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Older high-cost patients in Norwegian somatic hospitals: a register-based study of patient characteristics

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ABSTRACT

Objective Two-thirds of the economic resources in Norwegian hospitals are used on 10% of the patients. Most of these high-cost patients are older adults, which experience more unplanned hospital admissions, longer hospital stays and higher readmission rates than other patients. This study aims to examine the individual and clinical characteristics of older patients with unplanned admissions to Norwegian somatic hospitals and how these characteristics differ between high-cost and low-cost older patients.

Design Observational cross-sectional study.

Setting Norwegian somatic hospitals.

Participants National registry data of older Norwegian patients (≥65 years) with ≥1 unplanned contact with somatic hospitals in 2019 (n=2 11 738).

Primary outcome measure High-cost older patients were defined as those within the 10% of the highest diagnosis-related group weights in 2019 (n=21 179). We compared high-cost to low-cost older patients using bivariate analyses and logistic regression analysis.

Results Men were more likely to be high-cost older patients than women (OR=1.25, 95% CI 1.21 to 1.29) and the oldest (90+ years) compared with the youngest older adults (65–69 years) were less likely to cause high costs (OR=0.47, 95% CI 0.43 to 0.51). Those with the highest level of education were less likely to cause high costs than those with primary school degrees (OR=0.74, 95% CI 0.69 to 0.80). Main diagnosis group (OR=3.50, 95% CI 3.37 to 3.63) and dying (OR=4.13, 95% CI 3.96 to 4.30) were the clinical characteristics most strongly associated with the likelihood of being a high-cost older patient.

Conclusion Several of the observed patient characteristics in this study may warrant further investigation as they might contribute to high healthcare costs. For example, MDGs, reflecting comprehensive healthcare needs and lower education, which is associated with poorer health status, increase the likelihood of being high-cost older patients. Our results indicate that Norwegian hospitals function according to the intentions of those having the highest needs receiving most services.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study examines characteristics of high-cost older patients by using data on an individual level.
⇒ The study has a large sample size derived from national registers, which allowed us to include all older patients in Norway with at least one unplanned contact with somatic hospitals during 2019.
⇒ The individual characteristics included in this study provide important knowledge about variation in the utilisation of hospital services in the older Norwegian population. However, targeted preventive measures may not be an appropriate line of action as several of the individual characteristics associated with being high-cost older patients are non-modifiable.
⇒ Given the universal health coverage and structure of the Norwegian healthcare system, our findings may be transferable to countries with similar health coverage and healthcare systems.

BACKGROUND

Two-thirds of all available economic resources in Norwegian hospitals are used on a small proportion (10%) of patients. These high-cost patients experience more unplanned hospital admissions, longer hospital stays and higher readmission rates than other patients.[1] Approximately half of these patients are older adults (≥65 years) with multiple chronic conditions, frailty, longer hospital stays and/or more hospital contacts than other patients.[2 3] These factors are associated with increased hospital costs, and older adults are particularly at risk of becoming high-cost patients due to complex health conditions and long-term healthcare needs.[2] A small number of medical conditions including circulatory, neurological, respiratory and gastrointestinal diseases drive the overall resource utilisation most strongly, and circulatory and respiratory diagnoses account for approximately 20% of resources used on Norwegian high-cost older patients.[1] A substantial rise in the number of older adults will likely increase the number of high-cost patients in the future.[4] Therefore, healthcare systems have an increased interest in the implementing of new strategies for quality improvement and health outcomes for high-cost older patients in somatic hospitals.[5]

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Previous studies have examined the associations between patient characteristics and the utilisation of hospital services of high-cost older patients.[6 7] However, most studies were conducted in North America, which limits the transferability of results to the Norwegian health system due to differences in welfare models, private and public insurance coverage and institutional designs across countries.[8 9] In contrast to healthcare systems relying on private health insurance and private healthcare providers, the Norwegian healthcare system is publicly financed aiming to provide free and equal healthcare to all citizens.[10] As a result, Norwegian high-cost older patients may differ from other high-cost groups described in the international literature. Hence, this study aims to examine the individual and clinical characteristics of older adult patients with unplanned admissions to Norwegian somatic hospitals and assess how these characteristics are associated with being classified as high-cost or low-cost older patients, using odds ratio (OR) as a measure of association.

METHOD

Study population and data sources

This is a population-based, cross-sectional study using data from the Norwegian Patient Registry (NPR) and Statistics Norway (SSB). NPR contains national activity data from the specialist healthcare services, including information about age, sex, number and types of hospital admissions, length-of-stay (LOS), main diagnosis group (MDG) and diagnosis-related groups (DRG).[11] SSB provided information on educational attainment, marital status and index of municipal centrality. We included all older adults ≥65 years with at least one documented unplanned contact with a somatic hospital between 1 January and 31 December 2019 (figure 1).

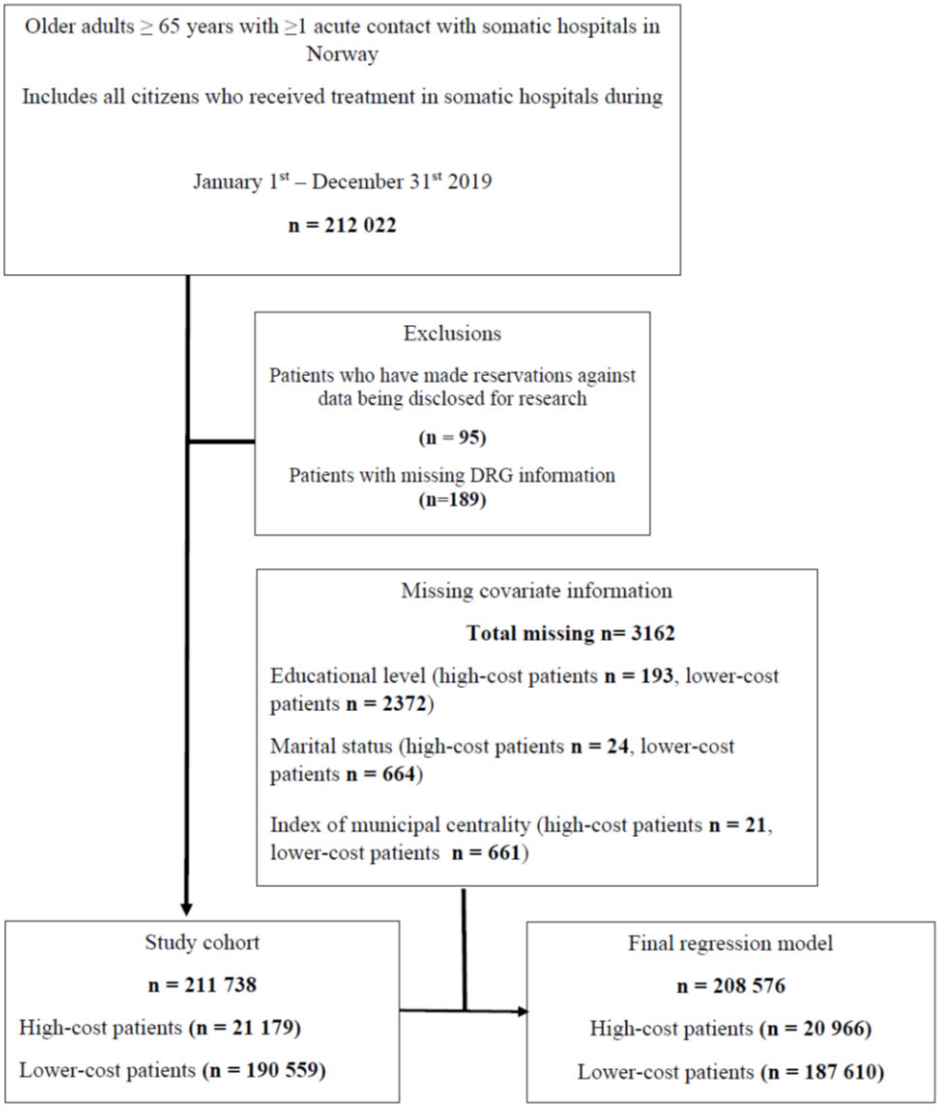

Figure 1 Study population inclusion/exclusion criteria.

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This includes all citizens who have received treatment in Norwegian somatic hospitals nationwide. Unplanned hospital contacts include day treatment, outpatient care and admittance to acute care wards. Patients who had an unplanned incident during a planned hospital admission were included in the study population. The study sample constitutes 23% of the total population aged 65 years or older in Norway in 2019.[12] Patients who did not consent to data disclosed for research (n=95), and 189 patients with missing data on DRG estimates were excluded from the study.

Study setting

Norwegian hospitals provide services to all patients in need of treatment and are funded and regulated by the Ministry of Health and Care Services. Patients are admitted to hospital either through referrals by general practitioners or via the emergency services. Public hospitals are owned by the state and their funding is determined by activity-based DRG and government subsidies through block grants.[9] Hospital reimbursement based on DRG weights requires that treatments and activities are reported to national health registries, and DRG provides cost expenditures calculated at an individual level, reflecting an individual's total healthcare costs.[13] DRG weight is a relative quantity that expresses what a hospital contact costs on average compared with the average patient.[14] In 2019, 1 DRG was estimated to be 44654 NOK (4532.7 EUR/ 4047.7US$ by the average exchange rate) and is considered the 'baseline' for the average hospital costs per patient.[15]

Patient and public involvement

This study consists of anonymised registry data and no patients or public officials were involved in any processes of this study. The aim and results of this study have been presented and discussed with a reference group consisting of patient representatives, primary- and specialised healthcare service employees and members of the senior council for Troms County to raise awareness of this study population.

Main outcome variable

Studies on high-cost patients have argued that cost is a reasonable measurement of healthcare utilisation,[16 17] because cost has far-reaching impacts on the adequacy and performance of patient services.[18] In this study, DRG weights were selected as a measurement for overall resource use, reflecting total healthcare costs for each patient admitted to hospital wards. In alignment with previous studies on high-cost patients and healthcare utilisation,[19 20] we defined the high-cost older patients as those whose healthcare costs are among the top 10% of the study population (ie, within the 90th percentile of DRG weights). The comparison group consisted of the remaining 90% of participants, and the variable was binary-coded as either high cost (1) or lower cost (0).

Individual characteristics as predictors

The individual characteristics included sex, age, educational level, marital status and index of municipal centrality. Sex was categorised as men or women. Age categories included 5-year intervals from 65 to 69 years to 90+ years. As previous studies have found most high-cost older patients to be within the younger age groups of older adults (65–80 years), the reference level was set at 65–69 years.[17 21 22] Education was categorised in four levels (primary school, high school, higher education<4 years, higher education≥4 years). Marital status included four groups (married/registered partner/cohabitant, single/unmarried, divorced/separated, widow/widower/surviving partner). The index of municipal centrality was included as a measure for municipal distance to workplaces and various services, including health centres and hospitals.[23] The variable was categorised at six levels (from most to least central municipalities) and further merged into three categories (most central, middle central and least central municipalities).

Clinical characteristics as predictors

The clinical characteristics included information about in-hospital service use, MDGs and month of death. In-hospital service use included LOS, total hospital contacts and DRG weight.[24 25] Based on 22 available MDGs in NPR (online supplemental appendix 1), we determined whether an individual had multimorbidity (≥3 MDG) or not (≤2 MDG).[26] Month of death was recoded to a binary variable showing if the patient died during 2019 and was included to adjust for the high healthcare costs that may occur in the time prior to death.[27]

Statistical analyses

We described the sample using numbers/proportions for categorical variables, and medians and IQR for continuous variables since data were skewed. Bivariate analyses were used to compare differences in each characteristic between high-cost and low-cost older patients. We assessed categorical variables by using X^2 test of independence and continuous variables by using the Mann-Whitney U test (significance level at 0.05). Potential outliers were addressed by categorisation of the variables. Univariable regression analyses were conducted to compare each characteristic between high-cost and lower-cost older patients. We conducted a multiple logistic regression and employed the OR along with 95% confidence intervals (CIs) as a measure of the association between the independent variables and the outcome of being classified as either a high-cost or low-cost older patient. The OR quantifies the likelihood of being a high-cost older patient relative to being a lower cost older patient based on the individual and clinical characteristics. The model was run in blocks where the individual characteristics were included in block I, and the clinical was included in block II. Approximately 1.5% of all participants had missing information on covariates (educational level, index of municipal centrality and/or marital status).

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Since there was a low percentage of missing data, we excluded records with missing data from the regression model. The inclusion of variables in the regression model was guided by previous research and by the availability of variables in the data set. The five most prevalent MDGs found within the study population are presented in the descriptive overview but were excluded from the regression model as they are included in the binary multimorbidity variable. DRG weight and LOS were excluded from the regression model due to close correlation to the outcome variable. The multivariable model included sex, age, educational level, marital status, municipal centrality, multimorbidity/MDGs (two groups), death and number of hospital contacts. The model did not demonstrate any multicollinearity problems (variance inflation factor <1.2, tolerance >0.8). All statistical tests were two sided with p values at alpha level (<0.05) considered significant. The study used Strengthening the Reporting of Observational Studies in Epidemiology cross-sectional guidelines[28] and the statistical analyses were conducted using IBM SPSS Statistics V.29 and STATA V.17.

RESULTS

Descriptive statistics and bivariate analysis

A total of 211 738 patients aged 65 years and older had an unplanned hospital contact in 2019 with 21 179 (10%) considered high-cost older patients and 190 559 (90%) lower cost patients. Individual characteristics and bivariate analyses are presented in table 1. A higher proportion of men (56.6%) was classified as high-cost older patients compared with women (43.5%). We further found differences across age groups where almost 70% of the high-cost older patients were in the younger older adult category (ie, below 80 years old). Regarding marital status, the results showed small differences between the two groups. Similar small differences were observed across educational levels where 31% had a primary school degree, almost half of all included participants had a high-school degree and 5% of the participants had a higher education of 4 years or more. Regarding municipal centrality, we found no significant differences between the high-cost and low-cost group, where less

Table 1 Descriptive statistics and bivariate analysis of individual characteristics, study population (n=211 738)

	Lowest 90% low-cost older patients (n=190 559)	Top 10% high-cost older patients (n=21 179)	P
Sex (%)			<0.001
Men	87 659 (46.0%)	11 959 (56.5%)	
Women	102 900 (54.0%)	9220 (43.5%)	
Age in 5-year intervals (%)			< 0.001
65–69 years	35 892 (18.8%)	4132 (19.5%)	
70–74 years	42 550 (22.3%)	5703 (26.9%)	
75–79 years	36 172 (19.0%)	4798 (22.7%)	
80–84 years	30 556 (16.1%)	3424 (16.2%)	
85–89 years	25 546 (13.4%)	2137 (10.1%)	
90+years	19 843 (10.4%)	985 (4.6%)	
Marital/partner status (%)			< 0.001
Married/cohabitant/partner	95 170 (50.1%)	11 638 (55.0%)	
Single/unmarried	12 063 (6.4%)	1440 (6.8%)	
Divorced/separated	29 117 (15.3%)	3507 (16.6%)	
Widow/widower	53 545 (28.2%)	4570 (21.6%)	
Educational level (%)			< 0.001
Primary school	58 428 (31.0%)	6585 (31.4%)	
High school*	90 710 (48.2%)	10 442 (49.8%)	
Higher education<4 years	29 188 (15.5%)	2908 (13.9%)	
Higher education≥4 years	9861 (5.2%)	1051 (5.0%)	
Index of municipal centrality (%)			0.064
Least central municipalities	33 309 (17.5%)	3847 (18.2%)	
Middle central municipalities	81 857 (43.1%)	9070 (42.9%)	
Most central municipalities	74 732 (39.4%)	8241 (38.9%)	

Bivariate analysis: X^2 test of independence.
*Includes high school and vocational school.

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Table 2 Descriptive statistics and bivariate analysis of clinical characteristics, study population (n=2 11 738)

	Lowest 90% low-cost older patients (n=1 90 559)	Top 10% high-cost older patients (n=21 179)	P
In-hospital service use (median, IQR)			
Length of stay in hospital	2.0 [0–6)	21.0 (13–35)	<0.001
Number of total hospital contacts*	3.0 (2–6)	12.0 (7–21)	<0.001
DRG weight	1.25 [0.43–2.42)	8.67 [7.13–11.39)	<0.001
Most prevalent main diagnosis groups† (%)			
Diseases of the circulatory organs	61 483 (32.3%)	9566 (45.2%)	<0.001
Diseases of the respiratory organs	34 144 (17.9%)	8220 (38.8%)	<0.001
Diseases of the digestive organs	33 597 (17.6%)	7756 (36.6%)	<0.001
Diseases of the nervous system	36 720 (19.3%)	5060 (23.9%)	<0.001
Diseases of the musculoskeletal system	65 016 (34.1%)	6664 (31.5%)	<0.001
Multimorbidity/number of main diagnoses‡ (%)			<0.001
≤ 2 main diagnoses registered	124 793 (65.5%)	5137 (24.3%)	
≥ 3 main diagnoses registered	65 766 (34.5%)	16 042 (75.7%)	
Mortality (%)			<0.001
Alive by 31.12.2019	173 017 (90.8%)	16 319 (77.1%)	
Died during 2019	17 542 (9.2%)	4860 (22.9%)	

Bivariate analysis: Mann-Whitney U or X^2 test of independence.
*Includes daytime treatment, outpatient care and admittance to hospital wards in the dataset.
†Most prevalent main diagnoses found in the dataset.
‡Includes all 22 main diagnosis groups from NPR.
DRG, diagnosis-related group; NPR, Norwegian Patient Registry.

than 20% lived in the least central municipalities and approximately 40% of the participants lived in the most central municipalities.

In table 2, we present the clinical characteristics. High-cost older patients exhibited significantly longer LOS with a median of 21 days (IQR 13–35) compared with low-cost older patients. The high-cost older patient group had a median of 12 hospital contacts (IQR 7–21) throughout 2019, while the low-cost group had a median of three contacts (IQR 2–6). Additionally, the median cost was significantly higher for high-cost older patients, with a DRG of 8.67 (IQR 7.13–11.39) (equivalent to 39.298.5 € or 387150.18 NOK), compared with low-cost older patients, who had a DRG of 1.25 (IQR 0.43–2.42) (approximately 5.693 €). MDGs affecting the circulatory (45.2% vs 32.3%) and respiratory organs (38.8% vs 17.9%) were more prevalent among the high-cost older patients. However, MDGs affecting the musculoskeletal system were most prevalent in the lower cost group (34.1% vs 31.5%). Of all high-cost older patients, 75.7% were diagnosed with three or more different main diagnoses, and nearly 23% of them passed away during the study period. The total percentage for the most prevalent MDGs in both the high-cost and low-cost group exceeds 100% due to multiple morbidity among many patients. Throughout 2019, several patients in both groups were diagnosed with more than one MDG. The cumulative percentage represents the proportion of patients diagnosed with each individual MDG, regardless of whether it was their initial diagnosis.

Regression analysis

The logistic regression model included 208 576 participants. The multivariable model (table 3) suggests that men were more likely to be high-cost older patients than women (OR 1.25, 95% CI 1.21 to 1.29). Compared with the youngest older adults (65-69), all age groups 80 years and older were associated with a lower likelihood of being high-cost older patients, and the oldest older adults (90+) had the lowest likelihood (OR 0.47, 95% CI 0.43 to 0.51). When compared with the univariable model, no significant association was found for marital status at any level in the multivariable model. Compared with participants with primary school education, lower likelihoods of being high-cost older patients were observed within the highest levels of educational attainment, with the lowest likelihood found within higher education ≥4 years (OR 0.741, 95% CI 0.69 to 0.80). Patients living in middle (OR 0.89, 95% CI 0.85 to 0.93) or most central municipalities (OR 0.90, 95% CI 0.86 to 0.94) had lower probability of being high-cost older patients than those living in least central municipalities. Based on the pseudo-R^2, the first block consisting of individual characteristics explained 2% of the variance in the regression model, while the second block including clinical variables contributed to nearly

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Table 3 Logistic regression: OR with p values for being a high-cost older patient by individual and clinical characteristics

	Univariable		Multivariable*	
Characteristics	OR (95% CI)	p	OR (95% CI)	P
Sex				
Women	Ref.		Ref.	
Men	1.52 [1.48 to 1.57)	<0.001	1.25 [1.21 to 1.29)	<0.001
Age in 5-year intervals		<0.001		<0.001
65–69 years	Ref.		Ref.	
70–74 years	1.16 [1.12 to 1.22)	<0.001	1.06 [1.01 to 1.11)	0.018
75–79 years	1.15 [1.10 to 1.20)	<0.001	1.01 [0.96 to 1.06)	0.730
80–84 years	0.97 [0.93 to 1.02)	0.268	0.92 [0.87 to 0.97)	0.001
85–89 years	0.73 [0.69 to 0.77)	<0.001	0.72 [0.67 to 0.76)	<0.001
90+ years	0.43 [0.40 to 0.46)	<0.001	0.47 [0.43 to 0.51)	<0.001
Marital/partner status		<0.001		0.182
Married/cohabitant/partner	Ref.		Ref.	
Single/unmarried	0.98 [0.92 to 1.03)	0.415	1.06 [0.99 to 1.13)	0.077
Divorced/separated	0.70 [0.67 to 0.73)	<0.001	1.03 [0.99 to 1.08)	0.144
Widow/widower	0.99 [0.95 to 1.03)	0.457	1.03 [0.98 to 1.07)	0.282
Educational level		<0.001		<0.001
Primary school	Ref.		Ref.	
High school†	1.02 [0.99 to 1.06)	0.202	0.92 [0.89 to 0.96)	<0.001
Higher education≤4 years	0.89 [0.84 to 0.93)	<0.001	0.79 [0.75 to 0.83)	<0.001
Higher education≥4 years	0.95 [0.88 to 1.01)	0.110	0.74 [0.69 to 0.80)	<0.001
Index of municipal centrality		0.64		<0.001
Least central municipalities	Ref.		Ref.	
Mid-central municipalities	0.96 [0.92 to 1.00)	0.041	0.89 [0.85 to 0.93)	<0.001
Most central municipalities	0.96 [0.92 to 0.99)	0.025	0.90 [0.86 to 0.94)	<0.001
Multimorbidity/number of main diagnoses‡				
≤ 2 main diagnoses registered	Ref.		Ref.	
≥ 3 main diagnoses registered	5.93 [5.73 to 6.12)	< 0.001	3.50 [3.37 to 3.63)	<0.001
Mortality				
Alive by December 31 2019	Ref.		Ref.	
Died during 2019 (01.01–31.12)	2.94 [2.83 to 3.04)	< 0.001	4.13 [3.96 to 4.30)	<0.001
All hospital contacts in 2019§				
Number of hospital contacts	1.10 [1.09 to 1.10)	< 0.001	1.07 [1.06 to 1.07)	<0.001

Individual characteristics: sex, age in 5-year intervals, martial/partner status, education level, index of municipal centrality. Clinical characteristics: multimorbidity/number of diagnoses, mortality, all hospital contacts in 2019.
*Nagelkerke pseudo R^2: Block I (individual characteristics): 0.020, Block II (clinical characteristics): 0.255.
†Includes high school and vocational school.
‡Includes all 22 main diagnosis groups from NPR.
§Includes daytime treatment, outpatient care and admittance to hospital wards.
NPR, Norwegian Patient Registry.

26% of the total variance. The analysis showed increased likelihood of being a high-cost older patient among those who died in 2019 (OR 4.13, 95% CI 3.96 to 4.30). Being diagnosed with three or more MDGs (OR 3.50, 95% CI 3.37 to 3.63) and number of hospital contacts (OR 1.07, 95% CI 1.06 to 1.07) also contributed to an increased likelihood of being a high-cost older patient.

DISCUSSION

In this study, we used individual patient data from national registers to examine the individual and clinical characteristics of high-cost older patients in Norwegian somatic hospitals. The results show that both individual and clinical characteristics were associated with a higher likelihood of being a high-cost older patient. The median total

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DRG costs among high-cost older patients were nearly seven times higher than among the low-cost patients. In addition, the high-cost older patient group had more contacts with somatic hospitals and considerably greater LOS. Overall, our findings correspond with the existing main body of research on high-cost older patients, despite different healthcare systems and study contexts.[10 29] While the results indicate that clinical characteristics are the strongest drivers for high hospital costs in this study,[30] the individual characteristics might explain some of the variation in how and why more resources are used on high-cost older patients in Norway.

In this study, we observed several variations in the likelihood of being high-cost older patients across the individual characteristics. The results indicated that men were more likely to be a high-cost older patient than women. Older men and women are known to utilise healthcare differently due to variation in lifespan and diagnoses.[31] For example, a 2020 Norwegian study on healthcare utilisation trends observed that men were admitted to hospitals more frequently, whereas women had higher use of home-based healthcare services and more general practitioner consultations.[27] Reports from the Norwegian Institute of Public Health show that cardiovascular and respiratory diagnoses are overall more prevalent in Norwegian men than women.[32 33] Previous studies suggest that these conditions are associated with both higher mortalities, multimorbidity and high costs,[34 35] as indicated by the high number of participants who died in the high-cost group in our study. Because these main diagnoses may have serious long-term health consequences, healthcare utilisation and costs for these patients increase in the years following diagnosis.[17] We further found a lower likelihood of being a high-cost older patient among the oldest older age groups compared with the youngest older age groups. International studies in study populations with health coverage comparable to Norway have confirmed these findings,[21 22] and similar results have been reported in previous Norwegian studies focusing on older adult populations.[3 36] This is interesting considering that the oldest older adults have higher risk of complications and limited or poor health outcomes than younger older adults, which is associated with prolonged LOS.[37] The availability of other treatment options for in-patient hospital care, such as municipal emergency medical wards or nursing home care,[38 39] might also be a contributing factor in the lowered likelihood observed in the oldest older adults. A 2014 OECD report suggested that strategies for improving and strengthening municipal care can efficiently reduce hospitalisation rates, LOS and, thus, hospital costs for the oldest adult population.[40] Higher costs and longer hospital stay for older adults are more commonly reported in study populations where municipal healthcare is not publicly funded or provided through universal health coverage.[40 41]

The results further showed that older adults living in least central municipalities had a higher likelihood of being within the high-cost older patient group, than those living in more central municipalities. Although the Norwegian healthcare system is decentralised, the larger hospitals with the more advanced services including outpatient care are located in urban centres, which might contribute to longer LOS for older adults living in rural areas. Furthermore, we found that higher education, compared with primary school education, was associated with a lower likelihood of being a high-cost older patient. Health inequalities in Norway are to a large extent connected to social status where poor health is more commonly seen among those with low income and lower education.[42 43] Our results might, thus, indicate that those patients with the highest needs receive most hospital services. This study concurs with previous reports and studies showing that there are significant social differences in the utilisation of some health services, particularly across educational levels.[42–44] Individuals with lower education tend to have higher use of general practitioners and are more often admitted to hospitals. In comparison, individuals with higher education more frequently visit specialists, physiotherapists and dentists.[45]

Strengths and limitations

This study analysed national data of all older adults aged 65 years and older with unplanned contacts to somatic hospitals in 2019 and contribute with new knowledge about high-cost older patients in Norwegian somatic hospitals. Given the universal health coverage and structure of the Norwegian healthcare system, our findings may be transferrable to countries with similar health coverage and healthcare systems. The major strength of this study is the large sample derived from national registers from which we have used data on an individual level. The individual characteristics included in this study provide important knowledge about variation in the utilisation of hospital services in the older Norwegian population. However, targeted preventive measures may not be an appropriate line of action as several of the individual characteristics associated with being high-cost older patients are non-modifiable. While clinical characteristics such as death have a strong association with high healthcare costs, it is important to emphasise that this is not a predictive factor for identifying future high-cost older patients. The variable does not provide any causal explanation for high healthcare costs due to the limitations of this variable. Nonetheless, the association between death and high healthcare cost offers valuable insight into the patterns of resource utilisation in Norwegian somatic hospitals. Due to patient privacy concerns, the dataset did not include information on ICD-10 codes or the Charlson Comorbidity Index, which are often included in similar studies. Our data only included a measure of the number of MDGs. We assume that MDGs can be used as a viable proxy measurement for multimorbidity, given the coherency of our results with similar studies. Variable information on income status was not available for nearly 23% of the high-cost older patients and 10% of the lower cost older patients in our study. SSB only

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collects household income data for the participants who were registered with an address by the end of each year, thus the data had missing information on income status for the participants who died in 2019. This is a limitation as the combination of income and educational level would have contributed to a more accurate measure of socioeconomic status than education alone.[46] Furthermore, our study's focus on observed associations rather than future predictions limits the use of certain methodological approaches. One such approach is the PROGnosis Research Strategy framework,[47] which is commonly employed to guide prognostic factor research. This would have facilitated direct comparisons with studies following its guidelines, enhancing our methodological structure. However, the nature of our data constrained our ability to explore prognostic factors but underscores the need for future research with longitudinal data to investigate future outcomes among high-cost older patients. Finally, some registrations from multiward hospital stays were not aggregated in the NPR data set, which caused possible misregistration in 4066 of the participants. These data could have incorrect values for DRG weights or missing information on unplanned contact types. This misregistration may regard some admissions to multiple hospital wards, or admissions before 01.01.2019 where registrations from the individual wards are not aggregated. Of 1777 (43.7%) of the patients with possible misregistration were high-cost older patients based on their estimated DRG weights. As their DRG weights are underestimated, rather than overestimated, they were not excluded from this study since they provide valuable information about the characteristics of high-cost older patients.

Conclusion

The ideal of universalism and equitable access to healthcare is inherent in the Nordic welfare model and the Norwegian healthcare system. Equitable access would imply unequal use because some patients have more substantial healthcare needs than others. This study investigated the individual and clinical characteristics of older adult patients with unplanned admissions to Norwegian somatic hospitals and their association with being classified as high-cost or low-cost older patients, using OR as a measure of association. The findings of this study suggest that certain individual and clinical characteristics influence the likelihood of being classified as a high-cost older patient. While upholding the ideal of equitable access to healthcare, it is essential to consider the diverse healthcare needs of older patients. Several of the observed patient characteristics in this study may warrant further investigation as they might contribute to high healthcare costs. For example, patients with multiple MDGs, that is, the patients with the most comprehensive healthcare needs, are more likely to be high-cost patients. Similarly, patients with lower education, previously documented to have poorer health status, are more likely to be high-cost patients. Understanding the underlaying factors contributing to these variations could aid in the development of targeted interventions to manage healthcare and improve patient outcomes. Considering this viewpoint, our results indicate that Norwegian hospitals function according to the intentions of those having the highest needs receiving most services. Based on our results, we cannot conclude that being a high-cost older patient is a consequence of insufficient local healthcare services, such as primary healthcare services. This should be subjected to future studies.

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Contributors ML-N designed the study, analysed the data, wrote the first draft of the manuscript and is responsible for the overall content as the guarantor. MDJ designed the study and was involved in the data analysis, interpretation of results and writing process. TSB contributed with the planning of data analyses, interpretation of results and editing of the manuscript. BHB and MH contributed to the writing of the article and discussion. J-MM designed the study, conducted data management and contributed to both the analyses and writing of the article. All authors have critically reviewed and edited the draft article. All authors read and approved the final version of the manuscript.

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Ethics approval The data were de-identified prior to being released to the researchers to avoid any confidentiality concerns. The Regional Committee for Medical and Health Research Ethics provided dispensation from the duty of confidentiality (reference number 143644). The Norwegian Centre for Research Data (NSD) has approved the study in accordance with the General Data Protection Act (reference number 402445). We conducted this study in compliance with research ethical guidelines. We did not acquire informed consent from any study participant as the study is based on anonymised secondary data from existing health registers, which can be released for research if expedient.

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