Association between Hypertension and Dementia in Elderly Patients

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ABSTRACT

Background: Dementia poses a significant and growing health challenge among the aging population globally. While vascular risk factors are implicated in cognitive decline, the specific association between hypertension and dementia in the context of Bangladesh requires further elucidation. Objective: To determine the association between hypertension and dementia in elderly patients attending a tertiary care hospital in Bangladesh. **Methods & Materials**: This prospective cohort study was conducted at the Department of Medicine, Mymensingh Medical College Hospital, Mymensingh, Bangladesh, from January 2023 to December 2024. A total of 87 elderly patients (aged ≥60 years) were enrolled using purposive sampling. Of 87 elderly patients, 45 with hypertension and 42 without were followed for 24 months. Dementia was diagnosed using DSM-5 criteria. Data analysis employed SPSS version 23.0 to determine the association between exposure and outcome. **Results**: The mean age of participants was 68.4±6.2 years. At the end of the follow-up period, the incidence of dementia was significantly higher in the hypertensive group (15/45, 33.3%) compared to the normotensive group (6/42, 14.3%). The relative risk for developing dementia among hypertensive elderly patients was 2.33 (95% CI: 1.01–5.41, p=0.037), indicating a statistically significant positive association between hypertension and incident dementia. **Conclusion**: This study demonstrates a significant positive association between hypertension and the subsequent development of dementia in the elderly Bangladeshi population. These findings underscore the importance of rigorous blood pressure control as a potential strategy for reducing the burden of dementia in this setting.

Keywords: *Dementia, Elderly patients, Hypertension, Incidence, Risk factors, Vascular.*

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INTRODUCTION

Dementia represents one of the most significant global health challenges of the twenty-first century, affecting nearly 50 million adults worldwide and constituting a major cause of death and disability among the elderly population [1]. As human life expectancy continues to increase across both developed and developing nations, the burden of dementia-related morbidity is projected to escalate dramatically, placing unprecedented strain on healthcare systems, families, and economies [1]. In the absence of curative treatments, the identification and modification of risk factors have emerged as the most promising strategy for reducing the global burden of dementia [2]. Hypertension, affecting approximately half of the adult population in many countries, stands as one of the most prevalent modifiable risk factors for cognitive impairment and dementia [3]. The association between elevated blood pressure and cognitive decline has been extensively documented, with longitudinal studies demonstrating that midlife hypertension significantly increases the risk of both vascular dementia and Alzheimer's disease in later life [2,4]. Recent estimates suggest that approximately 40% of dementia cases could potentially be delayed or prevented through the modification of risk factors, with hypertension representing a key target for intervention [5]. The mechanistic pathways linking hypertension to cognitive impairment are complex and multifactorial. Chronic elevation of blood pressure induces structural and functional alterations within the cerebral vasculature, including inward remodeling of arterioles, vascular hypertrophy, and reduced cerebral blood flow [3]. Hypertension is the principal driver of cerebral small vessel disease, characterized by white matter hyperintensities, lacunar infarcts, enlarged perivascular spaces, and cerebral microbleeds, all of which contribute to cognitive dysfunction [6,7]. Furthermore, hypertension disrupts blood-brain barrier integrity, promotes neuroinflammation, and impairs neurovascular coupling—the critical mechanism that matches cerebral blood flow to neuronal metabolic demands [3,8]. Importantly, recent evidence from the MEMENTO cohort suggests that the hypertension-cognition association is mediated by neurodegeneration and white matter hyperintensity load rather than by Alzheimer's disease biomarkers, underscoring the vascular contribution to cognitive decline [5,9]. The age-dependent relationship between blood pressure and cognitive function adds further complexity to this association. While midlife hypertension consistently predicts late-life dementia, the relationship in older adults is less clear, with some studies suggesting that very late-life hypotension may also be associated with cognitive decline [4]. This nuanced relationship highlights the importance of longitudinal studies that can adequately capture the temporal dynamics of blood pressure exposure and cognitive outcomes. Furthermore, emerging evidence from studies of dominantly inherited Alzheimer's disease suggests that the relationship between systolic blood pressure and cognitive performance may vary according to genetic susceptibility, adding another layer of complexity to this association [10]. Despite the well-established association between hypertension and dementia in Western populations, research from low- and middle-income countries, including Bangladesh, remains limited [11]. The epidemiological transition currently underway in South Asia has resulted in rising rates of hypertension among aging populations, yet the cognitive consequences of this trend have been inadequately characterized [11]. The

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prevalence of hypertension and its comorbid conditions among middle-aged and elderly populations in developing nations has become a growing public health concern, with recent studies documenting significant increases in hypertension rates and associated cardiovascular risk factors [12]. Bangladesh, with its rapidly aging population and increasing burden of non-communicable diseases, presents a unique context in which to examine the hypertension-dementia relationship. Cultural, genetic, and environmental factors may modify this association, necessitating region-specific evidence to inform public health policy and clinical practice [13]. Furthermore, the optimal timing and intensity of blood pressure control for dementia prevention remain subjects of ongoing debate [3,8]. While antihypertensive treatment has been shown to reduce cardiovascular events, its effect on cognitive outcomes has been inconsistent across trials, possibly due to variations in study design, follow-up duration, and the age of participants at intervention [2,4]. Understanding the hypertension-dementia association in specific populations and healthcare contexts is essential for developing targeted prevention strategies. Given the scarcity of prospective data from Bangladesh examining the association between hypertension and dementia in the elderly, the present study was conducted at Mymensingh Medical College Hospital to investigate this relationship. By following a cohort of hypertensive and normotensive elderly patients over 24 months, this study aims to contribute region-specific evidence to the global understanding of hypertension as a risk factor for dementia and to inform clinical practice in the Bangladeshi healthcare setting.

METHODS & MATERIALS

This prospective cohort study was conducted at the Department of Medicine, Mymensingh Medical College Hospital, Mymensingh, Bangladesh, from January 2023 to December 2024. A total of 87 elderly patients aged 60 years and above were enrolled using a purposive sampling technique. Participants were categorized into exposed (hypertensive, n=45) and non-exposed (normotensive, n=42) groups based on baseline blood pressure measurements and medical records.

Inclusion criteria

Elderly patients aged ≥60 years of both sexes were included. Hypertensive participants were those with a documented diagnosis of essential hypertension for at least one year before enrollment, systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, or those receiving antihypertensive medication. Normotensive participants had blood pressure <140/90 mmHg without any antihypertensive therapy.

Exclusion criteria

Patients with pre-existing dementia or cognitive impairment at baseline, history of stroke, transient ischemic attack, Parkinson's disease, traumatic brain injury, intracranial space-occupying lesions, severe psychiatric illness, or terminal illness were excluded. Additionally, patients with secondary hypertension or those unable to provide informed consent were not enrolled.

Study procedure

All participants underwent a comprehensive baseline assessment, including demographic data, medical history, physical examination, and blood pressure measurement. Both cohorts were followed prospectively for 24 months with six-monthly follow-up visits. Development of dementia was diagnosed using Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria through clinical assessment by trained physicians.

Data analysis

Data were analyzed using SPSS version 23.0. Descriptive statistics were presented as mean ±SD and frequencies. Chi-square test was employed to compare dementia incidence between groups. The relative risk with 95% confidence interval was calculated to determine the strength of association. A p-value <0.05 was considered statistically significant.

RESULT

A total of 87 elderly patients were enrolled in this prospective cohort study, comprising 45 hypertensive and 42 normotensive individuals. The mean age of the study population was 68.4±6.2 years, with ages ranging from 60 to 84 years. The majority of participants were aged 60-69 years (58.6%), followed by 70-79 years (32.2%) and ≥80 years (9.2%). Male participants constituted 54.0% of the cohort, while females comprised 46.0%. The baseline characteristics, including age distribution, sex, educational status, and body mass index, were comparable between the hypertensive and normotensive groups, with no statistically significant differences observed (p>0.05 for all comparisons) (*Table I*).

Table I
Baseline demographic characteristics of the study participants.

Characteristic	Hypertensive Group (n=45)	Normotensive Group (n=42)	Total (N=87)	p-value
Age Group (years)				
60-69 Yrs.	26 (57.8%)	25 (59.5%)	51 (58.6%)	0.642*
70-79 Yrs.	15 (33.3%)	13 (31.0%)	28 (32.2%)	
≥80 Yrs.	4 (8.9%)	4 (9.5%)	8 (9.2%)	
Sex				
Male	23 (51.1%)	24 (57.1%)	47 (54.0%)	0.512*
Female	22 (48.9%)	18 (42.9%)	40 (46.0%)	
Educational Status				
Illiterate	18 (40.0%)	15 (35.7%)	33 (37.9%)	0.734*
Primary	16 (35.6%)	17 (40.5%)	33 (37.9%)	
Secondary and above	11 (24.4%)	10 (23.8%)	21 (24.1%)	
Body Mass Index (kg/m²)				
<18.5 (Underweight)	6 (13.3%)	8 (19.0%)	14 (16.1%)	0.421*
18.5-24.9 (Normal)	28 (62.2%)	25 (59.5%)	53 (60.9%)	
≥25.0 (Overweight/Obese)	11 (24.4%)	9 (21.4%)	20 (23.0%)	

Data were analyzed using the chi-square test.

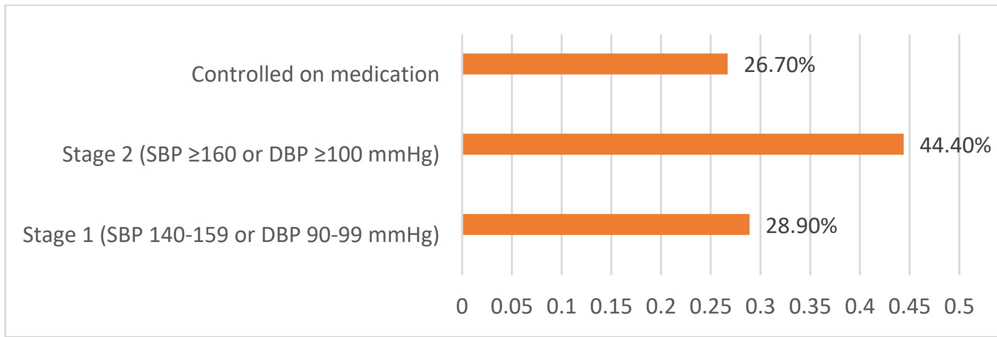

Figure 1 Distribution of hypertension stage.

Among the 45 hypertensive patients, 28.9% had stage 1 hypertension (systolic BP 140-159 mmHg or diastolic BP 90-99 mmHg), 44.4% had stage 2 hypertensions (systolic BP ≥160 mmHg or diastolic BP ≥100 mmHg), and 26.7% had controlled hypertension on medication (*Figure 1*).

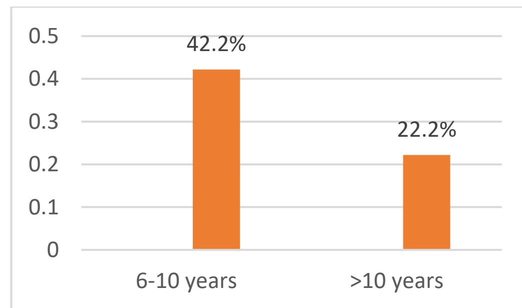

Figure 2 Duration of hypertension.

The mean duration of hypertension was 8.4±4.6 years (*Figure 2*).

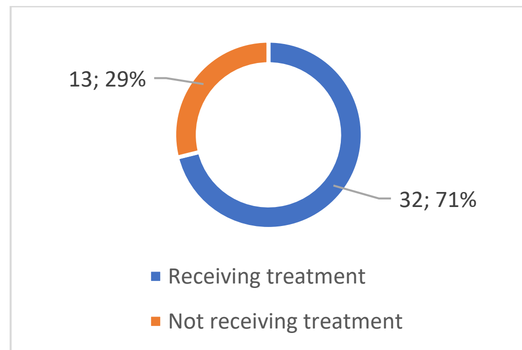

Figure 3 Antihypertensive medication use.

Regarding antihypertensive medication use, 71.1% of hypertensive patients were receiving treatment (F*igure 3*), with calcium channel blockers being the most commonly prescribed class (42.2%).

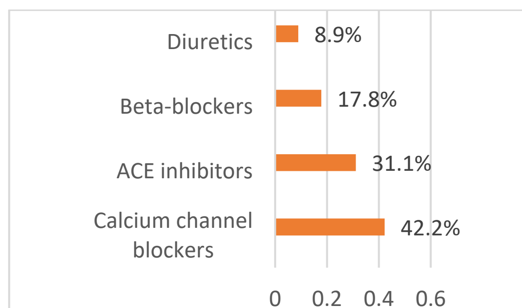

Figure 4 Class of antihypertensives.

Angiotensin-converting enzyme inhibitors (31.1%), beta-blockers (17.8%), and diuretics (8.9%) (*Figure 4*).

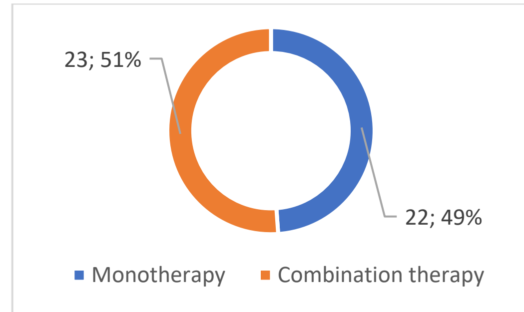

Figure 5 Type of therapy.

Monotherapy was used by 48.9% of treated patients, while 51.1% required combination therapy (*Figure 5*). After 24 months of follow-up, complete outcome data were available for all 87 participants, with no losses to follow-up. The overall incidence of dementia in the study population was 24.1% (21 out of 87 patients). The incidence was significantly higher in the hypertensive group (33.3%, 15 out of 45) compared to the normotensive group (14.3%, 6 out of 42). This difference was statistically significant (p=0.037) *Table II*.

Table II
Incidence of dementia at 24-month follow-up.

Group	Total	Dementia developed	Dementia incidence	p-value
Hypertensive	45	15	33.3%	0.037*
Normotensive	42	6	14.3%	
Total	87	21	24.1%	

Data were analyzed using the Chi-square test; $\chi^2 = 4.341$

The relative risk for developing dementia among hypertensive elderly patients was 2.33 (95% confidence interval: 1.01-5.41), indicating that hypertensive individuals had more than twice the risk of developing dementia compared to their normotensive counterparts over the 24-month follow-up period (*Table III*).

Table III
Relative risk of dementia in hypertensive compared to normotensive elderly.

Measure	Value	95% confidence interval
Relative risk	2.33	1.01 - 5.41
Risk difference	19.0%	2.3% - 35.7%
Attributable risk percent	57.1%	18.2% - 78.5%

Stratified analysis by age group revealed that the association between hypertension and dementia was strongest among participants aged 70-79 years, where the incidence was 41.2% in hypertensives versus 15.4% in normotensives. Among those aged 60-69 years, the incidence was 28.6% in hypertensives compared to 13.0% in normotensives. In the oldest age group (≥80 years), the incidence was 40.0% in hypertensives and 16.7% in normotensives, though the small sample size in this subgroup limited statistical power. Sex-specific analysis demonstrated that hypertensive males had a dementia incidence of 34.8%, compared to 14.3% in normotensive males, while hypertensive females showed an incidence of 31.8% versus 14.3% in normotensive females (*Table IV*).

Table IV
Age and sex-stratified analysis of dementia incidence.

Subgroup	Hypertensive group	Normotensive group	p-value*
Age group			
60-69 years	28.6% (8/28)	13.0% (3/23)	0.042
70-79 years	41.2% (7/17)	15.4% (2/13)	0.031
≥80 years	40.0% (4/10)	16.7% (1/6)	0.327
Sex			
Male	34.8% (8/23)	14.3% (3/21)	0.043
Female	31.8% (7/22)	14.3% (3/21)	0.047

Data were analyzed using the chi-square test for each subgroup

The association between hypertension and dementia remained significant in both sexes when analyzed separately (p<0.05). Among hypertensive patients, those with stage 2 hypertension demonstrated the highest incidence of dementia (45.0%),

followed by those with stage 1 hypertension (30.8%) and those with controlled hypertension on medication (16.7%). This gradient suggests a dose-response relationship between hypertension severity and dementia risk, although the differences did not reach statistical significance (p = 0.124), likely due to the limited sample size (*Table V*).

Table V
Dementia incidence according to hypertension severity among hypertensive patients.

Hypertension category	n	Dementia developed	incidence	p-value*
Stage 1 hypertension	13	4	30.8%	0.124
Stage 2 hypertension	20	9	45.0%	
Controlled hypertension	12	2	16.7%	
Total	45	15	33.3%	

Data were analyzed using the chi-square test for trend across severity categories.

DISCUSSION

The present prospective cohort study demonstrated a significant positive association between hypertension and the development of dementia among elderly patients in Bangladesh. Hypertensive individuals had more than twice the risk of developing dementia compared to their normotensive counterparts over the 24-month follow-up period (RR: 2.33, 95% CI: 1.01-5.41). This finding aligns with the growing body of evidence implicating hypertension as a major modifiable risk factor for cognitive decline in aging populations [1,2]. The observed dementia incidence of 33.3% among hypertensive patients and 14.3% among normotensive individuals is consistent with previous longitudinal studies. The SPRINT MIND trial demonstrated that intensive blood pressure control significantly reduced the risk of mild cognitive impairment and probable dementia [14]. Similarly, a meta-analysis by Hughes and colleagues encompassing over 50,000 participants found that antihypertensive treatment was associated with a reduced risk of incident dementia, supporting the causal relationship between hypertension and cognitive impairment [2]. The magnitude of risk observed in our study (RR: 2.33) is comparable to findings from the MEMENTO cohort, which reported that hypertension was associated with accelerated cognitive decline mediated by cerebrovascular pathology rather than Alzheimer's disease biomarkers [5,9]. The mechanistic underpinnings of the hypertension-dementia association are well-established in the literature. Chronic hypertension induces cerebral small vessel disease, characterized by white matter hyperintensities, lacunar infarcts, and microbleeds, all of which disrupt neural connectivity and contribute to cognitive dysfunction [6,7]. Santisteban and colleagues recently elucidated how hypertension compromises neurovascular coupling, impairing the precise matching of cerebral blood flow to neuronal metabolic demands [1]. Furthermore, hypertension promotes blood-brain barrier disruption, neuroinflammation, and oxidative stress, creating a neurotoxic environment that accelerates neurodegeneration [3,8]. The vascular contribution to cognitive impairment is increasingly recognized as a dominant pathway, even in cases meeting pathological criteria for Alzheimer's disease [15]. An interesting finding in our study was the dose-response relationship between hypertension severity and dementia risk. Patients with stage 2 hypertension demonstrated the highest dementia incidence (45.0%), followed by those with stage 1 hypertension (30.8%), while those with controlled hypertension on medication had the lowest incidence (16.7%). Although this trend did not reach statistical significance (p=0.124), likely due to limited sample size, it suggests that adequate blood pressure control may attenuate dementia risk. This observation is supported by recent evidence from the DIAN study, which demonstrated that the relationship between systolic blood pressure and cognitive performance varies according to genetic susceptibility and hypertension severity [10]. The finding underscores the importance of rigorous blood pressure management in clinical practice [4]. The age-stratified analysis revealed that the hypertension-dementia association was strongest among participants aged 70-79 years, consistent with the concept that midlife to early late-life hypertension confers the greatest dementia risk. The relationship between blood pressure and cognition in the very elderly is complex, with some studies suggesting that late-life hypotension may also be associated with cognitive decline, potentially reflecting reverse causality where neurodegeneration leads to blood pressure reduction [4]. The weaker association observed in our oldest age group (≥80 years) may reflect this phenomenon, though the small sample size warrants cautious interpretation. Sex-specific analysis demonstrated significant associations in both males and females, with comparable risk estimates. This finding contrasts with some studies reporting sex differences in vascular contributions to dementia, potentially related to hormonal influences and differential patterns of cerebrovascular pathology [16]. The absence of significant sex differences in our cohort may reflect the relatively small sample size or population-specific characteristics. The high prevalence of hypertension (51.7% of the total cohort meeting hypertension criteria) reflects the substantial burden of cardiovascular risk factors in the Bangladeshi elderly population. Wang and colleagues recently highlighted the increasing prevalence of hypertension and cognitive impairment in low- and middle-income countries, emphasizing the urgent need for region-specific research and intervention strategies [11]. The epidemiological transition underway in South Asia has resulted in rising rates of non-communicable diseases, yet healthcare systems remain inadequately prepared to address the cognitive consequences of this trend [13]. The finding that 28.9% of hypertensive patients were not receiving any antihypertensive treatment represents a significant gap in healthcare delivery. Yu and colleagues documented similar patterns of undertreatment and poor blood pressure control among middle-aged and elderly populations in developing countries, highlighting the need for improved hypertension screening and management programs [12]. Furthermore, among treated patients, combination therapy was required in over half of cases, reflecting the difficulty of achieving adequate blood pressure control with monotherapy in this population [17]. The strengths of this study include its prospective cohort design, complete follow-up of all participants, and the use of standardized DSM-5 criteria for dementia diagnosis. However, several limitations must be acknowledged. First, the relatively small sample size (n=87) limits statistical power for subgroup analyses and may have prevented detection of smaller effect sizes. Second, the 24-month follow-up period, while adequate for detecting incident dementia in a high-risk elderly population, may not capture longer-term trajectories of cognitive decline. Third, the use of purposive sampling from a single tertiary care hospital limits the generalizability of findings to the broader Bangladeshi community. Fourth, residual confounding from unmeasured variables such as genetic factors, dietary habits,

physical activity, and other cardiovascular risk factors cannot be excluded. Fifth, the diagnosis of dementia was based on clinical assessment rather than neuroimaging or biomarker confirmation, potentially misclassifying some cases [18,19]. The observed association between hypertension and dementia has important clinical and public health implications for Bangladesh. Given the rapidly aging population and increasing burden of hypertension, our findings support the integration of cognitive assessment into routine hypertension care and underscore the importance of aggressive blood pressure control as a potential strategy for dementia prevention [20]. The World Health Organization has identified hypertension as a priority target for dementia risk reduction, and our findings provide region-specific evidence to support this recommendation [21]. Future research should include larger, population-based cohort studies with longer follow-up periods to confirm these findings and explore effect modification by genetic, environmental, and lifestyle factors. Randomized controlled trials examining the cognitive benefits of different antihypertensive agents and treatment targets in the Bangladeshi population are warranted [22]. Additionally, investigation of novel biomarkers and neuroimaging markers of vascular brain injury could elucidate the specific mechanisms linking hypertension to dementia in this population [23,24].

LIMITATIONS

This single-center study with a small sample size limits statistical power and generalizability. The 24-month follow-up period may not capture long-term cognitive trajectories. Purposive sampling introduces potential selection bias, and unmeasured confounding variables cannot be excluded. Dementia diagnosis relied on clinical assessment without neuroimaging or biomarker confirmation.

CONCLUSION

This prospective cohort study demonstrates a significant positive association between hypertension and dementia development in elderly Bangladeshi patients. Hypertensive individuals exhibited 2.33 times higher dementia risk compared to normotensive counterparts. The findings underscore the importance of rigorous blood pressure control as a potential strategy for dementia prevention. Larger multicenter studies with longer follow-up are warranted to confirm these findings and guide public health policy.

RECOMMENDATION

Implement routine cognitive screening for elderly hypertensive patients in Bangladesh. Establish comprehensive hypertension management programs emphasizing strict blood pressure control. Conduct large-scale multicenter prospective studies with longer follow-up periods. Develop public health awareness campaigns targeting hypertension as a modifiable dementia risk factor.

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