



Glucose-lowering effects of physical activity in type 1 diabetes: A causal modelling and matched-pair analysis approach

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Disclosures

I am supported in preparing content by **Chad**, my ChatGPT AI Assistant. All ideas, interpretations, and responsibility remain my own. Chad helps polish and refine language to make content more engaging and accessible.

Honoraria / Speaking Fees

- ROCHE Diabetes
- Dexcom
- Insulet
- Abbott
- SBK Healthcare
- EXTOD
- Ypsomed

Consulting / Advisory Roles

- ROCHE Diabetes
- Abbott

Non-Profit Work

- Owner and Creator of www.TheGlucoseNeverLies.com

Barriers to Physical Activity in T1D

less than 50% of individuals with type 1 diabetes meet recommendations

Fear of Hypoglycaemia

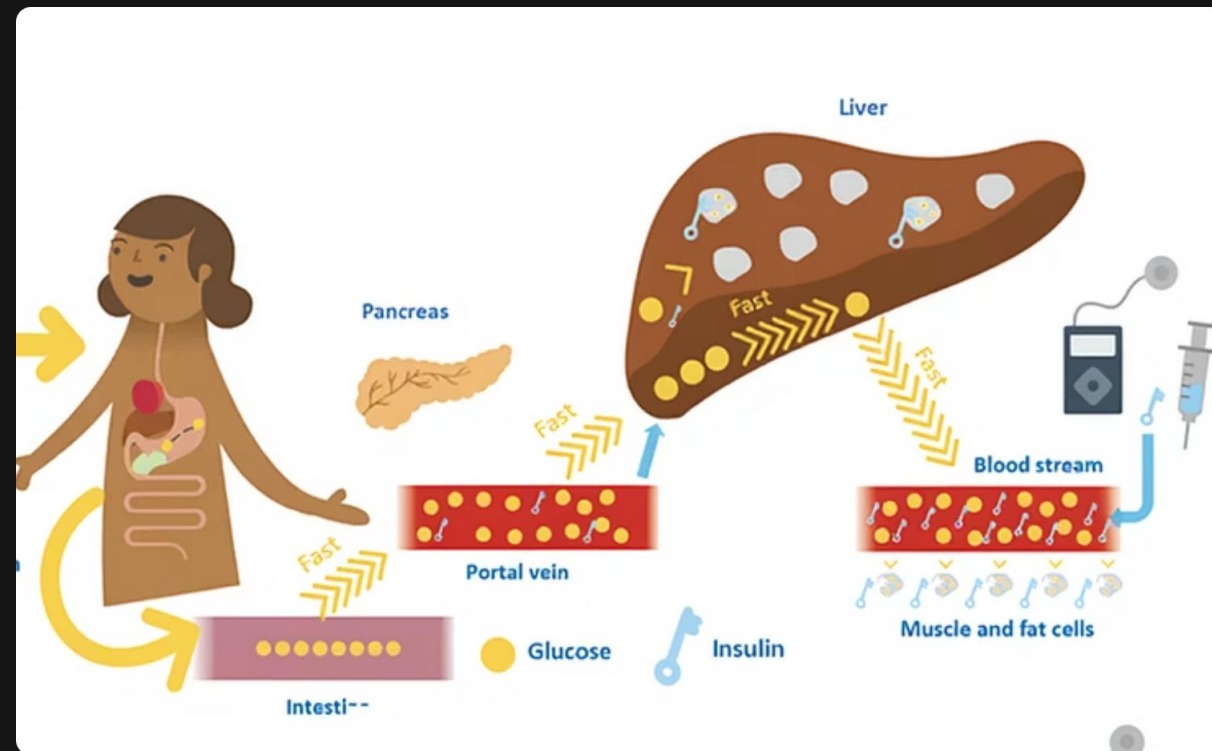
Complex Management Requirements

Lack of Education

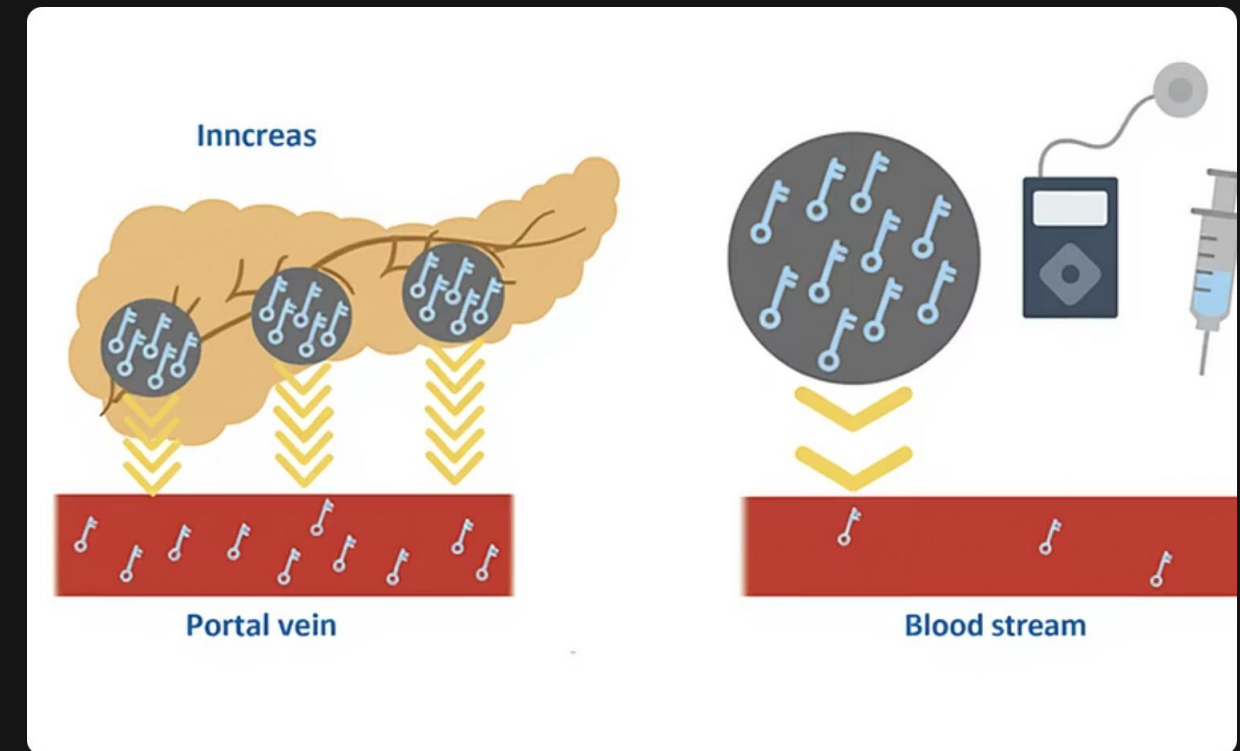
Social and Psychological Factors

References: Appl Physiol Nutr Metab. 2021;46:95-107. Canadian journal of diabetes. 2024;48:105-11.e5. PLoS One. 2014;9:e108019. Canadian journal of diabetes. 2024;48:401-8. Diabetic medicine: 2024;41:e15149. BMC Public Health 22, 1964 (2022). <https://doi.org/10.1186/s12889-022-14385-1>

Type 1 Diabetes Insulin Challenges

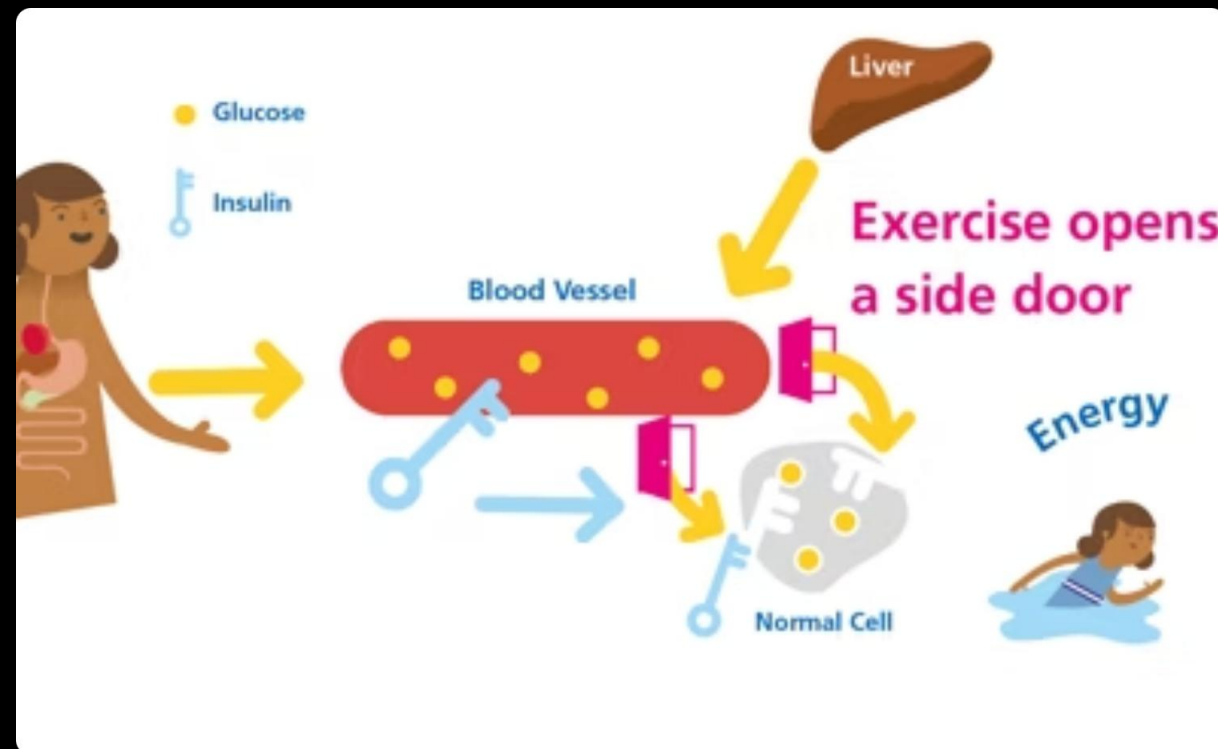


Low portal vein insulin concentrations

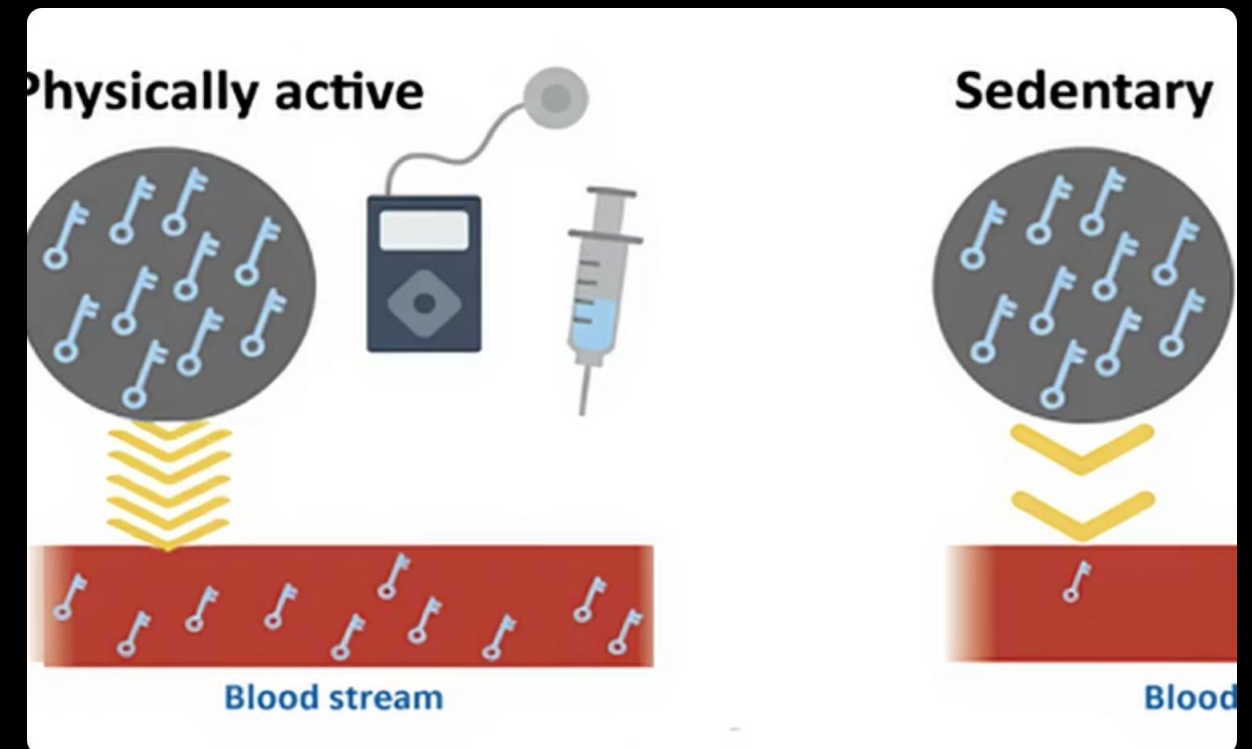


Slow subcutaneous insulin absorption

Physical Activity to the Rescue



Non-insulin Mediated Uptake



Faster Insulin Absorption

Duration of physical activity required to Ameliorate hyperglycemia without causing hypoglycemia in type 1 diabetes: A T1DEXI adults and pediatric cohort analyses

John Pemberton ^a · Zoey Li ^b · Robin L. Gal ^b · Lauren V. Turner ^c · Simon Bergford ^b · Peter Calhoun ^b · Michael C. Riddell ^c   Show less

Affiliations & Notes  Article Info 

^a Birmingham Women’s and Children’s Foundation Trust, Birmingham, United Kingdom

“But John... There’s No Control!”

Peter Calhoun: “It’s nice data, but John, there is no control. The glucose may have dropped without activity!”

John Pemberton: "I know a Data Scientist I can challenge to take on a matched pair analysis"

Catherine Russon: "Challenge accepted!"

Study Overview: Aims, Criteria & Population

AIMS

Assess glucose changes during physical activity in adults and adolescents with T1D using a pair-matching approach

INCLUSION CRITERIA

Starting glucose >10.0 mmol/L (180 mg/dL)

Self-reported activity: 10-30 min

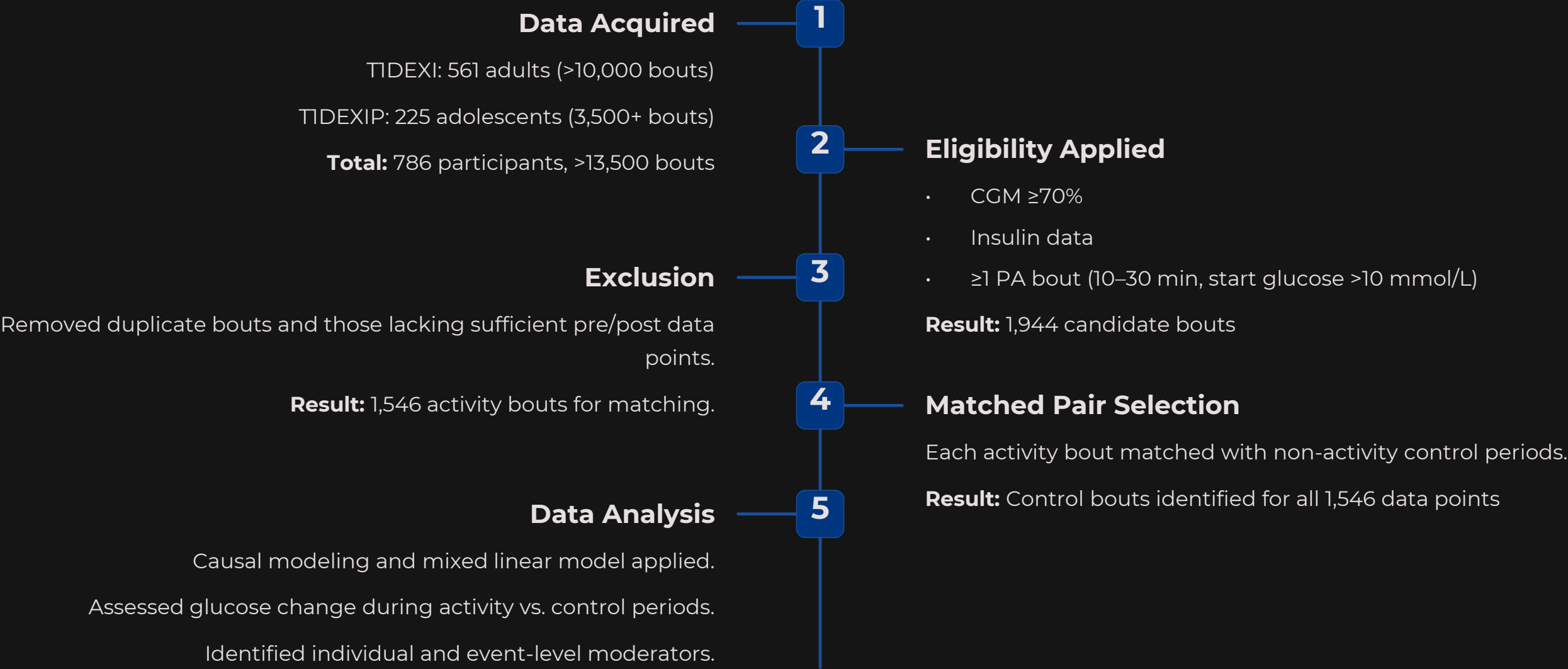
CGM data available $\geq 70\%$ for 1 hour before and 20 mins after

STUDY POPULATION

TIDEXI: 561 adults

TIDEXIP: 225 adolescents

Study Overview



Hierarchal Variable Selection (Mixed Liner Model)

Within Participant Matching: Activity Day vs Matched No Activity Day

Starting Glucose

Glucose Rate of Change

Insulin on Board

Glucose co-efficient of Variation in 1-hour prior



Acceptable
Threshold
SMD <0.1



Our Matched-Pair
Analysis
SMD <0.01

Main Results

Glucose-lowering effects of physical activity in type 1 diabetes: A causal modelling and matched-pair analysis approach



REAL-WORLD DATA

PA [median 23 minutes: IQR (20, 30)]

Mean glucose change of -2.2 mmol/L ($p < 0.001$)

Matched Non-PA Periods

Mean glucose change of 0.3 mmol/L ($p < 0.001$)

Mean Difference

-1.9 mmol/L ($p < 0.0001$)

No Significant Differences

By age, gender, activity type, intensity

Hypoglycaemia

Less than 2%

Individual- and Event-Level Moderators of the Differential Glucose Drop Between Physical Activity and Non-PA

Legend: This figure displays individual- and event-level factors that influenced the difference in glucose change between physical activity (PA) and matched non-PA periods:

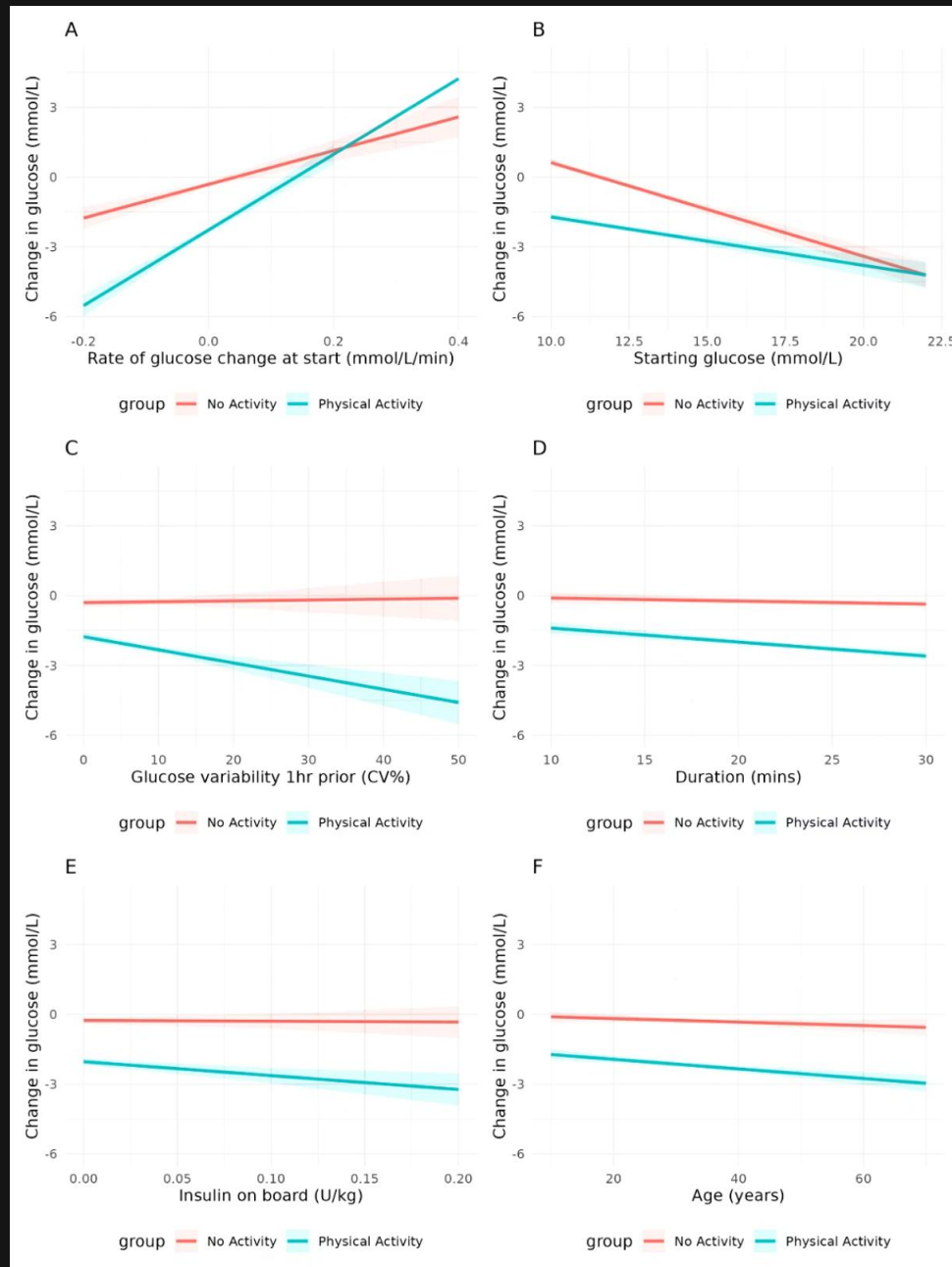
(A) starting glucose rate of change

(B) starting glucose level

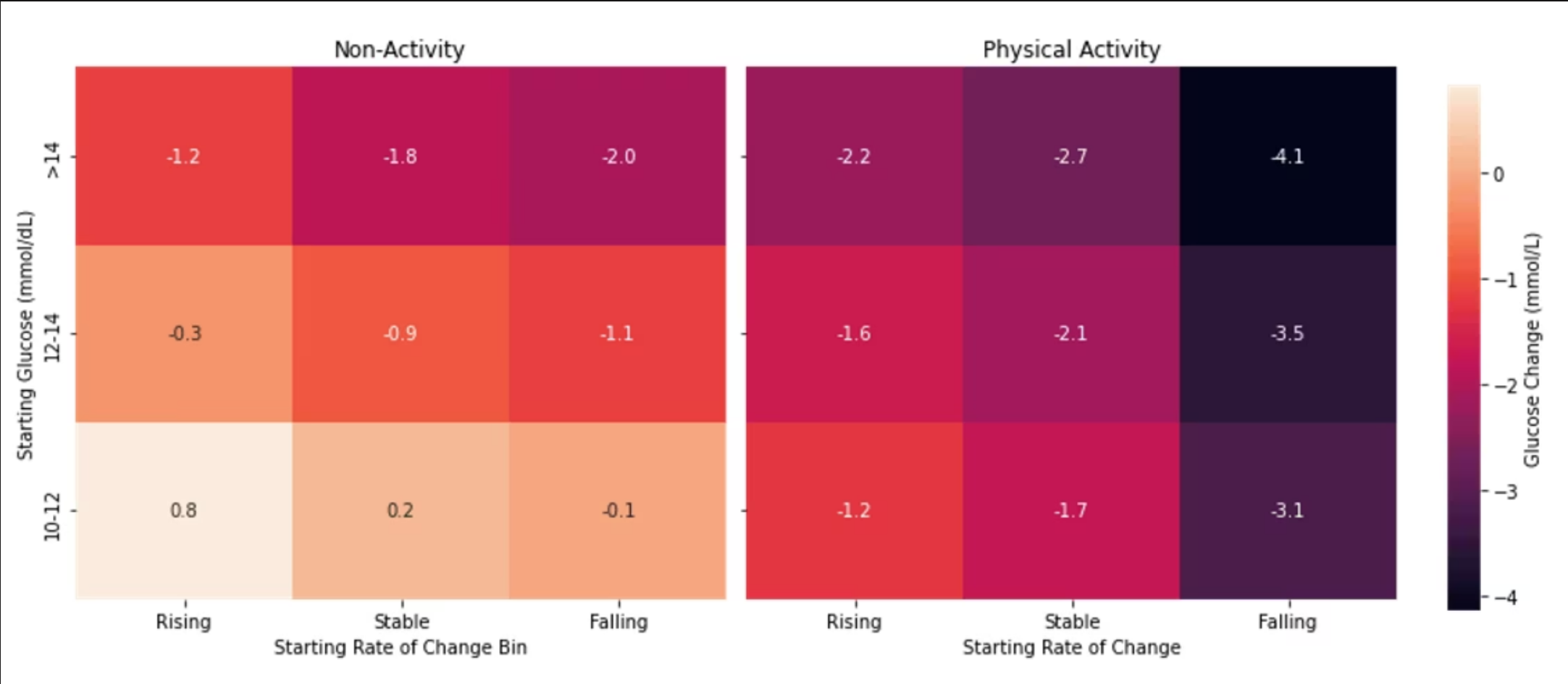
(C) Pre-PA (1-hour) glucose coefficient of variation (CV) (D) Activity duration

(E) starting insulin on board (IOB)

(F) Age



Predicted Glucose Trajectories Based on Physical Activity Status, Starting Glucose, and Glucose Rate of Change (mmol/L)



Predicted Glucose Trajectories Based on Physical Activity Status, Starting Glucose, and Glucose Rate of Change (mg/dL)



Strengths and Limitations

Strengths

High Ecological Validity

large sample size across wide age range

Rigorous Pair-Matching

Approach controlling for multiple predictors of glucose change

Consistency Across Cohorts

Findings replicated across all ages

Data Capture

CGM and pump Uploads

Limitations

Unable to Differentiate

Intensities of anerobic were low (heart rate)

Activity Bouts

Were of limited duration 10-30 mins

Short Observation Period

20-min post activity

Study Population Bias

Mainly white ethnicity and private health insurance

The 20 by 2 Rule

Physical Activity Lowers High Glucose Levels

Step 1 – "Is the Glucose Level Above 10 mmol/L?"

⚠ If glucose >15.0 mmol/L:

- Avoid physical activity if ketones ≥ 0.6 mmol/L (pump)
- Avoid physical activity if ketones ≥ 1.5 mmol/L (injections)



Step 2 – "Has Bolus Insulin Been Given <4hrs?"

Physical activity works best if a bolus insulin was given in the last 4 hours



Step 3 – Do 20 Minutes of Physical Activity

Light-to-moderate activity (walking is ideal, but any enjoyable activity works)



Result – 20 by 2

20 minutes of physical activity lowers glucose by about **2 mmol/L**

- ⓘ
- Avoid using physical activity to lower hyperglycaemia before breakfast
 - Apply this guidance only if it feels right for you

References: Moser, Zaharieva, et al. *Diabetologia*. 2024;67(2):255–280.; Pemberton, Li, et al. *Diabetes Research and Clinical Practice*. 2025;220:111981.; Pemberton, Russon, et al. *Diabet Med*. 2025; In press



20 by 2 or 20 by 40

The 20 by 40 Rule

Physical Activity Lowers High Glucose Levels

Step 1 – "Is the Glucose Level Above 180 mg/dL?"

⚠ If glucose >270 mg/dL:

- Avoid physical activity if ketones ≥ 0.6 mmol/L (pump)
- Avoid physical activity if ketones ≥ 1.5 mmol/L (injections)



Step 2 – "Has Bolus Insulin Been Given <4hrs?"

Physical activity works best if a bolus insulin was given in the last 4 hours



Step 3 – Do 20 Minutes of Physical Activity

Light-to-moderate activity (walking is ideal, but any enjoyable activity works)



Result – 20 by 40

20 minutes of physical activity lowers glucose by about **40 mg/dL**

- ⓘ
- Avoid using physical activity to lower hyperglycaemia before breakfast
 - Apply this guidance only if it feels right for you

References: Moser, Zaharieva, et al. *Diabetologia*. 2024;67(2):255–280.; Pemberton, Li, et al. *Diabetes Research and Clinical Practice*. 2025;220:111981.; Pemberton, Russon, et al. *Diabet Med*. 2025; In press

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North American Research Team

- Zoey Li
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- Cat Russon
- Richard Pulsford
- Brad Metcalf
- Emma Cockcroft
- Michael Allen
- Anne-Marie Frohock
- Rob Andrews

📄 Special thanks to Chad, my ChatGPT AI Assistant, for polishing and refining my work. The insights and responsibility remain mine — Chad simply helps make the content more enjoyable to follow.



20 by 2 or 20 by 40



“99 Problems
But High
Glucose Ain’t
One”

