



Prevalence and Determinants of Hypertension in Coastal and Estuarine Communities

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Abstract

Introduction: Hypertension has been a globally burden disease since the 1990s. It is known as one of the risk factors for cardiovascular disease. For more than a decade, hypertension was the most prevalent cause of death around the world, and one of ten leading causes of death in lower-middle-income countries including coastal and estuarine regions. As a preventable illness condition, hypertension has been found to be associated with some modifiable factors. This review aims to identify the prevalence and determinants of hypertension in coastal and estuarine regions, in high, low and middle-income countries.

Method: To carry out this review, four journal databases including Proquest, Science Direct, Google Scholar, and DOAJ were used to address the prevalence and determinants of hypertension in coastal and estuarine regions both in high, low and middle-income countries.

Results: The prevalence of hypertension ranged from 6.445% to 85.1%. In coastal regions, the prevalence of hypertension ranged from 6.45% to 51.1%, while the prevalence of prehypertension ranged from 26.5% to 39.75%. In estuarine regions, the prevalence of hypertension was about 25.29%. The highest prevalence both in prehypertension and hypertension was observed in Kerala, India. This is while the lowest prevalence was observed in China. High sodium intake is strongly associated with an increased risk of hypertension. Other risk factors including older age, lower education, gender, and lower economic status; body weight status (overweight or obese), health behavior (physical inactivity, daily smoker, heavy alcohol drinking), and psychosocial stress (depression), were all linked to hypertension.

Conclusion: According to the findings of this study, it can be stated that strategies are needed to improve the prevention of hypertension in coastal and estuarine regions, particularly managing and modifying some modifiable factors.

Keywords: Risk Factors, Cause of Death, Prevalence, Hypertension, Sodium

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Introduction

Hypertension has been one of the risk factors of Cardiovascular Diseases (CVD) and a global burden.¹ The CVD has been known as the main leading factor of death around the world and has also caused more than 17 million deaths annually.¹ Furthermore, Raal et al. explained that the incidence of CVD has declined for decades particularly in developed countries, due to the improvement of CVD risk factor related management. However, in developing countries, CVD is still increasing and has contributed to up to 80% of deaths globally.¹

In recent times, up to 25% of adults have been living with hypertension globally, and it has been estimated that the global prevalence will increase up to 29% by 2025.² Notably, the phenomenon of high blood pressure has been also identified among children and adolescents since the last decade.³ Hypertension which begins in childhood can continue to adulthood, and as a result will increase the prevalence of morbidity and mortality related to CVD as they get older.⁴ The global population living with hypertension

has been calculated at approximately 2 billion people.⁵

Hypertension is also a major health issue in the community settings.⁵ It can be found in various areas such as urban, semi-urban, rural, inland, mainland, small island, highland, coastal, and estuarine areas, ranging from low, middle, and high-income countries.⁶ In some countries, coastal and estuarine areas have become of inhabitants of living. For example, 14 out of 25 metropolitans in Brazil are located in estuarine areas.⁷

In 2011, the World Health Organization (WHO) aimed for a quarter global alleviation in regards to the prevalence of hypertension by 2025, but progress widely varied among countries.⁸ Globally, the prevalence of hypertension in adults was approximately 22% in 2014.⁹ While, the prevalence of prehypertension in the middle-aged population was estimated to be about 50%.¹⁰ Regarding the recent available data concerned about controlled blood pressure worldwide, the prevalence of controlled blood pressure reached to 68.9% and 37.5%, in the US and China, respectively.¹¹

Based on the World Health Survey, a study comparison on

hypertension prevalence in both rural and urban settings in Africa, South Africa and the Democratic Republic of the Congo, showed that the prevalence rates were 10% higher in urban areas compared to rural areas.¹² In previous studies, it has been found that the prevalence of hypertension was about 31.2% among urban slum dwellers in Egypt. Surprisingly, the prevalence was much higher than what was nationally reported in 2015, which was about 17.2%.¹³

A numerous of the study had been conducted on prevalence and determinants of hypertension in urban and rural communities both in high-, and low- and middle-income countries. However, the identification of the prevalence and determinants in coastal and estuarine regions has been conducted in a few studies.

Aims

The present study has aimed to identify the prevalence and determinants of hypertension among people who live in coastal and estuarine areas from around the world, with low middle, and high-incomes.

Methods

This review study used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) approach to select appropriate resources to determine the prevalence and determinants of hypertension among people who live in coastal and estuarine areas. Quantitative studies including a cross-sectional study, survey, and retrospective longitudinal study were examined in this review. It was aimed to find relevant articles related to the prevalence and determinants of hypertension in coastal and estuarine regions. The keywords used in this study included: “prevalence,” “determinants,” “risk factors,” “hypertension,” “high blood pressure,” “coastal areas,” “coastal community,” “estuarine areas,” “estuarine communities.” Available titles and abstracts of the articles were reviewed systematically to obtain the relevant articles. Four databases including DOAJ, Google Scholar, Proquest, and Science Direct, were used in this study. The inclusion criteria of this study included articles published in English, published from 2012 to 2018, original papers, available in full-text, and peer-reviewed articles.

Articles were extracted by applying the PRISMA method analysis, according to the following details:

- Identification

Two hundred and thirty six articles were identified from the DOAJ, Google scholar, Proquest and Science Direct journal databases.

- Screening

After removing duplicate articles (n = 7), 229 articles were retrieved

- Eligibility

The articles included in this study should have met the following inclusion criteria: the article was written in English in and after 2014, articles focus on the risk factors of hypertension, determinants of hypertension, hypertension in the coastal and estuarine regions, original articles, thesis, dissertation and systematic review articles. Articles were excluded for several reasons such as: the title of the review and abstract (n=153) was not related to the scope of this study (n=42), not being published in an academic journal such as review journals, letter to editor, short communication, case report, and commentary (n=8), having an inappropriate population such as inland, highland, and rural regions, and adolescence (n=13), and also not full text (abstract only) (n=5).

- Included

Articles included in this study should have met all the above mentioned inclusion criteria. As a result 8 articles were chosen.

Results

This review identified that there are eight journals which fulfill all the inclusion criteria of the study. The majority of journals were cited from Asian countries such as China, India, Myanmar, and Vietnam. This is while, three of these journals were cited from Latin American Countries, Brazil, Peru, and Suriname. This review specifically focused on the prevalence and determinants of hypertension in coastal and estuarine regions. The prevalence of hypertension is presented in [Table 1](#), while the determinants are presented in [Table 2](#).

Discussion

5.1 Prevalence of hypertension

The prevalence of hypertension among people who lived in coastal and estuarine regions was different in every single site of study, even in the same country such as China. The lowest prevalence was found in Eastern Coastal China, which counted for around 6.5%. This is while the highest prevalence was observed among people who lived in the delta area in Myanmar (about 33.3%). According to this review, the prevalence of hypertension ranges from 6.5% to 33.3%. The variety of the prevalence might be affected by different factors or determinants from the population of the study. A study among Han and multi-ethnic population in Diqing, China found that the prevalence of hypertension did not significantly differ across sex and ethnicity.¹⁴

5.2 Determinants of hypertension

According to articles that were examined in this review, 28 determinants were identified. Then, all these determinants were classified into six categories such as anthropometrics, diet, environmental factor, lifestyle, psychological status, and socio-demographics.

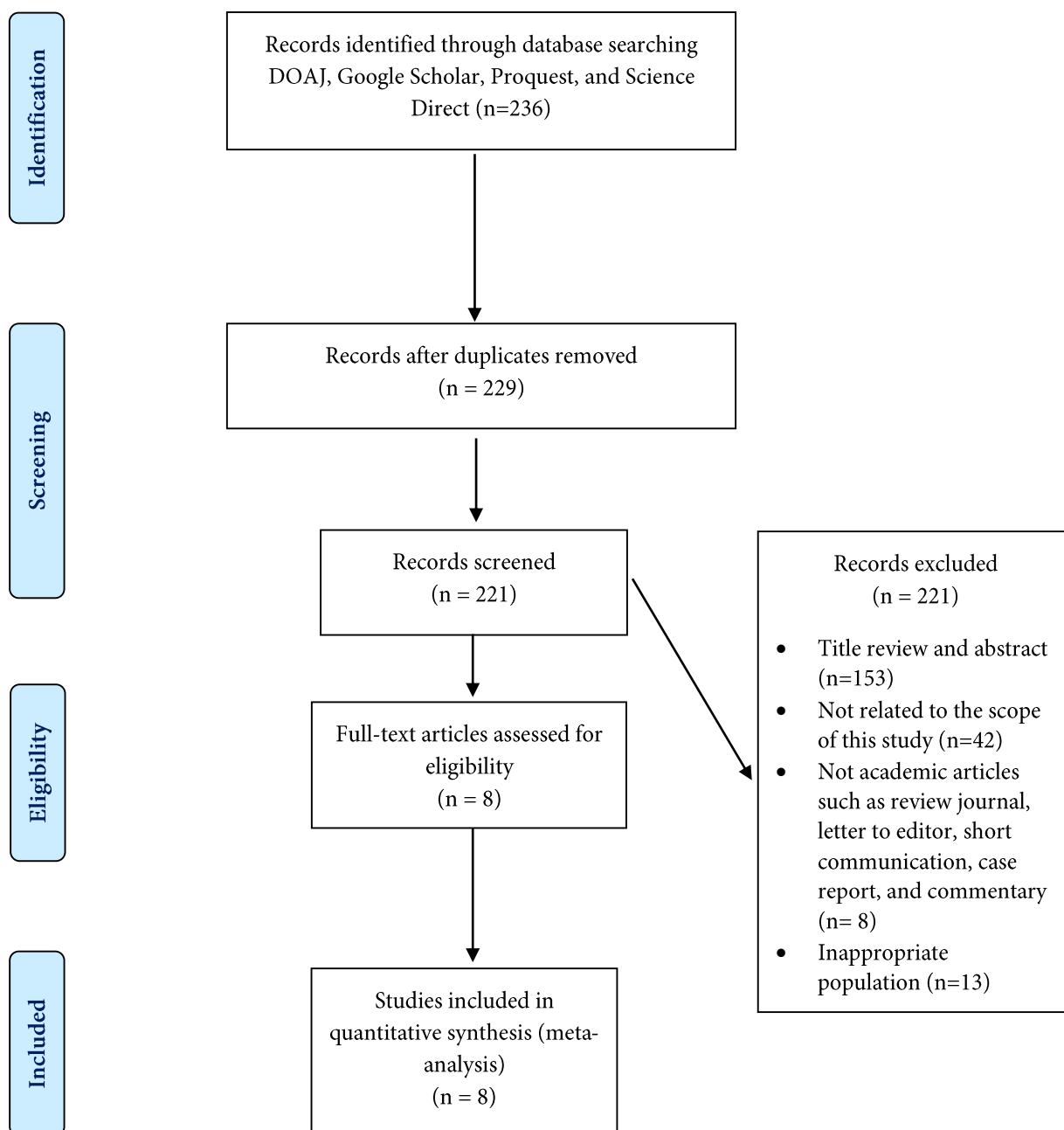


Figure 1. PRISMA Analysis

5.2.1 Anthropometrics

Overweight, obese, waist circumference and adiposity distribution were identified as attribute factors of hypertension. A study conducted by Bernabe-Ortiz et al. found that population attributable risk of obesity as high as 15.7%.¹⁵ Furthermore, obesity was a consistently leading risk factor of hypertension the prevalence of which ranged from 9.5% in rural to 24.1% in urban areas. Another research stated that overweight, and adiposity were the determinants of hypertension in Myanmar and this finding has been supported by previous study results.¹⁶ Increased waist circumference was significantly associated with hypertension among Burmese. Being overweight in both sexes, emerged as

a significant risk factor for hypertension among tribal residents in India.¹⁷ In contrast, a study among Vietnamese who lived in both urban and rural areas found that being underweight also had a significant impact on the prevalence of hypertension.¹⁸

A longitudinal study conducted by Choi et al. found that an increased Waist-to-Height Ratio (WHtR) was found to be positively associated with the development of hypertension.¹⁹ Only 1.2% of the agricultural population lived with obesity. However, the study found that BMI has a positive association to hypertension.²⁰ It is possible that additional metrics related to body mass and metabolism, such as Waist Circumference (WC), would better elucidate patterns in this population.

Table 1. Prevalence of hypertension

Authors	Country	Sample Size	Areas	Prevalence			Age Range of Participants
				Men	Women	Total	
Son et al. 2012	Vietnam	9832 participants from the general population	Coastal City	n/a	n/a	20.5 34.7	Aged 25 years and over
Bernab�-Ortiz et al., 2016	Peru	3238 participants, 48.3% male,	Semiurban Coastal	n/a	n/a	26.9	Mean age 45.3 years
Bjertness et al., 2016	Myanmar	7429 citizens	Coastal Delta	28.62 35.8	30.2 30.8	29.9 33.3	15–64 years
Chen et al., 2016	China	876 residents,	Coastal, large and small islands	n/a	n/a	28.42	18–88 years
Krishnadath, Jaddoe, Nahar-van Venrooij & Toelsie (2016).	Suriname	5748 participants. 49.7% male	Urban Coastal Rural Coastal	n/a n/a	n/a n/a	25.40 27.61	15-64
Ribeiro ^[11] et al., 2016	Brazil	3920 families	Coastal Estuarine	n/a n/a	n/a n/a	19.3 25.29	19-60
Deo, Pawar, Kanetkar, Kakade. 2017	Maharashtra India	410 adult Katkaris (219women)	Coastal villages	34	35	16.83	18-60 years
Yu et al., 2017	China	1.907.484 patients with NCDs from 2003 to 2014, 50.05% and 81.53% of them were men and aged 50 years or older.	Eastern coastal China	6.05	6.84	6.445	51->80

Table 2. Determinants of hypertension

Author, Year	Results of the study	Determinants	Determinants Classification
Son et al., 2012	Changing lifestyles to western habits due to massive industrialization and modernization impacts such as high-fat diets, smoking, alcohol consumption, and work-related stress may have a significant contribution to the development of high BP.	<ul style="list-style-type: none"> Lifestyle High-fat diets Smoking Alcohol consumption Work-related stress 	Anthropometrics <ul style="list-style-type: none"> Overweight Obese
Bernab�-Ortiz et al., 2016	Daily smoking (≥ 1 cigarette/day), heavy alcohol consumption (2 or more nights of alcohol intake in the past month and having ever drunk 6 or more drinks at a time), leisure time and transport-related physical activity, watching TV 2 or more hours per day during weekdays, self-report), minimum consumption 5 or more servings of fruits or vegetables per day, and obesity (using traditional body mass index (BMI) traditional cutoffs.	<ul style="list-style-type: none"> Smoking Heavy alcohol drinking Sedentary lifestyle (watching TV) Fruit and vegetable intake Obesity 	Diet <ul style="list-style-type: none"> High-fat diet/oils Fruit and vegetable Salt Meat
Bjertness et al., 2016	Overweight and low physical activity as determinants of hypertension, adiposity in terms of higher BMI, waist circumference is strongly associated with hypertension than BMI above 25 kg/m ²	<ul style="list-style-type: none"> Overweight Low physical activity Adiposity Waist circumference 	Environmental factor <ul style="list-style-type: none"> Live in the contaminated area such as Mercury, Cadmium, Lead, Organo-chlorine pesticides
Chen et al., 2016	Age (older ages), obesity, having a family history of hypertension, gender (male), having a larger family population, and lower education. Higher consumption of salt, meat, and oil will increase the risk of high BP.	<ul style="list-style-type: none"> Age (be older) Obese Family history Male Having a large family population Lower education Salt, meat and oil intake 	Lifestyle <ul style="list-style-type: none"> Smoking Alcohol consumption Sedentary
Krishnadath, Jaddoe, Nahar-van Venrooij & Toelsie (2016).	Demographic-related factors such as education, income, occupational status, and area of residence have been associated with hypertension. Income in Creoles, living in the rural interior in Maroons, and living with a partner in Hindustani, Javanese, and Maroons are associated to increase hypertension prevalence.	<ul style="list-style-type: none"> Education Income Employment Ethnics 	Psychological aspect <ul style="list-style-type: none"> Work-related stress
Ribeiro et al., 2016	The highest prevalence was seen among people who live in contaminated regions for > 20 years, receiving 1-5 min wages as family income and with an education level lower than 8 years of schooling. This is associated with exposure to chemicals, especially mercury, cadmium, lead, and organo-chlorine pesticides.	<ul style="list-style-type: none"> Living in contaminated areas Income Education Exposure to chemicals (Hg, cadmium, Pb, and organo-chlorine pesticides) 	Socio-demographic <ul style="list-style-type: none"> Age Family history Male Having a large family population
Deo, Pawar, Kanetkar, Kakade. 2017	Being overweight, body fat distribution, hyperlipidemia, unhealthy imbalanced diet (a diet rich in fat) and sedentary lifestyle are the most important risk factors for both diabetes and hypertension. Age, in general, is considered to be a risk factor both for diabetes and hypertension.	<ul style="list-style-type: none"> Overweight Body fat distribution Hyperlipidemia High-fat diet Sedentary lifestyle Age 	Socio-demographic <ul style="list-style-type: none"> Lower education Income Employment Ethnics
Yu et al., 2017	Older >41 years	<ul style="list-style-type: none"> Age 	

5.2.2 Diet

High consumption of fat in diets, mixed edible oils, fruit and vegetable, salt, and meat have a strong correlation with increased hypertension both Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP). Chen et al. found that increased salt and meat consumption was associated with both increased SBP and DBP.²¹ Furthermore, they observed that consuming marine products has a significant positive and inverse relation with SBP, and the use of mixed edible oil was associated with SBP. High consumptions of edible oil was an independent risk factor for high Blood Pressure (BP) in undiagnosed island residents.

There was also a significant positive association between edible oil consumption and DBP. The use of sesame oil in cooking as compared with the use of peanut oil was associated with lower hypertension prevalence in both males (OR = 0.64 (0.5–0.9) and females (OR = 0.75 (0.6–0.9) among the Burmese population.¹⁶ A study conducted by Bernabe-Ortiz et al. found that in populations with low fruit and vegetable intake, the rate of hypertension was high (57.9%).¹⁶

An important point to mention was the fact that the consumption of marine products was significantly associated with SBP.²¹ As a matter of fact, fish are considered as one of the most important marine products. The majority of studies have found that high fish diets lead to a reduced risk of hypertension, lower BP levels, and reduced risk of cardiovascular diseases. High fish oil intake was associated with lower BP especially among hypertensive subjects. As a component of fish or other seafood, fatty acid in fish oil, high-quality proteins, amino acids, and vitamins play an important role in controlling BP.

Even in Bjertness et al.'s (2016) study was missing salt intake information, however, the main ingredient in the majority of Burmese cooking was fermenting fish or shrimp and added salt.¹⁶ Salt intake is high among South-East Asian countries and as a result, increases Monosodium Glutamate (MSG) which is predicted as major contributors to the burden of hypertension. Both MSG and salt intake are highly associated with high BP. Sun et al. have stated that high salt intake is considered as one of the most important and critical dietary factors.²² Furthermore, the International Salt (INTERSALT) study has emphasized that high individual salt intake is significantly associated with increased BP. A meta-analysis study has shown that salt restriction was effective in BP management in both hypertension and normal BP patients and as result, decreased BP by 3.4/1.5 mm Hg on average.

Three main types of dietary patterns, namely 'healthy pasture', 'tubers and meat', and 'fruit and vegetables' were identified, which in total explained 25.4% of the variants of food intake. The first type is very relative to yogurt, soy products, and eggs. The second type is characterized by a

high intake of tubers, beef and mutton, and pork. The third type is highly correlated with fruits and vegetables. The prevalence of hypertension decreases in quintiles of three dietary patterns. When the 'Healthy grass', 'Bulbs and meat' and 'Fruits and vegetables' diet scores increased, the prevalence of hypertension decreased from 33.7 to 23.3%, 35.1% to 26.7%, 34.4% to 28.4%, respectively.¹⁴

5.2.3 Environmental Factor

In a study conducted by Ribeiro et al., it has been stated that the population who live in contaminated regions due to exposure to environmental contaminants such as Mercury, Cadmium, Lead, and Organo-chlorine pesticides are at high risks of hypertension.⁷ Even in that study was a lack of primary contamination measurements, however, some of the studies were conducted in that same place provided trustworthy evidence on chemical contamination of the area. This study found a similar result to the previous study. The riverside population residing downstream showed the highest prevalence, it was counted for 34.5% when compared to the upstream population.

Another study reported that heavy metal contamination in food is of great concern in China. Different heavy metal affects the health status of people, e.g. cadmium mainly affects kidneys while environmental lead is known to affect blood pressure.²³ However, another study has shown that the association between Hg exposure and the prevalence of hypertension was nonlinear, with no association in populations exposed to low-to-moderate mercury (hair Hg < 2 lg=g) and evident association in populations exposed to high mercury (hair Hg ≥ 2 lg=g). However, the results of the above mentioned study has been criticized due to the limitations of the study design.²⁴

5.2.4 Lifestyle

Smoking, alcohol consumption and a sedentary lifestyle were strong predictors of hypertension. A study conducted by Bernabe-Ortiz et al. found that the population attributable risk of daily smoking and heavy alcohol drinking was, 3% and 2.7%, respectively.¹⁵ The prevalence of hypertension in Vietnam was high in urban and lowland regions compared to coastal areas. As lowland areas have mostly become provincial centers, they have experienced industrialization and modernization during the past few decades. As a result, lifestyle in these regions has changed towards western habits such as high-fat diet, smoking, alcohol consumption, and work-related stress. These lifestyle changes may contribute to the development of hypertension.¹⁸

5.2.5 Psychological Status

A study conducted in an industrialization and modernization region in Vietnam identified that work-

related stress might contribute to the development of hypertension among urban residents due to their lifestyle changes.¹⁸ However, another study found that there was no significant relationship between lifestyle and stress-related factors such as household size, tobacco, and alcohol usage.²⁰

5.2.6 Socio-Demographics

Age, gender (male), family history, a large family population, lower education, lower income, unemployment, and ethnics were found to have a significant impact on the prevalence of hypertension.

The prevalence of hypertension progressively increased with age in both sexes and was higher among men in the age groups up to 64 years compared to women.¹⁸ However, women aged 65 and over had a higher prevalence than men (58.2% vs 53.4%; and 70.5% vs 68.8%, respectively). In contrast, based on the World Health Organization (WHO) report, men are known to have a slightly higher prevalence of hypertension compared to women in all WHO regions (21%, and 16%, respectively) in 2014.⁹ According to other findings, the prevalence of hypertension is 30% for both sexes, and 6% for men and 11% for the total population using anti-hypertensive drugs. The average SBP is 5 mmHg higher in men compared to women, while there is no difference in the average DBP.¹⁶ According to the age group, the prevalence of hypertension increased for both sexes from the lowest age group (15-24 years: men: 12.9%; women 7.5%) to the highest age group (55-64 years: men: 50.1%; women: 53.4%). In addition, sex and age factors are very relevant in assessing risk scores, because after 45 years stratification scores are higher risk scores for women in all age groups, consequently, higher cardiovascular risk. However, there is a direct relationship between improvement in the age group and the predominance or appearance of risk factors associated with both sexes.²⁵

The state of hypertension is positively predicted based on age and BMI, while the effect of sex is not significant.²⁰ Current population-based studies in Malaysia show that hypertension is relatively higher in men, the older group, and those with low incomes in the household. The prevalence of stage 1 hypertension is greater among men, rural populations, people with ethnic Malays, basic education, diabetes mellitus, hypercholesterolemia, those who are widowed or divorced, low income, obese, and have abdominal obesity. In contrast, stage 2 hypertension is more frequent in women than men (6.1% versus 5.7%). A higher prevalence was also found among those living in rural areas, ethnic Malays, having informal education, divorced or widowed, low-income, non-smokers, having diabetes mellitus, having hypercholesterolemia, obesity, and abdominal obesity. Age, gender, locality of residence, socioeconomic status, ethnicity, and other comorbidities

have been shown to influence the possibility of an increase in BP. More precisely, those who are older, male, never married, live rationally, have lower socioeconomic status, ethnic Malays, diabetes, hypercholesterolemia, and overweight tend to have higher BP levels. The first national study examining the prevalence of hypertension, awareness, treatment, and control in Ghana revealed that the prevalence of hypertension among Ghanaians aged between 15 and 49 years was 13.1%. Increase in age, previous marriages, higher wealth status, and living in urban areas correlates with this issue.²⁷

In Yu et al.'s study, it was found that high urbanization increases the occurrence of cardiovascular and circulatory diseases such as hypertension.²⁸ Regarding education levels, a higher prevalence of hypertension was observed among estuarine residents with primary education (52.8%), and low income with 1-5 minimum wages (75.4%).⁷ More than 95% of the participants, in a study conducted in coastal Maharashtra, were "Yellow card" holders, an indication that they were below the poverty line by the criteria used by the Government of India. Also, about three-fourth of tribal women and about 60% of men were illiterate as they could not even sign their names.¹⁷ The highest hypertension prevalence was seen in men living in cities (37.8%) and the lowest was observed in women living in highland areas (17.1%). Hypertension prevalence was significantly higher in urban areas than in rural areas (32.7 vs 17.3%, $P < 0.001$).¹⁸

A family history of hypertension has been a significant risk factor for hypertension in Vietnamese communities, and it has also been associated with a great of awareness.¹⁸

In a study, it has been reported that there are several contributing factors related to pre-hypertension and hypertension in women such as smoking tobacco, consuming caffeine-related drinks, overweight, obese, and history of high blood pressure. While in men, marriage status (married), overweight, obese, drinking alcohol, smoking tobacco, consuming caffeine-related drinks, and not being previously informed about hypertension were identified as the main contributing factors related to prehypertension and hypertension cases.²⁹

In terms of ethnicity, a study has been conducted among six ethnic groups in Suriname (Creole, Hindustani, Javanese, Amerindian, and Marrons). The study results revealed that the highest prevalence of hypertension was found in Creoles and the lowest was observed in Maroons.³⁰ However, some attributable factors which may affect increased levels of BP need to be addressed. For example, in the mentioned study information related to participants' diet was not considered.

Conclusion

Hypertension is a global burden and a major risk factor of cardiovascular disease which contributes to a large number

of morbidity and mortality all over the world. Since the prevalence of hypertension among coastal and estuarine communities has a wider range, the incidence increases gradually due to some factors. Modifying the risk factors in order to manage hypertension among coastal and estuarine regions would bring a positive impact on the reduction of the prevalence of this disease. Due to the lack of study about hypertension among coastal and estuarine areas, affect the result of this study review.

Conflict of Interest Disclosures

The authors declare they have no conflicts of interest.

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