RESEARCH PAPER

Association Of Pharmaceutical Care Intervention With Glycemic Control, Health-Related Quality Of Life, And Treatment Costs Among Covid-19 Recovered Patients With Diabetes Mellitus

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Abstract

Background: Covid-19 recovery in patients with diabetes mellitus is frequently associated with persistent metabolic disturbances, increased treatment complexity, impaired health-related quality of life (hrqol), and elevated healthcare costs. Pharmaceutical care interventions may play a crucial role in optimizing post-covid diabetes management by improving clinical outcomes, enhancing quality of life, and reducing economic burden.

Objective: To evaluate the association of pharmaceutical care intervention with glycemic control, health-related quality of life, and treatment costs among covid-19 recovered patients with diabetes mellitus and comorbidities.

Methods: A single-arm interventional study was conducted over 18 months (december 2022 to may 2024) at a tertiary care hospital. A total of 350 covid-19 recovered patients with type 2 diabetes mellitus and associated comorbidities were enrolled. Clinical parameters, including glycemic indices, lipid profile, inflammatory markers, and renal function, were assessed at baseline and follow-up. Hrqol was evaluated using the world health organization quality of life–bref (whoqol-bref) questionnaire. Pharmacoeconomical outcomes were analyzed by comparing direct and indirect healthcare costs before and after pharmaceutical care intervention. Statistical analysis was performed using paired tests, with $p < 0.05$ considered statistically significant.

Results: A statistically significant reduction in hba1c levels was observed at follow-up compared to baseline ($p = 0.0493$), indicating improved glycemic control. Other clinical parameters remained stable during the study period. Hrqol scores demonstrated significant improvement across all four whoqol-bref domains, including physical, psychological, social, and environmental health ($p < 0.001$ for all). Pharmacoeconomical analysis revealed a reduction of 19% in total direct costs, 29% in indirect costs, and an overall 21% decrease in total healthcare expenditure following pharmaceutical care intervention.

Conclusion: Pharmaceutical care intervention was significantly associated with improved glycemic control, enhanced health-related quality of life, and reduced treatment costs among covid-19 recovered patients with diabetes mellitus.

Keywords: Covid-19, Pharmaceutical Care, Diabetes Mellitus, Health-Related Quality Of Life, Pharmacoeconomics, Glycemic Control.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) has emerged not only as an acute viral illness but also as a condition associated with long-term health consequences, particularly among individuals with pre-existing chronic diseases. Diabetes mellitus has been identified as one of the most prevalent comorbidities influencing COVID-19 severity, recovery, and post-infection outcomes. Emerging evidence suggests that patients with diabetes who recover from COVID-19 continue to experience persistent metabolic disturbances, increased

medication burden, and impaired health-related quality of life (HRQOL), thereby necessitating structured post-recovery care [1-3].

Poor glycemic control in the post-COVID period is frequently attributed to factors such as stress-induced hyperglycemia, corticosteroid use during acute infection, reduced physical activity, and disruption of routine healthcare services. These challenges are often compounded by the presence of comorbid conditions, including hypertension, cardiovascular disease, and dyslipidemia, which further increase clinical complexity and economic burden. Consequently, COVID-19 recovered diabetes patients represent a vulnerable population requiring comprehensive and coordinated healthcare interventions [4-8].

Pharmaceutical care is a patient-centered practice in which pharmacists assume responsibility for optimizing medication therapy to achieve definite clinical outcomes. Through medication review, patient education, adherence monitoring, and lifestyle counseling, pharmaceutical care has demonstrated significant benefits in improving glycemic control, reducing drug-related problems, and enhancing quality of life in patients with chronic diseases. In the context of post-COVID care, pharmacist-led interventions may play a critical role in addressing medication complexity, preventing therapeutic duplication, and promoting rational drug use.

In addition to clinical outcomes, the economic impact of long-term diabetes management following COVID-19 recovery warrants attention. Increased medication use, frequent laboratory investigations, and recurrent hospital visits contribute substantially to treatment costs, particularly in low- and middle-income settings. Pharmacoeconomical evaluation of pharmaceutical care interventions is therefore essential to determine their value in reducing financial burden while maintaining or improving therapeutic outcomes[9-14].

Despite growing recognition of the pharmacist's role in chronic disease management, there is limited evidence evaluating the combined clinical, humanistic, and economic outcomes of pharmaceutical care among COVID-19 recovered diabetes patients. Most available studies focus either on acute COVID-19 management or isolated clinical endpoints, with minimal emphasis on post-recovery quality of life and cost implications [15-19].

Therefore, the present study was undertaken to evaluate the association of pharmaceutical care intervention with glycemic control, health-related quality of life, and treatment costs among COVID-19 recovered patients with diabetes mellitus and comorbidities. By integrating clinical, HRQOL, and pharmacoeconomical outcomes, this study aims to provide comprehensive evidence supporting the role of pharmaceutical care in post-COVID diabetes management.[20-26]

EXPERIMENTAL METHODS

Study Design

Single arm interventional study conducted from December 2022 to May 2024 for period of 18 months.

Study Population

Patients with Type2 Diabetes and comorbidities who visited Tertiary care hospital.

Ethics Approval

This study was approved by Sweccha Indenpendent Ethics Committee (Ref number:10/2022) and this study enrolled and approved by CTRI.

Subject Selection

Inclusion Criteria: Patients diagnosed with Type 2 diabetes mellitus with COVID recovery with or without underlying co-morbidities .Individuals who are at least 18 years of age, possess clear consciousness and understanding, possess the ability to effectively communicate with the researcher .Patients Who received COVID Vaccination.Individuals who are willing and able to participate in the study.

Exclusion Criteria: Pregnant and lactating mothers.Patients with a history of depression and psychiatric disorders. Patients with dementia or psychosis are excluded,. Patients who have experienced an unpleasant event, such as the death of a relative, within the prior three months are excluded.

Sample size: The sample size was calculated using standard statistical methods based on estimation of a proportion, with a 95% confidence level and 5% margin of error. Based on previous studies involving diabetes patients and post-COVID outcomes, the minimum required sample size was estimated to be 338 participants. To compensate for potential non-response, loss to follow-up, and incomplete data, an additional 5% contingency was incorporated. Accordingly, the final sample size was increased to

350 participants, all of whom were included in the study analysis.

Source of data: The data for this study were obtained from COVID-19 recovered patients with diabetes mellitus and associated comorbidities attending the outpatient and inpatient departments of a tertiary care teaching hospital. Patient-related information was collected from medical records, laboratory reports, and direct patient interviews using a structured data collection form.Clinical data, including glycemic parameters and lipid profile, were extracted from hospital records and laboratory databases. Information related to medication use, comorbid conditions, Health-related quality of life data were collected using a validated questionnaire administered through face-to-face interviews.

RESULTS AND DISCUSSION

The anthropometric analysis of the sample population included measurements of height, weight, and BMI. The mean height was 1.62 meters (SD=0.087), with a mean weight of 71.40 kg (SD=13.07), and the mean BMI was 27.39 (SD=5.77). Descriptive statistics for these measurements indicated a wide range of variation in height, weight, and BMI across the sample

Table 1: Descriptive statistics of Height, Weight, BMI.

	Height	Weight	BMI
Mean	1.6206	71.3967	27.2166
Std. Deviation	.08690	13.07348	4.83409
Minimum	1.35	40.00	16.56
Maximum	1.86	116.00	43.06

The weight distribution analysis showed that most patients weighed between 70-79 kg (33.1%), followed by 60-69 kg (25.7%) and 50-59 kg (15.7%). The Kolmogorov-Smirnov (KS) test (p=0.038) and Shapiro-Wilk (SW) test (p=0.105) indicated a slight deviation from normal distribution. A Q-Q plot further confirmed this minor deviation.

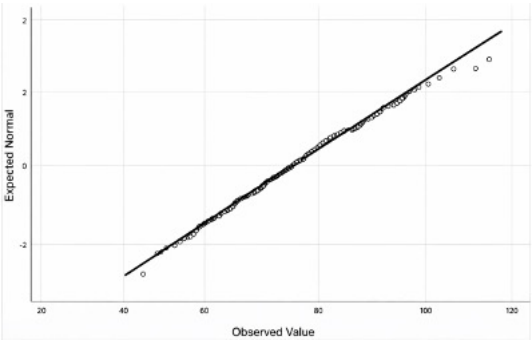

Figure 1: Q-Q plot for distribution of Weight.

The analysis of BMI showed that most patients were overweight (46.6%), followed by those with a healthy weight (27.7%) and

obesity (22.9%). A small percentage (2.9%) were underweight. Normality tests (KS and SW, p<0.01) indicated a significant deviation from a normal distribution, highlighting the variation in the sample.

Table 2: Test for Normality of BMI.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
BMI	0.089	50	0.000	0.971	350	0.000

Chi-square tests were used to examine associations between BMI and gender, and BMI and age. Results indicated a significant relationship between BMI and gender (p=0.042), as well as BMI and age (p=0.019). Males showed a higher prevalence of healthy weight, while females tended to have higher obesity rates. In the age group analysis, patients aged 51-70 years predominantly fell within the overweight category (50.9%), followed by those aged 31-50 years (37.8%)

Table 3: Crosstabulation BMI*Age.

BMI (Categories)	Age (Categories)			
	18-30	31-50	51-70	71-90
Underweight	0	3	5	2
	0.0%	3.7%	2.2%	5.9%
Healthy weight	6	21	58	12
	75.0%	25.6%	25.7%	35.3%
Overweight	1	31	115	16
	12.5%	37.8%	50.9%	47.1%

Table 4: Chi Square test, BMI*AGE

Chi-Square Test			
	Value	Df	Asymptotic Significance (2-sided)

Pearson Chi-Square	19.818	9	.019
Obesity	1	27	48
	12.5%	32.9%	21.2%

Biochemical parameters at baseline and follow-up: Comparison of clinical parameters at baseline and follow-up revealed a statistically significant reduction in HbA1c levels following pharmaceutical care intervention ($p = 0.0493$), indicating improved long-term glycemic control. Although fasting blood glucose levels showed a numerical decrease at follow-up, the difference did not reach statistical significance ($p = 0.0516$). Lipid profile parameters, including total cholesterol, triglycerides, HDL-cholesterol, and LDL-cholesterol, did not demonstrate statistically significant changes between baseline and follow-up ($p > 0.05$) Table 5. Similarly, inflammatory marker C-reactive protein and renal function assessed by serum creatinine levels showed no significant variation over the study period. Overall, the findings suggest that pharmaceutical care intervention was associated with significant improvement in glycemic control, while other clinical parameters remained stable during the follow-up period.

Table 5: Biochemical parameters at baseline and follow-up

Parameter	Baseline	Follow up	P value
HbA1c (%)	6.8 ± 0.7	6.1 ± 0.4	0.0493*
Fasting Glucose (mg/dL)	128.5 ± 15.2	112.5=7 ± 12.1	0.0516
Total Cholesterol (mg/dL)	198.4 ± 25.6	192.1 ± 22.3	0.2105
Triglycerides (mg/dL)	152.3 ± 40.1	154.5 ± 39.6	0.1124
HDL-Cholesterol (mg/dL)	42.7 ± 8.3	43.4 ± 8.9	0.0967
LDL-Cholesterol (mg/dL)	125.8 ± 20.7	129.1 ± 19.6	0.1052
CRP (mg/L)	6.5 ± 3.2	6.2 ± 3.4	0.469
Serum Creatinine (mg/dL)	0.96 ± 0.18	0.90 ± 0.20	0.2195

Health-Related Quality of Life Outcomes:

Comparison of health-related quality of life scores between baseline and follow-up demonstrated a statistically significant improvement across all four WHOQOL-BREF domains following pharmaceutical care intervention. Health-related quality of life was evaluated using the World Health Organization Quality of Life–BREF (WHOQOL-BREF) questionnaire, a validated tool consisting of 26 items that assess four domains of quality of life. The questionnaire was administered according to the guidelines provided by the World Health Organization [27-28]. The Physical Health domain showed a significant increase in mean score from 45.8 ± 10.2 at baseline to 59.6 ± 9.1 at follow-up, with a mean change of 13.8 ($p < 0.001$). Similarly, the Psychological Health domain improved significantly from 47.3 ± 9.4 to 61.2 ± 8.6, reflecting a mean increase of 13.9 ($p < 0.001$). The Social Relationships domain also showed a marked improvement, with mean scores increasing from 50.9 ± 11.1 at baseline to 64.1 ± 9.4 at follow-up (mean change = 13.2; $p < 0.001$).

A significant enhancement was additionally observed in the Environmental Health domain, where mean scores increased from 54.6 ± 8.7 to 67.4 ± 7.9, corresponding to a mean change of 12.8 ($p < 0.001$). Overall, these findings indicate a substantial improvement in health-related quality of life among the study participants during the follow-up period (Table 6).

Table 6: HRQOL Domain scores

Domain	**Baseline (Mean ± SD)**	**Follow-up (Mean ± SD)**	**Mean Change**	***p* value**

Physical Health	45.8 ± 10.2	59.6 ± 9.1	13.8	<0.001*
Psychological Health	47.3 ± 9.4	61.2 ± 8.6	13.9	<0.001*
Social Relationships	50.9 ± 11.1	64.1 ± 9.4	13.2	<0.001*
Environmental Health	54.6 ± 8.7	67.4 ± 7.9	12.8	<0.001*

Pharmacoeconomical Outcomes:

Direct Costs: Analysis of direct healthcare costs demonstrated a substantial reduction following pharmaceutical care intervention. Mean hospitalization costs decreased from ₹45,000 ± 12,000 at baseline to ₹35,500 ± 10,200 at follow-up, representing a 21% reduction. Medication-related expenses were also reduced from ₹12,500 ± 3,200 to ₹10,200 ± 2,800, corresponding to an 18% decrease. Similarly, laboratory investigation costs declined from ₹7,800 ± 1,500 at baseline to ₹6,900 ± 1,200 at follow-up, reflecting a 12% reduction.

Overall, the total direct healthcare cost showed a notable decrease from ₹65,300 ± 14,500 during the pre-pharmaceutical care period to ₹52,600 ± 12,700 post-intervention, accounting for a 19% reduction in direct costs.

Indirect Costs: Indirect cost analysis revealed a marked reduction in productivity-related losses following the intervention. Expenses associated with sick leave and lost workdays decreased from ₹8,200 ± 2,100 at baseline to ₹5,600 ± 1,700 at follow-up, corresponding to a 32% reduction. Caregiver-related expenses also declined from ₹3,100 ± 900 to ₹2,400 ± 800, indicating a 23% reduction.

Consequently, the total indirect cost decreased from ₹11,300 ± 3,000 at baseline to ₹8,000 ± 2,400 at follow-up, reflecting an overall 29% reduction in indirect costs.

Total Healthcare Cost:

When combining both direct and indirect costs, the total healthcare expenditure demonstrated a significant decline following pharmaceutical care intervention. The mean total cost decreased from ₹76,600 ± 15,800 at baseline to ₹60,600 ± 13,100 at follow-up, representing an overall 21% reduction in healthcare costs.

Table 7: Direct, Indirect Medical cost & Total Health care cost

Direct Cost			
Cost Component	**Baseline (Pre-Pharmaceutical Care)**	**Follow-up (Post-Pharmaceutical Care)**	**% Change (reduced)**
Hospitalization	45,000 ± 12,000	35,500 ± 10,200	21%
Medications	12,500 ± 3,200	10,200 ± 2,800	18%
Laboratory tests	7,800 ± 1,500	6,900 ± 1,200	12%
Total Direct Cost	65,300 ± 14,500	52,600 ± 12,700	19%
Indirect Cost			
Parameter	**Baseline (₹)**	**Follow-up (₹)**	**% Change (reduced)**
Lost workdays	8,200 ± 2,100	5,600 ± 1,700	32%
Caregiver expenses	3,100 ± 900	2,400 ± 800	23%
Total Indirect Cost	11,300 ± 3,000	8,000 ± 2,400	29%
Total Healthcare Cost (Direct + Indirect)			
Parameter	**Baseline (₹)**	**Follow-up (₹)**	**% Change (reduced)**
Total Cost	76,600 ± 15,800	60,600 ± 13,100	21%

CONCLUSIONS

The present study conclusively demonstrates that structured pharmaceutical care significantly improves health-related quality of life (HRQOL), medication adherence, and clinical outcomes among COVID-recovered diabetes patients with comorbidities. Significant improvements were observed across all WHOQOL-BREF domains, indicating enhanced physical functioning, psychological well-being, social relationships, and environmental satisfaction following pharmaceutical care.

From a pharmacoeconomic perspective, improved adherence and clinical outcomes suggest a reduction in healthcare utilization, preventable complications, and overall treatment costs, highlighting pharmaceutical care as a cost-effective and sustainable healthcare strategy, particularly in resource-limited settings.

Limitation of the study :

This study has certain limitations that should be considered while interpreting the findings. First, the study was conducted at a single tertiary care center, which may limit the generalizability of the results to other healthcare settings or populations. Second, the follow-up period was relatively short, which may not fully capture long-term changes in glycemic control, health-related quality of life, and treatment costs. Future multicenter studies with longer follow-up durations are warranted to validate and extend these findings.

Strengths:

This study comprehensively evaluated the clinical, humanistic, and economic outcomes of pharmaceutical care intervention among COVID-19 recovered patients with diabetes mellitus, providing a holistic assessment of patient care. The inclusion of baseline and follow-up assessments allowed for meaningful comparison of outcomes over time.

Weakness:

Despite its strengths, the study has certain limitations. Being conducted at a single tertiary care center, the findings may have limited generalizability to other healthcare settings. The short to medium duration of follow-up may not adequately reflect long-term clinical, quality of life, and economic outcomes.

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