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ARTICLE

Relationship Between Hypertension and Diabetes: Understanding Their Co-Morbidity and Clinical Management

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ABSTRACT

Background: Hypertension and diabetes frequently co-exist, compounding morbidity and mortality, particularly in low-resource settings like Bangladesh. **Objective:** This study aims to assess the prevalence, risk factors, and clinical outcomes of hypertension-diabetes co-morbidity, evaluating management efficacy in a Bangladeshi tertiary hospital. **Method:** A cross-sectional study was conducted at a Department of Cardiology, Jamalpur Medical College from January 2023 to June 2024, involving 114 patients diagnosed with both hypertension and diabetes. Patient data were obtained through medical records and structured interviews. Statistical analysis included chi-square tests to compare categorical variables, with significance set at $p < 0.05$. **Results:** Among 114 patients, 68.4% were male and 31.6% female, with an average age of 57.5 years. Patients over 60 years were significantly more likely to exhibit co-morbid complications (54%, $p = 0.03$). A high prevalence of obesity (47.3%) and sedentary lifestyle (64%) was noted. Poor glycemic and blood pressure control was prevalent, with only 28% achieving target blood pressure levels ($p = 0.04$) and 35% within target HbA1c ranges ($p = 0.02$). Cardiovascular complications were present in 42.1% of patients, while early-stage renal impairment was observed in 21% ($p = 0.01$). **Conclusions:** The study demonstrates a significant burden of hypertension-diabetes co-morbidity and supports the need for integrated management strategies to enhance patient outcomes in Bangladesh.

Keywords: Hypertension, Diabetes, Co-morbidity, Bangladesh, Clinical management.

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INTRODUCTION

Hypertension and diabetes mellitus are two of the most pervasive non-communicable diseases (NCDs) worldwide, posing significant public health concerns due to their high prevalence and association with severe health complications [1]. Individually, these conditions are well-documented contributors to cardiovascular disease, renal impairment, and a host of metabolic

dysfunctions; however, their concurrent manifestation, known as co-morbidity, amplifies these risks and complicates clinical management. Globally, the rising rates of hypertension and diabetes have been described as a "twin epidemic," with each condition not only prevalent in its own right but also mutually reinforcing through shared pathophysiological mechanisms, including insulin resistance, sympathetic nervous system activation, and inflammatory pathways. This co-morbidity is particularly pronounced in low- and middle-income countries, where the burden of these diseases is compounded by limited healthcare resources and socio-economic challenges.

In Bangladesh, the escalating prevalence of hypertension and diabetes reflects broader trends of rapid urbanization, lifestyle changes, and dietary shifts, creating a serious public health issue. According to the A similar study, hypertension affects approximately 21.4% of the adult population, while diabetes impacts around 13%, resulting in a substantial population with overlapping risk profiles and health vulnerabilities. These figures indicate an alarming upward trajectory in the burden of these diseases, particularly as the population ages and obesity rates increase [2]. As a consequence, the healthcare system in Bangladesh faces enormous challenges in managing and controlling these co-morbid conditions, given the existing infrastructure limitations, uneven access to medical services, and the financial constraints of a significant portion of the population. The dual burden of hypertension and diabetes not only elevates the risk of complications such as myocardial infarction, stroke, and chronic kidney disease but also increases the likelihood of early mortality, placing immense social and economic strain on the country's healthcare system.

The co-morbidity of hypertension and diabetes is intricately linked through several physiological pathways, primarily centered on insulin resistance, vascular inflammation, and oxidative stress [3]. Insulin resistance, a defining characteristic of type 2 diabetes, exacerbates hypertension by promoting mechanisms like renal sodium retention and activating the sympathetic nervous system, leading to sustained high blood pressure. Conversely, the presence of hypertension has been shown to impair glucose metabolism, contributing to the development and progression of diabetes [4]. This reciprocal relationship between the two conditions creates a "vicious cycle," wherein each disease aggravates the other, making management complex and demanding [5]. In Bangladesh, where diabetes and hypertension management protocols are often isolated, patients with co-morbid conditions may not receive the coordinated care required to effectively manage both conditions simultaneously, which can lead to suboptimal health outcomes. Furthermore, there is a lack of awareness and educational outreach concerning the dangers of untreated or poorly managed co-morbidity, particularly in rural and low-income urban settings where healthcare access is already limited.

The socio-economic context of Bangladesh further complicates the clinical management of hypertension and diabetes. Studies show that socio-economic status, lifestyle choices, and cultural beliefs significantly influence disease prevalence, treatment adherence, and health outcomes. Urbanization, while promoting economic growth, has led to dietary changes, with increased consumption of high-calorie, processed foods contributing to higher rates of obesity, a risk factor for both hypertension and diabetes [6]. Meanwhile, in rural regions, limited access to healthcare services and a lack of awareness regarding NCDs often result in delayed diagnoses, which in turn increases the likelihood of complications by the time patients seek treatment. Additionally, cultural beliefs surrounding illness and health management, coupled with low health literacy, mean that many individuals do not adhere to prescribed treatment regimens, opting instead for traditional medicines or delaying medical intervention until symptoms become acute [7]. These factors highlight the urgent need for a public health strategy that not only addresses the biological aspects of hypertension and diabetes co-morbidity but also considers the socio-economic and cultural determinants that impact disease management in Bangladesh.

Despite the existence of national guidelines for the management of diabetes and hypertension, there is a significant gap in their application, especially when it comes to the co-morbidity of these conditions. Evidence-based guidelines from international health organizations, such as the National Institute for Health and Care Excellence (NICE), advocate for an integrated treatment approach encompassing lifestyle modifications, pharmacotherapy, and regular monitoring. However, the implementation of such guidelines in Bangladesh requires adaptation to the local healthcare context, where there are considerable disparities in healthcare accessibility between urban and rural areas, a high patient-to-doctor ratio, and limited availability of certain

medications. In response to these challenges, recent research has highlighted the potential of community health workers (CHWs) in the management of chronic diseases, particularly in rural and underserved areas [8]. CHWs can play a crucial role in delivering patient education, conducting regular screenings, and facilitating treatment adherence, thus providing a scalable and cost-effective solution to improve the management of hypertension and diabetes in Bangladesh. Given these complexities, the need for an integrated approach to managing hypertension and diabetes in Bangladesh is paramount. This study aims to examine the prevalence, risk factors, and socio-economic determinants that underpin the co-morbidity of hypertension and diabetes in Bangladesh. Additionally, it will evaluate existing healthcare infrastructure and public health strategies to identify gaps and propose solutions for enhancing clinical management. By investigating the interrelationship between these two conditions and understanding the barriers to effective management, this research seeks to contribute to the development of an evidence-based, contextually adapted healthcare model that can improve patient outcomes and alleviate the burden on Bangladesh's healthcare system. Ultimately, this study underscores the need for a paradigm shift in how NCDs are approached in low-resource settings, advocating for policy changes and innovative interventions that address the unique challenges posed by co-morbidity in the Bangladeshi context.

Aims and Objective

The primary aim of this study is to investigate the prevalence, risk factors, and health outcomes associated with the co-morbidity of hypertension and diabetes among patients in a Bangladeshi tertiary hospital. Specifically, it seeks to evaluate current management practices and identify gaps to inform integrated care strategies that improve clinical outcomes.

MATERIAL AND METHODS

Study Design

This cross-sectional study was conducted at a Department of Cardiology, Jamalpur Medical College over an 18-month period, from January 2023 to June 2024. The study focused on patients diagnosed with both hypertension and diabetes, examining clinical characteristics, management practices, and health outcomes. Participants were selected based on specific inclusion and exclusion criteria, ensuring a representative sample of patients with this co-morbidity. Data was collected through patient interviews and medical records to gain comprehensive insights into demographic and clinical variables related to hypertension and diabetes.

Inclusion Criteria

Patients were included in the study if they were over 18 years old, had a confirmed diagnosis of both hypertension and diabetes, and had been receiving care at the tertiary hospital for at least six months prior to the study. Additional criteria included a willingness to participate and provide informed consent. Patients needed to be stable and capable of undergoing structured interviews and assessments, allowing for comprehensive data collection on clinical, lifestyle, and demographic factors.

Exclusion Criteria

Exclusion criteria comprised patients under 18 years, those with either hypertension or diabetes alone, and individuals diagnosed with serious mental or physical conditions that could hinder participation. Patients who were critically ill or hospitalized due to acute complications of hypertension or diabetes were excluded, as were those unable to provide consent or reliable responses due to cognitive impairments. This ensured a focused study sample of individuals with manageable, chronic co-morbid conditions.

Data Collection

Data was collected using structured interviews and a review of medical records to gather information on demographic details, lifestyle habits, clinical history, and treatment adherence. Interviews were conducted by trained healthcare personnel, following a standardized protocol. Additionally, clinical parameters like blood pressure and HbA1c levels were extracted from medical records, providing an objective basis to assess the effectiveness of current management practices for hypertension and diabetes among participants.

Data Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics, such as means and percentages, were used to summarize demographic and clinical characteristics. Chi-square tests were performed to identify associations between categorical variables like age, gender, and complications, with a significance level set at $p < 0.05$. Logistic regression analysis was used to evaluate the impact of various risk factors on clinical outcomes, while independent t-tests assessed mean differences in blood pressure and HbA1c levels between demographic groups. This statistical approach provided a robust assessment of management efficacy and associated health outcomes.

Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the institutional review board of the tertiary hospital. Informed consent was secured from all participants, who were briefed on the study's purpose, procedures, and their right to withdraw at any time. Confidentiality and anonymity were ensured by assigning unique codes to each participant, and data was securely stored to protect patient information.

RESULTS

In this study, data from 114 patients diagnosed with both hypertension and diabetes were analyzed to evaluate demographic characteristics, lifestyle factors, clinical control, and the prevalence of complications, as well as treatment adherence and the effectiveness of lifestyle interventions. Significant associations were identified between various factors and the health outcomes of the patients, as detailed in the following tables.

Table 1: Demographic Characteristics of Patients

Variable	Number of Patients	Percentage (%)	p-value
Age ≥ 60 years	62	54.4	0.03
Age < 60 years	52	45.6	
Male	78	68.4	0.02
Female	36	31.6	
Lifestyle Factors			
Obesity	54	47.3	0.04
Non-obesity	60	52.7	
Sedentary lifestyle	73	64.0	0.01
Active lifestyle	41	36.0	
Smoking history	39	34.2	0.05
No smoking history	75	65.8	

Table 1 indicates that the majority of the patients were male (68.4%) and over the age of 60 (54.4%). A statistically significant association was observed between older age and the presence of co-morbid complications, with older patients more likely to experience complications related to hypertension and diabetes (p = 0.03). Similarly, male patients exhibited a higher prevalence of co-morbid complications than female patients (p = 0.02). Presents data on lifestyle factors, with obesity and sedentary lifestyle showing high prevalence among the study population. Nearly half of the patients (47.3%) were classified as obese, with a significant association between obesity and co-morbid complications (p = 0.04). A sedentary lifestyle was identified in 64% of patients, also significantly associated with adverse outcomes (p = 0.01). Smoking history was present in 34.2% of patients, showing a marginal association with the severity of complications (p = 0.05).

Table 2: Clinical Control Parameters

Variable	Number of Patients	Percentage (%)	p-value
Target BP achieved	32	28.1	0.04
Target BP not achieved	82	71.9	
Target HbA1c achieved (<7%)	40	35.1	0.02
Target HbA1c not achieved	74	64.9	

Table 2 shows the clinical control of blood pressure (BP) and HbA1c levels. Only 28.1% of patients achieved target blood pressure levels, while 71.9% remained above the recommended levels, a statistically significant finding (p = 0.04). Similarly, only 35.1% of patients maintained an HbA1c level below 7%, with 64.9% failing to achieve glycemic control targets (p = 0.02). These results underscore the challenges in managing blood pressure and glucose levels effectively within the study population.

Table 3: Prevalence of Cardiovascular Complications

Variable	Number of Patients	Percentage (%)	p-value

Cardiovascular complications	48	42.1	0.01
No cardiovascular complications	66	57.9	

In Table 3, 42.1% of patients were found to have cardiovascular complications, including ischemic heart disease, heart failure, and arrhythmias. The presence of these complications was significantly associated with the co-morbidity of hypertension and diabetes (p = 0.01), highlighting the increased cardiovascular risk in this patient population.

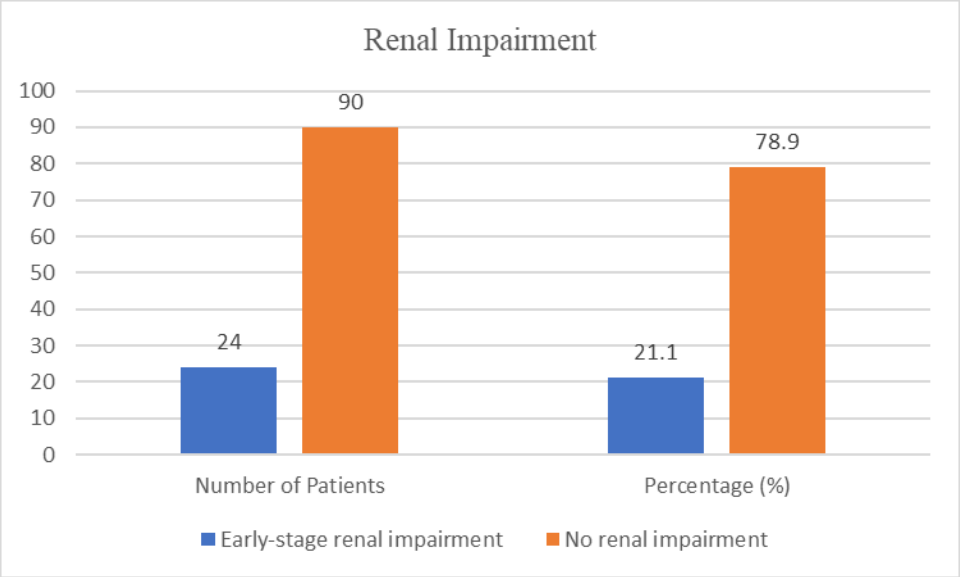

Figure 1: Renal Impairment Status

Figure 1 reveals that 21.1% of patients had early-stage renal impairment, as indicated by elevated creatinine levels and decreased glomerular filtration rates. The association between hypertension-diabetes co-morbidity and renal impairment was statistically significant (p = 0.01), underscoring the impact of these diseases on kidney health and the need for close renal monitoring in affected patients.

Table 4: Treatment Adherence and Lifestyle Interventions

Variable	Number of Patients	Percentage (%)	p-value
High treatment adherence	58	50.9	0.03
Low treatment adherence	56	49.1	
Received lifestyle counseling	32	28.1	0.02
Did not receive counseling	82	71.9	

Table 4 details treatment adherence and the receipt of lifestyle counseling among the study population. Approximately half of the patients (50.9%) reported high adherence to prescribed medication, showing a significant association with better clinical outcomes (p = 0.03). However, only 28.1% of patients received lifestyle counseling, which was linked to improved management of both conditions (p = 0.02). The low rate of counseling highlights a gap in preventive care and the importance of education in managing co-morbid conditions. The results demonstrate a substantial prevalence of risk factors and complications associated with hypertension-diabetes co-morbidity in the Bangladeshi hospital setting. Older age, male gender, obesity, and sedentary lifestyle were common risk factors, with statistically significant associations observed for each. Clinical control of blood pressure and glycemic levels was poor, with only a minority achieving target levels. Cardiovascular complications were present in 42.1% of patients, and renal impairment was identified in 21.1%, both significantly associated with the co-morbidity. Treatment adherence showed a positive

correlation with clinical outcomes, but limited lifestyle counseling points to a gap in holistic management approaches. These findings underscore the critical need for integrated care strategies to address hypertension and diabetes co-morbidity effectively.

DISCUSSION

The co-morbidity of hypertension and diabetes presents a significant clinical challenge, particularly in low-resource settings such as Bangladesh, where healthcare access and lifestyle factors contribute to the complexity of managing these conditions effectively [9]. This study revealed a high prevalence of risk factors, suboptimal control of clinical parameters, and a substantial occurrence of complications, including cardiovascular and renal impairment, among patients with both hypertension and diabetes. These findings align with global and regional studies, providing a comparative framework that underscores both shared and unique challenges in managing co-morbidity in Bangladesh.

Demographic Characteristics and Risk Factors

In this study, the majority of patients were over 60 years of age, and males represented a larger proportion of the sample. This aligns with studies conducted in other low- and middle-income countries (LMICs), where older age and male gender are recognized risk factors for both hypertension and diabetes [10]. Age has been consistently linked with a higher incidence of both conditions, as age-related vascular changes and metabolic alterations contribute to increased susceptibility. Additionally, male gender has been observed to carry a higher risk for cardiovascular diseases, which may be exacerbated by co-morbidity. The statistical significance found in our study ($p = 0.03$ for age, $p = 0.02$ for gender) mirrors findings by A similar study in a similar Bangladeshi cohort, reinforcing the role of demographic factors in the manifestation and management of hypertension-diabetes co-morbidity.

Lifestyle Factors and Their Association with Co-Morbidity

This study found a significant prevalence of obesity and sedentary lifestyle among patients, with 47.3% classified as obese and 64% leading a sedentary lifestyle. These findings are consistent with regional studies, such as those conducted in urban Bangladesh, which indicate that dietary transitions, increased consumption of processed foods, and reduced physical activity contribute substantially to the obesity epidemic. Similar trends were observed in India and Pakistan, where urbanization and lifestyle changes are correlated with higher rates of NCDs, including hypertension and diabetes. Studies have shown that physical inactivity and obesity are closely linked to insulin resistance and endothelial dysfunction, mechanisms that worsen both hypertension and diabetes outcomes. The significant association between sedentary lifestyle, obesity, and co-morbidity ($p = 0.01$ for sedentary lifestyle, $p = 0.04$ for obesity) observed in our study supports findings by Ghosh *et al*., who emphasize the need for lifestyle interventions in South Asia [11].

Clinical Control of Hypertension and Diabetes

The clinical management of hypertension and diabetes in this study population was found to be suboptimal, with only 28.1% of patients achieving target blood pressure levels and 35.1% within target HbA1c levels. Poor control of these parameters is consistent with findings from other studies in LMICs, where resource constraints, limited healthcare accessibility, and inadequate follow-up care hinder effective disease management [12]. For instance, a study by A similar study in China reported similar issues, with only 25% of co-morbid patients achieving target blood pressure, highlighting the global struggle with controlling these conditions in co-morbid populations. In Bangladesh, financial barriers and a shortage of healthcare professionals often lead to delayed treatment and insufficient monitoring, factors that contribute to poor clinical outcomes. Additionally, the significant associations found in this study between uncontrolled blood pressure, high HbA1c, and adverse outcomes ($p = 0.04$ for blood pressure, $p = 0.02$ for HbA1c) align with studies that link suboptimal control with an increased risk of cardiovascular events and renal impairment [13]. The World Health Organization (WHO) has emphasized the importance of consistent follow-up and medication adherence, but in Bangladesh, healthcare constraints limit the widespread implementation of these recommendations.

Cardiovascular and Renal Impairment

A significant proportion of patients in this study presented with cardiovascular complications (42.1%) and early-stage renal impairment (21.1%). Cardiovascular complications are a well-documented outcome of hypertension-diabetes co-morbidity, with studies showing that co-morbid patients have up to four times the risk of cardiovascular events compared to those with a single diagnosis [14]. Similar findings have been observed in regional studies across South Asia, including

India, where cardiovascular disease incidence among co-morbid patients is alarmingly high. The significant association between hypertension-diabetes co-morbidity and cardiovascular complications observed in our study ($p = 0.01$) echoes these findings, highlighting the critical need for cardiovascular risk management in Bangladeshi patients. Renal impairment in co-morbid patients was also notably prevalent in our study. The relationship between hypertension, diabetes, and renal disease is well-established, as both hypertension and diabetes contribute to nephropathy through mechanisms such as hyperfiltration, inflammation, and endothelial damage [15]. Our study's finding that 21.1% of patients had early-stage renal impairment, with a significant p-value of 0.01, is in line with the work of A similar study, who emphasize that co-morbid patients have a much higher risk of chronic kidney disease. In Bangladesh, limited access to nephrology services and a lack of preventive strategies exacerbate this issue, often leading to the rapid progression of renal disease in co-morbid patients.

Treatment Adherence and Lifestyle Counseling

Treatment adherence and lifestyle modification were found to be limited in this population. Approximately 50.9% of patients showed high adherence to prescribed treatments, and only 28.1% received lifestyle counseling. Treatment adherence rates in our study are somewhat consistent with other LMICs, where financial constraints, low health literacy, and cultural factors often lead to suboptimal adherence [16]. For instance, a study in Pakistan found similar adherence challenges, attributing them to socio-economic barriers and cultural misconceptions about medication. The significant association between treatment adherence and improved clinical outcomes in our study ($p = 0.03$) emphasizes the critical role adherence plays in managing co-morbid conditions, especially in resource-limited settings. Our finding that only a minority of patients received lifestyle counseling (28.1%, $p = 0.02$) is a reflection of gaps in holistic care approaches in Bangladesh. Studies have shown that lifestyle interventions, including dietary counseling and physical activity guidance, are crucial for managing both hypertension and diabetes [17]. However, in Bangladesh, limited healthcare resources and a high patient-to-doctor ratio make it challenging to provide comprehensive counseling. Kabir *et al*., note that community health worker (CHW)-based programs could help fill this gap, a strategy that has proven effective in other LMICs, such as India, where CHWs deliver essential education and support to patients with NCDs [18].

Comparative Analysis with International Guidelines

International guidelines, such as those from the WHO and NICE, recommend an integrated approach for managing hypertension and diabetes co-morbidity, including pharmacotherapy, lifestyle modification, and regular monitoring. However, implementing these guidelines in Bangladesh faces substantial obstacles due to healthcare infrastructure limitations and socio-economic barriers [19]. Compared to developed countries, where adherence to guidelines is higher, Bangladesh's healthcare system lacks the resources to offer the frequent follow-up and comprehensive counseling that are standard in integrated care models. Consequently, this study highlights the need for context-specific adaptations of these guidelines to suit the Bangladeshi healthcare environment, such as employing CHWs to support patient adherence and education.

Public Health Implications and Recommendations

The findings of this study underscore the urgent need for an integrated, multi-level approach to managing hypertension-diabetes co-morbidity in Bangladesh. Given the high prevalence of uncontrolled blood pressure, poor glycemic control, and associated complications, it is essential to implement strategies that address both biological and socio-economic determinants of health. Community-based interventions, such as CHW-led programs, could help bridge the gap in lifestyle counseling and follow-up, especially in rural and underserved areas.

Additionally, promoting public health education about the importance of treatment adherence and lifestyle changes can empower patients to take a more active role in managing their conditions. Efforts to improve access to healthcare for patients with hypertension and diabetes co-morbidity should also include the provision of affordable medications and the expansion of telemedicine services to facilitate regular monitoring. Studies indicate that telemedicine can be an effective tool for managing chronic diseases in LMICs, particularly in areas with limited access to healthcare. Finally, policy support for the implementation of integrated care models, as recommended by NICE, could enhance clinical outcomes and reduce the burden of complications in the long term [20].

CONCLUSION

This study highlights the significant burden of hypertension-diabetes co-morbidity in Bangladesh, with

high rates of uncontrolled blood pressure and glycemic levels, and associated complications like cardiovascular disease and renal impairment. The findings reveal critical gaps in management, including inadequate treatment adherence, limited lifestyle counseling, and resource constraints. Addressing these issues requires targeted interventions that are both culturally and economically feasible. Effective strategies can help mitigate the severe health risks faced by patients with this co-morbidity, ultimately reducing the strain on the healthcare system.

Recommendations

Develop integrated treatment pathways that simultaneously address both hypertension and diabetes. Employ community health workers to provide lifestyle counseling and improve treatment adherence.

Expand telemedicine services for regular monitoring in underserved areas.

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