NCD

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Submission date: 25-Feb-2024 02:01AM (UTC+0530)
Submission ID: 2303309138
File name: Manuscript_NCD_2.25.24.docx (447.98K)
Word count: 7042
Character count: 44132

Patterns of Hypertension, Diabetes, and Hypercholesterolemia: A Cross-Sectional Study Across Six Southeast Asian Nations

Summary

Background

NCDs stand as the primary cause of mortality globally and pose an increasingly significant health concern. Our objective was to evaluate the prevalence and factors influencing behavioral and biological risk factors linked to certain noncommunicable diseases (NCDs), namely hypertension, diabetes, and hypercholesterolemia, across Southeast Asian regions (SEARs).

Methods

We utilized the most recent WHO STEPwise approach to NCD risk factor surveillance (STEPS) survey from six SEARs cross-sectional studies. Our analysis focused on three primary types of NCDs. Initially, we conducted cross-tabulation and Chi-square tests to evaluate the prevalence of NCDs and their associations among participants across various countries, as well as in the pooled dataset encompassing all six countries.

Findings

This study observed elevated rates of hypertension, diabetes, and hypercholesterolemia in Timor-Leste (39.30%), Bangladesh (8.30%), and Myanmar (36.70%), respectively. Conversely, lower rates were noted in Maldives (19.07%), Timor-Leste (1.50%), and Nepal (11.19%), respectively. The pooled analysis conducted in these countries revealed prevalence rates of 28.76% for hypertension, 5.76% for hyperglycemia, and 32.15% for hypercholesterolemia.

Interpretation

The study highlighted a concerning elevation in the prevalence of NCDs and their associated risk factors within certain SEARs. It underscores the imperative for concerted efforts to develop comprehensive national action plans aimed at addressing the mounting burden of NCDs.

Funding None.

Introduction

Non-communicable diseases (NCDs), such as cardiovascular diseases, cancer, respiratory conditions, and diabetes mellitus, persist over time due to a complex interplay of genetic, physiological, environmental, and behavioral risk factors [1]. Furthermore, these diseases are progressively emerging as prominent factors contributing to morbidity and mortality in low- and middle-income countries (LMICs) [2], [3], [4], [5]. As per the World Health Organization (WHO) assessments, NCDs account for 71% of total global fatalities. Approximately 85% of premature deaths in LMICs, and within this demographic, 61% of the deaths affect individuals below the age of 70 [6]. In 2012, NCDs led to a total of 277,500 fatalities, equating to a mortality rate of 564.1 per 100,000 in males and 531.9 per 100,000 in females [7]. Numerous conducted studies have determined that socio-demographic characteristics play a role in the variation of NCD risk factors [8–12]. In addition, according to WHO's Global Health Risks Report, the primary global risk factor for NCDs in terms of attributable deaths is elevated blood pressure, responsible for 13% of global fatalities. Tobacco use (9%), elevated blood glucose (6%), physical inactivity (6%), and overweight/obesity (5%) are notable risk factors.

The risk factors associated with these significant NCDs are extensively documented and commonly shared by WHO [1]. In LMICs, a notable increase in NCD risk factors is attributed to behavioral (smoking, alcohol, unhealthy diet, physical inactivity) and biological factors (elevated BP, blood glucose, cholesterol, overweight) [8] [9]. Furthermore, the likelihood of non-communicable diseases (NCDs) advancing is noted to escalate when multiple risk factors coexist in an individual, a phenomenon termed clustering [10]. The World Health Report 2002 emphasized the importance of concentrating on risks and risk factors for both assessment and interventions. In the adult population of the South Asian Region (SAR), there is a clustering of risk factors for NCDs, and this clustering becomes more apparent as individuals age. In the South Asia Region, cardiovascular diseases, cancer, diabetes, and chronic respiratory diseases, primarily, pose a significant and escalating challenge to health and development [11]. In Bangladesh, Bhutan, Myanmar, Nepal, and Cambodia, hypertension and central obesity prevail as major risk factors. Vietnam and Pakistan face hypertension and total cholesterol as predominant risks, while Timor-Leste sees hypertension and diabetes as prevalent. In the Lao People's Democratic Republic, total cholesterol and overweight/obesity are prominent risk factors. Sri Lanka reports hypertension and diabetes as top risk factors [12] [13].

The Southeast Asian regions (SEARs) have witnessed a concerning proliferation of NCDs, marked by a pronounced surge in NCD-related fatalities between 2000 and 2012, surpassing other global regions. Currently, the region contends with an annual toll exceeding 8.5 million deaths attributable to NCDs [14]. In 2021, NCDs accounted for nearly two-thirds of all deaths within countries comprising the WHO SEAR, with half of these fatalities occurring among individuals aged 30–69 years [15]. Predominantly, NCD-related mortality is attributed to cardiovascular diseases (CVDs), followed by cancers, chronic respiratory diseases, and diabetes. Particularly susceptible are the region's impoverished populations, predisposed to bearing the brunt of NCDs, thereby exacerbating health and socioeconomic disparities. This escalating trend is chiefly propelled by factors including urbanization, economic advancement, and globalization, precipitating the adoption of unhealthy lifestyle practices among the populace. These practices include consumption of nutritionally deficient diets, sedentary behaviors, and tobacco use, culminating in heightened susceptibility to NCDs [16].

The confluence of communicable diseases and NCDs presents a formidable obstacle for the already fragile healthcare systems and constrained health budgets prevalent in Southeast Asia [17], [18]. Compounded by the region's historical focus on infectious diseases and acute care, healthcare infrastructures are inadequately equipped to address the escalating demand for chronic care services [17], [19]. midst of the persisting challenges in maternal and child health, coupled with the resurgence of communicable diseases, SEARs have increasingly prioritized NCDs on their public health agendas. This shift is underscored by substantial political advocacy efforts, bolstered by support from the World Health Organization (WHO) through guidance and tools like the NCD surveillance dashboard, fostering momentum and enhancing accountability in NCD management. By 2021, ten countries within the region had formulated integrated national action plans for NCDs, aligning with the Sustainable Development Goal (SDG) 3.4 target of a 33.3% reduction in premature NCD mortality by 2030, alongside the establishment of time-bound objectives addressing NCD risk factors and management [20]. The NCD implementation roadmap for Southeast Asia (2022–2030) endeavors to streamline and expedite the deployment of impactful interventions, with a particular emphasis on leveraging digital solutions [21].

In response, the WHO STEPwise approach to NCD risk factor surveillance (STEPS) in 2000. This methodology is centered on acquiring fundamental data related to established risk factors that play a pivotal role in determining the major disease burden [22]. The member states of the WHO have reached a consensus on 25 indicators categorized into three areas. These areas concentrate on crucial outcomes, risk factors, and the necessary national system responses for preventing and managing NCDs. This includes one target related to mortality, six targets about risk factors, and two targets associated with national systems [23]. The WHO STEPS survey comprises three steps: behavioral assessment through questionnaires (STEP 1), identification of anthropometric risk factors through physical measurements (STEP 2), and identification of biochemical risk factors through measurements (STEP 3) [22].

Assessing the prevalence of NCDs and identifying high-risk populations is crucial for developing community-based interventions aimed at reducing risk factors. Currently, there is inadequate information for a comprehensive nationwide comparison of NCD prevalence and associated risk factors in the SEAR. Previous community-based studies in this area have been constrained to specific regions, providing a limited and potentially skewed representation of the overall NCDs scenario [2], [3], [4], [5], [8], [10], [12], [13], [24]. This study aims to assess epidemiological patterns and determinants of behavioral and biological risk factors associated with specific NCDs in SEARs. Moreover, it will help policymakers and planners SEAR take convenient and efficient steps regarding this crucial matter.

Methods

Data source & study design

We utilized data from the latest cross-sectional studies of the STEPS survey, following the standardized approach developed by the WHO for monitoring NCD risk factors in the SEAR. The STEPS survey is a global initiative conducted every three to five years in SEAR countries, employing a consistent protocol. The survey's scope encompasses all men and women aged 18 years or older **(Figure 1)**. It is noteworthy that the study considered individuals living in that country, irrespective of their citizenship status, and excluded only those temporarily visiting (e.g., tourists), residing in military bases or group quarters (e.g., dormitories), or institutionalized (e.g., hospitals, prisons, nursing homes). Essentially, the study aimed to encompass individuals residing across all geographic areas of the country. Samples were collected using a geographically stratified probability-based method with standardized protocols across countries. STEPS surveys follow ethical and technical review processes, seeking approval from national ethics committees. Participants provide oral and written consent, ensuring the survey respects rights and safeguards ethical considerations. Informed consent is obtained from each participant before interviews, adhering to WHO guidelines [22].

Data collection

We sourced the latest STEPS survey data for six SEARs—Bangladesh, Maldives, Myanmar, Nepal, Sri Lanka, and Timor-Leste—from https://extranet.who.int/ncdsmicrodata/index.php/catalog/. Out of 12 potential countries, we focused on these six for our study. These countries were selected based on meeting our inclusion criteria and having current standard STEPS data. Some countries were excluded either because WHO did not conduct a STEPS survey in those areas, or their data was not available in the public domain, lacked sufficient data, and relevant variables, and had unreported non-response rates. Additionally, some survey reports were either not publicly accessible or not in English.

Outcome variables

We examined three categories of outcome variables: raised blood pressure (hypertension), raised blood glucose (diabetes), and raised blood cholesterol (hypercholesterolemia). Each of these outcome variables is binary, designated as "YES = 1/NO = 0 **(Table 1)**.

Hypertension, a significant health risk factor, often shows no symptoms and is known as a "silent killer." Diagnosis requires consecutive systolic blood pressure readings≥140 mm Hg and diastolic readings≥90 mm Hg. Contributing factors include an unhealthy diet, lack of physical activity, tobacco/alcohol use, and being overweight [25]. Blood pressure measurements utilized a digital monitor, with participants resting for 15 minutes. Three readings were taken, and the mean of the second and third readings was calculated. Observations outside the valid range were excluded. If the third reading was invalid, the average of the first two was considered [22]. Diabetes, characterized by elevated blood glucose, results from insufficient insulin production (Type 1) or ineffective use (Type 2), causing damage to vital organs. Type 2 diabetes, prevalent in those aged 35+, is linked to obesity, inactivity, and smoking, with fasting blood glucose≥126 mg/dL or 7 mmol/L indicating diabetes [26]. Lifestyle changes, including regular physical activity, maintaining a healthy weight, nutritious diet, and avoiding tobacco, can prevent or delay Type 2 diabetes onset. Blood glucose levels were assessed with observations falling outside the range of fasting blood glucose <18 mg/dL or >630 mg/dL excluded [22]. Elevated blood cholesterol, defined as a lipid profile ≥190 mg/dL or currently on medication, poses heart disease and stroke risks. Elevated blood cholesterol or hypercholesterolemia is specifically ≥190 mg/dL or 5 mmol/L. Approximately one-third of global ischemic heart disease cases are attributed to high cholesterol. Early detection through regular screening is a key public health strategy [20]. Observations outside the cholesterol range of <75 mg/dL or >470 mg/dL were excluded, with none falling within this range [22].

In addition, due to insufficient measured data on blood glucose in the Maldives, this study employed self-reported blood glucose levels to assess prevalence. Participants were asked, 'Have you ever been informed by a healthcare professional that you have raised blood glucose or diabetes?' Those who responded affirmatively were categorized as diabetic patients or 'Yes'; otherwise, responses were classified as 'No'. Furthermore, the Maldives STEP survey of 2011 did not include reporting on blood cholesterol levels. So, we excluded that from the country-wise analysis and also in the pooled analysis.

Explanatory variables

Sociodemographic details and health measures (tobacco use, diet, physical activity) were collected. Physical assessments included height, weight, and hip/waist circumference using validated instruments, with barefoot participants in light clothing. Physical activity data was transformed into MET minutes per week. Measurements were conducted by trained enumerators and medical technologists with post-graduate qualifications. Staff underwent comprehensive training, including interactive sessions and pilot testing [22] **(Table 2)**.

Statistical Analysis

When analyzing survey datasets, addressing issues like uneven unit selection probabilities is crucial. Sample weights are essential to mitigate bias resulting from disproportionate sampling and non-response, significantly influencing standard error calculations. Excluding weights may lead to biased estimates. Categorical variables were appropriately defined for interpretation. After extracting variables from each country dataset, we analyzed them in two ways. Firstly, we performed a comprehensive analysis using descriptive statistics (percentages) to assess NCD prevalence among participants from different countries and socio-economic backgrounds and health measures. This stage helped us to cross-check the prevalence of each country's reports. Next, we pooled all six countries' data into a single dataset. In STATA, a singleton was introduced to handle a single primary sampling unit (PSU) within a stratum. We chose the singleton (scaled) approach for analysis. We used this method because each country has a different PSU in each study, using singleton (scaled) will provide a single PSU for all countries or combined datasets. In addition, a single PSU in the stratum can occur for various reasons such as missing data. This leads to numerous problems in analyzing the data such as not being able to calculate standard errors [27]. Singleton PSUs also handle those issues and provide standard errors. Cross-tabulation and Chi-square tests evaluated the association, with significance set at $p < 0.05$ and 95% confidence intervals. Informed consent and adherence to ethical guidelines, including the revised declarations of Helsinki, were ensured. Weighted estimates were used for national accuracy, and the STROBE Statement guided study reporting **[Supplementary Table S1]**. All analysis was conducted using STATA 16.

Results

The characteristics of participants in the sample varied across the six countries. After the exclusion of less than 18 years participants, participants had not measured blood pressure, blood glucose, or blood cholesterol, and missing information, the weighted sample size for raised blood pressure ranged from Maldives 1646 to 8483 in Myanmar. For raised blood glucose, the weighted sample size ranged from Maldives 1646 to 8324 in Myanmar, and for raised blood cholesterol 1320 in Maldives and 8333 in Myanmar.

The mean systolic blood pressure exhibited the highest value in the Maldives at 148.83 mmHg (95% CI: 123.95-173.71) and the lowest in Bangladesh at 121.44 mmHg (95% CI: 120.66-122.23). Conversely, the mean systolic blood pressure for the SEAR as a whole was calculated at 127.45 mmHg (95% CI: 125.56-129.37). Similarly, the mean diastolic blood pressure was recorded as highest in the Maldives and lowest in Bangladesh, with values of 104.42 mmHg (95% CI: 79.42-129.41) and 79.21 mmHg (95% CI: 78.66-79.75), respectively. The mean diastolic blood pressure for the SEAR was determined as 82.72 mmHg (95% CI: 81.61-83.83). Moreover, the mean blood glucose and mean blood cholesterol levels were observed to be highest in Bangladesh (97.32 mg/dL) and Myanmar (188.10 mg/dL), respectively, while lowest in Timor-Leste (80.38 mg/dL and 139.69 mg/dL) for both parameters. Conversely, the pooled mean values for blood glucose and blood cholesterol for the SEAR were calculated at 90.98 mg/dL and 180.69 mg/dL, respectively **(Table 3)**.

As **Figure 2** shows, the percentage of participants who have raised blood pressure or hypertension was highest in Timor-Leste (39.30%) and lowest in Maldives (19.07%). The percentage of participants who have raised blood glucose or diabetes was highest in Bangladesh, at 8.30%, and lowest in Timor-Leste, at 1.50%. The percentage of participants who raised cholesterol or hypercholesterolemia was highest in Myanmar, at 36.70%, and lowest in Nepal, at 11.19%.

Table 4 illustrates a clear association between age and the prevalence of raised blood pressure, with an overall increase observed as age advances. Notably, Timor-Leste and Nepal deviate from this trend. Examining the 18-29 age group, we find varying percentages of raised blood pressure across different countries: Maldives (9.42%), Sri Lanka (17.91%), Myanmar (10.13%), Timor-Leste (46.26%), Bangladesh (9.05%), and Nepal (15.74%). In contrast, the 60 years or above age group shows higher percentages in the same countries: Maldives (61.39%), Sri Lanka (54.84%), Myanmar (45.66%), Timor-Leste (38.37%), Bangladesh (37.66%), and Nepal (44.56%). Sri Lankan (27.16%) and Bangladeshi (16.94%) men exhibit the lowest percentage of raised blood pressure, while women have the highest percentage, 28.74%, and 23.40%, respectively. This pattern is reversed in the other four countries. The prevalence of raised blood pressure is highest among individuals with no formal education or basic literacy and the lowest in people of college, university, or postgraduate completion.

Table 5 presents an examination of the prevalence between age and raised blood glucose, revealing a consistent increase as age progresses. Analyzing the 18-29 age group, varying percentages of raised blood glucose are observed lowest across different countries: Maldives (1.87%), Sri Lanka (2.62%), Myanmar (1.12%), Timor-Leste (1.04%), Bangladesh (4.48%), and Nepal (2.40%). In contrast, the 60 years or above age group exhibits higher percentages in the same countries: Maldives (20.49%), Sri Lanka (11.83%), Myanmar (11.49%), Timor-Leste (1.41%), Bangladesh (14.38%), and Nepal (8.00%). Accept Bangladesh and Nepal, men display the lowest percentage of high blood glucose, while women have the highest percentage. The other four countries exhibit the prevalence of raised blood glucose is highest among men and lowest in women. The raised blood sugar is highest among individuals with no formal education or basic literacy in the Maldives (8.41%) and Nepal (15.97%), lowest in Sri Lanka (4.52%), Myanmar (6.03%), Timor-Leste (0.98%) and Bangladesh (8.40%). Conversely, the prevalence is higher in Sri Lanka, Myanmar, Timor-Leste, and Bangladesh for people who achieved higher degrees and that category people faced lower raised blood sugar in Maldives and Nepal.

Table 6 reveals a consistent rise with age increases. Analyzing the 18-29 age group, varying percentages of raised cholesterol are noted across different countries: Sri Lanka (13.44%), Myanmar (20.90%), Timor-Leste (8.48%), Bangladesh (19.42%), and Nepal (6.05%). In contrast, the 60-year-old or above age group displays higher percentages in the same countries: Sri Lanka (14.39%), Myanmar (49.06%), Timor-Leste (18.62%), Bangladesh (35.73%), and Nepal (21.63%). Except Timor-Leste, Sri Lanka, Myanmar, Bangladesh, and Nepal exhibit a noticeable pattern where women have the highest percentage of raised blood cholesterol than men. Notably, except for Sri Lanka and Timor-Leste, the prevalence of raised cholesterol is highest among individuals with no formal education or basic literacy.

Table 7 presents the association between selected risk factors and major NCDs within pooled data from SEARs. In these nations, hypertension, hyperglycemia, and hypercholesterolemia have prevalence rates of 28.76%, 5.76%, and 32.15%, respectively. Among younger individuals (aged 18-29), these rates are notably lower at 14.19%, 1.65%, and 17.91%, respectively, while in the older age group (60 years and above), they peak at 48.04%, 11.37%, and 42.55%, respectively.

Women exhibit higher prevalence rates of hypertension (29.20%), hyperglycemia (6.66%), and hypercholesterolemia (35.99%) compared to men (28.51%, 4.88%, and 28.42%, respectively). Currently, married individuals display higher rates of NCDs compared to unmarried individuals. For instance, hypertension, hyperglycemia, and hypercholesterolemia rates are 29.24%, 5.86%, and 35.24% among married participants, whereas among unmarried individuals, they are lower at 24.89%, 4.31%, and 34.63%, respectively. Regarding employment status, hypertension is more prevalent among unemployed participants (30.14%) than among employed individuals, homemakers, or voluntary workers. Similarly, hyperglycemia is more common among the unemployed, homemakers, or voluntary workers (5.90%) compared to the employed (5.06%). Additionally, hypercholesterolemia rates are higher among homemakers or voluntary workers compared to the employed or unemployed.

The prevalence of NCDs is lowest among daily or regular smokers and highest among non-smokers or irregular smokers, although this difference is not statistically significant. Similarly, the frequency of fruit consumption per week shows no statistical significance. However, hypertension and hyperglycemia rates are highest among those who do not consume fruits weekly, while hypercholesterolemia rates are highest among weekly fruit consumers. Conversely, with vegetable consumption, the highest rates of hypertension and hyperglycemia occur among weekly consumers, while hypercholesterolemia rates are lowest among this group.

Regarding salt intake, hypertension prevalence is highest (43.41%) among those who sometimes or rarely add salt to their meals. Conversely, hyperglycemia and hypercholesterolemia rates are 3.15% and 17.78%, respectively, among those who always add salt. Similarly, the prevalence of hypertension and hyperglycemia is highest among those using coconut, groundnut, sunflower, or mustard oil, while hypercholesterolemia rates are lowest among this group and highest among those using olive, corn, or unspecified oils. Individuals who have not eaten meals outside exhibit the highest prevalence of hypertension, hyperglycemia, and hypercholesterolemia (29.64%, 5.95%, and 32.27%, respectively). In terms of physical activity, those engaged in vigorous or moderate activity show the lowest prevalence of NCDs, with rates of 21.73%, 2.71%, and 22.58%, respectively. Obese individuals demonstrate higher NCD prevalence compared to non-obese individuals, with rates of 56.83%, 11.64%, and 40.46% compared to 26.44%, 5.41%, and 31.39%, respectively.

Discussion

National surveys across the SEAR have provided insights into the prevalence of hypertension and its associated risk factors. This paper synthesizes key findings from these initiatives and surveys, highlighting significant risk factors for major NCDs among Southeast Asians and emphasizing the importance of addressing behavioral factors to prevent and control this widespread health condition. Recent national surveys across the region have revealed varying rates of hypertension prevalence; for instance, 19.07% in Maldives (2011) [28], 30.70% in Sri Lanka (2014) [29], 26.40% in Myanmar (2014) [30], 39.30% in Timor-Leste (2014) [31], 21.00% in Bangladesh (2018) [32], and 26.60% in Nepal (2019) [33] and pooled prevalence is 28.76%.

In this study, significant risk factors for hypertension among Southeast Asians include age, marital status, dietary habits (such as the type of oil used and frequency of meals eaten outside), levels of physical activity (including vigorous exercise and active transport), obesity, and medication use. Additionally, some studies have highlighted statistically significant associations between hypertension and factors like sex, education level, and employment status [34], [35], [36], [37]. Consistent with our findings, previous research has indicated significant correlations between hypertension and marital status, types of oil consumed, and frequency of meals eaten outside [36], [37], [38], [39]. Besides age, behavioral factors emerge as the most crucial and modifiable risk determinants for hypertension. For instance, unhealthy dietary patterns and insufficient physical activity contribute to overweight or obesity, elevated blood pressure, and adverse lipid profiles. These behavioral factors, coupled with tobacco use, account for at least 75% of cardiovascular diseases [40]. Addressing behavioral risk factors, particularly promoting healthy diets and physical activity, holds promise for hypertension prevention. Initiatives aimed at reducing salt intake can significantly contribute to hypertension prevention and control [41], [42], [43], [44]. Notably, high body mass index (BMI) stands out as a well-established risk factor for hypertension, with several studies highlighting its strong association with the condition [40], [45]. In 2018, India and Thailand initiated efforts to intensify their programs aimed at managing hypertension [46], [47]. By 2022, the India Hypertension Control Initiative had enrolled over 6 million individuals for treatment, resulting in notable enhancements in quarterly cohort blood pressure control rates [46]. Thailand's initiative similarly led to the monthly diagnosis of approximately 50,000–70,000 hypertension cases, accompanied by improved blood pressure management at the clinic level [47].

The rise in noncommunicable diseases (NCDs) across the SAR is attributed to a shift in disease patterns from communicable to noncommunicable ailments [48]. Factors contributing to this transition include heightened life expectancy, rapid population expansion, unplanned urbanization, low levels of literacy, and increased external debt leading to reductions in national healthcare expenditure [49]. These collective issues have led to the emergence of significant regional health challenges, notably the prevalence of NCDs such as diabetes. Recent national surveys in the region have revealed varying rates of diabetes prevalence, 3.73% in Maldives (2011) [28], 7.40% in Sri Lanka (2014) [29], 5.90% in Myanmar (2014) [30], 1.50% in Timor-Leste (2014) [31], 8.30% in Bangladesh (2018) [32], 5.76% in Nepal (2019) [33] and pooled rates is 5.76%.

Within this study, several factors including age, sex, education level, marital status, dietary habits (such as extra salt intake and choice of cooking oil), levels of physical activity (including vigorous and moderate activities as well as active transport and leisure activities), obesity, and medication usage were identified as significant risk factors for diabetes among South East Asians. Additionally, some studies have highlighted associations between diabetes and socioeconomic factors such as wealth or income [50], [51], [52], although this relation is not represented in our study due to insufficient data. Consistent with existing research, our findings corroborate associations between diabetes and variables including sex [53], [54], education level [55] marital status [56], [57], adding extra salt, types of oil [58], [59] and office-based occupation [23]. The recent epidemic of diabetes in the region could be primarily due to environmental factors such as diet and physical activity levels coupled with a genetic predisposition [48], [51], [60]. The recent diabetes epidemic in the region is largely attributed to environmental factors such as dietary habits and levels of physical activity, compounded by genetic predisposition [47], [50], [59]. Moreover, increasing age and body weight play significant roles in diabetes susceptibility, with associations observed between diabetes and indices such as body mass index (BMI), waist-hip ratio, and abdominal obesity [60], [61], [62]. These factors contribute to the heightened vulnerability to diabetes and related metabolic abnormalities among South Asians [63].

Hypercholesterolemia, characterized by elevated levels of cholesterol in the blood, is linked to an augmented risk of cardiovascular disease [64]. Its prevalence is escalating in developing nations, contributing to a global upsurge in coronary heart disease [65]. Individuals with familial hypercholesterolemia (FH) face a substantially heightened risk of coronary artery disease, estimated to be ten times greater than that of healthy counterparts [66]. Timely diagnosis and management of FH play a pivotal role in reducing the burden of low-density lipoprotein cholesterol (LDL-C), thereby mitigating the progression of atherosclerosis and improving coronary outcomes. Consequently, screening initiatives employing cascade testing or universal screening methods are recommended to identify FH early and mitigate cardiovascular risk in a considerable portion of the population [67]. Recent national surveys in the region have revealed varying prevalence rates of hypercholesterolemia, 23.70% in Sri Lanka (2014) [29], 36.70% in Myanmar (2014) [30], 21.00% in Timor-Leste (2014) [31], 28.40% in Bangladesh (2018) [32], 11.19% in Nepal (2019) [33] and pooled percentage is 32.15%.

This study identified age, sex, education level, work status, levels of physical activity (both vigorous and leisure), obesity, and medication usage as significant risk factors for hypercholesterolemia among Southeast Asians. However, associations observed with marital status, dietary habits, and modes of physical activity did not attain statistical significance. The positive correlation observed between age and hypercholesterolemia aligns with findings from prior studies [68], [69]. Similarly, the modestly increased risk of hypercholesterolemia associated with lower educational attainment is consistent with existing literature [69], [70]. Lifestyle and behavioral factors among the Southeast Asian population exhibit a notable influence in this study. In Thailand, transitioning towards Westernized lifestyles and behaviors poses challenges in preventing and managing coronary heart disease, along with other conditions prevalent among more sedentary and obese populations [71]. In the Malaysian context, hypercholesterolemia prevalence is reported to be notably high among individuals who are overweight or obese, regardless of gender.

The studies identified several limitations, including the lack of differentiation between various categories within NCDs in Southeast Asian prevalence studies. For instance, while exploring the association with hypertension, distinctions such as primary or secondary, stage 1, or stage 2 were not considered. Similarly, diabetes data were examined in a generalized manner without distinguishing between type 1 and type 2 diabetes. Moreover, the classification of hypercholesterolemia into genetic or acquired forms was not specified. Another limitation was that all studies included in the analysis were community-based surveys, potentially underestimating the true regional burden as hospital admissions and care center data were not accounted for. Additionally, some studies relied solely on self-reported NCDs, and changes in definitions and diagnostic criteria over time may have influenced prevalence rates. However, to present prevalence data for individual countries, only the most recent studies were included, minimizing variations in diagnostic criteria as older studies were excluded.

Despite these methodological limitations, promoting public awareness through health education emerges as a crucial strategy for altering mass dietary habits and tobacco consumption behaviors in the region. Implementing initiatives such as healthy urban community design to encourage walkability and promoting healthy food options in schools and cafeterias could help mitigate the growing obesogenic environment. Tailored intervention programs targeting high-risk groups based on identified risk factors are essential for early detection and treatment of major NCDs.

Conclusion

This study identified the prevalence of major NCDs and their high-risk groups. Common health risk factors such as inadequate consumption of fruits and vegetables, tobacco use, low levels of physical activity, and abdominal obesity prevalent among adults in Southeast Asia. The study outcomes advocate for both individual and collective program interventions, with a particular focus on elderly individuals, women, and urban populations. Moreover, the findings are poised to contribute significantly to the development of comprehensive national action plans aimed at mitigating the escalating burden of NCDs. Hence, a population-based approach utilizing the primary healthcare system is warranted for risk reduction, early detection, and treatment. Given the substantial number of individuals already diagnosed with hypertension and diabetes, hospital-based strategies should also be considered.

Furthermore, non-health sectors should actively participate in preventive efforts targeting specific demographic groups, considering variations in risk factor distribution across rural and urban areas, as well as by gender and socioeconomic status. In addition, a primary strategy for alleviating the burden of NCD risk factors is to prevent or reduce modifiable risk factors, which could be more cost-effective than solely providing curative services. However, addressing modifiable risk factors necessitates collaborative endeavors from multiple sectors to foster an environment conducive to behavior change. The current federal structure, wherein municipalities are responsible for various sectors including health, education, infrastructure, and environment, presents an opportunity for coordinated interventions across sectors, ultimately contributing to the reduction of NCD risk factors in Southeast Asian countries.

Data sharing statement

The data are available on request to the corresponding author.

Declaration of interests

There is no conflict of interest.

Acknowledgements

We gratefully acknowledge the WHO STEPwise approach to NCD risk factor surveillance (STEPS) survey for granting access to the SEARs datasets.

References

[1] WHO, “Noncommunicable diseases.” Accessed: Dec. 02, 2023. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

[2] A. Boutayeb, “The double burden of communicable and non-communicable diseases in developing countries,” *Trans R Soc Trop Med Hyg*, vol. 100, no. 3, pp. 191–199, Mar. 2006, doi: 10.1016/J.TRSTMH.2005.07.021/2/M_100-3-191-TBL001.GIF.

[3] A. Alwan *et al.*, “Monitoring and surveillance of chronic non-communicable diseases: progress and capacity in high-burden countries,” *Lancet*, vol. 376, no. 9755, pp. 1861–1868, Nov. 2010, doi: 10.1016/S0140-6736(10)61853-3.

[4] K. P. Msyamboza *et al.*, “The Burden of Selected Chronic Non-Communicable Diseases and Their Risk Factors in Malawi: Nationwide STEPS Survey,” *PLoS One*, vol. 6, no. 5, p. e20316, 2011, doi: 10.1371/JOURNAL.PONE.0020316.

[5] B. Bista *et al.*, “Prevalence of non-communicable diseases risk factors and their determinants: Results from STEPS survey 2019, Nepal,” *PLoS One*, vol. 16, no. 7, p. e0253605, Jul. 2021, doi: 10.1371/JOURNAL.PONE.0253605.

[6] WHO, “Chronic Diseases-Core package,” 2006.

[7] WHO, “Global status report on noncommunicable diseases 2014.” Accessed: Nov. 22, 2023. [Online]. Available: https://www.who.int/publications/i/item/9789241564854

[8] M. Aboobakur *et al.*, “Surveillance for non-communicable disease risk factors in Maldives: results from the first STEPS survey in Male,” *Int J Public Health*, vol. 55, no. 5, pp. 489–496, 2010, doi: 10.1007/S00038-009-0114-Y.

[9] WHO, “WHO EMRO | Causes | NCDs.” Accessed: Dec. 02, 2023. [Online]. Available: https://www.emro.who.int/noncommunicable-diseases/causes/index.html

[10] S. M. Ahmed *et al.*, “Clustering of chronic non-communicable disease risk factors among selected Asian populations: levels and determinants,” *Glob Health Action*, vol. 2, no. 1, pp. 68–75, 2009, doi: 10.3402/GHA.V2I0.1986.

[11] WHO, “Noncommunicable diseases - SEARO.” Accessed: Dec. 03, 2023. [Online]. Available: https://www.who.int/southeastasia/health-topics/noncommunicable-diseases

[12] T. Biswas *et al.*, “Clustering of metabolic and behavioural risk factors for cardiovascular diseases among the adult population in South and Southeast Asia: findings from WHO STEPS data,” *The Lancet Regional Health - Southeast Asia*, vol. 12, p. 100164, May 2023, doi: 10.1016/J.LANSEA.2023.100164.

[13] B. K. Riaz *et al.*, “Risk factors for non-communicable diseases in Bangladesh: findings of the population-based cross-sectional national survey 2018,” *BMJ Open*, vol. 10, no. 11, p. 41334, Nov. 2020, doi: 10.1136/BMJOPEN-2020-041334.

[14] “Noncommunicable diseases - SEARO.” Accessed: Feb. 23, 2024. [Online]. Available: https://www.who.int/southeastasia/health-topics/noncommunicable-diseases

[15] "Noncommunicable diseases - SEARO." Accessed: Feb. 16, 2024. [Online]. Available: https://www.who.int/southeastasia/health-topics/noncommunicable-diseases

[16] M. Fritz and H. Fromell, "How to dampen the surge of non-communicable diseases in Southeast Asia: insights from a systematic review and meta-analysis," *Health Policy Plan*, vol. 37, no. 1, pp. 152–167, Jan. 2022, doi: 10.1093/HEAPOL/CZAB138.

[17] A. Dans, N. Ng, C. Varghese, E. S. Tai, R. Firestone, and R. Bonita, "The rise of chronic non-communicable diseases in southeast Asia: Time for action," *The Lancet*, vol. 377, no. 9766, pp. 680–689, Feb. 2011, doi: 10.1016/S0140-6736(10)61506-1.

[18] T. J. Bollyky, T. Templin, M. Cohen, and J. L. Dieleman, "Lower-Income Countries That Face The Most Rapid Shift In Noncommunicable Disease Burden Are Also The Least Prepared," *Health Aff (Millwood)*, vol. 36, no. 11, pp. 1866–1875, Nov. 2017, doi: 10.1377/HLTHAFF.2017.0708.

[19] L. Meiqari, T. P. L. Nguyen, D. Essink, P. Wright, and F. Scheele, "Strengthening human and physical infrastructure of primary healthcare settings to deliver hypertension care in Vietnam: a mixed-methods comparison of two provinces," *Health Policy Plan*, vol. 35, no. 8, pp. 918–930, Oct. 2020, doi: 10.1093/HEAPOL/CZAA047.

[20] "SEARO NCD Dashboard." Accessed: Feb. 22, 2024. [Online]. Available: https://searncddashboard.searo.who.int/NCDMortality

[21] A. de Silva *et al.*, "Non-communicable diseases in South-East Asia: journeying towards the SDG target," *The Lancet Regional Health - Southeast Asia*, vol. 18, Nov. 2023, doi: 10.1016/J.LANSEA.2023.100305.

[22] WHO, "Noncommunicable Disease Surveillance, Monitoring and Reporting." Accessed: Dec. 02, 2023. [Online]. Available: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps

[23] "About the 66th World Health Assembly." Accessed: Dec. 02, 2023. [Online]. Available: https://www3.paho.org/hq/index.php?option=com_content&view=article&id=8659:2013-66th-world-health-assembly&Itemid=0&lang=fr#gsc.tab=0

[24] M. M. Zaman *et al.*, "Clustering of non-communicable diseases risk factors in Bangladeshi adults: An analysis of STEPS survey 2013," *BMC Public Health*, vol. 15, no. 1, pp. 1–9, Jul. 2015, doi: 10.1186/S12889-015-1938-4/FIGURES/3.

[25] WHO, "Hypertension." Accessed: Dec. 04, 2023. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/hypertension

[26] WHO, "Diabetes." Accessed: Dec. 04, 2023. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/diabetes

[27] T. Y. Tan *et al.*, "A head-to-head evaluation of the diagnostic efficacy and costs of trio versus singleton exome sequencing analysis," *European Journal of Human Genetics 2019 27:12*, vol. 27, no. 12, pp. 1791–1799, Jul. 2019, doi: 10.1038/s41431-019-0471-9.

[28] "SEA-NCD-91 Distribution: General WHO STEPS survey on risk factors for noncommunicable diseases Maldives, 2011," 2014.

[29] "2015 STEPS Country Report Sri Lanka." Accessed: Feb. 16, 2024. [Online]. Available: https://www.who.int/publications/m/item/2015-steps-country-report-sri-lanka

[30] "2014 STEPS Country Report Myanmar." Accessed: Feb. 16, 2024. [Online]. Available: https://www.who.int/publications/m/item/2014-steps-country-report-myanmar

[31] "Timor-Leste - STEPS 2014." Accessed: Feb. 16, 2024. [Online]. Available: https://extranet.who.int/ncdsmicrodata/index.php/catalog/687

[32] "2018 STEPS Fact Sheet Bangladesh." Accessed: Feb. 16, 2024. [Online]. Available: https://www.who.int/bangladesh/about-us/publications-1/m/item/2018-steps-fact-sheet-bangladesh

[33] "Nepal - STEPS 2019." Accessed: Feb. 16, 2024. [Online]. Available: https://extranet.who.int/ncdsmicrodata/index.php/catalog/771

[34] R. Das Gupta, P. A. Chakraborty, and M. B. Hossain, "Association of household wealth and education level with hypertension and diabetes among adults in Bangladesh: a propensity score-based analysis," *Tropical Medicine & International Health*, vol. 26, no. 9, pp. 1047–1056, Sep. 2021, doi: 10.1111/TMI.13625.

[35] Y. Yokobori *et al.*, "Sex differences in the association between socioeconomic status and untreated hypertension among residents with hypertension in rural Khánh Hòa, Vietnam: a post-hoc analysis," *BMC Cardiovasc Disord*, vol. 24, no. 1, pp. 1–9, Dec. 2024, doi: 10.1186/S12872-024-03706-4/FIGURES/2.

[36] D. Neupane *et al.*, "Prevalence of Hypertension in Member Countries of South Asian Association for Regional Cooperation (SAARC): Systematic Review and Meta-Analysis," *Medicine*, vol. 93, no. 13, 2014, doi: 10.1097/MD.0000000000000074.

[37] A. Mohammed Nawi *et al.*, "The Prevalence and Risk Factors of Hypertension among the Urban Population in Southeast Asian Countries: A Systematic Review and Meta-Analysis," *Int J Hypertens*, vol. 2021, 2021, doi: 10.1155/2021/6657003.

[38] H. K. Segawa *et al.*, "Gender with marital status, cultural differences, and vulnerability to hypertension: Findings from the national survey for noncommunicable disease risk factors and mental health using WHO STEPS in Bhutan," *PLoS One*, vol. 16, no. 8, p. e0256811, Aug. 2021, doi: 10.1371/JOURNAL.PONE.0256811.

[39] M. Alfaqeeh, S. D. Alfian, and R. Abdulah, "Factors Associated with Hypertension Among Adults: A Cross-Sectional Analysis of the Indonesian Family Life Survey," *Vasc Health Risk Manag*, vol. 19, p. 827, 2023, doi: 10.2147/VHRM.S438180.

[40] R. Khanam *et al.*, "Prevalence and factors associated with hypertension among adults in rural Sylhet district of Bangladesh: a cross-sectional study," *BMJ Open*, vol. 9, no. 10, p. 26722, Oct. 2019, doi: 10.1136/BMJOPEN-2018-026722.

[41] Y. Kokubo, S. Padmanabhan, Y. Iwashima, K. Yamagishi, and A. Goto, “Gene and environmental interactions according to the components of lifestyle modifications in hypertension guidelines,” *Environ Health Prev Med*, vol. 24, no. 1, pp. 1–11, Mar. 2019, doi: 10.1186/S12199-019-0771-2/TABLES/5.

[42] F. J. Rios, A. C. Montezano, L. L. Camargo, and R. M. Touyz, “Impact of Environmental Factors on Hypertension and Associated Cardiovascular Disease,” *Canadian Journal of Cardiology*, vol. 39, no. 9, pp. 1229–1243, Sep. 2023, doi: 10.1016/J.CJCA.2023.07.002.

[43] A. K. Zambrano *et al.*, “Genetic diet interactions of ACE: the increased hypertension predisposition in the Latin American population,” *Front Nutr*, vol. 10, p. 1241017, Oct. 2023, doi: 10.3389/FNUT.2023.1241017/BIBTEX.

[44] T. Ojangba *et al.*, “Comprehensive effects of lifestyle reform, adherence, and related factors on hypertension control: A review,” *The Journal of Clinical Hypertension*, vol. 25, no. 6, p. 509, Jun. 2023, doi: 10.1111/JCH.14653.

[45] M. M. Ibrahim and A. Damasceno, “Hypertension in developing countries,” *Lancet*, vol. 380, no. 9841, pp. 611–619, 2012, doi: 10.1016/S0140-6736(12)60861-7.

[46] “India Hypertension Control Initiative (IHCI), 2021.” Accessed: Feb. 22, 2024. [Online]. Available: https://www.who.int/southeastasia/internal-publications-detail/india-hypertension-control-initiative-(ihci)-2021

[47] “Reducing cardiovascular disease (hypertension and sodium).” Accessed: Feb. 22, 2024. [Online]. Available: https://www.who.int/thailand/activities/reducing-cardiovascular-disease

[48] R. Jayawardena, P. Ranasinghe, N. M. Byrne, M. J. Soares, P. Katulanda, and A. P. Hills, “Prevalence and trends of the diabetes epidemic in South Asia: A systematic review and meta-analysis,” *BMC Public Health*, vol. 12, no. 1, pp. 1–11, May 2012, doi: 10.1186/1471-2458-12-380/TABLES/3.

[49] A. Islam and M. Zaffar Tahir, “Health sector reform in South Asia: New challenges and constraints,” *Health Policy (New York)*, vol. 60, no. 2, pp. 151–169, 2002, doi: 10.1016/S0168-8510(01)00211-1.

[50] A. Ramachandran *et al.*, “High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey,” *Diabetologia*, vol. 44, no. 9, pp. 1094–1101, 2001, doi: 10.1007/S001250100627.

[51] U. Das and N. Kar, “Prevalence and risk factor of diabetes among the elderly people in West Bengal: evidence-based LASI 1st wave,” *BMC Endocr Disord*, vol. 23, no. 1, Dec. 2023, doi: 10.1186/s12902-023-01421-3.

[52] D. M. Nathan *et al.*, “Impaired fasting glucose and impaired glucose tolerance: Implications for care,” *Diabetes Care*, vol. 30, no. 3, pp. 753–759, Mar. 2007, doi: 10.2337/dc07-9920.

[53] A. Kautzky-Willer, M. Leutner, and J. Harreiter, “Sex differences in type 2 diabetes,” *Diabetologia*, vol. 66, no. 6, pp. 986–1002, Jun. 2023, doi: 10.1007/S00125-023-05891-X.

[54] J. Ramke, L. Lee, and G. Brian, “Prevalence of diabetes among adults aged ≥40years in Timor-Leste,” *J Diabetes*, vol. 4, no. 4, pp. 392–394, Dec. 2012, doi: 10.1111/J.1753-0407.2012.00217.X.

[55] A. Ramachandran, S. Mary, A. Yamuna, N. Murugesan, and C. Snehalatha, “High prevalence of diabetes and cardiovascular risk factors associated with urbanization in India,” *Diabetes Care*, vol. 31, no. 5, pp. 893–898, May 2008, doi: 10.2337/DC07-1207.

[56] K. L. Ong *et al.*, “Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021,” *The Lancet*, vol. 402, no. 10397, pp. 203–234, Jul. 2023, doi: 10.1016/S0140-6736(23)01301-6.

[57] W. P. Aung, E. Bjertness, A. S. Htet, H. Stigum, and M. K. R. Kjøllesdal, “Trends in Diabetes Prevalence, Awareness, Treatment and Control in Yangon Region, Myanmar, Between 2004 and 2014, Two Cross-Sectional Studies,” *Int J Environ Res Public Health*, vol. 16, no. 18, Sep. 2019, doi: 10.3390/IJERPH16183461.

[58] J. Morrison *et al.*, “Participatory learning and action to address type 2 diabetes in rural Bangladesh: a qualitative process evaluation,” *BMC Endocr Disord*, vol. 19, no. 1, Nov. 2019, doi: 10.1186/S12902-019-0447-3.

[59] E. Fottrell *et al.*, “Intermediate hyperglycaemia, diabetes and blood pressure in rural Bangladesh: five-year post-randomisation follow-up of the DMagic cluster-randomised controlled trial,” *The Lancet Regional Health - Southeast Asia*, vol. 10, p. 100122, Mar. 2023, doi: 10.1016/J.LANSEA.2022.100122.

[60] S. Akhtar, A. Ali, M. Asghar, I. Hussain, and A. Sarwar, “Original research: Prevalence of type 2 diabetes and pre-diabetes in Sri Lanka: a systematic review and meta-analysis,” *BMJ Open*, vol. 13, no. 8, p. 68445, Aug. 2023, doi: 10.1136/BMJOPEN-2022-068445.

[61] N. A. Majeed, S. A. Shiruhana, J. Maniam, C. A. Eigenmann, A. Siyan, and G. D. Ogle, “Incidence, prevalence and mortality of diabetes in children and adolescents aged under 20 years in the Republic of Maldives,” *J Paediatr Child Health*, vol. 56, no. 5, pp. 746–750, May 2020, doi: 10.1111/JPC.14726.

[62] R. P. Rannan-Eliya *et al.*, “Prevalence of diabetes and pre-diabetes in Sri Lanka: a new global hotspot-estimates from the Sri Lanka Health and Ageing Survey 2018/2019,” *BMJ Open Diabetes Res Care*, vol. 11, no. 1, Feb. 2023, doi: 10.1136/BMJDRC-2022-003160.

[63] A. H. Barnett *et al.*, “Type 2 diabetes and cardiovascular risk in the UK south Asian community,” *Diabetologia*, vol. 49, no. 10, pp. 2234–2246, 2006, doi: 10.1007/S00125-006-0325-1.

[64] C. Cimminiello, A. Zambon, and H. Polo Friz, “[Hypercholesterolemia and cardiovascular risk: advantages and limitations of current treatment options],” *G Ital Cardiol (Rome)*, vol. 17, no. 4 Suppl 1, pp. 6S – 13, Apr. 2016, doi: 10.1714/2254.24276.

[65] T. A. Gaziano, A. Bitton, S. Anand, S. Abrahams-Gessel, and A. Murphy, “Growing Epidemic of Coronary Heart Disease in Low- and Middle-Income Countries,” *Curr Probl Cardiol*, vol. 35, no. 2, p. 72, Feb. 2010, doi: 10.1016/J.CPCARDIOL.2009.10.002.

[66] U. Groselj, A. Wiegman, and S. S. Gidding, “Screening in children for familial hypercholesterolaemia: start now,” *Eur Heart J*, vol. 43, no. 34, pp. 3209–3212, Sep. 2022, doi: 10.1093/EURHEARTJ/EHAC224.

[67] F. Sadiq *et al.*, “Mapping of familial hypercholesterolemia and dyslipidemias basic management infrastructure in Pakistan: a cross-sectional study,” *The Lancet Regional Health - Southeast Asia*, vol. 12, May 2023, doi: 10.1016/j.lansea.2023.100163.

[68] M. Y. Lee *et al.*, “Association between height and hypercholesterolemia in adults: a nationwide population-based study in Korea,” *Lipids Health Dis*, vol. 18, no. 1, Nov. 2019, doi: 10.1186/S12944-019-1148-7.

[69] J. Al-Zahrani *et al.*, “The prevalence of hypercholesterolemia and associated risk factors in Al-Kharj population, Saudi Arabia: a cross-sectional survey,” *BMC Cardiovasc Disord*, vol. 21, no. 1, Dec. 2021, doi: 10.1186/S12872-020-01825-2.

[70] C. L. Jackson, M. Zordok, and I. J. Kullo, “Familial hypercholesterolemia in Southeast and East Asia,” *Am J Prev Cardiol*, vol. 6, p. 100157, Jun. 2021, doi: 10.1016/J.AJPC.2021.100157.

[71] V. Lohsoonthorn, B. Dhanamun, and M. A. Williams, “Prevalence of metabolic syndrome and its relationship to white blood cell count in a population of Thai men and women receiving routine health examinations,” *Am J Hypertens*, vol. 19, no. 4, pp. 339–345, Apr. 2006, doi: 10.1016/j.amjhyper.2005.10.008.

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PAGE 17