Effect of Body Mass Index on Different Glycemic Responses to Psychological Stress in Patients with Type 1 Diabetes

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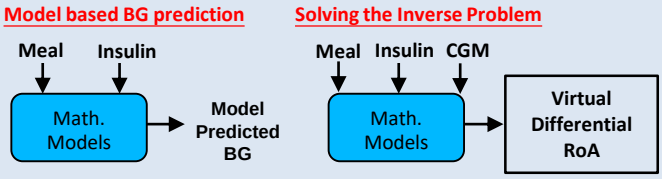
Introduction

- Psychological stress is thought to impact blood glucose (BG), with changes in glucocorticoids, catecholamines, growth hormone, and prolactin as possible mechanisms[1].
  - Studies on the effect of stress on BG in type 1 diabetes (T1DM) have reported diverse results[2,3,4,5]. The data of this study was previously used to demonstrate that increased stress was associated with higher BG variability[6].
- Physiologically, body mass index (BMI) is also known to affect metabolism and endocrine system[7,8].

This study explores whether BMI is a factor in differing glycemic responses to daily psychological stress.

Material and Methods

- **Protocol and Data Collection:** Thirty-seven participants (pump users) with T1DM with age range 25-62 years (46.8±10.8), HbA1c range 5.7-9.9% (7.4±0.98) and BMI range 21.5-39.4kg/m² (28.2±4.9) were recruited[9].
  - Continuous blood glucose monitor (CGM) data, insulin pump data, carbohydrate intake, self-reported daily stress levels [0 (none) – 4 (extreme)] and physical activity were collected for 1 week during which participants followed their daily routines.
  - The dataset consisted of 188 days from thirty-seven participants.
- **Methods:** Daily carbohydrate (CHO) intake, total daily insulin, and average BG were compared on days with no stress vs. some reported stress among participants based on their BMI levels.
- A model-based daily "effectiveness index" (EI) was computed as the time-average of instantaneous glucose rate-of-appearance (RoA) removed in order to reconcile CGM data with model-predicted BG[10].



- EI was compared across stress levels to capture behavior independent (metabolic) glycemic changes.
  - A positive EI "explains" observed blood glucose that is lower than the value predicted by carbohydrate and insulin intake alone.
- Linear mixed effects (LME) models were used to explore relationships between stress/BMI **predictors** and behavioral/metabolic **response variables.**
  - Studied response variables: daily total CHO, total insulin, average BG and average EI.
  - LME models were designed as follows:
    Response Variable = Stress + BMI + Stress * BMI + Error
  - Inter-participant variation was modeled as a random factor.

Results

Exploratory Data Analysis (BMI Grouped)

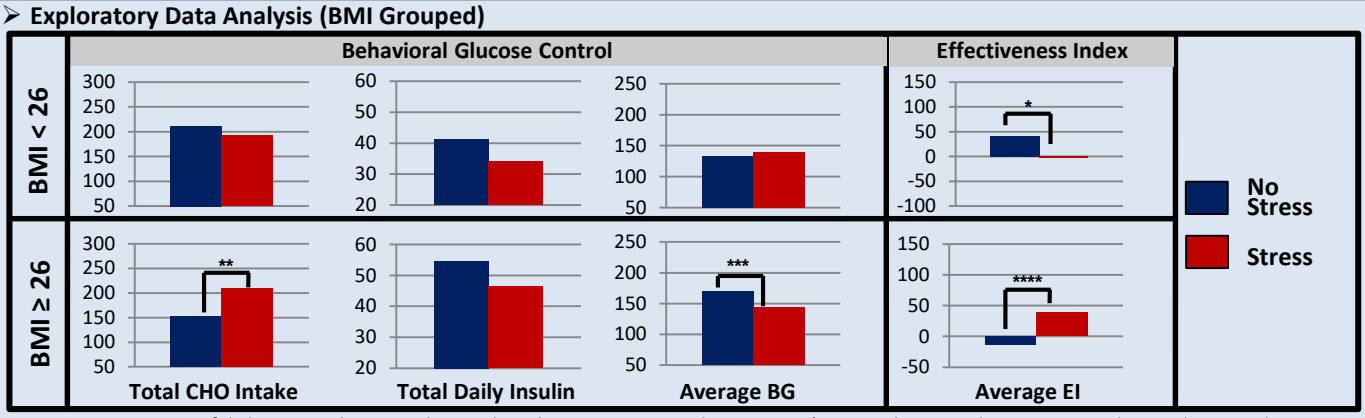


Figure 1. Comparison of daily reported CHO intake, total insulin, average BG and average EI. (Mann-Whitney-Wilcoxon test results are shown with *: p<0.05,**: p<0.01,***: p<0.001 ,****: p<0.0001).

On Days with Stress…

The Low BMI group exhibited
- No significant change in
  - CHO intake
  - total daily insulin
  - avg. BG
- Significant decrease in avg. EI

The High BMI group exhibited
- Significant increase in CHO intake
- No significant change in total daily insulin
- Significant decrease in avg.BG
- Significant increase in avg. EI

In order to account for potential exercise influence on the results, exploratory analysis was also performed excluding days that participants reported exercising (not shown). The results were similar to Figure 1.

Confirmatory Data Analysis (BMI Continuous)

Results from LME models supported that…

Higher BMI on stress days is associated with:
- increased CHO intake (p<0.05),
- no significant change in total daily insulin,
- no significant change in average BG
- increased average effectiveness index (p<0.05)

Note that BMI is a continuous variable in the LME models while it is grouped as lower and higher than 26 kg/m² in exploratory analysis for visualization (Figure 1).

Conclusions

- The results show that stress may influence blood glucose dynamics in T1DM both behaviorally and metabolically.
- The type and magnitude of the influence are not identical for all patients and likely affected by patient BMI.
- While heightened daily stress was expected to increase BG levels, we observed a reverse effect with higher BMI despite increased carbohydrate intake and no significant change in total daily insulin.
- The observed BMI x Stress effects were preserved when exercise days were excluded.
- Different types of stress (e.g. acute stress) may reveal different results.
- Further studies are needed to clarify the specifics of body mass index interaction to stress effect on glycemic changes in T1DM.

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Disclosure

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