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Original Research Article

Effect of polypharmacy on healthcare costs in hospitalized patients diagnosed with hypertension and diabetes mellitus in a tertiary care teaching hospital

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ABSTRACT

Background: Hospitalised patients with diabetes mellitus and hypertension, particularly older adults, often have multiple comorbidities requiring polypharmacy. While the clinical consequences of polypharmacy are well documented, its economic impact, including healthcare expenditure, financial burden, and cost-related medication nonadherence, remains underexplored in resource-limited settings. Objectives of the study were to evaluate the association of polypharmacy and comorbidities with healthcare costs, financial burden, and cost-related medication non-adherence among hospitalised patients with diabetes mellitus and hypertension.

Methods: A cross-sectional study was conducted among 180 hospitalised patients with diabetes mellitus and hypertension, with or without comorbidities, at a tertiary care teaching hospital. Data were collected using a validated proforma through patient interviews and medical records. Polypharmacy was defined as the use of ≥6 medications. Healthcare costs were categorized into direct medical, direct non-medical and indirect costs. Financial burden was estimated by comparing healthcare expenditure to income and cost-related medication nonadherence was assessed using a structured questionnaire. Statistical significance was set at $p<0.05$.

Results: Polypharmacy was observed in 94.4% of patients. Those with polypharmacy incurred significantly higher direct medical (INR 8,380.24 versus INR 4,705; $p<0.001$), direct non-medical (INR 4,388.22 versus INR 1,174; $p<0.001$), and indirect costs (INR 2,638.82 versus INR 1,200; $p=0.038$). Patients with comorbidities had higher direct medical and non-medical costs, greater financial burden (70.29% versus 52.5%), and higher cost-related medication nonadherence (65.34% versus 32.5%).

Conclusions: Polypharmacy and comorbidities substantially increase healthcare costs, financial burden, and cost-related medication nonadherence among hospitalised patients with diabetes and hypertension. Strategies to optimize medication use and improve financial support are essential to reduce these burdens.

Keywords: Diabetes mellitus, Hypertension, Polypharmacy, Healthcare costs

INTRODUCTION

The growing burden of non-communicable diseases (NCDs), particularly hypertension and diabetes mellitus, represents a major global health challenge and accounts for more than 60% of deaths in India.[1] Hypertension is a major global public health concern and one of the leading causes of premature death worldwide, affecting more than one billion people.[2] Simultaneously, diabetes has emerged as a major public health challenge, with approximately 106.9 million adults diagnosed with the disease in India as of 2024.[3] These two conditions are mostly comorbid; almost half of patients with diabetes also have hypertension, which forms synergistic risk, significantly increases the

chances of serious macrovascular and microvascular complications.[4,5]

Treatment is typically complex and multiple chronic diseases may lead to the use of five or more medications (polypharmacy), which is generally defined as the use of five or more medications.[6] The use of multiple medications has become an important challenge in the current healthcare system due to the high cost and adverse effects of polypharmacy on patient outcomes.[7,8] Hospitalized patients are a specific population with high incidence of polypharmacy (up to 94.4%) because of the high intensity of pharmacological management for acute and chronic diseases.[1] Polypharmacy may be clinically appropriate to address multiple chronic conditions, but also can be a result of multiple factors including population ageing and poor coordination of care between healthcare providers, commonly referred to as the prescribing cascade, in which adverse effects of drugs are perceived as a new condition requiring the prescription of a new drug.[9,10]

Multiple comorbid conditions usually require the involvement of multiple healthcare specialists, which leads to complex medication regimens and increases the risk of adverse drug reactions and drug-drug interactions.[11,12] These complications significantly contribute to the overall healthcare burden by prolonging hospital stays and increasing healthcare costs.[8,13] The economic burden of chronic non-communicable diseases is mainly classified into direct and indirect costs, reflecting both the immediate utilization of healthcare resources and the broader impact on society's productivity.[14,15] Direct costs represent the monetary value of resources used directly to manage health conditions.[14] These expenses are also broken down into direct medical and non-medical expenses. Direct medical costs refer to spending on health care received in inpatient and outpatient facilities, consultation by physician, diagnostic testing, medical equipment and pharmaceutical treatment.[15,16] These costs are significant in patients with diabetes and hypertension where hospitalization and surgery due to complications is a significant factor in the costs.[17,18] Non-medical costs are those costs that are not related to the formal health care system, including transportation to health care facilities, travel or relocation to receive care, and informal care costs provided by family members.[14,15]

Indirect costs represent the loss of productivity experienced by society due to morbidity, disability, and premature mortality.[15,19] These costs are typically estimated using the human capital approach, which considers the factors affecting labour force participation, including absenteeism (time away from work), presenteeism (reduced efficiency at work) and early retirement due to illness.[19,20] Polypharmacy is a major contributor to this economic burden; it has been estimated that inappropriate or suboptimal prescribing practices account for almost 40% of avoidable health care costs globally.[10] Patients on multiple medications are likely to use pharmacy services more often and have higher prescription refill rates than patients on simpler treatment regimens.[21] In tertiary care, polypharmacy is frequently related with the presence of several comorbid conditions that are linked to longer hospital stays and higher drug-related costs.[8,22]

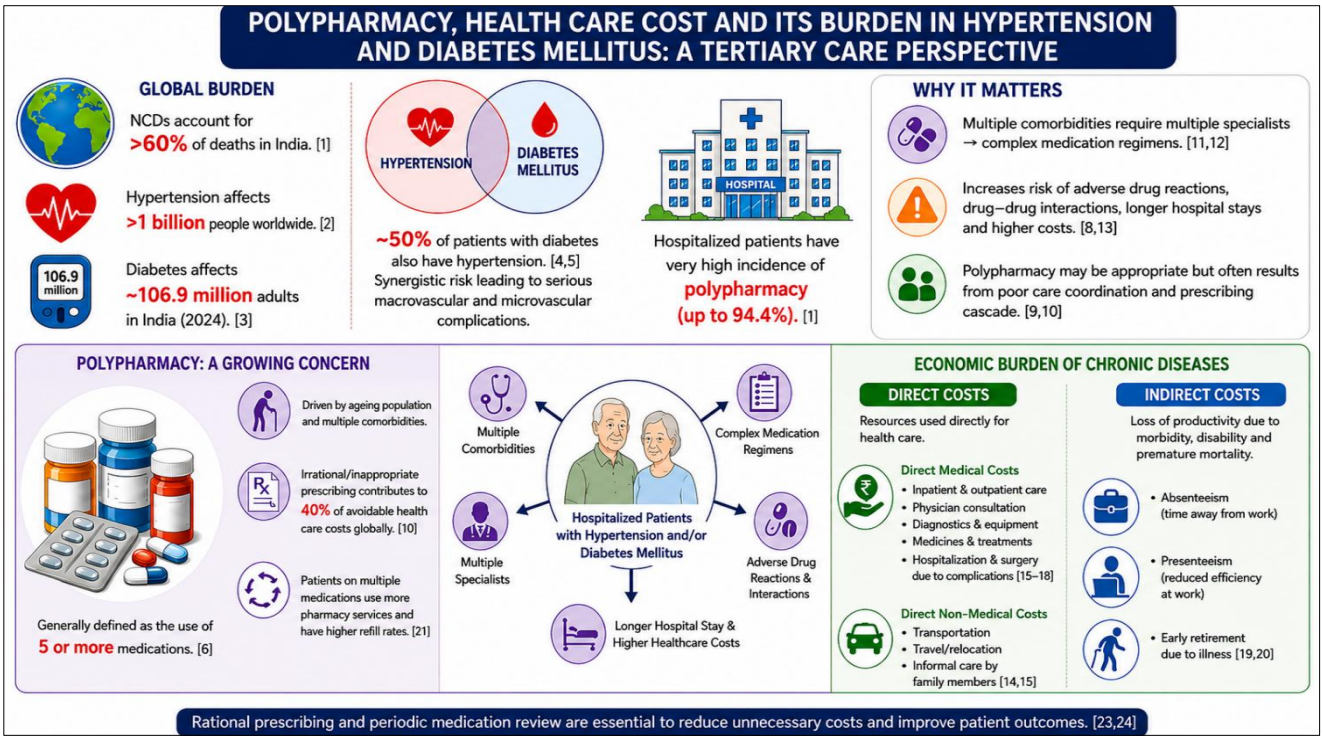

Figure 1: Conceptual framework illustrating the impact of polypharmacy on healthcare costs in hospitalized patients with hypertension and diabetes mellitus.

The use of more than one medicine might be required in the treatment of chronic and progressive diseases like hypertension and diabetes, but rational prescribing of medicines and periodic review of medicines should be used to reduce unnecessary health care costs and potential complications.[23,24] The adverse impacts of polypharmacy on clinical outcomes have been well documented and there is limited economic data on impact of polypharmacy on outcomes in hospitalized patients at the local level in tertiary care centers in India.

This study aimed to evaluate the effect of polypharmacy on total health care cost, direct/indirect cost of the hospitalized patients of hypertension and diabetes mellitus with or without associated co-morbidity in a tertiary care teaching hospital. The hypothesis is that the direct medical costs and financial burden of patients and the healthcare system in general increase significantly with an increase in the number of prescribed medications (polypharmacy) (Figure 1).

METHODS

Study design and setting

A prospective observational study was conducted over six months from 13 February to 15 August 2025 in the Department of General Medicine at Adichunchanagiri Hospital and Research Centre. Ethical approval was obtained from the institutional ethics committee of Adichunchanagiri Hospital and Research Centre ethical approval reference number IEC/AH&RC/AC/17/2025.

Sample size

The prevalence of polypharmacy among patients with comorbid hypertension and diabetes is 49-50%. We considered a prevalence of 49%. Using the formula given, considering a confidence level of 95% with a corresponding z-score of 1.96, and a margin of error (d) of 5% (0.05), the calculated sample size required for the study was 167 patients. We have achieved a sample of 180 in a prescribed timeline.

$$n = z^2 \times p(1-p)/d^2$$

Where, n=required sample size, z=z-value (standard normal deviate corresponding to the desired confidence level, e.g., 1.96 for 95% confidence), p=estimated proportion of the population (commonly set to 0.5 when unknown), d=margin of error (desired precision).

Study participants

Hospitalised patients aged >18 years, diagnosed with hypertension and diabetes mellitus with or without comorbidities for at least three months, and receiving more than two medications were enrolled after obtaining written informed consent. Patients with psychiatric illnesses, those without a diagnosis of hypertension or diabetes mellitus, and patients with type 1 diabetes mellitus or gestational diabetes were excluded from the study.

Study procedure

Figure 2 shows the overview of the study procedure, from participant selection and ethical safeguards through data collection, sociodemographic and clinical characterization, and economic cost assessment.

Statistical analysis

Data were entered into Microsoft excel and analyzed in statistical package for the social sciences (SPSS) version 27. Categorical variables were presented as frequencies and percentages and continuous variables were presented as means and standard deviations. The relationship of categorical variables was analyzed with the Chi-square test or the Fisher's exact test.

RESULTS

Sociodemographic characteristics of participants

A total of 180 patients with diabetes mellitus (DM) and hypertension (HTN) with or without any other comorbidities were recruited in the study with the predefined inclusion criteria (Table 1).

The sociodemographic and clinical data of the study subjects are presented in Table 1. The majority of the participants (104 patients, 57.8%) were male and 76 (42.2%) were female. Concerning age distribution, the study population was elderly, with the largest number of patients being between 70-79 years (n=53, 29.4%) followed closely by the age group of 60-69 years (n=49, 27.2%). Taken together, these results suggest that elderly people were the predominant patient group in the hospital.

On the socioeconomic status (modified Kuppuswamy classification), most of the participants were from upper-lower (n=64, 35.6%) and lower-middle (n=63, 35.0%) socioeconomic groups. There was also a fair amount (n=48, 26.7%) in the upper-middle class, while a minimal number (n=4, 2.2%) were classified as lower and (n=1, 0.6%) upper socioeconomic status.

Clinical profile with a distribution of comorbidities

The majority of the patients (107, 59.4%) had DM with HTN and at least one associated condition, while 73 others (40.6%) had only DM and HTN. Ischemic heart disease (IHD) was the most common associated comorbidity, seen in 39 patients (21.7%), followed by chronic kidney disease (CKD) in 26 (14.4%) and cerebrovascular accident (CVA) in 24 (13.3%) and heart failure in 24 (13.3%). Other rare co-morbidities included chronic obstructive pulmonary disease (COPD) (10 patients, 6.3%' to '18 patients, 10%), hypothyroidism (7.2%), chronic liver disease (CLD) (5.6%) and asthma (3.3%).

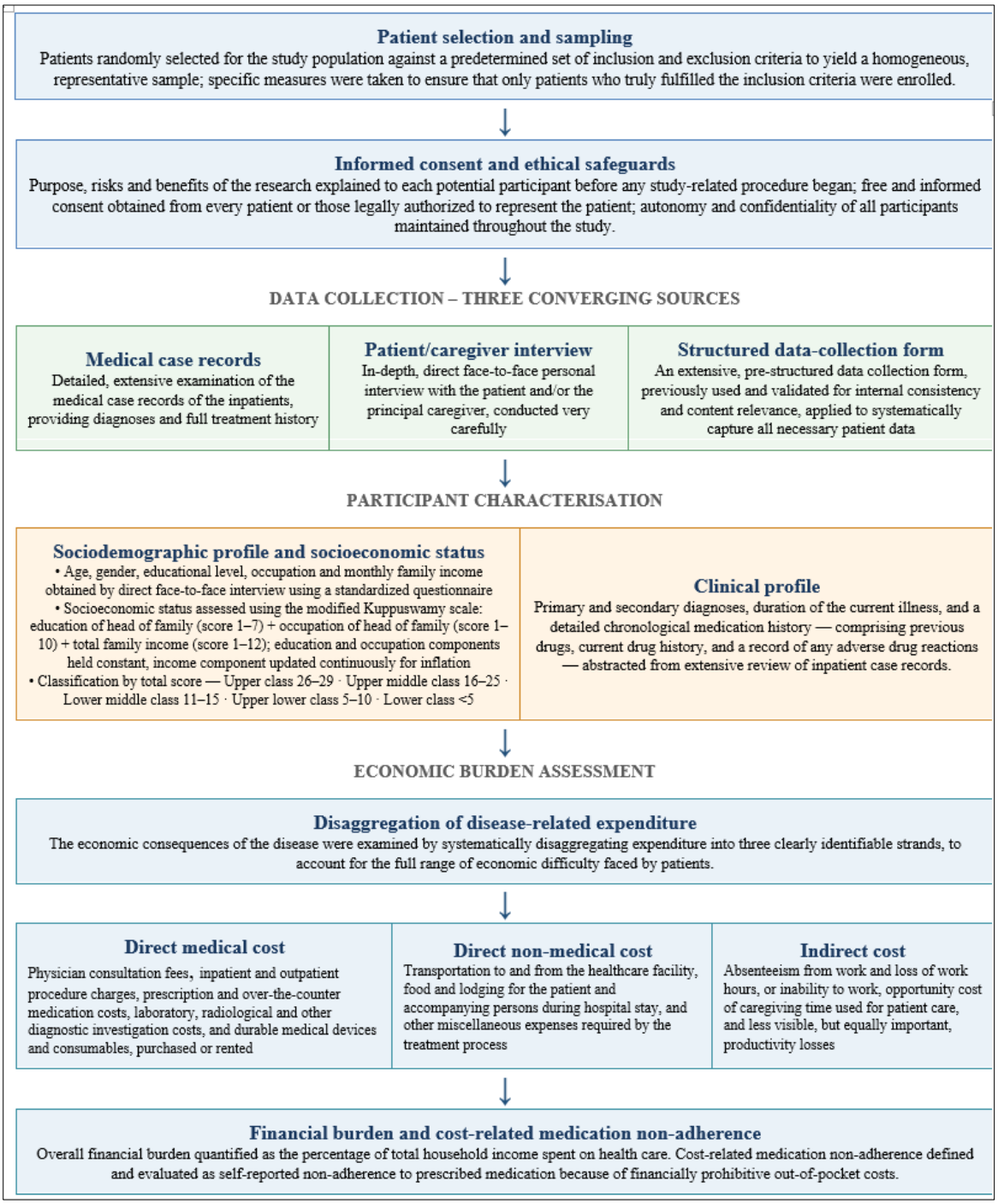

Figure 2: Overview of the study procedure, from participant selection and ethical safeguards through data collection, sociodemographic and clinical characterization, economic cost assessment, and statistical analysis.

Medication burden and polypharmacy

The medication burden is shown in Table 2 and Figure 3, separated into those who have, and those who do not have, polypharmacy (defined as the use of six or more medications). A total of 10 patients with a mean drug count of 4.9±0.316 were in the non-polypharmacy group while 170 patients with a mean drug count of 8.45±1.781 were in the polypharmacy group, which was significantly higher. This difference was statistically significant ($p<0.001$), suggesting a significantly higher burden of medications in the polypharmacy group.

Expenditure on healthcare by polypharmacy status

Table 3 and Figure 4, present the mean cost components of the healthcare system, by polypharmacy status (non-polypharmacy versus polypharmacy). The results revealed that exposure to polypharmacy had high economic costs for the patients in all cost categories. The mean cost of

direct medical expenses was higher in the polypharmacy group (INR 8,380.24) compared to the non-polypharmacy group (INR 4,705) (p<0.001). Similarly, the mean direct non-medical costs of the patients with 6-10 drugs were significantly higher as compared with patients with 0-5 drugs (INR 4,388.22 and INR 1,174, respectively) (p<0.001). Indirect costs were also significantly different between the groups with the polypharmacy group having higher indirect costs (INR 2,638.82) than the non-polypharmacy group (INR 1,200) (p=0.038). These results taken together highlight the significant economic impact of polypharmacy in hospitalized patients.

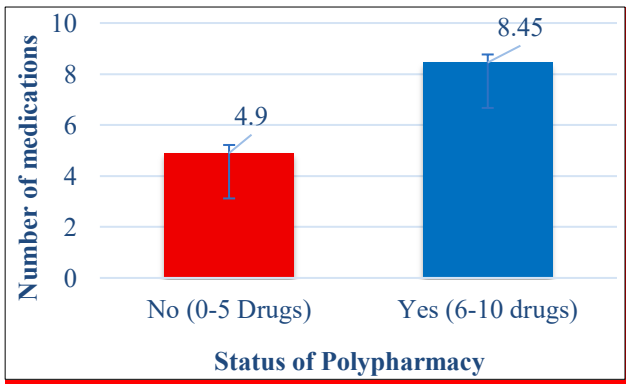

Figure 3: Comparison of the mean number of prescribed drugs between non-polypharmacy and polypharmacy groups.

Healthcare expenditure by comorbidity status

Table 4 and Figure 5, provide mean cost components for the healthcare system for patients with DM and with or without a comorbidity. Additional comorbidities were found to be significantly associated with an increase in the economic burden, especially direct costs, in the analysis. Patients with DM and comorbidities also had a significantly higher mean direct medical cost (INR 9,032.36) than patients with DM and HTN (INR 6,920.93) (p<0.001). Similarly, patients with co-morbidities also had significantly higher direct non-medical costs (INR 4,986.93) compared to patients without co-morbidities (INR 3,070.34) (p<0.001).

The costs however were comparable in the two groups, with patients with comorbidities having a slightly lower cost (INR 2,504.67) versus patients without comorbidities (INR 2,638.36) (p=0.83). Overall, these findings indicate that the presence of co-morbid conditions greatly increases direct health care expenditures and does not significantly affect indirect costs.

Financial burden and cost-related medication non-adherence

Table 5 provides an overview of the overall financial cost and cost-related medication nonadherence cases based on the presence or absence of comorbidities. Of patients with DM alone and HTN alone, >50% (n=42, 52.5%) reported high financial burden, 37.5% (n=30) moderate financial burden, and only 10% (n=8) low financial burden. Contrastingly, patients with DM, HTN and comorbidities had a much higher financial impact, with the majority (n=71, 70.29%) reporting a high financial burden and 27 (26.7%) patients reporting a moderate financial burden and 3 (2.97%) patients reporting a low financial burden.

In terms of medication nonadherence due to cost, 26 patients (32.5%) with DM and HTN alone were nonadherent and 54 (67.5%) adherents. In patients with DM, HTN and comorbidities, however, more patients reported cost-related nonadherence (n=66, 65.34%) than patients who did not report any cost-related nonadherence (n=35, 34.65%). Overall, these findings suggest that there is an association between increased financial burden, brought on by admission for multiple comorbidities, and that having multiple comorbidities significantly contributes to having medication nonadherence due to cost among inpatients.

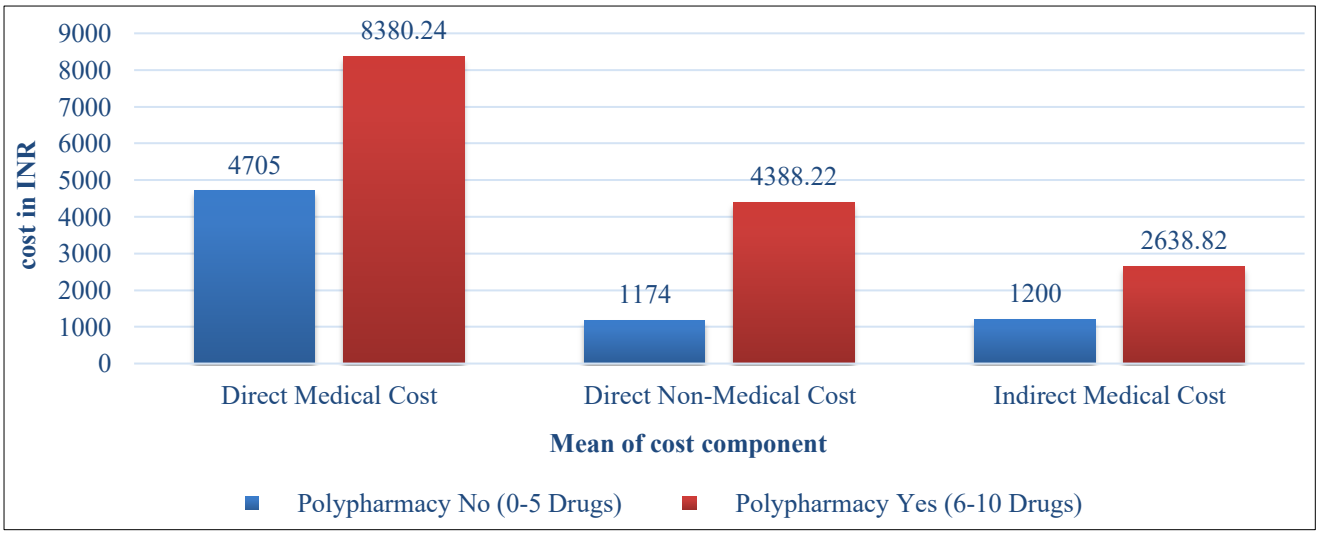

Figure 4: Comparison of mean healthcare cost components by polypharmacy and non-polypharmacy group.

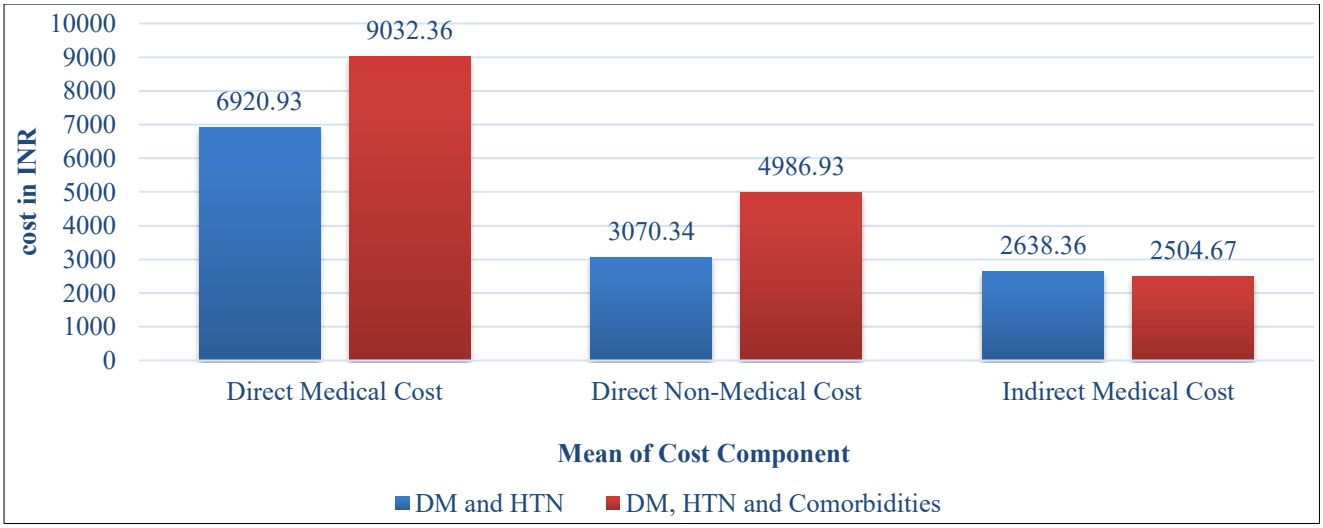

Figure 5: Comparison of mean healthcare cost components in patients having diabetes mellitus and hypertension with or without comorbidities.

Table 1: Sociodemographic, economic, and clinical characteristics of the study participants.

Characteristics	Frequency (%)
Gender	
Male	104 (57.8)
Female	76 (42.2)
Age (years)	
20-29	1 (0.6)
30-39	3 (1.7)
40-49	19 (10.6)
50-59	41 (22.8)
60-69	49 (27.2)
70-79	53 (29.4)
80 and above	14 (7.8)
Socio economic status	
Lower class	4 (2.2)
Upper class	64 (35.6)
Lower middle	64 (35.6)
Upper middle	48 (35)
Upper class	01 (0.6)
Diagnosis	
Diabetes and HTN	73 (40.6)
Diabetes, HTN and co morbidities	107 (59.4)
Disease co morbidity	
CVA	24 (13.3)
CLD	10 (5.6)
Hypothyroidism	13 (7.2)
CKD	26 (14.4)
IHD	39 (21.7)
Heart failure	24 (13.3)
Asthma	6 (3.3)
COPD	18 (10)
Anemia	18 (10)

Table 2: Comparison of the mean number of prescribed drugs between non-polypharmacy and polypharmacy groups.

Polypharmacy	N	Mean	Standard deviation	P value
No (0-5 drugs)	10	4.9	0.316	<0.001
Yes (6-10 drugs)	170	8.45	1.781	

Table 3: Comparison of mean healthcare cost component by polypharmacy and non-polypharmacy groups.

Mean of cost component	Polypharmacy status		P value
	No (0-5 drugs)	Yes (6-10 drugs)	
Direct medical cost	4705	8380.24	<0.001
Direct non-medical cost	1174	4388.22	<0.001
Indirect medical cost	1200	2638.82	0.038

Table 4: Comparison of mean healthcare cost component in patients having diabetes mellitus and hypertension with or without comorbidities.

Mean of cost component	DM and HTN	DM, HTN and comorbidities	P value
Direct medical cost	6920.93	9032.36	<0.001
Direct non-medical cost	3070.34	4986.93	<0.001
Indirect medical cost	2638.36	2504.67	0.83

Table 5: Distribution of financial burden and cost related non-adherence among patients with diabetes mellitus and hypertension with or without comorbidities.

Characteristics	Frequency (%) of DM and HTN	Frequency (%) of DM, HTN with comorbidities
Financial burden		
Low burden	8 (10)	3 (2.97)
Moderate burden	30 (37.5)	27 (26.7)
High burden	42 (52.5)	71 (70.29)
Cost-related non-adherence		
Yes	26 (32.5)	66 (65.34)
No	54 (67.5)	35 (34.65)

DISCUSSION

This study provides a comprehensive picture of the economic burden of polypharmacy and comorbidities in hospitalized individuals with hypertension and diabetes mellitus in a tertiary care hospital. The findings indicate a notably high prevalence of polypharmacy (94.4%), reflecting the growing complexity of managing coexisting non-communicable diseases (NCDs) in India.[1] This rate is greater than that reported in various regional studies; however, it is in line with the observations of Zhao et al who reported that older patients hospitalized with multiple healthcare conditions are particularly prone to being prescribed multiple medicines.[8]

One of the main observations of this study is the marked difference in medical expenses between patients with and without polypharmacy. Patients taking six or more medications experienced substantially higher direct medical costs (INR 8,380.24 versus INR 4,705), direct non-medical costs (INR 4,388.22 versus INR 1,174), and indirect costs (INR 2,638.82 versus INR 1,200). These outcomes are consistent with those reported by Sapkota et al who identified polypharmacy as a major contributor to financial burden in South Asian clinical settings.[7] Furthermore, the increase in direct medical cost is consistent with the hospital-based cost analysis by Alshammari et al which found that the cost of pharmaceuticals and diagnostic testing are significant contributors to the cost of diabetes.[17] Comorbidities also had an impact on medical costs. Costs of care were significantly higher among patients with both diabetes and hypertension with any other comorbid conditions than among those without the comorbid conditions (INR 9,032.36 versus 6,920.93).

This observation is supported by Mutowo et al who demonstrated that complications associated with diabetes and hypertension are strongly linked to increased hospitalization costs.[18] The combined effect of hypertension and diabetes, as described by Chen et al and Khunti et al not only enhances the risk of macrovascular and microvascular complications but also requires a multidisciplinary treatment approach, usually resulting in a "prescribing cascade".[4,5,10] In this scenario, additional drugs are used to manage the side effects of existing therapies, further increasing the economic burden on patients.[10] Interestingly, although direct costs were significantly influenced by the presence of comorbidities, indirect costs did not differ significantly (p=0.83). This suggests that the human capital measures of productivity loss may be more related to the main diabetes and hypertension conditions and less to the number of other comorbidities at the time of hospitalization. This is somewhat different than the more general economic forecasts of East Asian populations by Bloom et al who estimated that the prevalence of multimorbidity has a significant impact on workforce participation in the longer term.[15] Financial burden and cost-based medication non-adherence were also seen in this study, as a high percentage of patients with comorbidities (70.3% financial burden; 65.3% cost-based non-adherence) encountered financial difficulties. These rates are higher than others reported in other low- and middle-income countries, including Pakistan, where Butt et al found significant, but relatively low rates of cost-related non-adherence.[9]

This study's higher rate of non-adherence is alarming because it might result in poorer clinical outcomes, higher risk of re-hospitalization, and ongoing disease burden as noted by Piao et al and Scotti et al.[11,13]

Limitations

The study was conducted in a single tertiary care teaching hospital, which may limit the generalizability of the findings to other healthcare settings, such as primary care centers or private hospitals.

The study excluded patients managed in outpatient settings. As a result, the findings may not fully reflect the economic and clinical impact of polypharmacy in community-dwelling individuals.

Patients with DM and HTN were managed not only by general medicine but also by specialists such as cardiologists, nephrologists, and endocrinologists. Variation in prescribing practices between departments may have influenced the number and type of medications prescribed, potentially contributing to polypharmacy and cost variation. This factor was not separately analyzed in the study.

CONCLUSION

This study highlights the high prevalence of polypharmacy among hospitalized people with HTN and DM, especially among older people, people with a longer duration of the disease and people with other co-morbidities like cardiovascular disease, chronic kidney disease and dyslipidemia. Patients with diabetes, hypertension and without any other chronic disease needed more drugs and had much higher health care costs, compared to patients

suffering from diabetes and hypertension only. The highest proportion of the total expenditure was for direct medical costs, mainly associated with medicines and diagnostic investigations, and direct non-medical costs, and indirect costs associated with productivity loss further contributed to the economic burden. Polypharmacy is frequently clinically indicated but greatly adds to the complexity of treatment and costs, especially in lower socioeconomic groups.

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Ethical approval: The study was approved by the Institutional Ethics Committee (IEC/AH&RC/AC/17/2025)

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