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Original Article

Feedback Loop between Diabetes Management and Quality of Life: A Synthesis of Direct and Indirect Effects

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Abstract

Objectives: To address the feedback loop between glycemic control and quality of life and to see the direct and indirect effect of self regulation through resilience on the quality of life.
Study design, settings and duration: A cross-sectional questionnaire based survey design was used to collect data from outpatient departments of various hospitals in Rawalpindi and Islamabad during October-November, 2012.
Patients and Methods: Patients taking treatment for type 2 diabetes on outdoor basis were included in the study. Patients having major diabetic complication causing or coexisting with a physical disability, medical condition or psychiatric co morbidity were excluded. Informed consent was taken from all patients before filling of questionnaires. Quality of Life was assessed using the Murphy et al tool while resilience was measured using State-Trait Resilience Inventory, developed by Hiew et al and for self-regulation the scale translated by Sawar was used. Self-regulation was defined as the cognitive ability of an individual to manage with adverse life events and to continue with a proactive life[13] while resilience was the quality of an individual that allowed him to face adversities of life and come back even stronger. Statistical analyses were conducted using SPSS and AMOS version 21.
Results: Overall patients with higher glucose levels had poor quality of life ($r = -.16$, $p < .05$) but the relationship was not significant in the feedback loop. Whereas along with direct and indirect effect of self-regulation ($\beta = .45$, and $\beta = .26$ respectively; $p < .05$) and direct effect of resilience ($\beta = .33$, $p < .05$) on quality of life, Model 2 (without feedback loop) suggested that current glucose level is directly predicted by quality of life ($\beta = -.13$, $p < .05$) and indirectly by resilience and self-regulation through quality of life ($\beta = -.09$, and $\beta = -.04$ respectively; $p < .05$).
Conclusion: Self-regulation has a significant direct and indirect effect through resilience on quality of life. Life style change is a stable indicator of glycemic control than glycemic control changing life style.
Key words: Feedback loop, self-regulation, resilience, quality of life, direct and indirect effect.

Introduction

Quality of life of patients suffering from chronic diseases has been extensively studied over past few decades[1-3] and there is ample evidence that there is a decline in quality of life of patients diagnosed with a chronic disease like diabetes.[4] The burden of self-care associated with diabetes type 2 requires additional efforts to maintain an otherwise normal life.[5] Patients adhering to their diabetes treatment enjoy better quality of life, increased life expectancy and decreased risk of disease related complication.[6] A reverse relationship shows that any improvement in patients' quality of life may help to gain a better control of the disease.[1,7] Access to better treatment and life style facilities paves ground for such a relationship.[1,7-9] It is possible that improvement in quality of life may result in better access to healthy lifestyle (i.e., food choice, treatment affordability etc.) which is directly linked with management of a chronic disease like diabetes.[8] Given the reciprocal nature of relationship, it is expected that there might be a feedback loop between diabetes control and quality of life of diabetic patients.

Literature on diabetes also suggests that there are other considerable factors playing an imperative role in quality of life of these patients.[5,10-12] These factors include self-regulation and resilience.[3,5,10-12] Self-regulation is the cognitive ability of individuals to manage with adverse life events and to continue with a proactive life.[13] Self-management of diabetes is reflected by applying self-regulatory strategies like identification

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of problem, formulation of plan for effective problem solving and appraisal for evaluation of goal directed behaviors[14]. There are evidences which suggest the role of self-regulation in diabetes management and the quality of life of these patients.[5,11,12]

Resilience is another important strength of individual that may effect adjustment with chronic diseases.[15,16] Resilience is the quality of an individual that allows him to face adversities of life and come back even stronger.[15] Literature on diabetes suggests that quality of life of patients with diabetes is positively associated with their resilience.[10,12,15] Rather than letting failure overcome and drain their life, resilient patients face challenges and find a way to rise from the ashes.[15] Evidence suggests that resilient people are well managed and take little stress of disease burden resulting in a better quality of life.[10,15]

Self-regulation and resilience, the two empirically established indicators of quality of life are also interrelated[17,18] and there is a strong positive association of both the predictors (i.e., resilience and self-regulation) with quality of life.[1,5,10-12] Given the interrelations among quality of life, self-regulation and resilience, we assume that both self-regulation and resilience may have a positive direct effect on quality of life of diabetes patients. Additionally, we assume that self-regulation directly and indirectly (i.e., through resilience) predicts quality of life of patients with diabetes. With these assumptions, the present study was designed to address quality of life of diabetes patients with two objectives. First to test feedback loop between glycemic control and quality of life and second to investigate the direct and indirect effect of self regulation through resilience on quality of life of diabetes patients.

Patients and Methods

A cross-sectional questionnaire based survey design was used to collect data from outpatient departments of various hospitals in Rawalpindi and Islamabad during October-November, 2012. The outpatient services were approached and hospital authorities were requested for a formal permission to contact with diabetic patients. Inclusion criteria were patients diagnosed with diabetes taking treatment in an out patient's facility. Patients having any complication resulting from diabetes i.e., neuropathy, retinopathy, nephropathy, diabetic foot, major physical disability, medical condition or psychiatric co-morbidity were excluded. Patients were briefed about the study objectives and informed consent was taken from them. Questionnaires were individually administered on patients and on average it took 10-15 minutes to complete the questionnaire. Analyses were conducted using SPSS 21 and AMOS 21. Statistical testing was done using bivariate correlation, and model testing was done using structural equation modeling technique.

WHO Quality of Life (QOL-BREF) tool developed by Murphy et al.[19] was used to measure patients' quality of life. The instrument assesses the quality of life in four dimensions i.e. (1) physical functioning, (2) psychological functioning, (3) environment, and (4) social dimension. A sum score for each of the four subscales was computed by adding individuals' responses on items of respective scales. High score on a subscale indicated better quality of life of an individual on the respective component. For the present study, Urdu version of scale translated and adapted by Khan et al was used which has well documented psychometric properties.[20]

Resilience was assessed using the State-Trait Resilience Inventory, developed by Hiew et al.[21] The inventory has two subscales. (1) Trait Resilience consisting of 18 items measures resilience as a personality factor i.e., resilience by birth. (2) State Resilience consisting of 15 items is a measure of situational resilience. Situational or current resilience is adapted according to demand of environment. All items of the two scales are added to compute a total score of resilience and for individual dimensions the responses of individuals on respective items were calculated and summed. A high score was indicative of high resilience on respective component as well on total scale. Urdu version of the instrument translated by Sawar was used which has well established psychometric properties.[22]

The self-regulation scale (SRS) translated by Sawar [22] was used to assess self-regulation. It consists of 109 items. Responses were collected on a four point rating scale. The scale measures seven dimensions of self-regulation. The subscales includes social skills consisting of 24 items, psychological adjustment is measured on 23 items, self-confidence using 12 items, physical health on 17 items, helping behavior on 12 items, achievement with 11 items, and goal directedness on a 10 items scale. The original scale for a one-dimensional construct of the self-regulation consisted of 10 items which was used to measure the goal directedness component of SRS scale.[23] The adapted version of the scale in Urdu consisted of original items which were translated using the standard back translation method. A high score on any subscale indicated more ability of self regulation for that specific dimension. The literature suggests well documented psychometric properties of the scale.[22] Chronbachs' alpha reliability of the scale ranged from 0.67 to 0.89 for the study sample.

Results

A total of 250 patients were inducted in the study, out of whom 242 patients (96.8%) completed the questionnaire. There were 43% females and 57% males whose ages ranged from 17 year to 85 years (mean 44.56 ± 16.56).

Table 1: Bivariate correlations.

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Age		-.14*	.13	.61**	.16*	.05	.08	-.06
Education			.46**	-.20**	-.17*	.21**	.15*	.19**
Income (10000)				.03	-.03	.11	.15*	.13
Duration of disease (Years)					.27**	-.08	-.08	-.24**
Current glucose level						-.09	-.10	-.16*
Resilience							.74**	.60**
Self Regulation								.66**
Quality of life								
Mean	44.64	12.67	2.53	7.62	233.80	110.73	303.38	81.78
Std. Deviation	16.41	4.09	2.84	7.36	124.58	26.35	47.83	15.83

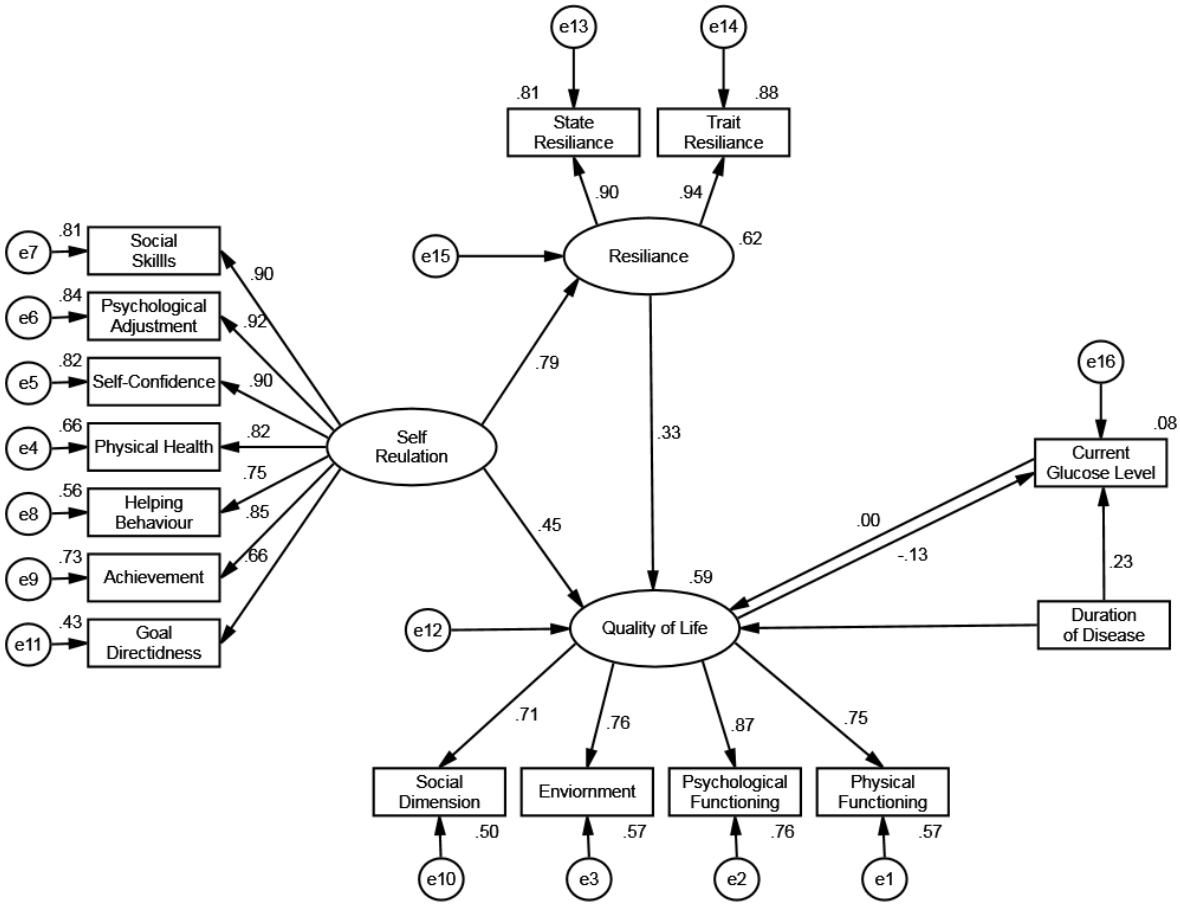

Figure: Presenting latent variable model - M2.

Overall blood glucose level showed positive correlation with age (r = .16, $p < .05$), and income (r = .27, $p < .01$) and negatively correlated with education (r = -.17, $p < .05$). Additionally, as presented in Table-1, blood glucose level negatively correlated with quality of life (r= -.16, $p < .05$).

For the main analysis, latent variable model was developed in AMOS to conduct structural equation modeling (SEM) analysis with three latent variables including self-regulation, resilience, and quality of life. Self-regulation was estimated as latent variable, and the indicators included composite score on all dimensions of self-regulation with very high loading (lambda range = .66 to .92). Resilience as latent variable was estimated using composite score of the two subscale i.e., state resilience (lambda = .90) and trait resilience (lambda = .94). Similarly, latent variable quality of life was estimated with composite score of dimension of quality of life (lambda range = .71 to 87). The latent variable model was designed to estimate direct effect of self-regulation on quality of life and indirect effect of self-regulation on quality of life through resilience. Observed values of latest blood glucose was used to develop the feedback loop between quality of life and blood glucose

whereas model was controlled for duration of diabetes. Figure shows the latent variable model with feedback loop between quality of life and blood glucose level.

Three variations of the model were tested and compared by applying constraints on feedback loop. As shown in Table-2, Model 1 with no constraints on feedback loop resulted in a stable non recursive model (stability index = 0.002) and model fitted well to the data (i.e., fit indices χ^2 (df) = 213.5(118), NFI, TLI, CFI, IFI ≥ .95, and RMSEA = .058). Table-3 shows that self-regulation directly predicted the quality of life (β = .45, p < .01) and indirectly predicted the resilience (β = .26, p < .05). Self-regulation also directly predicted resilience (β = .79, p < .05) and resilience directly predicted quality of life. (β = .33, p < .01). No significant direct or indirect effect was seen from blood glucose levels to diabetes and vice versa.

Model 2 was administered as a variation of model 1 where path from current glucose level to quality of life was constrained to be zero, hence eliminating the feedback loop and retaining direction of prediction from quality of life to current glucose level. Direct and indirect effect of self-regulation (β = .45, and β = .26 respectively; p < .05) and direct effect of resilience (β = .33, p < .05) on quality of life, Model 2 as shown in Figure 1 also suggested that current glucose level directly predicted the quality of life (β = -.13, p < .05) and indirectly predicted the resilience and self-regulation through quality of life (β = -.09, and β = -.04 respectively; p < .05). The model not only fitted to the data very well but it also improved $\Delta\chi^2$ (df) = 0.062 (1) over the Model 1.

Table 2: Model fit indices.

Model	*χ^2 (df)*	*NFI*	*IFI*	*TLI*	*CFI*	*RMSEA*	*AIC*	*BIC*	*$\Delta\chi^2$ (df)*	*p*
M1	213.5(118)	.95	.98	.97	.98	.058	283.5	405.6		
M2	213.6(119)	.95	.98	.97	.98	.057	281.6	400.2	0.062 (1)	.80
M3	215.5(119)	.95	.98	.97	.98	.058	283.5	402.1	1.966 (1)	.16

M1: Non-Recursive Model, M2: Quality of Life Predicting CGL, M3. CGL Predicting Quality of Life

Table 3: Comparison of direct and indirect effect.

Model		*Resilience*		*Current Glucose Level (CGL)*						*Quality of Life*					
		Direct		*Direct*		*Indirect*		*Total*		*Direct*		*Indirect*		*Total*	
		β	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*	*β*	*p*
Non-Recursive Model	Duration of Disease	0	...	.235	.023	.026	.138	.261	.019	-.216	.011	-.004	.895	-.219	.009
	Self-Regulation	.79	.012	0	...	-.085	.152	-.085	.152	.445	.005	.26	.026	.705	.01
	Resilience	0	...	0	...	-.039	.153	-.039	.153	.328	.03	.001	.511	.328	.03
	Current Glucose Level	0	...	0	...	.002	.545	.002	.545	-.015	.895	0	.892	-.015	.895
	Quality of Life	0	...	-.12	.175	0	.21	-.12	.167	0	...	.002	.545	.002	.545
Quality of Life Predicting CGL	Duration of Disease	0	...	.231	.02	.029	.016	.26	.02	-.219	.009	0	...	-.219	.009
	Self-Regulation	.79	.012	0	...	-.095	.04	-.095	.04	.446	.005	.259	.025	.705	.012
	Resilience	0	...	0	...	-.044	.028	-.044	.028	.328	.032	0	...	.328	.032
	Current Glucose Level	0	...	0	...	0	...	0	...	0	...	0	...	0	...
	Quality of Life	0	...	-.134	.048	0	...	-.134	.048	0	...	0	...	0	...
CGL Predicting Quality of Life	Duration of Disease	0	...	.268	.019	0	...	.268	.019	-.202	.009	-.019	.087	-.221	.009
	Self-Regulation	.79	.012	0	...	0	...	0	...	.442	.005	.26	.023	.702	.008
	Resilience	0	...	0	...	0	...	0	...	.329	.03	0	...	.329	0.03
	Current Glucose Level	0	...	0	...	0	...	0	...	-.07	.097	0	...	-.07	.097
	Quality of Life	0	...	0	...	0	...	0	...	0	...	0	...	0	...

Finally, Model 3 was tested as another variation of Model 1. In M3, contrary to M2, path from quality of life to current glucose level was constrained to be zero, hence eliminating the feedback loop and yet retaining the direction of prediction from current glucose level to quality of life. In affirmation with M1 and M2, significant direct effect of self-regulation ($\beta = .44$, $p < .01$), resilience ($\beta = .33$, $p < .05$), and duration of diabetes ($\beta = -.20$, $p < .01$) appeared on quality of life and significant indirect path appeared between self-regulation and quality of life through resilience ($\beta = .26$, $p < .05$). No significant (direct or indirect) link was seen between current glucose level and quality of life. The model showed good fit to the data, and some improvement over the Model 1 i.e., $\Delta\chi^2$ (df) = 1.97 (1). The fit didn't appear to be better than M2. This was further supported by lowest values of AIC and BIC for Model 2 as compared to Model 1 and Model 3, confirming that Model 2 presented better scenario as compared to its competing models.

Discussion

The present study showed negative correlation between glycemic control and quality of life. Earlier literature also shows a negative relationship between glycemic control and quality of life.[1,3,5,10] Low magnitude of the relationship in the present study might be due to two reasons. First, glycemic control was measured with fasting blood glucose level which is not a stable measure of glycemic control, and second a generic measure of quality of life was used in this study.[1,2] This relationship may become clearer if glycemic control is assessed using a stable measure such as HBA1c and quality of life is assessed more precisely i.e., using a diabetes specific quality of life instrument.

A significant relationship between glycemic control and the quality of life has been documented in randomized clinical trials[8,9] and cross-sectional studies.[3,5]A review of empirical literature suggests a two way association between glycemic control and quality of life.[1] Where some studies suggest that improving the indicators of quality of life improved the glycemic control.[7-9] Contrary to this some longitudinal cohort studies showed no effect of interventions aimed at controlling glycemic control on quality of life.[24] Glycemic control as a covariate (either as a predictor or an outcome) of quality of life provides a stronger base to assume a feedback loop between glycemic control and quality of life.[1-3,7-10] In the present study, we assumed that relationship between glycemic control and quality of life has a reciprocal nature. The feedback loop between diabetes control and quality of life was tested as part of a larger conceptual framework addressing direct and indirect effect of self-regulation on quality of life through resilience.

The latent variable model confirmed our assumption regarding significant direct effect of both self-regulation and resilience on quality of life. These findings are similar to other reports which showed a positive effect of self-regulation [5,11] and resilience [9,10,12] on quality of life of diabetic patients. Given the interrelations between self-regulation and resilience,[17] the study further contributed by testing meditational role of resilience between self-regulation and quality of life. The significant indirect effect supported our assumptions that resilience mediates and augments effect of self-regulation on quality of life of diabetic patients. In other words, quality of life of patients with diabetes is positively predicted with self-regulation [2,5,11] by translating its effect to enhance resilience. Self-regulatory strategies may serve as a very effective tool for improving quality of life and their efficacy and effectiveness may be maximize by incorporating intervention for enhancing resilience in patients with diabetes.

Further, model testing supported presence of feedback loop between quality of life and glucose level[1] with non-significant direct and indirect relations between glucose levels and quality of life. A reason of the non-significant parameters with a stable feedback loop might be cross-sectional nature of the data. Contrary to that, results of the model testing supported literature suggesting glucose level as significant determinant of quality of life[3,5,8,9] when feedback loop was eliminated from the model. These results are supported by earlier intervention studies. [8,9] Improvement in any indicator of quality of life (i.e., social, environmental, psychological, or physical) of patients with diabetes may have a stable and sustainable impact on diabetes control.[7-9] This makes more sense particularly when improvement in quality of life is translated into healthy life style. This was further confirmed with a non-significant relationship between glucose levels and quality of life [24] when current glucose level was used as predictor of quality of life while not incorporating a feedback loop. Among the three possible assumptions for the relationship between glycemic control and quality of life, our results with a stable feedback loop partially supported the reciprocal relationship between glucose levels and quality of life. Additionally, our results presenting significant direct and indirect effect suggest that sustainable improvement in glycemic control may be achieved with intervention improving life style of the patients with diabetes.

Conflict of interest: None declared.

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