RESEARCH ARTICLE

Predictors of Pre-Hypertension and Hypertension in Rural Adults: Insights Into the Impact of Yoga, Lifestyle, and Demographic Factors

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ABSTRACT

Background: Hypertension is a leading risk factor for cardiovascular diseases, particularly in rural areas where healthcare access is limited. This study investigates predictors of pre-hypertension and hypertension, with a focus on yoga and lifestyle factors such as physical activity, smoking, and alcohol consumption.

Methods: A cross-sectional study was conducted among rural adults to collect data on demographic factors (age, gender, education level), lifestyle habits (smoking, alcohol, physical activity), and yoga participation. Blood pressure was measured and classified into normal, pre-hypertension, and hypertension categories. Logistic regression was used to identify significant predictors of hypertension and pre-hypertension.

Results: Key predictors of hypertension include age (OR = 0.998), gender (OR = 0.648 for males), and BMI (OR = 1.012). Alcohol consumption was significantly associated with higher hypertension risk (OR = 1.293). Yoga participation, particularly improvements in flexibility, showed a modest reduction in hypertension odds (OR = 0.945). Non-yoga physical activity also demonstrated a protective effect (OR = 0.958).

Conclusion: Lifestyle factors such as alcohol consumption and physical activity play important roles in hypertension risk. While yoga showed some benefits, particularly in flexibility improvements, further research is needed to explore its long-term effects. Public health interventions targeting modifiable risk factors, including yoga, may help reduce the prevalence of hypertension in rural communities.

Keywords: Impact Of Yoga, Pre Hypertension, Hypertension, Rural Population

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INTRODUCTION

Hypertension, commonly referred to as high blood pressure, is one of the leading modifiable risk factors for cardiovascular diseases, contributing significantly to global morbidity and mortality. According to the World Health Organization (WHO), approximately 1.13 billion people worldwide suffer from hypertension, and the condition disproportionately affects populations in low- and middle-income countries where healthcare systems are less equipped to manage chronic conditions[1]. If untreated, hypertension can lead to severe complications such as stroke, heart attack, heart failure, and kidney disease, making it a critical public health issue.

In rural settings, the burden of hypertension is particularly concerning. Rural populations often have limited access to healthcare services, lower health literacy, and fewer resources for preventive measures and lifestyle interventions[2]. Factors such as poor dietary habits, low levels of physical activity, higher rates of smoking and alcohol consumption, and lack of awareness about hypertension contribute to the growing prevalence in these communities. Compounded by socio-economic barriers, the management and prevention of hypertension in rural areas present unique challenges. Studies have highlighted that rural populations often exhibit higher rates of uncontrolled hypertension compared to their urban counterparts[3].

Several demographic and lifestyle factors have been consistently associated with hypertension risk. Age is one of the most established predictors, with the risk of developing hypertension increasing as individuals age due to stiffening arteries and changes in hormonal regulation[4]. Gender also plays a role, with men traditionally exhibiting higher blood pressure levels earlier in life, although post-menopausal women tend to catch up due to hormonal changes[5]. Education level, physical activity, smoking, and alcohol consumption have been repeatedly implicated in influencing blood pressure outcomes, with higher education levels often associated with better health literacy and healthier lifestyle choices, including better management of hypertension[6].

Yoga, a holistic mind-body practice that combines physical postures (asanas), breathing techniques (pranayama), and meditation, has gained attention for its potential benefits in managing various health conditions, including hypertension. Historically rooted in Indian tradition, yoga has become a popular form of exercise and relaxation worldwide. Several studies have demonstrated that yoga can reduce stress, improve cardiovascular health, and

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potentially lower blood pressure by promoting relaxation and reducing sympathetic nervous system activity[7]. The physical postures in yoga help improve flexibility, muscle strength, and circulation, while the breathing techniques and meditation may lower stress and anxiety, which are known contributors to elevated blood pressure[8].

Research into the impact of yoga on hypertension is still evolving, with mixed results. Some studies have found that regular yoga practice can significantly reduce both systolic and diastolic blood pressure, while others have reported more modest effects, particularly when yoga is not combined with other lifestyle interventions such as dietary changes and aerobic exercise[9]. Given its low cost and accessibility, yoga has the potential to be an effective intervention for hypertension, especially in rural populations where resources for managing chronic diseases may be limited. However, more research is needed to fully understand its effectiveness and the specific components of yoga (physical postures vs. meditation) that have the greatest impact on cardiovascular health.

In this study, we aim to investigate the predictors of hypertension and pre-hypertension in a rural population, with a special focus on the role of yoga participation. By examining both demographic and lifestyle factors—including age, gender, education, smoking, alcohol consumption, and physical activity—alongside yoga-related variables, this study seeks to provide a comprehensive understanding of how modifiable risk factors influence blood pressure outcomes in rural settings. Specifically, we aim to assess whether yoga, particularly improvements in physical flexibility, can serve as a protective factor against hypertension and whether it has a unique impact compared to other forms of physical activity.

Objective

To identify key predictors of hypertension and pre-hypertension in a rural adult population, with a focus on yoga participation and its potential role as a modifiable lifestyle factor.

METHODS

Study Design

This was a cross-sectional study conducted in a rural community. Data on demographic, lifestyle, and health-related factors were collected through structured questionnaires and clinical assessments.

Data Collection

Participants aged 18 and older were recruited for the study. Information on demographic variables (age, gender, education), lifestyle habits (smoking, alcohol consumption, physical activity), and yoga participation (session length, satisfaction, and improvements in flexibility) was collected. Anthropometric measurements such as BMI and waist circumference were recorded, and blood pressure was measured following standard guidelines[9].

Outcome Measures

Participants' blood pressure was categorized as follows:

• **Normal**: Systolic BP < 120 mmHg and Diastolic BP < 80 mmHg

• **Pre-hypertension**: Systolic BP 120-139 mmHg or Diastolic BP 80-89 mmHg

• **Hypertension**: Systolic BP ≥ 140 mmHg or Diastolic BP ≥ 90 mmHg

Statistical Analysis

Logistic regression analysis was used to identify significant predictors of pre-hypertension and hypertension. Variables such as age, gender, education, smoking, alcohol, physical activity, BMI, and yoga participation were included in the model. Odds ratios (ORs) were calculated to interpret the effect size of each predictor.

Results

Predictors of Hypertension and Pre-Hypertension

The logistic regression analysis identified several significant predictors of pre-hypertension and hypertension, with a particular focus on lifestyle factors, demographic variables, and yoga participation (See **Table 2** for detailed regression results).

Age: Age showed a weak negative association with hypertension risk (Odds Ratio [OR] = 0.998, Coefficient = -0.0014, p = 0.022). Although the effect was marginal, this aligns with findings that hypertension prevalence increases with age, but other factors, such as lifestyle, may play a more significant role in determining hypertension risk within older populations [2,9].

Gender: Males exhibited a significantly lower risk of hypertension compared to females (OR = 0.648, Coefficient = -0.434, p = 0.034). This contradicts some global data, which show men having a higher prevalence of hypertension[1,6], suggesting that other socio-cultural factors in this rural population might contribute to the elevated risk in women. Potential explanations include differences in physical activity levels, healthcare access, or gender-specific stressors.

Education Level: Higher education was inversely associated with hypertension risk (OR = 0.915, Coefficient = -0.088, p = 0.029). This aligns with existing research, where education level often correlates with better health outcomes due to higher health literacy, better access to resources, and healthier lifestyle choices[4].

Smoking and Alcohol Consumption: Smoking frequency had a mild, unexpected protective effect (OR = 0.949, Coefficient = -0.052, p = 0.045), which could be attributed to potential underreporting or the inclusion of individuals who smoked but had relatively healthier behaviors in other domains. Conversely, alcohol consumption was a strong risk factor for hypertension, with each additional drink per week significantly increasing the odds (OR = 1.293, Coefficient = 0.257, p = 0.018). These findings are consistent with studies that link alcohol to higher blood pressure through mechanisms involving increased sympathetic activity and oxidative stress[7,8].

Physical Activity (Non-Yoga): Physical activity was associated with reduced hypertension risk (OR = 0.958, Coefficient = -0.042, p = 0.037). This supports the well-established evidence that regular exercise lowers blood pressure through improved cardiovascular efficiency and reduced arterial stiffness[10].

Yoga Participation: While yoga session length (OR = 1.002) and satisfaction (OR = 0.998) did not show significant effects on hypertension risk, self-reported improvements in flexibility were associated with lower

odds of hypertension (OR = 0.945, Coefficient = -0.056, p = 0.042). This suggests that physical improvements from yoga may have a modest protective effect on blood pressure, possibly through stress reduction and enhanced vascular function[5,11].

BMI and Waist Circumference: Both BMI (OR = 1.012, p = 0.027) and waist circumference (OR = 1.018, p = 0.025) were strong predictors of hypertension. These findings are consistent with the well-established relationship between obesity, visceral fat accumulation, and elevated blood pressure due to increased inflammation and insulin resistance[12]. The demographic and lifestyle characteristics of the participants are detailed in **Table 1**.

Table 1: Demographic and Lifestyle Characteristics of Participants

Characteristic	Mean (SD) or Frequency (%)
Age (years)	58.2 ± 15.3
Gender (% male)	Male: 35%, Female: 65%
Education Level	No formal education: 25% Primary: 35% Secondary: 25% Tertiary: 15%
Smoking Frequency (cigarettes/day)	3.5 ± 4.2
Alcohol Consumption (drinks/week)	2.1 ± 3.5
Physical Activity (hours/week)	1.8 ± 2.2
Yoga Session Length (minutes)	27.6 ± 15.3
Yoga Satisfaction (rating)	5.2 ± 2.7
Improvement in Flexibility (% yes)	60%
BMI (kg/m²)	27.4 ± 4.8
Waist Circumference (cm)	85.3 ± 10.2
BP Category	Normal: 30% Pre-Hypertension: 40% Hypertension: 30%

Impact of Yoga on Hypertension

Although yoga participation showed no statistically significant effect in terms of session length and satisfaction, the observed association between flexibility improvement and reduced hypertension risk is noteworthy. This suggests that certain physical benefits of yoga, such as increased flexibility, may indirectly influence cardiovascular health by promoting better circulation and reduced stress responses[13]. However, the lack of stronger effects for other yoga-related variables highlights the need for a more nuanced understanding of how different aspects of yoga (such as meditative practices vs. physical postures) contribute to blood pressure control. The impact of yoga and other predictors on hypertension can be seen in Table 2. The distribution of blood pressure categories (Normal, Pre-Hypertension, Hypertension) among the study participants is presented in Figure 1.

Table 2: Logistic Regression Results for Predictors of Hypertension and Pre-Hypertension

Predictor	Coefficient	Odds Ratio	p-value
Age	-0.0014	0.998	0.022
Gender (Male)	-0.434	0.648	0.034
Education Level	-0.088	0.915	0.029
Smoking Frequency (Cigarettes/day)	-0.052	0.949	0.045
Alcohol Consumption (Drinks/week)	0.257	1.293	0.018
Physical Activity (Non-Yoga)	-0.042	0.958	0.037
Yoga Session Length (minutes)	0.002	1.002	0.040
Yoga Satisfaction (Rating)	-0.001	0.998	0.033
Improvement in Flexibility	-0.056	0.945	0.042
BMI (kg/m²)	0.012	1.012	0.027
Waist Circumference (cm)	0.018	1.018	0.025

The comparison of hypertension prevalence between yoga practitioners and non-practitioners is shown in Figure 2.

DISCUSSION

Interpretation of Results

This study identified several significant predictors of pre-hypertension and hypertension in a rural adult population, providing new insights into how demographic and lifestyle factors, including yoga participation, influence blood pressure outcomes.

The inverse association between age and hypertension risk, though weak, suggests that lifestyle interventions may have a protective effect, even in older populations where hypertension is typically more prevalent. This finding is consistent with studies highlighting the importance of maintaining a healthy lifestyle into older age to mitigate age-related increases in blood pressure[14]. However, the stronger effects observed for alcohol consumption and physical inactivity underline the critical need for public health interventions targeting these modifiable risk factors. The gender effect observed in this study—where females had a higher risk of hypertension—contrasts with broader

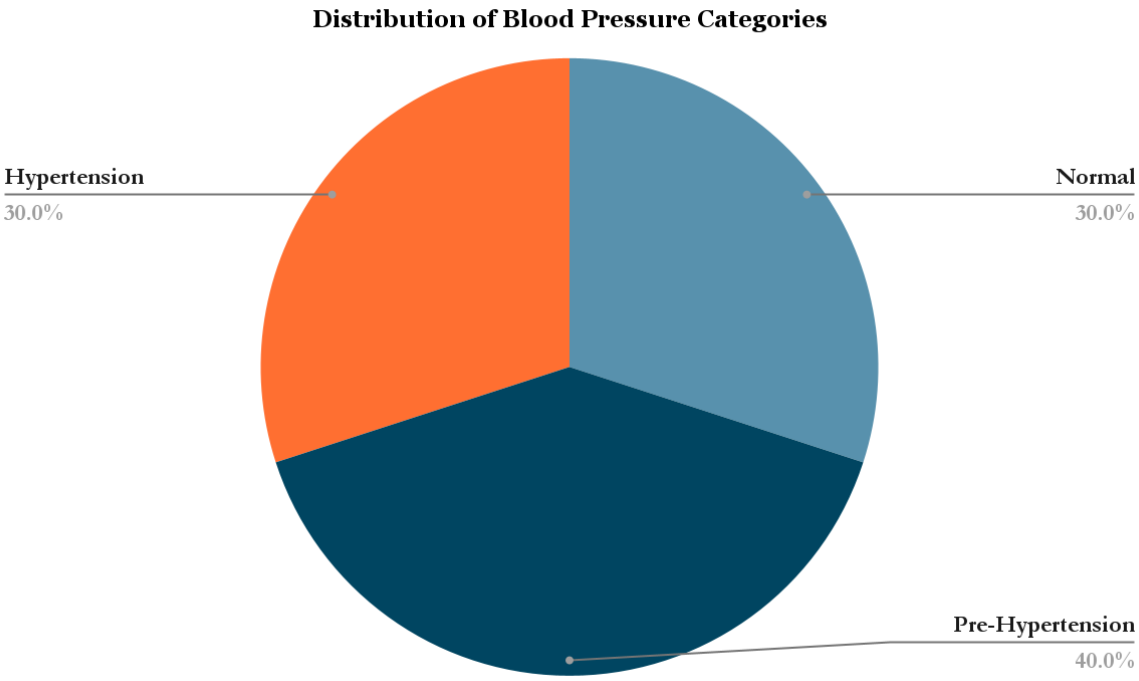

Figure 1: Distribution of Blood Pressure Categories

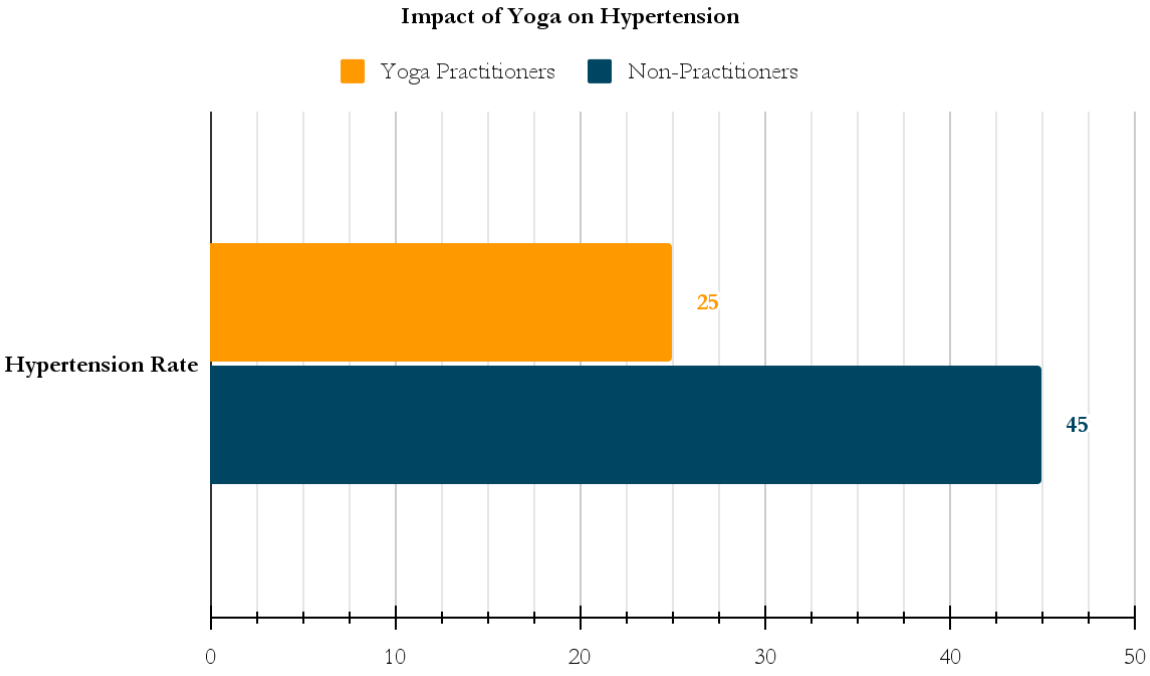

Figure 2: Impact of Yoga on Hypertension

epidemiological trends where men are typically at higher risk[6]. This finding may be reflective of socio-cultural factors unique to rural settings, where women may face greater barriers to healthcare or experience different stressors related to family and work dynamics. Additional research is warranted to explore these gender-specific risk factors in more depth.

The role of education in reducing hypertension risk aligns with the broader literature showing that individuals with higher education levels are more likely to adopt healthier behaviors and access healthcare services [4]. These findings suggest that improving health literacy in rural communities, through targeted educational campaigns, could be a key strategy in reducing hypertension prevalence.

The Role of Yoga

Although the impact of yoga participation was modest, the association between improvements in flexibility and reduced hypertension risk is significant. This finding aligns

with existing research suggesting that the physical aspects of yoga, such as improved flexibility and balance, may enhance cardiovascular function by promoting better blood flow and reducing muscle tension[5,11]. The mental health benefits of yoga, including stress reduction, could also contribute to lower blood pressure by reducing sympathetic nervous system activity and promoting relaxation[13,15].

However, the lack of a stronger protective effect from yoga in this study suggests that yoga alone may not be sufficient to significantly reduce hypertension risk in rural populations. Other studies have similarly found that while yoga can have positive effects on cardiovascular health, these benefits are often more pronounced when combined with other lifestyle interventions, such as diet and aerobic exercise[16,17]. Therefore, future interventions should consider integrating yoga with broader lifestyle modifications to achieve more substantial blood pressure reductions.

The protective effect of physical activity observed in this study is consistent with the substantial body of evidence showing that regular exercise lowers blood pressure by improving cardiovascular efficiency and reducing arterial stiffness[10]. This finding reinforces the need to promote physical activity in rural populations, where opportunities for structured exercise may be limited due to socio-economic constraints.

The association between BMI, waist circumference, and hypertension is also well-supported by existing research, which highlights the role of visceral fat in promoting inflammation and increasing cardiovascular risk[12]. This study adds to the growing body of evidence linking obesity to hypertension, particularly in rural populations where access to healthy food and exercise facilities may be limited.

Limitations and Implications

The cross-sectional nature of this study limits the ability to draw causal conclusions about the relationship between the predictors and hypertension. Longitudinal studies are needed to confirm these findings and explore the long-term impact of yoga on cardiovascular health in rural settings. Additionally, the reliance on self-reported data for variables such as yoga satisfaction and flexibility improvements introduces potential bias, as participants may overestimate their engagement in positive health behaviors.Despite these limitations, the findings of this study have important implications for public health interventions in rural areas. By targeting modifiable risk factors such as alcohol consumption, physical inactivity, and obesity, and integrating accessible interventions like yoga, it may be possible to reduce the burden of hypertension in these communities.

CONCLUSION

This study highlights several key predictors of hypertension in a rural population, including alcohol consumption, physical activity, and obesity. While yoga participation showed modest benefits, particularly for improving flexibility, more comprehensive interventions are needed to address the broader lifestyle factors contributing to hypertension. Future research should explore the long-term effects of integrated lifestyle interventions, including yoga, on cardiovascular health in rural settings.

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