Impact of an Aging Population and Shift to Chronic Illness on Emergency Department Admissions in a Tertiary Hospital Over Ten Years

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Abstract

Background: This study aimed to determine to what extent an aging population and shift to chronic illness has contributed to emergency admissions at a tertiary care hospital over ten years.

Methods: This was a retrospective observational study performed using a database of all emergency admissions from the Emergency Department (ED) at a single tertiary hospital in Singapore during a ten-year period (January 1st, 2008 to December 31st, 2017). Emergency admissions were defined as ED visits with inpatient admission as the disposition. This study analyzed the trends of demographics, pre-existing comorbidities, chronic conditions or ambulatory care sensitive conditions (ACSC) of all patients who underwent emergency admissions in SGH.

Results: A total of 446,484 emergency records were included. While the annual number of emergency admissions increased by 22% from 2008 to 2017, the rate of emergency admissions for the Singapore elderly population (aged >65 years) had a relative decrease of 15% during the same period. For elderly patients, lower proportions of them had pre-existing multimorbidity at the time of undergoing emergency admissions. The proportions of emergency admissions whose ED primary diagnoses were categorized as chronic conditions and certain chronic ACSC including chronic obstructive pulmonary disease, congestive heart failure, diabetes complications, and epilepsy also decreased for elderly patients.

Conclusions: In Singapore, despite a rapidly ageing population, there have been surprisingly fewer chronic conditions, pre-existing comorbidities, and chronic ACSC among the elderly emergency admissions. This is possibly consistent with an overall improved management of the chronic conditions among the elderly population and will be interesting to compare with other healthcare settings in different countries in future studies.

Background

Worldwide, the pace of population ageing is increasing, both in the developed and developing countries.[1] As people live longer, multimorbidity also becomes increasingly common, which is associated with increased use of inpatient and outpatient care.[2, 3] Singapore is facing one of the fastest aging populations in the world. The proportion of the elderly population is expected to rise from 9% in 2010 to 22.5% in 2030.[4]

Like many other countries, Singapore is challenged by a rising demand for emergency care, as evidenced by a 47% increase in annual total visits to public sector emergency departments (EDs) from 2005 to 2015.[5] A significant portion of ED visits go on to eventually become emergency admissions. Emergency admissions, defined as patients visiting ED who are admitted for inpatient care, are a major policy concern. While inpatient care can be effective, it can be costly and may not be in the best interest of the patients when ambulatory care is possible. In particular, when elderly patients (age 65 and above) visit the ED, they are more likely to have emergency admissions compared to younger patients.[6, 7] Additionally, after emergency admissions, elderly patients are more likely to have a longer hospital stay, higher healthcare cost, and higher overall mortality rate.[8–10]

Although many of the drivers for increased ED visits have been well described,[10–13] those for emergency admissions specifically have not. There has been evidence showing that a higher Charlson Comorbidity Index is associated with an increased rate of emergency admissions.[5, 11] Wittenberg et al. have argued that proximity to the end of life, instead of older age per se, is associated with a higher rate of emergency admission.[14] Ambulatory care sensitive conditions (ACSC)[15] have been commonly used as an indicator of potentially

preventable hospital admissions and a proxy measure of the quality and accessibility of primary care. There have been several trend analysis of ACSCs in different parts of the world. However, the results are far from universal and the trends vary greatly by countries and by specific conditions.[16–21]

The overall objective of this study is to determine to what extent the aging population and chronic conditions have contributed to the volume of elderly emergency admissions. It was hypothesized that an aging population with an increasing number of chronic conditions[22] was associated with a higher number of emergency admissions. We aim to test this hypothesis using a ten-year, comprehensive single-centre database.

Methods

Study Design

This was a retrospective observational, single-centre study. This study was approved by Singapore Health Services' Centralized Institutional Review Board.

Study Setting and Population

We performed the study using a database from the Singapore General Hospital (SGH), the largest and oldest tertiary medical centre in Singapore, with comprehensive clinical services and over 1700 inpatient beds. Annually, the SGH ED receives more than 120,000 ED visits, over 40,000 of which converted to inpatient admissions. The analysis was based on extracted data from SGH's electronic medical health system, namely Singhealth Electronic Health Intelligence System (eHints). The data was recorded as per the emergency admission episode. All patients who underwent emergency admissions at SGH from 1 January 2008 to 31 December 2017 were included in this study. Patients at SGH below the age of 18 were excluded.

Measures

Selected variables included 3 demographic variables, 3 administrative variables, and 18 clinical variables. Demographic variables included age, gender, and postal code. ED administrative variables included anonymized case identification number, anonymized admission number, and ED registration date. Clinical variables included the presence of 17 comorbidities from the past 5 years of hospital discharge records before the index emergency admission, and primary ED diagnosis. Patients' identifying information was removed to ensure anonymity.

Identification of pre-existing comorbidities

The definitions of comorbidities employed in this study were based on the Charlson Comorbidity Index.[23] The 17 comorbidities defined in this study included prior myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatological disease, peptic ulcer disease, mild liver disease, diabetes, cerebrovascular (hemiplegia) event, moderate to severe renal disease, diabetes with chronic complications, cancer without metastases, moderate to severe liver disease, metastatic solid tumor, and acquired immune-deficiency syndrome (AIDS). Pre-existing comorbidities were determined from their past 5 years of hospital discharge records prior to the referenced emergency admission. The number of pre-existing comorbidities was further grouped into three categories – no pre-existing comorbidity, single pre-existing comorbidity, and pre-existing multimorbidity in which the patient had two or more of the comorbidities. For our dataset, the information needed to trace 5 years back in their medical records were only available from 2012 onwards. Therefore, the timeline for this analysis only included 2012–2017.

SNOMED CT to ICD-10 Conversion for Primary ED diagnosis

In our eHints dataset, primary ED diagnoses were recorded according to the International Classification of Diseases Version 9 (ICD-9) from 2008 to 2014. From 2015 to 2017, the EHR switched to Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT) for the computerized coding of ED diagnoses. To facilitate consistent comparison of primary ED diagnoses across the years, SNOMED CT codes were first converted to ICD-10 using SNOMED CT to ICD-10-CM Map released by the National Library of Medicine[24]. In cases where they were multiple possible matches of ICD-10 codes to one SNOMED CT code, only the first matched ICD-10 code was retained.

Identification of chronic conditions in primary ED diagnosis

To determine whether the primary ED diagnosis would be categorized as a chronic condition or non-chronic condition, we adapted Chronic Condition Indicator (CCI) for ICD-9[25] and ICD-10[26], respectively, developed by Agency for Healthcare Research and Quality. A chronic condition is defined as a condition expected to last twelve months or longer and results in functional limitations and/or the need for ongoing medical intervention. [27]. Each emergency admission episode's primary ED diagnosis can, therefore, be designated either chronic or not chronic based on its ICD-9 or ICD-10 code.

Identification of ambulatory care sensitive conditions (ACSC) in primary ED diagnosis

Emergency admissions for ACSC were identified from the ICD-9 or ICD-10 primary ED diagnoses. The lists of diagnosis codes adopted in this study were based on the lists described by Billings et al. [15] and the subsequent ICD-10 version. [28] The algorithm detects 24 ACSC conditions. ACSC conditions are further categorised into acute, chronic, and avoidable conditions. This study focused on the 9 chronic ACSC (Table S1).

Statistical methods

Data wrangling and analysis were performed using R version 4.0.2 (R Foundation, Vienna, Austria). Proportion estimates in a given year were reported with 95% confidence interval. Mann-Kendall test (MK) was used to statistically assess whether there is a monotonic upward or downward trend of a proportion over time. A monotonic upward or downward trend means the proportion consistently increased or decreased over time, but the trend may not necessarily be linear. Additionally, a modified Mann-Kendall test (MMKH) using Hamed and Rao variance correction approach [29] was performed on trend analysis to address the issue of seiral correlation. The serial correlation was evaluated using the *acf* function in R. The serial correlation (at lag 0–20) was detected in monthly aggregated data, thus we performed MMKH test for the monthly aggregated analysis. For annually aggregated data with much fewer time points, the serial correlation was negligible. Trend analysis was performed on the proportions of elderly emergency admissions with pre-existing multimorbidity at the time of admission, whose primary ED diagnosis was categorized as chronic conditions, and whose primary ED diagnosis was identified as ACSC.

Results

General Trends

There were 446,484 emergency admission episodes included in the analysis from 2008 to 2017. The emergency admission patient population at SGH represents a wide geographical distribution across the country (Figure S1), with a higher concentration in the immediate neighborhood Bukit Merah and the eastern region in Singapore, which correlates well with the coverage area of the health cluster.[30]

The average monthly number of emergency admissions at SGH increased by 22% from 3204 in 2008 to 3902 in 2017. MMKH was performed on the trend of monthly number ($p < 0.001$). From 2008 to 2017, the year-on-year increase averaged at 3.4%. Despite the overall upward trend, the average monthly number started to plateau from 2015 (Fig. 1).

From 2008 to 2017, the proportion of elderly in the Singapore population increased from 8.7–13.1%. [31] The aging population is reflected in the trend of the proportion of elderly in the SGH emergency population, which increased from 46–53% during the same period. The rates of emergency admission, which is defined as the number of emergency admission at SGH per 1000 Singapore population, have remained constant for the general Singapore population (MK: $p > 0.05$) but decreased for the elderly population (MK: $p < 0.05$) (Fig. 2).

Trends of pre-existing comorbidity

The proportion of emergency admission patients at SGH with multimorbidity stayed constant for the non-elderly population but decreased for all age groups in the elderly population from 2012 to 2017 (Fig. 3). This number has also been consistently higher in the elderly population than in the non-elderly population.

Trends of chronic conditions

There were statistically significant downward trends for the proportions of chronic conditions as the ED primary diagnosis for SGH emergency admissions from 2008 to 2017 across all age groups. (Fig. 4)

Trends of chronic ambulatory care sensitive conditions (ACSC)

Of the eight chronic ACSCs included, 4 of them – COPD, asthma, diabetes complications, and epilepsy - had statistically significant reductions in their proportions as the ED primary diagnosis of SGH elderly emergency admissions from 2008 to 2017. The rest did not show any statistically significant monotonic trends, although these conditions had very low proportions (less than 1.5%), to begin with, in 2008. (Fig. 5).

Discussion

In this study, we found that the rate of emergency admissions for the Singapore elderly population decreased from 2008 to 2017. Although counterintuitive at first – as elderly patients usually have more utilization of medical resources in general [2, 3] – this trend is compatible with some previous reports. In the United Kingdom, elderly patients contributed to less than half of the increase in emergency admissions [32, 33], younger cohorts of elderly contributed less to emergency admissions compared to older cohorts during the same period.[14]

In this study, we also demonstrated that, chronic conditions as a whole showed a relative decline in elderly patients who were emergency admissions. A decreasing trend of emergency admissions for chronic obstructive pulmonary diseases (COPD), diabetes complications, epilepsy was consistent with reports in Colombia and Brazil. [16, 18] While a United Kingdom study reported a significant increase in emergency admissions for COPD, diabetes complications and epilepsy, it also showed a substantial reduction in congestive heart failures, which is consistent

with our findings.[17] The marked variation in the trends among countries can be the results of different epidemiology and healthcare approaches in managing these conditions. Taken together, we found that chronic conditions have not been a major driver in the increasing number of emergency admissions in Singapore. However, the heterogeneity of the impact from an ageing population is a reminder that context-specific analysis is needed.

Several factors could have contributed to reducing the speed of growth of emergency admissions for the elderly population. Singapore has made efforts in the last decade to improve the quality and accessibility of ambulatory care, including primary care and outpatient specialist care. A notable example is CHAS (Community Health Assist Scheme), which subsidizes Singapore Citizens for chronic medical care at private General Practioner (GP) clinics as well as public Specialist Outpatient Clincis (SOCs) [34]. Since its inception in 2009, CHAS has been iteratively enchanced to be more inclusive in terms of patient demographics and eligible conditions. Other policies such Family Medicine Clinics and Primary Clinic Networks models have also been introduced with the aim to improve chronic disease management.[35]

Another possible explanation for this trend is that the ED has been more effective in gatekeeping unnecessary emergency admissions. Locally, there has been a move towards ambulatory management for specific conditions or procedures rather than admission. On the supply side, Singapore has also been increasing the capacity of public hospitals by progressive opening of new hospitals.

Elderly patients pose special diagnostic and management challenges to ED physicians due to multimorbidity, polypharmacy, atypical presentations for dangerous conditions, and various social issues.[36] Practice thresholds for admissions are directly related to admission rates, which has been described in the United States [37] and the United Kingdom [38]. Looking forward, the ED, along with the rest of the healthcare system, will need to transform together in order to manage a rapidly aging population. EDs might benefit from developing targeted protocols and clinical pathways for common geriatric problems and emphasis on geriatric training for staff. The ED could also play an increasingly significant role in coordination of care for elderly patients, for example by refer the elderly patients to appropriate long-term care directly, EDs can expedite the transition of care.

Limitations

Our study has several potential limitations. First, the study was done with a single-centre dataset, which limits the generalizability of its conclusions. As a tertiary academic medical centre, SGH might receive a different epidemiology compared to the general population. Secondly, as a retrospective observational study using administrative data, the accuracy of the results is susceptible to the bias created by information recording. For example, over the 10-year study period, ED physicians may have changed their preferences to record certain diagnoses as the primary diagnosis over secondary diagnosis, or vice versa. The switch from ICD-9 to SNOMED CT in 2015 as the administrative coding system could also have introduced bias despite the best efforts in grouping diagnoses into broad categories. However, it is worth noting that few of the trends described started to change in 2015, mitigating this concern. Thirdly, due to limited data availability, this study only included admitted patients. However, epidemiology of all ED visits including discharged patients would have provided us with a better understanding of the context of our analysis.

Conclusions

We found that despite an ageing population, there have been surprisingly fewer chronic conditions, pre-existing comorbidities, and chronic ACSC among the elderly emergency admissions. In Singapore, policies to improve access and quality of ambulatory care and other public health efforts have possibly helped to reduce the demand for emergency admissions. It will be interesting to compare with other healthcare settings in different countries in future studies.

Abbreviations

ACSC: ambulatory care sensitive conditions

AIDS: acquired immunodeficiency syndrome

CHAS

COPD: chronic obstructive pulmonary disease

ED: Emergency Department

GP: general practitioner

ICD-9: International Classification of Diseases Version 9

ICD-10: International Classification of Diseases Version 10

MK: Mann-Kendall test

MKKH: modified Mann-Kendall test using Hamed and Rao variance correction approach

SGH: Singapore General Hospital

SNOMED CT: Systematized Nomenclature of Medicine Clinical Terms

SOC: Specialist Outpatient Clinic

Declarations

Ethics approval and consent to participate

This study was approved by Singapore Health Services' Centralized Institutional Review Board.

Consent for publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from Singapore Health Services but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly

available. Data are however available from the authors upon reasonable request and with permission of Singapore Health Services.

Competeing interests

The authors declare that they have no competing interests

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Authors' contirbutions

ZX wrote the R code, and analyzed and interptred the data. FJS, NL, MO interpreted the data and provided general guidance. QF advised on statistical methods. SL assisted with data acquisition. All authors read and approved the final manuscript.

Ackowledgements

Not applicable

Prior Presentations

The work described in the manuscript has not been formally presented at a scientific meeting.

Conflicts of interests

None to declare

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Figures

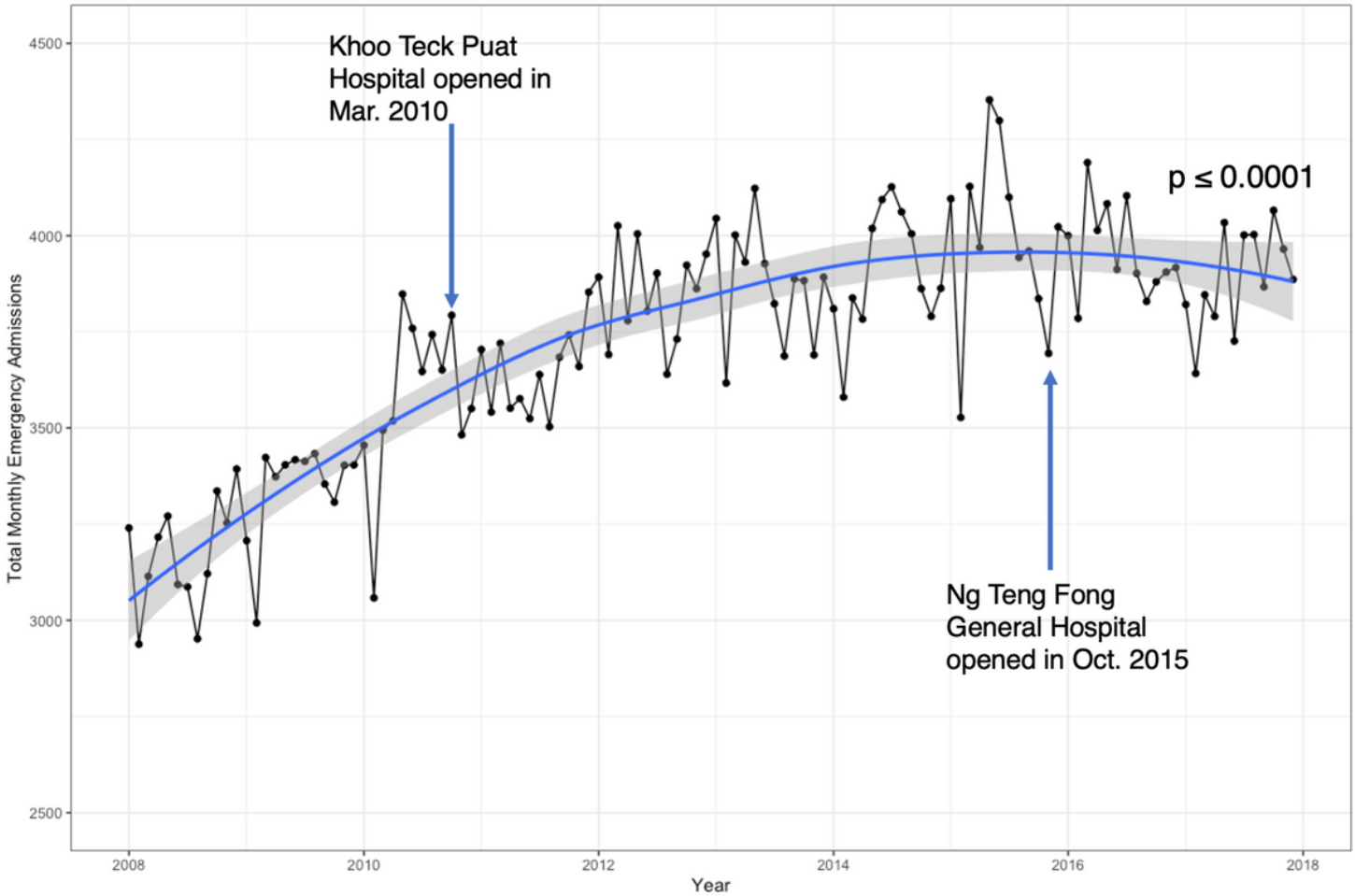

Figure 1

Monthly number of emergency admissions at SGH from 2008 to 2017. Regression line with 95% CI was plotted using LOESS (locally estimated scatterplot smoothing). Mann-Kendall test was performed to assess the presence of monotonic trend of monthly number ($p < 0.001$).

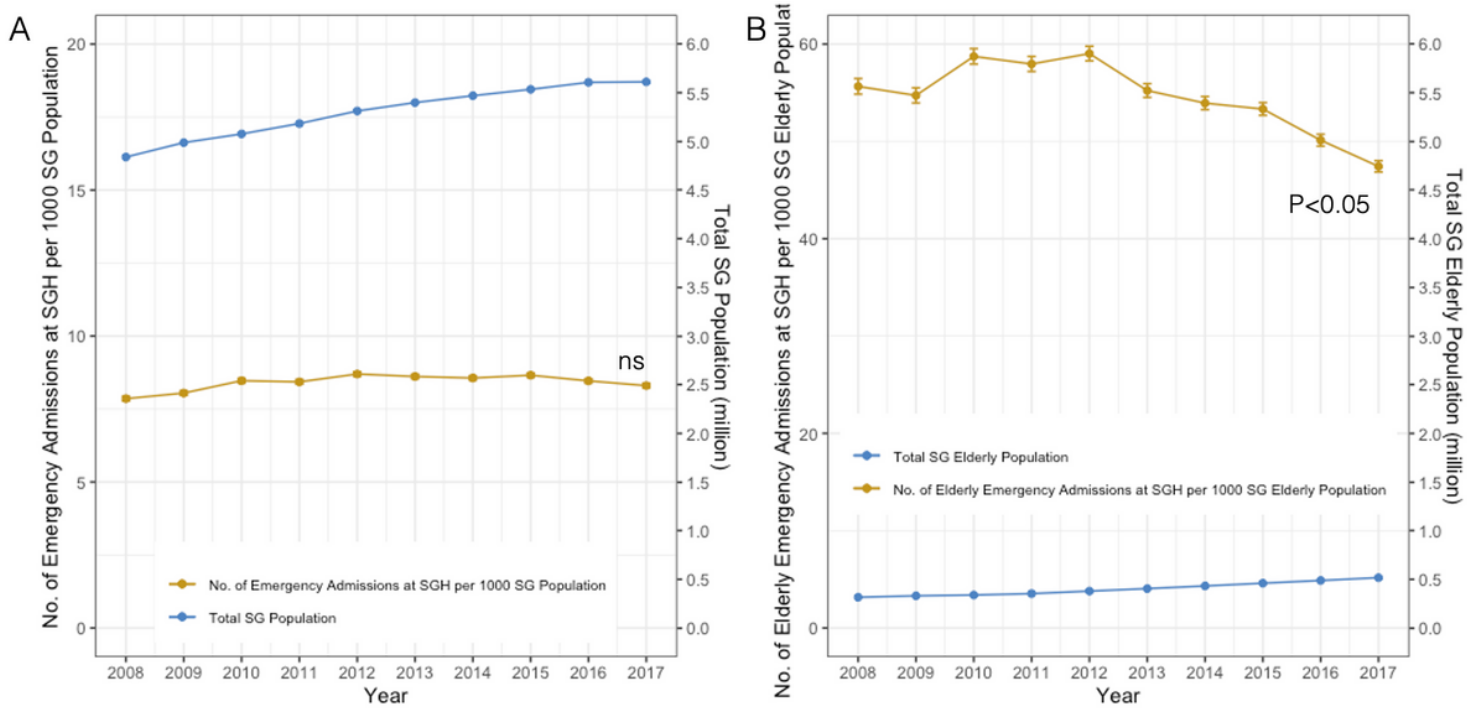

Figure 2

A) Trends of Singapore (SG) population and rate of emergency admission at SGH for SG population from 2008 to 2017 B) Trends of Singapore (SG) elderly population and rate of emergency admission at SGH for SG elderly population from 2008 to 2017. Mann-Kendall test was performed to assess the presence of monotonic trend of rates of emergency admissions. (ns: not statistically significant).

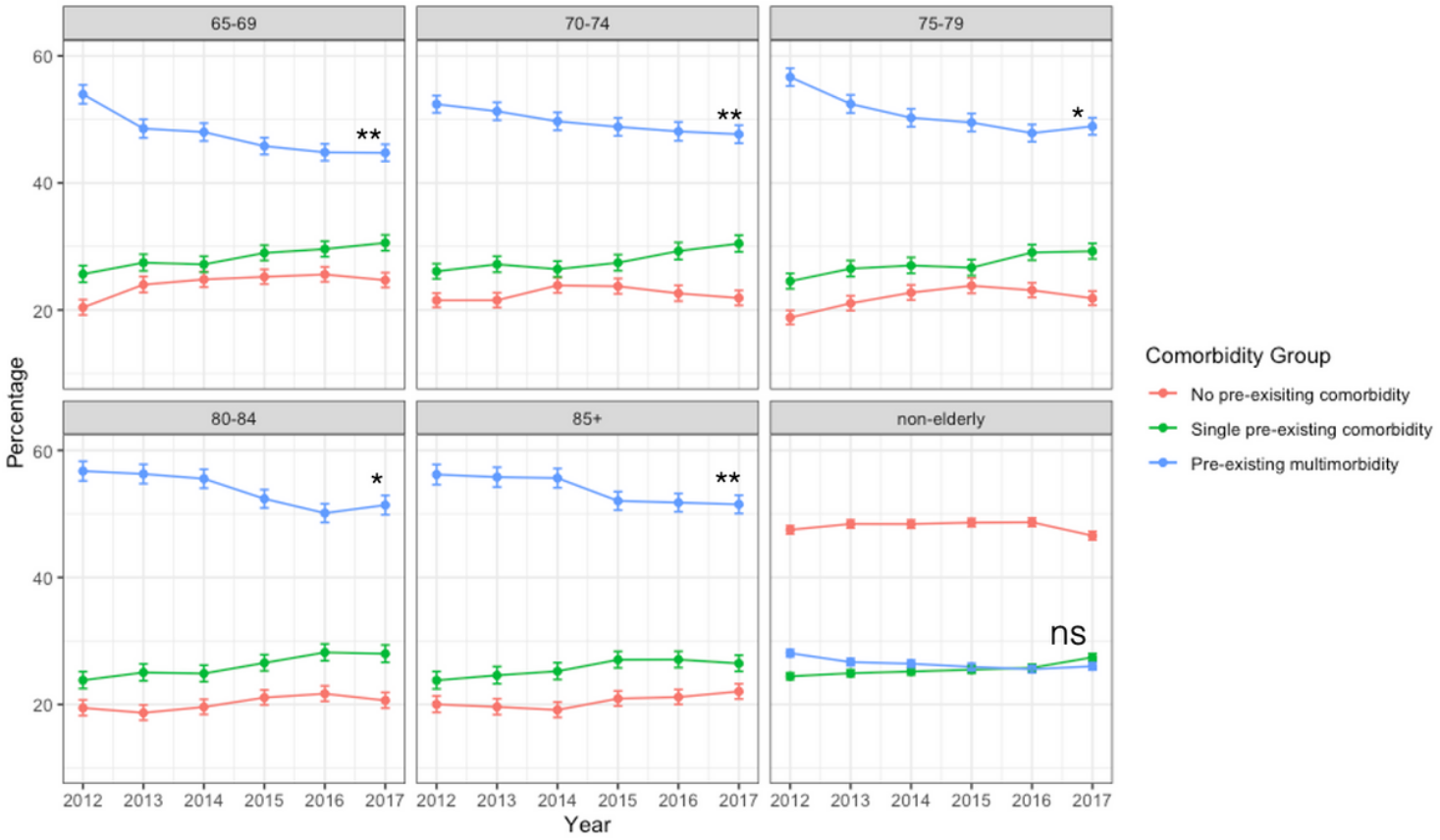

Figure 3

Trends of number of pre-existing comorbidities at the time emergency admissions by age group from 2012 to 2017. Mann-Kendall test was performed to assess the presence of a monotonic trend in the proportions of pre-existing multimorbidity. (ns: not statistically significant, *: p<0.05, **: p<0.01).

Figure 4

Trends of chronic conditions at the time emergency admissions by age group from 2008 to 2017. Mann-Kendall test was performed to assess the presence of a monotonic trend in the proportions of chronic conditions. (ns: not statistically significant, *: p<0.05, **: p<0.01).

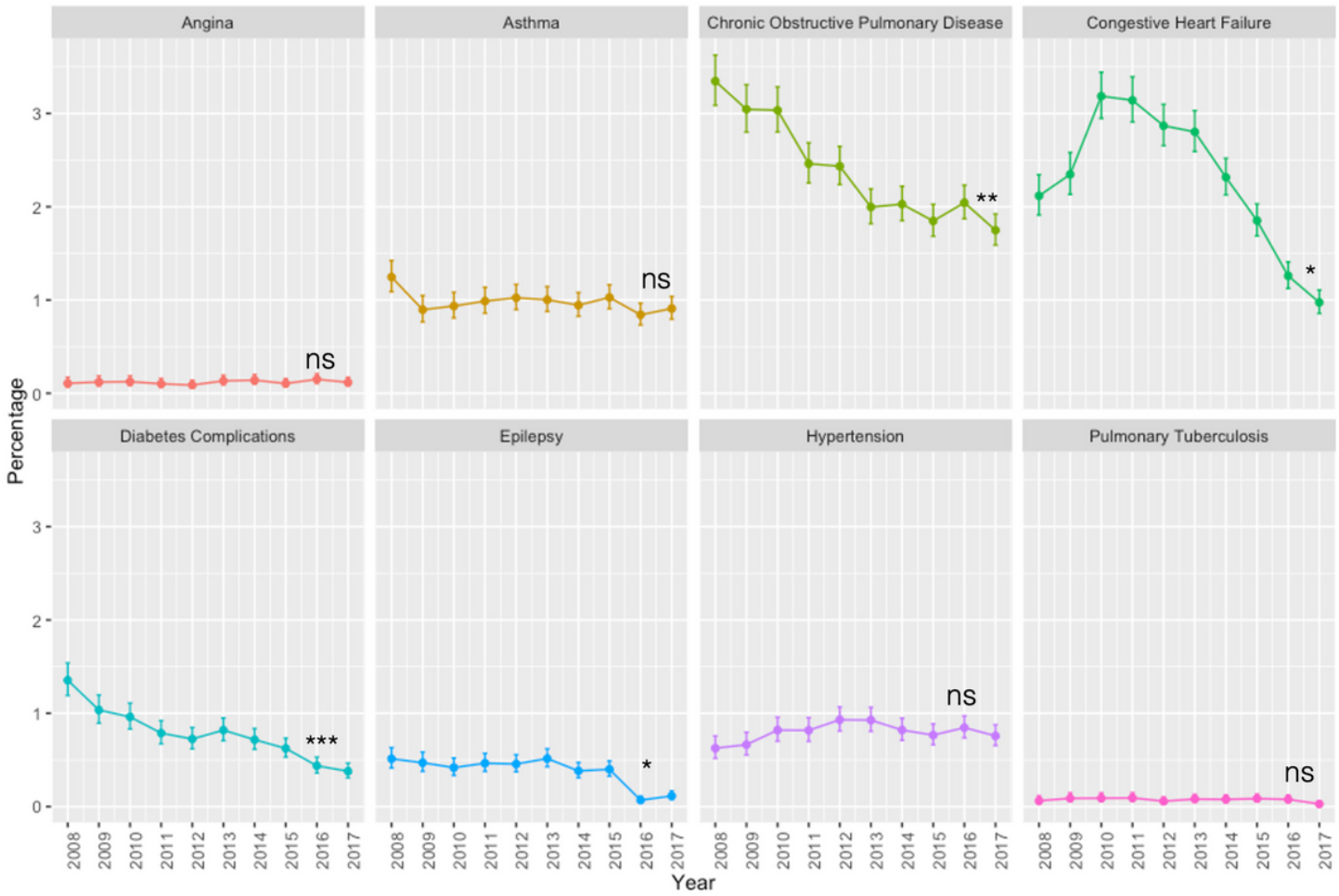

Figure 5

Trends of chronic ACSC as primary ED diagnosis for emergency admissions by condition from 2008 to 2017. Mann-Kendall test was performed to assess the presence of a monotonic trend in the proportions of chronic ACSCs. (ns: not statistically significant, *: p<0.05, **: p<0.01, ***: p<0.001).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementalFile.pdf