A statistical analysis proposal: Emergency hospital admissions associated with Non-Communicable Diseases 1998-2019: An Ecological Study

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Introduction

Background and Rationale

England is considered to be in stage 4 of both the demographic and epidemiological transition models, characterized by low birth rates, increased life expectancies, rates of Non-Communicable Diseases (NCDs) and degenerative diseases [1].

The World Health Organisation (WHO) aims to reduce mortality from NCDs by 25% by 2025 [2 3]. In the United Kingdom, an estimated 89% of deaths are related to NCDs [4].

Whilst the burden of mortality is well described [5], there has been a lack of emphasis on NCD-related health service utilization, and specifically the emergency services., This analysis will seek to describe those NCDs most responsible for emergency admissions, in the context of the overall trend in hospital admission episodes.

This study will use national summary data to analyse how the numbers of emergency admissions due to the main groups of NCDs have changed. This study will also examine the age profile of those admitted to hospital with NCDs. Using Office for National Statistics (ONS) resources this will be compared with the demographic changes in the overall population.

Objectives

- To test the hypothesis that there is an increasing number of emergency admissions associated with NCDs
- To describe the individual ICD-10 coded diseases most responsible for these changes
- To describe the incidence of NCDs noted as comorbidities in those admitted to hospital
- To investigate whether trends in the UK hospital admissions data are replicated in other countries in stage 4 of the demographic and epidemiological models

Proposed Methods

Study design

This will be a time trend ecological study using national summary data from NHS Digital. Publicly available summary data will be extracted for England from 1998-2019. England accounts for 82.2% of NHS funding and 84.2% of the population of the UK. Data will be additionally available for Wales from 1999-2018, Northern Ireland 2011-2018, Scottish data is available in aggregated format and National Services Scotland will be approached for the individual ICD-10 coded admissions data.

This study will use only publicly available, anonymised, aggregated data that is available under an Open Government License v3.0 [6]. According to the Health Research Authority this analysis is classified as research but does not require Research Ethics Committee approval.

Data Sources

The Global Burden of Disease Study is a comprehensive, collaborative effort to monitor trends in the epidemiology of disease worldwide. It will be used to describe the top ten diseases causing morbidity and the top ten diseases causing mortality in the United Kingdom.

Hospital Episode Statistic (HES) data is collected about each admission and every finished consultant episode of care in NHS hospitals in England. Aggregated data are published on an annual basis with an ICD-10 code for the primary diagnosis associated with that episode of care and any additional ICD-10 codes for secondary diagnoses. An episode of care is a period of treatment under one consultant specialty, therefore in a single admission it is possible to have multiple finished consultant episodes of care if a patient has multiple ICD-10 conditions treated sequentially. The count of finished consultant episodes is subdivided by mechanism of admission, either emergency or planned, mean length of stay and the age profile of patients. The ICD-10 coding has been used throughout the UK for coding admissions since 1996. The age profile of patients is published in the aggregated data set as the mean age, and the number of completed episodes of care for a particular age bracket (0-14 years; 14-59 years; 60-75 years, 75+ years).

The Phenome Wide Association Studies (pheWAS) phecode ICD-10 mapping relating individual ICD-10 codes to a range of phenotypes will be used to select the relevant ICD-10 codes for each disease group identified as being in the top ten causes of morbidity or mortality in the GBD study [7].

The Elixhauser Comorbidity Index will be used to assess the number of ICD-10 codes present as secondary diagnoses that represent comorbidities [8].

The ONS data on the age demographics of the population from 1998-2019 will be used as a reference for the overall demographic trends in the population of England. If comparable data is freely available online from other stage 4 developed nations, then their central government statistics will be used to give context to the trends seen in the UK data.

Exposure

ICD-10 codes as defined by WHO which will be subdivided to disease groups as follows[3]:

- Cancer (C00-C97)
- Cardiovascular disease (I00-I99)

- Respiratory (J40-47)
- Diabetes mellitus (E10-E14)
- Digestive system including cirrhosis (K00-K93)

Additionally NCD groups causing the greatest burden of mortality and morbidity in the GBD study will be identified and the phecode ICD-10 mapping used to select appropriate ICD-10 codes.

Chronic Kidney Disease (CKD) will also be recorded as a separate group as it is likely under diagnosed and represents a significant burden in those with co morbid NCDs [9 10]. (Figure 1 and 2)

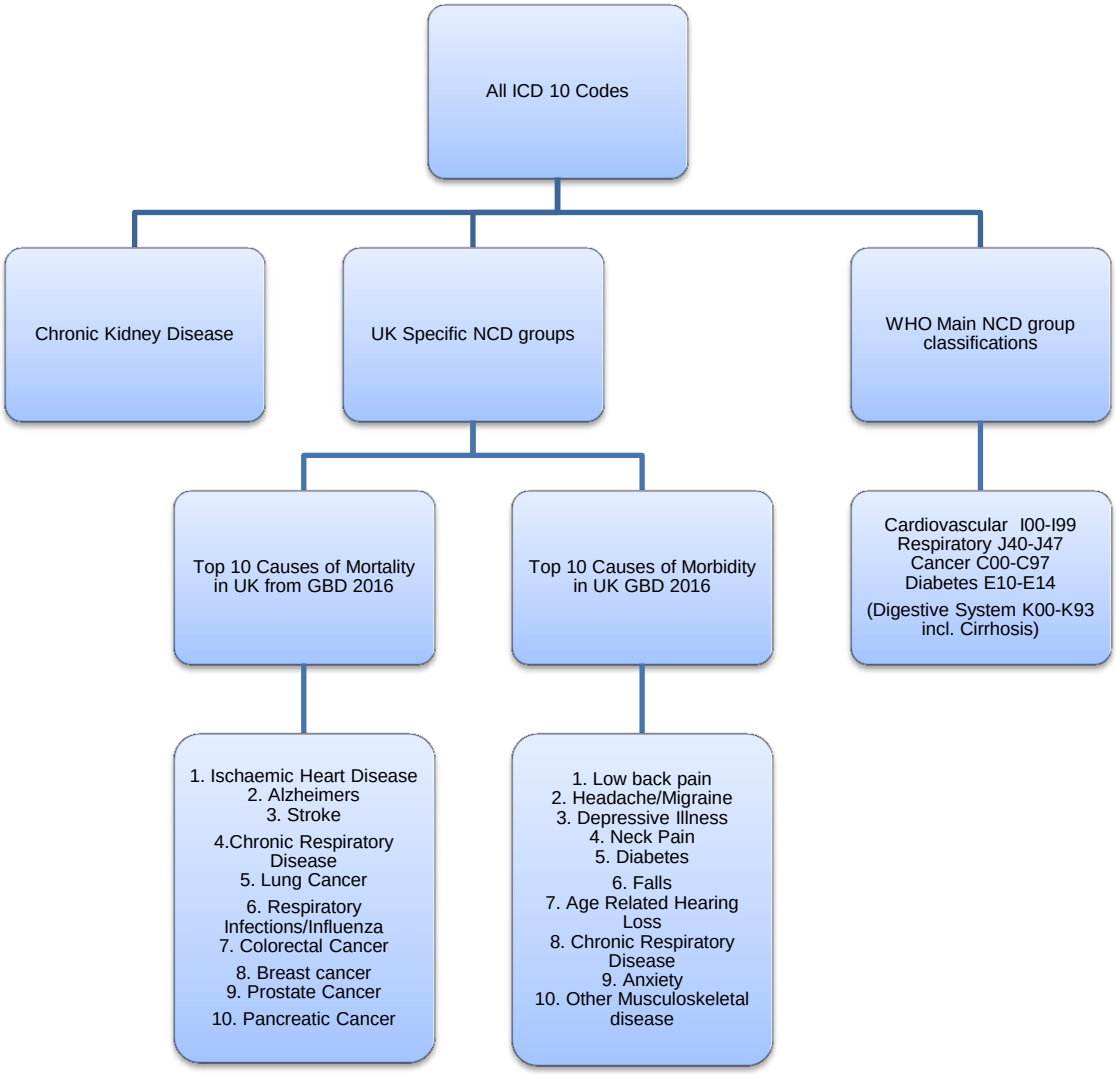


Figure 1. Map of groups of ICD 10 codes of interest

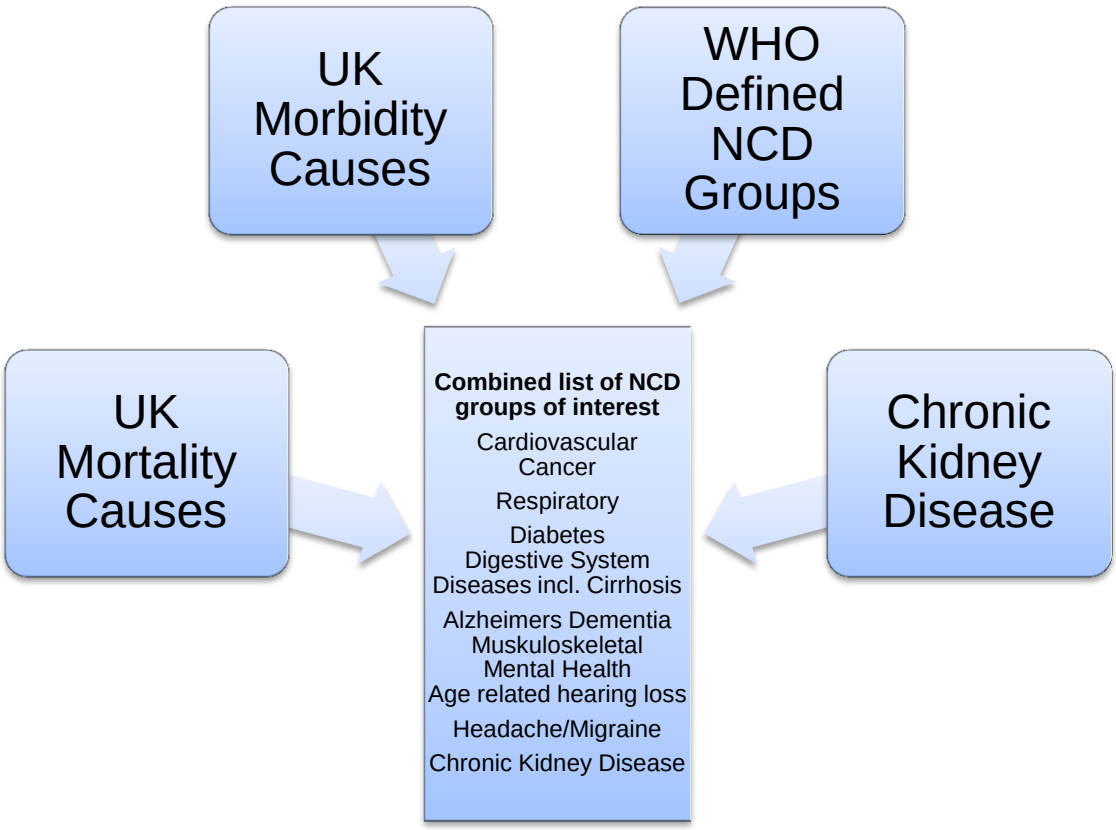


Figure 2. Combined list of NCD groups of interest

Primary Outcomes

- The change in number of number of emergency admissions and finished consultant episodes of care associated with each group of NCDs over the period 1998-2019

Secondary Outcomes

- Individual ICD-10 coded NCDs responsible for greatest change in number of emergency admissions and finished consultant episodes of care 1998-2019

- Individual ICD-10 coded NCDs with the greatest change in proportion of admissions that are emergency admissions
- Change in age profile of those admitted due to NCDs compared with background change in general population
- Individual ICD-10 coded NCDs responsible for the greatest number of admissions and emergency admissions in 15-59 age category
- Change in the number of ICD-10 coded NCDs recorded as secondary diagnoses as a measure of the changing comorbidity profile of patients admitted to hospital
- Comparison with other internationally available datasets to place UK trends in broader context
- Comparison to all infectious, top five infectious and sepsis specific ICD-10 coded episodes causing admission for context

Processing

We will extract the relevant data about number of episodes, type of episode and age profile per disease group for the years 1998 – 2019. We will group these conditions into the main NCD causes of premature mortality as defined by the WHO and GBD study. We will analyse the trend in emergency admissions and total number of FCEs caused by the main NCD disease groups over time to see if there is a change in proportion of emergency admissions and if there is a change in the age demographic of those who are being admitted.

We will use the total number of times ICD-10 codes for the main groups of NCDs appear in an episode and subtract the number of times it is recorded as the primary diagnosis giving the number of times a patient was admitted with an NCD as a comorbidity.

We will calculate the number of episodes of care caused by all infectious diseases, the top five most common infections and specifically by sepsis. To do this we will extract the number of episodes of care coded explicitly as sepsis and use this as a lower bound estimate that is likely to under represent

the true figure. We will then calculate the number of admissions due to any infectious disease as an upper bound.

We will also calculate the total number of male and female admissions and hospital episodes, the total number of admissions and episodes when all age categories are summed together and compare with the official total to assess the completeness of the HES dataset.

Statistical Analysis

Data will be held in Office Excel 2007 (Microsoft; Redmond WA) and analysed in R (R core team; v). We will use a linear regression model to compare the changes in demographics of those admitted and the population demographics.

Exploratory Analysis

We will list the individual ICD-10 codes for the top 20 NCDs causing the most admissions, most emergency admissions and that have seen the greatest increase in admissions. We will also analyse which ICD-10 codes have seen the largest change in demographics of those patients admitted over the period observed.

We will describe the ICD-10 coded NCDs that are responsible for the greatest number of admissions in the 15-59 age.

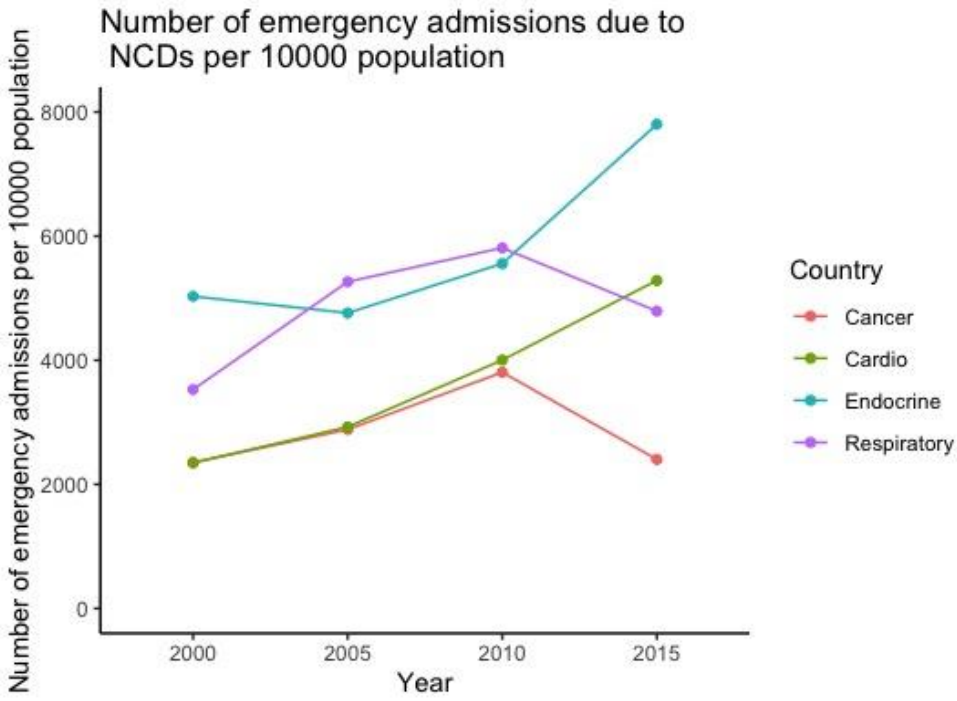
ONS statistics on the population and predicted demographic changes will be used to compare the current trends in the age of those admitted and allow projection of the future admissions profile based on the number of admissions per age group.

Sample Figures

Primary Outcome:

NCD Group	ICD-10 codes associated	Number of emergency admissions	Change in emergency admissions 1998-2019 (%)	Proportion of admissions as emergency (%)	Change in proportion of emergency admissions 1998-2019 (%)
Cardiovascular	I00-I99				
Respiratory	J40-J47				

Table 1. Primary outcome change in number of emergency admissions and proportion emergency for each NCD group 1998-2019



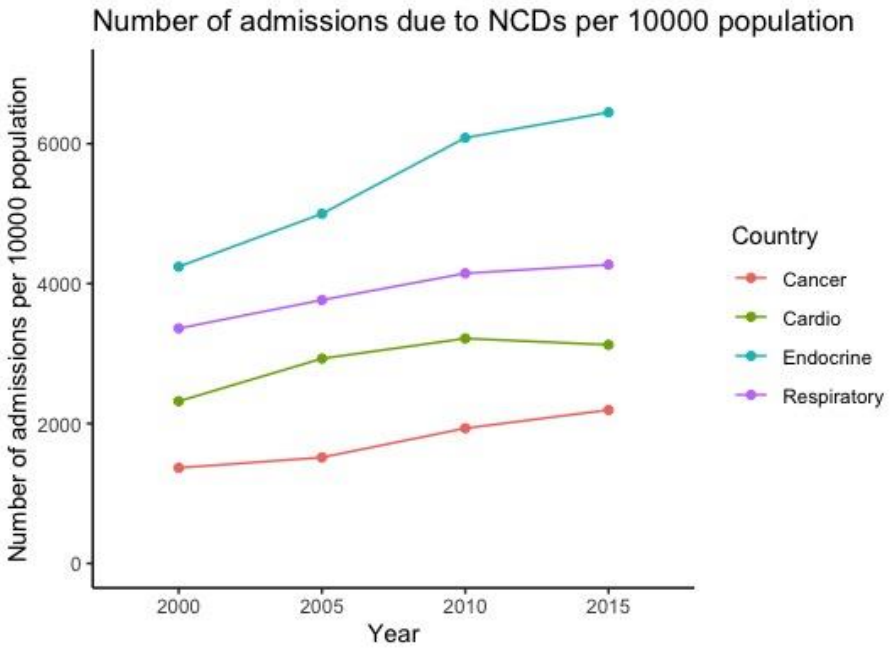


Fig 3.1 & 3.2 Primary outcome graphs - Change in emergency admissions and total admissions over time (additional figures to compare the number of admissions caused by NCDs as a proportion of total admissions for context)

Secondary Outcomes:

Rank	ICD-10 Code	Disease Description	Number of emergency admissions	Change in number of emergency admissions (%)
1	I50	Heart Failure – Ischaemic Heart Disease	xxxx	
2				

Table 2. ICD-10 coded diseases responsible for most emergency admissions.

Rank	ICD-10 Code	Disease Description	Proportion of emergency admissions (%)	Change in proportion of emergency admissions (%)
1	I50	Heart Failure	xxxx	
2				

Table 3. ICD10 coded diseases ranked by greatest proportion of emergency admissions

Rank	ICD-10 Code	Disease Description	Number of emergency admissions in 15-59 age group	Change in number of emergency admissions (%)	Number of FCE in 15-59 age group	Change in number of FCE in 15-59 age group (%)
1	I50	Heart Failure	xxxx			
2						

Table 4. ICD-10 coded diseases responsible for most emergency admissions and FCE in the 15-59 age group

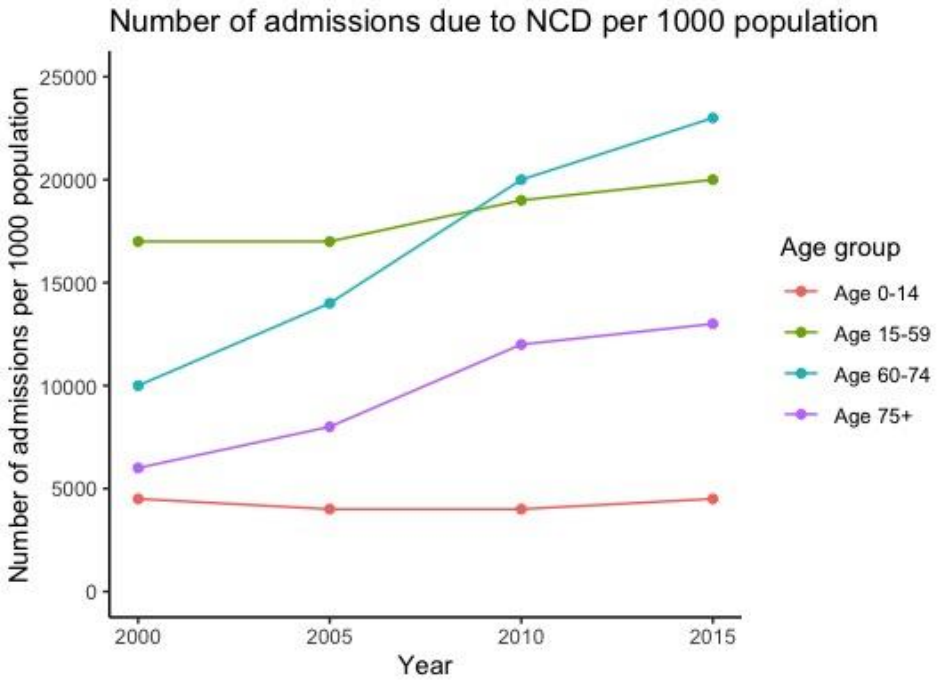


Fig 4. Change in the number of admissions associated with each NCD for each age group. Separate graphs for each group of NCDs

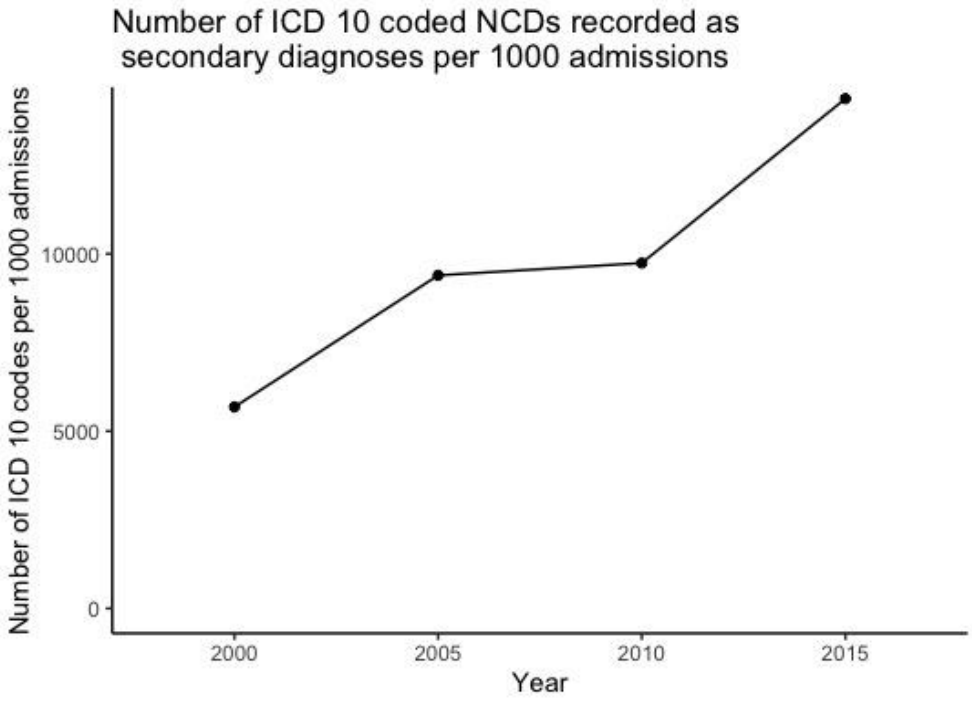


Figure 5. Number of ICD 10 codes associated with comorbidity recorded as secondary diagnoses in admitted patients for all admissions 2012-2019

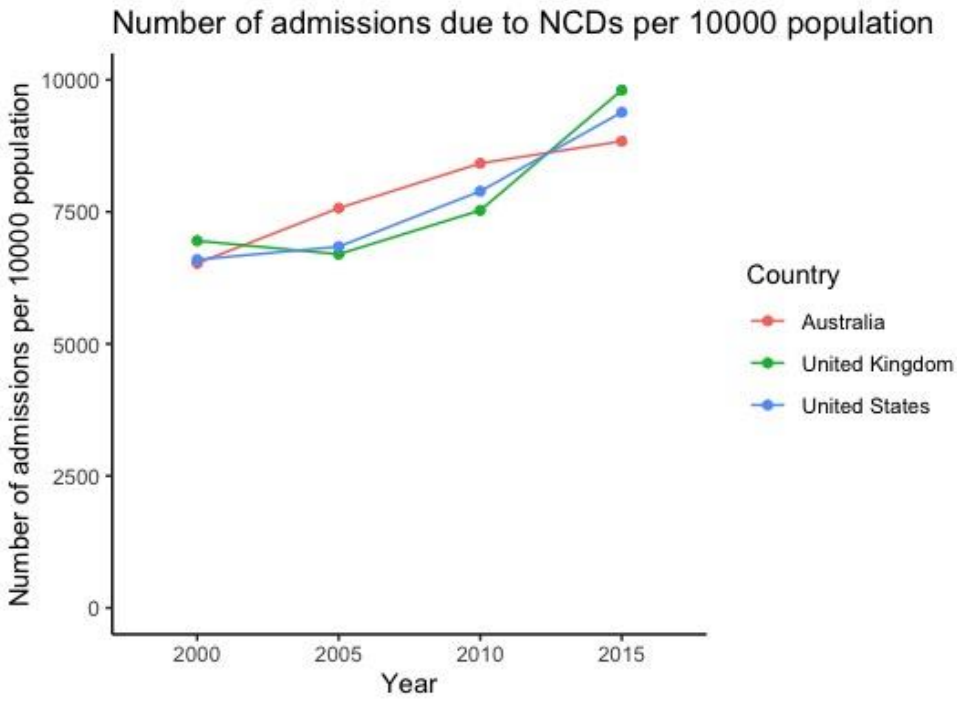


Figure 6. Comparison of number of emergency admissions due to NCDs per 10000 population for other countries in stage 4 of demographic transition model

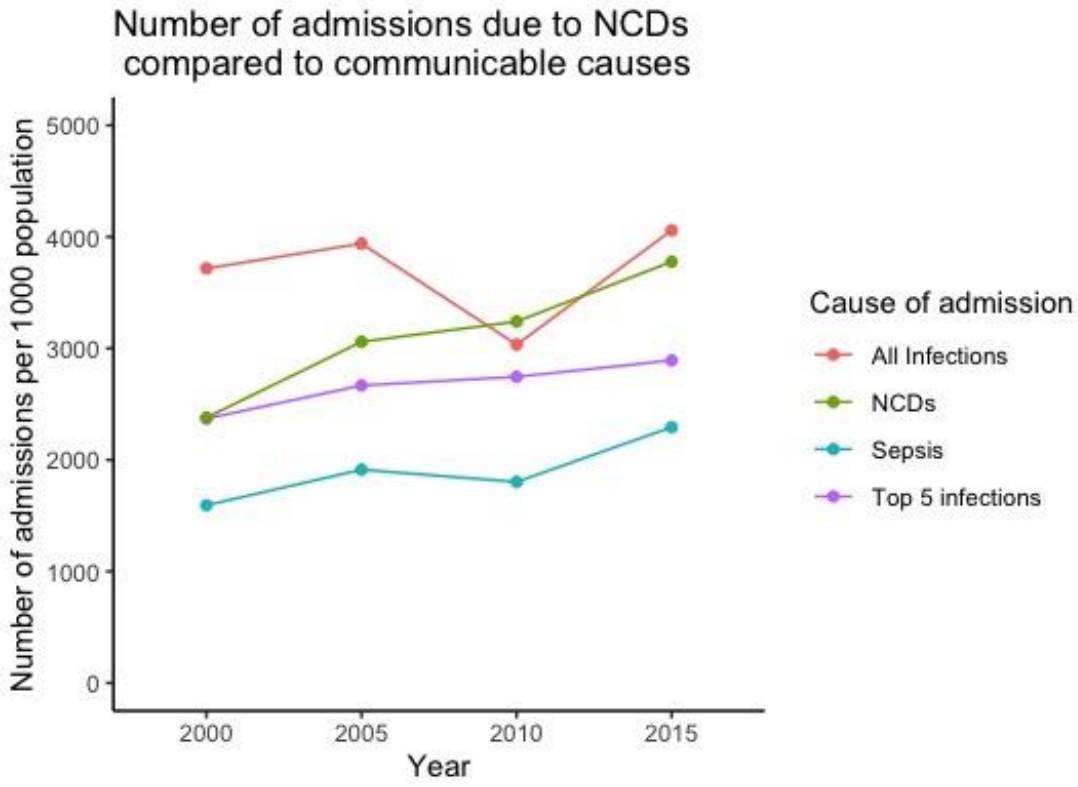


Figure 7. Comparison of the change in number of admissions due to NCDs with total number of admissions for all infections, sepsis specific ICD-10 codes and the five most common infections

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