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Socio-economic factors and rural-urban differences in patients undergoing emergency laparotomy

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Background: Emergency laparotomy (EL) is a common surgical procedure with high rates of mortality and complications. Socio-economic circumstances and regional differences have an influence on the utilization of care and outcomes in many diagnostic groups, but there are only a few studies focusing on their effect in EL population. The aim of this study was to examine the socio-economic and regional differences in the rate of EL within one tertiary care hospital district.

Methods: Retrospective single-center study of 573 patients who underwent EL in Oulu University Hospital between May 2015 and December 2017. The postal code area of each patient's home address was used to determine the socio-economic status and rurality of the location of residence.

Results: The age-adjusted rate of EL was higher in patients from low-income areas compared to patients from high-income areas [1.46 ((95% CI 1.27–1.64)) vs. 1.15 (95% CI, 0.96–1.34)]. The rate of EL was higher in rural areas compared to urban areas [1.29 (95% CI 1.17–1.41 vs. 1.42 (1.18–1.67)]. Peritonitis was more common in patients living in low-income areas. There were no differences in operation types or mortality between the groups.

Conclusions: The study findings suggest that there are socio-economic and regional differences in the need of EL. The patients living in low-income areas had a higher rate of EL and a higher rate of peritonitis. These differences cannot be explained by patient demographics or comorbidities alone.

Keywords emergency laparotomy, regional differences, socio-economic differences

Introduction

Emergency laparotomy (EL) is a common surgical procedure with a high risk of mortality and complication[1,2]. Although this patient population is heterogeneous, patients undergoing EL are often elderly and have several comorbid conditions[3,4].

Several studies show differences in the utilization of care in different diagnostic groups, including sepsis, cancer, and poisoning, in relation to socio-economic factors and rural-urban differences[4–7]. In Finland, substantial disparities are also seen in preventive healthcare like cancer screening[8]. In emergency general surgery (EGS) patients the relationship between socio-economic factors, rural-urban differences and postoperative outcomes is complex: in U.S. inpatient population EGS patients with lower income from an urban setting had a higher rate of postoperative adverse events, than similar patients from a rural environment[9].

There are only few studies focusing on socio-economic factors or rural-urban differences in EL population. Patients undergoing EL often have a time-crucial pathology and many of the previous studies focus on travel time and distance to hospital. The impact of distance to hospital and rurality on mortality after EGS is controversial. Previous studies demonstrate effects from beneficial to harmful[10,11]. In a recent Scottish study on EL patients, there were no differences in inpatient or 1-year mortality either in distance to the hospital or rurality[10]. The findings were similar in an analysis of NHS data. Travel time to the hospital did not affect short-term mortality following EL[11].

HIGHLIGHTS

- In Northern Finland, patients residing in low-income areas had a 25% higher rate of EL compared to those residing in high-income areas.
- Differences in the rate of EL cannot be explained by patient demographics or comorbidities alone.
- Regional differences in the rate of emergency laparotomy may have an impact on resource planning.

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Lower socio-economic position has been associated with an increased risk of non-malignant EL[4].

A Danish study presented there are socio-economic disparities associated with non-malignant EL, and this disparity still existed after adjustment for confounders including comorbidities. This indicates there are also other factors, like educational level, employment status and health behavior involved[4]. In a study based on NHS National Emergency Laparotomy Audit EL patients from low-income areas were more likely to present with a more serious condition, and peritoneal contamination was seen more often. The authors believe this finding might be due to late hospital admissions[12].

The Finnish healthcare system is based on adequate public social, health and medical services to which everyone residing in the country is entitled. Distances to hospitals are often long, especially in Northern Finland. Residents of rural areas are typically older and have a lower socio-economical position[13,14]. The aim of the present study was to examine the differences in the rate of EL within one tertiary hospital district in relation to income and rural-urban differences. The main interests of the study are regional differences and resource management. We hypothesized that the rate of EL may be higher in low-income areas and rural areas.

Material and methods

This retrospective study was conducted in Oulu University Hospital located in Northern Ostrobothnia, Finland. The setting is a tertiary academic hospital that provides public healthcare services for the population of the Northern Ostrobothnia healthcare district area. As there are no private hospitals providing emergency surgical care in Finland, all the EL patients of the region are treated in this study center. Northern Ostrobothnia healthcare district is geographically large and sparsely populated with a surface area of 36 800 km². The overall population of the catchment area was 434 983. The study protocol was approved by the hospital administration (reference number 66/2018). According to the local protocol, no statement from the Ethics Committee was required because of the retrospective study design. The results have been reported in line with the STROCSS criteria[15].

Patients

All patients ($N = 674$) who underwent midline EL between May 2015 and December 2017 were identified and reviewed from hospital discharge records. The inclusion criteria were midline EL and age older than 18 years. The exclusion criteria were age younger than 18 years, urgent or emergency cholecystectomy or appendectomy and emergency or urgent laparotomy due to a gynecological cause. All patients living in Northern Ostrobothnia were included, leaving a total of 573 EL patients.

Data extraction

The data were obtained from electronic medical records, anesthesia charts and operation charts. The following data were collected: patient demographics, diagnosis, type of operation, type of complication, hospital length of stay (LOS) and pre-surgery LOS. The severity of the underlying comorbidities was assessed using the Charlson Comorbidity Index (CCI). The American Society of Anesthesiologists classification (ASA) was used to estimate the patient's preoperative risk.

The postal code area of each patient's home address was used to determine the socio-economic status and rurality of the location of residence.

Definition of income areas and rural-urban differences

Statistics Finland provides open data on postal code areas, including inhabitants' demographics. (https://www.stat.fi/tup/paavo/index_en.html). The postal code areas of the hospital district were ranked according to inhabitants' annual net income and the population was divided into three categories: low-income areas (11757–19402e/year), middle-income areas (19420–22497e/year) and high-income areas (22516–26813e/year).

The postal code area was considered urban if the number of inhabitants was more than 2500 and the population density was above 76.5 inhabitants/km^2. The postal code areas not fulfilling these criteria were considered rural.

The population demographics of the postal code areas are presented in Table 1. The highest proportion (95.6%) of the population in highest income areas were urban, while corresponding proportion in middle- and low-income areas were 76.8% and 69.9%.

Statistical analysis

Statistical analysis was performed using SPSS 27 for Windows software. Proportional data are presented as numbers (N) and percentages (%) and is tested using Pearson's χ^2. Continuous variables are presented in medians and 25th and 75th percentiles [25th–75th PCT] and tested using non-parametric Kruskall–Wallis test.

The rate of ELs was calculated per 1000 inhabitants per year. Age-weighting of EL rates was performed by calculating crude rate for each 5-years age group and weighting the rates by their proportion.

Results

Out of 573 EL patients included in the study, 136 (23.7%) resided in high-income areas, 196 (34.2%) in middle-income areas and 241 (42.1%) in low-income areas. The distribution of the inhabitants by income is presented in Figure 1. 441 (77.0%) patients resided in urban areas. 129 (94.9%) of the patients from high-income areas reside in urban areas. The comparison of patients from different postal code areas is presented in Table 2.

The median straight-line distance to Oulu University Hospital from the residential areas was 29 [5–83] km. The distance to the hospital was significantly shorter from high-income areas compared to low-income and middle-income areas ($P \leq 0.001$). The mean straight-line distance to hospital was 12 [4–23] km from high-income areas, 38 [21–116] km from middle-income areas and 51 [3–89] km from low-income areas. (Table 2).

Overall, the most common diagnosis was bowel occlusion and peritonitis (Table 2). There were no significant differences in diagnosis between the groups, except peritonitis, which was more common in patients residing in low- and middle-income areas ($P = 0.03$). There were no differences between the populations in the use of preoperative CT scan. (Data not shown). There were no

Table 1

Demographics and inhabitant profile of different postal code areas

	Overall	Low-income areas 11757–19402e	Middle-income areas 19420–22497e	High-income areas 22516–26813e	*P*
Postal code areas	230	121	74	35	
Inhabitants	434 983	142 926	146 795	145 282	
Median population density (inhabitants/km^2)	5.4 [1.7–35.2]	2.6 [0.9–6.4]	11.3 [3.8–40.7]	70.1 [17.8–335.0]	< 0.001
Inhabitants in urban areas	361 453 (80.8)	99 841 (69.9)	112 723 (76.8)	138 889 (95.6)	< 0.001
Population aged more than 18 years	332 282 (76.4)	119 236 (83.4)	111 366 (75.9)	101 680 (70.0)	< 0.001
Unemployed	30 070 (6.9)	11 815 (8.3)	9528 (6.5)	8727 (6.0)	< 0.001
Retired	100 626 (23.1)	41 381 (29.0)	36 068 (24.6)	23 177 (16.0)	< 0.001

Proportional data were tested using Pearson's χ^2. Continuous variables were tested using non-parametric Kruskall–Wallis test.

differences between the populations in the rate of treatment restrictions. (Data not shown). There were no differences in operation types between the groups. Patients living in high-income areas were younger than those living in middle- and low-income areas [63 (49.5–74.5) and 69 (59–77.5) vs. 68 (58–78), $P = 0.005$]. There were no differences in gender distribution, ASA class, ICU admissions, hospital LOS or pre-surgery LOS between the groups.

The patients living in high-income areas had significantly lower CCI- scores compared to patients from middle-income areas [3.5 (1–6) vs. 4 (2–79) 5 (2–7) vs. 3.5 (1–6), $P = 0.018$], but there were no differences in CCI scores when comparing urban and rural patients (Tables 2 and 3).

There were no differences in diagnosis groups and operation types between rural and urban populations (Table 3).

The overall age-adjusted rate of EL was 1.31 (95% CI 1.20–1.42) per 1000 inhabitants per year. The age-adjusted rate of EL was higher in patients residing in low-income areas compared to patients residing in high-income areas [1.46 (95% CI 1.27–1.64) vs. 1.15 (95% CI, 0.96–1.34)]. The rate of EL was higher in rural areas compared to urban areas [1.29 (95% CI 1.17–1.41 vs. 1.42 (1.18–1.67)]. The rates of EL per 1000 inhabitants per year of different postal code areas are presented in Table 4.

There were no differences in mortality between the groups (Table 4). There were no differences in the rate of operations between the regular and holiday seasons or between winter or summer seasons (data not shown).

Discussion

There were three main findings in this study. First, the patients residing in low-income areas had a 25% higher rate of EL compared to those residing in high-income areas. Second, the rate of EL in rural areas was ~10% higher compared to urban areas. These findings confirm our hypothesis; acute abdominal surgery is associated with socio-economic factors and there are rural-urban differences even within one hospital district. Third, there were differences in the diagnosis profiles between the residential areas; peritonitis was more common in patients from low-income areas.

When a surgeon decides to perform an emergency laparotomy, the decision is based on several factors: patient-related factors, expected diagnosis, planned surgical intervention and post-operative risks, among others. The aim of this study, however, is to examine the regional differences in the rate EL. Postoperative care of laparotomy is often demanding and resource-consuming; appendectomy, cholecystectomy and laparoscopies were excluded due to the different expectations of recovery. All the patients of the area were treated in the same hospital, which minimizes selection bias and protocol-related reasons behind the results. In this study setup, we found no differences in treatment-related factors: there were no significant differences in the use of CT scan,

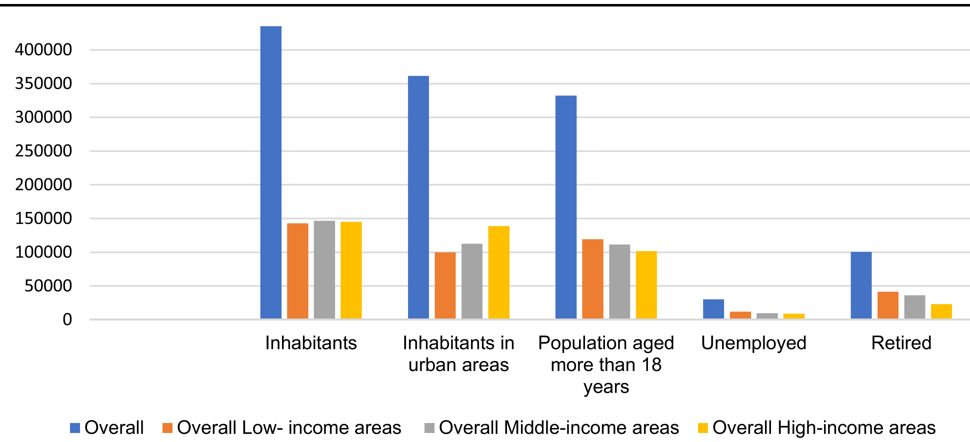

Figure 1. Urbanity, age group and employment status of the inhabitants by income.

Table 2

Comparison of patients from the different postal code areas

	Overall $N=573$	Low-income areas $N=241$	Middle-income areas $N=196$	High-income areas $N=136$	P
Age	67 [55–75]	68 [58–78]	69 [59–77.5]	63 [49.5–74.5]	0.005
Male sex	311 (54.3)	137 (56.8)	98 (50.0)	76 (55.9)	0.328
Distance to Oulu University Hospital (km)	29 [5–83]	51 [3–89]	38 [21–116]	12 [4–23]	0.000
Inhabitants in urban areas	441 (77.0)	151 (62.7)	161 (82.1)	129 (94.9)	< 0.001
ASA > 2	433 (75.6)	185 (76.8)	149 (76)	99 (72.8)	0.679
CCI	4 [2–6]	4 [2–7]	5 [2–7]	3.5 [1–6]	0.018
Diagnosis					
Cancer	58 (10.1)	24 (10)	22(11.2)	12 (8,8)	0.874
Vascular	38 (6.6)	18 (7.5)	11 (5.6)	9 (6.6)	
GI bleeding	46 (8)	21 (8.7)	13 (6.6)	12 (8.8)	
Peritonitis	114 (19.9)	53 (22.0)	43 (21.9)	18 (13.2)	
Hernia	40 (7)	16 (6.6)	11 (5.6)	13 (9.6)	
Bowel occlusion	166 (29)	67 (27.8)	57 (29.1)	42 (30.9)	
Trauma	11 (1.9)	3 (1.2)	5 (2.6)	3 (2,2)	
Complication	68 (11.9)	27 (11.2)	22 (11.2)	19 (14.0)	
Other	32 (5.6)	12 (5)	12 (6.1)	8 (5.9)	
Operation					
Hernia	25 (4.4)	9 (3.7)	6 (3.1)	10 (7.4)	0.313
Upper GI	45 (7.9)	21 (8.7)	10 (5.1)	14 (10.3)	
Exploratory	242 (40.8)	97 (40.2)	90 (45.9)	55 (40.4)	
Bowel resection	234 (40.8)	103 (42.7)	82 (41.8)	49 (36)	
Complication surgery	23 (4)	9 (3.7)	8 (4.1)	6 (4.4)	
Other	4 (0.7)	2 (0.8)	0	2 (1.5)	
Postoperative ICU admission	174 (30.4)	71 (29.5)	61 (31.1)	42 (30.9)	> 0.9
Pre-surgery LOS (day)	1 [0–3]	1 [0–2]	1 [0–3]	1 [0–3]	0.842
Hospital LOS (day)	10 [6–17]	10 [6–19]	9 [6–15]	10 [6–17]	0.447

Proportional data were tested using Pearson's χ^2. Continuous variables were tested using non-parametric Kruskall–Wallis test.
ASA, American society of anesthesiologist; CCI, Charlson comorbidity index; GI, gastrointestinal; LOS, length of stay.

treatment restrictions or operation types. Different seasons did not seem to influence the results. This indicates the causes of the findings are either patient-related or initiated in the earlier stages of the illness, possibly even in the preventive phase.

Health inequalities are known to exist in all countries and the findings are consistent: people with lower income are more likely to have poor health[8]. In Finland, health disparities between different income and educational groups are substantial, and premature death is more common in the eastern and northern parts of Finland than in the western and southern parts of the country. Circulatory diseases and alcohol-related factors are the main reasons behind the differences in mortality[14]. Comorbidities do not, however, explain the difference seen in the rate of EL in this study: though the patients living in high-income areas had significantly lower CCI- scores compared to patients from middle-income areas, there was no significant difference in ASA class between the three income groups and no significant difference in CCI-score or ASA class in the rural-urban setting.

Northern Finland is a sparsely populated area with long distances, which makes it an interesting setting for this study. A population of 2500 was chosen as the cut-off between rural and urban, since the postal code areas are relatively small in terms of the number of inhabitants; a high proportion of actual urban areas would have been classified as "rural" if the higher cut-off would have been used.

In Finland, the primary healthcare system is divided into public services, occupational healthcare and private services[13]. Due to public services all the residents are entitled to adequate healthcare, regardless of their place of residence or income. However, previous studies in Finland have shown there are geographical disparities in the use of medical services[13,16]. There are also distinct differences in medical service accessibility in Finland, particularly in rural areas[13]. Previous studies have shown people living further away from a general practitioner (GP) or in rural areas are less likely to see a GP than those living closer or in urban areas. In a Finnish study, the biggest problems in getting medical care when needed were the lack of health services in the area and the long distance to reach them[16]. The same kind of phenomenon is seen in other countries too: in the United States, regional differences have been reported in colorectal cancer screening and treatment accessibility in rural-urban settings[17], and rural-urban differences in hospital-based care utilization were observed for women in reproductive age too[18].

The association between socio-economic status and the need of care has been well established in previous studies in other diagnostic groups[4–6,19], and there is growing evidence of the same phenomenon in the EL population as well[4,9,12]. Poulton *et al.*[12] reported in their study that the patients from low-income areas were more likely to present with a more serious condition, and peritoneal contamination was seen more often. This finding might be due to late hospital admissions[12]. The current study also presents an increased proportion of peritonitis in patients residing in low-income areas. Unfortunately, our study setting prevented any further evaluation of a causative relationship.

Previous studies have focused on the distance to the hospital for EL and the impact of the travel time on mortality. Even though patients undergoing EL often have a time-crucial pathology, previous studies indicate that travel time does not affect short-term outcomes[10,11,19]. In an NHS study, travel time was not a significant outcome factor among patients in need of

Table 3

Comparison between urban and rural patients

	Patients from rural areas N = 132	Patients from urban areas N = 441	P
Age	68 [57–77]	67 [55–77]	0.485
Male sex	76 (57.6)	235 (53.3)	0.386
Distance to Oulu University Hospital (km)	78 [49–106]	12 [3–61]	0.000
ASA > 2	102 (77.3)	331 (75.1)	0.603
CCI	4 [2–6.5]	4 [2–6]	0.553
Diagnosis			
Cancer	12 (9.1)	46 (10.4)	0.866
Vascular	10 (7.6)	28 (6.3)	
GI bleeding	9 (6.8)	37 (8.4)	
Peritonitis	31 (23.5)	83 (18.8)	
Hernia	8 (6.1)	32 (7.3)	
Occlusion	36 (27.3)	130 (29.5)	
Trauma	1 (0.8)	10 (2.3)	
Complication	18 (13.6)	50 (11.3)	
Other	7 (5.3)	25 (5.7)	
Operation			
Hernia	3 (2.3)	22 (5)	0.121
Upper GI	7 (5.3)	38 (8.6)	
Exploratory	53 (40.2)	189 (42.9)	
Bowel resection	58 (43.9)	176 (39.9)	
Complication surgery	9 (6.8)	14 (3.2)	
Other	2 (1.5)	2 (0.5)	
Pre-surgery LOS (day)	1 [0–2]	1 [0–3]	0.190
Hospital LOS (day)	10.5 [6–18]	10 [6–16]	0.323

Proportional data were tested using Pearson's χ^2. Continuous variables were tested using non-parametric Kruskall–Wallis test.
ASA, American society of anesthesiologist; CCI, Charlson comorbidity index; GI, gastrointestinal; LOS, length of stay.

urgent surgery (within 2 h)[11]. However, the average distance to a hospital varies greatly between areas and different countries have different kinds of healthcare infrastructures. Therefore, the results may not be fully extrapolated to other countries.

In this study, the distance to the hospital was significantly longer from low-income areas compared to high-income areas. In general, distances in Northern Finland are long, the longest straight-line distance to the hospital in this study was more than 100 km. Furthermore, in Northern Ostrobothnia the elderly are more likely to live in low-income and rural areas, whereas for example in the UK, the population structure is different. In the UK, the patients from low-income areas lived closer to the hospital compared to the patients from high-income areas[11]. The elderly lived further away from the hospital, but even patients over 80 years of age, the median distance to the hospital was 9,5 km, which is shorter than the distance to the hospital from any socio-economic area in this study[11]. These differences may affect the results.

In our study, the patients from low-income areas were significantly older than the patients from high-income areas. Additionally, patients from rural areas were more likely to have low income. Employment rates are very low in many rural areas in Finland, and this leads to the internal migration of young and educated people towards larger settlements[20]. The population of rural areas is ageing rapidly[13]. In previous studies, the association between increasing age and mortality has been shown clearly[3,21]. Age, however, cannot explain all the differences seen in this study and as discussed above, neither do comorbidities. Møller *et al.*[4] presented that there are socio-economic disparities associated with non-malignant EL, and this disparity still existed after adjustment for confounders including comorbidities. The authors concluded that there may also be other mechanisms besides disease burden involved. The patients from low-income areas were less likely to be married, their educational level was lower, and they were more often unemployed or on early retirement pension than the reference population[4]. Our results support this argument.

De Jager *et al.*[9] argued that healthcare segregation is a possible reason behind socio-economic disparity in emergency general surgery outcomes in America; low-income patients are more likely to receive care in a low-quality hospital[9]. In Northern Ostrobothnia this is an unlikely explanation, since all the EL patients of the district are treated in the same hospital by the same, relatively small group of surgeons. However, there might be differences in access to care in the earlier stages of illness. Patients from low-income areas are more likely to be unemployed or retired and thus have no access to occupational healthcare, limiting access to preventive measures and disease screening. In

Table 4

Rates of emergency laparotomies per 1000 inhabitants per year of in different postal code areas

	Overall	Low-income areas 11757–19402e	Middle-income areas 19420–22497e	High-income areas 22516–26813e
All areas				
Crude rate	0.53 (0.48–0.57)	0.68 (0.59–0.76)	0.55 (0.47–0.63)	0.37 (0.31–0.43)
Crude rate > 65 years of age	1.55 (1.38–1.72)	1.70 (1.42–-1.98)	1.54 (1.26–1.82)	1.31 (0.98–1.63)
Age-adjusted rate	1.31 (1.20–1.42)	1.46 (1.27–1.64)	1.27 (1.09–1.44)	1.15 (0.96–1.34)
Rural areas				
Crude rate rural areas	0.62 (0.51–0.72)	0.85 (0.68–1.03)	0.42 (0.28–055)	0.28 (0.07–0.49)
Crude rate > 65 years of age	0.97 (0.75–1.19)	1.95 (1.43–2.46)	1.08 (0.6–1.57)	1.12 (0–2.4)
Age-adjusted rural areas	1.42 (1.18–1.67)	1.74 (1.38–2.10)	1.14 (0.76–1.52)	1.31 (0.34–2.28)
Urban areas				
Crude rate urban areas	0.50 (0.46–0.55)	0.60 (0.51–0.70)	0.57 (0.48–0.66)	0.38 (0.31–0.44)
Crude rate > 65 years of age	0.95 (0.83–1.07)	1.57 (1.24–1.91)	1.67 (1.35–2.00)	1.32 (0.98–1.66)
Age-adjusted urban areas	1.29 (1.17–1.41)	1.37 (1.15–1.59)	1.45 (1.23–1.68)	1.18 (0.98–1.38)
Crude 90-day Mortality	0.09 (0.08–0.11)	0.12 (0.09–0.16)	0.11 (0.08–0.14)	0.05 (0.03–0.07)
Age-adjusted 90-day mortality	0.35 (0.28–0.35)	0.38 (0.27–0.49)	0.43 (0.30–0.56)	0.28 (0.15–0.42)
Crude mortality	0.19 (0.16–0.21)	0.24 (0.19–0.30)	0.21 (0.16–0.25)	0.11 (0.07–0.14)
Age-adjusted mortality	0.68 (0.58–0.77)	0.72 (0.57–0.87)	0.70 (0.54–0.86)	0.64 (0.44–0.84)

Proportional data were tested using Pearson's χ^2. Continuous variables were tested using non-parametric Kruskall–Wallis test.

the U.S. also insurance status affects access to care and health resource use[18]. This should not be the case in Finish universal healthcare system, except for private services, which might not be affordable to all citizens.

It is important to note that not all rural patients are the same. Rurality does not necessarily indicate low income or education levels, and these factors are not necessarily correlated with comorbid states in the studied population. In this study, there were no differences in ASA class or CCI scores between the groups. However, there are differences in health behavior between the socio-economic groups. For example, heavy alcohol consumption and smoking are more common in the low-income population[22,23]. There are differences in primary healthcare accessibility in Finland, particularly in rural areas[13]. There might also be differences in symptom awareness between the socio-economic groups, most likely due to differences in educational levels. Delay in medical attention, combined with differences in health behavior might explain why peritonitis was more common in patients residing in low-income areas.

Clinical impact

The present study showed differences in the need of EL between different residential areas within one hospital district. The results may have an impact in resource planning; preventive measures and screening should be ensured in areas with low income and long distances. Finland has recently decided to launch colorectal cancer screening[24], and finding GI cancers earlier might enhance the health of the populations in low-income areas as well as among the rural populations.

The present study was performed in a noticeably different environment than the previous studies and clearly shows that some socio-economic disparity in EL population does exist in a universal public paid healthcare system. This finding is of great importance: in retrospective studies performed in the same hospital district, 90-day mortality after EL was 17.8% and 2-year mortality 30.1%[25]. Complication rates are high, and many patients are admitted to ICU postoperatively[25,26]. Furthermore, the financial burden is substantial; in America, the estimated cost of EGS was $28.37 billion in 2010 and the costs are expected to rise by 45% by 2060, due to the growing and aging population[27]. Further studies should be aimed to identify the most vulnerable population.

Limitations

This study is limited to a retrospective discussion in one tertiary academic hospital. However, the study center is the only hospital providing emergency surgical care in a geographically large area. We did not have the data on the income of individual patients; the socio-economic status was determined by the wealth of the neighborhood. However, it is notable that this method has been used previously[5–7].

In this study setup, there is a risk of bias. We were not able to obtain data concerning the use of other healthcare system resources, which might have had an impact on the results. Especially the data concerning primary healthcare resources could have been of interest. Also, reliable data on the history of excessive alcohol usage and smoking could have enhanced the study since these factors may have an impact on the utilization rate. Furthermore, we were not able to include the data concerning patients out of this cohort; the number of laparoscopies could be higher in urban and high-income areas while the conservative approach in patients from rural areas. Our main interest, however, is resource management.

Finally, the cut-off values, which were used in the categorization of the income areas can be considered arbitrary. However, there are only national cut-off values available, and these cannot be used in Northern Finland, since they are weighted by the population of Southern Finland with higher annual income and higher number of inhabitants compared to Northern Finland. The selected cut-off values were based on the population of the area, which was divided in three categories. The same method has been used before[5–7,28].

Conclusion

The rate of EL was higher in low-income areas and in rural areas. Patients residing in low-income areas had a higher rate of peritonitis as the cause of EL. These findings could not be explained by patient demographics including age, sex, or comorbidities.

Ethical approval

Due to retrospective study design and according to local protocol no statement from the Ethical committee was obtained.

Consent

Due to retrospective study design and according to Finnish law no informed consent statements were obtained.

Source of funding

This trial did not receive any funding.

Author contribution

A.P.: study design and preparing the manuscript. A.Y.: study design, data collection and finalizing the manuscript. J.N.: statistical analysis and finalizing the manuscript. S.L.: finalizing the manuscript. M.K.: finalizing the manuscript. M.V.: finalizing the manuscript. T.K.: finalizing the manuscript. L.R.: study design and finalizing the manuscript. J.L.: study design, statistical analysis and finalizing the manuscript.

Conflicts of interest disclosure

The authors declare no conflicts of interest.

Research registration unique identifying number (UIN)

Due to retrospective study design no clinical trial registration was made.

Guarantor

Anne Pouke.

Data availability statement

Due to Finnish legislation it is not possible to provide any data related to this study public.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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