ATTD
Advanced Technologies & Treatments for Diabetes

A Paradigm Shift

Using CGM to Dose Physical Activity to Optimize Time in Range

THE 18TH INTERNATIONAL CONFERENCE ON

ADVANCED TECHNOLOGIES & TREATMENTS FOR DIABETES

AMSTERDAM

19-22 MARCH 2025, AMSTERDAM & ONLINE

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John Pemberton RD, Birmingham Children's Hospital

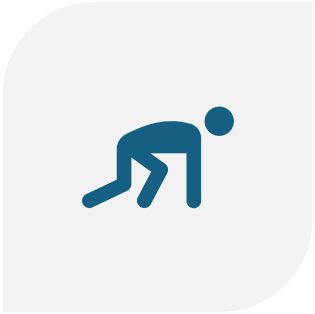
	No, Nothing to disclose
Y	Yes, please specify disclosures

Company / Name	Honoraria / Expense	Consulting / Advisory Board	Funded Research	Royalties / Patent	Stock Options	Ownership / Equity Position	Employee	Other (Please specify)
ROCHE	Y	Y						
Dexcom	Y							
Insulet	Y							
Abbott	Y	Y						

Agenda

PHYSICAL ACTIVITY RECOMMENDATIONS AND BARRIERS

HOW CLOSE DO CURRENT THERAPIES GET TO ACHIEVING GLUCOSE TARGETS?



PARADIGM SHIFT: USING PHYSICAL ACTIVITY TO OPTIMIZE TIME IN RANGE

World Health Organisation

Br J Sports Med. 2020;54:1451-62

Barriers to Physical Activity

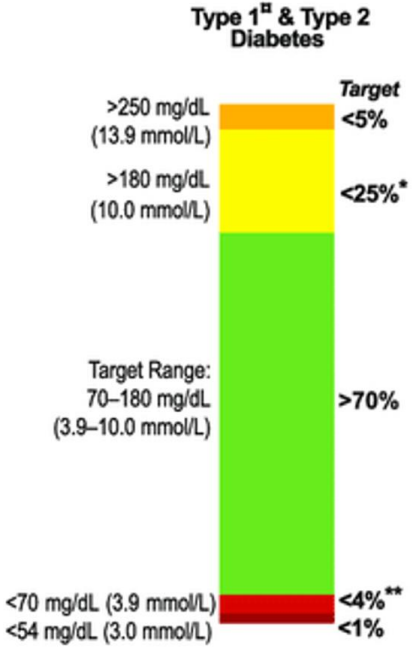
BMC Public Health **22**, 1964 (2022).

https://doi.org/10.1186/s12889-022-14385-1

OpenAI. (2025). ChatGPT. https://chat.openai.com/chat

Appl Physiol Nutr Metab. 2021;46:95-107.
Canadian journal of diabetes. 2024;48:105-11.e5.
Canadian journal of diabetes. 2024.
PLoS One. 2014;9:e108019.
Canadian journal of diabetes. 2024;48:401-8.
Canadian journal of diabetes. 2023;47:124-32.
Diabetic medicine : 2024;41:e15149.
OpenAI. (2025). ChatGPT. https://chat.openai.com/chat

How many people with T1D achieve 70% TIR?

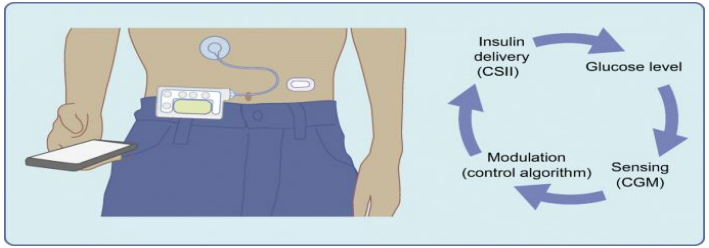


Diabetes Care. 2019 Aug;42(8):1593-1603.
Diabetes care. 2024;47:S111-s25.
Pediatr Diabetes. 2022;23:1270-6.

Real world data 20-36%

JAMANetworkOpen.2023;6(2):e230077.

doi:10.1001/jamanetworkopen.2023.0077

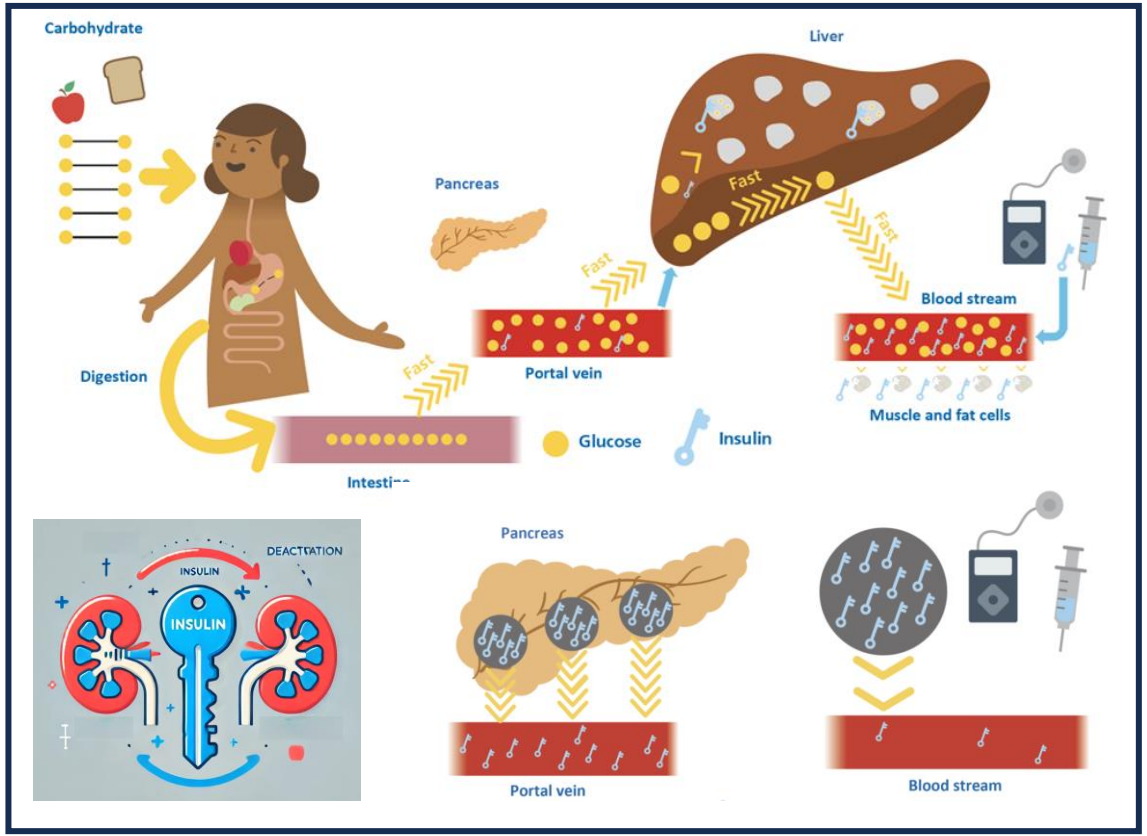


Real world data < 50%

BMC Med . 2024 Apr 24;22(1):175. doi: 10.1186/s12916-024-03396-x.

Diabetes Care. 2023 Oct 1;46(10):1831-1838.

Challenges

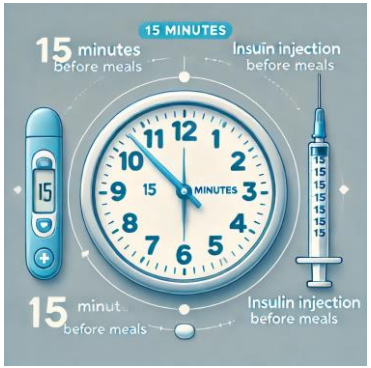


Graphics courtesy of:

GNL The Glucose Never Lies®

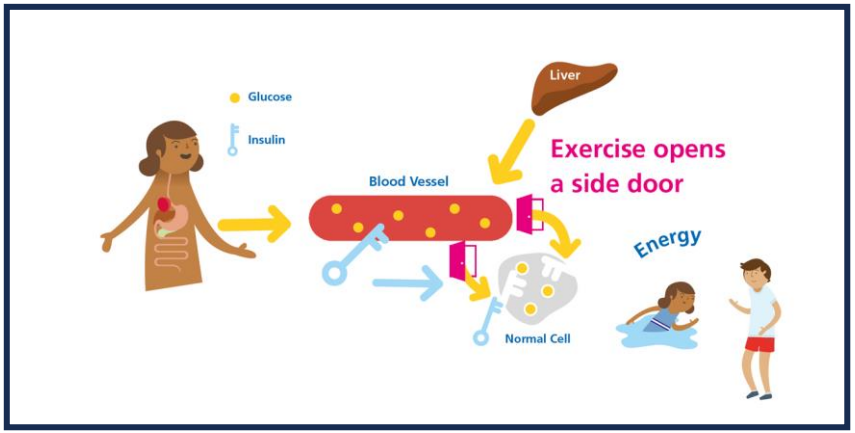
Diabetic Med. 1998; (15): 972-978; Diabet Med. 2018;35(3):306–16; J Diabetes Sci Technol. 2017;11:753-8.; Diabetes Res Clin Pract. 2013;99:19-23;

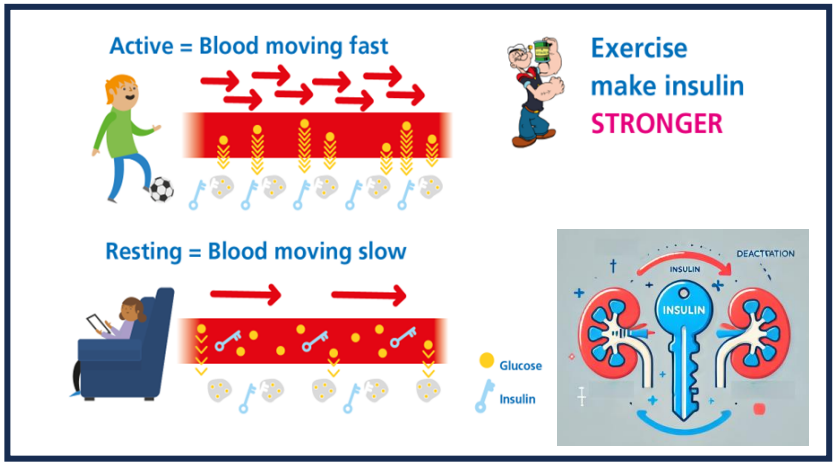
Challenges

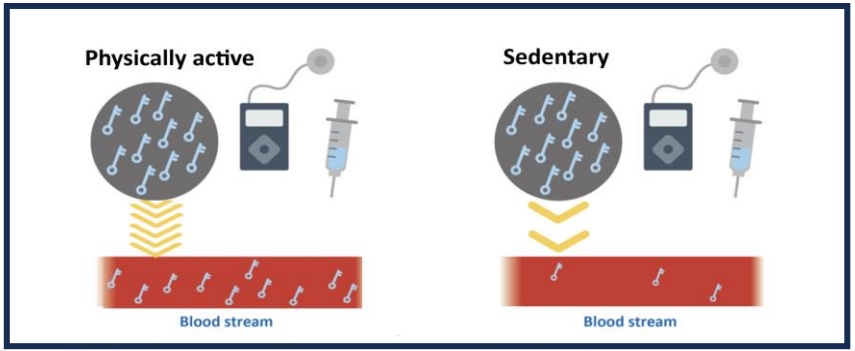


Diabetic Med. 1998; (15): 972-978; Diabet Med. 2018;35(3):306–16; J Diabetes Sci Technol. 2017;11:753-8.; Diabetes Res Clin Pract. 2013;99:19-23; OpenAI. (2025). ChatGPT. https://chat.openai.com/chat

Physical activity can tackle physiologic & behavioural challenges by Supercharging Insulin







Graphics courtesy of:

GNL The Glucose Never Lies®

Diabetes Obesity & Metabolism (2024). https://doi.org/10.1111/dom.16088; Nat Rev Endocrinol. 2017 Mar 1;13(3):133–48.; Physiol Rev. 2015;95(2):549–601.

What we already know?

- Walking for 30-minutes after meals stops hyperglycaemia for T1D and non-T1D
  - Diabetes Care 35:2493–2499, 2012
- **Lauren Turner**: Walking for 20-minutes before meals improves post-meal glucose
  - Diabetes Obes Metab. 2024;26:2492–2496
- **3 every 30:**
  - 3 minutes of walking every 30 minutes improves 24hr time in range by ~14%
  - Diabetes Obes Metab. 2023 Dec;25(12):3589-3598. doi: 10.1111/dom.15254
- All with minimal impact on hypoglycaemia risk
- **But what if the glucose is already above 180 mg/dL (10 mmol/L)?**

N = 1

Riddell et al., Paediat Diabetes 2019; 20(1): 99-106

Individual glucose responses to prolonged moderate intensity aerobic exercise in adolescents with type 1 diabetes: The higher they start, the harder they fall

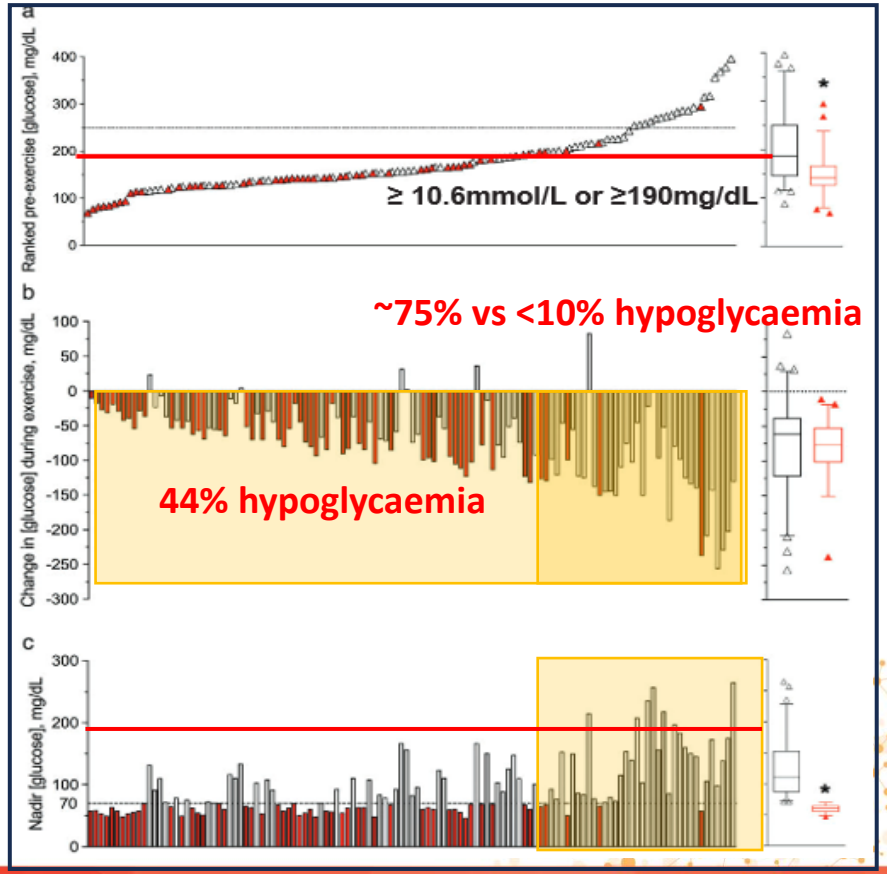
Michael C. Riddell[1,2] | Dessi P. Zaharieva[1] | Michael Tansey[3] | Eva Tsalikian[3] | Gil Admon[4] | Zoey Li[5] | Craig Kollman[5] | Roy W. Beck[5]

45 minutes drops by:

110 mg/dL or 6.1 mmol/L

15 minutes drops by:

~40 mg/dL or ~2 mmol/L



Riddell et al., Paediat Diabetes 2019; 20(1): 99-106

An effective and cost-saving structured education program teaching dynamic glucose management strategies to a socio-economically deprived cohort with type 1 diabetes in a VIRTUAL setting

John S. Pemberton[1] | Timothy G. Barrett[1,2] | Renuka P. Dias[1,3] | Melanie Kershaw[1] | Ruth Krone[1] | Suma Uday[1,3]

15 mins drops glucose by ~2.0 mmol/L (40 mg/dL)

M = Mode of exercise that can be done

E = Exercise when high alert sounds

Glucose mmol/L mg/dL	Trend arrow			How many minutes
	Libre	Dexcom	Medtronic	
8.0 - 9.9 145 - 179	↗		↑	5
	↑		↑↑	10
			↑↑↑	15
10.0 - 14.0 180 - 250	→			15
	↗		↑	20
	↑		↑↑	25
			↑↑↑	30
More than 14.0 250	↓		↓↓	15
	↘		↓	20
	→			25
	↗		↑	30
	↑		↑↑	40

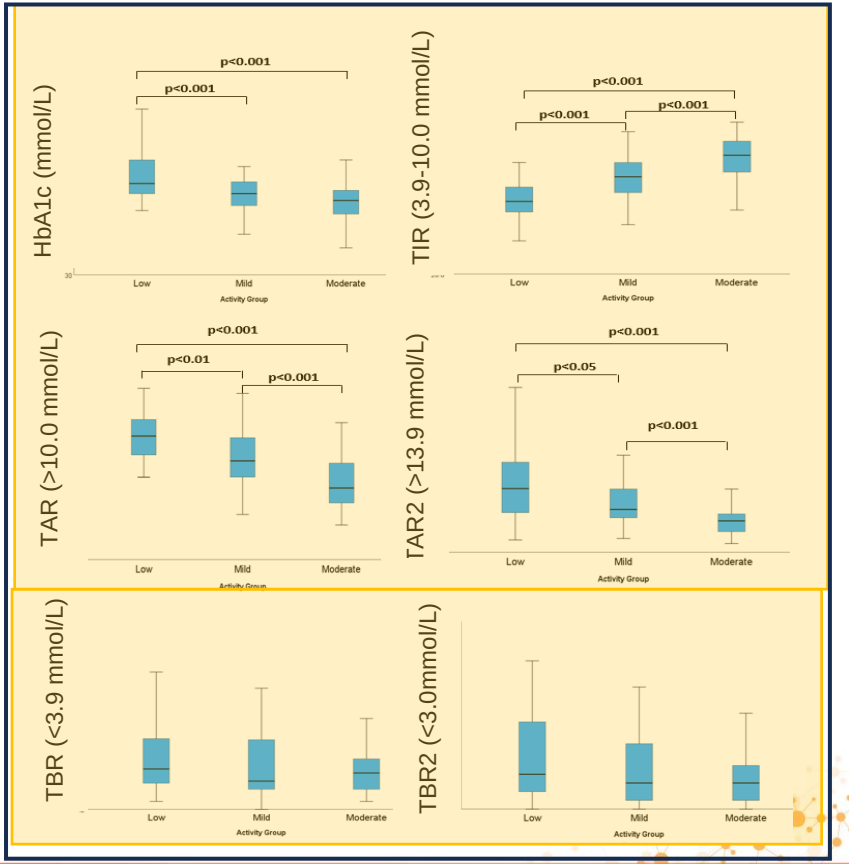
Pediatr Diabetes. 2022;23(7):1045-1056.

Integrating Physical Activity Strategies to Lower Hyperglycaemia in Structured Education Programmes for Children and Young People with Type 1 Diabetes Improves Glycaemic Control without Augmenting the Risk of Hypoglycaemia

John Stuart Pemberton,[1] Ankita Gupta,[2] Gar Mun Lau,[2] India Dickinson,[2] Pranav Viswanath Iyer,[2] and Suma Uday[1,3]

125 paediatrics: Use of GAME?

- Low (30%)
- Mild (34%)
- Moderate (36%)
- No difference in HbA1c at baseline



Limitations:

- Self-report
- Intensity not verified
- Association not causation

Pediatr Diabetes. 2023 Article ID 2519368. https://doi.org/10.1155/2023/2519368

N = 120

Diabetes Care
American Diabetes Association

Examining the Acute Glycemic Effects of Different Types of Structured Exercise Sessions in Type 1 Diabetes in a Real-World Setting: The Type 1 Diabetes and Exercise Initiative (T1DEXI)

Michael C. Riddell, Zoey Li, Robin L. Gal, Peter Calhoun, Peter G. Jacobs, Mark A. Clements, Corby K. Martin, Francis J. Doyle III, Susana R. Patton, Jessica R. Castle, Melanie B. Gillingham, Roy W. Beck, and Michael R. Rickels, for the T1DEXI Study Group

>8,000 sessions

Diabetes Care 2023;46(4):1–10 | https://doi.org/10.2337/dc22-1721

Diabetes Care
American Diabetes Association

The Acute Effects of Real-World Physical Activity on Glycemia in Adolescents With Type 1 Diabetes: The Type 1 Diabetes Exercise Initiative Pediatric (T1DEXIP) Study

Michael C. Riddell, Robin L. Gal, Simon Bergford, Susana R. Patton, Mark A. Clements, Peter Calhoun, Lindsey C. Beaulieu, and Jennifer L. Sherr

>3,500 sessions

Diabetes Care 2024;47(00):1–8 | https://doi.org/10.2337/dc23-1548

Sorry Mike

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,*]

Aims:

- Estimate activity duration to lower glucose from above target range (>180 mg/dL) to within target range (TIR: 70–180 mg/dL) in individuals with type 1 diabetes (T1D).

Methods:

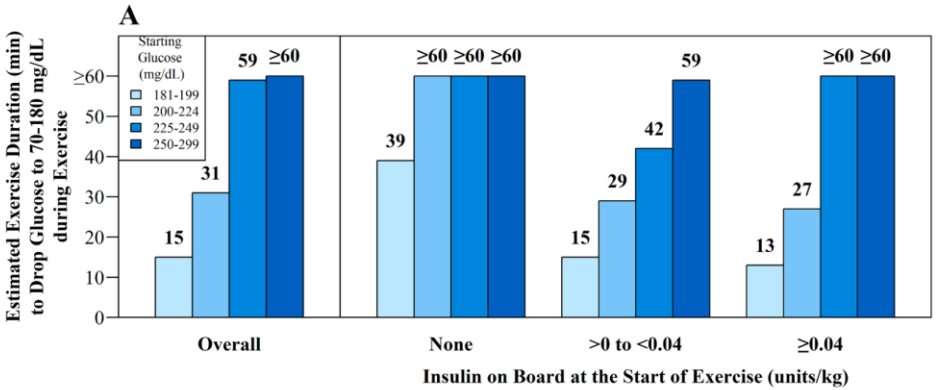
- 404 adults and 149 adolescents with T1D.
- Activities **(N = 1902, Adults = 1599, Adolescent = 303)**
- Starting glucose between **181-300 mg/dL**,
- Duration **10–60 min** with **no reported meals** during activity

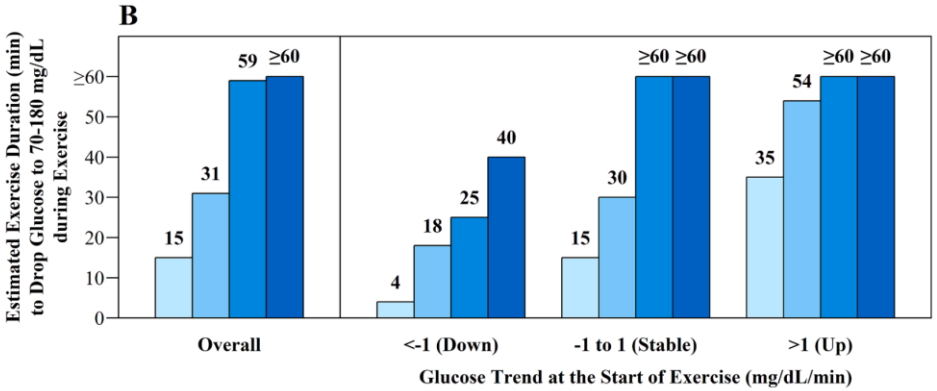
N = 2,000

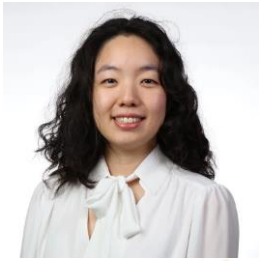
Result categories:

- Starting glucose level (181–199, 200–224, 225–249, and 250–300 mg/dL)
- Insulin on board (None, >0 to <0.04, ≥0.04 u/kg – **four-hour linear decay model**)
- Rate of change (Falling: <-1 mg/dL/min, Stable -1 to 1 mg/dL/min, Rising >1 mg/dL/min)

Diabetes Research and Clinical Practice, Volume 220, 111981







Diabetes Research and Clinical Practice, Volume 220, 111981

Other key findings

No differences by:

- Therapy type (49% HCL, 35% CSII, 16% MDI)
- Age (Adults vs Adolescent)
- Activity type (Aerobic, Interval, Resistance)

Longer duration required for female adults starting between 225-249 mg/dL

0-11% risk of hypoglycaemia overall, up to 30 minutes a maximum 7% risk with fast falling ROC

Chance of glucose increasing during activity

- >0 units/kg insulin on board: 11-31%
- Zero insulin on board: up to 54%

Diabetes Research and Clinical Practice, Volume 220, 111981

Key take home messages

10–30 minutes of activity effective when 181 to 249 mg/dL (10.0-13.9 mmol/L)

Low risk of hypoglycaemia.

If bolus insulin within 4 hours

For glucose levels above 250 mg/dL (13.9 mmol/L), check for ketones:

If ketones >0.6 mmol/L, only use insulin to correct

If ketones <0.6 mmol/L, provide a 50% correction before physical activity.

This strategy should be used at the **discretion** of the individual with type 1 diabetes,

Would the glucose have dropped without the activity?

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Short Bouts of Physical Activity as a Strategy to Reduce Post-Meal Hyperglycaemia in Type 1 Diabetes

CL Russon[1], RM Pulsford[1], BS Metcalf[1], E Cockroft[1], M Allen[1], AM Frohock[2], RC Andrews[1,3], JS Pemberton[4]

1 University of Exeter Medical School, 2 Oxford University Hospitals, 3 NIHR Exeter Biomedical Research Centre, 4 Birmingham Women's and Children's

Study design

- **Retrospective cohort:**
  - T1-DEXI: Structured 30-minute activity sessions (six sessions over 30 days), with additional free-living activity data included.
  - T1-DEXIP: Free-living activity recorded over 10 days in young people (12-18yrs)
- **Exercise Bouts:** selected *10–30 minutes*, starting glucose *>10 mmol/L*.
- **Outcome:** Glucose change from *start to 20 minutes post-exercise* (accounting for CGM lag).

Matched-Pairs Design

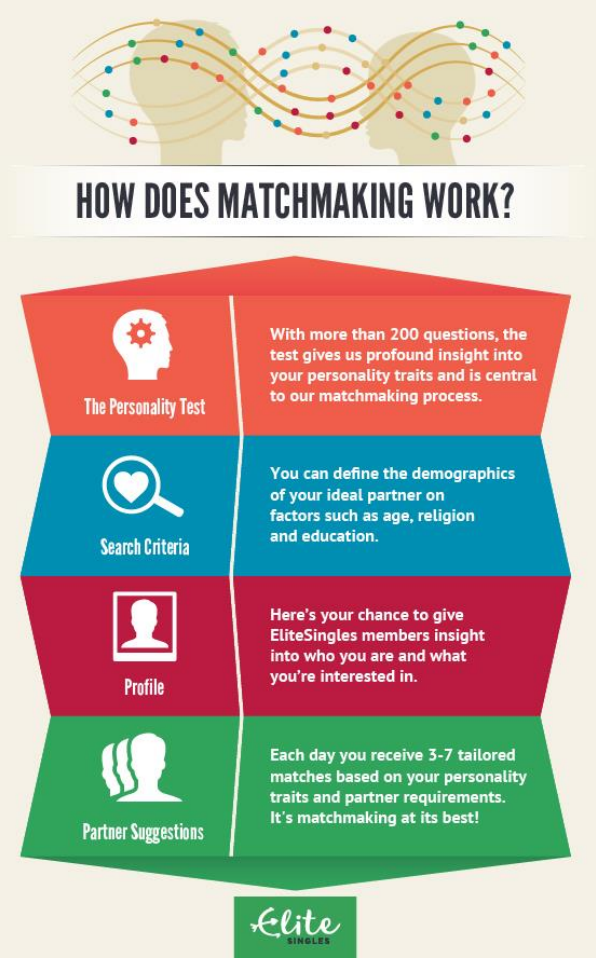
- **Matching Method:** Novel *weighted Mahalanobis distance* algorithm.
- **Matching Variables:** Starting glucose, rate of change, IOB, and glycaemic variability.
- **Balance Check:** Confirmed that all variables had a standardised mean difference (SMD) < 0.1 between activity and matched pairs.

Statistical Analysis

- **Dataset:** 1837 matched bouts from 531 participants
- **Model:** Linear Mixed-Effects Model (random intercepts & slopes).
- **Adjusted Covariates:** Age, BMI, HbA1c starting glucose, rate of change, IOB, glycaemic variability,

SMD <0.1 is needed and our model was <0.01?

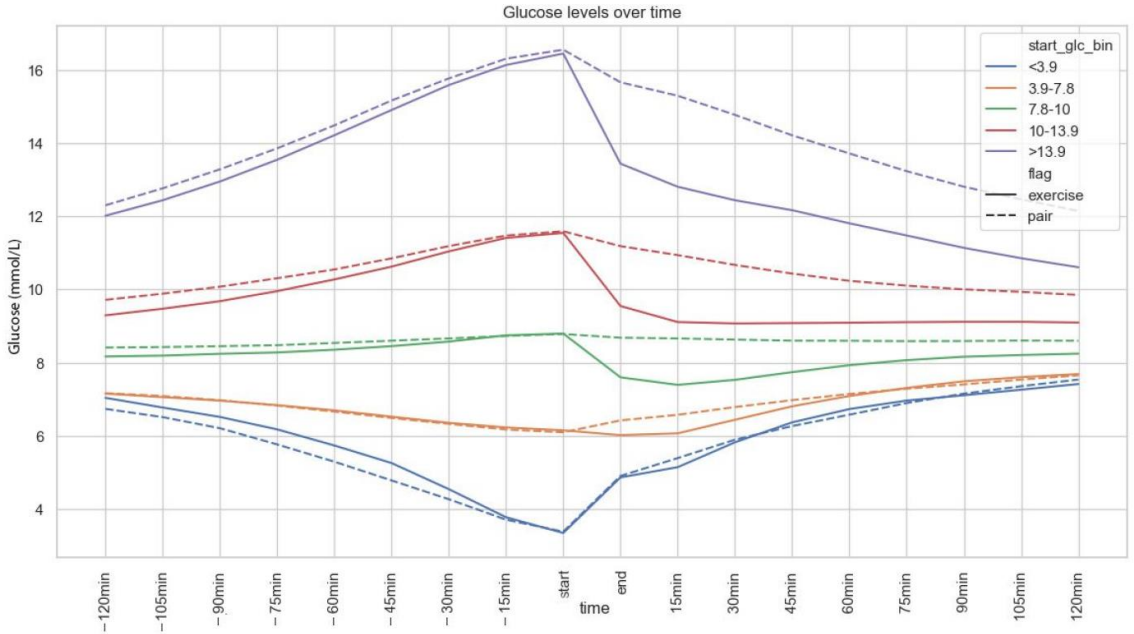
Pretend I am stupid...


HOW DOES MATCHMAKING WORK?
The Personality Test
With more than 200 questions, the test gives us profound insight into your personality traits and is central to our matchmaking process.
Search Criteria
You can define the demographics of your ideal partner on factors such as age, religion and education.
Profile
Here's your chance to give EliteSingles members insight into who you are and what you're interested in.
Partner Suggestions
Each day you receive 3-7 tailored matches based on your personality traits and partner requirements. It's matchmaking at its best!
Elite SINGLES

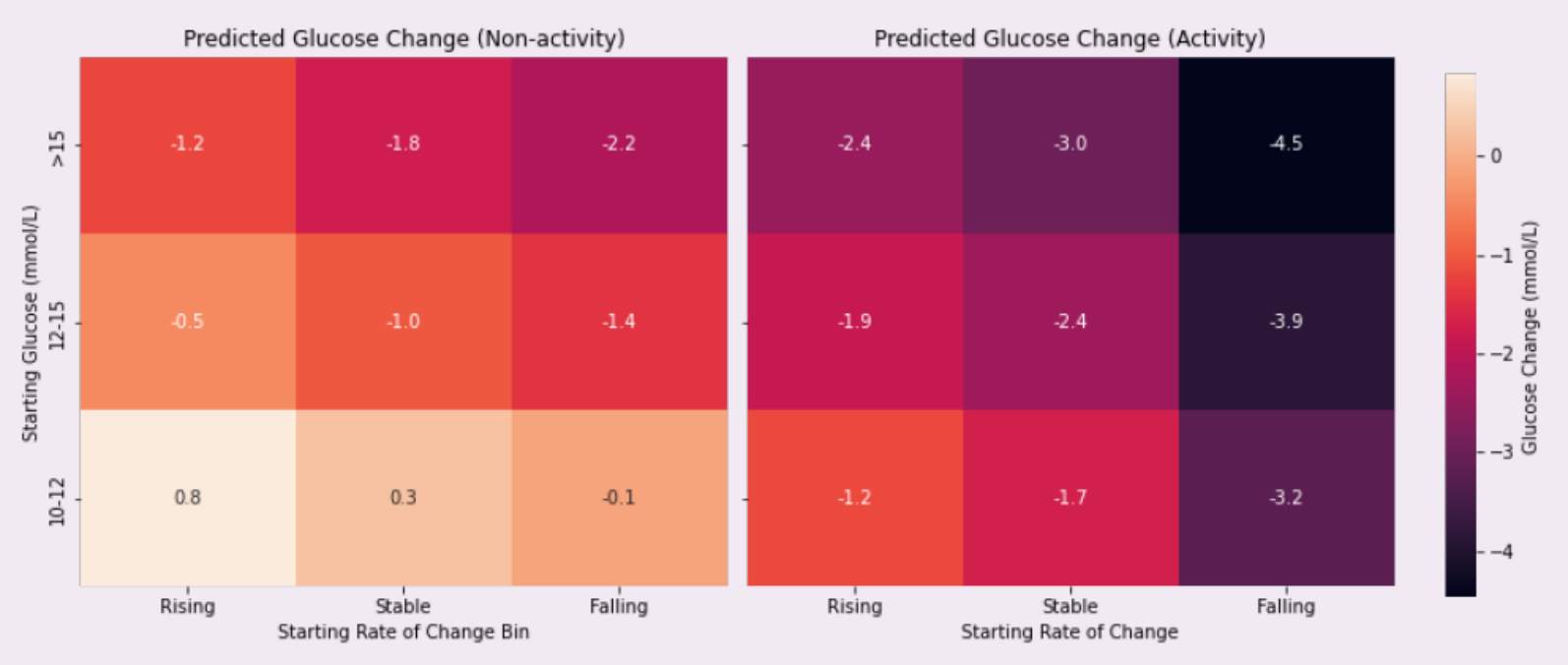
On average: for 20 mins after activity non-activity vs 20 mins of activity

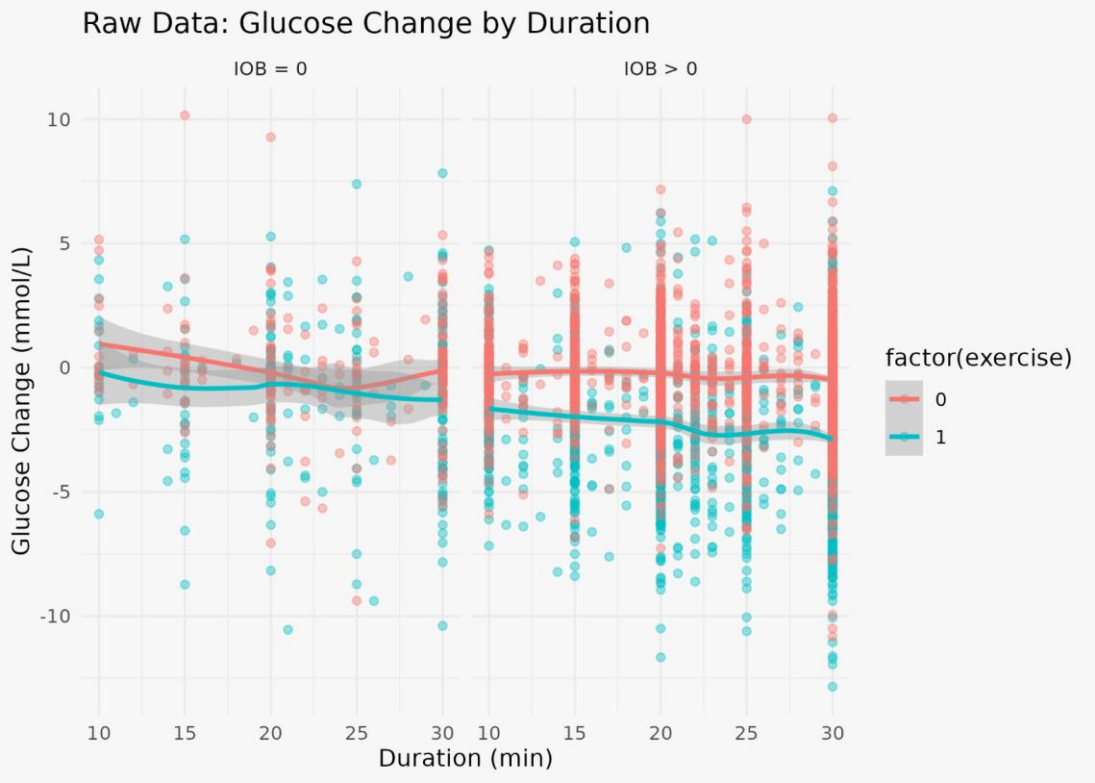
0.6 mmol/L vs 2.4 mmol/L in 20 mins

11 mg/dL vs 44 mg/dL is 20 mins

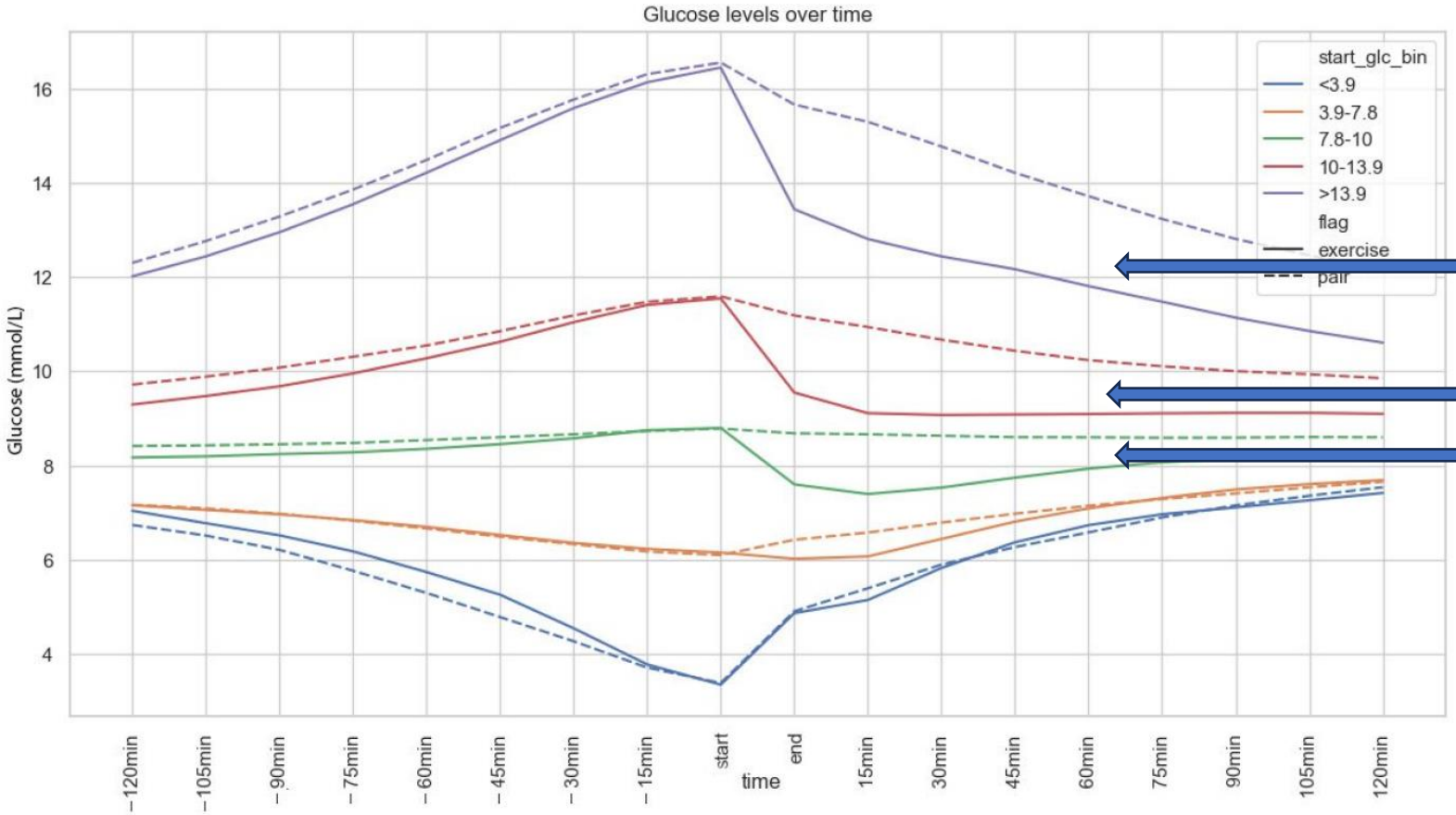



ACTIVITY
ACTIVITY
INSULIN
4X


Predicted Glucose Change (Non-activity)
Predicted Glucose Change (Activity)
Starting Glucose (mmol/L)
>15
12-15
10-12
-1.2
-1.8
-2.2
-0.5
-1.0
-1.4
0.8
0.3
-0.1
-2.4
-3.0
-4.5
-1.9
-2.4
-3.9
-1.2
-1.7
-3.2
Rising
Stable
Falling
Starting Rate of Change Bin
Starting Rate of Change
Glucose Change (mmol/L)
0
−1
−2
−3
−4



Bolus insulin within
4 hours for hours



What about 2-hour area under the curve reductions?

Dr. Dessi P Zaharieva

DiabetesWISER

Prof Rob Andrews

EXTOD

Chris Bright

Inspire T1D

Summary

3 every 30: 3-minute activity snacks throughout the day to optimise time in range (3.9-10.0 mmol/L or 70-180 mg/dL)

Before meals: 20 minutes walking to sensitise the body to insulin

After-meals: 15-30 mins walking to stay in range (tight range)

15 by 2 or **15 by 40:** After-meals: >10.0 mmol/L (180 mg/dL):

Activity Supercharges Bolus Insulin by 4X

Acknowledgements

North American Team:

- Zoey Li
- Robin L. Gal
- Lauren V. Turner
- Simon Bergford
- Peter Calhoun
- Michael C. Riddell

The UK Team:

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

THE LEONA M. AND HARRY B. HELMSLEY CHARITABLE TRUST

verily

dexcom

99 Problems
But High Glucose Aint One

Podcast

Activity Snacking to increase TIR

Download 99 Problems …

Resources

Click on the link for "Google Drive"

johnpemberton@nhs.net

OpenAI. (2025). ChatGPT. https://chat.openai.com/chat