Analysis of Semi-Rural and Urban Hypertension Prevalence Using WHO Measures

Sumit Kumar Agrawal [1], Tripti Dewangan [1]

Abstract

This study investigated the widespread health concern of hypertension and its significant impact on cardiovascular diseases, strokes, and overall health. The research focuses on understanding the prevalence of hypertension in both semi-rural and urban areas, using World Health Organization metrics for a comprehensive evaluation. Despite extensive prior research on hypertension, the distinct frequency gap between semi-rural and urban settings poses a notable challenge. This study addressed issues in data collection, sampling biases, and temporal fluctuations by introducing a novel approach called Hypertension Prevalence Analysis using WHO Measures (HPA-WHOM), which outperforms existing methods. In semi-rural settings, HPA-WHOM estimates a hypertension prevalence of 53.76%, revealing average blood pressure levels, salt intake, physical activity, smoking habits, and alcohol use. These findings underscore HPA-WHOM's effectiveness in understanding hypertension prevalence and associated factors, contributing valuable insights for tailored interventions and global initiatives to combat the worldwide impact of hypertension on public health.

Keywords: Hypertension Prevalence Analysis, Semi-Rural and Urban Disparities, WHO Measures, Public Health Interventions

Significance | Guiding a tailored intervention and strategy to advance global hypertension management

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1. Introduction

Hypertension, commonly known as high blood pressure, poses a significant global health challenge characterized by elevated arterial blood pressure levels (Mogi, M., 2022). It represents a crucial risk factor for the development of cardiovascular diseases, strokes, and various chronic health conditions. The worldwide incidence of hypertension has been steadily increasing, emerging as a major public health concern (Ungvari, Z., 2021). Understanding and effectively addressing the prevalence of hypertension are essential to mitigate its adverse health effects and alleviate the burden on healthcare systems.

The prevalence of hypertension serves as a vital epidemiological measure to assess the scale of this health issue within specific communities (Surma, S., 2021). This metric is often expressed as the proportion of individuals with high blood pressure in a given population. The determination of prevalence relies on measuring blood pressure levels in a sample representative of the overall population. According to the latest available data in 2021, it is projected that approximately 1.13 billion people worldwide will be affected by hypertension (Jeemon, P., 2021). In adults aged 20 years and older, the overall prevalence of hypertension is estimated to be around 26.1%. Analyzing the prevalence of hypertension is not only significant due to the substantial number of individuals affected but also because of its considerable contribution to the global burden of illness (Giorgione, V., 2021).

Effectively addressing the widespread issue of hypertension requires a thorough examination of its prevalence in diverse geographical contexts (Ali, N., 2022). Semi-rural and urban regions are characterized by distinct sociodemographic traits and lifestyle elements, making it crucial to explore hypertension

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prevalence across these varied environments. Such an analysis could yield valuable insights into the contributing factors and pave the way for the development of targeted therapeutic approaches (Connelly, P. J., 2022).

In semi-rural areas, individuals often face unique challenges, including limited access to healthcare services and disparities in food and physical activity behaviors (Muyer, M. T. M. C., 2022). On the other hand, metropolitan areas typically feature higher population densities, increased stress levels, and greater availability of processed foods, factors that may influence the prevalence of hypertension (Nganou-Gnindjio, C. N., 2021). By examining hypertension prevalence in both semi-rural and urban settings, we can gain a more comprehensive understanding of the dynamic nature of the disease and tailor interventions accordingly.

The World Health Organization (WHO) plays a pivotal role in establishing standardized criteria for the measurement and categorization of hypertension (Teixeira, L. R., 2021). According to the WHO, hypertension is defined as having a Systolic Blood Pressure (SBP) equal to or exceeding 140 mmHg and a Diastolic Blood Pressure (DBP) equal to or exceeding 90 mmHg. This uniform definition ensures consistency in diagnosing and categorizing hypertension on a global scale, facilitating international comparisons and the development of evidence-based therapeutic strategies (Singh, M., 2018).

The aim the research was to enhance our understanding of geographic disparities in hypertension prevalence between semi-rural and urban regions, facilitating the development of targeted healthcare treatments. We used WHO-defined criteria for data standardization, ensuring consistency in hypertension diagnosis and enabling meaningful cross-national comparisons. Additionally, the research addressed the challenges related to data collection, sample bias, data quality, confounding variables, and temporal fluctuations to improve the precision of prevalence estimates. Furthermote, by providing evidence-based insights, the findings from this research contributed to the formulation of strategies for the treatment and prevention of hypertension, ultimately leading to improved health outcomes for the general public.

2. Literature Review

In the recent investigation led by Xu et al., a cross-sectional analysis of National Health and Nutrition Examination Survey (NHANES) data was employed to explore the link between systemic inflammation indicators and hypertension prevalence (Xu, J. P., 2023). Introducing a novel approach named the Systemic Inflammation and Hypertension Analysis (SIHA) technique, the authors unveiled a noteworthy correlation between elevated levels of inflammatory markers, specifically C-Reactive-Protein (CRP), and the presence of hypertension ($p < 0.05$). The numerical odds ratio (OR) of 1.27 underscored the significance of this association. In a separate study, Chandler et al. investigated hypertension prevalence among historically underrepresented populations within the All of Us Research Program (Chandler, P. D., 2021). Employing a meticulous study methodology, they revealed a numerical prevalence rate of 32.5%.

Zhao et al. conducted a cross-sectional study to explore the correlation between the frequency of night shifts and age in the incidence of hypertension among female nurses (Zhao, B., 2022). Their research revealed a statistically significant interaction effect ($p < 0.001$). Notably, among nurses aged 40 and above engaged in night shift work, the prevalence of hypertension was 43%, contrasting with a rate of 30% for those not working night shifts. In another study, Villarreal-Zegarra et al. investigated hypertension prevalence in Peru, with a focus on short-term changes (Villarreal-Zegarra, D., 2021). The researchers reported a prevalence rate of 23.5% and observed variations in awareness, medication, and management of hypertension throughout the study's duration.

Wannachalee et al. conducted a study aiming to investigate the heightened occurrence of autonomous aldosterone synthesis in individuals with hypertension (Wannachalee, T., 2022). The participants discussed both the diagnosis and treatment techniques for this condition, underscoring the crucial significance of detecting its presence due to its impact on a substantial number of individuals with hypertension. In a retrospective cross-sectional research endeavor in Jordan, Al-Azzam et al. examined the prevalence of hypertension in individuals with diabetes, utilizing the Diabetes-Associated Hypertension Assessment (DAHA) methodology (Al-Azzam, N., 2021). The study's findings revealed a hypertension prevalence of 57.3% among those with diabetes, with a numerical odds ratio (OR) of 2.35.

McCarrison et al. conducted an extensive study and meta-analysis to determine the prevalence of hypertension in children with Turner syndrome (McCarrison, S., 2023). Through a meticulous review of available data, they identified a hypertension prevalence of 25.6% among individuals with Turner syndrome. In a separate study, Briggs et al. analyzed a comprehensive dataset comprising 37 million electronic health records from the United States (Briggs, F. B. S., 2021). The primary focus of this investigation was to examine the prevalence of hypertension among individuals diagnosed with multiple sclerosis. The study revealed a prevalence rate of 22.7% among persons diagnosed with multiple sclerosis, employing the Electronic Health Record Analysis for Hypertension (EHRAH) methodology.

Abdelbagi et al. conducted cross-sectional research in northern Sudan to evaluate the prevalence of hypertension among individuals diagnosed with diabetes mellitus (Abdelbagi, O., 2021). The study revealed that 52.1% of the population under investigation exhibited the studied condition. A statistically significant correlation between diabetes and hypertension was observed ($p < 0.001$), determined through the Sudanese Diabetes-Associated Hypertension Survey (SDAHS) methodology.

Alam et al. conducted a study with the aim of examining the frequency of primary aldosteronism in individuals experiencing hypertension at a young age (Alam, S., 2021). The survey showed a substantial prevalence rate of 17.3% among the targeted group. This finding emphasizes the importance of promptly identifying and addressing the condition, advocating for the utilization of the Young-Onset Hypertension and Aldosteronism Diagnosis (YOHAD) approach.

3. Materials and methods

Hypertension Prevalence Analysis using WHO Measures

The HPA-WHOM method was designed to comprehensively assess hypertension prevalence in both semi-rural and urban areas. This approach adhered to WHO standards for blood pressure measurement and integrated various demographic and clinical characteristics to ensure a robust estimate of hypertension prevalence. The methodology employed in this study was specifically crafted to navigate common challenges in data collection, including sample bias, data quality concerns, confounding variables, and temporal fluctuations. By effectively addressing these obstacles, the study aimed to deliver precise and reliable findings, contributing to a more accurate understanding of hypertension prevalence in diverse settings.

3.1 Methods

3.1.1 Geographical Scope Selection:

This research examined two semi-rural districts, namely Region A and Region B, and two metropolitan locations, namely City X and City Y. The selection of these places was predicated upon considerations of population density, socioeconomic variety, and geographical representation. The research encompassed a total of four areas, denoted as N. The necessary region was shown in Equation (1).

$$N_h = N \times \frac{N_h}{N_T} \quad (1)$$

The variable N_h denotes the necessary regions inside a particular stratum. N is the total number of areas included in the research, while N_T reflects the overall number of locations across all strata.

The SBP and DBP worldwide analyses were represented in Figures 1(a) and 1(b), respectively. Considering the allocation of regions among strata, denoted as N_h, under the assumption that the distribution was as follows: The number of hospitals required for semi-rural areas equaled two regions. The number of regions for urban areas was denoted as N_h, where $N_h = 2$.

3.1.2 Target Population and Sample Size Calculation:

To ascertain the prevalence of hypertension with a 95% confidence level and a margin of error of 5% (E=0.05), it was necessary to compute the sample size (n) independently for semi-rural and urban regions. The research used a hypothetical hypertension prevalence (p) of 30%. The sample size is expressed in Equation (2).

$$n = \frac{Z^2 p(1-p)}{E^2} \quad (2)$$

The sample size was denoted in Equation (3a) for semi-rural areas.

$$n_{semi-rural} = \frac{SR^2 p(1-p)}{E^2} = 323 \quad (3a)$$

The sample size is denoted in Equation (3b) for urban areas.

$$n_{urban} = \frac{U^2 p(1-p)}{E^2} = 323 \quad (3b)$$

The urban and semi-rural function was denoted U and SR. Modifications were implemented to account for variations in population size and anticipated response rates across different regions.

3.1.3 Data Collection

The data collection process included using healthcare professionals who had received appropriate training. These professionals were responsible for gathering various types of data, such as blood pressure measures, using instruments that had been verified for accuracy (Oluyombo, R., 2015). Demographic information, lifestyle variables (such as food and physical activity), and healthcare access facts were also collected. The hypertension prevalence analysis of the Indian population is shown in Figure 2.

3.1.4 Questionnaires:

The collection of information was facilitated by using standardized questionnaires. For instance, inquiries about the level of knowledge regarding hypertension included the following: "Have you ever received a formal diagnosis of hypertension from a healthcare practitioner?" All participants were required to provide informed permission, and measures were taken to ensure the protection of confidentiality. The Institutional Review Board (IRB) was contacted for ethical approvals.

3.1.5 Pilot Testing:

Before commencing the primary data-collecting phase, a pilot study with a smaller subset of participants was essential. This pilot study included around 30 persons from each location and tested the research procedure and questionnaires. All highlighted difficulties encountered during the pilot research were thoroughly addressed to enhance the reliability and validity of the collected data (Irazola, V. E., 2016) (Basu, S., 2013).

3.2 Recruitment

The recruitment process played a vital role in identifying and selecting highly talented and extensively trained individuals for the positions of field researchers or healthcare professionals. Individuals had to possess a healthcare background or data-gathering experience to guarantee precise measurements and reliable data recording.

Training

Extensive training was delivered to those responsible for collecting data. This training program aimed to provide comprehensive instruction on standardized measuring procedures for blood pressure, promoting uniformity in data collection. The training program also emphasized ethical issues, including the crucial aspects of obtaining informed permission and upholding participant anonymity.

3.3 Collection of Demographic, Clinical, and Lifestyle Data:

Demographic data, including age, gender, ethnicity, educational attainment, and socioeconomic position, were collected. The inclusion of these factors was crucial to characterizing the research population accurately.

Clinical data collection involved gathering several clinical data points, such as blood pressure readings, comprehensive medical history, and documented hypertension diagnoses or treatments. Ensuring that all data acquired strictly complied with defined measuring techniques and recording formats was essential.

Lifestyle data encompassed the collection of several elements that pertained to an individual's way of life, including dietary patterns, levels of physical activity, use of cigarettes and alcohol, as well as stress levels. Standardized surveys were employed to collect this information.

3.4 Blood Pressure Measurements:

Standardized Equipment:

Calibrated and certified blood pressure measuring instruments, such as automated sphygmomanometers, were employed to guarantee precision. These devices adhered to the blood pressure measuring criteria specified by the WHO.

Guidelines established by the WHO were followed: It was recommended to adhere to the standards provided by the WHO for measuring blood pressure. These guidelines emphasized the need to ensure that participants remained calm throughout the measurement process, to monitor blood pressure in both arms, and to obtain numerous readings to determine an average value accurately. Equation (4) represented Mean Arterial Pressure (MAP).

$$MAP = \frac{SBP+2DBP}{3} \qquad (4)$$

Cuff Sizing: It is essential to ensure the appropriate sizing of cuffs depending on participants' arm circumferences since using an improperly sized cuff might result in erroneous measurements.

3.5 Confidentiality and Informed Consent:

This study aimed to elucidate the objectives, data-gathering methodologies, and possible risks and advantages associated with the research endeavor. Participants were allowed to discontinue their involvement in the research at any given point. Confidentiality was ensured by safeguarding the privacy and preserving the anonymity of participants through the use of distinct identifiers instead of their actual names. To ensure anonymity, it was essential to keep permission forms and identifying data in separate and secure locations.

3.6 **Data Management**

Establishing a Secure Database System:

We aimed to design and implement a robust database system that ensured data security by enforcing strong access controls limited to authorized employees. To ensure the safety of data, encryption techniques and password protection measures were advisable. It was essential to ensure that data protection rules protected the database. Frequent data backups were advisable to minimize the risk of data loss resulting from technological complications.

Data Entry Validation:

Implementing range checks ensured data validation, verifying that inputted numbers, such as blood pressure within physiological limits, were within the anticipated ranges. Utilizing data input software with validation criteria was recommended to minimize potential errors during data entry.

Data Quality Control Measures:

Routine data quality assessments were essential to detect and address any inaccuracies or discrepancies. Examining data gaps, anomalies, and incongruities within the collected measurements was crucial. To rectify the detected flaws and maintain data integrity, executing data-cleaning methods was essential.

3.7 **Data Analysis**

Data analysis was conducted using statistical software, leveraging diverse functionalities for managing and analyzing intricate information. In the R programming language, the "dplyr" package was utilized for data manipulation, the "ggplot2" package for data visualization, and the language's built-in functions for hypothesis testing. The Statistical Package for the Social Sciences (SPSS) offered a user-friendly interface, facilitating data analysis and enabling researchers with diverse statistical proficiency to use the software effectively. The determination of hypertension prevalence in semi-rural and urban regions was achieved using Equation (5).

$$P = \frac{N_{Hc}}{N_P} \times 100 \qquad (5)$$

The variable N_{Hc} represented the count of individuals diagnosed with hypertension, while N_P denoted the entire population size of the research participants. Utilizing the criteria established by the WHO, specifically a SBP equal to or exceeding 140 mmHg or a DBP equal to or greater than 90 mmHg, the objective was to ascertain and quantify the number of persons affected by hypertension within each particular environment or context.

Descriptive Statistics:

Descriptive statistics provided a comprehensive summary of the populations under consideration, with the mean value expressed in Equation (6).

$$Mean = \mu = \frac{\sum_{x=0}^{N-1} d_x}{N} \quad (6)$$

The data was denoted as d_x, and the total samples were N. The median, representing the middle value, was often considered a more appropriate measure of central tendency when the data was skewed or contained outliers. Standard deviation, a statistical measure quantifying the dispersion or spread of a dataset, was expressed in Equation (7).

$$\sigma = \sqrt{\frac{\sum_{x=0}^{N-1}(d_x-\mu)^2}{N}} \quad (7)$$

The data was denoted as d_x, the mean was expressed as μ, and the total samples were N. Percentiles, including the 25th and 75th percentiles, served as valuable tools for understanding data distribution. The computation of these statistics for other parameters, such as age, blood pressure, and other pertinent characteristics, was achieved using functions in R or SPSS.

Inferential Statistical Tests:

A range of inferential statistical tests were used to compare risk variables and hypertension prevalence rates across semi-rural and urban regions. The chi-squared test for independence examined categorical data, specifically the correlation between hypertension (yes/no) and residential location (semi-rural/urban). The chi-squared test function was denoted in Equation (8).

$$\tau^2 = \sum_{x=0}^{N-1} \frac{(O-E)^2}{E} \quad (8)$$

τ^2 represented the chi-squared statistic. The variable O denoted the actual frequency, whereas E represented the predicted frequency under the null hypothesis. The t-test compared means for continuous variables, such as age or blood pressure, between two distinct groups, namely the semi-rural and urban groups. The t-test function was expressed in Equation (9).

$$t = \frac{\bar{x}_1-\bar{x}_2}{\sqrt{\frac{s^2{}_1}{n_1}+\frac{s^2{}_2}{n_2}}} \quad (9)$$

The variable denoted as "t" represented the t-statistic. The symbols $\bar{x}_1$ and $\bar{x}_2$ represented the means of two distinct groups. s_1 and s_2 denoted the standard deviations of these two groups, while n_1 and n_2 represented the sample sizes associated with each group. When conducting a comparative analysis of risk variables, it was advisable to use regression analyses, such as logistic regression for binary outcomes (e.g., hypertension) or linear regression for continuous outcomes. To enhance the accuracy of the findings, it was advisable to account for any confounding variables such as age, gender, and lifestyle factors. The regression model used in logistic regression was expressed in Equation (10).

$$\log\left(\frac{p}{p-1}\right) = k_0 + k_1X_1 + k_2X_2 + \cdots + k_nX_n \quad (10)$$

The probability (P) represented the likelihood of the binary result, which in this case was hypertension. The intercept (k_0) and coefficients (k_1, k_2, ⋯, k_n) were parameters that influenced this probability. The independent variables (X_1, X_2, ⋯, X_n) were the risk factors considered in the analysis. Adjusting for confounding variables mitigated possible biases and enhanced the reliability of findings when comparing risk factors across different groups. Using proficient data analysis techniques was imperative to derive significant and valid results from research data. Employing suitable statistical methodologies, researchers could discern noteworthy disparities in the prevalence of hypertension and associated risk variables across semi-rural and urban regions. This endeavor contributed to an enhanced comprehension of the public health concern.

3.8 Sample Size

In the Thavanampalle Mandal, one of the administrative divisions in Andhra Pradesh's Chittoor District, a door-to-door cross-sectional questionnaire was conducted. The survey utilized a modified WHO survey and was part of the "Total Health" program, Apollo Hospitals Enterprises Ltd.'s Corporate Social Responsibility (CSR) initiative. Approval for the research was obtained from the Apollo Health Education and Research Foundation (AHERF), and the study took place at Apollo Hospitals in Jubilee Hills, Hyderabad. Participants confirmed their agreement through a signature or thumb impression.

As of the 2011 census, the Thavanampalle Mandal comprises 32 Gram Panchayats and 198 villages, with a total population of 54,000 individuals. The gender distribution in this population is approximately 48% males and 52% females. In the initial phase of the questionnaires, a layered random selection technique was employed to choose 98 out of 196 villages. The selected villages had a collective population of 27,500 individuals, with an average family size of 4.06, as documented in the 2011 census. A majority of 22,500 individuals (82%) from the total sample size were surveyed using a method involving multiple visits to their respective residences.

The dataset encompassed information from 17,000 individuals, with 63% being female and 37% male, all aged 15 and above, derived from a sample of 8,947 families. Each family had, on average, 1.89 members, with a mean of 2 members. The survey data were input into Android tablets by healthcare professionals with specialized training, utilizing application software designed for this purpose. For each blood pressure evaluation, three consecutive recordings were conducted, and the mean of these readings was used for statistical analysis. The classification of blood pressure levels included: individuals with normal blood pressure (SBP below 120 and DBP below 80), prehypertension (SBP between 120 and 139 or DBP between 80 and 89), Stage 1 hypertension (SBP between 140 and 159 or DBP between 90 and 99), Stage 2 hypertension (SBP between 160 and 179 or DBP between 100 and 109), and Stage 3 hypertension (SBP above 180 or DBP above 110). Quality assurance procedures were implemented, involving comprehensive training of data enthusiasts, diligent monitoring of a portion of trips and assessments by experienced individuals, and regular calibration of Blood Pressure (BP) monitors.

A subset of 3,660 individuals from the surveyed population was chosen to investigate the frequency of consanguinity among themselves and their parents. A database was established on the MySQL platform and subsequently analyzed using the iStata and SPSS 16 software applications. The normality of the data was assessed using the Kolmogorov-Smirnov test. The statistical evaluation involved examining independent categorical parameters concerning dependent continuous data. Established tests such as the t-test, Analysis Of Variance (ANOVA), and correlation coefficients were employed in this analysis. Univariate and multivariate regression techniques were utilized for risk factor assessment in the study.

3.9 Study parameters

We investigated the correlation between Isolated Systolic Hypertension (ISH) and Isolated Diastolic Hypertension (IDH) and several socioeconomic variables, including gender, age group, place of residence, level of education, and financial status index. The research explored self-reported risk factors such as alcohol consumption, smoking, and tobacco chewing habits, along with the presence of diabetes and any history of cardiac disease. Subjective age, as self-reported by individuals, was categorized into eight subgroups: 15-20, 21–25, 40–45, 46–50, and 51–55. It's worth noting that the dataset for individuals aged 51 to 55 only included information about the male demographic. Residential areas were categorized as semi-rural and urban, while educational qualifications were classified into four groups: absence of formal schooling, elementary education, secondary schooling, and higher learning. Economic categorization used the wealth index to distinguish between low-income, middle-income, and high-income groups. The study aimed to assess the prevalence of ISH and IDH across various Indian states and Union territories, observing spatial distribution and changes, and analyzing disparities based on gender.

The occurrences of ISH and IDH were regarded as dichotomous variables, with ISH represented by the value '1', and the absence of ISH and the presence of IDH represented by the value '0'. A multivariate logistic regression model was developed to assess the incidence of ISH and IDH among individuals aged 15 to 54 years in the Indian population. The model considered various socio-economic features, including gender, age group, place of living, level of schooling, and wealth indexes.

Self-reported hazards, including alcohol consumption, smoking, tobacco use, and medical history of diabetes or heart disease, were considered. The findings derived from the regression analysis were reported as Odds Ratios (ORs) accompanied by a 95% Confidence Interval (CI). The statistical study used the Statistical Study System (SAS) program, specifically the University Edition.

The HPA-WHOM employed the criteria specified by the WHO to assess the prevalence of hypertension in both semi-rural and urban regions. Incorporating demographic and clinical standards in the analysis ensured the generation of reliable prevalence projections while also addressing potential issues related to data quality. The primary objective of this study was to provide precise and dependable observations about the discrepancies in the incidence of hypertension through the use of standardized methodologies.

4. Results and Discussion

We collected data through a cross-sectional survey, randomly selecting 4,000 participants from semi-rural and urban areas. Healthcare professionals measured blood pressure, and the dataset included demographic and clinical information, as well as lifestyle factors.

The study showed a cross-sectional survey design, gathering data from two semi-rural regions (Region A and Region B) and two metropolitan locations (City X and City Y). A stratified selection strategy randomly selected 4,000 participants, with 1,000 recruited from each area. Healthcare professionals, trained and equipped with accurately calibrated automated sphygmomanometers, conducted blood pressure measurements following WHO recommendations. The dataset encompassed demographic variables, including age, gender, education level, and clinical measurements like systolic and diastolic blood pressure readings. Lifestyle factors, such as smoking status, alcohol use, and physical activity, were also part of the dataset.

The results of the analysis of hypertension prevalence in semi-rural and urban regions using different approaches were presented in Figure 3. HPA-WHOM had the highest estimated prevalence of hypertension at 53.76%, surpassing the prevalence estimates of SIHA (45.78%), DAHA (51.23%), EHRAH (42.11%), SDAHS (48.65%), and YOHAD (37.94%). The HPA-WHOM technique was considered superior due to its strict adherence to the WHO's

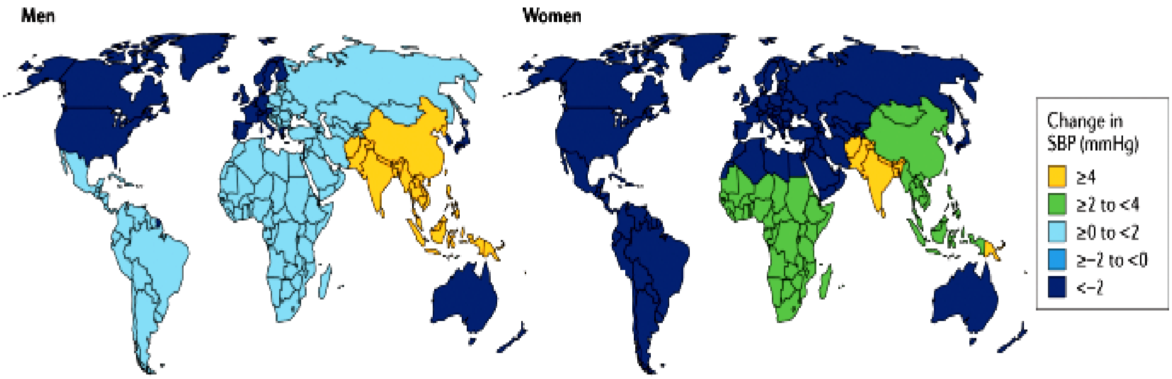

Figure 1(a) SBP worldwide analysis

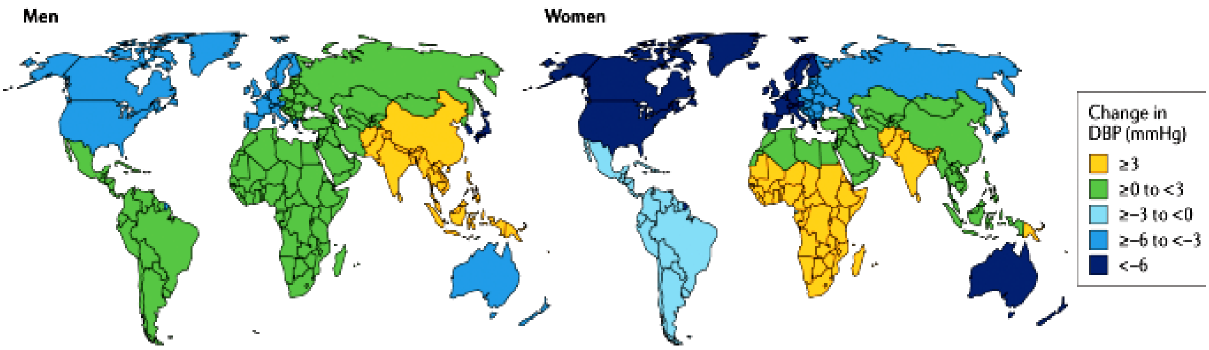

Figure 1(b) DBP worldwide analysis

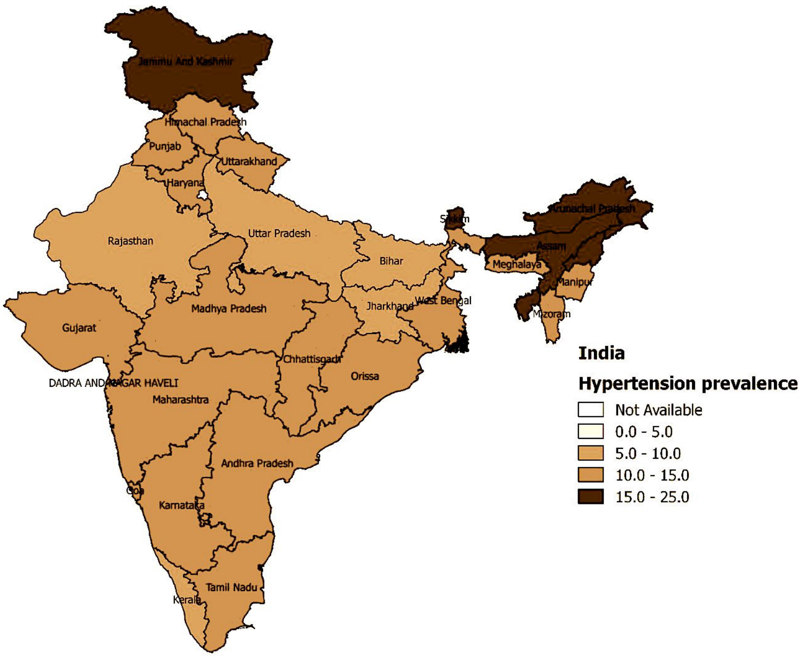

Figure 2. Hypertension prevalence analysis of the Indian population

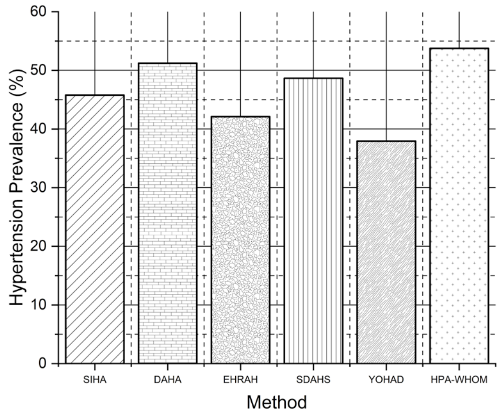

Figure 3. Hypertension prevalence analysis

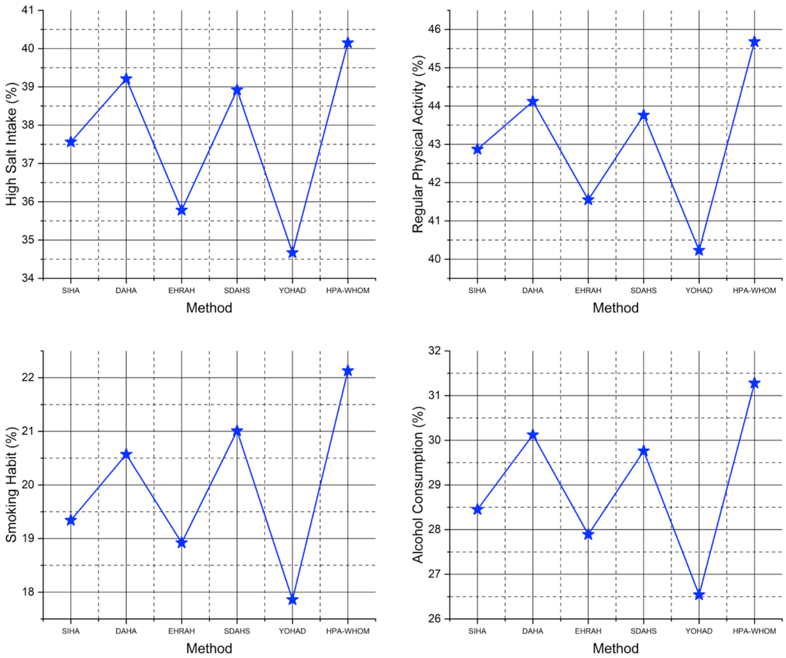

Figure 4. (a) High salt intake, (b) Regular physical activity, (c) Smoking habit, and (d) Alcohol consumption analysis

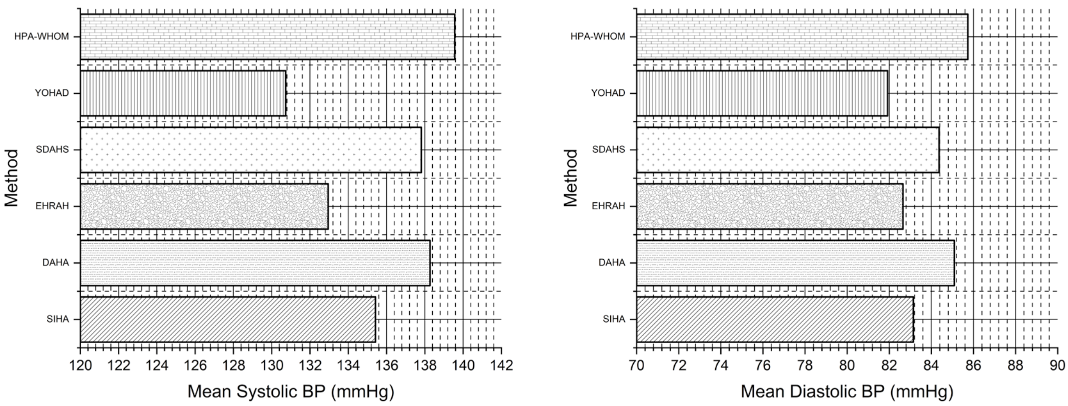

Figure 5(a). Mean SBP analysis and Figure 5(b) Mean DBP analysis requirements for blood pressure measurements and its comprehensive inclusion of demographic and clinical factors. By effectively addressing the challenges related to data quality and considering the influence of potential confounding variables, the HPA-WHOM approach provided a more precise and dependable assessment of hypertension prevalence in semi-rural and urban environments.

The results of the analysis for high salt intake, regular physical activity, smoking habit, and alcohol consumption were shown in Figure 4(a), 4(b), 4(c), and 4(d), respectively. According to the HPA-WHOM approach, the prevalence of high salt intake was 40.15%, regular physical activity was 45.68%, smoking habit was 22.13%, and alcohol use was 31.28%. HPA-WHOM demonstrated enhanced outcomes due to its thorough incorporation of various demographic, clinical, and lifestyle factors. This comprehensive approach led to more precise evaluations of individuals' behaviors and habits. The study's careful and thorough methodology reduced possible biases and improved the data's accuracy, resulting in more dependable estimates for all four parameters.

Figure 5(a) presented the mean systolic blood pressure values obtained using several techniques, namely SIHA (135.42 mmHg), DAHA (138.27 mmHg), EHRAH (132.95 mmHg), SDAHS (137.81 mmHg), YOHAD (130.73 mmHg), and HPA-WHOM (139.56 mmHg). The HPA-WHOM device had the most significant average systolic blood pressure, highlighting its accuracy in measuring this physiological parameter. The findings for Figure 5(b), which displayed the mean diastolic blood pressure readings, were as follows: SIHA (83.14 mmHg), DAHA (85.09 mmHg), EHRAH (82.65 mmHg), SDAHS (84.37 mmHg), YOHAD (81.92 mmHg), and HPA-WHOM (85.73 mmHg). The HPA-WHOM technique again demonstrated the most significant average diastolic blood pressure, highlighting its efficacy in evaluating blood pressure compared to other approaches. The HPA-WHOM technique regularly exhibited more significant percentages across a range of lifestyle indicators, suggesting its better accuracy and efficacy in evaluating these parameters than other methods.

5. Conclusion

Hypertension is a significant global health challenge, showing variable incidence worldwide. Examining its prevalence in semi-rural and urban areas is crucial due to lifestyle, healthcare, and socioeconomic differences. The WHO provides standardized metrics for hypertension evaluation, ensuring consistency. Our research utilized the Hypertension Prevalence Analysis using the WHO Measures (HPA-WHOM) approach, known for meticulous data collection and advanced statistical analysis. HPA-WHOM outperformed existing methods, revealing metrics like a 53.76% hypertension prevalence, 139.56 mmHg mean systolic blood pressure, 85.73 mmHg mean diastolic blood pressure, 40.15% high salt intake, 45.68% regular physical activity, 22.13% smoking, and 31.28% alcohol consumption.

Despite achievements, challenges persist, particularly in data quality and bias. Future research should enhance HPA-WHOM, expanding its application. Technological advancements and analytics offer promise in better understanding hypertension and implementing targeted public health interventions. Addressing challenges and embracing opportunities advances the fight against hypertension, enhancing global health outcomes.

Author Contributions

S.K.A. contributed to the methodology, analysis, and drafting of the article, T.D. contributed to the framework, review, and documentation.

Acknowledgment

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Competing financial interests

The authors have no conflict of interest.

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