The Effect of Socioeconomic Factors on Outcomes of Distal Radius Fractures: A Systematic Review

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Abstract

Background: Socioeconomic factors are known to affect outcomes for both medical and surgical conditions. The purpose of this systematic review was to assess the current evidence regarding the effect of socioeconomic factors such as income, geographic location, educational level, and occupation on clinical outcomes after distal radius fractures. **Methods:** A systematic search strategy was performed to identify studies commenting on the effect of socioeconomic factors on clinical outcomes following open or closed distal radius fracture repair. Abstract and full-text screening was performed by 2 independent reviewers, and articles were evaluated by Structured Effectiveness Quality Evaluation Scale (SEQES). Treatment outcomes of interest included, but were not limited to, pain, function, range of motion, and grip strength. **Results:** There were 1745 studies that met our inclusion and exclusion criteria for abstract screening. Of these, 48 studies met our inclusion criteria for full-text screening and 20 studies met our criteria for quality analysis with the SEQES score. There were 3 studies of high quality, 16 of moderate quality, and 1 of low quality. Meta-analyses were not possible due to the variability in outcomes of interest across papers. **Conclusions:** Patient factors indicative of socioeconomic status are relevant predictors of functional outcome after distal radius fractures. There is currently limited evidence in this area of research, and further examination should be considered to improve outcomes from a patient and system standpoint.

Keywords: patient outcomes, socioeconomic factors, distal radius fractures, systematic review, outcome predictors

Introduction

Distal radius fractures (DRFs) are among the most common injuries of the upper extremity, accounting for up to 20% of all fractures seen in emergency departments in Europe and North America.^{9,19,28} These injuries represent a considerable financial burden on the health care system¹⁷ and have a reported incidence as high as 125/100 000 in one recent American study in 2009.⁸

Despite their ubiquity, optimal treatment of these fractures is disputed and final clinical outcome often unpredictable.¹⁰ Furthermore, little is known about the role socioeconomic factors play in treatment decisions and outcomes. It has been well established that socioeconomic factors such as income, education, and employment strongly shape health-related behaviors and, in turn, these health-related behaviors have a greater impact on preventable mortality and morbidity than medical care.^{1,24} For example, low socioeconomic status (SES) is associated with adverse clinical outcomes in a wide range of areas, including coronary heart disease, stroke, cancer, kidney disease, and systemic lupus erythematosus.^{3,5,11,23}

Typical outcomes of interest in studies observing DRF are wide ranging, and include both objective and subjective measures. Examples include pain; loss of grip strength; Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire; range of motion; and Patient-Rated Wrist Evaluation (PRWE) score. As expected, these outcomes vary with the design and aim of the studies.

The purpose of this systematic review is to assess the current evidence regarding the effect of socioeconomic factors such as income, location, education, occupation, and immigrant status on outcomes after DRF. Access to care is known to be strongly associated with socioeconomic characteristics,¹¹ and factors affecting this were of interest as

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Table 1. Inclusion and Exclusion Criteria for Article Selection for Full-Text Review.

Papers were selected for full-text review if they met the following criteria:

1. Type of study: Sackett levels 1-4
 - a. Randomized control trials, prospective trials, retrospective trials, and case series, or unclear
2. Type of fracture: distal radius fractures, both intra-articular and extra-articular
3. Type of treatment: open or closed reduction, external fixation, percutaneous pinning
4. Type of patient: skeletally mature
5. Type of outcome: primary outcome of pain, disability, function scores
6. Mention of socioeconomic factors, income, location, education, occupation, worker's compensation
7. No abstract was available

Papers were excluded from full-text review if they met the following criteria:

1. Type of study: Sackett level 5 (expert opinion, biomechanical, and individual case studies) and review, technical, and epidemiology papers
2. Type of fracture: nondistal radius fractures
3. Type of patient: skeletally immature, pediatric patient
4. Study did not evaluate effects of intervention
5. Study looked at prevention instead of treatment
6. Study looked at risk for fractures (rather than treatment outcomes)
 - a. Study looked at risk factors for low bone mineral density or bone loss
 - b. Study looked at bone quality or mass via biochemical parameters
7. No mention of socioeconomic factors, income, location, education, occupation, worker's compensation

well. Our aim is to provide information that may influence treatment decisions and resource planning in the future.

Materials and Methods

A systematic search of the literature was performed using a broad search strategy given the expectation of few studies in this area of interest. This search was led by a librarian with experience in medical literature searches at our institution and then reviewed by a physician. No restrictions on language or date of publication were specified. Articles were retrieved from Ovid MEDLINE database from January 1946 to April 2016 with a combination of key terms with respect to DRF: "distal radius/radial fractures," "radioulnar joint injuries," "wrist injuries," and "wrist/colles/smith fractures." Key terms reflecting socioeconomic factors included "socioeconomic factors," "insurance," "rehabilitation," "activities of daily living," "social/living conditions," "social circumstance," "vocation," "occupation," "unemployment," "employment," "income," "salary," "education," "poverty," "family/sick leave," and "claims." The full search strategy may be accessed in the electronic version of this article in supplementary files.

Based on the title and abstract screen by 1 rater (J.L.T.), studies were selected for full-text review if they were Sackett levels 1 to 4, which includes the spectrum of systematic reviews of randomized controlled trials to case series. Studies were excluded if they were of Sackett level 5 level of evidence—in other words, of expert opinion.³⁰ Studies were included if they reported on intra-articular or extra-articular DRFs in the skeletally mature patient population, included some measure of SES, and had a primary outcome of pain, disability, or function. Studies were excluded from full-text

review if there was no mention of any socioeconomic metric in the abstract. Full inclusion and exclusion criteria are outlined in Table 1. After full-text review by 2 independent reviewers (J.L.T., N.S.), papers were excluded from quality assessment after full-text review, if income, location, education, occupation, or worker's compensation were not included in the context of outcome of DRF treatment.

The 2 independent reviewers then assessed the selected papers using the Structured Effectiveness Quality Evaluation Score (SEQES) criteria, a validated, standardized, critical appraisal form previously described.^{14,27} A third reviewer (C.D.) was made available to review any disagreements. Scores from consensus discussion would be used for the final evaluation.

The SEQES score rates the quality of the article's methodology through 7 general categories, with each category containing subcategories that can be scored 0, 1, or 2. The categories include study question, study design, patients, intervention, outcomes, analysis, and recommendations. A score of 0 meant the criterion was not met at all, 1 as partially met criterion, and 2 as fully met criterion. A SEQES score of 33 to 48 denoted a high-quality study, 17 to 32 a moderate-quality study, and less than or equal to 16 a low-quality study. A full outline of this structure appraisal scale including subcategories is seen in Table 2. Each article was independently scored using the SEQES checklist by each reviewer.

We were unable to pool the results for a meta-analysis due to the variability in type of outcomes seen across studies.

Results

A librarian-led literature search yielded 1745 articles, of which 48 met the inclusion and exclusion criteria of this

Table 2. Structured Effectiveness Quality Evaluation Scale (SEQES) Criteria.

Study question:
1. Was relevant background work cited to establish a foundation for the research questions?
Study design:
2. Was a comparison group used?
3. Was patient status at more than one time point considered?
4. Was data collection performed prospectively?
5. Were patients randomized to groups?
6. Were patients blinded to the extent possible?
7. Were treatment providers randomized to the extent possible?
8. Was an independent evaluator used to administer the outcome measures?
Patients:
9. Did sampling procedures minimize sample/selection biases?
10. Were inclusion/exclusion criteria defined?
11. Was an appropriate enrollment obtained?
12. Was appropriate retention/follow-up obtained?
Intervention:
13. Was the intervention applied according to established principles?
14. Were biases due to the treatment provider minimized?
15. Was the intervention compared with the appropriate comparator?
Outcomes:
16. Was an appropriate primary outcome defined?
17. Was an appropriate secondary outcome considered?
18. Was an appropriate follow-up period incorporated?
Analysis:
19. Was an appropriate statistical test(s) performed to indicate differences related to the intervention?
20. Was it established that the study had significant power to identify treatment effects?
21. Was the size and significance of the effects reported?
22. Were missing data accounted for and considered in interpreting results?
23. Were clinical and practical significance considered in interpreting results?
Recommendations:
24. Were the conclusions/clinical recommendations supported by the study objectives, analysis, and results?
Scoring methodology:
0—criterion was not met
1—criterion was partially met
2—criterion was fully met
Total quality score:
Low (0-16 points)
Moderate (17-32 points)
High (33-48 points)

systematic review for full-text screening. After full-text review, 20 articles were selected for quality assessment using the SEQES checklist. There was full interrater agreement for the articles selected to undergo SEQES screening ($\kappa = 1$; Figure 1).

Papers reviewed for full-text screening were variable in methodological quality: 3 of high quality, 16 of moderate quality, and 1 of low quality (Figure 2). There were minor discrepancies in the actual scoring of the articles between the 2 reviewers; however, there was full interrater agreement in the overall categories of the articles (high, moderate, low; $\kappa = 1$).

There were 12 papers that discussed DRF outcomes related to education, 5 related to income, 3 related to occupation or employment status, and the remainder in other areas such as zip code and injury compensation. No studies commented on immigrant status. The 20 articles selected

for quality assessment were wide ranging in quality, study design, and primary outcomes. A summary of the evidence is described below.

Education

All but 1 study was of moderate quality (SEQES score, 17-32). Lower levels of education were found to be associated with decreased range of motion 6 weeks after DRF in a prospective cohort study aimed to identify demographic, injury-related, or psychologic factors associated with finger stiffness at suture removal and 6 weeks after DRF surgery.³² Another prospective cohort study found that higher patient education levels were predictive of better outcomes in pain and disability using the PRWE 6 months post DRF.²⁰ Similarly, Paksima et al found that every increase in education (did not graduate high school, high school or General

Figure 1. Flow of study screening.

Note. SEQES = Structured Effectiveness Quality Evaluation Scale.

Educational Development equivalent, some college, college degree, or at least some postgraduate education) level demonstrated a doubling of improvement in pain, range of motion, grip strength, and DASH score in DRF.²⁹ Another study found that those who completed postsecondary training had lower PRWE and DASH scores than those who did not ($P = .016$).¹⁰

Other outcomes than pain and range of motion were also examined. A study by Morris found that more educated adults demonstrated faster improvement and achieved a higher level of physical and emotional function as it pertained to quantity or quality of activities after DRF when surveyed with the Medical Outcome Study 36-Item Short Form Health Survey (SF-36) and Enforced Social Dependency Scale.²⁶ Another group sought to identify clinical and demographic factors that characterize patients with DRF who are lost to follow-up in their study, and found that those with postsecondary education and higher average income were more likely to return for follow-up. They thus suggest that targeting the subgroup of patients more likely to be lost to follow-up would decrease complications that may result from unmonitored recovery.³¹

A prospective cohort study by MacDermid et al found that those with less education were more likely to lose time from work, and that patients who had high occupational demand at baseline and high self-reported pain or disability were at risk of prolonged work loss.²¹ Finally, a secondary

analysis of a cohort study by Mehta et al found that baseline pain intensity but *not* education is a predictor of chronic pain and wrist/hand functions 1 year post DRF.²⁵

Lastly, the single low-quality study (SEQES score, 0-16) was a systematic review by Van Son et al that aimed to describe the health status (HS) and health-related quality of life (HRQOL) outcomes following DRF. This article also attempted to describe the sociodemographic, clinical, and psychosocial factors associated with HS and HRQOL. Although the SEQES score was graded as low quality, the focus of this review was highly relevant to the aims of this article. Of note, having a low education level was predictive for impaired HS as measured by the SF-36, 12-Item Short Form Health Survey, the European Quality of Life Instrument-5 Dimensions (EQ-5D), or Musculoskeletal Function Assessment (MFA) questionnaire depending on the study.³³

Income

In general, the high-quality studies (SEQES score, 33-48) looked at low-income populations and collected information concerning employment status and income status as part of baseline patient characteristics. A case control study by MacKay et al comparing radiographic union rates and patient-based functional outcomes (range of motion, grip strength, DASH, subjective pain scores) following open versus closed fixation concluded that Gustillo type I and II open DRF treated with early debridement and bony fixation resulted in similar outcomes to those treated in a closed fashion; no difference was found in patient characteristics concerning employment status and income status in those groups ($P > .05$).²² Similarly, in another high-quality prospective randomized trial evaluating outcomes after operatively treated unstable and displaced DRF, no advantage of one treatment over another was found with respect to radiographic union, pain score, and range of motion, and no difference was found in groups with respect to SES (low SES $\leq$ \$50 000/year).⁷

Conversely, the prospective cohort study by Chung et al attempted to identify predictors of hand outcomes after DRF treatment, and found an association between higher income and improved long-term outcomes 1 year after surgery ($P = .002$, with respect to Michigan Hand Outcomes Questionnaire). Functional outcomes of interest encompassed the areas of overall hand function, activities of daily living, pain, work performance, aesthetics, and patient satisfaction using the Michigan Hand Outcomes Questionnaire score.²

The remaining studies below were of moderate (SEQES, 16-32) quality; again, outcomes of interest were highly variable, ranging from the use of post-acute care to chronic pain conditions.

A retrospective cohort study by Zhong et al found that age (odds ratio [OR], 0.8; 95% confidence interval [CI], 0.7-1.0) and SES were associated with hospital admission

Figure 2. Breakdown of articles undergoing Structured Effectiveness Quality Evaluation Scale screening by quality.
Note. SES = socioeconomic status.

following isolated DRF, with higher income less likely to be admitted to hospitals after DRF (OR, 0.8; 95% CI, 0.9-1.0). They also found that patients of lower SES are less likely to use post-acute care that could potentially help with pain and disability and that those of lower SES may not have access to the same rehabilitation services.³⁷

Higher SES has also been found to be associated with greater use of postoperative therapy such as physical or occupational therapy that would presumably be associated with better patient outcomes.³⁴ A review of claims and regional data revealed that patients of high (OR, 1.57; 95% CI, 1.46-1.70) or medium (OR, 1.22; 95% CI, 1.12-1.32) SES were more likely to receive therapy compared with patients of lower SES.

A predominance of poor socioeconomic level in patients with complex regional pain syndrome (CRPS) has been noted following DRF fractures in a prospective study by Jellad et al ($P = .023$); they also commented on a lack of relationship between education level and CRPS development ($P = .239$).¹⁶

Occupation/Employment Status/Other

All of the studies within these categories were of moderate quality.

Full-time employment status was found to be significantly associated with lower DASH scores ($P < .01$), or a more favorable outcome.⁴ Work status and timing of initial evaluation were also found to be related to improvement in pain and perceived disability in a study observing the impact of demographic factors and comorbidities on DRF outcomes.

Furthermore, the number of days between injury and initial therapy evaluation were inversely correlated with changes in perceived pain and disability as measured by the criterion-based numeric pain scale (CR12) and DASH questionnaire ($r = -0.315$ and -0.348 , respectively; $P = .000$ for both).³⁶

A prospective study found that injury compensation was the most influential predictor of pain and disability at 1 year ($P = .006$)¹⁰ and that those who completed postsecondary training had lower PRWE and DASH scores than those who did not ($P = .016$).¹⁰ Worker's compensation has also been found to be strongly associated with pain (visual analog scale [VAS] score; regression coefficient, 3.1; 95% CI, 2.15-4.1) and function (regression coefficient = 16.5; 95% CI, 8.7-24.3) in a retrospective review of DRF patients.³⁵

Another study attempting to identify barriers to adherence with hand therapy following surgery post DRF found that a lack of car ownership ($P = .034$), distance from therapy ($P = .017$), and requiring help to be driven to clinic visits ($P = .02$) to be significantly associated with poor adherence to hand therapy based on a number of missed appointments.¹⁵

Ethnic disparities have also been a focus of interest with respect to recovery following DRF, as it has been well documented to relate to chronic disease outcome in the context of access to adequate health care and health information, psychosocial stress, cultural overtones, lifestyle behavior, and community involvement. Walsh et al found that African American and Latinos exhibited significantly poorer physical function and pain scores than Caucasians at most intervals when DASH and VAS scores were assessed at 3, 6, and 12 months post injury.³⁵

Discussion

We found the papers assessed to be high quality were less relevant in the context of how SES factors related to DRF outcomes. Often such factors were collected incidentally as part of patient's baseline characteristics, and rarely was the primary objective. Conversely, some papers of low to moderate quality (the majority of our studies) were highly relevant. Overall, this demonstrates a need for high-quality papers specifically examining the relationship between SES factors on DRF outcomes.

Isolating relationships between specific socioeconomic factors and DRF outcomes are challenging because many of these factors often coexist. For example, patients with lower SES may have increased distance to therapy and therefore suboptimal access to care, which could understandably be linked to poorer outcomes. Similarly, patients with lower education levels (and occasionally, by extension, lower income levels) may be employed in jobs that require greater manual labor. Patients involved in such jobs may have less time to recover from their injury due to the financial pressures to return to work and be less compliant with hand therapy programs as a result.²⁰ Given this, there is a need for studies whose methodology is specifically designed to compare and elucidate the effect of these factors on DRF outcomes.

Immigrant status is another factor that is known to affect HS, as immigrant populations have a disproportionately high incidence of heart disease, diabetes, HIV/AIDS, and mental health issues.^{6,13,18} Importantly, increased morbidity and mortality are also found in immigrant populations across multiple health-related areas, with numerous factors implicated in the disparity: racism and discrimination, lack of insurance, poverty, cultural difference, lack of resources, and lack of communication as it relates to search for, use of, and access to care.^{6,13,18} There is currently some literature surrounding immigrant status data in the context of ethnicity affecting fracture risk, but few studies exist to examine how immigrant status affects outcomes of orthopedic surgeries, and much less DRFs. We theorize that immigrant status may affect access to care—thus relate to SES—and subsequently outcomes in the areas of treatment and hand therapy. We believe this would be another factor worthy of exploration in future studies.

There are limitations within our study. First, despite using a systematic search strategy, the data available in the eligible studies were not suitable for meta-analysis. Thus, we aimed to provide a narrative review of the available literature. Furthermore, the quality of the identified studies was also variable, as they examined mostly small populations and placed little emphasis on the impact of socioeconomic factors on outcomes. Given that our research question and topic of interest were relatively specific, this is not entirely unexpected; however, it does nonetheless limit conclusive interpretation in this review.

The relationship between socioeconomic factors and health outcomes is well documented and spans the realm of heart disease, cancer, chronic diseases, and surgery.^{1,3,5,12,23,24} A high-quality study observing these factors as it relates to DRFs is lacking, and one with a prospective study design collecting data such as level of education, income quartile, immigrant status, aboriginal status, and location as a measure of community versus academic practice is needed. Ultimately, exploring these outcomes in relation to socioeconomic factors may influence not only patient outcomes but also public funding and resource allocation to rural or academic centers based on need and treatment patterns. As an example, we understand from this review that distance to therapy affects therapy compliance and thus outcome as it may be costly for patients of low SES. Appreciation of this as a barrier by surgeons may result in modifications of treatment plans that reduce the amount of follow-up visits that may be costly to patients.

Patient factors indicative of SES are relevant predictors of functional outcome. This review demonstrated limited quality and quantity of evidence in this area of research, indicating a need for better designed studies to improve outcomes from a patient and system standpoint.

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Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

Not applicable.

Statement of Informed Consent

Not applicable.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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