Not Just Where, But When: Towards Predicting Blood Glucose Rises from Passive Semantic Location

Naziha Shekh Khalil
University of Manchester
naziha.shekhkhalil@manchester.ac.uk

Hood Thabit
Diabetes, Endocrine and Metabolism Centre, Manchester Royal Infirmary
hood.thabit@mft.nhs.uk

Paul W. Nutter
University of Manchester
P.Nutter@manchester.ac.uk

Sukru Eraslan
Middle East Technical University, Northern Cyprus Campus
seraslan@metu.edu.tr

Yeliz Yesilada
Middle East Technical University, Northern Cyprus Campus
yyeliz@metu.edu.tr

Simon Harper
University of Manchester
simon.harper@manchester.ac.uk

1 Introduction

Managing Type 1 Diabetes (T1D) requires frequent blood glucose (BG) monitoring and daily insulin dosing. Injected insulin takes 30 to 90 minutes to reduce BG levels [1], while continuous glucose monitoring (CGM) readings lag by approximately 5 to 10 minutes [2]. These delays make timely decisions harder and highlight the value of mobile, ubiquitous systems for context-aware self-management. Our work explores whether passively sensed semantic location categories such as cafés, bars, and work, combined with CGM data, can help identify patterns in BG rises. Specifically, we investigate two linked questions: (1) whether visited location categories are associated with BG rises, and (2) whether, in long-duration locations such as home or work, rise timing relative to arrival also matters.

2 Method

We analysed passively collected data from six people with T1D over 3–13 weeks, including 46,265 CGM readings and 2,718 location records mapped to 79 semantic location categories. BG rises were detected from CGM traces and aligned with location visits derived from smartphone location history. We then examined associations between location category and BG rises, and for long-duration visits analysed temporal offset: the time from arrival to rise onset.

3 Findings

Our first finding was that location category showed an overall association with BG rises in four of the six participants. At the category level, bars, cafés, art galleries, route, flying, health, and train travel were linked to more frequent rises, while driving was consistently linked to fewer rises.

Our second finding was that, in long-duration locations such as home, work, lodging, location category alone is insufficient. In these places, it also matters when a rise occurs relative to arrival (temporal offset), as illustrated in Figure 1. During weekday daytime periods, the first rise often happened within 30 minutes of arrival, while later rises were more common after longer intervals. During midnight and nighttime periods, rises generally happened after longer intervals overall, with first rises at home often appearing after more than 6 hours. This suggests that rises shortly after arrival may reflect what happened before reaching the location, whereas later rises are more likely to be related to the current location itself. This distinction is important for interpreting BG behaviour in long-duration visits.

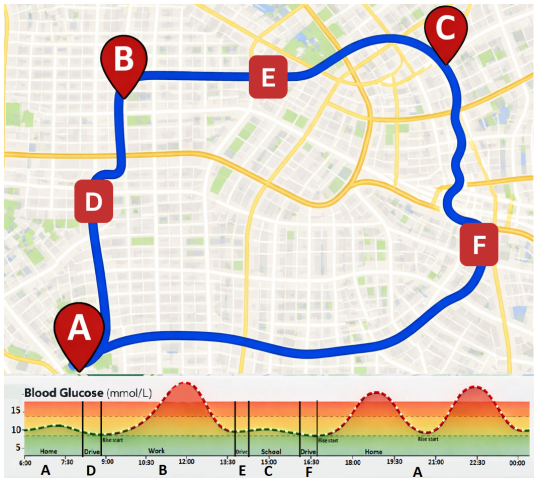

Figure 1: BG change across daily locations and transitions. A = home, B = work, C = school, and D–F = short drive events. The figure shows one rise beginning at work, another appearing immediately after arriving home from school, and a later additional rise during the same home stay.

4 Contribution

This work shows that knowing where a person is, together with temporal patterns learned from previous visits, can help future systems provide personalised alerts for BG rises. By using visited location categories to anticipate rises, and by considering when rises occur within long-duration visits, such systems could move towards more adaptive and context-aware diabetes self-management support, prompting people to take appropriate action at the right time in the current location context. Together, these insights support the development of adaptive systems that combine location and timing to deliver more accurate and timely alerts.

References

[1] Dawn E DeWitt and Irl B Hirsch. Outpatient insulin therapy in type 1 and type 2 diabetes mellitus: scientific review. *Jama*, 289(17):2254–2264, 2003.

[2] Günther Schmelzeisen-Redeker, Michael Schoemaker, Harald Kirchsteiger, Guido Freckmann, Lutz Heinemann, and Luigi Del Re. Time delay of cgm sensors: relevance, causes, and countermeasures. *Journal of diabetes science and technology*, 9(5):1006–1015, 2015.