**HYPERTENSION: SILENT DESTROYER**

VARSHA SANE: EUID: vs1625

SAI SHIVANI PARIMI: EUID: sp3403

SUNITHA BYRAPAKA: EUID: sb3073

RIA SINGH: EUID: rs1711

**Medical Condition: I10**

**Data Source: MEPS**

**Number of Data Records: 5929**

HYPERTENSION: SILENT DESTROYER

**INTRODUCTION**

Hypertension is a widespread illness that is becoming more and more prevalent. Based on data from the World Health Organization, the total number of adults globally with hypertension has doubled since 1990, to 1.28 billion. The average systolic blood pressure was 127.0 mmHg for males and 122.3 mmHg for women, according to studies by Mills, K. T. (2016) and Zhou, B. (2015), while the normal diastolic BP was 78.7 mmHg for men and 76.7 mmHg for women. The American College of Cardiology–American Heart Association (ACC–AHA) Hypertension Guideline implemented a newer range in 2017, the systolic blood pressure and diastolic blood pressure shouldn't be more than 130mm Hg and 80 mm Hg respectively (Whelton PK et al., 2017). Although, in past years hypertension was defined with the blood pressure value of 140/90 mm Hg or more. Higher blood pressure was more prevalent in South Asia, Africa, and Central and Eastern Europe.

The primary causes of this increase are aging populations and increasing exposure to lifestyle-related risks (Katherine T. Mills et al.,2020). Of these, 42% are not getting treatment for their hypertension. Unexpectedly, only 50% of hypertension individuals who are told to take medication have their blood pressure controlled according to standards. More than half of all cases of stroke and coronary heart disease (CHD) are triggered by hypertension, which is the leading cause of risk for death in the world. Blood pressure (BP) is regularly linked to both heart attacks and strokes as well as chronic renal disease. However, we need to make choices on both diagnosis and medication based on blood pressure limits. (Elizabeth Adeyeye et al., 2022).

**Types and Causes**

There are 2 types of hypertensions - Essential and Secondary hypertension. Essential is characterized by elevated BP without secondary causes like renovascular disease, renal failure, pheochromocytoma, aldosteronism, or other factors leading to secondary hypertension or Mendelian forms (monogenic). This contributes to 95% of high blood pressure cases. The cause for this type of hypertension is not completely known as this is due to genetic variations and phenotypes that regulate blood pressure. Factors that contribute to this are poor intake of potassium and calcium, age, stress, excessive alcohol and salt intake, insulin resistance, and obesity (Carretero et al.,2000).

Secondary hypertension is when blood pressure is raised because of a known cause.

1. Hypertension impacts more than half of the people with renal parenchymal disease.

(Connell et al., 2008) and it rises as renal parenchymal disorders worsen (Roa et al., 2008)

2. As a result of an overproduction of hormones, several endocrine disorders have been proven to be causative agents for high blood pressure. For example, certain endocrine diseases have traditionally been linked with secondary hypertension: primary aldosteronism, pheochromocytoma, and Cushing's syndrome. Among these primary aldosteronism is the most prominent in most of those cases (Sica,D. A. 2008).

3. Renovascular disorders have been identified to cause hypertension, which is rare and is caused by to narrowing of one or both renal arteries (Mannemuddhu et al., 2020). In older individuals, atherosclerosis has been identified as the main reason for renal artery stenosis while in younger females fibromuscular hyperplasia has been determined to be the main origin of this condition (Ramet al.,1995).

4. The classic example of the vascular cause of secondary hypertension in young adults is the coarctation of the aorta. (Kim et al., 2020)

5. Obstructive sleep apnea, polycystic ovarian syndrome, and preeclampsia medications are also associated with secondary hypertension. (Kapa et al., 2008)

6. A review of a patient's drug is essential as drug-induced hypertension is considered one of the major causes of secondary hypertension. The list of such medications that can increase blood pressure includes but is not limited to NSAIDs, sodium-containing antacids, ADHD medications antidepressants, etc. (Masi et al.,2019)

**Risk and Influential Factors**

1. Hypertension is a highly prevalent disease whose incidence sharply increases as people get older. (Buford, T. W. 2016)
2. With regard to the modifiable conditions, obesity accounted for 38.2% of the weighted PAR%, whereas poor physical activity and sedentary behavior together were responsible for 3.1% (Hou & Yang,2024).
3. In developed nations, those who have a family history of hypertension have been estimated to have a danger of developing high blood pressure up to four times higher than compared to the average person. (Mills, K. T. 2016)
4. Cardiovascular disease (CVD) is the primary contributor to preventable illness which accounts for 7.1 million annual deaths. Smoking and drinking are a significant risk factor for heart disease, consumption of these has a direct link with hypertension (Venkataraman et al., 2024).
5. Patients with hypertension are more likely to have obstructive sleep apnea than the local population. (Floras,2015). OSA is identified in epidemiological evidence as a prevalent and modifiable factor in the development of HTN (Konecny et al.,2014)
6. Socioeconomic status (SES) is a prominent risk indicator for high blood pressure

(Busingye et al., 2014). Low SES is linked with higher blood pressure (Leng, B et al., 2015). High-income areas like the Western world and the Asia-Pacific region have lower blood pressure.

**Treatment & Management**

Treatments for hypertension include both pharmacologic and nonpharmacologic approaches. Guidelines issued by ACC–AHA in 2017 recommends estimating the 10-year risk of cardiovascular disease for those with stage 1 hypertension who do not have any of these conditions (Whelton PK et al., 2017).

The first-line therapy of hypertension is a topic of debate. Based on the JNC-7 report, beta-blockers and thiazide diuretics are highlighted as appropriate medications for initial management. It is currently recommended to initiate treatment with an ACE inhibitor for younger individuals and a CCB for older individuals, gradually adjusting the drug therapy until the desired targets are achieved (Gupta, Rajeev & Gupta Soneil,2010). Changes in lifestyle are part of the nonpharmacologic approach, such as limiting daily sodium consumption to 1500 mg (Aburto NJ et al., 2013). controlling our food intake, avoiding alcohol use, increasing intake of foods high in potassium, and losing weight if an individual is obese can all help.

AI helps us to manage hypertension easily. It enables us to support telemedicine and prediction of disease early through machine learning. Using wearable devices like watches and smart phone applications we can continuously monitor the range and take preventive measures (Tsoi et al.,2021).

**Why Did we choose to do this medical condition:**

Adult hypertension treatment cost $47.3 billion in total in 2008, according to MEPS, for all medical treatments. Prescription drugs contributed to more than fifty percent of the costs related to hypertension ($21.3 billion), while outpatient visits ($13.0 billion) and other treatments ($13.0 billion) contributed to the other 27%. The research questions that we hope to have addressed by the end of our project using MEPS data for hypertension. Using MEPS data for hypertension the research questions that we want to find out by the end of our project:

**RESEARCH QUESTIONS**

1. How does the presence of hypertension influence total healthcare expenditures, and what is the extent of its economic burden compared to individuals without hypertension?
2. Is there a significant relationship between hypertension and person weight and how does weight variability contribute to hypertension prevalence?
3. What is the association between hypertension and diabetes diagnoses, and how frequently do these conditions coexist in the studied population?
4. Does a diagnosis of hypertension correlate with the likelihood of coronary heart disease, and what are the implications for cardiovascular health management?

**RELATED WORK**

There are few existing studies that investigated the similar topic which we did:

1. Descriptive statistics were used to estimate the magnitude of out-of-pocket health expenditure, linear regression model was fitted to identify the factors associated with the outcome variable at a significance level of value of *p* < 0.05 and 95% confidence interval. The study concluded that OOP expenses were high compared to national per capita health expenditure, emphasizing the need for improved chronic disease prevention, expanded health insurance, and subsidized medication for low-income patients(Alemayehu et al., 2023).
2. A study utilized IBM SPSS version 25 for statistical analysis, Normality tests were performed, with continuous data presented as mean ± SD or median (IQR) and categorical data as numbers (percentages). Statistical significance was defined as a two-tailed p-value < .05. Analytical methods included:

**Two-sample t-test**, **ANOVA with post hoc tests. Mann-Whitney U and Kruskal-Wallis tests** for non-normally distributed data and **Chi-square test** . For uncontrolled hypertension predictors in diabetic patients with hypertension, univariate binary logistic regression identified significant determinants (p < .2), which were tested in a multivariate logistic model. Correlation tests indicated significant collinearity between non-HDL cholesterol and TC (Total Cholesterol)(r = 0.73, p = .001), and TG (Triglycerides)and AIP (Atherogenic Index of Plasma)

(r = 0.75, p < .001)and separate logistic regression models were used for these variables (Rabizadeh et al., 2021).

1. In a study CLARIFY registry involved 32,703 outpatients with stable coronary artery disease (CAD) across 45 countries (2009–2010), data were collected via standardized electronic forms at baseline and yearly for up to 5 years, recording clinical outcomes, treatments, and blood pressure (BP) measurements. Comparisons between the average PP categories were made using either 1-way ANOVA or the Kruskal–Wallis test for continuous data, depending on the distribution of the data, or the χ2 test for categorical data. This suggests increased cardiovascular risk at both low and high DBP levels in this patient group (Vidal-Petiot et al., 2017).
2. In a study used multiple imputation by chained equations to address missing data, imputing variables such as BMI, physical activity, and dietary habits. Five imputed datasets were generated for analysis. Normality of continuous variables was assessed using the **Kolmogorov-Smirnov test and Quantile-Quantile plots**. Baseline characteristics were summarized using weight-adjusted means for continuous variables and percentages for categorical data, with differences analyzed via weighted linear regression and the **Rao-Scott χ² test.** Multivariate logistic regression models were employed to calculate odds ratios (ORs) and confidence intervals (CIs) for hypertension risk factors, with adjustments for sample weights. Population attributable risk percentages (PAR%) were calculated to estimate the proportion of cases potentially preventable by eliminating specific risk factors. Mediation analysis was conducted to quantify the indirect effects of lifestyle risk factors on blood pressure through overweight/obesity. All analyses used SAS (version 9.4) with statistical significance set at P < 0.05.This study clarified the independent effects of metabolic and lifestyle factors on hypertension. It ranked the modifiable risk factors for hypertension according to weighted PAR%, with overweight/obesity, sedentary behaviour and low physical activity ranked in order (Hou & Yang,2024).

**METHODS:**

**Phase 1 Report on Hypertension**

**Aim of the Report:** The primary aim of this phase is to identify a medical condition for data analysis and gain knowledge about the disease, including its causes, treatments, and influential factors. Our requirement for data analysis was to select a condition that has at least 500 data instances from Medical Expenditure Panel Survey (MEPS).

**Disease of Interest: Hypertension**

* **ICD-10 Code**: I10
* **Dataset Information**: We used MEPS dataset for this analysis, which has 5,929 unique records.

**Dataset Overview**

* **MEPS**: A large-scale survey capturing data from families, individuals, medical providers, and employers in the U.S.
* **Variables**: Includes medical conditions, socioeconomic factors (e.g., gender, income), healthcare costs, and utilization.
* **Steps for Data Extraction**:
  1. **Filter Data**: Extracted records based on the ICD-10 code (I10- Hypertension).
  2. **Count Records**: Total number of records found for hypertension are 6010.
  3. **Remove Duplicates**: Using DUPERSID as an identifier we removed duplicates as got 5929 unique records.

**Outcome:** The dataset met the requirement with more than 500 unique records for hypertension which offered a strong base for further data analysis.

**Phase 2 Report:**

1. **Selection of Patients and Removal of Duplicates**: The dataset h214.csv was filtered using the ICD-10 code I10 to identify patients with hypertension and removed duplicates based on the unique identifier DUPERSID.
2. **Joining Data:** The filtered h214.csv file was merged with h216.csv, a consolidation file containing additional variables.
3. **Variable Selection:** The following variables were considered relevant based on their connection to hypertension and its outcomes:
   1. Demographic and Socioeconomic Factors: SEX, RACETHX, FAMINC19, INSCOV19: Key factors influencing hypertension prevalence and access to healthcare.
   2. EMPST31: Related to stress and healthcare accessibility.
   3. Medical Variables: HIBPDX, BPMLDX, CHDDX, CHOLDX, CHOLAGED, STRKDX, MIDX, DIABDX\_M18: Direct or associated medical conditions and risk factors. PERWT19F, RXNUM, OBDRV19: Indicate disease burden and management.
   4. Behavioral and Lifestyle Factors: MNHLTH31, ACTLIM31, OFTSMK53: Reflect the impact of hypertension on mental health, activity limitation, and modifiable risk factors
   5. Other Variables:TOTTCH19: Captures economic impact.
4. **Processing Missing Data:** Mean imputation was used for numerical variables and mode imputation for categorical variables.
5. **Removal of Outliers:** Thresholds: Lower Bound: Q1−1.5× IQR, Upper Bound: Q3+1.5×IQRQ3

* Rows with more than three outlier attributes were considered extreme and removed. This standard statistical method preserved data integrity while filtering anomalies.

1. **Redundancy Check:** Correlation test such as Person's correlation coefficient for numeric data and Pearson’s χ2 correlation coefficient, degree of freedom, and critical values for categorical data were performed to check for any redundant variables and we found
   1. OFTSMK53 with a high p-value (indicating insignificance) was removed.
   2. CHOLAGED is highly correlated with CHOLDX. So, CHOLAGED is dropped by keeping CHOLDX assuming it is directly associated with health outcomes.
2. **Answering our Research Questions:** Descriptive analysis was performed to answer our research questions which are as follows:
   1. How does the presence of hypertension influence total healthcare expenditures, and what is the extent of its economic burden compared to individuals without hypertension?
   2. Is there a significant relationship between hypertension and person weight and how does weight variability contribute to hypertension prevalence?
   3. What is the association between hypertension and diabetes diagnoses, and how frequently do these conditions coexist in the studied population?
   4. Does a diagnosis of hypertension correlate with the likelihood of coronary heart disease, and what are the implications for cardiovascular health management?

**RESULTS:**

1. **How does hypertension influence health care expenditure?**

**Answer:** To answer this question, we compared **HIBPDX vs TOTTCH19** variables. Before deciding which test needs to be performed, we must see how the data is distributed. Data was found to be not normally distributed which can be seen in the following graphs.

**A graph with a line going up

Description automatically generated**

**Sample with Hypertension**

**A graph with a blue line

Description automatically generated**

**Samples without Hypertension**

* This can also be confirmed by High skewness values for both groups (4.27 and 3.06, respectively) & excessive kurtosis values (24.17 and 9.12, respectively).
* The non-normality of the data suggests that parametric tests (e.g., t-tests, ANOVA) may not be appropriate for statistical analysis. Instead, **non-parametric tests** (e.g., Mann-Whitney U test or Kruskal-Wallis test) should be applied to compare these groups.
* We had used, Mann-Whitney U test and got a p-value (**0.0000126**) which is significantly smaller than the conventional significance threshold ((\alpha = 0.05)). This indicates that there is a **statistically significant difference** in the total healthcare expenditures (TOTEXP16) between individuals **with hypertension** and **without hypertension**.

**Visual representation of results**:

A graph with different colored bars

Description automatically generated

A graph of a graph

Description automatically generated with medium confidence

1. **Is there a significant relationship between hypertension & a person’s weight?**

**Answer:**  To analyze this, we used **HIBPDX vs PERWT19F.** Before deciding which test needs to be performed, we must see how the data is distributed. Data was found to be close to normal for hypertension groups and for non-hypertension group it is not normally distributed which can be seen in the following graphs.

A graph with a blue line

Description automatically generated

**Samples with Hypertension**

A graph with a blue line

Description automatically generated

**Samples without hypertension**

* This can also be confirmed by the Skewness (0.85 & 1.81) and kurtosis (0.95 & 3.75) values which deviate from normality.
* Parametric tests (e.g., t-tests, ANOVA) may be appropriate for the hypertension group but could yield biased results for the non-hypertension group due to its greater skewness and kurtosis. So, Non-parametric tests (e.g., Mann-Whitney U test) was used to analyze them.
* The p-value (**0.0295**) is smaller than the standard significance threshold ((\alpha = 0.05)). This indicates a **statistically significant difference** in the distributions of the variable under consideration between the two groups (e.g., individuals with and without hypertension.

**Visual representation of results:**

A graph of blue and orange bars

Description automatically generated

A graph of a graph with lines and dots

Description automatically generated with medium confidence

1. **Is there an association between hypertension and diabetes?**

**Answer:** To analyze this we used **HIBPDX vs DIABDX\_M18** variables.

* Since these two are categorical variables, we used chi-square test to analyze them.
* **Interpretation:** Since the p-value (**0.00268**) is much smaller than the significance level ((\alpha = 0.05)), suggests that there is a **statistically significant association** between hypertension and diabetes diagnoses

1. **Does a diagnosis of hypertension correlate with the likelihood of coronary heart disease?**

**Answer:** To analyze this we used **HIBPDX VS CHDDX** variables.

* Since these two are categorical variables, we used chi-square test to analyze them.
* Interpretation: The p-value (0.0411) indicates a statistically significant association between hypertension and coronary heart disease. This means individuals with hypertension are more likely to have coronary heart disease (or vice versa).

**Discussion:**

When discussing the results it is also important to interpret the findings and provide their significance.

1. Higher Healthcare Expenditures for Hypertensive Patients:
   1. **Finding**: Compared to people without hypertension, hypertension considerably raises overall healthcare costs (p = 0.0000126).
   2. **Possible Explanation**: This may be due to hypertension, which requires continuous medication, and routine monitoring. Patients with hypertension may also have associated diseases such as diabetes or heart disease, further contributing to higher costs.
   3. **Implication for Future Research**: We should focus on how to reduce the cost in further studies which could reduce burden on both patient and the healthcare system. Moreover, understanding socioeconomic factors such as insurance coverage and income levels might give a more detailed explanation on health care disparities.
2. Association Between Hypertension and Weight:
   1. **Finding:** Hypertensive patients tend to have higher weights compared to non-hypertensive individuals (p=0.0295p = 0.0295p=0.0295).
   2. **Possible Explanation:** This may be due to the fact that obesity is a major risk factor for hypertension.
   3. **Implication for Future Research:** Focusing on weight-management programs for hypertensive patients may help to derive effective outcomes.
3. **Hypertension and Diabetes Coexistence**
   1. **Finding**: There is a strong association between hypertension and diabetes (p=0.00268p = 0.00268p=0.00268).
   2. **Possible Explanation**: Hypertension and diabetes often co-occur as part of metabolic syndrome. Shared risk factors, including obesity, poor diet, and physical inactivity, are probably driving this relationship.
   3. **Implication for Future Research**: Results for managing diabetes and hypertension may be enhanced by combined treatment. Future research could also focus on finding treatment to reduce the risks connected to this double diagnosis.
4. **Hypertension as a Risk Factor for Coronary Heart Disease (CHD)**
   1. **Finding**: Hypertension correlates significantly with CHD (p=0.0411p = 0.0411p=0.0411).
   2. **Possible Explanation**: Hypertension leads to arterial damage and atherosclerosis, which increases the chances of CHD.
   3. **Implication for Future Research**: Research should focus on early detection and treatment of hypertension to prevent its progression to CHD.

**REFLECTION:**

This semester has been a transformative journey through health data analytics, equipping us with practical Python skills for data preprocessing and analysis, and enhancing our understanding of statistical methods like T-tests, Chi-square tests, and correlation analysis. We learned to select appropriate methods for valid results and interpreted complex data patterns, uncovering trends in medical conditions and treatments that can improve patient outcomes. Although challenges like limited data access and result ambiguity were encountered, this experience emphasized the value of technical skills, critical thinking, and collaboration in addressing real-world health problems

**CONCLUSION:**

1. From the 1st research analysis we found that hypertension patients have higher healthcare expenditures than non-hypertensive individuals due to ongoing management, frequent medical visits, and complications. This underscores the need for preventive measures and efficient management strategies to reduce financial strain on the healthcare system.
2. From the 2nd research analysis we found that hypertension is linked to higher weights in individuals, while non-hypertensive individuals may have a broader range of weights. So, this analysis highlights the importance of weight management as a preventive strategy for hypertension.
3. From the 3rd research analysis we found that there is a link between hypertension and diabetes, which aligns with existing medical knowledge that hypertension and diabetes often coexist as part of metabolic syndrome or related health conditions. So, healthcare providers should consider monitoring patients with one condition for the presence of the other to improve management and outcomes.
4. From the last research analysis we found that hypertension may be a major risk factor for coronary heart disease. So, healthcare providers should monitor patients with hypertension for signs of coronary heart disease to improve early diagnosis and treatment outcomes.

**Authorship:**

1. Shivani: Selection of the disease, Literature review, Conduct Research Question 1 using Mann-Whitney U test, Prepare a report for the same, and report for preprocessing as well
2. Varsha: Preprocess and clean the data, Conduct Research Question 2 using Mann-Whitney U test, Prepare report for the same.
3. Ria: Conduct Chi – square test for research question 3 and write a report for the same and a report on reflection
4. Sunitha: Conduct Chi – square test for research question 4 and report for the same and review the tests.

**References**

Alemayehu, M., Addis, B., & Hagos, T. (2023). Out-of-pocket health expenditure and associated factors among patients with hypertension in Debre-Tabor Comphrensive Specialized Hospital, South Gondar zone, Northwest Ethiopia, 2020. *Frontiers in Public Health*, *11*, 1014364. <https://doi.org/10.3389/fpubh.2023.1014364>

Buford, T. W. (2016). Hypertension and aging. Ageing Research Reviews, 26, 96–111. <https://doi.org/10.1016/j.arr.2016.01.007>

Busingye, D., Arabshahi, S., Subasinghe, A. K., Evans, R. G., Riddell, M. A., & Thrift, A. G. (2014b). Do the socioeconomic and hypertension gradients in rural populations of low- and middle-income countries differ by geographical region? A systematic review and meta-analysis. International Journal of Epidemiology, 43(5), 1563–1577. <https://doi.org/10.1093/ije/dyu112>

Carey, R. M., Moran, A. E., & Whelton, P. K. (2022). Treatment of hypertension: a review. *Jama*, *328*(18), 1849-1861. doi:10.1001/jama.2022.19590

Carey, R. M., Moran, A. E., & Whelton, P. K. (2022). Treatment of hypertension: a review. *Jama*, *328*(18), 1849-1861. DOI:10.1056/NEJMcp1613481.

Carretero, O. A., & Oparil, S. (2000). Essential Hypertension. *Circulation*, *101*(3), 329–335. <https://doi.org/10.1161/01.cir.101.3.329>

Cuffee, Y., Ogedegbe, C., Williams, N. J., Ogedegbe, G., & Schoenthaler, A. (2014). Psychosocial risk factors for hypertension: an update of the literature. *Current hypertension reports*, *16*, 1-11. <https://link.springer.com/article/10.1007/s11906-014-0483-3>

Davis, K. E. STATISTICAL BRIEF# 337: Expenditures for Treatment of Hypertension among Adults Age 18 and Older, 2008: Estimates for the US Civilian Noninstitutionalized Population.

Floras, J. S. (2015). Hypertension and Sleep Apnea. *Canadian Journal of Cardiology*, *31*(7), 889-897. <https://doi.org/10.1016/j.cjca.2015.05.003>

Gupta, R., & Guptha, S. (2010). Strategies for initial management of hypertension. *indian Journal of medical research*, *132*(5), 531-542. <https://journals.lww.com/ijmr/fulltext/2010/32050/strategies_for_initial_management_of_hypertension.13.aspx>

Hou, Y., & Yang, S. (2024). Association of risk factors for high blood pressure across 46 low- and middle-income countries: A multi-country cross-sectional analysis. *Journal of Global Health*, *14*. <https://doi.org/10.7189/jogh.14.04087>

Kannel, W. B. (1989). Risk factors in hypertension. *Journal of cardiovascular pharmacology*, *13*, S4-S10. <https://journals.lww.com/cardiovascularpharm/abstract/1989/00131/Risk_Factors_in_Hypertension.3.aspx>

Kapa, S., Kuniyoshi, F. H. S., & Somers, V. K. (2008). Sleep Apnea and Hypertension: Interactions and Implications for Management. *Hypertension*, *51*(3), 605–608. <https://doi.org/10.1161/hypertensionaha.106.076190>

Kim, Y. Y., Andrade, L., & Cook, S. C. (2020). Aortic Coarctation. *Cardiology Clinics*, *38*(3), 337-351. <https://doi.org/10.1016/j.ccl.2020.04.003>

Konecny, T., Kara, T., & Somers, V. K. (2014). Obstructive sleep apnea and hypertension: an update. *Hypertension*, *63*(2), 203-209. <https://doi.org/10.3390/jcm13175001>

Leng, B., Jin, Y., Li, G., Chen, L., & Jin, N. (2015e). Socioeconomic status and hypertension. Journal of Hypertension, 33(2), 221–229. <https://doi.org/10.1097/hjh.0000000000000428>

Lobo, M. D. Elizabeth Adeyeye Vikas Kapil. *MEDICINE*, *50*(7), 399. [https://doi.org/10.1016/j.mpmed.2022.04.002](https://doi-org.libproxy.library.unt.edu/10.1016/j.mpmed.2022.04.002)

Mannemuddhu, S. S., Ojeda, J. C., & Yadav, A. (2020). Renovascular Hypertension. *Primary Care: Clinics in Office Practice*, *47*(4), 631-644. <https://doi.org/10.1016/j.pop.2020.08.009>

Masi, S., Uliana, M., Gesi, M., Taddei, S., & Virdis, A. (2019). Drug-induced hypertension: Know the problem to know how to deal with it. *Vascular Pharmacology*, *115*, 84-88. <https://doi.org/10.1016/j.vph.2019.02.002>

Mills, K. T. et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circulation 134, 441–450 (2016). <https://doi.org/10.1161/CIRCULATIONAHA.115.018912>

Mills, K. T., Stefanescu, A., & He, J. (2020). The global epidemiology of hypertension. *Nature Reviews Nephrology*, *16*(4), 223-237. DOI:10.1038/s41581-019-https://www.nature.com/articles/s41581-019-0244-2

Mills, K. T., Stefanescu, A., & He, J. (2020). The global epidemiology of hypertension. *Nature Reviews Nephrology*, *16*(4), 223-237. <https://doi.org/10.1038/s41581-019-0244-2>

Rabizadeh, S., Gholami, B., Kani, S. M., Rajab, A., Farrokhpour, H., Esteghamati, A., & Nakhjavani, M. (2021). Uncontrolled hypertension in patients with type 2 diabetes: What are the correlates? *The Journal of Clinical Hypertension*, *23*(9), 1776. <https://doi.org/10.1111/jch.14352>

Ram, C. V., Clagett, G. P., & Radford, L. R. (1995). Renovascular hypertension. *Seminars in nephrology*, *15*(2), 152–174.

Rao, M. V., Qiu, Y., Wang, C., & Bakris, G. (2008). Hypertension and CKD: Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES), 1999-2004. *American Journal of Kidney Diseases*, *51*(4), S30-S37. <https://doi.org/10.1053/j.ajkd.2007.12.012>

Sandberg, K., & Ji, H. (2012). Sex differences in primary hypertension. *Biology of sex differences*, *3*, 1-21. <https://doi.org/10.1186/2042-6410-3-7>

Sica, D. A. (2008). Endocrine Causes of Secondary Hypertension. *The Journal of Clinical Hypertension*, *10*(7), 534-540. <https://doi.org/10.1111/j.1751-7176.2008.08097.x>

Taler, S. J. (2018). Initial treatment of hypertension. *New England Journal of Medicine*, *378*(7), 636-644.DOI: 10.1056/NEJMcp1613481

Tsoi, K., Yiu, K., Lee, H., Cheng, M., Wang, D., Tay, C., Teo, B. W., Turana, Y., Soenarta, A. A., Sogunuru, G. P., Siddique, S., Chia, C., Shin, J., Chen, H., Wang, G., & Kario, K. (2021). Applications of artificial intelligence for hypertension management. *The Journal of Clinical Hypertension*, *23*(3), 568-574. https://doi.org/10.1111/jch.14180

van der Sande, M. A., Walraven, G. E., Milligan, P. J., Banya, W. A., Ceesay, S. M., Nyan, O. A., & McAdam, K. P. (2001). Family history: an opportunity for early interventions and improved control of hypertension, obesity and diabetes. *Bulletin of the World health organization*, *79*(4), 321-328.<https://www.scielosp.org/pdf/bwho/v79n4/v79n4a07.pdf>

Venkataraman, R., Bp, S. K., Kumaraswamy, M., Singh, R., Pandey, M., Tripathi, P., Sharath, V., George, J. V., & Dahal, P. (n.d.). *SMOKING, ALCOHOL AND HYPERTENSION*. Cloudfront.net. Retrieved September 27, 2024, from

Vidal-Petiot, E., Greenlaw, N., Ford, I., Ferrari, R., Fox, K. M., Tardif, J., Tendera, M., Parkhomenko, A., Bhatt, D. L., & Steg, P. G. (2017). Relationships Between Components of Blood Pressure and Cardiovascular Events in Patients with Stable Coronary Artery Disease and Hypertension. Hypertension, 71(1), 168–176. https://doi.org/10.1161/hypertensionaha.117.10204

Whaley-Connell, A. T., Sowers, J. R., Stevens, L. A., McFarlane, S. I., Shlipak, M. G., Norris, K. C., Chen, S., Qiu, Y., Wang, C., Li, S., Vassalotti, J. A., & Collins, A. J. (2008). CKD in the United States: Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES) 1999-2004. *American Journal of Kidney Diseases*, *51*(4), S13-S20. <https://doi.org/10.1053/j.ajkd.2007.12.016>

Zhou, B. et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with a systematic review and meta-analysis. Lancet 387, 957–967 (2016). <https://www.julkari.fi/handle/10024/131920>