



Emergency department use and length of stay by younger and older adults: Nottingham cohort study in the emergency department (NOCED)

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Abstract

Background Younger and older adults attending the Emergency Department (ED) are a heterogeneous population. Longer length of ED stay is associated with adverse outcomes and may vary by age.

Aims To evaluate the associations between age and (1) clinical characteristics and (2) length of ED stay among adults attending ED.

Methods The NOTtingham Cohort study in the Emergency Department (NOCED)—a retrospective cohort study—comprises new consecutive ED attendances by adults ≥ 18 years, at a secondary/tertiary care hospital, in 2019. Length of ED stay was dichotomised as < 4 and ≥ 4 h. The associations between age and length of ED stay were analysed by binary logistic regression and adjusted for socio-demographic and clinical factors including triage acuity.

Results 146,636 attendances were analysed; 75,636 (51.6%) resulted in a length of ED stay ≥ 4 h. Attendances of adults aged 65 to 74 years, 75 to 84 years and ≥ 85 years, respectively, had an increased risk (odds ratio (95% confidence interval) of length of ED stay ≥ 4 h of 1.52 (1.45–1.58), 1.65 (1.58–1.72), and 1.84 (1.75–1.93), compared to those of adults 18 to 64 years (all $p < 0.001$). These findings remained consistent in the subsets of attendances leading to hospital admission and those leading to discharge from ED.

Discussion and conclusion In this real-world cohort study, older adults were more likely to have a length of ED stay ≥ 4 h, with the oldest old having the highest risk. ED target times should take into account age of attendees.

Keywords Emergency department · Older adults · Quality of care · Healthcare utilisation · Hospital-based cohort study · Geriatric emergency medicine

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Introduction

Older adults are significant users of the Emergency Department (ED). In many countries, they account for about 12% to 24% of all ED attendances, and are generally overrepresented in ED, compared with their proportion in the general population [1–4]. Moreover, their use of ED has been increasing [2, 3], possibly outpacing the ageing of populations [5].

Previous literature has explored the patterns of ED attendance and outcomes of younger versus older adults [1–3]. Yet, few papers focussed on the heterogeneity of older adults, especially the oldest old [6–8]. Compared to younger adults, older adults presented to the ED with higher levels of urgency, arrived more often by ambulance, were more likely to have investigations in ED and be admitted to hospital from the ED [1–3]. Older adults were more likely to experience a longer length of ED stay, partly because of higher rates of hospital admission [1]. Indeed, adults admitted to hospital, compared to those discharged from ED, had longer length of ED stay and were more likely to exceed target times [9–11]; yet, different rates of admission to hospital may not fully explain the longer length of ED stay of older adults [12]. This could also be due to atypical presentations of disease and multiple comorbidities in older adults, requiring more thorough examination, more investigations and more intensive diagnostic work-up; moreover, delirium, sensory or cognitive impairments may affect interactions between older adults and healthcare professionals, making history collection and communication in general challenging [2, 3, 12–15].

A longer length of ED stay has been associated with an increased risk of adverse clinical outcomes, including mortality [16]. Older adults with longer versus shorter length of ED stay may be at higher risk of delirium, falls, pressure sores, hospital-acquired infections, deconditioning, psychological distress and prolonged hospital stay [17, 18]. Longer length of ED stay contributes to ED crowding, which is in turn associated with adverse outcomes (e.g. increased risk of in-hospital mortality and longer times to treatment for pneumonia or acute pain) [3, 19–23]. Studies from the U.S. suggested that adults from ethnic minorities or more deprived areas may face longer length of ED stay [24].

Therefore, length of ED stay is a measure of quality of healthcare in many countries, and policies have been implemented to reduce inappropriate length of ED stay, by setting specific targets [22]. In 2000, the National Health Service (NHS) England mandated the “4-h target”—i.e. the maximum length of ED stay for 98% of patients should be ≤ 4 h [25]. This target was then revised but remained as a reference in clinical practice and scientific literature [26, 27]. A few studies showed that older adults had an increased risk of exceeding

recommended targets [26–28], while others showed that they were prioritised and seen within target times, after adjusting for triage categories [29, 30]. A French study found that age was no longer associated with length of ED stay after adjustment for covariates [31]. Of note, the associations between age and length of ED stay may vary based on presenting complaint (e.g. trauma versus non-trauma) [32]. Moreover, older adults attending the ED are a very heterogeneous population and the associations between age and length of ED stay may vary among the older age groups [12].

We designed the Nottingham Cohort study in the Emergency Department (NOCED), a retrospective observational hospital-based cohort study, to profile the attendances of younger and older adults to the ED of a large UK hospital. To explore the heterogeneity between older adults, we defined multiple older age groups.

This paper had two main objectives. First, to compare the patterns of ED use of younger and older adults; we hypothesized a direct age-gradient in the frequency and urgency of attendances, and a diverse mix of presenting complaints across age groups. Second, to explore the association between age and length of ED stay in: (1) all attendances, (2) those leading to hospital admission and (3) those leading to discharge from ED, respectively. We hypothesized that older adults would have longer length of ED stay, with significant differences between older age groups, regardless of hospital admission or discharge from ED.

Methods

Setting

Nottingham is a city in Nottinghamshire, region of East Midlands, UK. Supplementary Fig. 1 shows the age structure of the adult population—aged ≥ 18 years—of Nottingham, Nottinghamshire and East Midlands [33–35].

Nottingham University Hospitals NHS Trust—comprising Nottingham City Hospital and the Queen’s Medical Centre (QMC)—is a high volume university hospital [36, 37]. It provides universal health coverage, free of charge to all adults, as part of the NHS. The ED, located at QMC, is the only ED in Nottingham. In 2019, it had on average 402 attendances of adults ≥ 18 years per day. It is the tertiary referral centre for Major Trauma, Neurosurgery, Spinal Surgery, adult Burns, Plastic Surgery and transplant complications for East Midlands. A few hospitals in Nottinghamshire refer patients with specialist needs to this ED out-of-hours (i.e. from 5 pm to 9 am and in the week-ends). Therefore, the catchment area of this ED is Nottingham and most of Nottinghamshire for secondary care, and East Midlands for tertiary care related to a number of specialties. According to the 2011 Census, the population aged ≥ 18 years comprised

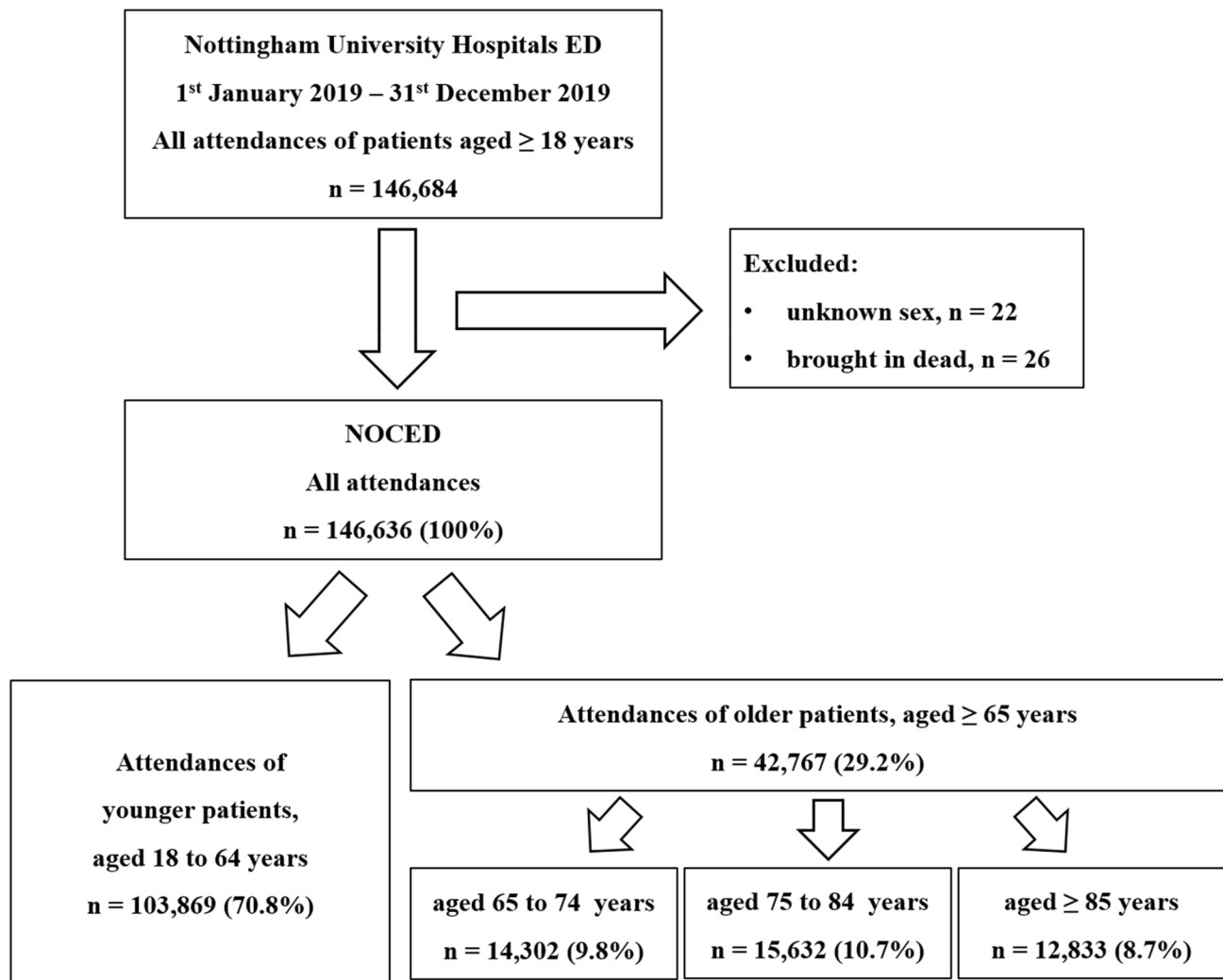


Fig. 1 Flow chart of the NOttingham Cohort study in the Emergency Department (NOCED). *n* number, *ED* Emergency Department

about 240,000 adults in Nottingham Local Authority, 620,000 adults in Nottinghamshire and 3,600,000 adults in the East Midlands (Supplementary Fig. 1) [33–35].

Study design and population

We designed the NOttingham Cohort study in the Emergency Department (NOCED), a hospital-based retrospective cohort study, with the primary aim to explore differences in patterns of use, clinical characteristics and outcomes of younger and older adults attending the ED.

In July 2021, two data analysts (MC, KSN) retrieved all electronic records of all new consecutive attendances of adults ≥ 18 years, at the ED of Nottingham University Hospitals NHS Trust, between 1st January to 31st December 2019 ($n = 146,684$). They gave anonymised data to a third researcher (GO), who excluded the attendances of adults of unknown sex ($n = 22$), or brought in dead

($n = 26$). Therefore, NOCED is a retrospective, observational cohort study that profiles 146,636 attendances of men and women, consecutively presenting alive to the ED of Nottingham University Hospitals NHS Trust, in 2019. A patient could have multiple attendances. We classified the attendances based on the age of the attendees: younger adults aged 18 to 64 years and older adults ≥ 65 years; older adults were further classified as aged 65 to 74 years, 75 to 84 years and ≥ 85 years (Fig. 1).

We chose the year 2019 as the timeframe, to have data on ED use prior to the COVID-19 pandemic. NOCED had complete data on age, sex, date and time of arrival to ED, and other variables that were recorded in mandatory fields in the electronic systems, yet with possible options such as “unknown” or “not stated”.

The sample size of NOCED was determined by the number of alive, adult patients attending the ED during the timeframe, and minimally by missing data on sex. The sample

size was not determined by power calculations. The timeframe of one calendar year was chosen to allow for comparisons and future linkage with other datasets; we also wanted our timeframe to include all months and seasons, as seasonality in ED use has been reported [38].

Ethical approval was not required as the analysis entailed use of anonymised routinely collected data; audit office governance approval was obtained (project number 21-386C). We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement guidelines [39, 40].

Sources of data

At arrival to ED, the following data were routinely collected into the electronic systems for each adult: age, sex, date and time of arrival, mode of arrival, referral source, ethnicity (based on UK Census categories), type of residence, postcode of residence, triage category, chief presenting complaint and initial National Early Warning Score 2 (NEWS-2 score) [41]. At discharge from ED, date and time of discharge and disposition outcome were routinely collected.

The dates and times of arrival and discharge were automatically recorded in the electronic systems, when hospital staff gave the electronic command of admission or discharge. The postcode was typed. All other variables were categorized into mutually exclusive, predefined categories, chosen from a drop-down list in the electronic systems, by nursing or administrative staff.

For each variable, we reclassified the predefined categories into a smaller number of categories, as detailed below and in Supplementary Tables 1–5. This was done to allow for statistical analyses using categories with large number of cases.

Date and time of arrival

We classified the *time of arrival* to ED as day (8:00 to 19:59) versus night (20:00 to 07:59). We classified the *day of arrival* as weekday (Monday to Friday) versus weekend (Saturday and Sunday).

Socio-demographic characteristics

Mode of arrival was classified as follows: urgent ambulance; ambulance transfer; police or prison transport; own or other transport (Supplementary Table 1). We identified 41 *sources of referral* in our data, which we dichotomized as self-referral versus all other referrals (Supplementary Table 2). There were 19 *ethnicities* in our data, which we categorized into three categories: (1) white British, (2) all other ethnicities and (3) not known or not stated (Supplementary Table 3).

We categorized the predefined *types of residence* as follows: own stable accommodation; permanent inpatient; nursing home; residential home; warden controlled accommodation; homeless; prison; not known (Supplementary Table 4).

Based on postcodes, the data analysts extrapolated the *English Index of Multiple Deprivation (IMD) 2019 quintile* [42]. The IMD measures relative deprivation for small areas in England [42]. The higher the IMD quintile, the less deprived the area of residence [42]. We did not assign an IMD quintile to patients who were not resident in England or those without an own stable accommodation.

Clinical characteristics

We classified the 140 mutually exclusive, predefined *chief presenting complaints* into 28 categories (Supplementary Table 5). For each chief presenting complaint, we created a dummy variable to indicate whether the patient presented with that complaint or not (e.g. whether the patient presented with chest pain as chief presenting complaint or not).

Based on the Emergency Care Data Set classification, we classified the *triage categories* as follows: “resus”; “majors/high acuity”; “minors/low acuity” [43]. Triage categories were generally allocated to patients at arrival to ED by nurses, who were Band 6 or above and specifically received Assessment Training during Nurse Induction. In the UK, nurses qualify into Bands based on competencies, rather than years of training.

The *NEWS-2 score* is a proxy for the severity of acute illness, based on an adult’s clinical observations; the higher the NEWS-2 score, the more acutely severe the illness is [42].

Investigations in ED and disposition outcome

We collected data on whether certain *investigations* (i.e. electrocardiogram (ECG) and blood tests) were performed during the ED stay. For each attendance, we retrieved the *disposition outcome*, which we categorized as follows: “admitted to hospital”; “died in ED”; “discharged from ED”; “did not wait”; “not set or other”.

Length of ED stay

We defined the *length of ED stay* as the total time in ED, from arrival to discharge, regardless of the disposition outcome. Based on the date and time of arrival to and discharge from ED, we calculated the length of ED stay for each attendance. Based on previous literature [11, 16, 24, 26, 27], we categorised the length of ED stay into these categories: < 4 h; ≥ 4 and < 6 h; ≥ 6 and < 8 h; ≥ 8 h. Furthermore, we dichotomised the length of ED stay as < 4 or ≥ 4 h; < 6 or ≥ 6 h; < 8 or ≥ 8 h, respectively.

Statistical analyses

We used SPSS version 25.0 for all analyses. In compliance with our hospitals' information governance rules, we used age categories, rather than age as a continuous variable. We defined four age categories—18 to 64 years; 65 to 74 years; 75 to 84 years; ≥ 85 years—based on those commonly used by the Office of National Statistics [33–35] and in scientific literature.

The characteristics of attendances and attendees were reported as number (percentage) for categorical variables. We tested for differences in these characteristics across age categories, by Pearson's chi-square test for categorical variables.

Binary logistic regression models were used to assess the association between age categories (determinant) and length of ED stay ≥ 4 h (outcome). The age category 18 to 64 years was set as the reference. We performed our analyses in two steps. First, we adjusted our analyses for sex (Model 1). Then, we adjusted for sex, mode of arrival, self-referral (versus all other referrals), residence (own accommodation versus all others), time of arrival (night versus day), day of arrival (weekday versus weekend), triage acuity (resus versus majors versus minors), ethnicity (White British versus all other ethnicities versus not stated or unknown) (Model 2). In the sample of attendances of adults with own accommodation and known IMD quintile, we repeated the analyses by adjusting for Model 2 plus deprivation. The choice of covariates was based on previous literature on risk factors for prolonged length of ED stay.

Furthermore, we performed sensitivity analyses: (1) in attendances resulting into hospital admission and (2) in attendances resulting into discharge from ED, respectively. This was based on previous literature showing that attendances leading to hospital admission have longer length of ED stay compared to those resulting into discharge from ED [9–11].

In addition, we repeated the analyses using length of ED stay of ≥ 6 h and ≥ 8 h as outcome, respectively. Moreover, to explore heterogeneity between older age categories, we repeated the analysis by setting the age category ≥ 85 years as the reference.

Results

Patterns of ED use

NOCED included 146,636 attendances of men and women, aged ≥ 18 years, to the ED of Nottingham University Hospitals, from 1st January to 31st December 2019. Of these, 103,869 (70.8%) were of adults aged 18 to 64 years, 14,302

(9.8%) of adults 65 to 74 years, 15,632 (10.7%) of adults 75 to 84 years, and 12,833 (8.7%) of adults ≥ 85 years (i.e. the oldest old). The oldest old were overrepresented in NOCED, compared to their proportions in the catchment areas (Supplementary Fig. 1). The number of ED attendances per day ranged from 276 to 507, with mean 401.7 (standard deviation 29.9). Most attendances occurred during the day and on weekdays (Table 1).

Clinical characteristics

Overall, 76,933 (52.5%) attendances were by women, 84,297 (57.5%) followed arrival by own or other transport, and 79,162 (54.0%) were self-referred (Table 1). Over half of attendances were triaged as “minors/low acuity” ($n = 84,465$; 57.6%; Table 1).

The distribution of all variables differed by age of attendees; an age-gradient was observed in mode of arrival, source of referral, residence type and ethnicity. Attendances of adults ≥ 85 years were most likely to follow arrival by urgent ambulance, and least likely to follow self-referral (Table 1). Most attendances of adults aged 18 to 64 years were triaged as “minors/low acuity”, while most attendances of adults ≥ 85 years were triaged as “majors/high acuity” (Table 1). The highest proportion of adults of white British ethnicity was observed among the oldest old.

Most attendances were of adults who had an own stable accommodation, across all age categories (Table 1). Of the attendances of the oldest old, 11,000 (85.7%) were of oldest old adults with an own stable accommodation, while 1333 (10.4%) and 358 (2.8%) were of residents in a nursing or residential home, respectively (Table 1).

Chief presenting complaints

Injury (excluding self-harm) ranked first as chief presenting complaint across all age categories (Supplementary Table 6). The top six chief presenting complaints for adults ≥ 85 years were: “Injury (excluding self-harm)”; “Collapse/fainting episode/dizziness”; “Dyspnoea”; “Chest pain”; “Falls/unsteady on feet/generalised or limb weakness”; “Confusion/alterd behaviour/hallucinations/delusions/drowsiness” (Supplementary Table 6).

Among injuries, those of shoulder/upper limbs, those of hip/lower limbs and head injuries were the most frequent subtypes, across all age categories (Supplementary Tables 6 and 7). The frequency of injuries of shoulder/upper limbs decreased with ageing, while those of injuries of hip/lower limbs and head injuries increased with ageing (Supplementary Table 7).

Table 1 Characteristics of attendances and attendees, by age categories

	All attendances <i>n</i> = 146,636	Aged 18 to 64 years <i>n</i> = 103,869	Aged 65 to 74 years <i>n</i> = 14,302	Aged 75 to 84 years <i>n</i> = 15,632	Aged ≥ 85 years <i>n</i> = 12,833	<i>P</i> value
Women, <i>n</i> (%)	76,933 (52.5)	53,311 (51.3)	7046 (49.3)	8514 (54.5)	8062 (62.8)	<0.001
Mode of arrival, <i>n</i> (%)						
Urgent ambulance	60,413 (41.2)	30,489 (29.4)	7,906 (55.3)	11,092 (71.0)	10,926 (85.1)	<0.001
Ambulance transfer	314 (0.2)	189 (0.2)	32 (0.2)	58 (0.4)	35 (0.3)	
Police/prison transport	1,612 (1.1)	1,547 (1.5)	30 (0.2)	29 (0.2)	6 (0)	
Own or other transport	84,297 (57.5)	71,644 (69.0)	6334 (44.3)	4453 (28.5)	1866 (14.5)	
Self-referral, <i>n</i> (%)	79,162 (54.0)	62,158 (59.8)	6844 (47.9)	6129 (39.2)	4031 (31.4)	<0.001
Time of arrival, <i>n</i> (%):						
Night 20:00 to 07:59	49,190 (33.5)	36,380 (35.0)	4162 (29.1)	4569 (29.2)	4079 (31.8)	<0.001
Day 8:00 to 19:59	97,446 (66.5)	67,489 (65.0)	10,140 (70.9)	11,063 (70.8)	8754 (68.2)	
Day of arrival, <i>n</i> (%):						
Weekday	104,944 (71.6)	74,229 (71.5)	10,439 (73.0)	11,210 (71.7)	9066 (70.6)	<0.001
Weekend	41,692 (28.4)	29,640 (28.5)	3863 (27.0)	4422 (28.3)	3767 (29.4)	
Residence type, <i>n</i> (%)						
Own stable accommodation	141,628 (96.6)	101,964 (98.2)	13,935 (97.4)	14,729 (94.2)	11,000 (85.7)	<0.001
Permanent inpatient	204 (0.1)	163 (0.2)	16 (0.1)	20 (0.1)	5 (0)	
Nursing home	2359 (1.6)	202 (0.2)	200 (1.4)	624 (4.0)	1333 (10.4)	
Residential home	696 (0.5)	125 (0.1)	52 (0.4)	161 (1.0)	358 (2.8)	
Warden controlled	652 (0.4)	396 (0.4)	74 (0.5)	76 (0.5)	106 (0.8)	
Homeless	668 (0.5)	652 (0.6)	6 (0)	3 (0)	7 (0.1)	
Prison	295 (0.2)	271 (0.3)	12 (0.1)	9 (0.1)	3 (0)	
Not known	134 (0.1)	96 (0.1)	7 (0)	10 (0.1)	21 (0.2)	
IMD quintile, <i>n</i> (%)						
First	37,940 (25.9)	28,320 (27.3)	3481 (24.3)	3534 (22.6)	2605 (20.3)	<0.001
Second	25,208 (17.2)	18,345 (17.7)	2438 (17.0)	2571 (16.4)	1854 (14.4)	
Third	24,630 (16.8)	17,838 (17.2)	2427 (17.0)	2520 (16.1)	1845 (14.4)	
Fourth	22,816 (15.6)	16,042 (15.4)	2274 (15.9)	2488 (15.9)	2012 (15.7)	
Fifth	29,760 (20.3)	20,434 (19.7)	3222 (22.5)	3519 (22.5)	2585 (20.1)	
Not given: own stable accommodation	1274 (0.9)	985 (0.9)	93 (0.7)	97 (0.6)	99 (0.8)	
Not given: not own stable accommodation	5,008 (3.4)	1,905 (1.8)	367 (2.6)	903 (5.8)	1833 (14.3)	
Ethnicity, <i>n</i> (%):						
White British	99,930 (68.1)	65,656 (63.2)	10,997 (76.9)	12,603 (80.6)	10,674 (83.2)	<0.001
All other ethnicities	24,929 (17.0)	21,664 (20.9)	1205 (8.4)	1233 (7.9)	827 (6.4)	
Not stated or unknown	21,777 (14.9)	16,549 (15.9)	2100 (14.7)	1796 (11.5)	1332 (10.4)	
Triage category						
Resus	2,517 (1.7)	1,605 (1.5)	353 (2.5)	347 (2.2)	212 (1.7)	<0.001
Majors/high acuity	59,654 (40.7)	30,088 (29.0)	7,874 (55.1)	10,980 (70.2)	10,712 (83.4)	
Minors/low acuity	84,465 (57.6)	72,176 (69.5)	6,075 (42.5)	4,305 (27.5)	1,909 (14.9)	
NEWS-2 score, <i>n</i> (%):						
0	41,401 (28.2)	29,200 (28.1)	4,153 (29.0)	4,501 (28.8)	3,547 (27.6)	<0.001
1–4	50,362 (34.3)	30,313 (29.2)	5,844 (40.9)	7,353 (47.0)	6,852 (53.4)	
5–6	4,620 (3.2)	2,137 (2.1)	704 (4.9)	907 (5.8)	872 (6.8)	
7 or more	3,229 (2.2)	1,219 (1.2)	587 (4.1)	795 (5.1)	628 (4.9)	
Missing	47,024 (32.1)	41,000 (39.5)	3,014 (21.1)	2,076 (13.3)	934 (7.3)	

n number, NEWS-2 score National Early Warning Score 2. *P* values were calculated by Pearson's chi-square test

Table 2 Investigations in ED, disposition outcome, and length of ED stay, by age categories

	All attendance <i>n</i> = 146,636	Aged 18 to 64 years <i>n</i> = 103,869	Aged 65 to 74 years <i>n</i> = 14,302	Aged 75 to 84 years <i>n</i> = 15,632	Aged ≥ 85 years <i>n</i> = 12,833	<i>P</i> value
Investigations						
ECG performed, <i>n</i> (%)	19,309 (13.2)	11,786 (11.3)	2465 (17.2)	2781 (17.8)	2277 (17.7)	<0.001
Blood tests, <i>n</i> (%)	75,687 (51.6)	42,730 (41.1)	9709 (67.9)	12,252 (78.4)	10,996 (85.7)	<0.001
Disposition outcome, <i>n</i> (%)						
Admitted	50,846 (34.7)	25,146 (24.2)	7117 (49.8)	9592 (61.4)	8991 (70.0)	<0.001
Discharged	82,821 (56.5)	66,985 (64.5)	6542 (45.7)	5672 (36.3)	3622 (28.2)	
Did not wait	12,542 (8.5)	11,570 (11.1)	564 (3.9)	273 (1.7)	135 (1.1)	
Died	287 (0.2)	53 (0.1)	67 (0.5)	89 (0.6)	78 (0.6)	
Not set or other	140 (0.1)	115 (0.1)	12 (0.1)	6 (0)	7 (0.1)	
Length of ED stay, <i>n</i> (%)						
< 4 h	71,000 (48.4)	58,558 (56.4)	5275 (36.9)	4476 (28.6)	2691 (21.0)	<0.001
≥ 4 and < 6 h	29,941 (20.4)	20,719 (20.0)	3098 (21.7)	3399 (21.8)	2725 (21.2)	
≥ 6 and < 8 h	19,053 (13.0)	11,779 (11.3)	2266 (15.8)	2689 (17.2)	2319 (18.1)	
≥ 8 h	26,642 (18.2)	12,813 (12.3)	3663 (25.6)	5068 (32.4)	5098 (39.7)	

n number, NEWS-2 score National Early Warning Score 2. *P* values were calculated by Pearson's chi-square test

Investigations in ED

The proportion of attendances leading to investigations in ED (i.e. ECG and blood tests) was lowest among those of adults aged 18 to 64 years (Table 2).

Disposition outcome

Overall, 50,846 (34.7%) of all attendances resulted in admission to hospital, 82,821 (56.5%) in discharge from ED, 12,542 (8.5%) in the attendees leaving the ED without waiting for admission or discharge (“did not wait”), 287 (0.2%) in death in ED, and 140 (0.1) were not set or other (Table 2).

A direct age-gradient was observed in the proportion of attendances leading to hospital admission, ranging from 24.2% in adults aged 18 to 64 years, to 49.8% in those 65 to 74 years, to 61.4% in those 75 to 84 years, and up to 70.0% in those ≥ 85 years (Table 2).

Among the attendances leading to hospital admissions (*n* = 50,846), 643 (1.3%) led to admission from ED to Adult Intensive Care Unit (ITU), while 7767 (15.3%) to Geriatric Medicine wards. The proportion of admissions to ITU was highest in adults aged 18 to 64 years (483/25,146, 1.9%), and lowest in those ≥ 85 years (Supplementary Table 8). In contrast, a direct age-gradient was observed in admission from ED to Geriatric Medicine wards (Supplementary Table 8).

An inverse age-gradient was found in the proportion of attendances leading to discharge from ED, being highest in adults aged 18 to 64 years (64.5%), and declining to 45.7%, 36.3% and 28.2% in those aged 65 to 74 years, 75 to 84 years

and ≥ 85 years, respectively (Table 2). An inverse age-gradient was found in the proportion of “did not wait” attendances; 11.1% of attendances of adults aged 18 to 64 years resulted in “did not wait”, compared to 1.1% of those of adults ≥ 85 years (Table 2).

Length of ED stay: frequencies

Overall, 71,000 (48.4%) and 75,636 (51.6%) of all attendances were characterised by a length of ED stay < 4 h and ≥ 4 h, respectively (Table 2). Supplementary Figure 2 illustrates the length of ED stay, across age categories, for all attendances, regardless of attendance outcome.

Figure 2 shows the length of ED stay, across age categories, for attendances resulting into hospital admission or discharge from ED, respectively. Of the attendances resulting into hospital admission (*n* = 50,846), 36,774 (72.3%) were characterised by a length of ED stay ≥ 4 h. Of the attendances resulting into discharge from ED (*n* = 82,821), 33,798 (40.8%) were characterised by length of ED stay ≥ 4 h. Further details are shown in Supplementary Table 9.

Length of ED stay: binary logistic regression

In sex-adjusted analyses, attendances of adults aged 65 to 74 years, 75 to 84 years, and ≥ 85 years had an increased risk (OR (95% CI)) of length of ED stay ≥ 4 h of 2.21 (2.13–2.29), 3.23 (3.11–3.35) and 4.91 (4.70–5.13), respectively, compared to those aged 18 to 64 years (Model 1, Table 3).

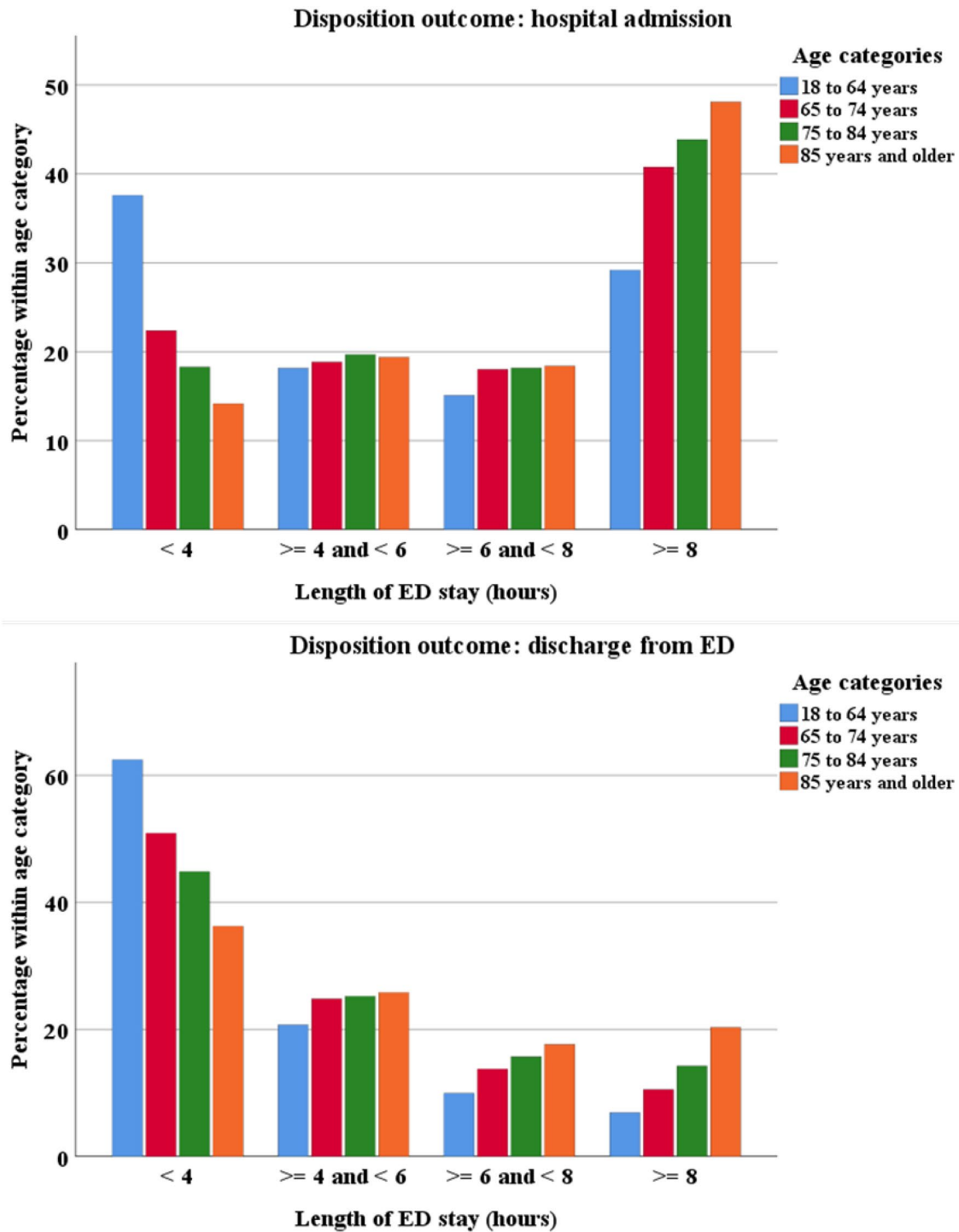


Fig. 2 Length of ED stay in attendances resulting into hospital admission and discharge from ED, respectively. *ED* Emergency Department. The top graph shows data on 50,846 attendances resulting into hospital admission; among these, the age distribution of attendees was as follows: aged 18 to 64 years: $n=25,146$; aged 65 to 74 years:

$n=7117$; aged 75 to 84, $n=9,592$; aged ≥ 85 years, $n=8991$. The bottom graph shows data on 82,821 attendances leading to discharge from ED; among these, the age distribution of attendees was as follows: aged 18 to 64 years: $n=66,985$; aged 65 to 74 years: $n=6542$; aged 75 to 84, $n=5672$; aged ≥ 85 years, $n=3622$

Table 3 Association between age categories and length of ED stay ≥ 4 h (binary outcome)

	All attendances ($n = 146,636$)			Admitted to hospital ($n = 50,846$)			Discharged ($n = 82,821$)		
	n (%)	OR [95% CI]	P value	n (%)	OR [95% CI]	P value	n (%)	OR [95% CI]	P value
Model 1									
Aged 18 to 64 years	45,311 (43.6)	1 (ref)		15,693 (62.4)	1 (ref)		25,148 (37.5)	1 (ref)	
Aged 65 to 74 years	9,027 (63.1)	2.21 [2.13; 2.29]	<0.001	5524 (77.6)	2.07 [1.94; 2.20]	<0.001	3212 (49.1)	1.61 [1.53; 1.69]	<0.001
Aged 75 to 84 years	11,156 (71.4)	3.23 [3.11; 3.35]	<0.001	7839 (81.7)	2.70 [2.55; 2.86]	<0.001	3129 (55.2)	2.05 [1.94; 2.17]	<0.001
Aged ≥ 85 years	10,142 (79.0)	4.91 [4.70; 5.13]	<0.001	7718 (85.8)	3.72 [3.49; 3.97]	<0.001	2309 (63.7)	2.94 [2.74; 3.15]	<0.001
Model 2									
Aged 18 to 64 years	45,311 (43.6)	1 (ref)		15,693 (62.4)	1 (ref)		25,148 (37.5)	1 (ref)	
Aged 65 to 74 years	9,027 (63.1)	1.52 [1.45; 1.58]	<0.001	5524 (77.6)	1.46 [1.36; 1.57]	<0.001	3212 (49.1)	1.34 [1.27; 1.42]	<0.001
Aged 75 to 84 years	11,156 (71.4)	1.65 [1.58; 1.72]	<0.001	7839 (81.7)	1.47 [1.38; 1.58]	<0.001	3129 (55.2)	1.35 [1.27; 1.44]	<0.001
Aged ≥ 85 years	10,142 (79.0)	1.84 [1.75; 1.93]	<0.001	7718 (85.8)	1.57 [1.46; 1.69]	<0.001	2309 (63.7)	1.40 [1.29; 1.51]	<0.001

Odds ratios and 95% confidence intervals are calculated by binary logistic regression. Model 1: adjusted for sex. Model 2: adjusted for sex, mode of arrival, self-referral (versus all other referrals), residence (own accommodation versus all others), time of arrival (night versus day), day of arrival (weekday versus weekend), triage acuity (resus versus majors versus minors), ethnicity (white British versus all other ethnicities versus not stated or unknown). n number of attendances with length of stay ≥ 4 h (the number in brackets is the percentage within age and ED disposition outcome categories), *OR* odds ratios, *CI* confidence intervals, *ref* reference

In fully adjusted analyses, attendances of adults aged 65 to 74 years, those 75 to 84 years, and those ≥ 85 years had an increased risk (OR (95% CI)) of length of ED stay ≥ 4 h of 1.52 (1.45–1.58), 1.65 (1.58–1.72) and 1.84 (1.75–1.93), respectively, compared to those of adults aged 18 to 64 years (Model 2, Table 3).

These findings remained consistent in the sample of attendances resulting into hospital admission and discharge from ED, respectively (Table 3). Further adjustment for deprivation did not modify these findings, in the sample of adults with own accommodation and known deprivation ($n = 140,354$, data not shown).

We observed similar associations between age categories and the outcomes of length of ED stay ≥ 6 h and ≥ 8 h, respectively (Supplementary Tables 10 and 11).

Supplementary Table 12 presents the associations between age categories and length of ED stay ≥ 4 h, when setting the age category ≥ 85 years (oldest old) as the reference. In sex-adjusted analyses, the attendances of the oldest old were associated with an increased risk of length of ED stay ≥ 4 h, respectively, compared to all the other age groups (Model 1, Supplementary Table 12). In fully adjusted analyses, the differences between attendances of the oldest old and those of adults aged 65 to 74 years and 75 to 84 years remained significant when analysing all attendances, but became non-significant when analysing attendances leading to hospital admission and discharge from ED, separately (Model 2, Supplementary Table 12).

Discussion

The NOCED cohort study describes the attendances of younger and older adults to the ED of a secondary and tertiary care UK hospital, over one year. In this hospital-based retrospective cohort study, attendances of older adults were more likely to be associated with length of ED stays ≥ 4 h, compared to those of younger adults, after adjusting for covariates such as triage categories. These associations were consistent in both attendances resulting into hospital admission and those leading to discharge from ED. Furthermore, an age-gradient in risk of length of ED stay ≥ 4 h was shown in older age categories, with this risk being highest in the oldest old.

In NOCED, older adults ≥ 65 years accounted for 29.2% of all ED attendances. This proportion is slightly higher compared to those of previous literature (12–24%) [1–3] and possibly reflects an increasing use of ED by older adults in recent years [5, 7]. Consistent with previous literature [3], the proportions of older adults aged 75 to 84 years and ≥ 85 years in NOCED were higher than those in the catchment areas. In particular, the proportion of adults ≥ 85 years was three times those in the catchment areas.

In NOCED, attendances of older adults were more frequently triaged as “majors / high acuity”, were more frequently associated with arrival by ambulance and less frequently followed a self-referral. Consistently, previous

authors emphasized that the overrepresentation of older versus younger adults in ED is not explained by more trivial or non-urgent visits [2]. NOCED showed a lower proportion of “did not wait” attendances in older versus younger adults, in line with previous literature [16].

In NOCED, injuries were the main chief presenting complaint across all age groups, as in other studies [15, 16]. In NOCED, injuries excluding self-harm accounted for about one third (30.0%) and one fifth (21.5 to 24.0%) of attendances of younger and older adults, respectively. Slightly higher proportions of attendances for trauma were observed in a small volume ED in Italy [15] and high volume EDs in Canada [16]. Atypical presentations of disease, as reflected by complaints such as collapse or dizziness or confusion were more frequent in the oldest old in NOCED, as expected [2, 13–15].

The major finding of this study is to show that ED attendances of older adults are more likely to be characterised by a length of stay of ≥ 4 h, compared to younger adults, also when separately examining attendances that resulted into hospital admission and ED discharge, respectively. A novelty of NOCED is to describe the heterogeneity within older adults, by profiling three older age groups, and specifically the oldest old. An age-gradient was shown in length of ED stay among older adults.

Previous literature on the association between age and length of ED stay has been conflicting. A few studies only reported unadjusted median or mean length of ED stay across age groups [4, 6, 32]. In studies from Canada [4] and Korea [6], mean length of ED stay increased with age; in particular, Lee et al. showed that mean length of ED stay was longer in the oldest old versus youngest-old and middle-old ED patients [6]. In a German hospital, median length of ED stay was longer in trauma patients ≥ 70 years versus trauma patients aged 18 to 70 years, while no age-related difference was observed among non-trauma patients [32]. In a teaching hospital in Milan, Italy, older age was associated with longer length of ED stay, after adjusting for disposition outcome [12]. In three French hospitals, Casalino et al. showed that older age was a predictor of longer length of ED stay in unadjusted analyses, but not after adjusting for arrival mode and acuity level [31]. In contrast, older adults were prioritised and less likely to exceed waiting times in ED in China [29, 30].

These discrepancies on the association between age and length of ED stay across studies may have various non-mutually exclusive explanations. First, a few studies presented only unadjusted analyses; yet, clinical characteristics such as acuity differ between younger and older adults, and impact on length of ED stay. Thus, analyses taking into account acuity should be presented alongside unadjusted or minimally adjusted analyses. Second, many studies did not perform separate analyses for admitted and discharged patients.

However, older adults are more likely to be admitted than younger adults, and the impact of disposition on length of ED stay is well acknowledged. Third, cross-country variation may be related to differences in the social and healthcare systems [22].

Different factors may influence the length of ED stay of admitted versus discharged patients. Patients requiring admission versus not requiring admission may have more complex conditions, receive more investigations in ED and need clinical stabilisation before being transferred to a hospital bed; waiting times for a hospital bed may be affected by bed occupancy rates [19–22]. In view of all these, we performed sensitivity analyses.

Different explanations may be proposed for longer length of ED stay in older versus younger adults. First, the diagnostic work-up may be more intensive in older versus younger adults, due to a higher prevalence of high acuity conditions, multiple comorbidities, polypharmacy and atypical presentation of disease [2, 3, 13, 14]. The collection of history and medical assessment of older patients may be complicated by the presence of delirium and communication barriers due to cognitive and sensory impairment; older adults’ caregivers may need to be involved for collateral history and assent [13, 14]. A few older adults who are discharged may have to wait for transfer back to a care home or for social sorting.

A major strength of NOCED is the use of real-world, routinely collected healthcare data, obtained for administrative and clinical purposes, without specific a priori research goals. This entails several advantages. First, these data were not subject to observer’s bias, as they were recorded over a year prior to this research. Second, these data are relatively low-cost for researchers, as they are routinely generated in clinical practice, the cost of which was already sustained. A retrospective cohort study is a cost-effective way to analyse already existing data, test hypotheses and promptly provide results for the benefit of healthcare. The alternative would be a prospective cohort study that would require more funding and time to generate data and the results of which may not be available for years. Third, this study could be replicated in similar hospital settings in the UK or other countries.

Further strengths include the large sample size, the richness and completeness of data, and length of stay outcomes reflecting quality of care targets. To our knowledge, NOCED is the largest single-ED cohort study in Europe. Besides comparing younger and older adults, it profiles three age groups within older adults, thus detailing the heterogeneity of their clinical characteristics and outcomes. The findings from NOCED may be directly generalisable to high volume EDs in the UK and of interest to other countries, given the increasing ED use by older adults, internationally. We chose total length of ED stay as our main outcome, as this can be easily measured and compared across international studies.

This study has a few limitations. First, the findings from NOCED may partly reflect the social and healthcare systems of the UK. The UK has universal health coverage, through the NHS, and an enhanced network of community and primary care. These may reduce inappropriate ED use by older adults. In contrast, in countries with predominant private health insurance, the underinsured and uninsured may disproportionately rely on the ED [22]. Similarly, reliance on the ED for primary care complaints may increase where the network of community and primary care is weaker [22, 44]. Notably, only 0.3% of all attendances in NOCED were due to social or prescription issues; this proportion may be higher in contexts lacking community services alternative to the ED.

We acknowledge that the UK's NHS healthcare system differs from those of other countries. The NHS has a long-standing history of Geriatric Medicine in both hospital and community settings [45, 46]. Notably, in our study, almost one in six attendances resulting into hospital admission was to a Geriatric Medicine ward, directly from the ED. In NHS hospitals, specific Geriatric care flow pathways for frailer older adults have been established for decades and, by liaising with community geriatric and non-geriatric services, they facilitate the hospital discharge of older patients and their follow-up in the community. Compared to the UK, other countries may have less developed geriatric community services and, as result, increased pressure on the EDs by older adults with chronic conditions. Furthermore, the burden of acute and chronic diseases varies considerably by countries [47].

A second limitation is that we recorded the chief presenting complaint at arrival to ED, rather than the diagnosis at discharge from ED. However, the information on chief presenting complaints—rather than final diagnosis—was the information available to clinicians when the attendees presented to the ED. Information on chief presenting complaints was also available for attendees who “did not wait” and those discharged. Third, our data may be subject to human error during real-time recording; we deem this error to be minimal, random and unlikely to affect our findings. Fourth, we had missing data, labelled as “missing” or “unknown” or “not set” into compulsory electronic fields. However, the proportion of missing data was very low and unlikely to affect our findings. Fifth, age and length of ED stay were used as categorical rather than continuous variables. However, we chose categories that are widely used in healthcare research and clinical practice, allowing for direct comparison with other studies. Sixth, data on radiological or other investigations were not reported in this first NOCED study. However, we aim to collect data on these in future studies. Seventh, we did not explore how admissions to ITU from the ED—more likely in younger adults and more likely

associated with shorter length of ED stay—affected our findings. Indeed, in our study, we found an inverse age-gradient in admissions to ITU. However, only a minority of attendances resulted into ITU admissions from the ED—less than 2% in adults aged 18 to 64 years—and this is unlikely to affect our findings. Finally, we did not explore the components of length of ED stay (e.g. time to be seen, waiting times for results of investigations, and, in admitted patients, waiting times from agreed allocation to a specialty to availability of a hospital bed). With regards to older frailer adults requiring admission, we speculate that a certain amount of time is spent in discussions between ED doctors and hospital specialists to agree on the specialty allocation of these patients. We aim to explore the relative contributions to total length of ED stay of its components in further NOCED studies.

In conclusion, this large observational study showed that attendances of older adults had an increased risk of length of ED stay ≥ 4 h, compared to those of younger adults, independently of triage acuity. This finding was consistent when examining attendances leading to hospital admission and discharge from ED, separately. The age-mix of patients should be taken into account when assessing the performances of different EDs. When evaluating quality of healthcare, we would recommend age-specific targets for length of ED stay, to reflect the complexity of the older adults attending the ED. We are not advocating unnecessary long length of ED stay that would be detrimental especially to older adults. Instead, we advocate that assessors of quality of healthcare should benchmark EDs with high proportions of attendances by older adults against EDs with a similar case-mix. Finally, knowledge of the age distribution of ED attendees should prompt the development of geriatric patient flow pathways in hospitals with higher and increasing attendances by older adults, as well as support to community geriatric services.

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Authors' contributions Giulia Ogliari and Tahir Masud were responsible for study concept and design, analysis and interpretation of the data and drafting the manuscript. Mike Christopher and Kosma Szychowski-Nowak were responsible for acquisition of the data. Frank Coffey, Lisa Keillor, Darren Aw, Michael Y. Azad, Mohammad Allaboudy, Aamer Ali, Tom Jenkinson, Mike Christopher and Kosma Szychowski-Nowak were responsible for critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

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Code availability Not applicable.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethics approval Not applicable. Audit office governance approval was obtained from Nottingham University Hospitals NHS Trust (project number 21-386C).

Informed consent For this type of study, no informed consent is required.

Consent to participate This article uses anonymised data.

Consent for publication Not applicable. Personal data were not identifiable during the analysis.

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