Multifactorial Determinants of Long-Term Glycemic Control in Type 2 Diabetes: An Institutional Study from a Tertiary Care Endocrine Clinic in Sri Lanka

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Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder marked by persistent hyperglycemia. Glycated hemoglobin (HbA1c) is the standard indicator of long-term glycemic control. In Sri Lanka, T2DM affects about 9.8% of adults, yet institutional-level evidence on influencing factors and patient perspectives, remain limited. The study aimed to identify factors affecting long-term glycemic control among T2DM patients attending a tertiary care Endocrine Clinic in Sri Lanka and explore patients' perceptions regarding their disease management. A mixed-method cross-sectional study with retrospective clinical record review was conducted among 200 T2DM patients attending the Endocrine Clinic, National Hospital, Kandy. Data were collected through in-person questionnaires and clinical records. Glycemic control was evaluated using baseline and follow-up HbA1c values (%) over three months, including ΔHbA1c (follow-up minus baseline) and poor control (HbA1c ≥7%). Eight latent factors with socio-demographic moderators were assessed. Quantitative analysis included descriptive statistics, Elastic Net (prediction), Random Forest (model performance), Double Machine Learning (causal inference), SHAP (predictor interpretability), and Partial Least Squares Structural Equation Modeling (PLS-SEM) (theory validation) using SmartPLS v4.1.1.5. Qualitative data underwent content analysis. The mean baseline and follow-up HbA1c were 9.02% and 8.96%, respectively, with 86.5% (n=173) classified as poorly controlled. Random Forest outperformed Elastic Net (R^2=−0.160, RMSE=2.887), indicating non-linear relationships. Double Machine Learning showed no causal effect of adherence (ATE=0.011, p=0.918). SHAP highlighted income, cost, and disease burden as influential factors. PLS-SEM explained 7.2% variance, identifying medication adherence as the only significant predictor (β=0.838, p=0.029), that strongly affecting HbA1c and highlighting the multifactorial nature of glycemic control. Poor long-term glycemic control remains prevalent among T2DM patients in tertiary care. Findings indicate that medication adherence alone is insufficient, as glycemic outcomes are influenced by interacting behavioral, clinical, psychosocial, and socioeconomic factors. Integrated, multifaceted interventions are needed to improve sustainable diabetes management in tertiary care settings.

Keywords: glycated hemoglobin, medication adherence, PLS-SEM, tertiary care, type 2 diabetes mellitus