

BMJ Open Patient-related healthcare disparities in the quality of acute hip fracture care: a 10-year nationwide population-based cohort study

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ABSTRACT

Objectives To characterise and quantify possible patient-related disparities in hip fracture care including temporal changes.

Design Population-based cohort study.

Setting All Danish hospitals treating patients with hip fracture.

Participants 60 275 hip fracture patients from 2007 to 2016.

Interventions Quality of care was defined as fulfilment of eligible care process measures for the individual patient recommended by an expert panel. Using yearly logistic regression models, we predicted the individual patient's probability for receiving high-quality care, resulting in a distribution of adjusted probabilities based on age, sex, comorbidity, fracture type, education, family mean income, migration status, cohabitation status, employment status, nursing home residence and type of municipality. Based on the distribution, we identified best-off patients (ie, the 10% of patients with the highest probability) and worst-off patients (ie, the 10% of patients with the lowest probability). We evaluated disparities in quality of care by measuring the distance in fulfilment of outcomes between the best-off and worst-off patients.

Primary and secondary outcome measures The primary outcome was fulfilment of all-or-none, defined as receiving all relevant process measures. Secondary outcomes were fulfilment of the individual process measures including preoperative optimisation, early surgery, early mobilisation, assessment of pain, basic mobility, nutritional risk and need for antiosteoporotic medication, fall prevention and a postdischarge rehabilitation programme.

Results The proportion of patients receiving high-quality care varied over time for both best-off and worst-off patients. The absolute difference in percentage points between the best-off and worst-off patients for receiving all-or-none of the eligible process measures was 12 (95% CI 6 to 18) in 2007 and 23 (95% CI 19 to 28) in 2016. Disparities were consistent for a range of care processes, including assessment of pain, mobilisation within 24 hours, assessment of need for antiosteoporotic medication and nutritional risk assessment.

Conclusions Disparity of care between best-off and worst-off patients remained substantial over time.

Strengths and limitations of this study

- The first large-scale nationwide study of overall patient-related disparity in the quality of hip fracture care.
- New way of analysing disparities in care by measuring the distance in fulfilment of care recommendations between the 10th and 90th percentile in the distribution of adjusted probabilities for receiving high-quality care.
- The study quantifies unjustified differences in quality of care over a 10-year period.
- Other aspects of quality of care, including the patient perspective, were not examined.

INTRODUCTION

Avoiding disparities in quality of care is a high priority in advanced healthcare systems.^{1 2} Patients should receive adequate healthcare when needed, irrespectively of their gender, age, race, comorbidity and socioeconomic status. To reach this goal, many countries have implemented strategies for improving quality that involve clinical guidelines, continuous quality monitoring, systematic auditing and accreditation, among others.³⁻⁷ Patients with hip fracture are often singled out as targets for quality-improvement initiatives because multidisciplinary acute care is essential to their prognosis and because the hip fracture patients' care pathway is highly standardised.^{8 9} Thus, a favourable prognosis hinges on multiple factors, for example, multidisciplinary care processes including preoperative optimisation, early surgery, early mobilisation, assessment of pain, functional level, nutritional risk and need for antiosteoporotic medication, fall prevention and preparation of a postdischarge rehabilitation programme.^{8 9} Furthermore, several countries, including Sweden, Norway, Finland, the UK, Italy and Denmark, have implemented

continuous performance monitoring of hip fracture care.^{10–16} Although these initiatives have existed for many years, evidence has focused mainly on benchmarking and public disclosure of performance data at the hospital level as an established way of improving quality of care.^{3 17–19} Only a few studies have examined disparity in quality of care between subgroups of hip fracture patients.^{20–25} Previous research has focused on individual patient demographics, including age, sex, socioeconomic status and the association of these characteristics with quality of care rather than on patients' entire prognostic profile.^{22 23 26 27} We; therefore, do not know which levels of disparities patients may encounter in the healthcare.

The aim of this study was to characterise and quantify the association between a broad range of possible patient-related disparities and the quality of hip fracture care, including temporal changes.

METHODS

We conducted a population-based cohort study using prospectively collected data from Danish medical registries. Informed participant consent is not required for registry-based studies in the Nordic countries.²⁸ Denmark is located in Northern Europe and has 5.8 million inhabitants. The public healthcare services are financed by taxes and all residents have free access to healthcare. All residents have a unique civil registration number which is used in all healthcare contacts.²⁹ The civil registration number allows unambiguous linkage between all administrative and healthcare registries. All emergencies, including hip fractures, are exclusively treated at the nearest public hospital.³⁰ The cohort of hip fracture patients was identified through the Danish Multidisciplinary Hip Fracture Registry (DMHFR).¹⁶

Data sources

The DMHFR is a national clinical quality register on all patients aged ≥ 65 admitted with femoral fractures and treated with surgery from 2003 and onwards.¹⁶ The DMHFR contains patient-level data on process performance measures reflecting current guidelines for in-hospital care. The register also contains sociodemographic and clinical characteristics on all patients. By law, reporting to the DMHFR is mandatory for all departments treating hip fracture patients, and data are entered prospectively by the care staff starting from patient admission.^{10 31}

Patient-level data on clinical characteristics and process performance obtained from the DMHFR were supplemented with data from the nationwide Danish National Patient Registry,³² the Civil Registry System²⁹ and socioeconomic registries from Statistic Denmark.³³ The Danish National Patient Registry holds data on all non-psychiatric hospital admissions since 1977 and all outpatient and emergency room visits since 1995, recorded according to the International Classification of Diseases (ICD) 8th Revision until the end of 1993 and the 10th Revision (ICD-10) thereafter.²⁹ The Civil Registry System

holds records of changes in vital status and migration for the entire Danish population since 1968, which allows complete follow-up on mortality in this study irrespective of place of death.²⁹ Statistic Denmark holds detailed information on residents in Denmark, including level of education, employment status household income, migration status, cohabitant status, nursing home residence and regional and municipality residency.^{33 34} All registers are updated yearly.

Study population

We included all patients aged ≥ 65 years admitted with femoral fractures (ICD-10 codes: medial (S720), pertrochanteric (S721) or subtrochanteric (S722)), who were treated surgically with osteosynthesis or alloplastic in the period from 2007 to 2016 (N=66 577).³⁵ To ensure sufficient information on previous income and comorbidity we excluded patients living in Denmark for less than 5 years prior to the date of the hip fracture surgery. Furthermore, we excluded patients for the following reasons: missing information on population registry, family income or surgery. Patients with multiple events during the study period were only included with data from their first event. Furthermore, patients treated in January and February 2010 and in December 2014 were excluded due to changes in the reporting system. Lastly, patients registered at hospital departments with less than 10 hip fracture patients per year were excluded, as these low volume departments may have less experience in data reporting and which may impair the data quality. To ensure high comparability of clinical needs among the included patients, we restricted to patients, who were relevant for at least 50% of the recommended care processes in the year of their index admission. The final hip fracture cohort included 60 275 patients (figure 1).

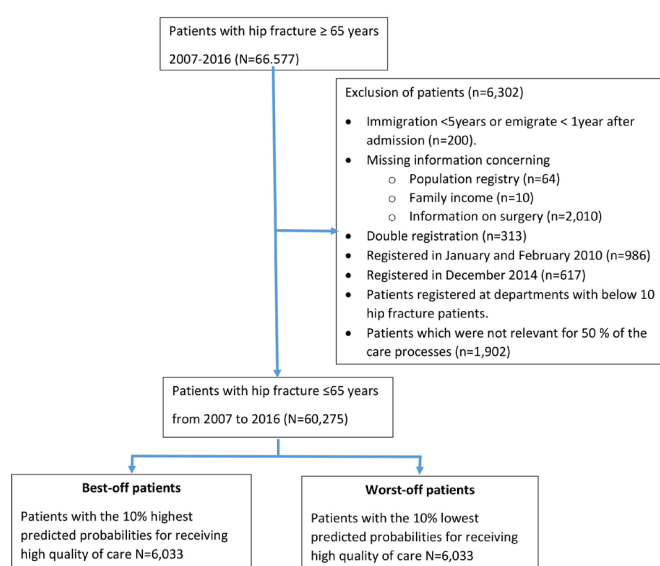


Figure 1 Flow chart.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pain assessment	+	+	+	+	+	+	+	+		
Mobilization within 24 hours				+	+	+	+	+		+
Assessment of nutrition risk	+	+	+						+	+
Assessment of need for osteoporotic medication				+	+	+	+	+	+	+
Fall prevention				+	+	+	+	+	+	+
Prevention of osteoporotic fractures	+	+	+							
Post discharge rehabilitation program	+	+	+	+	+	+	+	+		+
Assessment of functional level at admission	+	+	+				+	+	+	+
Assessment of functional level at discharge	+	+	+	+	+	+	+	+	+	+
Time to surgery within 24 hours									+	+
Time to surgery within 36 hours									+	+
Preoperative optimization										+

Figure 2 Overview of process performance measures in the time period.

Quality of acute hip fracture care

The quality of acute hip fracture care has been measured in the DMHFR since 2003. A multidisciplinary steering committee which comprised experienced clinicians appointed by relevant scientific societies and professional associations has selected a number of process performance measures to assess quality of care. The process performance measures reflect recommended basic care from the national clinical guideline for in-hospital care, which are continuously monitored in the registry by clinicians. The recommended care processes examined during the study period are shown in [figure 2](#). The recommendations have changed over time due to changes in evidence and clinical practice. Patients are classified as eligible or ineligible for each care process according to clinical judgement based on detailed data definitions. Annually, the quality of care assessed at the hospital level are released in a report and a structured audit process is carried out to assess critically the quality of the dataset and results. We defined the quality of care using two approaches: (1) fulfilment of the composite all-or-none measure for patients relevant for a minimum 50% of the process performance measures and (2) fulfilment of the individual process performance measures. Fulfilment of all-or-none required fulfilment of all relevant process performance measures for the individual patient, that were valid in a given year. Otherwise, patients were categorised as not fulfilled. Therefore, all-or-none was a measure for whether a patient received the complete recommended bundle of care.

Patient characteristics

Patient characteristics included demographic, lifestyle and socioeconomic factors in addition to fracture type because these factors have been shown to be associated with the probability of receiving optimal treatment and with clinical outcome following hip fracture ([table 1](#)).^{20–23 26 27} We used the Charlson Comorbidity Index (CCI) to summarise each patient's 10-year comorbidity history.³⁶ The CCI categorises comorbidities based on ICD codes obtained from the Danish National Patient Registry. Each comorbidity category has an associated weight based on the adjusted risk of mortality; the sum of all the weights yields a single comorbidity score for each patient. Fracture type was classified as either non-displaced medial fracture, displaced medial or pertrochanteric and subtrochanteric fracture,³⁷ or missing fracture type (missing fracture type only for the years 2010 and forward due to a change in the digital platform for reporting). To account for yearly variation in family income, we calculated the average yearly total income in the 5 years preceding admission for each patient and their cohabiting partner and categorised these data into three tertiles of increasing income.²² We classified educational achievement and employment status according to the nomenclature used in Statistic Denmark.²² We dichotomised migration status into migrant versus native due to low numbers of migrants among hip fracture patients.

Statistical methods

For each patient, we calculated the all-or-none as a measure of fulfilment of all relevant care processes

Table 1 Patient characteristics overall and for best-off and worst-off patients

	Total N=60 275		Best-off patients N=6033		Worst-off patients N=6033	
Age group (at admission in year)						
65–74	19%	(11 636)	28%	(1660)	16%	(984)
75–84	38%	(22 699)	46%	(2792)	31%	(1889)
>85	43 %	(25 940)	26%	(1581)	52%	(3160)
Sex						
Male	28%	(16 780)	16%	(970)	40%	(2401)
Female	72%	(43 495)	84%	(5,063)	60%	(3632)
CCI						
0 point: no comorbidity	18%	(11 120)	40%	(2393)	12%	(716)
1: low comorbidity	23%	(13 973)	21%	(1296)	21%	(1266)
2 point moderate comorbidity	20%	(12 312)	11%	(672)	25%	(1530)
+3 point: high comorbidity	38%	(22 870)	28%	(1672)	42%	(2521)
Fracture type						
Non-displaced medial fracture	8%	(4641)	18%	(1059)	8%	(476)
Displaced medial fracture	39%	(23 589)	52%	(3154)	13%	(808)
Pertrochanteric or subtrochanteric fracture	47%	(28 312)	30%	(1818)	27%	(1634)
Missing	6%	(3733)	0%	(0)	52%	(3115)
Education						
Low primary school (7–10 years)	49%	(29 550)	60%	(3595)	41%	(2509)
More than elementary school, but no university degree	25%	(15 103)	27%	(1,25)	23%	(1391)
Obtained university degree	9%	(5390)	7%	(426)	12%	(702)
Missing	17%	(10 232)	6%	(387)	24%	(1431)
Family mean income						
Low	33%	19 822	31%	(1847)	33%	(2011)
Medium	33%	20 176	33%	(2010)	33%	(2002)
High	34%	20 277	36%	(2176)	34%	(2020)
Migration status						
Immigrant	3%	1788	2%	(134)	9%	(532)
Native	97%	58 487	98%	(5899)	91%	(5501)
Cohabiting status						
Living alone	64%	38 255	55%	(3328)	68%	(4092)
Living together*	37%	22 020	45%	(2705)	32%	(1941)
Employment status						
Retired	89%	53 781	85%	(5145)	90%	(5405)
Employed	2%	1430	6%	(381)	2%	(121)
Missing	8%	5064	8%	(507)	8%	(507)
Nursing home residence						
Nursing home residence	12%	6916	3%	(190)	24%	(1466)
Living in own home	88%	53 259	97%	(5843)	76%	(4567)
Type of municipality						
Non peripheral municipality	88%	53 170	70%	(4240)	86%	(5191)
Peripheral municipality†	12%	7150	30%	(1793)	14%	(842)

*Married couple, other types of couples or households including several families.

†Defined by the ministry of cities, residence and rural districts: Patients living in the municipalities: Lolland, Bornholm, Langeland, Ærø, Tønder, Varde, Lemvig, Struer, Norddjurs, Samsø, Ringkøbing-Skjern, Morsø, Skive, Thisted, Vesthimmerland or Læsø.
CCI, Charlson Comorbidity Index.

included for that year. We identified best-off and worst-off patients for each calendar year. We used a multivariable logistic regression model taking all patient characteristics into account to predict the probability of fulfilment of the all-or-none composite. The multivariable logistic regression model is presented in online supplemental method. We calculated the predicted probability for receiving high-quality care defined as fulfilment of the all-or-none composite for each patient, which yielded a distribution of adjusted probabilities. Based on each patient's predicted probability, we identified two categories of patients according to their individual chance of receiving high or low quality of care corresponding to the two most extreme deciles; hereafter designated best-off and worst-off patients. The best-off patients were the ones with the highest predicted chance of fulfilment of the all-or-none composite, corresponding to patients from the 90th percentile or patients above this percentile in the predicted chance distribution. By contrast, the worst-off patients had the lowest chance of fulfilment of the all-or-none composite and thus fell into the lowest 10th percentile. We then evaluated patient-level disparities in receiving high-quality hip fracture care by measuring the distance between the 10th and the 90th percentile in fulfilment of the all-or-none composite as well as individual process performance measures. We evaluated the ability of the logistic prediction models to discriminate between groups by deriving the C-index and calibration using receiver operator curve analyses and calibration curves.

First, we examined patient characteristics for best-off and worst-off patients by calendar years.

Second, we quantified possible patient-related disparities in the quality of hip fracture care as the yearly difference in fulfilment of the all-or-none composite, as well as the differences in fulfilment of individual care processes.

Third, performing a sensitivity analysis, we repeated the analyses excluding all patients with missing information to explore whether missing information could explain our results.

Patient involvement statement

This research was done without patient involvement. Patients were not invited to comment on the study design and were not consulted to develop patient-relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

RESULTS

The overall hip fracture cohort included 60 275 patients. Based on the logistic regression models, the best-off and worst-off groups each comprised 6033 patients. Overall patient characteristics for the entire population and the best-off and worst-off patients are presented in [table 1](#). Throughout the years, best-off patients were typically females between 75 and 84 years (online supplemental table 1). We observed no clear pattern for comorbidity and type of fracture for best-off patients (online supplemental table 1). In contrast, among worst-off patients, we observed a male preponderance and more were 85 years or older and had high comorbidity levels (online supplemental table 1). In addition, for a majority of the worst-off patients, registration of fracture type and type of education was missing for many of the worst-off patients (online supplemental table 1). Best-off and worst-off patients did not differ according to employment, household income or cohabiting status.

The proportion of patients receiving high quality of care defined as all-or-none varied over the years for both patient groups, as shown in [figure 3](#). Best-off and worst-off

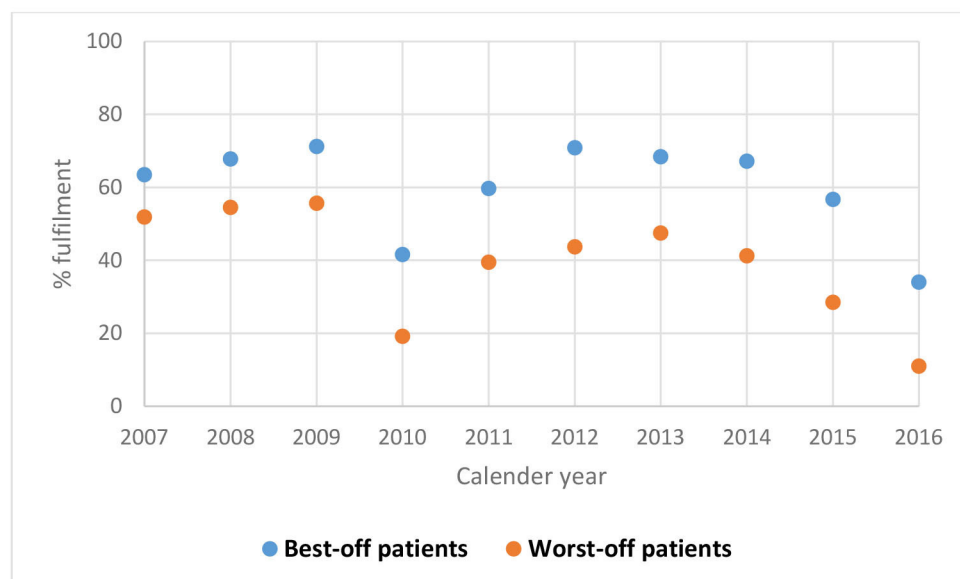


Figure 3 The proportion of best-off- and worst-off patients, who fulfilled the all-or-none by calendar year.



patients showed the same pattern with an increase in fulfilment of quality criteria until 2010 followed by a notable drop. In 2012, best-off patients had the same fulfilment as in 2009; however, this was not the case for the worst-off patients. Consequently, the difference in percentage points between best-off and worst-off patients for receiving the all-or-none composite rose over the years from 12 percentage points (95% CI 6 to 18) in 2007 to 23 percentage points (95% CI 19 to 28) in 2016. The greatest difference was in 2015, with 28 percentage points (95% CI 23 to 33), whereas the lowest was in 2007. We primarily observed differences in quality of care between best-off and worst-off patients in four individual care processes: assessment of pain, mobilisation within 24 hours, assessment of need for antiosteoporotic medication and nutritional risk assessment (figure 4). Fulfilment of assessment of functional level and joining a postdischarge rehabilitation programme increased for both patient categories during the study period; and so did prevention of osteoporotic fractures, which was applicable early in the study period. No clear pattern was seen for the care processes time to surgery and preoperative optimisation, which were applicable only for the two last years and 2016, respectively. The exact numbers for the figures are provided in online supplemental table 2. The sensitivity analysis, excluding patients with missing information on fracture type, showed a lower level of disparity in quality of care between the best-off and the worst-off patients (online supplemental figure 1).

The final models for predicting fulfilment of the all-or-none composite had a C-index between 0.55 and 0.60, indicating that the models provided a poor-to-moderate discrimination between different patients. However, the calibration curves overlapped the identity line in the histograms as illustrated in online supplemental figure 2, indicating good model calibration.

DISCUSSION

This population-based study among hip fracture patients in Denmark shows that disparity in the quality of care among hip fracture patients has remained substantial over time. The disparity was observed consistently for a range of individual recommended care processes, including assessment of pain, mobilisation within 24 hours, assessment of need for antiosteoporotic medication and nutritional risk assessment.

The strengths of this study include the use of a large, well-characterised nationwide cohort with national coverage of prospectively collected data, the use of the unique individual personal registration number ensuring no loss to follow-up and linkage between national registries with detailed information. Furthermore, the care processes used represent basic hip fracture care recommended by experienced clinicians and in accordance with international standards³⁸; and the processes have been shown to be associated with improved outcome.^{8,9} Several initiatives were taken to handle potential heterogeneity

in the individual patients' needs. Only eligible care processes for the individual patient were included in the analysis as staff was able to exclude patients ineligible for the recommended care process, for example, patients with dementia who would be incapable of reporting their level of pain. We cannot exclude the possibility that the clinical assessment of the eligibility criteria for individual patients may have varied. However, the included process performance measures reflect basic care elements for which only a small proportion of hip fracture patients were considered ineligible. In addition, in the analyses we only included patients who were relevant for a minimum of half of the care processes. Hence, the clinical need for fulfilment of the process performance measures was considered comparable among best-off and worst-off patients, and any non-differential misclassification of eligibility would most likely have biased our findings in a conservative direction. The predictive performance of the logistic regression models was poor to moderate, indicating that factors not available to us influenced the likelihood of receiving some dimension of recommended care. Still, the calibration curves showed that the models were well calibrated in the area where data were available. Furthermore, we observed substantial differences in patient characteristics and the received quality of care when comparing the best-off with the worst-off patients, even if the model showed suboptimal discriminative performance. Potential bias related to miscoding and misclassification in the database may have affected our results. In addition, information on fracture type and education was lacking for a substantial proportion of the worst-off patients. However, a sensitivity analysis excluding all patients with missing data confirmed the disparity between best-off and worst-off patients from the primary analysis. Data validity is highly prioritised in the DMHFR, which has detailed data definitions and auditing of data quality performed continuously at local and regional levels and annually at national level.

Ideally, the study should have been done in a setting where individual performance measures remained the same throughout the entire study period. However, attempts to improve quality of care are ever ongoing; and even though our approach produced a very heterogeneous measure, our use of the all-or-none composite represents the perceived professional definition of high quality of care at any given time during the study period.

Hip fracture patients have a high risk of serious complications and death.³⁹ Thus, a growing body of evidence shows the importance of multidisciplinary interventions for the prognosis after hip fracture.^{8,9,12,38,40,41} Quality of care requirements have therefore risen over time, and it has become more difficult for hospitals to fulfil the all-or-none composite. However, even though the requirements for quality of care have become more detailed and operational, disparity in care remains substantial.

In this study, we were able to discriminate between best-off and worst-off patients on the basis of age, sex and severity of disease, which corresponds to previously

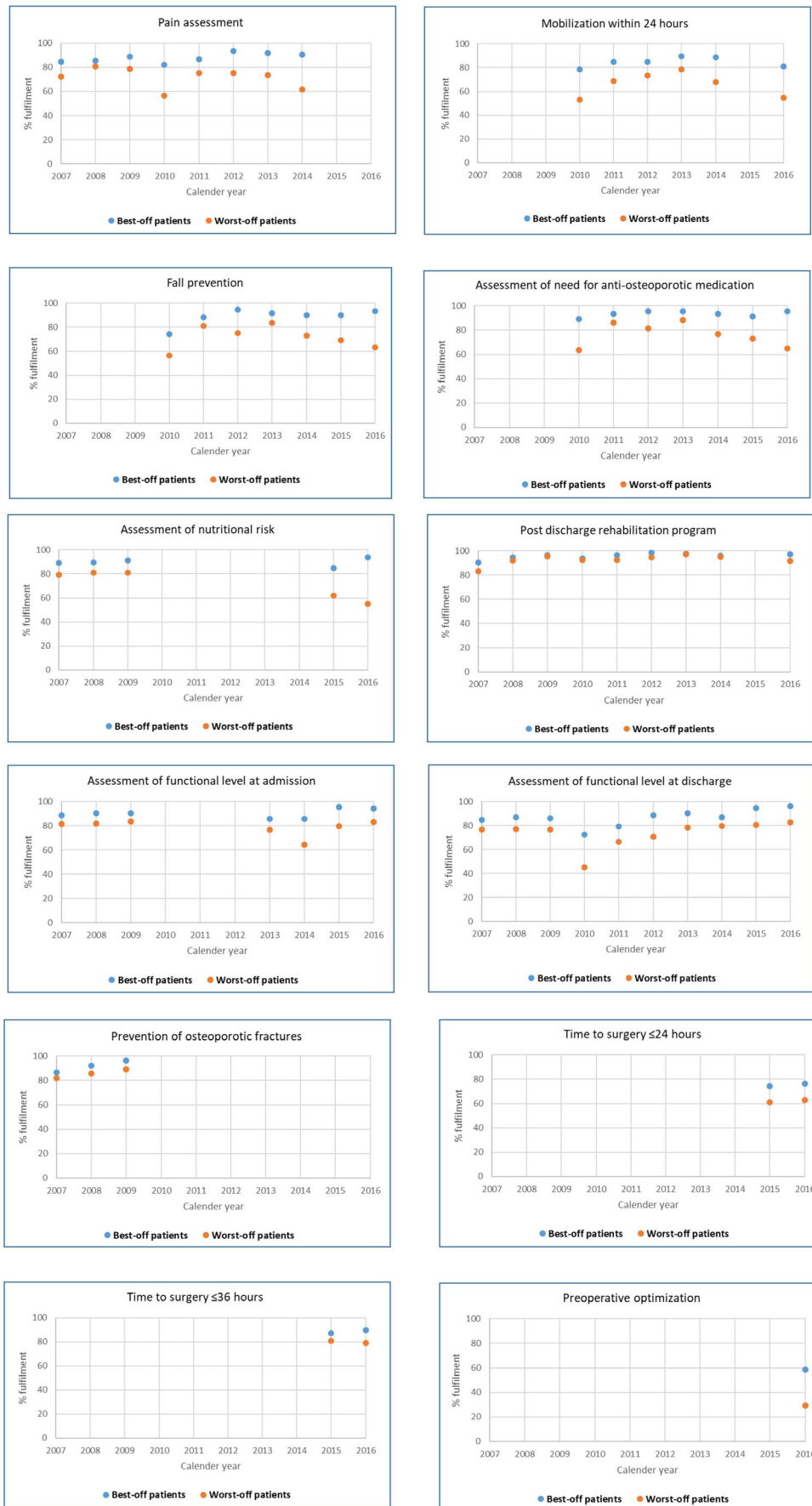


Figure 4 The proportion of best-off and worst-off patients, who fulfilled the individual process performance measure by calendar year.



observed trends linking higher age and males with a lower chance of mobilisation within 24 hours after surgery.²³ An important part of the disparity seems to be associated with missing registration of fracture type, indicating that deficient registration practices in medical records are associated with lower quality of care. Most other covariates were highly correlated and therefore not possible to attribute separate importance. The finding of minimal discrimination in relation to socioeconomic markers like employment, household income and education also corroborates with previous findings of no difference in the recommended hip fracture care in Denmark according to individual socioeconomic markers.²² This indicates that socioeconomic inequality in the quality of hip fracture care may not be a prominent problem in Denmark; however, substantial inequality still exists in the clinical outcomes, which leaves the healthcare system with an unmet challenge.²² Our study extends the understanding of patient-related disparity in the quality of hip fracture care as it quantifies the overall sum of unjustified difference. The overall size of disparity in healthcare is an important issue that deserves further scrutiny, not least since the healthcare system has sought to minimise the disparity in quality of care through implementation of clinical guidelines and continuous monitoring in recent decades.

Much effort has been made through the years to standardise treatment for patients with similar needs, including the introduction of universal patient rights; however, our study shows that it is difficult to ensure uniform high-quality care for all hip fracture patients even in tax-financed healthcare system like the Danish system. The lack of systematic monitoring of differences in quality of care among vulnerable patient groups makes it inherently difficult to identify potential problems. Our results, therefore, highlight the need for detailed monitoring of the quality of care among subgroups of hip fracture patients to ensure that vulnerable patient groups also benefit from the advances in hip fracture care seen in recent years.

In conclusion, this nationwide study shows disparity in the quality of care among hip fracture patients. The size of the disparity has remained substantial despite changes in clinical practice and the introduction of clinical guidelines. However, reducing disparities in care should not be the sole target as the overall quality of care needs to be improved for all types of hip fracture patients.

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Contributors PKK: design of methodology, literature search, data interpretation, writing up original draft preparation, final approval of the version to be published. AMF-J: design of methodology, project administration, visualisation of tables, data interpretation, writing, reviewing and editing, and final approval of the version to be published. MM: design of methodology, data curation, data analysis, data

interpretation, writing, reviewing and editing, and final approval of the version to be published. SPJ: conceptualisation and design, supervision, data interpretation, writing, reviewing and editing, and final approval of the version to be published. PKK is the guarantor of the manuscript

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Competing interests None declared.

Patient consent for publication Not applicable.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Data cannot be shared publicly because of ethical and data safety reasons. Data are available from the Danish Multidisciplinary Hip Fracture Registry and Statistics Denmark after approval of the research project by Danish Data Authorities and Steering Committee from the Danish Multidisciplinary Hip Fracture Registry.

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