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Correlation Between Evaluative Beliefs of Patients, Reminder and Medication Adherence

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ABSTRACT

Patients often fail to comply with the instructions given by their physicians. They miss the timing, forget, neglect, or procrastinate taking their medication. This deteriorates the health and causes financial burden to the patient and family. Reminders have been successfully used in many phases of day-to-day activities, increasing the efficiency and productivity. This paper tries to identify the relationship between reminder and the perception of importance of medication based on 15 different factors. These factors have been further assessed to find their relationship with adherence of medication. Hence, with a two-way approach, the studies use exploratory factor analysis method to identify the latent factors, and these latent factors have been used to find the correlation between reminder and adherence through confirmatory factor analysis. It was found that there is positive and significant correlation between reminder and the latent factors and also between the latent factors and adherence.

KEYWORDS

Beliefs, Factor Analysis, Medication Adherence, Physician Instructions, Reminder, Side Effects, Sikkim

INTRODUCTION

In the report of 2003, WHO stated that "increasing the effectiveness of adherence interventions may have a far greater impact on the health of the population than any improvement in specific medical treatment" (Sabaté et al., 2003). Medication adherence is an essential part of the patient healthcare and recovery system. Proper medication adherence and physician instruction are necessary to obtain the maximum benefits of the treatment process. Medication non-adherence is the term given to the behaviour when a patient does not follow the medication regime prescribed by the physician. Around 50 to 60 percent of the patients suffering from chronic diseases have been reported to be non-adherent to

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the medication regime as prescribed by their physician (Fernandez-Lazaro et al., 2019). Approximately 33-69 percent of medication-related hospital admissions in the United States have been reported to be a consequence of medication non-adherence (Kong et al., 2020). Non-adherent patients suffer extended financial burdens due to increases in healthcare costs (Kang et al., 2018), jeopardizing their treatment process and increasing the chances of morbidity and fatality (Korhonen et al., 2017).

According to WHO, medication adherence is "the extent to which the persons' behaviour corresponds with agreed recommendations from a healthcare provider" (Sabaté et al., 2003). The process of medication adherence starts with treatment of the disease, following the instructions prescribed by the physician and termination of the pharmacotherapy. It is a dynamic process that changes over time. It involves three constituents: initiation, implementation, and persistence (Vrijens et al., 2017). Medication non-adherence can be classified as primary or secondary. Non-adherence related to patients failing to initiate their medication therapy or failing to fill the prescription after commencing the treatment is termed primary non-adherence (Fischer et al., 2010). On the contrary non-adherence related to patients who fail to adhere to the medication regime even after filling their prescriptions is termed secondary non-adherence. The latter form of non-adherence is associated with increased patient financial costs (Solomon & Majumdar, 2010).

Patients' beliefs are essential to their medication adherence (Im & Huh, 2022). A systematic review of health beliefs and medication adherence report that fewer perceived barriers to adherence and higher self-efficacy had a significant effect on greater medication adherence across different studies (Al-Noumani et al., 2019). Cognitive and emotional representations of sickness are both a part of individual beliefs. There are five main cognitive belief domains: (i) "causes" which refers to beliefs about the potential causes of a condition. The emotions brought on by sickness, such as worry and/or despair, are known as emotional representations (ii) "identity" – it refers to people's perceptions of the name of the illness, its symptoms, and its prognosis (iii) "control" - it refers to beliefs about how easily an illness may be treated, prevented, or cured (iv) "consequences" refers to perceptions of the disease's seriousness and its effects on daily life (v) "timeline" refers to how long an illness lasts, including its symptoms and recovery (Shahin et al., 2019).

Most studies on medication adherence focus on limited number of variables and are based on clinical trials. The adherence changes when patients move from clinical settings to their home environment. Hence, this study tries to provide insight into medication adherence behaviour of patients when they are in their home environment. There is limited literature with concerning studies on medication adherence in Sikkim, India. Hence, this study attempts to bridge these gaps.

BACKGROUND

With a land size of 7096 square kilometres, Sikkim is the second smallest and least populated state in India. There are just for districts in the state: the North, West, East, and South districts. It is home to the Nepalese, Bhutia, and Lepcha ethnic groups. This state has 6.1 lakh residents, roughly 0.05% of the entire Indian population. A little over 60% of people in the state are of working age, while 35% are between the ages of 0 and 14. Up to 82% of people are literate in the state (Gupta et al., 2021).

Numerous factors have been associated with medication non-adherence (Saha et al., 2021). A better understanding of these factors may help design interventions to improve adherence. WHO classified non-adherent factors into five categories: 1) patient, 2) condition, 3) socioeconomic, 4) health care system, and 5) therapy (Sabaté et al., 2001). Recent studies focus on the use of technology to improve medication adherence. The preferred mode of communication through SMS has now advanced to mobile applications, and the data is monitored in real-time to provide recommendations and corrective actions to defaulters (Saha et al., 2022).

Reminders used as interventions for increasing adherence are based on the principles of Behavioural Learning Theory (Leventhal & Cameron, 1987). The theory confirms that behaviour depends on cues or stimuli, internal thoughts of the patient, or external cues based on the environment.

Non-adherent behaviour of patients can be changed after an adequate recurrence of external stimuli or cues like reminders. Reminder systems have improved the quality of life in patients who have AIDS (Wu et al., 2006). In another study, reminder software programs reduced perceived pain among office workers (Irmak et al., 2012). A study conducted in Punjab, India, revealed that a reminder system could positively impact patients' follow-up visits (Das et al., 2021). A study on nudge theories and strategies influencing adult health behaviour and outcome reported that reminders help patients to overcome barriers and nudge them into action (Kwan et al., 2020). Reminders help to perform actions and complete responsibilities, overcome procrastination, inertia, and forgetfulness (Sunstein, 2014).

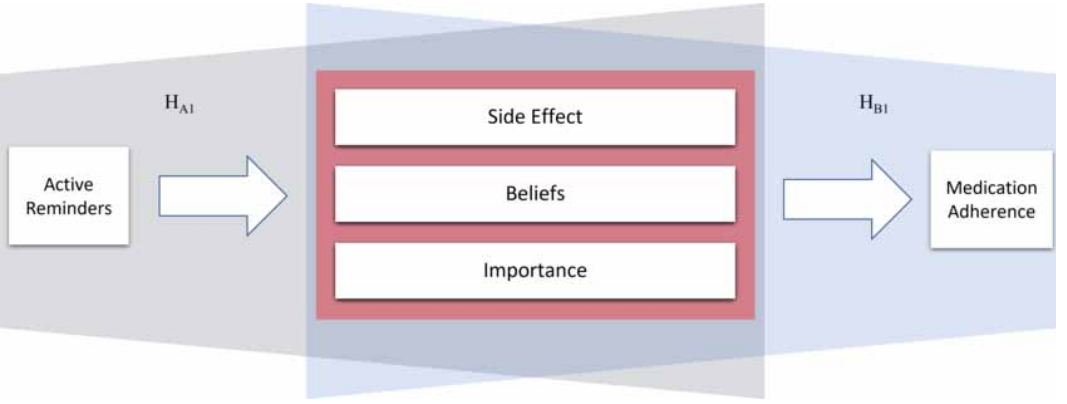
Hypothesis H_{A1}: Evaluative beliefs of patients is correlated with active reminders.

Many studies done in the past reported a significant correlation between patients' beliefs and medication adherence (Brown et al., 2005) (Veazie & Cai, 2007) (Byer & Myers, 2000) (George et al., 2006) (Horne et al., 2004) (Horne & Weinman, 1999). A significant positive correlation was found between adherence and patients' perception of disease severity (DiMatteo et al., 2007). Many researchers believe medication beliefs are better predictors of adherence than demographic variables. These could also be used as mediators between adherence and demographic characteristics (Horne & Weinman, 1999) (Schectman et al., 2002) (Ross et al., 2004) (Phatak et al., 2006). Nearly 20% of the variance in adherence behaviour could be attributed to the perception of side effects, medication necessity, and beliefs about medication (Horne & Weinman, 1999) (Phatak & Thomas, 2006). When patients start to have negative beliefs, it often results in a conscious non-adherent decision. Hence, they intentionally become non-adherence. Unintentional non-adherence can also creep up due to negative beliefs resulting in forgetfulness, improper following of instructions, and decreased perception of medication to be unimportant (Horne & Weinman, 1999) (Wroe, 2002). Hence, based on the above literature, the following hypothesis is framed:

Hypothesis H_{B1}: Medication adherence is correlated with evaluative belief of patients.

Figure 1 presents the proposed model for the research. For the first hypothesis, H_{A1}: it is assumed that the evaluative beliefs of patients are correlated with active reminders. For this study, three evaluative beliefs of patients concerning the importance given to side effects of medicines, beliefs about life responsibilities, and importance is given to physician instruction are taken. Hence, when patients receive active reminders, it is assumed that their perception of side effects of medications, like stomach-ache, formation of gas, feeling tired, or rashes in the skin, would be affected. The active reminders are also expected to affect patients' beliefs concerning their family responsibilities, whether they want to be self-dependent or not, and how comfortable they are being bedridden when

Figure 1. Hypothesized model



they are under medication. Active reminders are also expected to target patients' importance to the physician's instruction regarding diet control, following the timing of drugs, and other instructions related to their medicine.

The second hypothesis, H_{B1}: attempts to check whether medication adherence is correlated with evaluative beliefs of patients. In this part, it is assumed that the effect of active reminders on the selected evaluative beliefs of patients would affect their medication adherence rates. Hence, an attempt is made to check the correlation of these variables with adherence.

METHODOLOGY

Permission was taken from the ethical committee of Sikkim Manipal Institute of Medical Sciences to proceed with the research. The Medical Superintendent of Central Referral Hospital, Tadong, Sikkim permitted to survey the patients and collect their responses. Written consent was taken from the patients before including them in the research. A structured questionnaire was developed, which was validated by five experts concerning the questions' face validity, completeness, and appropriateness. With a sample size of 498, active reminders were given to the patients, and their responses were collected. Exploratory Factor Analysis (EFA) was conducted in SPSS version 26 to obtain the factors. The extracted factors were used to test the hypotheses through Confirmatory Factor Analysis (CFA) in AMOS version 26. To represent the latent variable "side effect," common side effects of medicines: stomach-ache, formation of gas, rashes, and feeling tired were taken (Ahuja et al., 2021; Martin et al., 2020; Tsvere et al., 2020). To represent the latent variable "beliefs," three variables were identified: patients' concern about fulfilling their responsibilities, being self-dependent, and how comfortable they are being bedridden when they are under medication. To represent the latent variable "importance," again three variables were identified: importance given to physician instruction concerning diet control, following the timing of medication, and other instructions (Etminani et al., 2020; Huang et al., 2020; Palanica et al., 2019; Prinjha et al., 2020; Rezaei et al., 2019).

ANALYSIS AND DISCUSSION

"Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity" was conducted to check the validity and reliability of factor analysis. The KMO score is 0.811 (close to 1 and above the commonly recommended value of 0.6) (Hafiz Johani et al., 2021), the samples are adequate, and the variables used are correct for measuring the intended concept. The value of "Bartlett's Test of Sphericity" is 0.00 (less than 0.05) is significant (Yusof et al., 2020). Hence, the significant test indicates that the factor analysis is valid.

For extracting the communalities, "Principal Component Analysis" method was used and the extraction scores of the variables are shown in table 1. As communalities represent the proportion of each variable's variance that the factors can explain, the values of each variable are above 0.6 (above the commonly recommended value of 0.5) (Mukherjee et al., 2020). Hence, extracted factors explain more of the variance of an individual item.

Table 2 summarizes the variance explained by the factors obtained from the "Principal Component Analysis" extraction method. As the total variance explained by the extracted five factors is 76.097% (above the commonly recommended value of 50%), the results are meaningful for the study. Also, on checking the percentage of variance for each factor, it was found that none of the factor's percentage of variance is too high (which would indicate that one factor alone explains most of the variance). The evenly distributed variances suggest that the factors extracted are meaningful. The percentage of the variance of the first factor is 29.309%, which is within the acceptable limits indicating that one factor alone is not responsible for explaining the total variance. Although the eigenvalue of the fifth component is below 1 (0.82), it has been kept because it explains nearly 5.5% of the variance. Thus, the total variance explained by all the factors is 76%.

The rotated component matrix with five different factors were obtained using the "Principal Component Analysis" extraction method and "Varimax with Kaiser Normalization" rotation method, as shown in Table 3. Component scores of the variables of the fifth factor are "Mobile" (0.905) and "Alarm" (0.713). Since both the variables of this factor are used to remind patients to take their medication, the factor has been named "Reminder". Component scores of the variables of the fourth factor are "Diet" (0.801), "Timing" (0.781), and "Instructions" (0.784). All these variables are associated with the perception of patients about the importance associated with instructions given by their physician on diet, timing of medication and the instructions to be followed. Hence, the factor is named "Importance." Component scores of the variables of the third factor is "Times missed" (0.816), "Defer" (0.816), and "Forgot" (0.785). These variables are associated with the medication adherence behaviour of patients. Hence, the factor is named "Adherence." Component scores of the variables of the second factor are "Self-dependent" (0.865), "Responsibilities" (0.89), and "Bed ridden" (0.809). These variables are associated with the perception of patients about their beliefs on benefits of medication adherence and its consequences. Hence, the variable is termed as "Beliefs." Component scores of the variables of the first factor are "Stomach" (0.948), "Gas" (0.919), "Tired" (0.839), and "Rashes" (0.873). All these variables are associated with the perception of the side effect of medication. Hence, the factor has been named "Side effect." The component scores obtained for the variables in each factor are above 0.7, indicating the convergent validity of the factors. There are no high cross-loadings (above 0.5) of the variables across the factors, so divergent validity is also ensured. With convergent and divergent validity established, the analysis can be further processed for confirmatory factor analysis.

To test the hypothesis H_{A1}: Evaluative belief of patients is correlated with active reminders, confirmatory factor analysis (CFA) was conducted in AMOS version 26. As the factors obtained in

Table 1. Communalities

Sl. No.	Variables	Initial	Extraction	Sl. No.	Variables	Initial	Extraction
1	Responsibilities	1.00	.828	9	Self-dependent	1.00	.790
2	Alarm	1.00	.800	10	Tired	1.00	.749
3	Diet	1.00	.704	11	Gas	1.00	.849
4	Times missed	1.00	.719	12	Bed ridden	1.00	.683
5	Timing	1.00	.647	13	Defer	1.00	.760
6	Mobile	1.00	.896	14	Instructions	1.00	.675
7	Forgot	1.00	.646	15	Stomach	1.00	.903
8	Rashes	1.00	.767				

Table 2. Total variance explained

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	4.396	29.309	**29.309**
2	2.985	19.901	**49.210**
3	1.948	12.984	**62.194**
4	1.265	8.434	**70.628**
5	.820	5.469	**76.097**

Table 3. Rotated component matrix

Sl. No.	Variables	Components				
		1 Side effect	2 Beliefs	3 Adherence	4 Importance	5 Reminder
1	Mobile					.905
2	Alarm					.713
3	Diet				.801	
4	Timing				.781	
5	Instructions				.784	
6	Times missed			.816		
7	Defer			.816		
8	Forgot			.785		
9	Responsibilities		.890			
10	Self-dependent		.865			
11	Bed ridden		.809			
12	Stomach	.948				
13	Gas	.919				
14	Tired	.839				
15	Rashes	.873				

exploratory factor analysis (EFA) represented the latent constructs, these were represented as ovals in AMOS, as shown in figure 2. The variables that were part of the factor or latent constructs were represented as rectangles in AMOS. Every variable was associated with an error term, and these were represented as circles with the labels "e" followed by a number. An arrow connects every latent construct with its variable. The number above the arrow represents the regression weight of the variable forming the latent construct. All regression weights are normalized to 1. The arcs joining each latent construct represent the correlation between them, and the number beside every arc is the correlation coefficient. The error terms e2 and e3 were also correlated to obtain a good model fit as they helped increase the model fitness.

To validate the model, different model fitness indices were calculated. The chi-square (χ^2) of the model was 81.737 with the degree of freedom DF=47. Thus, the ratio of χ^2/DF=1.739 indicates that the model is a good fit (Padgett & Morgan, 2020). The results of other indices are shown in table 4 and their interpretation.

Table 5 shows each variable's regression weights (standardized and unstandardized), standard error, composite reliability, and p-value. As the p-value of all the variables is less than 0.05, the regression weights are significant, and so are the correlation coefficients, as shown in Table 6.

As shown in table 6, the correlation estimates are positive for all the latent factors associated with the reminder. Although the estimates are positive, they are weak for the constructs "Reminder" and "Side Effect" (0.141), "Reminder" and "Beliefs" (0.229). It is moderate for "Reminder" and "Importance" (0.527). Since these correlation estimates are significant and positive, the hypothesis H_{A1} is accepted.

For the second hypothesis H_{B1}: Medication adherence is correlated with evaluative belief of patients, another structural model was framed in AMOS using the latent factors and "Adherence" as shown in figure 3.

Figure 2. Correlation between evaluative beliefs of patients and active reminder

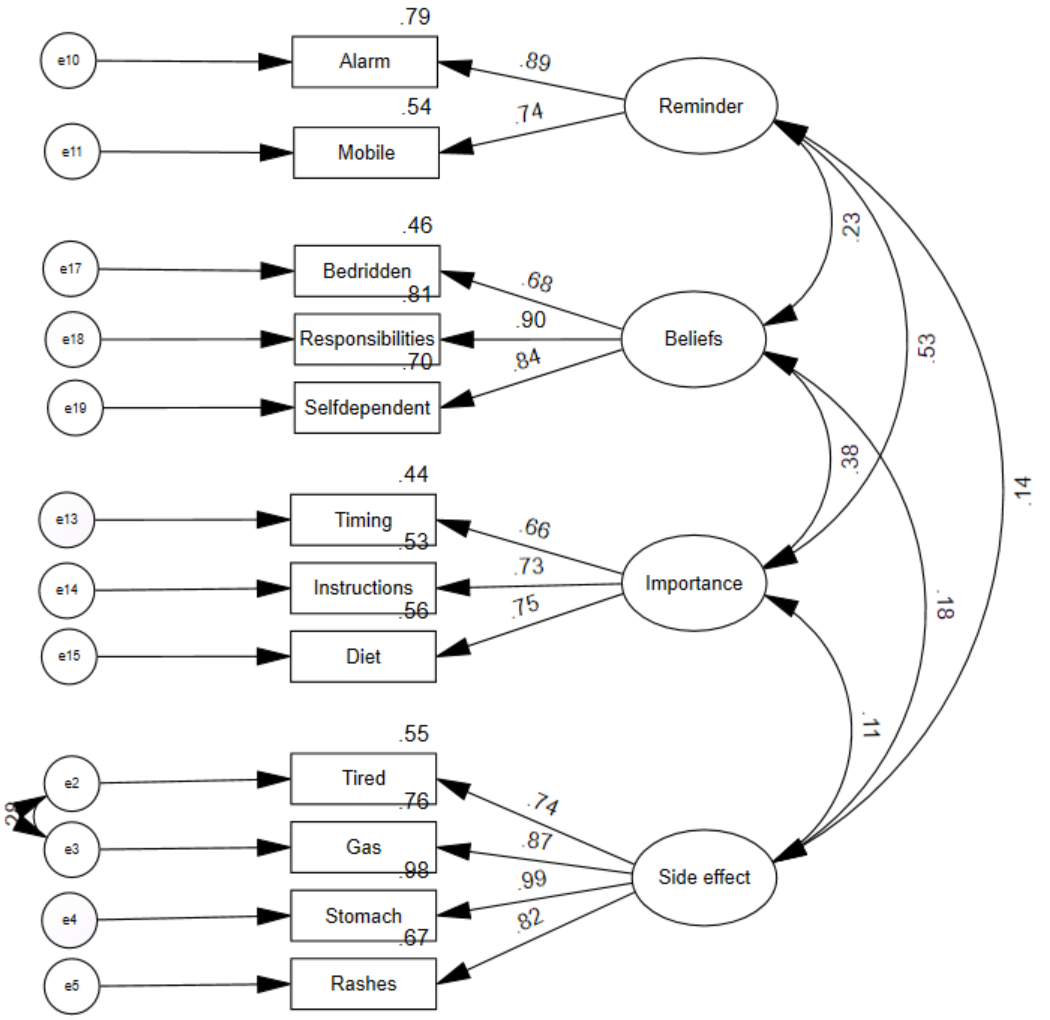


Table 4. Model fit indices of CFA for evaluative beliefs of patients and active reminder

Sl. No.	Model Fit Index	Score Obtained	Ideal Score	Interpretation
1	CFI - Comparative Fit Index	0.989	> 0.9	Model is a good fit
2	NFI - Normed Fit Index	0.975	> 0.9	Model is a good fit
3	TLI - Tucker-Lews index	0.985	> 0.9	Model is a good fit
4	RFI - Relative Fit Index	0.965	> 0.9	Model is a good fit
5	IFI - Bollen's incremental fit index	0.989	> 0.9	Model is a good fit
6	RMSEA - Root Mean Square Error of Approximation	0.038	< 0.05	Model is a good fit
7	PCLOSE	0.919	Close to 1	Model is a good fit

Table 5. Regression statistics of the variables with their latent constructs

Sl.No	Variables		Latent Constructs	Regression Weights				
				Unstandardized				Standardized
				Estimate	S.E.	C.R.	P	Estimate
1	Tired	←	Side Effect	0.731	0.032	22.655	***	0.744
2	Gas	←	Side Effect	0.874	0.027	32.265	***	0.871
3	Stomach	←	Side Effect	1				0.989
4	Rashes	←	Side Effect	0.857	0.031	27.947	***	0.821
5	Timing	←	Importance	0.869	0.071	12.193	***	0.661
6	Instructions	←	Importance	0.786	0.061	12.834	***	0.73
7	Diet	←	Importance	1				0.746
8	Bedridden	←	Beliefs	0.73	0.045	16.26	***	0.681
9	Responsibilities	←	Beliefs	1				0.901
10	Self-dependent	←	Beliefs	0.961	0.048	19.811	***	0.839
11	Mobile	←	Reminder	0.814	0.081	10.096	***	0.736
12	Alarm	←	Reminder	1				0.888

Table 6. Correlation between evaluative beliefs of patients and active reminder

Correlations			
Latent Constructs		**Latent Constructs**	**Estimate**
Side Effect	↔	Importance	0.111
Side Effect	↔	Beliefs	0.181
Reminder	↔	Side Effect	0.141
Importance	↔	Beliefs	0.376
Reminder	↔	Importance	0.527
Reminder	↔	Beliefs	0.229

The chi-square (χ^2) of the model was 89.780, and the degree of freedom DF=58. The ratio of χ^2/DF=1.548 indicates that the model is a good fit (Schneider et al., 2020). The results of other indices are shown in table 7 and their interpretation.

Table 8 shows the regression weights (standardized and unstandardized) of the variables, the standard error, composite reliability, and the p-value for each variable for the model shown in figure 3. As the p-value of all the variables is less than 0.05, regression weights are significant, and so are the correlation coefficients, which is shown in table 9.

As shown in table 9, the correlation estimates are positive for all the latent factors associated with adherence. Although the estimates are positive, they are weak for the constructs "Adherence" and "Beliefs" (0.186) and almost insignificant for "Adherence" and "Side Effect" (0.062). It is moderate for "Adherence" and "Importance" (0.445). The research results do not find a significant association between medication adherence and patients' perception regarding the side effect of medication. The reason for this could be attributed to the fact that the surveyed respondents did not suffer from significant side effects of medication. Respondents reported that on confronting any symptoms

Figure 3. Correlation between evaluative beliefs of patients and adherence

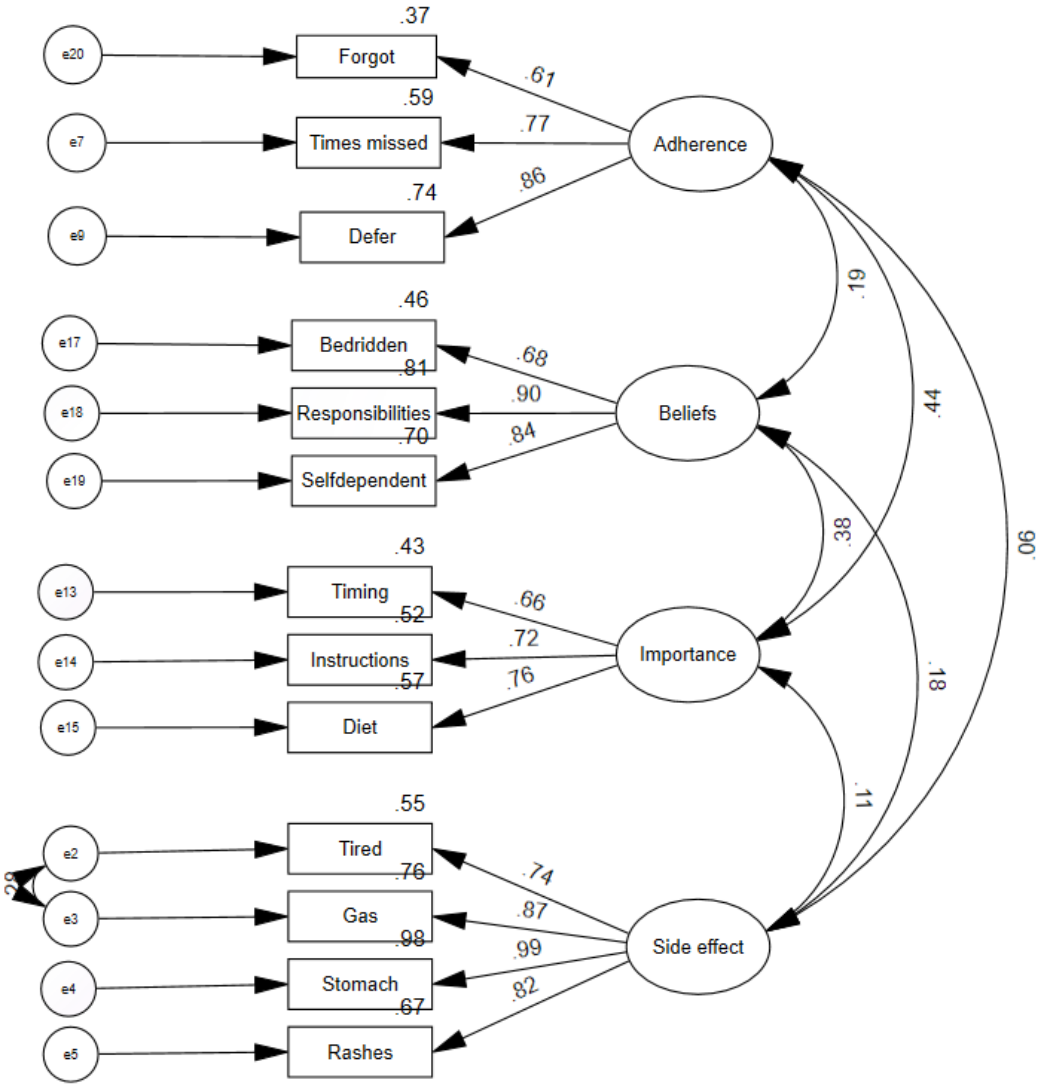


Table 7. Model fit indices of CFA for evaluative beliefs of patients and active reminder

Sl. No.	Model Fit Index	Score Obtained	Ideal Score	Interpretation
1	CFI - Comparative Fit Index	0.990	> 0.9	Model is a good fit
2	NFI - Normed Fit Index	0.974	> 0.9	Model is a good fit
3	TLI - Tucker-Lews index	0.987	> 0.9	Model is a good fit
4	RFI - Relative Fit Index	0.965	> 0.9	Model is a good fit
5	IFI - Bollen's incremental fit index	0.991	> 0.9	Model is a good fit
6	RMSEA - Root Mean Square Error of Approximation	0.033	< 0.05	Model is a good fit
7	PCLOSE	0.987	Close to 1	Model is a good fit

Table 8. Regression statistics of the variables with their latent constructs

Sl.No	Variables		Latent Constructs	Regression Weights				
				Unstandardized				Standardized
				Estimate	S.E.	C.R.	P	Estimate
1	Tired	←	Side Effect	0.731	0.032	22.635	***	0.744
2	Gas	←	Side Effect	0.874	0.027	32.229	***	0.871
3	Stomach	←	Side Effect	1				0.989
4	Rashes	←	Side Effect	0.856	0.031	27.92	***	0.821
5	Times Missed	←	Adherence	1				0.768
6	Defer	←	Adherence	0.998	0.069	14.548	***	0.863
7	Forgot	←	Adherence	0.545	0.043	12.597	***	0.607
8	Timing	←	Importance	0.852	0.071	12.058	***	0.659
9	Instructions	←	Importance	0.764	0.061	12.597	***	0.721
10	Diet	←	Importance	1				0.757
11	Bedridden	←	Beliefs	0.728	0.045	16.24	***	0.68
12	Responsibilities	←	Beliefs	1				0.903
13	Self-dependent	←	Beliefs	0.958	0.048	19.791	***	0.838

Table 9. Correlation between evaluative beliefs of patients and adherence

Correlations			
Latent Constructs		**Latent Constructs**	**Estimate**
Side Effect	↔	Adherence	0.062
Side Effect	↔	Importance	0.113
Beliefs	↔	Side Effect	0.181
Adherence	↔	Importance	0.445
Beliefs	↔	Adherence	0.186
Beliefs	↔	Importance	0.376

of side effects, they immediately consult the physician and ask for changing the medication. The correlation between "Beliefs" and "Adherence" is weak, and the correlation between "Adherence" and "Importance" is moderate. Since these correlation estimates are significant and positive, the hypothesis H_{B1} is accepted.

CONCLUSION

Medication adherence is a complex behaviour. Factor analysis of the variables revealed five distinct variables, which were named "Reminder," "Beliefs," "Adherence," "Side effect," and "Importance." The confirmatory factor analysis performed in AMOS also revealed distinct relationships within the variables. Using the latent constructs, CFA was conducted to test hypotheses H_{A1} and H_{B1}. It was found that although the two hypotheses were accepted, the correlation between the latent factor "Side effect"

and "Reminder" is weak which indicates that reminders do not have much effect on the perception of patients to continue medication when "Side effect" of the medication are pronounced. This was further seen in the correlation between the latent factor "Side effect" and "Adherence," where the correlation was found to be weak. The other correlations between "Adherence" and "Importance," "Reminder" and "Importance" was found to be moderately strong, and the correlation between "Adherence" and "Beliefs," and "Reminder" and "Beliefs" was found to be positive but weak. These indicate that reminder does influence the patients to change their behaviour and perception towards their life activities, responsibilities, and self-care. These further may lead to better medication adherence. A bibliographic analysis of medication adherence reports the increase in research in this field by different researchers from across countries (Saha, 2022). Researchers prefer the use of advanced techniques and methods to gain more insights into the problem of medication non-adherence. The popularity of mobile and e-healthcare facilities has benefited the patients and the service providers to share information and connect (Saha et al., 2023).

The research is vital as there are various factors for medication adherence, viz socioeconomic background, patient condition, healthcare system, therapy, patient factors, etc., that interact in multiple ways (Organization & others, 2003). A deeper understanding of the evaluative beliefs of patients will help medical practitioners, service providers, and other stakeholders to frame strategies to help patients increase their medication adherence rates. The research finds that active reminders are positively correlated with the evaluative beliefs of patients. Also, it has been found that the evaluative beliefs of patients are positively correlated with medication adherence. Hence, strategically designed active reminders which can target the evaluative beliefs of patients can help increase the medication adherence rates of patients. A study conducted in Greece with 518 patients also found a significant association between patients' health-related quality of life and association (Chantzaras & Yfantopoulos, 2022). To promote drug adherence, it is required to implement patient-centered, tailored interventions, create a collaboration between healthcare providers and patients, and consistent follow up and monitoring approach (Yfantopoulos et al., 2021).

As the research is conducted in Sikkim, India, there is a scope for doing the study with a larger sample size. In this research, only three evaluative beliefs of patients have been taken. Future research can be done with other factors like religious beliefs (Shahin et al., 2019), patient, environment, and physician factors. Research can also be done with a combination of active and passive reminders. Structural equation models could also be conducted to test the validity of the complete model.

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APPENDIX

Ethical Committee Certificate of Sikkim Manipal Institute of Medical Sciences, Sikkim (Ref: SMIMS/IEC/2018-064)
URL of Ethical Committee Certificate:
https://smu.edu.in/content/dam/manipal/smu/smit/documents/research/ActiveReminders/Ethical%20Committee%20Clearence%20Certificate.jpg
URL of Central Referral Hospital, Tadong, Gangtok, Sikkim approval letter for conducting the survey:
https://smu.edu.in/content/dam/manipal/smu/smit/documents/research/ActiveReminders/CRH%20Approval.jpg
Patient Consent Form:
https://smu.edu.in/content/dam/manipal/smu/smit/documents/research/ActiveReminders/Consent%20form%20for%20patients.pdf

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