Spatial distribution of non-communicable diseases; a case of Ischaemic Heart Diseases, Cancer and Diabetes in Sri Lanka

Distribuição espacial de doenças não transmissíveis; um caso de Doenças Isquêmicas do Coração, Câncer e Diabetes no Sri Lanka

Distribución espacial de las enfermedades no transmisibles; un caso de Cardiopatías Isquémicas, Cáncer y Diabetes en Sri Lanka

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Hansa Jayarathe Andradige
PhD Scholar, MA in Demography
Institution: Western Sydney University
Address: New South Wales, Australia
E-mail: 90953663@westernsydney.edu.au

Liwan Liyanage
PhD in Mathematics
Institution: School of Computer, Data and Mathematical Sciences, Western Sydney University
Address: New South Wales, Australia
E-mail: l.liyanage@westernsydney.edu.au

ABSTRACT
The abstract provides a comprehensive overview of the global prevalence of non-communicable diseases (NCDs) and their impact on public health, emphasizing their leading role in morbidity and mortality worldwide. It highlights the specific burden of Ischaemic heart diseases, cancers, and diabetes, with a significant portion of premature deaths occurring in low- and middle-income countries. Transitioning to Sri Lanka, the abstract underscores the country’s shift towards NCDs as the primary health concern, attributing over 80% of premature deaths to these diseases. The narrative emphasizes the influence of rapid lifestyle changes and socio-economic development on the rise of NCDs in Sri Lanka and emphasizes the urgent need for comprehensive research to understand trends, patterns, and contributing factors for effective preventive measures.

Keywords: non-communicable diseases, spatial distribution, mortality, prevalence.

RESUMO
O resumo apresenta uma visão geral abrangente da prevalência global das doenças não transmissíveis (DNTs) e seu impacto na saúde pública, enfatizando sua função principal na morbidade e mortalidade em todo o mundo. Ele destaca a carga específica de doenças isquêmicas do coração, cânceres e diabetes, com uma parcela significativa de mortes prematuras ocorrendo em países de baixa e média renda. Ao fazer a transição para o Sri Lanka, o resumo ressalta a mudança do país para as DNTs como a principal preocupação de saúde, atribuindo mais de 80% das mortes prematuras a essas doenças. A narrativa
enfatiza a influência das rápidas mudanças no estilo de vida e do desenvolvimento socioeconômico no aumento das DNTs no Sri Lanka e destaca a necessidade urgente de pesquisas abrangentes para entender as tendências, os padrões e os fatores contribuintes para medidas preventivas eficazes.

Palavras-chave: doenças não transmissíveis, distribuição espacial, mortalidade, prevalência.

**SUMMARY**

The summary offers a global view of the worldwide prevalence of non-communicable diseases (NCDs) and their impact on public health, emphasizing their role as leading causes of morbidity and mortality worldwide. Ischaemic heart diseases, cancers, and diabetes are the most prevalent. It then transitions its focus on Sri Lanka, where NCDs have overtaken communicable diseases as the primary health concern, attributing more than 80% of premature deaths to these diseases. The summary highlights the impact of rapid lifestyle changes and socio-economic development on the rise of NCDs in Sri Lanka.

**Palabras clave**: enfermedades no transmisibles, distribución espacial, mortalidad, prevalencia.

1 **INTRODUCTION**

The background provides an overview of the global prevalence of non-communicable diseases (NCDs), highlighting their status as leading causes of morbidity and mortality worldwide, with Ischaemic heart diseases, cancers, and diabetes being the most prevalent. It then transitions its focus on Sri Lanka, where NCDs have overtaken communicable diseases as the primary health concern, with over 80% of premature deaths attributed to NCDs. The introduction highlights the impact of rapid lifestyle changes and socio-economic development on the rise of NCDs in Sri Lanka.

1.1 **GLOBAL PREVALENCE OF NCDS**

Non-communicable diseases are the leading causes of morbidity and mortality around the world, revealing a huge public health issue. Between 1990 and 2015, NCDs claimed the lives of 41 million individuals worldwide, accounting for 71% of all deaths. Sixteen million people die from NCDs before they reach the age of 70, with 82
percent of these “premature” fatalities occurring in low- and middle-income nations. Ischaemic heart diseases account for most NCD deaths, or 17.9 million people annually, followed by cancers (9.3 million), and diabetes (1.5 million) (World Health Organization, 2021)

The growth of noncommunicable diseases as a public health problem is influenced by rapid changes in demography, as well as social and economic development. This is no longer limited to developed nations. It also applies to developing countries in Southeast Asia. Noncommunicable diseases are a major and growing burden on South-East Asia's health and development. “Globally, NCD deaths are projected to increase by 15 percent between 2010 and 2020 (to 44 million deaths) with an estimated 10.4 million deaths in South-East Asia.” (WHO, 2021). The high rate of premature mortality from NCDs (deaths before the age of 70) in several low- and middle-income nations is particularly concerning. The majority of the world's population has experienced dramatic changes in disease profiles and health status, with a shift away from infectious diseases and nutritional deficiencies and toward a predominance of chronic lifestyle diseases (WHO, 2020).

1.2 NON-COMMUNICABLE DISEASES IN SRI LANKA

Sri Lanka has made considerable strides from its initial focus on control of communicable disease, maternal and child health, and virtually eliminating vaccine-preventable diseases. Chronic non-communicable diseases (NCDs) have now become the primary causes of mortality and, morbidity in Sri Lanka, surpassing communicable diseases as the major health problem.

According to World Health Organization 2020, more than 80 percent of the premature deaths have occurred due to NCDs. Among them nearly one third of the deaths have occurred due heart diseases. Second and the third highest number of premature deaths have occurred due to the cancers and diabetes. The deaths occurred due to non-communicable diseases in Sri Lanka could be identified. The deaths have gradually increased from year 2011 to 2019 and increasing trend could be identified. Number of male deaths have recorded higher compared to the female deaths throughout the years.
The following major chronic NCDs have a significant disease burden in Sri Lanka, Ischaemic heart diseases, diabetes, and cancers. Many of these disease burdens occur in the productive mid-life period. In Sri Lanka, NCDs are on the increase due to a rapid transition in lifestyle. Consumerism and lifestyle changes that are resulting from social and economic transition are strongly linked to higher NCD risk in Sri Lanka (WHO, 2018). The absence of well-established disease surveillance mechanism and positive health seeking behaviour prevents precise estimation of the size of NCD burdens. These NCDs are largely preventable, hence this study attempts to. Identify the spatial distribution of the non-communicable diseases i.e. cancer, diabetes and heart diseases in Sri Lanka.

2 DATA AND METHODS

Vital statistics are used to identify the trends and patterns, and to analyse the hotspots (geographic regions) based on mortality of these diseases. Vital statistics are derived from the Civil Registration System (CRS) maintained by Registrar Generals Department and customarily tabulated according to the year of registration. Therefore, the number of occurrences of a vital event for a given year refers to the number of occurrences registered in that particular year. According to the law, registration of vital events is done at the place of occurrence. However, certain tabulations were prepared comply with the usual residence of deceased in case of deaths. Causes of death (COD) information are extracted from the Death Declaration for hospital deaths, Verbal Autopsy for home death or Coroner Report for sudden deaths. Civil registration activities have been decentralized up to the Divisional Secretariat level. Vital statistics are available only up to 2014 in Sri Lanka. Cause of death data by age, sex, and district from 2012 to 2014 have been taken from Registrar Generals Department for the study.

The study as calculated several rates related to mortality and morbidity to examine the trends and patterns of the existing non-communicable diseases. These calculations include prevalence rate and the cause specific death rates. Prevalence rate is the proportion of persons in a population who have a particular disease or attribute at a specified point in time or over a specified period of time. Prevalence differs from incidence in that prevalence includes all cases, both new and pre-existing, in the population at the specified time, whereas incidence is limited to new cases only. Prevalence rates will be calculated for selected three diseases for 2019 by districts.
Number of diagnosed cases from a disease will be taken from hospital statistics for the numerator while mid-year population will be taken from the Department of Census and Statistics as denominator.

Further, cause specific death rates (CSDR) are calculated for Sri Lanka. CSDR is the number of deaths from a specified cause per 100,000 person-years at risk. The numerator is typically restricted to resident deaths in a specific geographic area (country, state, county, etc.). Cause-specific death rates can be adjusted for the age and sex composition, or other characteristics of the population. The cause specific death rates by age and sex will be calculated for this study. Simply CSDR is defined as the number of deaths occurred due to a specific cause in a given year per 100,000 midyear population in the same year.

Vital statistics of deaths by cause obtained from Registrar Generals Department, Sri Lanka from 2012 -2014 and midyear population data will be used from Department of Census and Statistics. Cause specific death rates will also be used to measure the severity of the diseases for 2014. CSDR by districts would identify the hotspots of these diseases. Calculated prevalence rates and cause specific death rates by regions is further presented in maps to identify the high risk and low risk areas for each disease. Data would be visualized using ArcGIS mapping to distinguish the variations and the hotspots within the country.

3 RESULTS AND DISCUSSION

This chapter would examine the hotspots of NCDs based on mortality of these diseases in order to identify highly vulnerable districts in Sri Lanka for different diseases. The results are presented separately for the three non-communicable diseases, where the vulnerable districts for each disease have also been discussed separately. Supporting evidence from previous studies have also been incorporated to the discussion section to improve the credibility and the validity of the results.
Ischaemic heart disease is the leading cause of death, with 8,121 deaths recorded, accounting for 15.1% of all deaths. Zoonotic and other bacterial diseases, neoplasms, and diseases of the respiratory system follow closely behind as significant contributors to mortality. Ischaemic heart disease also has the highest mortality rate per 100,000 individuals, with 37.2 deaths per 100,000.

Diseases of the respiratory system, pneumonia, and pulmonary heart disease are also notable contributors to mortality, with mortality rates ranging from 18.7 to 26.4 deaths per 100,000. Traumatic injuries, diseases of the nervous system, and diabetes mellitus contribute to mortality but have lower proportions and mortality rates compared to the leading causes.

Addressing the leading causes of death, particularly ischaemic heart disease, zoonotic diseases, and neoplasms, should be prioritized in public health interventions. Strategies to prevent and manage respiratory diseases, pneumonia, and diabetes mellitus are also crucial for reducing mortality rates. In the provided data on causes of death, while diabetes mellitus has a relatively low proportion of mortality and a modest death rate per 100,000 individuals, it remains a significant concern due to its high prevalence and its impact on other diseases, particularly ischaemic heart disease. Despite its lower mortality rate compared to leading causes such as ischaemic heart disease, neoplasms, and respiratory diseases, diabetes mellitus warrants attention due to its widespread prevalence and its role as a risk factor for other serious conditions, notably heart diseases.
Table 1: Hospital Deaths and Case Fatality Rates Non-Communicable Diseases, 2018 - 2019

<table>
<thead>
<tr>
<th>Disease and ICD Code</th>
<th>Deaths 2018</th>
<th>Case Fatality Rate 2018</th>
<th>Deaths 2019</th>
<th>Case Fatality Rate 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Diabetes mellitus (E10 - E14)</td>
<td>365</td>
<td>344</td>
<td>0.76</td>
<td>339</td>
</tr>
<tr>
<td>Essential hypertension (I10)</td>
<td>265</td>
<td>296</td>
<td>0.6</td>
<td>267</td>
</tr>
<tr>
<td>Other hypertensive diseases (I11 - I15)</td>
<td>41</td>
<td>35</td>
<td>0.91</td>
<td>43</td>
</tr>
<tr>
<td>Ischaemic heart diseases (I20 - I25)</td>
<td>4,233</td>
<td>3,176</td>
<td>5.42</td>
<td>4,584</td>
</tr>
<tr>
<td>Cerebrovascular diseases (I60 - I69)</td>
<td>2,289</td>
<td>1,651</td>
<td>7.08</td>
<td>2,396</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary diseases (J40 - J44)</td>
<td>1,147</td>
<td>180</td>
<td>2.97</td>
<td>1,158</td>
</tr>
<tr>
<td>Asthma (J45 - J46)</td>
<td>261</td>
<td>311</td>
<td>0.33</td>
<td>267</td>
</tr>
<tr>
<td>Alcoholic liver diseases (K70)</td>
<td>234</td>
<td>19</td>
<td>8.85</td>
<td>164</td>
</tr>
<tr>
<td>Other diseases of liver (K71 - K76)</td>
<td>1,154</td>
<td>522</td>
<td>11.22</td>
<td>1,294</td>
</tr>
<tr>
<td>Neoplasms (C00 - D48)</td>
<td>3,223</td>
<td>2,566</td>
<td>3.66</td>
<td>3,462</td>
</tr>
<tr>
<td>Renal failure (N17 - N19)</td>
<td>1,282</td>
<td>695</td>
<td>2.13</td>
<td>1,435</td>
</tr>
</tbody>
</table>

Source: Ministry of Health, Sri Lanka, 2019

The table 1 presents hospital deaths and case fatality rates for various non-communicable diseases (NCDs) for the years 2018 and 2019. The case fatality rate and the deaths for diabetes mellitus, Ischaemic heart diseases and neoplasms remained relatively stable between 2018 and 2019. Overall, the data indicates varying case fatality rates for different NCDs, with some diseases showing stable rates over the two years while others displaying slight fluctuations.

Table 2: Hospital Deaths and Case Fatality Rates of Selected Non-Communicable Diseases by district 2019

<table>
<thead>
<tr>
<th>Districts</th>
<th>Neoplasms</th>
<th>Diabetes mellitus</th>
<th>Ischaemic heart disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Live</td>
<td>Deaths</td>
<td>Case Fatality Rate</td>
</tr>
<tr>
<td></td>
<td>Discharges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombo</td>
<td>66,728</td>
<td>2,527</td>
<td>3.65</td>
</tr>
<tr>
<td>Gampaha</td>
<td>4,498</td>
<td>294</td>
<td>6.14</td>
</tr>
<tr>
<td>Kalutara</td>
<td>2,280</td>
<td>69</td>
<td>2.94</td>
</tr>
<tr>
<td>Kandy</td>
<td>22,290</td>
<td>705</td>
<td>3.07</td>
</tr>
<tr>
<td>Matale</td>
<td>836</td>
<td>68</td>
<td>7.52</td>
</tr>
<tr>
<td>Nuwara Eliya</td>
<td>1,058</td>
<td>44</td>
<td>3.99</td>
</tr>
<tr>
<td>Galle</td>
<td>14,939</td>
<td>502</td>
<td>3.25</td>
</tr>
<tr>
<td>Matara</td>
<td>848</td>
<td>75</td>
<td>8.13</td>
</tr>
<tr>
<td>Hambantota</td>
<td>655</td>
<td>38</td>
<td>5.48</td>
</tr>
<tr>
<td>Jaffna</td>
<td>5,659</td>
<td>171</td>
<td>2.93</td>
</tr>
<tr>
<td>Kilinochchi</td>
<td>447</td>
<td>9</td>
<td>1.97</td>
</tr>
<tr>
<td>Mullaitivu</td>
<td>31</td>
<td>3</td>
<td>8.82</td>
</tr>
<tr>
<td>Vavuniya</td>
<td>306</td>
<td>10</td>
<td>3.16</td>
</tr>
<tr>
<td>Mannar</td>
<td>153</td>
<td>6</td>
<td>3.77</td>
</tr>
<tr>
<td>Batticaloa</td>
<td>6,437</td>
<td>56</td>
<td>0.86</td>
</tr>
<tr>
<td>Ampara</td>
<td>334</td>
<td>32</td>
<td>8.74</td>
</tr>
</tbody>
</table>

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The above table provides data on hospital deaths and case fatality rates of selected non-communicable diseases (NCDs) in various districts of Sri Lanka in 2019. The district with the highest number of cancer-related deaths is Colombo, followed by Kandy and Galle. Districts with lower population sizes, such as Mullaitivu and Kilinochchi, also report notable case fatality rates for cancer. Gampaha district has the highest case fatality rate for diabetes mellitus, despite having a relatively low number of deaths compared to other districts. Ratnapura and Kegalle districts also report higher case fatality rates for diabetes compared to the national average. Kurunegala district stands out with the highest number of deaths related to ischemic heart disease. Polonnaruwa district reports an exceptionally high case fatality rate for ischemic heart disease compared to other districts.

There are noticeable regional disparities in case fatality rates across different districts, indicating variations in healthcare access, quality, and disease management. Some districts with smaller populations report relatively high case fatality rates, suggesting potential issues with healthcare infrastructure or disease awareness. Nationally, ischemic heart disease has the highest number of deaths, followed by cancer and diabetes mellitus. The national average case fatality rates for all three diseases are notable, with ischemic heart disease having the highest rate, followed by cancer and diabetes mellitus. Overall, the analysis of data highlights the need for targeted interventions and improved healthcare infrastructure to address the burden of non-communicable diseases in Sri Lanka, especially in districts with higher case fatality rates and disparities in healthcare access.

Source: Ministry of Health, Sri Lanka, 2019
Map 1: Cause specific death rate (Cancer) in Sri Lanka by districts, 2012-2014

When focusing on the purpose of the study and considering the three diseases, map 1 illustrates the number of deaths caused by Cancer on a district basis in Sri Lanka from 2012-2014 respectively. Highest number of deaths due to cancer in 2012 were reported from Jaffna, Matale, Kandy and Colombo but in 2013 it is noted as Jaffna, Vauniya and Kandy. In 2012, though the Ratnapura and Monaragala reported a smaller number of deaths, it has been increased in the year 2013 to a moderate level. When 2014
is considered, it is noticeable that the highest number of deaths were reported from the districts of Jaffna, Matale, Kandy and Colombo. The least number of deaths were reported from the districts of Kilinochchi, Mannar, Mulattive, Vavuniya, and Polonnaruwa. The rest of the districts account for a moderate number of deaths.

Academic studies such as "Geographical Patterns of Cancer Incidence in Sri Lanka" (Fernando et al., 2020) has also provided insights into the epidemiological factors influencing cancer prevalence and mortality rates in specific regions. Factors such as lifestyle habits, environmental pollution, access to healthcare facilities, and genetic predispositions have identified as the contributing factors to the observed patterns.

Map 2: Cause specific death rate (Diabetes) in Sri Lanka by districts, 2012 -2014
Map 2 demonstrates the deaths caused as a result of diabetes by districts in Sri Lanka. Highest number of deaths due to diabetes in 2012 were reported from Jaffna, Kandy, Gampaha, and Colombo. Anuradhapura, Matale, Kegalle, Galle and Hambanthota show a moderate level of deaths. In 2013, Jaffna and Gamapaha have reduced a number of deaths due to diabetes. Accordingly, the highest number of deaths have been reported in 2014 from the districts of Gampaha, Colombo and Kandy. The districts of Jaffna, Matale, Kalutara, Galle, Rathnapura, and Hambantota depicts a moderate number of deaths. Moreover, all the other districts account for the least number of deaths. However, many districts have the least number of deaths compared to other two diseases.

Higher mortality rates in urbanized districts like Colombo, Kandy, and Gampaha can be associated with lifestyle factors such as sedentary behavior, unhealthy diet, and obesity. Academic research such as "Prevalence and Determinants of Diabetes Mellitus among Adults in Sri Lanka" has shed light on the prevalence of diabetes and its risk factors in different demographic groups and geographic regions. Access to healthcare services, diabetes management programs, and public health interventions may also influence mortality rates (Katulanda et al., 2012).
Map 3 of Sri Lanka provides information on the number of deaths caused due to heart disease from 2012-2014. The highest number of deaths in 2012 and 2013 were reported from Jaffna and Vauniya which is the northern part of the country. Districts of Kurunegala, Pollonnaruwa, Colombo, Kalutara, Nuwaraeliya and Badulla records moderate level of deaths due to Ischaemic heart diseases for year 2012 and 2013. As per
the data given in the map, more than 150 deaths were reported per 100,000 people from Jaffna, Colombo, Kurunegala, Kandy, Nuwara Eliya and Polonnaruwa districts in 2014. Less than 100 deaths per 100,000 people were reported in Kilinochchi, Mannar, Mulattivu, Anuradhapura, Moneragala and Hambantota districts.

Factors contributing to elevated heart disease mortality rates may include lifestyle choices, socioeconomic status, access to healthcare, and prevalence of risk factors such as hypertension and obesity. Academic studies such as "Epidemiology of Ischemic Heart Disease in Sri Lanka: A Review" (Katulanda et al., 2013) has provided insights into the epidemiological profile of heart diseases and their determinants in Sri Lanka. Public health interventions targeting risk factor modification, health education, and improved access to healthcare services may help mitigate the burden of heart diseases in vulnerable populations.

When comparing the diseases and districts between the two years of 2012 and 2014 we can identify that Jaffna has been reported for the highest prevalence of cause specific deaths for all the diseases. In 2012, Colombo and Kandy districts are also accounted for highest cause specific death rates for cancer and diabetes. By the year 2014, Colombo and Kandy districts have accounted for highest cause specific death rates for all three non-communicable diseases considered in the study. This indicated the necessary to keen observation on the above-mentioned districts. In addition, it can also be observed that Gampaha district has a highest cause specific death rate for diabetes for both years considered. Polonnaruwa and Kurunegala can be identified as newly emerged districts with highest cause specific death rates for heart diseases by the year 2014.

4 LIMITATIONS

It has been observed that the vital statistics in Sri Lanka is readily available for the year 2014 only at present. Even though the deaths are registered within two weeks, it takes a longer period to process and be available for the use. These implications hinder the implementation of policies which address the most recent issues due to the unavailability of the most recent data. This mainly affects when implementing gender-focused policies when there is a lack in the sex-aggregated data to draw conclusions.
5 CONCLUSION AND RECOMMENDATIONS

The conclusion drawn from the presented data and discussion emphasize the critical significance of addressing non-communicable diseases (NCDs) as a major public health challenge in Sri Lanka. The analysis reveals a notable shift in the country's health landscape, with NCDs surpassing communicable diseases as the leading causes of morbidity and mortality. Over 80% of premature deaths are attributed to NCDs, with Ischaemic heart diseases, cancers, and diabetes emerging as the primary contributors.

Highest cancer-related mortality rates were observed in districts such as Jaffna, Matale, Kandy, and Colombo during this period. Notable changes in mortality rates were observed over the years, with some districts showing an increase or decrease in the number of cancer-related deaths. Generally, districts in the Northern and Central provinces reported higher mortality rates compared to districts in the Eastern and Southern provinces. Districts such as Jaffna, Kandy, Gampaha, and Colombo consistently reported higher numbers of diabetes-related deaths during this period. Some fluctuations in mortality rates were observed over the years, with certain districts showing changes in the number of deaths attributed to diabetes. Overall, many districts had relatively lower mortality rates compared to cancer and heart diseases. Districts such as Kurunegala, Polonnaruwa, Colombo, Kalutara, Nuwara Eliya, and Badulla recorded moderate levels of deaths from heart diseases during these years. In 2014, districts like Jaffna, Colombo, Kurunegala, Kandy, Nuwara Eliya, and Polonnaruwa reported more than 150 deaths per 100,000 people from heart diseases. Conversely, districts like Kilinochchi, Mannar, Mulattivu, Anuradhapura, Moneragala, and Hambantota had less than 100 deaths per 100,000 people attributed to heart diseases. Overall, the maps highlight the geographical variation in mortality rates from cancer, diabetes, and heart diseases across different districts of Sri Lanka during the specified period.

The observed mortality patterns by districts highlight the pressing need for targeted interventions and policies aimed at mitigating the burden of NCDs, particularly in vulnerable populations and regions identified as hotspots. The study emphasizes the importance of understanding the underlying factors driving NCD prevalence and mortality rates, including lifestyle changes, access to healthcare, and socio-economic disparities. Moreover, it highlights the significance of evidence-based research and public health initiatives in informing effective strategies for prevention, early detection, and management of NCDs in Sri Lanka. By addressing these challenges comprehensively,
policymakers and healthcare stakeholders can work towards reducing the burden of NCDs and improving the overall health outcomes of the population. The discussion based on academic research emphasizes the importance of understanding the multifactorial nature of NCDs and their geographical distribution. Addressing NCDs requires a comprehensive approach involving health promotion, disease prevention, early detection, and effective management strategies tailored to the specific needs of different regions and population groups in Sri Lanka.
REFERENCES


