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Educational Interventions and Medication Reconciliation Performance of Hospital Pharmacists

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Abstract

Medication reconciliation is a validated patient-safety strategy aimed at minimizing medication-related adverse events. This study assessed the impact of educational interventions on the medication reconciliation practices of hospital pharmacists managing ambulatory patients with diabetes and hypertension. A non-randomised controlled clinical trial was conducted to evaluate medication reconciliation practices among pharmacists at two study sites. A total of 85 pharmacists at the intervention site and 61 pharmacists at the control site were included. To indirectly assess baseline medication reconciliation practices, the principal investigator performed medication reconciliation for 334 ambulatory patients with diabetes and/or hypertension (183 at the intervention site and 151 at the control site). Following baseline assessment, pharmacists at the intervention site received a general educational intervention. Subsequent medication reconciliation was performed by the principal investigator among two additional patient cohorts at three months (n=96; intervention 46, control 50) and six months (n=90; intervention 44, control 46) after the intervention to evaluate post-intervention practices. A focused educational intervention was later delivered to a subset of 15 pharmacists at the intervention site. After this targeted training, these pharmacists conducted medication reconciliation for another cohort of 140 patients. The completed medication reconciliation forms were independently reviewed by three clinical pharmacy experts. Data were analysed using descriptive statistics (frequencies, percentages, and mean ± standard deviation) and inferential tests, including Pearson's correlation, independent-samples t-test, and one-way analysis of variance (ANOVA), with statistical significance defined as $p<0.05$.Medication reconciliation practices were suboptimal at baseline at both study sites. Following the general educational intervention, a significant reduction of 42.8% in medication discrepancies was observed at the intervention site ($p<0.001$). Additionally, six months after the intervention, there was a significant 54.3% increase in the proportion of patients who brought their medication packs to clinic visits, facilitating more accurate medication reconciliation ($p=0.003$). Drug therapy problems identified by intervention pharmacists increased over time, with 35, 66, and 48 problems detected at one, three, and six months post-intervention by 31 (43.1%), 33 (66.0%), and 32 (71.1%) pharmacists, respectively. Following the focused educational intervention, the 15 trained pharmacists identified and resolved 75 medication discrepancies (10.8%) out of 695 prescribed medications among 42 patients (30%).Both general and focused educational interventions significantly enhanced pharmacists' medication reconciliation practices at the intervention site. These findings highlight the value of pharmacist education in improving medication safety and underscore the potential of such interventions to raise awareness and reduce medication-related harm in developing country settings.

Keywords: Medication reconciliation, Drug therapy problems, Diabetes, Hospital pharmacist, Educational intervention, Medication discrepancy

Introduction

Medication errors encompass any avoidable incidents that may result in improper medication use or cause harm to patients at any stage while a medication is under the responsibility of healthcare providers, patients, or consumers [1]. These errors place a considerable financial strain on healthcare systems and are linked to severe clinical and economic outcomes, including higher treatment costs and increased mortality rates [2-5]. Common adverse consequences associated with medication errors include harmful drug reactions, suboptimal medication adherence, and deterioration in patients' quality of life [6]. Medication discrepancies,

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which represent a specific category of medication errors, frequently occur during critical points of care such as hospital admission, inter-facility transfers, and patient discharge [7, 8]. Research has demonstrated that mismatches between prescribed therapies and medications actually consumed by patients can result in significant harm [1, 9, 10]. Documented examples include episodes of hypoglycaemia following the inappropriate administration of short-acting insulin to patients not previously treated with insulin, as well as the exacerbation of atrial fibrillation when prescribed anticoagulant therapy such as warfarin is unintentionally omitted.

Medication reconciliation is a structured patient safety process aimed at identifying and correcting medication discrepancies in order to prevent avoidable hospital readmissions and medication-related harm [11]. This process requires a systematic and comprehensive review of all medications a patient is using whenever there is a change in care or therapy, with the objective of detecting and preventing omissions, duplications, dosing inaccuracies, and clinically significant drug interactions, while also assessing adherence and compliance behaviours [12]. When consistently and appropriately applied, medication reconciliation substantially reduces differences between prescribed treatment plans and patients' actual medication use [13].

There is strong evidence supporting medication reconciliation as an effective approach to minimizing both the clinical risks and economic costs associated with medication errors, particularly during hospital admission and transitions of care [14]. In the United States, medication reconciliation interventions have been associated with a 52% reduction in the projected cost of preventable adverse drug events, lowering expenses from 472 US dollars under usual care to 266 US dollars per patient [15]. Comparable economic benefits have been reported internationally, including a net saving of 103 euros per patient in the Netherlands [16] and cost reductions of up to 80 pounds per patient in the United Kingdom [17]. Multiple investigations [15-18] have demonstrated that pharmacists are especially effective in obtaining accurate and detailed medication histories. Furthermore, the positive impact of pharmacist involvement in medication reconciliation within acute care environments has been consistently validated [19, 20]. Despite this growing body of evidence, formal documentation of medication reconciliation practices in Nigeria remains limited, and informal observations suggest that the process is often inconsistent, fragmented, or absent in routine clinical care.

The present study sought to determine the baseline level of medication reconciliation practice and to evaluate the effect of educational interventions on pharmacists' implementation of medication reconciliation among ambulatory patients with diabetes and hypertension in two Nigerian tertiary hospitals.

Materials and Methods

Setting and study design

This investigation employed a mixed-method, non-randomised clinical trial design and was conducted in two tertiary teaching hospitals in Nigeria. The intervention arm was implemented at the University College Hospital, Ibadan, a 950-bed institution affiliated with the University of Ibadan. The control arm was based at the University of Ilorin Teaching Hospital, Ilorin, a 650-bed facility affiliated with the University of Ilorin. Both hospitals function as major referral centres and provide comprehensive undergraduate and postgraduate training for healthcare professionals, including physicians, pharmacists, nurses, and allied health practitioners. The study was conducted over a 12-month period.

Participant selection criteria

Only pharmacists who voluntarily provided informed consent were included in the recruitment process across both study locations. Pharmacy undergraduates undertaking clinical placements were not eligible for participation. The study enrolled adult individuals (aged 18 years or older) with a confirmed diagnosis of diabetes, hypertension, or both, who attended appointments at the Endocrinology or Cardiology outpatient clinics. Exclusion applied to those not receiving pharmacological treatment for these conditions or who withheld consent.

Tools for data gathering

Data were collected using three specially designed semi-structured questionnaires (labeled Q1, Q2, and Q3). These instruments were crafted by the research team, informed by their academic and professional expertise along with an in-depth review of relevant published works [11-13, 17, 21-24].

The initial questionnaire (Q1), with 22 questions, was conducted via face-to-face interviews with patients by the lead researcher. Its purpose was to indirectly gauge

the quality of pharmacists' medication reconciliation activities. It featured Section A for capturing patient demographics (including age, sex, level of education, and employment status) and Section B for exploring reconciliation-related experiences, such as whether patients were encouraged to bring their home medication containers, and the thoroughness of medication history documentation (encompassing prescription drugs, non-prescription items, and any stopped treatments).

For pharmacists, two separate tools were utilised. The follow-up questionnaire (Q2), containing 18 items, served as a monitoring tool to track medication reconciliation practices at intervals of one, three, and six months after a broad-based training session. Pharmacists completed Q2 independently. It included Section A on their personal and professional background details, and Section B on practical aspects like how often they performed reconciliation, whether they reminded patients to carry their medicines to appointments, how they recorded the process, and their approach to detecting and addressing drug-related issues.

The final questionnaire (Q3), an 8-item tool, aimed to capture more comprehensive insights into reconciliation practices following a specialised training programme. Beyond basic demographic data, it delved into comparisons of patients' past and present drug regimens, the spotting and correction of inconsistencies in medication lists, and the handling of potential therapeutic complications. In this case, participating pharmacists interviewed patients directly using Q3 to ensure uniformity in reporting their own reconciliation efforts.

Prior to full implementation, the patient-focused questionnaire underwent pilot testing for face validity with 34 individuals managing diabetes and/or hypertension at Catholic Hospital in Oluyoro, Ibadan. Similarly, the pharmacist questionnaires were trialled for feasibility with 12 practitioners from the University Health Services at the University of Ibadan and the Military Hospital in Ojoo, Ibadan. All three instruments were reviewed for content validity by three experts from the Department of Clinical Pharmacy and Pharmacy Administration within the Faculty of Pharmacy at the University of Ibadan.

The sample size for patient participants was calculated using the formula provided in reference [25]:

$$M = 2[Z(1-\alpha/2) + Z(1-\beta)]2/\delta 2 \quad (1)$$

α = 5%(0.05), β = 20%(0.2), δ = 50%(0.5)

Participants were allocated equally across the intervention groups. All statistical tests were two-sided and assumed a normal distribution. To detect a treatment effect with 80% power at a 5% significance level, the following standard values were applied:

- Significance level: $Z(1-\alpha/2)$ at 5% = 1.96
- Power: $Z(1-\beta)$ at 80% = 0.8416

where $Z(1-\alpha/2)$ and $Z(1-\beta)$ represent the critical values from the normal distribution corresponding to the significance level and power, respectively, and δ denotes the standardized difference (effect size).

Substituting into equation (1): 2 $[1.96 + 0.8416]^2 / 0.52$ = 15.6978 / 0.25 = 62.8

After adjusting for an anticipated 10% attrition rate, the final sample size was rounded up to 70 patients per group. This calculated figure served as a target for patient recruitment, while a total sampling approach (convenience sampling of all available eligible individuals) was employed for enrolling pharmacists.

Participant enrollment and study procedures

Ethical clearance was obtained from the institutional review boards of both hospitals before the commencement of the study. In addition, administrative authorization was secured from the leadership of all departments involved in the research activities. All practicing pharmacists at the intervention and control hospitals were approached for participation using a total population sampling strategy. Prior to enrolment, detailed information regarding the objectives and procedures of the study was provided to pharmacists and consulting physicians. Pharmacists who agreed to participate provided informed consent and were subsequently engaged within their respective practice units for questionnaire administration.

To directly assess medication reconciliation activities, a self-completed questionnaire (Q2) was administered to 146 pharmacists, comprising 85 pharmacists from the intervention hospital and 61 from the control hospital. The study employed a mixed-method, non-randomised clinical trial design. In parallel, ambulatory patients attending outpatient clinics were recruited to support indirect assessment of pharmacists' medication reconciliation practices. Patients diagnosed with diabetes and/or hypertension were approached on scheduled clinic days, and study information was communicated in either English or Yoruba, depending on patient preference. Medication reconciliation interviews were conducted

using semi-structured interviewer-administered questionnaires (Q1 and Q3). Across the duration of the study, these tools were applied to a total of 660 patients, including 520 patients assessed with Q1 and 140 patients assessed with Q3, across multiple patient cohorts.

Diabetes and hypertension were selected as target conditions due to their high prevalence in Nigeria, estimated at 5.77% and 30.6%, respectively [26, 27]. Patients with these conditions were considered particularly vulnerable to medication-related problems because of long-term medication use and the frequent presence of comorbid illnesses.

Initial evaluation of pharmacists' medication reconciliation practices was conducted indirectly by the principal investigator through medication reconciliation performed for an initial group of 334 patients (183 at the intervention site and 151 at the control site). Findings from this baseline assessment informed the design of a general educational intervention delivered to pharmacists at the intervention hospital. These pharmacists are subsequently referred to as intervention pharmacists. Following this training, pharmacists' practices were monitored using Q2 at one-month, three-month, and six-month intervals.

Additional indirect assessments were conducted by the principal investigator using Q1 during post-intervention medication reconciliation sessions with new patient cohorts at three months (n=96; intervention 46, control 50) and six months (n=90; intervention 44, control 46).

A subsequent phase of the study involved a targeted educational programme delivered to a subgroup of 15 pharmacists selected from the intervention cohort. This phase was implemented at the Geriatric Centre of the intervention hospital.

Following the focused training, the 15 pharmacists independently conducted medication reconciliation for an additional cohort of 140 patients. The documentation generated during this phase was subjected to external review by three academic clinical pharmacy experts from the Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, University of Ibadan. These reviewers were selected based on extensive experience in clinical pharmacy education, research, and practice, particularly in medication history taking, clinical documentation, and the identification and resolution of medication discrepancies and drug therapy problems. The review panel consisted of one Associate Professor and two Senior Lecturers, all of whom have published extensively in peer-reviewed clinical pharmacy literature. Study outcomes assessed included detection and resolution of medication discrepancies, identification and management of drug therapy problems, and the proportion of patients presenting with medication packs during clinic visits.

Educational interventions

Educational activities were conducted by the principal investigator, a faculty member and doctoral researcher in the Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, University of Ibadan, Nigeria. His expertise in medication reconciliation was supported by formal training, including a two-week "Best Clinical Practices" programme organised by the University of Nigeria Teaching Hospital in collaboration with the Nigerian Association of Pharmacists and Pharmaceutical Scientists in the Americas (NAPPSA) in 2015, and a six-week International Pharmacists' Enrichment Programme at Howard University, Washington DC, jointly organised by FIP-Pharmabridge and Howard University in 2016.

The first educational intervention was delivered to all 85 pharmacists at the intervention hospital. This four-hour programme addressed essential components of medication reconciliation, including systematic medication history collection, patient-centred communication, collaboration with other healthcare professionals, and identification and management of drug therapy problems. Teaching approaches included interactive lectures, role-playing exercises, and case-based learning.

The second intervention was a brief, targeted follow-up session provided to 15 pharmacists. This one-hour session prioritised practical skill development, with emphasis on structured documentation of medication reconciliation activities. Participants engaged in hands-on exercises focused on medication reconciliation processes, clinical documentation, and resolution of medication discrepancies and drug therapy problems. The Q3 tool was used to standardise data collection during this phase. Both educational programmes were conducted within the Pharmacy Department of the intervention hospital.

Data analysis

All analyses were conducted using IBM SPSS Statistics for Windows (version 23.0; IBM Corp., New York, USA). Preliminary assessment of data distribution was performed using the Kolmogorov–Smirnov test to

determine normality. Based on the nature of the variables, different inferential statistical procedures were applied. Comparisons of the presence or absence of medication discrepancies between patients attending the intervention and control hospitals were examined using Fisher's exact test. Relationships between medication discrepancies and patient-related factors, including educational status, number of prescribed medications, and comorbid conditions, were explored through Pearson correlation analysis. Mean differences in medication discrepancy counts between the two study sites were assessed using an independent t-test. Temporal variations in medication discrepancies across the study duration at both hospitals were analysed using one-way analysis of variance. Statistical significance was defined a priori as $p < 0.05$. To determine consistency among expert reviewers who assessed medication reconciliation practices, inter-rater reliability was evaluated using Fleiss' Kappa coefficient.

Results and Discussion

One hundred and forty-six pharmacists were enrolled in the study. Of these, more than one-third of pharmacists at the intervention hospital (35; 35.0%) had qualifications beyond the Bachelor of Pharmacy degree, compared with fewer than one-quarter (14; 23.0%) at the control hospital. Professional experience among pharmacists was broadly similar across sites; the mean length of hospital practice was 7.76 years (SD ± 8.15) at the intervention site and 7.23 years (SD ± 9.23) at the control site. Additional characteristics of pharmacist participants are detailed in **Table 1.**

Attrition occurred throughout the follow-up period. At the intervention hospital, nearly half of the pharmacists (40; 49.4%) were lost to follow-up, while 31 pharmacists did not complete follow-up assessments at the control hospital. The flow of pharmacist and patient participation throughout the study is illustrated using Consolidated Standards of Reporting Trials (CONSORT) diagrams, presented in **Figures 1 and 2**, respectively.

Among patients recruited at baseline, females accounted for the majority at both locations. Specifically, 115 patients (62.8%) at the intervention hospital and 70 patients (46.4%) at the control hospital were female. A comprehensive summary of patient socio-demographic variables is provided in **Table 2**.

Table 1. Characteristics of pharmacist participants

Characteristic	Control (n = 61)		Intervention (n = 85)	
	Frequency	Percent	Frequency	Percent
Hospital position/rank				
Intern Pharmacist	28	45.9	27	31.8
Pharmacist I	11	18.0	24	28.2
Chief Pharmacist	4	6.6	13	15.3
Deputy Director of Pharmaceutical Services	9	14.8	7	8.2
Director of Pharmaceutical Services	0	0	1	1.2
Principal Pharmacist	6	9.8	2	2.4
National Youth Service Scheme Pharmacist	1	1.6	0	0
Senior Pharmacist	2	3.3	NA	NA
Assistant Director of Pharmaceutical Services	0	0	11	12.9
Gender				
Male	31	50.8	28	32.9
Female	30	49.2	57	67.1
Highest/postgraduate educational qualification(s)				
B. Pharm only	46	75.4	48	56.5
MBA	1	1.6	0	0
MBA + FPCPharm	1	1.6	1	1.2
M.Sc. + FPCPharm	3	4.9	13	15.3
M. Pharm / M.Sc. / MPH	4	6.6	9	10.6
FPCPharm	6	9.8	13	15.3
PhD	0	0	1	1.2
Years of experience in hospital pharmacy				

1–5 years	42	68.9	45	52.9
6–10 years	4	6.6	16	18.8
More than 10 years	15	24.6	24	28.2

MBA Master of Business Administration, B. Pharm Bachelor of Pharmacy, MPH Master of Public Health, M. Sc. Master of Science, PhD Doctor of Philosophy, M. Pharm Master of Pharmacy, Postgraduate College of Pharmacists, FPCPharm Fellow, NA Designation of Senior Pharmacists is not used at the intervention site

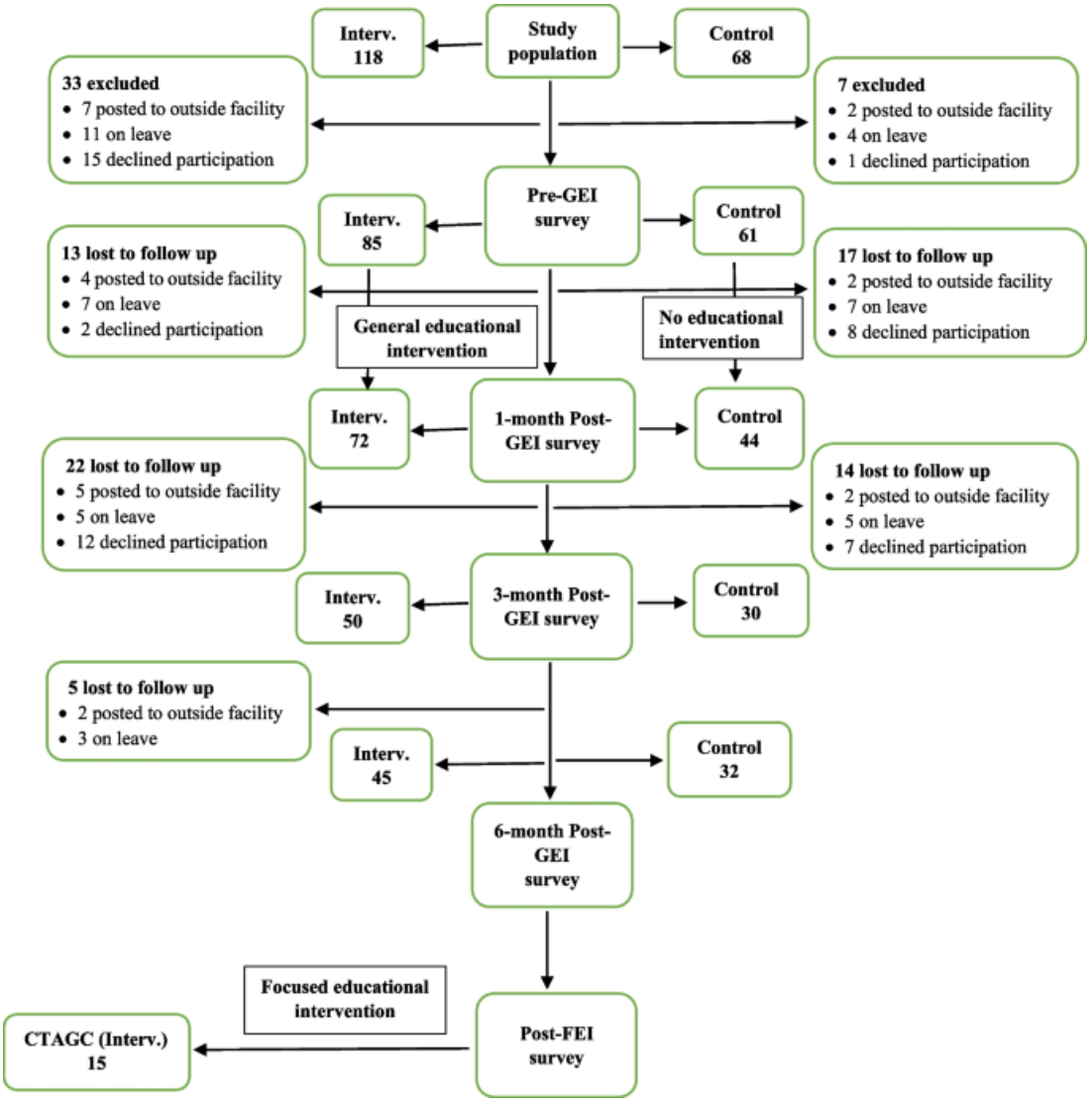

Figure. 1. CONSORT flow diagram illustrating pharmacist participation throughout the study. Interv., intervention; PI, post-intervention; CTAGC, GEI, general educational intervention; Chief Toni Anenih Geriatric Center; FEI, focused educational intervention.

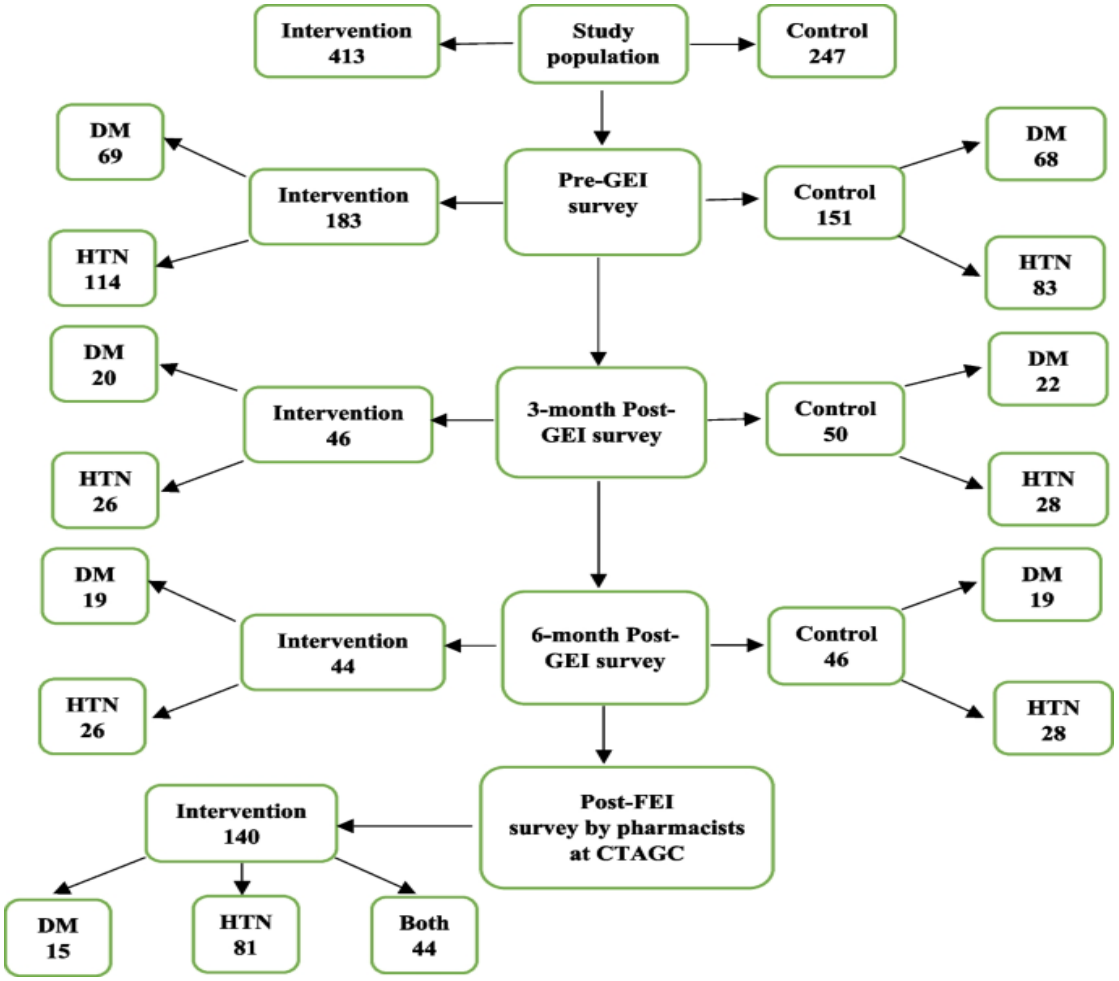

Figure. 2. CONSORT-based flow diagram illustrating patient enrolment and progression across study phases. CTAGC refers to the GEI, general educational intervention; Chief Toni Anenih Geriatric Center; FEI, focused educational intervention; PI, post-intervention; CONSORT, Consolidated Standards of Reporting Trials; Both indicates patients diagnosed with both diabetes and hypertension. Distinct patient cohorts were used at each study phase. Total number of patients assessed: 660.

Table 2. Socio-demographic profile of patient participants.

Variable	3-month post-GEI		6-month post-GEI		Baseline	
	Intervention (n=46)	Control (n=50)	Intervention (n=44)	Control (n=46)	Intervention (n=183)	Control (n=151)
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Gender						
Male	25 (54.3)	25 (50.0)	15 (34.1)	21 (45.7)	68 (37.2)	81 (53.6)
Female	21 (45.7)	25 (50.0)	29 (65.9)	25 (54.3)	115 (62.8)	70 (46.4)
Male:Female ratio	1:0.4	1:1	1:1.9	1:1.2	1:1.7	1:0.9
Religion						
Islam	16 (34.8)	9 (18.0)	7 (15.9)	11 (23.9)	42 (23.0)	87 (57.6)
Christianity	30 (65.2)	41 (82.0)	37 (84.1)	35 (76.1)	141 (77.0)	64 (42.4)
Age category (years)						

<50	4 (8.7)	24 (48.0)	0 (0.0)	7 (15.2)	30 (16.4)	27 (17.9)
50–59	9 (19.6)	13 (26.0)	0 (0.0)	13 (28.3)	14 (7.7)	41 (27.2)
60–69	17 (37.0)	8 (16.0)	19 (43.2)	9 (19.6)	68 (37.2)	43 (28.5)
>69	16 (34.8)	5 (10.0)	25 (56.8)	17 (37.0)	71 (38.8)	40 (26.5)
Level of education						
Primary	9 (19.6)	5 (10.0)	11 (25.0)	3 (6.5)	36 (19.7)	35 (23.2)
Secondary	8 (17.4)	3 (6.0)	12 (27.3)	16 (34.8)	48 (26.2)	36 (23.8)
None	8 (17.4)	0 (0.0)	5 (11.4)	0 (0.0)	19 (10.4)	22 (14.6)
Tertiary	21 (45.7)	42 (84.0)	16 (36.4)	27 (58.7)	80 (43.7)	58 (38.4)

1. Post-GEI (After General Educational Training)

Pre-analysis checks confirmed that the dataset met assumptions of normality. When comparing patient groups across study sites, the proportion of individuals experiencing at least one medication discrepancy showed no statistically meaningful difference at study entry, with discrepancies identified in 43.7% of patients at the intervention hospital (80 patients) and 35.8% at the control hospital (54 patients) ($p = 0.086$). A similar pattern was observed three months after the educational programme, where discrepancies affected 43.5% of intervention-site patients (20 patients) and 60.0% of control-site patients (30 patients) ($p = 0.078$). However, by six months following the intervention, a clear divergence emerged: only 25.0% of patients at the intervention site (11 patients) had medication discrepancies, compared with 65.2% at the control site (30 patients), a difference that reached strong statistical significance ($p < 0.001$).

Evaluation of discrepancy burden over time revealed a gradual reduction among patients attending the intervention hospital. Mean discrepancy counts declined from 0.76 ± 0.68 at baseline to 0.57 ± 0.75 at three months and further to 0.43 ± 0.66 at six months. Statistical testing showed that this reduction became significant only when baseline values were compared with those observed at the six-month assessment ($p = 0.013$). In contrast, patients at the control hospital showed little variation across the same period, with mean discrepancy values of 0.74 ± 0.84 at baseline, 0.72 ± 0.95 at three months, and 0.67 ± 0.76 at six months, none of which differed significantly.

Exploratory correlation analysis demonstrated that medication discrepancies increased with greater treatment complexity. Specifically, higher discrepancy rates were associated with a larger number of prescribed medications ($r = 0.212$, $p < 0.001$) and the presence of additional comorbid conditions ($r = 0.135$, $p < 0.001$). No statistically significant relationships were identified between medication discrepancies and patient age ($r = 0.062$, $p = 0.251$), sex ($r = -0.034$, $p = 0.533$), or level of formal education ($r = -0.091$, $p = 0.095$).

Pharmacist engagement in identifying drug therapy problems increased progressively following the educational intervention. One month after training, 31 pharmacists (43.1%) identified a total of 35 drug therapy problems. At three months, this increased to 66 problems detected by 33 pharmacists (66.0%), while at six months, 48 problems were identified by 32 pharmacists (71.1%). Improvements were also observed in professional practice behaviours: the proportion of pharmacists who reported documenting their clinical interventions rose from 33.3% at one month to 64.4% at six months. Similarly, the proportion of pharmacists advising patients to bring their medication packs to clinic appointments increased substantially, from 43.1% at one month to 75.6% at six months post-intervention.

Changes in patient behaviour mirrored these professional practice improvements. Among the 520 patients assessed across multiple cohorts from baseline through six months post-intervention, fewer than half of intervention-site patients brought their medication packs at baseline (48.6%), compared with 57.0% at the control site ($p = 0.152$). By three months post-intervention, a marked improvement was evident at the intervention site, where 71.7% of patients presented with their medications, compared with 44.0% at the control site ($p = 0.008$). This difference persisted at six months, with 75.0% of intervention-site patients bringing medication packs versus 43.5% at the control site ($p = 0.003$). The clinical implications of medication discrepancies identified and resolved over this period are summarised in **Table 3.**

Table 3. Clinical consequences of medication discrepancies detected and addressed between baseline and six months following the general educational intervention.

Discrepancy Identified	Potential Clinical Implication	Description of Medication Discrepancy	Baseline			3 Months Post-Intervention			6 Months Post-Intervention		
			Intervention (n=183) Frequency (%)	Control (n=151) Frequency (%)	p-value[a]	Intervention (n=46) Frequency (%)	Control (n=50) Frequency (%)	p-value[a]	Intervention (n=44) Frequency (%)	Control (n=46) Frequency (%)	p-value[a]
Total number of medication discrepancies			139	112		26	36		14	31	
Omission of medication	Therapeutic failure	Omission of medication for diabetes	13 (9.4)	3 (2.7)	0.001*	2 (7.7)	2 (5.6)	1.000	0 (0.0)	1 (3.2)	0.617
		Omission of antihypertensives	11 (7.9)	1 (0.9)		0 (0.0)	0 (0.0)		1 (7.1)	2 (6.5)	
Suboptimal medication therapy	Poor quality of care	Omission of key medication	18 (12.9)	14 (12.5)	1.000	3 (11.5)	6 (16.7)	0.490	2 (14.3)	7 (22.6)	0.158
		Omission of statins	10 (5.0)	2 (1.1)		0 (0.0)	1 (1.6)		0 (0.0)	1 (1.8)	
		Medication discontinued by patient	23 (16.5)	14 (12.5)	0.384	2 (7.7)	5 (13.9)	0.438	1 (7.1)	4 (12.9)	0.361
	Possible increased risk of cardiovascular disease	Omission of Aspirin/Clopidogrel	14 (7.0)	7 (3.9)	0.028*	1 (1.7)	2 (3.3)	0.618	0 (0.0)	2 (3.6)	0.242

		Substitution of prescribed medication by patients		**Duration of medication exceeded**				**Different dose/frequency of medication**
Therapeutic failure	Ineffective therapy	Adverse drug reaction	Safety	Adverse drug reaction	Toxicity	Adverse drug reaction	Increased medication cost	Therapeutic failure
Biguanide substituted for insulin	ACEIs substituted for CCBs	Aspirin substituted for Clopidogrel	Proton pump inhibitor prolonged use	Prolonged use of NSAID	High dose of digoxin	Dose-related adverse drug reactions	Higher dose-related cost increment	Too low dose of medication(s)
1 (0.7)	0 (0.0)	2 (1.4)	2 (1.4)	1 (0.7)	3 (2.2)	5 (3.6)	11 (8.0)	8 (5.8)
1 (0.9)	0 (0.0)	0 (0.0)	1 (0.9)	1 (0.9)	4 (3.6)	9 (8.0)	24 (21.5)	16 (14.2)
1.000	c	0.503	1.000	1.000	0.706	0.174	0.004*	0.034*
0 (0.0)	0 (0.0)	0 (0.0)	3 (11.5)	0 (0.0)	1 (3.8)	3 (11.5)	4 (15.4)	2 (7.7)
1 (2.8)	2 (5.6)	1 (2.8)	0 (0.0)	1 (2.8)	0 (0.0)	2 (5.6)	3 (8.4)	2 (5.6)
1.000	0.496	1.000	0.106	1.000	0.479	0.668	0.242	1.000
0 (0.0)	1 (7.1)	0 (0.0)	1 (7.1)	0 (0.0)	0 (0.0)	1 (7.1)	4 (28.5)	0 (0.0)
0 (0.0)	0 (0.0)	2 (6.4)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.2)	5 (16.1)	0 (0.0)
c	0.489	0.495	0.489	c	c	1.000	0.412	c

Additional medication not prescribed by physician	Dependence	Use of Bromazepam	0 (0.0)	1 (0.9)	0.452	1 (3.8)	0 (0.0)	0.479	1 (7.1)	0 (0.0)	0.489			
	Increased medication cost	High cost of added medications	6 (4.3)	6 (5.4)	0.775	3 (11.5)	3 (8.3)	1.000	0 (0.0)	4 (12.9)	0.117			
	Tolerance	Chronic use of salbutamol	1 (0.7)	0 (0.0)	1.000	0 (0.0)	1 (2.8)	1.000	0 (0.0)	0 (0.0)	c			
	Adverse drug reaction	Took Nifedipine with Amlodipine	3 (2.2)	4 (3.6)	0.706	0 (0.0)	2 (5.6)	0.496	0 (0.0)	1 (3.2)	1.000			
	Toxicity	Digoxin intake	3 (2.2)	1 (0.9)	0.630	0 (0.0)	1 (2.8)	1.000	0 (0.0)	1 (3.2)	1.000			
Duplication of medication with	Adverse drug reaction	Took 2 different brands of Metformin	0 (0.0)	1 (0.9)	0.452	0 (0.0)	0 (0.0)	c	1 (7.1)	0 (0.0)	c			
	Increased medication cost	Higher cost for duplicated drugs	0 (0.0)	0 (0.0)	c	0 (0.0)	0 (0.0)	c	1 (7.1)	0 (0.0)	0.489			
	Toxicity	Took 2 brands of digoxin	4 (2.9)	2 (1.8)	0.693	1 (3.8)	1 (2.8)	1.000	0 (0.0)	0 (0.0)	c			

1. Calcium channel blockers (CCBs); angiotensin-converting enzyme inhibitors (ACEIs); nonsteroidal anti-inflammatory agents (NSAIDs); intervention (Interv); general educational intervention (GEI); c Statistical analysis was not performed where values were invariant.
2. [a] Chi-square test (linear-by-linear association).
3. *Statistical significance defined as $p < 0.05$.

Following the focused educational phase, medication reconciliation activities were conducted by a group of 15 trained pharmacists at the Geriatric Center, involving 140 ambulatory patients. Females constituted a slight majority of this cohort, accounting for 78 individuals (55.7%). In terms of clinical conditions, 15 patients (5.4%) were being managed for diabetes alone, 81 patients (28.9%) had hypertension only, while 44 patients (15.7%) presented with coexisting diabetes and hypertension.

Medication burden was relatively high within this population, with patients receiving an average of 4.96 ± 1.94 medicines each. Most participants actively supported the reconciliation process, as 115 patients

(82.1%) presented their medication packs during clinic visits.

Assessment of medication use revealed that, among the 695 medicines reported across all patients, 75 discrepancies were identified, representing 10.8% of total medications reviewed. These discrepancies occurred in 42 patients, corresponding to 30% of the study cohort. The most frequently encountered issue was the use of medicines that had not been prescribed, including self-medications, which accounted for 35 cases (46.7%). Medication duplication was the next most common problem, identified in 21 instances (28.0%). Other discrepancies included incorrect dose or dosing frequency (6 cases; 8.0%), inappropriate duration of therapy (5 cases; 6.7%), unauthorized substitutions (6 cases; 8.0%), and omitted medicines (2 cases; 2.7%).

The range of potential clinical outcomes associated with these discrepancies, as identified and addressed by the intervention pharmacists, is summarized in **Table 4.**

Table 4. Possible clinical consequences of medication discrepancies detected and resolved by the 15 intervention pharmacists at the geriatric center.

Discrepancy Identified	Potential Clinical Implication(s)	Description of Medication Discrepancy	Physician's Response to Query Raised	Action Taken by Pharmacist	n (%)	% Accuracy
Unprescribed medications / Self-medication	Worsening of disease condition	Took Tab Prednisolone recommended by a friend for pain	Not required	Patients advised to discontinue the unprescribed medication due to risk of adverse events	1 (1.3)	
	Possible liver impairment, stomach pain, skin rash, orthostatic hypotension	Tab Ketoconazole	Not required		1 (1.3)	
	Disruption of normal microbial flora	Antibiotics	Not required		11 (14.7)	
	Risk of end-organ impairment (especially kidneys)	NSAIDs and other pain relief medications	Not required		13 (17.3)	
	Risk of cardiac arrhythmias	Tab Potassium	Not required		1 (1.3)	
	Risk of pneumonia	Cap Omeprazole	Not required		1 (1.3)	
	Risk of hypotension	Antihypertensive medications	Not required		4 (5.3)	
	Dependence	Took opioid pain relief medications	Not required		2 (2.7)	
	Increased risk of falls	Anxiolytics	Not required		1 (1.3)	
Subtotal					35 (46.7)	100%
Duplication	Increased risk of adverse drug reactions; risk of end-organ impairment	Two different brands of Atorvastatin taken together	Referred to physician (not required in most cases)	Patients advised to discontinue the duplicate medication due to risk of adverse events	3 (4.0)	

	Risk of cardiac arrhythmias	Tab Potassium and Tab Spironolactone taken together		Tab Potassium withdrawn	1 (1.3)	
		Two NSAIDs taken together	Not required		2 (2.7)	
		Two brands of Cap Doxycycline taken together	Not required		1 (1.3)	
		Two brands of Cap Omeprazole taken together	Not required		1 (1.3)	
	Risk of hypoglycemia	Duplicates of Tab Metformin taken together	Not required		3 (4.0)	
	Risk of hypotension	Duplicates of antihypertensive medications	Not required		8 (10.7)	
	Risk of bleeding	Aspirin and Clopidogrel taken together	Not required		2 (2.7)	
Subtotal					21 (28.0)	80.8%
Different dose / frequency of administration	Risk of hypotension	Tab Nifedipine 30 mg twice daily instead of once daily	Not required	Patient instructed to take the correct dose	1 (1.3)	
	Suboptimal dosing	Tab Metformin 500 mg twice daily instead of three times daily	Not required		1 (1.3)	
	Risk of adverse effects	Higher dose of statins taken	Not required		2 (2.7)	
	Risk of hypoglycemia	Higher dose of diabetes medications taken	Not required		2 (2.7)	
Subtotal					6 (8.0)	100%
Duration	Disruption of normal microbial flora	Patient continuing discontinued antibiotics	Not required	Medication withdrawn	2 (2.7)	
	Risk of pneumonia	Patient continuing discontinued PPIs			3 (4.0)	
Subtotal					5 (6.7)	83.3%
Substitution	Risk of gastric ulceration	Tab Aspirin substituted for Tab Clopidogrel	Clopidogrel retained; Aspirin discontinued	Referred to physician	1 (1.3)	
	Risk of hypotension	Tab S-Amlodipine 5 mg instead of Tab Amlodipine 5 mg	Amlodipine 5 mg retained	Referred to physician	1 (1.3)	
	Poorly controlled hypertension	Herbal remedies instead of	Not required		1 (1.3)	

		antihypertensive medications				
	Poorly controlled diabetes	Herbal remedies substituted for prescribed oral hypoglycemics	Not required	Patient advised to restart prescribed oral hypoglycemics	1 (1.3)	
	Suboptimal dosing	Tab Simvastatin 40 mg instead of Tab Atorvastatin 40 mg	Atorvastatin retained; Simvastatin discontinued	Referred to physician	1 (1.3)	
	Worsening heart failure	Tab Bisoprolol + Tab Ramipril substituted by patient for Tab Uperio®	Bisoprolol + Ramipril discontinued	Referred to physician; patient counseled on adherence	1 (1.3)	
Subtotal					6 (8.0)	85.7%
Omission	Increased risk of cardiovascular disease	Omission of Tab Atorvastatin	Atorvastatin prescribed	Referred to physician	1 (1.3)	
	Reduced quality of life	Omission of arthritis medication	Diclofenac prescribed	Referred to physician	1 (1.3)	
Subtotal					2 (2.7)	40%

1. Percentage accuracy was calculated using the formula:
2. *number of medication discrepancies identified by pharmacists ÷ number identified by expert reviewers × 100%.*
3. NSAIDs, non-steroidal anti-inflammatory agents; OHAs, oral hypoglycemic agents; PPIs, proton pump inhibitors; Uperio® (sacubitril/valsartan); CVD, cardiovascular disease.

Assessment of agreement among reviewers demonstrated an excellent level of concordance, with a Fleiss' Kappa value of 0.990 (95% confidence interval: 0.986–0.992; $p < 0.001$). Expert evaluation revealed that pharmacists failed to identify five instances of therapeutic duplication, one case each of incorrect treatment duration and inappropriate medication substitution, and three omission errors. These corresponded to accuracy rates of 80.8%, 83.3%, 85.7%, and 40.0%, respectively. In contrast, pharmacists correctly identified all cases of non-prescribed medication use and incorrect dosing, achieving 100% accuracy in these categories.

Findings from this study indicate that pharmacists at both hospitals demonstrated inadequate medication reconciliation practices prior to the intervention. Following the educational programmes—particularly the focused training—pharmacists at the intervention site showed marked improvement in reconciling medications, as reflected by fewer medication discrepancies and enhanced identification and management of drug therapy problems.

The absence of documented medication reconciliation activities at baseline, together with the gradual uptake of the practice during the study period, suggests that medication reconciliation was neither systematic nor intentionally embedded into routine pharmacy practice at either facility. Instead, it appeared sporadic, informal, and largely unmonitored, and was undertaken by only a small number of pharmacists. This observation may be explained by the fact that medication reconciliation has not yet been formally integrated into pharmacy practice standards in Nigeria [28]. Furthermore, unlike in many high-income countries, Nigerian hospital accreditation requirements do not mandate medication reconciliation as a quality or safety indicator [29, 30].

Documentation of pharmacists' clinical activities was also found to be uncommon. Evidence from previous studies conducted in southwestern Nigeria indicates that pharmacists rarely record their clinical interventions. For example, Aje and Erhun (2016) [31] and Aje and Davies (2016) [32] reported that fewer than half of community pharmacists documented interventions related to point-of-care testing or drug therapy problem identification. Similarly, Suleiman and Onaneye (2011) [33] found that

although prescription errors were frequently identified by both hospital and community pharmacists, none of the detected errors or subsequent interventions were recorded. Comparable findings have been reported in southeastern Nigeria, where Offu (2019) [34] observed that only about one-quarter of community pharmacists documented their professional activities. Another study among pharmacists in two tertiary hospitals in the same region revealed that more than one-tenth of pharmacists did not engage in documentation at all [35].

Informal discussions with hospital pharmacists further revealed that documenting pharmacists' clinical activities in patients' case notes is often discouraged, particularly where such documentation may be accessible to other healthcare professionals. Nevertheless, the significance of proper documentation has been widely emphasized in the literature [35, 36]. Cipolle *et al*. highlighted documentation as a critical component of pharmaceutical care, noting that it serves as tangible evidence of professional input and supports effective patient follow-up [37]. Likewise, Zierler-Brown *et al*. emphasized that documentation demonstrates service quality, validates pharmacists' contributions to patient care, supports quality assurance initiatives, and fosters interdisciplinary collaboration [38]. When medication reconciliation is appropriately conducted, it should yield a complete and accurate medication list that supports continuity of care for both patients and healthcare providers [13].

An essential element of medication reconciliation involves reviewing patients' previous medication use and comparing it with newly prescribed therapies. To facilitate this process, pharmacists and other healthcare professionals must consistently educate patients on the importance of bringing their medication containers to clinic visits. Reports from developed healthcare systems show variable rates of patients presenting with their medications during hospital appointments [19, 39–41]. Having access to medication packs enables healthcare providers to identify potential drug interactions, omissions, or duplications. Additionally, it offers an opportunity to indirectly assess medication adherence and supports accurate medication history taking. Although pill counts alone are not a definitive measure of adherence, they may complement other assessment approaches. In the present study, medication packs were primarily used to improve the accuracy of medication lists, as reliance on patient recall alone may introduce significant recall bias.

Medication reconciliation serves as a critical mechanism for identifying discrepancies in medication use across different healthcare settings or transitions of care, thereby reducing the risk of medication errors [21]. At baseline, indirect assessment of medication discrepancies revealed no statistically significant differences between the intervention and control sites. Notably, meaningful reductions in discrepancies were only observed six months after the general educational intervention, suggesting that adoption of medication reconciliation practices occurred gradually. This delayed effect may be attributed, in part, to the low pharmacist-to-patient ratio, which may limit the immediate impact of educational initiatives. However, pharmacists who received focused training demonstrated improved documentation skills and were able to avert medication-related harm during reconciliation activities. Their enhanced ability to review medication regimens, identify discrepancies, and resolve adverse drug-related issues likely contributed to improved patient safety outcomes.

A notable decline in medication discrepancy rates—from 43.75% at baseline to 25.0% after the general educational intervention—was observed at the intervention site. Comparable studies have reported discrepancy rates ranging from 33.2% to 86.1%, often among patients taking between six and ten medications [19, 22–24, 39]. Lower rates are generally expected in healthcare systems where medication reconciliation is well established as a routine practice. In the current study, patients were taking between two and ten medications, and despite this relatively wide range, a significant reduction in discrepancies was achieved. The higher prevalence of discrepancies reported in developed countries may be related to greater medication burden, particularly among elderly populations, as medication discrepancies tend to increase with the number of prescribed medicines [42].

Given that patient safety is the central objective of medication reconciliation, the educational interventions implemented in this study enhanced pharmacists' competencies and enabled them to contribute more effectively to patient safety by minimizing medication discrepancies. Institutionalizing medication reconciliation as a routine pharmacy practice is therefore likely to yield sustained reductions in medication-related errors over time.

Study limitations

This study experienced considerable attrition among pharmacist participants at both sites. Attrition occurred

due to staff transfers, personal withdrawals, and periods of leave during the study timeline. Additionally, as the study focused exclusively on ambulatory patients with diabetes and/or hypertension, the findings may not be generalizable to other patient populations or care transitions. Pharmacists' medication reconciliation activities were assessed using self-reported data, which may be subject to reporting bias [43]. Although direct observation by the principal investigator could have provided more objective data, such an approach might also have influenced pharmacist behaviour through the Hawthorne effect. Repeated administration of the same questionnaire following the general intervention may likewise have contributed to this effect.

Conclusion

Educational interventions significantly enhanced medication reconciliation practices among pharmacists at the intervention site and contributed to the prevention of medication-related harm. Expansion of similar training programmes across additional hospitals in Nigeria is recommended to promote the adoption of evidence-based medication reconciliation practices nationwide.

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