this study was to evaluate the social factors including age, gender, race, employment status, household income, educational level, presence of domestic workers, housing type, and smoking status associated with Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), Oxford Shoulder Score (OSS), and EuroQol-5 Dimensions (EQ5D) scores among people recovering from a nonoperatively treated fracture of the proximal humerus at 6 months and 1 year after the fracture.

Material and methods

This was a single-center prospective cohort study at a Level 1 trauma center from September 2017 to March 2021. Results were reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.[9] Ethical approval for this study was obtained from the Institutional Review Board (IRB), National Healthcare Group (NHG), and Domain Specific Review Board (DSRB) (reference number 2016/01241).

Patients

We included patients above 21 years of age who received nonoperative treatment for a PHF which presented within 3 weeks of sustaining the injury (Table I). Patients who presented more than 3 weeks postinjury, had an open fracture, severe soft tissue compromise, neurovascular injury, multiple injuries, pathological fractures, or were mentally incompetent, pregnant, deemed unfit for surgery due to multiple comorbidities (eg, heart failure, previous stroke) which predisposed to higher risk of surgery, and patients who received surgical treatment of PHF were excluded (Table I). Among the 219 patients who had a PHF between September 2017 and March 2021, 48 patients who received operative treatment were excluded. Overall, 171 patients were included in this study (Table II). All patients underwent a standardized rehabilitation program involving 3 main components of immobilization, followed by active and passive range of motion exercises and thereafter functional and strengthening exercises supervised by trained occupational therapists and physiotherapists.

Patient sociodemographic characteristics

The baseline demographic and social characteristics of patients included were age, gender, race, employment status, household income, educational level, presence of domestic workers, housing type, and smoking status. Charlson Comorbidity Index (CCI), Parker Mobility Score (PMS), and Barthel Index (BI) were also recorded.[3,17,18,20] The CCI is a weighted index based on a patient's comorbidities that is predictive of mortality. PMS is a composite measurement of the patient's mobility indoor, outdoors, and during shopping as a measure of mobility and has also been shown to be a predictor of mortality. BI is an ordinal scale used to measure performance in activities of daily living as a measure of functional independence.

In line with the Commission on Social Determinants of Health conceptual framework[27] (Fig. 1), social factors were chosen to represent social position (education, employment status, income, gender, ethnicity) and other cultural or societal norms (presence of domestic worker) that were associated with comfort and capability after PHF in an Asian cohort.[27] BI and PMS as measures of baseline comorbidities, ambulatory, ADL functional status, and potential significant confounders.

Outcome measures and radiographic evaluation

Patient-reported outcome measures (PROMs) including the Quick Disabilities of the Arm, Shoulder and Hand Score (QuickDASH), Oxford Shoulder Score (OSS), and EuroQol-5 Dimensions (EQ5D) questionnaires were used to assess the functional outcomes of patients at 6 months and 1-year postinjury. QuickDASH is an 11-item questionnaire used to evaluate the patient-reported symptoms and function of the entire upper extremity.[2] The QuickDash contains 11 items for which a total score ranging from 0 (best function/symptoms) to 100 (worst function/symptoms) may be obtained.[2] OSS is a validated scoring system based on a 12-item questionnaire to evaluate the patient-reported outcomes in terms of extent of shoulder pain, activities of daily living, and function in the last 4 weeks.[7] The OSS contains 12 items scored between 0 (worst function) to 4 (best possible function), with a score of 0 indicating poorest function and 48 indicating the best possible function.[8] EQ5D is a widely validated instrument used to assess generic quality of life (QoL), and comprises 5 questions on mobility, pain, self-care, psychological status, and usual activities.[21] For each of the 5 questions, a score of 1 (no problem) to 3 (severe problem) is rated by the patient, and a summary index with a maximum score of 1 (indicating the most optimal health state) can be calculated based on the scores of the 5 questions, with higher scores indicating poorer patient reported quality of life.[21]

Table I
Inclusion and exclusion criteria of patients.

Inclusion criteria	Exclusion criteria
More than 21 y of age	Presentation was delayed more than 3 week post-injury
Presented within 3 week of the injury	Open fracture
Received nonsurgical treatment	Mentally incompetent
	Severe soft-tissue compromise
	Neurovascular injury
	Multiple injuries
	Pathological fractures
	Pregnant at time of injury
	Multiple comorbidities and deemed unfit for surgery
	Received surgical treatment

The initial radiographs of the fractures were classified by a trained orthopedic senior resident using the Neer Classification.[18] The intra-rater reliability was assessed using kappa agreement, and good agreement was observed with kappa value of 0.610 with 78.07% agreement.

Sample size estimation

Sample size was calculated based using G*Power 3.1.9.4. The primary objective of the study was to explore the social factors predicting OSS, QuickDASH and EQ5D. Therefore, multiple linear regression was used in the study with the aim to explore 10 predictors. Given an effect size of 0.2, 0.05 type I error with 90% study power, the study targeted to recruit a total sample size of 113. The final sample size to be included into the study was 136 after accounting for 20% attrition rate.

Statistical analysis

Data were cleaned, explored, and analyzed using STATA version 14.0.[25] Descriptive statistics were used to describe the demographic characteristics and health related outcomes of the patients. The distribution of the continuous data were checked using skewness, kurtosis and histogram, and presented as median as the data were not normally distributed. Categorical variables were presented as frequency and percentage.

The factors associated with outcomes OSS, QuickDASH and EQ5D were explored using linear regression models. Bivariable analysis was performed and subsequently multivariable analysis with stepwise variable selection method. The final model was further adjusted for patients' age, Charlson Comorbidity Index (CCI), Parker Mobility Index (PMI), Barthel Index (BI), fracture severity (Neer classification), and nonunion to limit potential confounding. Variables with P value < .20 in bivariable analysis were included in the multivariable model. Multicollinearity and interaction terms were checked, and heteroscedasticity was checked using Breusch-Pagan/Cook-Weisberg test. Statistical significance was denoted as $P < .05$.

Results

Patient baseline demographics

Among the 171 included patients, the median age was 69 (Q62,Q78) years, with 76% (130 of 171) being females. Sixteen percent (25 of 171) of included patients had domestic workers and 79% (135 of 171) lived in the local government subsidized public housing, while 4% (6 of 171) lived in condominiums and 11% (19 of 171) lived in landed properties. One percent (2 of 171) lived in care facilities and 5% (8 of 171) lived in rental facilities. Eight percent (14 of 171) of patients had a PHF classified as Neer 1, 61% (105 of 171) had a Neer 2 PHF, 29% (49 of 171) had a Neer 3 PHF and 2% (3 of 171) had a Neer 4 PHF. The median CCI was 0 (Q0,Q2), while the median Barthel Index and Parker index were 20 (Q20,Q20) and 9 (Q9,Q9) respectively. The radiographs of patients at 1-year follow-up were assessed and 5 cases of nonunion were identified among patients. Further details of the patient demographics are summarized in Table II.

Table II
Demographic characteristics of the patients (n = 171).

Variables	Results
Age in y, median (IQR)	69 (62, 78)
Age in category, n (%)	
<65 y old	55 (32.16)
≥65 y old	116 (67.84)
Gender, n (%)	
Male	41 (23.98)
Female	130 (76.02)
Ethnicity, n (%)	
Chinese	149 (87.13)
Malay	11 (6.43)
Indian	7 (4.09)
Others	4 (2.34)
Employment status, n (%)	
Employed	61 (35.88)
Homemaker	34 (20.00)
Unemployed	5 (2.94)
Retired	70 (41.18)
Household income, n (%)	
<$1000	77 (45.83)
$1000-$5000	65 (38.69)
$5000-$10,000	18 (10.71)
>$10,000	8 (4.76)
Domestic worker, n (%)	
No	132 (84.08)
Yes	25 (15.92)
Housing type, n (%)	
Subsidized public housing	135 (79.41)
Condominium	6 (3.53)
Landed housing	19 (11.18)
Care facility	2 (1.18)
Rental housing	8 (4.71)
Education level, n (%)	
Below secondary	86 (50.59)
Secondary	56 (32.94)
Diploma	18 (10.59)
University	10 (5.88)
Smoking status, n (%)	
Non smoker	146 (85.38)
Current smoker	11 (6.43)
Ex-smoker	14 (8.19)
Neer classification, n (%)	
1	14 (8.19)
2	105 (61.40)
3	49 (28.65)
4	3 (1.75)
CCI, median (IQR)	0 (0, 2)
Barthel index, median (IQR)	20 (20, 20)
Parker index, median (IQR)	9 (9, 9)

CCI, Charlson Comorbidity Index; *IQR*, inter quartile range.

Social factors and QuickDASH

Patients with domestic workers had higher QuickDASH scores (lower capability) at 6 months postinjury (coef: 8.63 [95% CI: 1.39 to 15.86]; $P = .020$) (Table III). Patients who were employed reported lower QuickDASH scores (higher capability) at 1-year postinjury (coef: −5.02 [95% CI: −9.96 to −0.07]; $P = .047$) (Table III). There

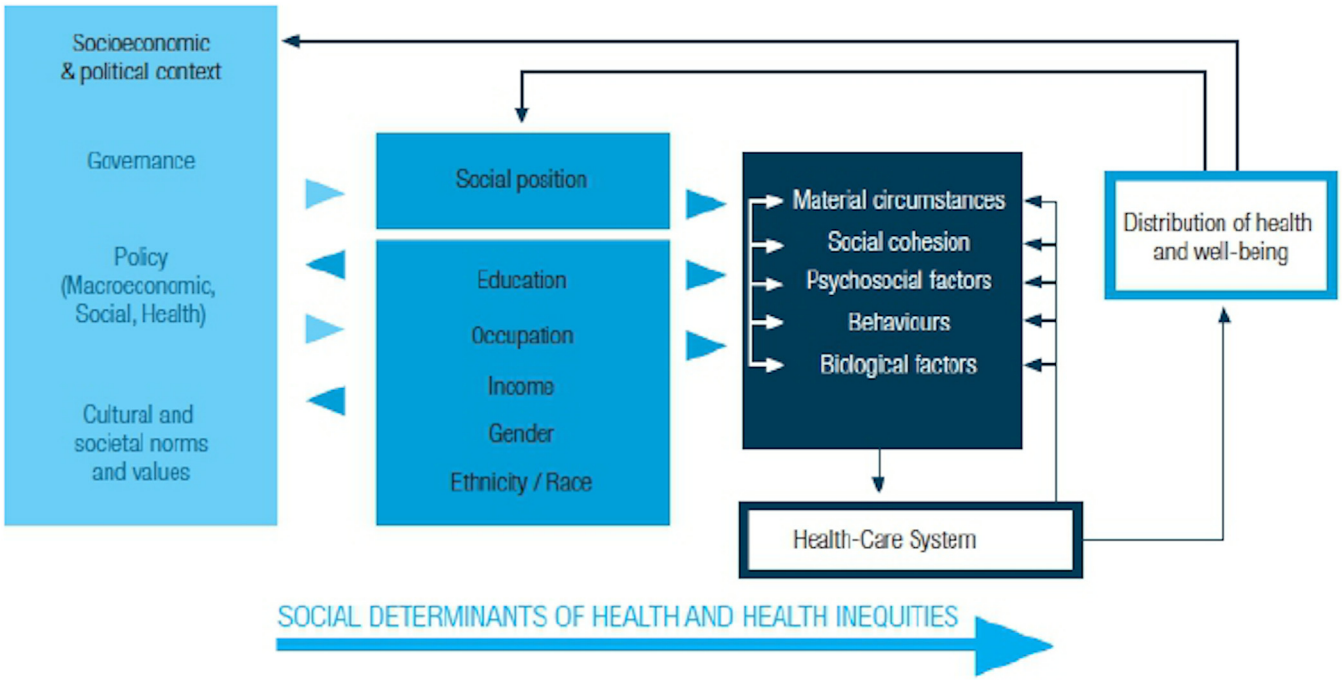

Figure 1 World Health Organization (WHO) social determinants of health conceptual framework.

was no association between the QuickDASH scores and Neer classification.

Social factors and OSS

Patients who had domestic workers reported lower OSS scores at 6 months (coef: −5.42 [95% CI: −8.95 to −1.90]; $P = .003$) and 1-year postinjury (coef: −4.07 [95% CI: −6.62 to −1.53]; $P = .002$) (Table IV), and patients living in care facilities reported lower OSS scores at 1-year postinjury (coef: −14.82 [95% CI: −22.24 to −7.39]; $P < .001$) (Table IV).

Social factors and EQ5D

Patients living in care facilities reported lower EQ5D scores at 6 months (coef: −0.57 [95% CI: −0.93 to −0.21] $P = .002$) and 1-year postinjury (coef: −0.59 [95% CI: −0.90 to −0.29] $P < .001$) (Table V). Patients who had domestic workers reported lower EQ5D scores (coef: −0.18 [95% CI: −0.29 to −0.07]; $P = .001$) (Table V) compared to patients without domestic workers at 1-year postinjury.

Discussion

Capability and comfort do not correspond with alignment of a healed, nonoperatively treated PHF.[24] Instead, the evidence points to variation in mindset, such feelings of worry or despair, and unhelpful thoughts such as worst case thinking and fear of painful movement.[4,10,13] We were interested in the association of social factors such as in-home caregivers and assisted living with capability and comfort, based on the rationale that an association could inform the development of care strategies. We found that an unemployed status and the presence of a dedicated caregiver (domestic worker or living in a care facility) were associated with poorer comfort and capability during recovery from a nonoperatively-treated PHF, independent of fracture severity characterized by the Neer classification.

Social factors and PROMs

The finding that employment status and the presence of a dedicated caregiver were associated with comfort and capability after nonoperatively treated PHF, irrespective of fracture severity and underlying premorbid status, direct us to consider social factors associated with independence in the development of care strategies. This is consistent with a prospective cohort study of patients with isolated PHFs which found that mental and social health factors (including kinesiophobia, resilience and better coping strategies) were more strongly associated with comfort and capability than biomedical factors such as radiographic severity and operative treatment.[13] Furthermore, a study from Scotland found that factors associated with social independence—such as living alone, dressing oneself or engaging in recreational activities—were associated with better shoulder function shown by higher Constant Scores 1-year after PHF.[4]

Beyond PHFs, increasing evidence is also highlighting the role played by social factors in determining outcomes in musculoskeletal health. Luong et al reviewed how social determinants affected outcomes in osteoarthritis (OA) and proposed a framework that could better explain the complex nuances and interlinks between social determinants that included mediators, moderators and common confounders.[16] While OA is a chronic degenerative condition in contrast to PHFs and the described framework may not be completely applicable to PHFs, what Luong et al described suggests that many social factors are associated with variation in capability and comfort related to musculoskeletal conditions and that social factors are complex and intertwined with other social and psychological factors.[16]

After adjustment for confounders such as age, comorbidities, premorbid activity, and functional levels of patients, we established that employment status was associated with comfort and capability after PHF, beyond premorbid age and infirmity. Employment status may be a maker of better health which may be linked to greater capability and higher self-efficacy.[1] Additionally, with employment,

Table III
Social factors predicting QuickDASH outcome at 6 mo and 1 y.

	6 mo				1 y			
	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]
Age	0.25 (0.01, 0.48)	.037			0.32 (0.14, 0.50)	.001		
Gender								
Male	Ref				Ref			
Female	3.73 (−2.54, 10.00)	.241			3.02 (−2.18, 8.23)	.252		
Race								
Chinese	Ref				Ref			
Malay	−1.28 (−11.66, 9.11)	.808			3.05 (−5.44, 11.54)	.478		
Indian	−10.48 (−28.03, 7.07)	.240			−3.41 (−15.18, 8.36)	.567		
Others	−2.89 (−14.66, 20.44)	.745			−5.22 (−21.70, 11.25)	.531		
Employment status								
Unemployed	Ref				Ref		Ref	
Employed	−6.34 (−11.74, −0.94)	.022			−8.30 (−12.56, −4.03)	<.001	−5.02 (−9.96, −0.07)	**.047**
Household income								
<$1000	Ref				Ref			
$1000-$5000	−5.54 (−11.21, 0.13)	.055			−3.16 (−8.16, 1.84)	.212		
$5000-$10,000	−6.24 (−14.32, 1.85)	.130			−5.49 (−12.02, 1.04)	.099		
>$10,000	−6.57 (−19.13, 5.99)	.303			−6.47 (−16.42, 3.48)	.200		
Housing type								
Subsidized public housing	Ref				Ref			
Condominium	1.45 (−11.05, 13.95)	.819			−0.97 (−12.74, 12.80)	.870		
Landed housing	3.51 (−4.49, 11.51)	.386			1.75 (−4.71, 8.20)	.592		
Care facility	22.20 (0.96, 43.44)	.041			0.10 (−23.03, 23.24)	.993		
Rental housing	1.28 (−12.34, 14.90)	.853			8.60 (−1.99, 19.20)	.110		
Domestic worker								
No	Ref		Ref		Ref			
Yes	10.76 (3.87, 17.64)	.002	8.63 (1.39, 15.86)	**.020**	7.55 (1.65, 13.44)	.013		
Education level								
Below secondary	Ref				Ref			
Secondary	−0.76 (−6.47, 4.95)	.792			2.39 (−2.51, 7.28)	.336		
Diploma	7.77 (−1.61, 17.16)	.104			3.17 (−4.99, 11.33)	.442		
University	−2.08 (−13.26, 9.11)	.714			−6.40 (−14.99, 2.19)	.142		
Smoking status								
Nonsmoker	Ref				Ref			
Current smoker	−7.45 (−18.37, 3.47)	.179			−6.69 (−16.25, 2.88)	.169		
Ex smoker	−1.99 (−11.84, 7.85)	.689			−5.90 (−15.47, 3.67)	.224		

Ref, reference group; *Coef*, coefficient; *QuickDASH,* Quick Disabilities of the Arm Shoulder and Hand score; *CI*, confidence interval.
Bold indicates significant values, $P < .05$.
[a]Simple linear regression.
[b]Multiple linear regression adjusted for age, Charlson Comorbidity Index, Neer classification, Barthel Index, Parker Index and non-union.

Table IV
Social factors predicting OSS outcome at 6 mo and 1 y.

	6 mo				1 y			
	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]
Age	−0.08 (−0.20, 0.03)	.149			−0.12 (−0.21, −0.03)	.007		
Gender								
Male	Ref				Ref			
Female	−2.18 (−5.26, 0.89)	.162			−0.63 (−3.14, 1.88)	.620		
Race								
Chinese	Ref				Ref			
Malay	−0.34 (−5.61, 4.94)	.900			−1.98 (−6.18, 2.22)	.352		
Indian	2.14 (−5.62, 9.89)	.587			2.46 (−3.71, 8.64)	.432		
Others	−0.45 (−9.37, 8.47)	.921			2.80 (−4.31, 9.90)	.437		
Employment status								
Unemployed	Ref				Ref			
Employed	2.75 (0.08, 5.42)	.044			3.27 (1.17, 5.38)	.003		
Household income								
<$1000	Ref				Ref			
$1000-$5000	1.58 (−1.25, 4.41)	.271			1.86 (−0.44, 4.17)	.113		
$5000-$10,000	3.43 (−0.58, 7.44)	.093			1.61 (−1.65, 4.86)	.331		
>$10,000	3.55 (−2.41, 9.52)	.240			3.55 (−1.29, 8.39)	.149		
Housing type								
Subsidized public housing	Ref				Ref		Ref	
Condominium	−0.40 (−6.69, 5.90)	.901			−0.27 (−5.16, 4.62)	.913		
Landed housing	−2.14 (−6.06, 1.77)	.281			−1.81 (−4.85, 1.24)	.242		
Care facility	−10.73 (−21.44, −0.02)	.050			−15.10 (−23.43, −6.78)	<.001	−14.82 (−22.24, −7.39)	**<.001**
Rental housing	−4.13 (−11.00, 2.73)	.236			−2.90 (−8.24, 2.43)	.284		
Domestic worker								
No	Ref		Ref		Ref		Ref	
Yes	−5.67 (−8.94, −2.41)	.001	−5.42 (−8.95, −1.90)	**.003**	−5.40 (−7.98, −2.83)	<.001	−4.07 (−6.62, −1.53)	**.002**
Education level								
Below secondary	Ref				Ref			
Secondary	−1.99 (−4.80, 0.81)	.162			−1.27 (−3.53, 0.98)	.266		
Diploma	−5.22 (−9.90, −0.53)	.029			−3.00 (−6.91, 0.91)	.132		
University	−1.16 (−6.47, 4.15)	.666			2.25 (−2.02, 6.51)	.300		
Smoking status								
Nonsmoker	Ref				Ref			
Current smoker	1.74 (−1.78, 9.25)	.182			2.57 (−1.83, 6.98)	.250		
Ex smoker	2.05 (−2.70, 6.81)	.395			2.92 (−1.05, 6.89)	.148		

Ref, reference group; *Coef*, coefficient; *OSS*, Oxford Shoulder Score; *CI*, confidence interval.
Bold indicates significant values, $P < .05$.
[a]Simple linear regression.
[b]Multiple linear regression adjusted for age, Charlson Comorbidity Index, Neer classification, Barthel Index, Parker Index and non-union.

Table V
Social factors predicting EQ5D outcome at 6 mo and 1 y.

	6 mo				1 y			
	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]	Coef (95% CI)	*P* value[a]	Adj coef (95% CI)	*P* value[b]
Age	−0.01 (−0.01, −0.00)	.006			−0.01 (−0.01, −0.00)	.010		
Gender								
Male	Ref				Ref			
Female	−0.11 (−0.22, 0.00)	.057			0.02 (−0.13, 0.08)	.694		
Race								
Chinese	Ref				Ref			
Malay	0.06 (−0.14, 0.25)	.547			−0.11 (−0.28, 0.07)	.232		
Indian	0.18 (−0.11, 0.47)	.217			0.07 (−0.19, 0.33)	.589		
Others	0.05 (−0.28, 0.38)	.786			0.14 (−0.16, 0.44)	.363		
Employment status								
Unemployed	Ref				Ref			
Employed	0.11 (0.01, 0.21)	.027			0.14 (0.05, 0.23)	.002		
Household income								
<$1000	Ref				Ref			
$1000-$5000	0.11 (0.00, 0.21)	.047			0.08 (−0.02, 0.18)	.106		
$5000-$10,000	0.15 (0.00, 0.30)	.045			0.08 (−0.05, 0.22)	.225		
>$10,000	0.09 (−0.13, 0.31)	.432			0.16 (−0.05, 0.36)	.126		
Housing type								
Subsidized public housing	Ref		Ref		Ref		Ref	
Condominium	0.10 (−0.13, 0.33)	.407			0.02 (−0.19, 0.22)	.883		
Landed housing	−0.06 (−0.21, 0.08)	.400			−0.03 (−0.16, 0.10)	.609		
Care facility	−0.56 (−0.95, −0.16)	.006	−0.57 (−0.93, −0.21)	**.002**	−0.62 (−0.98, −0.27)	.001	−0.59 (−0.90, −0.29)	**<.001**
Rental housing	−0.07 (−0.33, 0.18)	.558			−0.09 (−0.32, 0.13)	.423		
Domestic worker								
No	Ref				Ref		Ref	
Yes	−0.20 (−0.32, −0.08)	.001			−0.23 (−0.34, −0.12)	<.001	−0.18 (−0.29, −0.07)	**.001**
Education level								
Below secondary	Ref				Ref			
Secondary	−0.00 (−0.11, 0.10)	.970			−0.02 (−0.12, 0.07)	.635		
Diploma	−0.05 (−0.23, 0.12)	.556			−0.10 (−0.26, 0.07)	.248		
University	0.09 (−0.11, 0.29)	.396			0.11 (−0.07, 0.29)	.242		
Smoking status								
Non smoker	Ref				Ref			
Current smoker	0.17 (−0.03, 0.38)	.094			0.13 (−0.06, 0.32)	.171		
Ex smoker	0.11 (−0.06, 0.29)	.204			0.11 (−0.06, 0.28)	.201		

Ref, reference group; *Coef*, coefficient; *EQ5D*, EuroQol-5 Dimensions; *CI*, confidence interval.
Bold indicates significant values, $P < .05$.
[a]Simple linear regression.
[b]Multiple linear regression adjusted for age, Charlson Comorbidity Index, Neer classification, Barthel Index, Parker Index and non-union.

the desire to return to work can serve as motivation in rehabilitation and functional use, leading to early mobilization and improved recovery outcomes.[14] Furthermore, beyond PHFs, prefracture functional independence is associated with better recovery outcomes in terms of functional status measured by the modified Barthel index (MBI), as well as lower mortality and complication rates of hip fractures.[19,30] The finding that people recovering from PHF experience less incapability in proportion to their social independence (employment, absence of a caregiver such as a domestic worker at home and living outside of a care facility) emphasizes the important associations of social factors to musculoskeletal health, and the utility of accounting for social factors in the development and assessment of care strategies.

Limitations

Although there was comprehensive recording of a wide range of social outcomes, it is still important to note that there may be other biopsychosocial factors influencing associated with capability and comfort. Another limitation is the generalizability of this study as it was conducted in an Asian population, which has unique sociocultural characteristics compared to the predominantly Caucasian population in other studies.[4,10,12,13] Furthermore, the Neer classification was performed by a single senior resident, although good intra-rater reliability was established assessed based on kappa agreement. The decision for operative vs. nonoperative management for patients with PHFs were also determined based on surgeons' discretion from the assessment of patient characteristics, radiographic severity of the fractures and patient preferences. Lastly, our study focused on patients who were treated nonoperatively after a PHF. Future studies could explore the social factors affecting outcomes in operatively treated patients.

Conclusions

Our study found that social independence, be it in terms of employment or not having a caregiver, is associated with greater comfort and capability after a nonoperatively treated PHF. These findings help raise awareness of the relatively strong association of social factors, along with mental health factors, with capability and comfort (PROM scores) compared to pathophysiology severity. Screening of these social factors and identification of high-risk subpopulations can be incorporated as part of a holistic biopsychosocial care by clinicians for these PHFs patients, ideally supported by an integrated multidisciplinary team especially when the social issues are deep rooted and challenging to be tackled by the clinician alone. While certain social factors like one's employment status or the presence of caregivers may not be easily modifiable, clinicians can actively tailor their advice and management to encourage greater independence particularly among patients who are unemployed or have domestic workers at home and optimize patient outcomes.

Acknowledgments

The authors would like to thank Dr. Joshua Song for his help in the interpretation of the radiographs for this study.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Azar IAS. Quality of life hardiness self efficacy and self esteem a comparative study of employed and unemployed married women in Iran. Ger J Psychiat 2005;9:111-7.
2. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. J Bone Joint Surg Am 2005;87:1038-46. https://doi.org/10.2106/jbjs.D.02060.
3. Charlson ME, Carrozzino D, Guidi J, Patierno C. Charlson comorbidity index: a critical review of clinimetric properties. Psychother Psychosom 2022;91:8-35. https://doi.org/10.1159/000521288.
4. Clement ND, Duckworth AD, McQueen MM, Court-Brown CM. The outcome of proximal humeral fractures in the elderly: predictors of mortality and function. Bone Joint J 2014;96-b:970-7. https://doi.org/10.1302/0301-620x.96b7.32894.
5. Clement ND, McQueen MM, Court-Brown CM. Social deprivation influences the epidemiology and outcome of proximal humeral fractures in adults for a defined urban population of Scotland. Eur J Orthop Surg Traumatol 2014;24:1039-46. https://doi.org/10.1007/s00590-013-1301-3.
6. Dalstra JA, Kunst AE, Borrell C, Breeze E, Cambois E, Costa G, et al. Socioeconomic differences in the prevalence of common chronic diseases: an overview of eight European countries. Int J Epidemiol 2005;34:316-26. https://doi.org/10.1093/ije/dyh386.
7. Dawson J, Fitzpatrick R, Carr A. Questionnaire on the perceptions of patients about shoulder surgery. J Bone Joint Surg Br 1996;78:593-600.
8. Dawson J, Rogers K, Fitzpatrick R, Carr A. The Oxford shoulder score revisited. Arch Orthop Trauma Surg 2009;129:119-23. https://doi.org/10.1007/s00402-007-0549-7.
9. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;370:1453-7. https://doi.org/10.1016/s0140-6736(07)61602-x.
10. Goudie EB, MacDonald DJ, Robinson CM. Functional outcome after nonoperative treatment of a proximal humeral fracture in adults. J Bone Joint Surg Am 2022;104:123-38. https://doi.org/10.2106/jbjs.20.02018.
11. Handoll HH, Keding A, Corbacho B, Brealey SD, Hewitt C, Rangan A. Five-year follow-up results of the PROFHER trial comparing operative and non-operative treatment of adults with a displaced fracture of the proximal humerus. Bone Joint Lett J 2017;99-b:383-92. https://doi.org/10.1302/0301-620x.99b3.Bjj-2016-1028.
12. Iwelunmor J, Airhihenbuwa CO. Culture, a social determinant of health and risk: considerations for health and risk messaging. In: Oxford research encyclopedia of communication; 2017. https://doi.org/10.1093/acrefore/9780190228613.013.221.
13. Jayakumar P, Teunis T, Williams M, Lamb SE, Ring D, Gwilym S. Factors associated with the magnitude of limitations during recovery from a fracture of the proximal humerus: predictors of limitations after proximal humerus fracture. Bone Joint J 2019;101-b:715-23. https://doi.org/10.1302/0301-620x.101b6.Bjj-2018-0857.R1.
14. Kessemeier F, Stöckler C, Petermann F, Bassler M, Pfeiffer W, Kobelt A. [The significance of work motivation for rehabilitation Success]. Rehabilitation 2018;57:256-64. https://doi.org/10.1055/s-0043-118196.
15. Li X, Galvin JW, Li C, Agrawal R, Curry EJ. The impact of socioeconomic status on outcomes in orthopaedic surgery. J Bone Joint Surg Am 2020;102:428-44. https://doi.org/10.2106/jbjs.19.00504.
16. Luong ML, Cleveland RJ, Nyrop KA, Callahan LF. Social determinants and osteoarthritis outcomes. Aging Health 2012;8:413-37. https://doi.org/10.2217/ahe.12.43.
17. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. Md State Med J 1965;14:61-5.
18. Neer CS 2nd. Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg Am 1970;52:1077-89.
19. Pareja Sierra T, Bartolomé Martín I, Rodríguez Solís J, Bárcena Goitiandia L, Torralba González de Suso M, Morales Sanz MD, et al. Predictive factors of hospital stay, mortality and functional recovery after surgery for hip fracture in elderly patients. Rev Esp Cir Ortop Traumatol 2017;61:427-35. https://doi.org/10.1016/j.recote.2017.10.007.
20. Parker MJ, Palmer CR. A new mobility score for predicting mortality after hip fracture. J Bone Joint Surg Br 1993;75:797-8.
21. Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. Ann Med 2001;33:337-43.
22. Rangan A, Handoll H, Brealey S, Jefferson L, Keding A, Martin BC, et al. Surgical vs nonsurgical treatment of adults with displaced fractures of the proximal humerus: the PROFHER randomized clinical trial. JAMA 2015;313:1037-47. https://doi.org/10.1001/jama.2015.1629.
23. Sabesan VJ, Valikodath T, Childs A, Sharma VK. Economic and social impact of upper extremity fragility fractures in elderly patients. Aging Clin Exp Res 2015;27:539-46. https://doi.org/10.1007/s40520-014-0295-y.
24. Slobogean GP, Johal H, Lefaivre KA, MacIntyre NJ, Sprague S, Scott T, et al. A scoping review of the proximal humerus fracture literature. BMC Musculoskelet Disord 2015;16:112. https://doi.org/10.1186/s12891-015-0564-8.
25. StataCorp. Stata statistical software: release 14. College Station, TX: StataCorp LP; 2015.
26. Wolfensberger A, Vuistiner P, Konzelmann M, Plomb-Holmes C, Léger B, Luthi F. Clinician and patient-reported outcomes are associated with psychological factors in patients with chronic shoulder pain. Clin Orthop Relat Res 2016;474:2030-9. https://doi.org/10.1007/s11999-016-4894-0.
27. World Health Organization. A conceptual framework for action on the social determinants of health. Geneva: World Health Organization; 2010.
28. World Health Organization. International classification of functioning, disability and health : ICF. Geneva: World Health Organization; 2001.
29. Wylie JD, Suter T, Potter MQ, Granger EK, Tashjian RZ. Mental health has a stronger association with patient-reported shoulder pain and function than tear size in patients with full-thickness rotator cuff Tears. J Bone Joint Surg Am 2016;98:251-6. https://doi.org/10.2106/jbjs.O.00444.
30. Zhi Yang Loy CYN, Seng Kwing C, Ying Tze Lim J, Goh KS, Kiat Mun SL, Tan HW, et al. Assessing the relationship between cognition, premorbid function and functional outcomes after hip fracture surgery. Aging Med Healthc 2022;13:4-10. https://doi.org/10.33879/amh.131.2020.10039.