Association between age and length of stay in the emergency department in a tertiary care hospital: a retrospective observational study

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ABSTRACT

Background Older patients' attendances at EDs are rising. There are concerns that these individuals have prolonged stays, which have been shown to be associated with adverse clinical outcomes. We assessed the length of stay in older patients in a single ED in Singapore.

Methods This was an observational retrospective study of ED attendances between 2017 and 2019 at the Singapore General Hospital (SGH) using the SGH ED database. The primary outcome was ED length of stay, with prolonged stay defined as 4 hours or more. The association between age (categorised into 18–44, 45–64, 65–84 and 85+) and length of stay was analysed using a mixed-effects logistic regression adjusting for variables like gender, ethnicity and triage acuity. Associations are expressed as adjusted ORs (AOR) with 95% CI. A subgroup analysis was performed for all considered variables.

Results 391 171 patients qualified for analysis; median age 57 years (IQR 37–70) and 51.5% male. The median length of stay increased across age categories (age 18–44, 3.53 hours; 45–64, 4.04 hours; 65–84, 4.32 hours; and 85+, 4.46 hours). Using patients aged 18–44 as a reference, the AORs for prolonged length of stay by age group were 45–64 AOR 1.17 (95% CI 1.13 to 1.21), 65–84 AOR 1.26 (95% CI 1.21 to 1.30) and 85+ AOR 1.25 (95% CI 1.18 to 1.31). In the subgroup analysis, there was no association between age and length of stay for patients admitted, having multiple comorbidities, having blood tests or having high acuity scores.

Conclusion In this Singaporean tertiary hospital, older patients had increased median stays and were more likely to stay in the ED for more than 4 hours. However, this did not apply in some subpopulations. This potentially suggests the need for systematic changes in discharge planning and triaging to reduce prolonged stays and their consequences for older patients.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ There is conflicting evidence from previous research regarding whether there is an association between age and prolonged ED length of stay, with varying results from studies in different regions. There are no existing studies about this in Singapore.

WHAT THIS STUDY ADDS

⇒ This study of over 300 000 patients at Singapore General Hospital ED found that older age is associated with a prolonged ED length of stay. The association persisted when looking specifically at discharged patients: those with lower acuity, fewer comorbidities and who had less acute triaging priorities. However, the association with age was not observed among patients who were admitted, had high triage acuities, had multiple comorbidities or received blood tests.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study helps suggest factors to be considered to understand the mechanisms for prolonged length of stay of older patients in EDs and also suggests the need for EDs to become better equipped at treating and discharging older patients, especially those with lower severity.

INTRODUCTION

Emergency departments (EDs) worldwide are challenged with issues of crowding[1] and prolonged length of stay (LOS). In several countries with ageing populations, older patients (aged ≥65 years) account for over 15% of ED populations.[2 3] At our hospital, visits by older patients accounted for over 50% of adult ED attendances.[4] As by 2030, almost a quarter of Singaporeans will be over 65,[5] the proportion of older patients will likely increase.

ED crowding is associated with longer ED stays,[1] which have been linked with increased risks of unfavourable outcomes, including longer hospital stays,[6] in-hospital cardiac arrest and mortality.[7] Older adults, in particular, may be at higher risk of delirium,[8] hospital-acquired infections, falls and psychological distress.[9]

Prior research in countries such as the UK, Germany and Iran has indicated that EDLOS increases with age.[10–13] Reasons suggested for this include comorbidities[10] causing complex assessments, higher rates of hospital admission[14] and atypical presentations.[15] However, a study in Paris, France, did not find such an association after adjusting for factors like triage category.[16]

There is a paucity of Asia-specific research on this topic. Additionally, there is limited information on how these associations change among different

subgroups of older patients. However, this information could influence current ED systems to become more geriatric-friendly. It could also help understand the causes of prolonged EDLOS and bottlenecks in ED flow, which could help create targeted solutions to decrease crowding.

This study aimed to investigate the association between the age group of patients and the EDLOS in a Singaporean tertiary hospital. We hypothesised a positive association between age and EDLOS. The secondary aim was to investigate any differences in estimated association within subpopulations.

METHODS

Study design

This study was an analysis using a retrospective ED database at Singapore General Hospital (SGH). It was approved by Singapore Health Services' Centralised Institutional Review Board, and a waiver of consent was granted for data collection and analysis because of the retrospective nature of the study (ID: CIRB Ref: 2021/2122).

Setting

Singapore is a Southeast Asian city-state with a population of 5.92 million.[5] SGH is Singapore's largest and oldest acute tertiary hospital and academic medical centre, receiving over 120 000 visits yearly, out of which over 30% become inpatient admissions. As part of the SingHealth cluster (one of three integrated public sector clusters), it provides emergency care to Singapore's Eastern region.

Data source

The SGH ED database contains electronic records for ED patients. This dataset was previously created by extracting and compiling deidentified large-scale electronic records from the SingHealth Electronic Health Intelligence system (eHints).[17] eHints is a platform that integrates data from various clinical operations and research sources in the SingHealth cluster and feeds them into analytical tools.

Participant selection

This study included all adult (≥18 years) attendances at the SGH ED from 1 January 2017 to 31 December 2019. A patient could have multiple attendances, with each considered separately. Patients under 18 were excluded, as they were usually taken to a specialist paediatric hospital rather than the study hospital. We excluded cases where EDLOS was unavailable or greater than 168 hours (considered an unreasonable outlier).

The date range (2017–2019) was chosen to avoid the potential impact of the COVID-19 pandemic on the analysis. Owing to the study's retrospective nature, we did not calculate a precise sample size. However, based on the rule of 10 events per variable, we needed to include at least 250–300 events to be able to adjust for our covariates. The prevalence of events (≥4 hours EDLOS) was estimated at 40%–50%, according to a preliminary analysis of the dataset. From this, we expected that 3 years of data was more than a sufficient sample size for this analysis.

Variables

The variables of interest were patient demographics (age, gender and ethnicity), clinical factors (primary diagnosis, triage category, blood tests and comorbidities) and ED inflow and outflow (registration year, day of arrival, time of arrival, EDLOS and patient disposition).

For the analysis, age was treated as both continuous and, for ease of visualisation and interpretation, categorised into groups: 18–44, 45–64, 65–84 and 85+. These categories were chosen as they reflect different stages: young adults, middle-aged adults, older adults and very old adults, respectively, and have been previously used in research.[18 19] The Charlson Comorbidity Index (CCI) was used as an indication of comorbidities.[20] Triage categories were recorded according to the Singapore Patient Acuity Category Scale: P1 (critically ill patients requiring resuscitation), P2 (non-ambulant patients with major emergencies), P3 (ambulatory emergency patients) and P4 (non-emergency). (Further information about variables is in online supplemental Appendix A.)

Outcomes

This study's primary outcome was EDLOS: time from registration to ED discharge, regardless of disposition. The EDLOS was dichotomised into <4 or ≥4 hours for the main analysis because this is a commonly used cut-off for defining prolonged EDLOS,[10] and Singapore has no previous definition. Higher cut-offs (<6 or ≥6 hours, <8 or ≥8 hours, <12 or ≥12 hours and <24 or ≥24 hours) were also examined in sensitivity analyses, as previous studies have varying definitions of prolonged EDLOS.[9]

Statistical analysis

All data selection and analysis were conducted using R V.4.3.1. Continuous variables, such as LOS, are presented as medians with IQR and categorical variables, such as attendee characteristics, as numbers with percentages.

First, a mixed-effects logistic regression model ('glmmTMB' R package) was used to assess the association between age (age categories and age as a continuous variable) and EDLOS (≥ or <4 hours), adjusting for potential confounders (gender, time of arrival, day of arrival, triage category, ethnicity, CCI score, primary diagnosis category and disposition). This model also accounted for the potential effects of patients having multiple attendances on the outcome (EDLOS) by including a random intercept for patient ID. The results are presented as adjusted ORs (AORs) with 95% CIs. We then performed sensitivity analyses using cut-offs for ED stays ≥6 hours, ≥8 hours, ≥12 hours and ≥24 hours to assess the association's robustness. Secondarily, to investigate any non-linear trend between age and prolonged EDLOS, we conducted a restricted cubic spline curve analysis with a mixed-effects model using five knots at prespecified locations (5, 27.5, 50, 72.5 and 95 percentiles) adjusted for the aforementioned confounders.

Further post hoc exploratory analyses were conducted by subgrouping based on gender, time, day, triage category, ethnicity, CCI score, primary diagnosis category and disposition. For each subpopulation, regressions paralleling the main analysis with age categories were conducted.

Patient and public involvement

Patients and public were not involved in designing, conducting, reporting or disseminating this research.

RESULTS

Baseline characteristics

Of the 400 221 ED attendances recorded between 1 January 2017 and 31 December 2019, 9050 (2.26%) attendances were excluded, and 391 171 attendances were included (figure 1). Females accounted for 48.5% of attendances, and the median age (IQR) was 57 (37–70). Attendances comprised 130 188

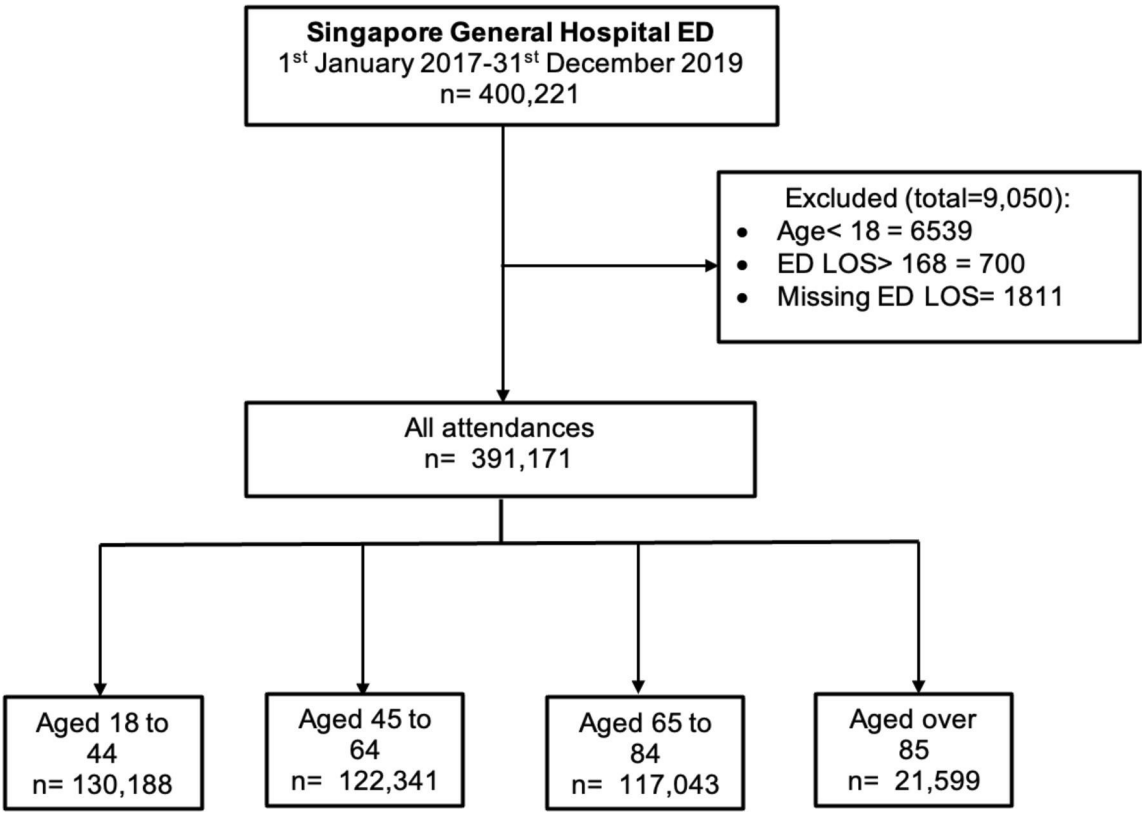

Figure 1 Patient selection flowchart. LOS, length of stay.

(33.3%) patients aged 18–44, 122 341 (31.3%) aged 45–64, 117 043 (29.9%) aged 65–84 and 21 599 (5.5%) aged 85+. A prolonged length of stay (≥4 hours) was found in 42% of those 18–44, 51% of those 45–64, 56% of those 65–84 and 58% of those 85+. The results when other prolonged EDLOS cut-offs were used followed a similar pattern: higher percentages of older patients had prolonged EDLOS compared with younger patients (online supplemental S-table 1).

Patient characteristics by age group

As shown in table 1, patient characteristics varied by age group. The proportion of female attendances rose (47.4%–60.8%). As age increased, the proportion of attendees of Chinese ethnicity (the majority of attendances) increased from 46.8% to 87.8%. In contrast, all other ethnicities decreased.

Similarly, the proportions of the patients arriving during the day, having blood tests and being admitted increased with

Table 1 Demographic and ED characteristics of attendance by age

Characteristics	All attendances (n=391 171)	Aged 18–44 (n=130 188)	Aged 45–64 (n=122 341)	Aged 65–84 (n=117 043)	Aged 85+ (n=21 599)
Median age (IQR)	57 (37–70)	31 (11–15, 17–25)	56 (51–60)	73 (69–78)	88 (86–91)
Gender (female)	189 771 (48.5%)	61 647 (47.4%)	56 032 (45.8%)	58 967 (50.4%)	13 125 (60.8%)
Ethnicity					
Chinese	250 880 (64.1%)	60 867 (46.8%)	76 971 (63%)	94 072 (80.4%)	18 970 (87.8%)
Indian	52 838 (13.5%)	23 461 (18%)	18 177 (15%)	9907 (8.5%)	1293 (6%)
Malay	44 238 (11%)	19 403 (14.9%)	16 187 (13%)	7893 (6.7%)	755 (3.5%)
Others	43 215 (11.3%)	26 457 (20.3%)	11 006 (9%)	5171 (4.4%)	581 (2.7%)
Day of week (weekday)	287 679 (73.5%)	93 148 (71.5%)	91 597 (74.9%)	87 136 (74.4%)	15 798 (73.1%)
Time of day (day)	278 760 (71.3%)	85 192 (65.4%)	87 948 (71.8%)	89 013 (76.1%)	16 607 (76.9%)
Charlson Comorbidity Index					
0	264 108 (67.5%)	119 013 (91.4%)	80 539 (65.8%)	56 269 (48.1%)	8287 (38.4%)
1–2	63 072 (16.1%)	8366 (6.4%)	21 644 (17.7%)	26 815 (22.9%)	6247 (28.9%)
3–4	31 830 (8.1%)	1439 (1.1%)	9576 (7.8%)	16 636 (14.2%)	4179 (19.3%)
5+	32 161 (8.2%)	1370 (1.1%)	10 582 (8.6%)	17 323 (14.8%)	2886 (13.4%)
Blood test (yes)	231 593 (59.2%)	55 178 (42.4%)	74 600 (61%)	84 296 (72%)	17 519 (81.1%)
Disposition (admitted)	158 377 (40.5%)	24,484 (18.8%)	49 979 (40.9%)	68 274 (58.3%)	15 640 (72.4%)

Continuous value is described as median and IQR.

Table 2 Clinical characteristics of attendances by age categories

Characteristics	All attendances (n=391 171)	Aged 18–44 (n=130 188)	Aged 45–64 (n=122 341)	Aged 65–84 (n=117 043)	Aged 85+ (n=21 599)
Triage category					
P1	61 033 (15.6%)	10 090 (7.8%)	21 113 (17.3%)	24 640 (21.1%)	5190 (24%)
P2	199 872 (51.1%)	57 552 (44.2%)	62 042 (50.7%)	66 780 (57.1%)	13 498 (62.5%)
P3–P4	130 226 (33.3%)	62 546 (48%)	39 186 (32%)	25 623 (21.9%)	2911 (13.5%)
Diagnosis category					
Circulatory	28 113 (7.2%)	2603 (2%)	10 807 (8.8%)	12 655 (10.8%)	2048 (9.5%)
Dermatology and musculoskeletal system	48 749 (12%)	17 743 (13.6%)	16 185 (13.2%)	12 851 (11%)	1970 (9.1%)
Endocrine, nutritional and metabolic diseases	12 135 (3.1%)	1031 (0.8%)	3371 (2.8%)	6215 (5.3%)	1518 (7%)
Gastrointestinal	26 130 (6.7%)	8646 (6.6%)	8432 (6.9%)	8529 (7.3%)	1523 (7.1%)
Infectious and parasitic diseases	22 376 (5.7%)	9203 (7.1%)	5757 (4.7%)	6057 (5.2%)	1359 (6.3%)
Neoplasms	4211 (1.1%)	554 (0.4%)	2120 (1.7%)	2299 (2%)	238 (1.1%)
Neurological and sensory	15 674 (4%)	5821 (4.5%)	5487 (4.5%)	3962 (3.4%)	404 (1.9%)
Others	112 327 (28.7%)	32 865 (25.2%)	37 560 (30.7%)	35 400 (30.2%)	6502 (30.1%)
Reproduction-related and genitourinary system	21 372 (5.5%)	9435 (7.2%)	6227 (5.1%)	4800 (4.1%)	910 (4.2%)
Respiratory	31 070 (7.9%)	11 446 (8.8%)	7723 (6.3%)	9342 (8%)	2559 (11.8%)
Trauma, poisoning and complication	52 857 (13.5%)	23 793 (18.3%)	14 012 (11.5%)	12 665 (10.8%)	2387 (11.1%)
Unknown	14 157 (3.6%)	7048 (5.4%)	4660 (3.8%)	2268 (1.9%)	181 (0.8%)

Triage category: descending scale: P1 (critical, requiring immediate attention) to P4 (non-emergency conditions), diagnoses are grouped based on International Classification of Diseases, 10th revision, Clinical Modification classification.

increasing age. The proportion of attendances with CCI scores of 1–2 (6.4%–28.9%), 3–4 (1.1%–19.3%) and 5+ (1.1%–13.4%) increased. However, a slightly greater percentage of patients aged 65–84 years (14.8%) had a CCI of 5+ than those 85+ (13.4%).

As demonstrated in table 2, the proportion of attendances triaged as P3–P4 decreased with increasing age (48%–13.5%), while the proportion triaged as P1 (7.8%–24%) or P2 (44.2%–62.5%) increased. Trauma, poisoning and complications were the most common diagnoses in all age groups (13.5%) after allowing for the 'other' category (28.7%), as this category was formed from smaller diagnosis classes. The prevalence of circulatory system diseases, endocrine, metabolic and nutritional diseases and neoplasms was higher in older individuals, whereas dermatology and musculoskeletal system diseases, neurological and sensory diseases and reproduction-related and genitourinary diseases appeared more prevalent in younger adults.

ED length of stay

The unadjusted median (IQR) length of stay increased across age categories: 3.53 (2.24–5.24) hours, 4.04 (2.71–6) hours, 4.32 (2.98–6.28) hours and 4.46 (3.16–6.32) hours for attendances in age categories 18–44, 45–64, 65–84 and 85+, respectively (online supplemental figure 1). The analysis using age as a continuous variable found that for each 10-year increase in age, the AOR (95% CI) of having EDLOS ≥4 hours increased by 1.05 (95% CI 1.05 to 1.06) (online supplemental S-Table 2). However, as seen in figure 2A, the spline shows that the increase in AOR appears logarithmic rather than linear, possibly suggesting that age categories are more appropriate to use than age as a continuous variable.

Mixed-effects analysis with age categories

When the age category 18–44 was the reference (figure 2B), patients in the 45–64, 65–84 and 85+ age groups had increased

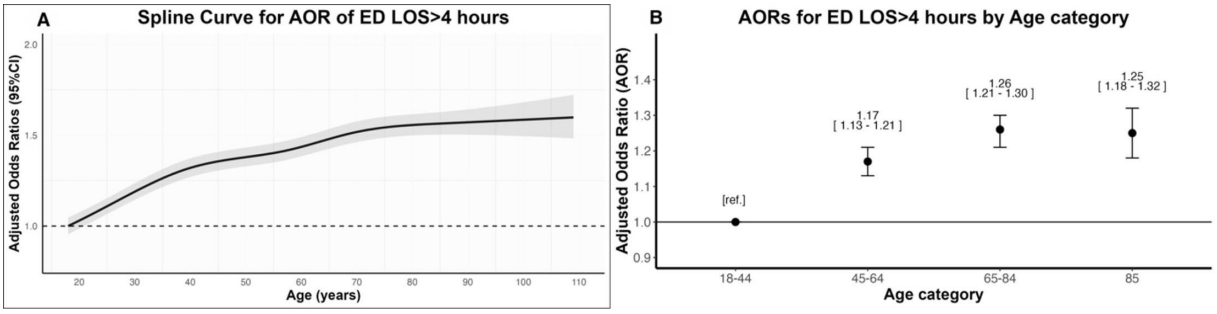

Figure 2 AORs of patients having a length of stay greater than the 4-hour threshold. (A) Restricted cubic spline curve showing the AORs at different ages when the reference age was 18. (B) Forest plots showing the AORs for different age groups, where patient's age 18–44 years was set as the reference category. AOR, adjusted OR; LOS, length of stay.

odds of an EDLOS of ≥4 hours of 1.17 (95% CI 1.13 to 1.21), 1.26 (95% CI 1.21–1.30) and 1.25 (95% CI 1.18 to 1.32), respectively (table 3). Similar results were seen in sensitivity analyses when prolonged EDLOS was defined as ≥6 hours, ≥8 hours, ≥12 hours and ≥24 hours (online supplemental S-Tables 3-6).

Table 3 Adjusted OR for a prolonged ED length of stay (defined as an ED stay greater than 4 hours), after adjusting for confounding factors.

Characteristic	OR	95% CI	P value
Age category			
18–44	—	—	
45–64	1.17	1.13 to 1.21	<0.001
65–84	1.26	1.21 to 1.30	<0.001
85+	1.25	1.18 to 1.32	<0.001
Gender			
Female	—	—	
Male	0.88	0.86 to 0.90	<0.001
Ethnicity			
Chinese	—	—	
Indian	1.02	0.98 to 1.06	0.288
Malay	1.06	1.02 to 1.10	0.005
Others	0.97	0.94 to 1.01	0.183
Disposition			
Admitted	—	—	
Discharged	0.40	0.39 to 0.41	<0.001
Day of week			
Weekday	—	—	
Weekend	0.55	0.54 to 0.57	<0.001
Time of day			
Day	—	—	
Night	0.97	0.94 to 0.99	0.01
Triage category			
P1	—	—	
P2	1.42	1.38 to 1.48	<0.001
P3–P4	2.89	2.77 to 3.02	<0.001
CCI			
0	—	—	
1–2	0.95	0.91 to 0.98	0.002
3–4	0.89	0.85 to 0.93	<0.001
5+	0.85	0.81 to 0.90	<0.001
Blood test			
No	—	—	
Yes	2.19	2.12 to 2.27	<0.001
Diagnosis category			
Circulatory system	—	—	
Dermatology and musculoskeletal system	0.75	0.71 to 0.79	<0.001
Endocrine, nutritional and metabolic diseases	1.11	1.03 to 1.20	0.009
Gastrointestinal	0.90	0.84 to 0.96	<0.001
Infectious and Parasitic diseases	0.83	0.77 to 0.88	<0.001
Neoplasms	0.80	0.72 to 0.90	<0.001
Neurological and sensory	0.71	0.66 to 0.76	<0.001
Others	1.17	1.11 to 1.23	<0.001
Reproductive and genitourinary system	1.03	0.96 to 1.10	0.359
Respiratory	0.70	0.65 to 0.74	<0.001
Trauma, poisoning and complication	0.87	0.82 to 0.92	<0.001
Unknown	0.87	0.80 to 0.94	<0.001

Intercept estimate: −0.214; intercept SE: 0.035 and random Intercept SD: 0.162.
CCI, Charlson Comorbidity Index.

ED LOS by subgroup

The observed trends differed between admitted and discharged groups (online supplemental file 1). In the analysis (figure 3 and online supplemental S-table 7) looking at the impact of disposition on ED length of stay, the AORs (95% CI) consistently increased across the age categories for discharged patients (1.22 (95% CI 1.17 to 1.26), 1.33 (95% CI 1.27 to 1.39), 1.60 (95% CI 1.45 to 1.76) in the 45–64, 65–84 and 85+ age groups, respectively). However, there was no significant difference in AORs for patients admitted to the hospital (0.96 (95% CI 0.90 to 1.03), 0.99 (95% CI 0.93 to 1.05) and 0.91 (95% CI 0.83 to 0.99) for attendances in the 45–64, 65–84 and 85+ age groups, respectively).

Furthermore, for subgroup analyses comparing those with and without blood tests (figure 3B and online supplemental S-table 8), different ethnicities (figure 3C and online supplemental S-table 9A and 9B), CCI (figure 3D and online supplemental S-table 10A and 10B) and different triage categories (figure 3E and online supplemental S-table 11), the association between age and prolonged EDLOS was only present among those who did not have blood tests, those that were Chinese/'Others' ethnicity, those with CCI scores of zero and those with P3–P4 acuity. However, there was an association between age and prolonged EDLOS regardless of the patient's gender (figure 3F and online supplemental S-table 12), time of day the patient presented (figure 3G and online supplemental S-table 13) or day of the week (figure 3H and online supplemental S-table 14).

Of note, when a subgroup analysis of the disease category was conducted: the circulatory system, dermatology and musculoskeletal system and trauma, poisoning and complication-related conditions also had increasing AORs for prolonged EDLOS across the age categories (online supplemental S-table 15A). The gastrointestinal system, reproduction-related and genitourinary system and endocrine nutritional and metabolic disease-related conditions appeared unaffected by age group (online supplemental S-table 15B). The other subpopulations had mixed trends, often with no significant differences (online supplemental S-table 15C and D).

DISCUSSION

This observational study at Singapore's largest tertiary care hospital's ED found that older patients were more likely to have a prolonged EDLOS compared with their younger counterparts. However, when split into subgroups, the association with age was only found in low-acuity attendances where the patient had no comorbidities, had no blood test, was of Chinese ethnicity and was discharged.

Our study's primary finding is supported by studies in Canada[2] and Korea[3] reporting unadjusted EDLOS increasing with age. Furthermore, studies in Iran[12] and England[10] reported increased AORs for prolonged EDLOS in older adults, with the English study finding significant increases within elderly age groups. However, Casalino *et al* noted no association between age and EDLOS after adjusting for factors like diagnostic tests, arrival mode and acuity.[16]

A novel contribution of this study was that the association of prolonged EDLOS with increasing age was absent within certain subpopulations. There was no association for attendances receiving blood tests, having high clinical acuity, having multiple comorbidities or leading to admission. Additionally, the trend was absent

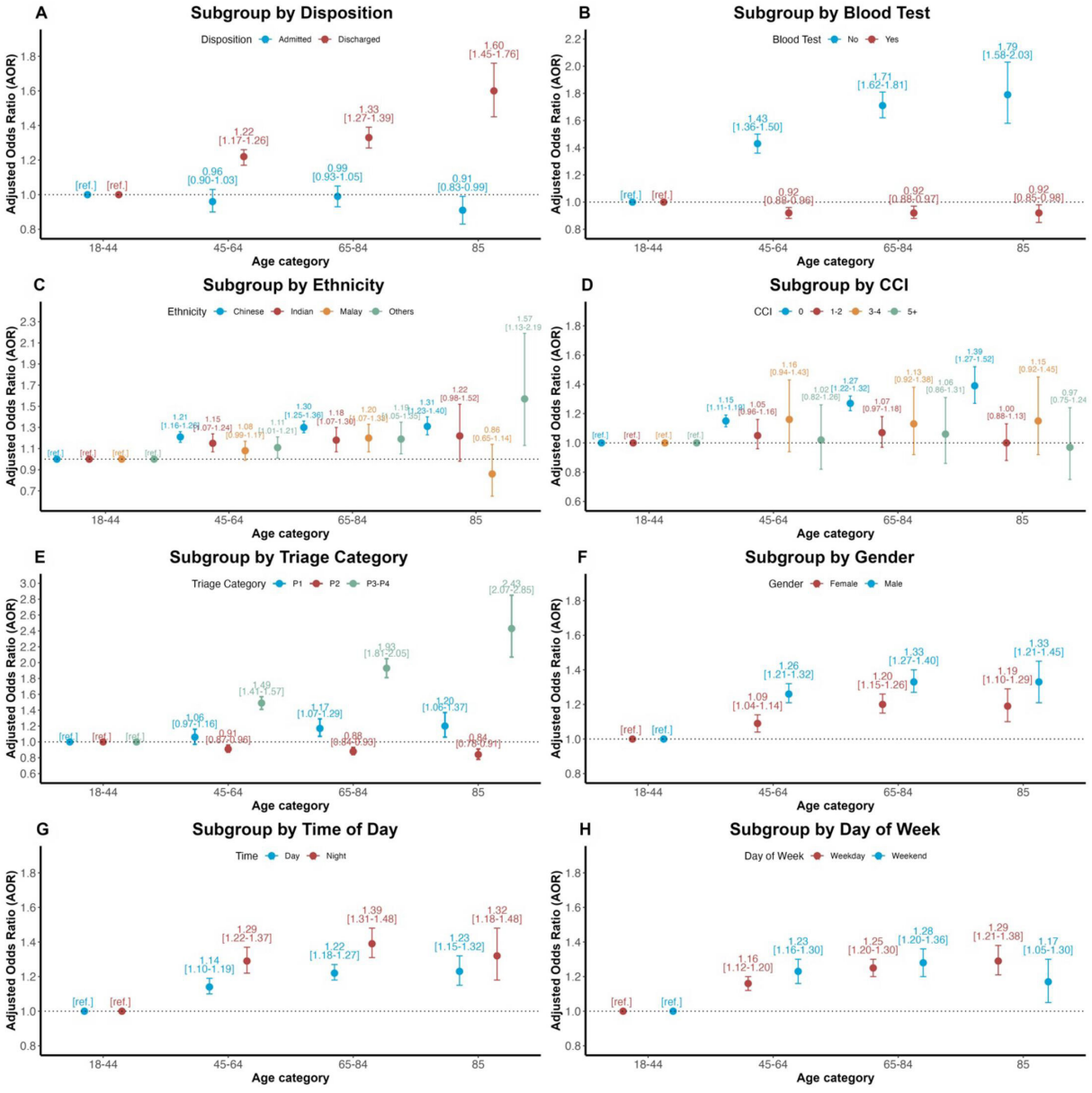

Figure 3 Forest plots showing the adjusted ORs of patients in different age groups having an ED length of stay greater than the 4-hour threshold, where patient's age 18–44 years is set as the reference category. The groups are distinguished by (A) the patient disposition, (B) the attendee's requirement for a blood test, (C) the attendee's ethnicity, (D) the attendee's Charlson Comorbidity Index score, (E) the attendee's assigned triage category, (F) the gender of the attendee, (G) the time of day at which the attendee entered the ED and (H) whether the attendance was on a weekday or weekend. AOR, adjusted OR; CCI, Charlson Comorbidity Index; LOS, length of stay.

in some diagnosis categories and ethnicities. Overall, these results may imply that only within attendances with less serious presentations are older adults at greater risk of prolonged EDLOS.

The finding that age-related associations were only observed in specific diagnosis category subgroups links back to age being a factor in some condition-specific studies but not others.[21 22] However, the finding regarding admitted patients contradicts previous literature findings that both admitted and discharged older patients are more likely to have a prolonged EDLOS.[10] Possible explanations for existing contradictions between our findings and prior literature could arise from considering different variables in our analyses, as well as regional differences in medical/social care systems and population demographics.

Possible reasons for the overall association between increasing age and EDLOS include factors such as a greater requirement for social history/care for older patients and older patients presenting with non-specific complaints[15]; hence, they require more time for complex assessments. Possibly, cognitive decline with age,[23] along with communication barriers,[24] may increase the difficulty of history-taking. Lastly, we hypothesise that non-care-related factors, such as the time taken to arrange for transportation of elderly patients back to the community setting or arranging for more complex post-ED care for these patients, could also contribute to the longer EDLOS in patients being discharged.

However, the effect of these factors may be limited in certain subpopulations. For instance, the association of age with prolonged length of stay may be absent for admitted patients due to their EDLOS being a result of waiting for inpatient beds rather than ED processes. This is possibly supported by admitted patients averaging longer EDLOS than discharged patients

across all age groups (online supplemental S-figure 2). Similarly, in patients with higher CCIs or receiving blood tests, the time requirements of more complex medical assessments or blood tests may impact EDLOS more than factors associated with increased age.

It was also found that the proportion of older adult attendances increased to 37.6% by 2019 (online supplemental S-figure 3), whereas they accounted for 25.5% of all attendances to SGH ED in the previous decade.[25] Furthermore, as demonstrated previously,[23] older adults were more frequently admitted and triaged with higher acuity.

Overall, the study's findings of discrepancies between EDLOS for younger versus older patients imply the need for systematic changes. For instance, including geriatric professionals in the ED, which has improved health and time-related outcomes in orthogeriatrics,[26] or strengthening geriatric care training among the ED healthcare team.[27] Including alternative care pathways, such as direct assessment by senior physicians[28] for older patients with less serious but non-specific presentations, could also help reduce EDLOS. They also potentially highlight a need for greater focus on social care and improved discharge planning to avoid prolonged EDLOS for lower-severity older discharged patients, who are at the greatest increased risk of prolonged EDLOS compared with their younger counterparts. For example, involving social care professionals in the ED has previously been shown to reduce EDLOS for older patients.[29] Lastly, the subgroup-based findings could also help understand the mechanisms for prolonged EDLOS for older adults and could be considered in EDLOS prediction, which yields benefits in terms of efficiency and ED outflow.[30]

A strength of this study is the large sample size, making this one of the largest single-ED observational studies for this topic, to our knowledge. Using EDLOS thresholds as the primary outcome allows for easy measurement and comparison across international studies, helping identify possible improvements.

There were limitations to this study. First, there were possible errors in recording data in the ED or creating the dataset used in this study. For example, certain attendances had unclear information about diagnoses, and it is unknown whether the recorded discharge time is always a true reflection of actual discharge or just when it was registered. This could lead to the risk of measurement bias. However, these errors would generally be random, minimal and unlikely to affect findings. Second, some attendances with missing or unreasonable EDLOS were excluded, but these formed less than 0.63% of the study population and are unlikely to have a substantial impact on the results. Third, the availability of some clinical information was limited. Previous studies have indicated that variables such as mode of arrival,[16] number of required consultations, patient's mental status,[31] requirement for other diagnostic investigations (such as X-rays or CT scans),[16] patient's socioeconomic status and whether trauma was the reason for ED attendance[11] may impact the EDLOS for patients. Lastly, this study was conducted using a single-centre dataset, limiting the results' national generalisability, given the demographic differences across Singaporean regions.

Future studies could consider other clinical variables such as polypharmacy and imaging requirements and involve mediation analyses to investigate mechanisms of prolonged EDLOS. Further work could include investigations on which presenting complaints are age-group-related and the causes for differing association estimates in subgroups. Lastly, it could explore components of ED stay, such as time to triage, time to see a provider and time to discharge after medical consultation, as these could vary across ages and acuities and provide detailed information about the stages at which possible bottlenecks arise.

CONCLUSION

This large observational study showed that after accounting for potential confounders, in Singapore, older adults faced increased odds of prolonged EDLOS compared with younger adults. This association was found in discharged patients with low acuity, no comorbidities, no blood tests and of Chinese ethnicity but absent for those admitted, having a higher CCI score, receiving blood tests and having high acuity. Overall, these results imply the need for changes in ED systems, such as the inclusion of geriatric expertise in the ED and enhanced discharge planning for older adults, to be better equipped for ageing demographics.

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