SLEEP & CIRCADIAN PHYSIOLOGY LAB

HEALTH UNIVERSITY OF UTAH

Effects of Circadian-Based Intervention on Cardiometabolic Health in Adults with Habitual Short Sleep Duration.

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Background

- Habitual Short Sleep Duration
  - Refers to individuals regularly sleeping less than 6.5 hours per night, often due to lifestyle factors rather than sleep disorders.
- Previous Studies
  - HSSD is linked to increased risk of cardiometabolic diseases.
  - Correlation between lack of sleep and reduced insulin sensitivity which is subsequently associated with type 2 diabetes
  - Circadian Misalignment due to late-night exposure to blue light corresponds with decreased insulin sensitivity
- **Study Objective:**
  - Explore how circadian interventions for individuals with habitual short sleep duration may influence sleep patterns in real-world settings and impact insulin sensitivity

Study Designs

Design: Randomized controlled trial with control and circadian intervention groups

Sample

- Ages
  - 18-45 Years
- BMI
  - 25.0-34.9 kg/m^2
- Sleep Duration
  - < 6.5 hours nightly
- 10 participants
  - 6 Control
  - 4 Intervention
- Duration
  - 8 weeks

Data Collection

- GENEActiv wrist-actigraphy
- Daily Sleep Logs
- Oral Glucose Tolerance Test

Exclusion Criteria

- Medical, Psychiatric, or Sleep Conditions
- Medications or supplements that could impact sleep or glucose
- Major Lifestyle factors
  - Shift work, smoking, excess alcohol use or caffeine consumption, pregnancy, etc..

Data Collection: Oral Glucose Tolerance Test

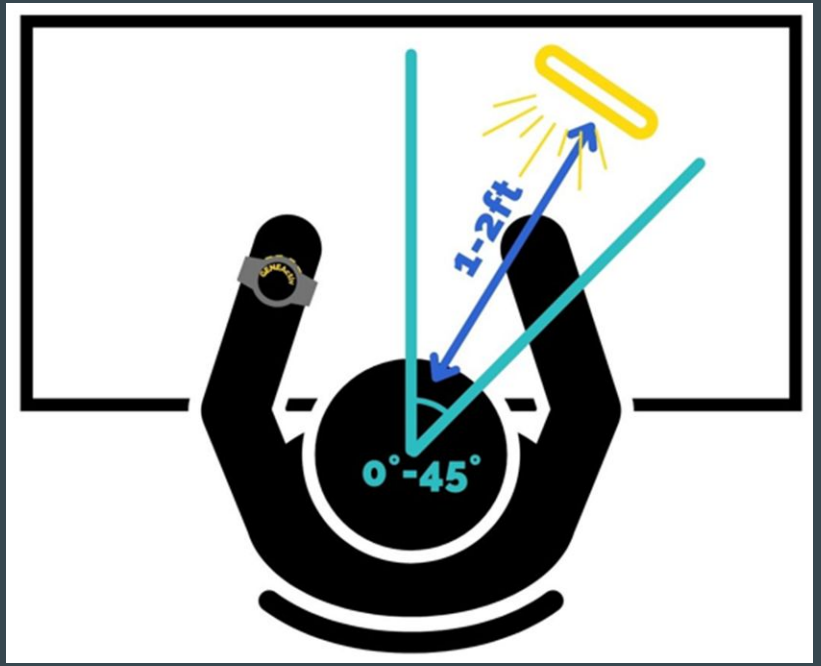
- Purpose
  - Measure insulin sensitivity using the Matsuda Index
  - Matsuda Index
    - a calculation that reflects whole-body insulin sensitivity based on glucose and insulin measures
    - Equation:
      - 10,000/√ [fasting glucose (mmol/l) × fasting insulin (pmol/l)] × [mean glucose (mmol/l) × mean insulin (pmol/l) during OGTT]
- Procedure
  - Measure blood glucose and insulin levels at multiple time points following the consumption of a 75g glucose solution.
- Timeline
  - Blood samples collected at baseline (0 minutes), and then at 10, 20, 30, 60, 90, and 120 minutes.

Intervention

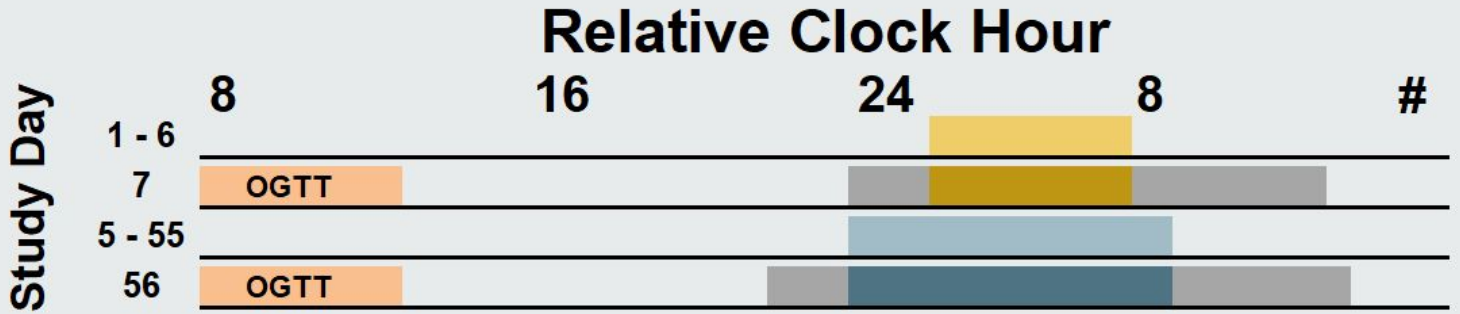
Goal: increase sleep duration and align sleep timing with their biological circadian clock in order to improve insulin sensitivity.

- 8-week intervention with regular monitoring, including wrist-actigraphy for sleep tracking, electronic sleep logs, and scheduled lab assessments to evaluate outcomes.

Circadian Intervention	Collection Method
Blue light blocking glasses 4 hrs before bedtime	Actiwatch
Light box 1 hr after awakening	Paper Logs



Timeline



Baseline ambulatory sleep monitoring

Baseline overnight testing with OGTT

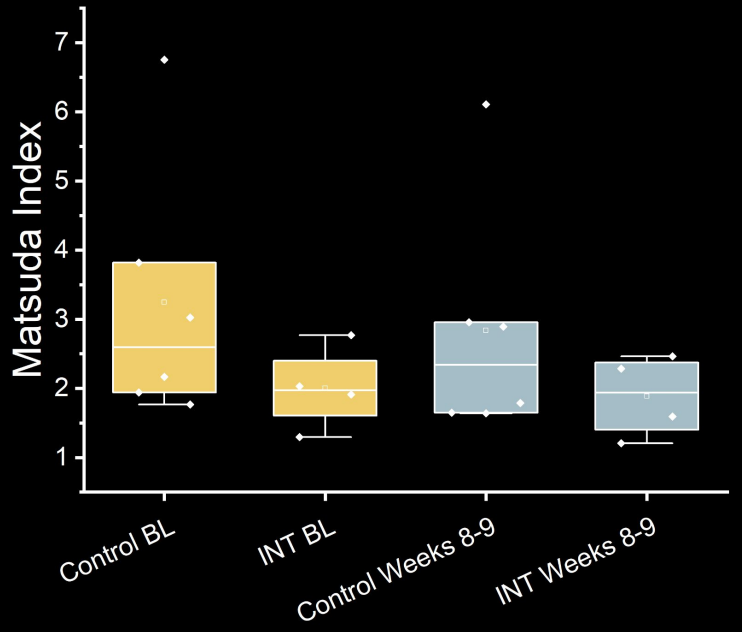
Intervention weeks 1 - 8

Intervention overnight testing with OGTT

Indicates Dim light setting

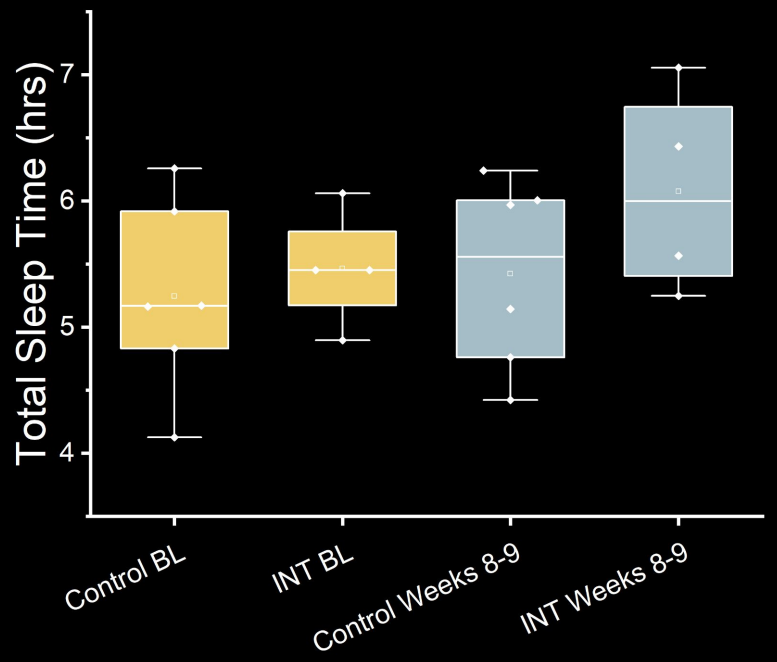
Results - Matsuda Index

Baseline -Between Groups	• P-value > 0.05 • No statistically significant difference between groups at the start.
Baseline Within Groups	• P-value > 0.05 • No statistically significant difference within groups at the start.
Post-Intervention Between Groups	• P- Value > 0.05 • No statistically significant difference in insulin sensitivity between the intervention and control groups post-intervention.
Change in MI from BL to Post Intervention	• P- Value > 0.05 • No statistically significant effect of the intervention on insulin sensitivity



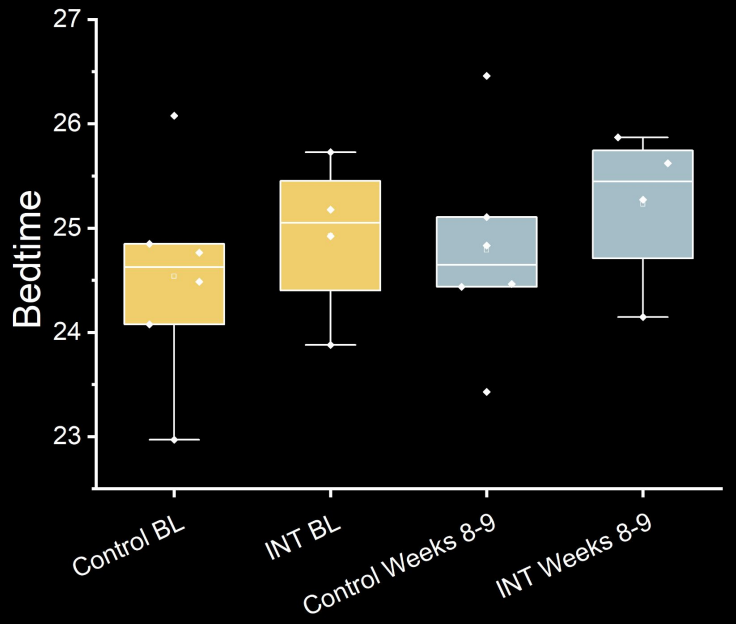
Results - Total Sleep Time

Baseline -Between Groups	• P-value > 0.05 • No statistically significant difference between groups at the start.
Baseline Within Groups	• P-value > 0.05 • No statistically significant difference within groups at the start.
Post-Intervention Between Groups	• P- Value > 0.05 • No statistically significant difference in total sleep time between the intervention and control groups post-intervention.
Change in TST from BL to Post Intervention	• P- Value > 0.05 • No statistically significant effect of the intervention on total sleep time.



Results - Bed Time

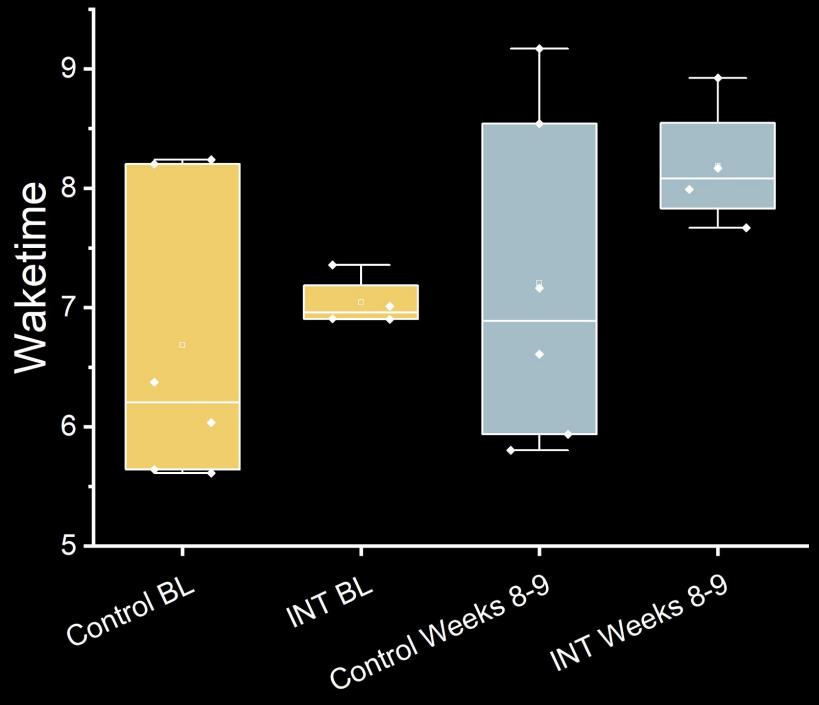
Baseline -Between Groups	• P-value > 0.05 • No statistically significant difference between groups at the start.
Baseline Within Groups	• P-value < 0.05 • There is a statistically significant difference within groups at the start.
Post-Intervention Between Groups	• P- Value > 0.05 • No statistically significant difference in bedtime between the intervention and control groups post-intervention.
Change in BT from BL to Post Intervention	• P- Value > 0.05 • No statistically significant effect of the intervention on bed time



Results- Wake Time

Baseline -Between Groups	• P-value > 0.05 • No statistically significant difference between groups at the start.
Baseline Within Groups	• P-value < 0.05 • There is a statistically significant difference within groups at the start.
Post- Intervention Between Groups	• P- Value > 0.05 • No statistically significant difference in wake time between the intervention and control groups post-intervention.
Change in WT from BL to Post Intervention	• P- Value > 0.05 • No statistically significant effect of the intervention on waketime

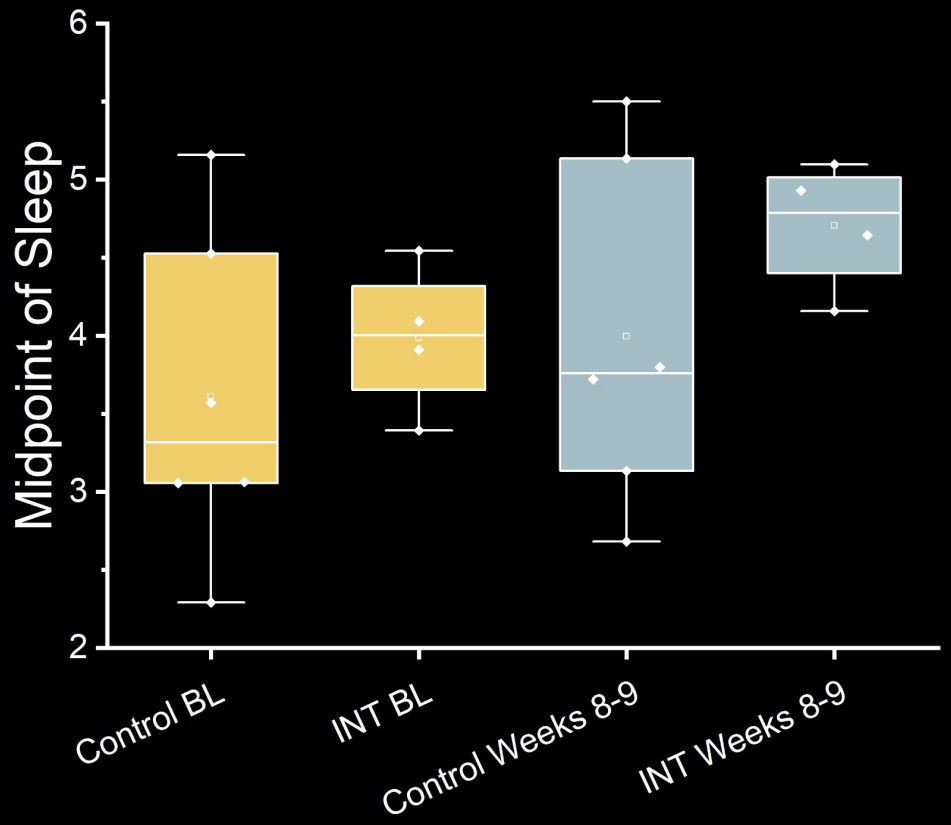
Wake Time

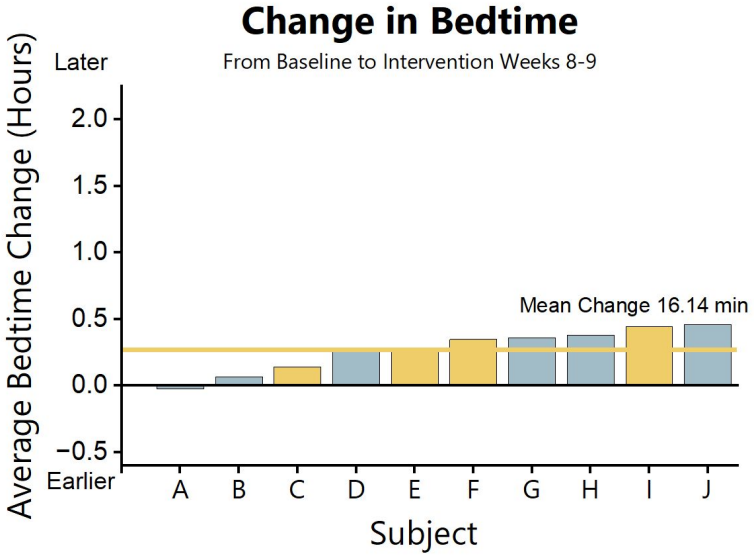

Waketime
9
8
7
6
5
Control BL
INT BL
Control Weeks 8-9
INT Weeks 8-9

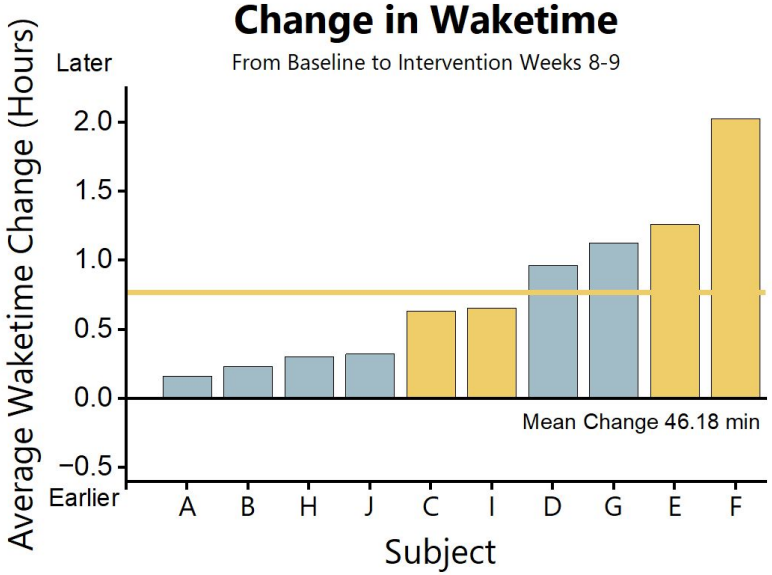
Results- Midpoint

Baseline -Between Groups	• P-value > 0.05 • No statistically significant difference between groups at the start.
Baseline Within Groups	• P-value < 0.05 • There is a statistically significant difference within groups at the start.
Post- Intervention Between Groups	• P- Value > 0.05 • No statistically significant difference in midpoint of sleep between the intervention and control groups post-intervention.
Change in MP from BL to Post Intervention	• P- Value > 0.05 • No statistically significant effect of the intervention on midpoint of sleep.

Midpoint


Midpoint of Sleep
6
5
4
3
2
Control BL
INT BL
Control Weeks 8-9
INT Weeks 8-9


Change in Bedtime
From Baseline to Intervention Weeks 8-9
Later
Earlier
Average Bedtime Change (Hours)
2.0
1.5
1.0
0.5
0.0
−0.5
Mean Change 16.14 min
A
B
C
D
E
F
G
H
I
J
Subject


Change in Waketime
From Baseline to Intervention Weeks 8-9
Later
Earlier
Average Waketime Change (Hours)
2.0
1.5
1.0
0.5
0.0
−0.5
Mean Change 46.18 min
A
B
H
J
C
I
D
G
E
F
Subject

Conclusions

- 10 out of 20 participants
  - No major conclusions can be made
- Continue this project in my Spring 2025 UROP

- Acknowledgements
  - Professor Depner
  - Depner Lab
  - Audrey Stegman

References

- Arble, D. M., Bass, J., Behn, C. D., Butler, M. P., Challet, E., Czeisler, C., Depner, C. M., Elmquist, J., Franken, P., Grandner, M. A., Hanlon, E. C., Keene, A. C., Joyner, M. J., Karatsoreos, I., Kern, P. A., Klein, S., Morris, C. J., Pack, A. I., Panda, S., ... Wright, K. P. (2015). Impact of sleep and circadian disruption on energy balance and diabetes: A summary of workshop discussions. *Sleep*, *38*(12), 1849–1860. https://doi.org/10.5665/sleep.5226
- Cappuccio, F. P., Taggart, F. M., Kandala, N.-B., Currie, A., Peile, E., Stranges, S., & Miller, M. A. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*, *31*(5), 619–626. https://doi.org/10.1093/sleep/31.5.619
- Centers for Disease Control and Prevention. (2021, December 17). *Diabetes*. Centers for Disease Control and Prevention. https://www.cdc.gov/globalhealth/healthprotection/ncd/diabetes.html
- Depner, C. M., Stothard, E. R., & Wright, K. P. (2014). Metabolic consequences of sleep and circadian disorders. *Current Diabetes Reports*, *14*(7). https://doi.org/10.1007/s11892-014-0507-z
- Duraccio, K. M., Kamhout, S., Baron, K. G., Reutrakul, S., & Depner, C. M. (2024). Sleep extension and cardiometabolic health: What it is, possible mechanisms and real-world applications. *The Journal of Physiology*. https://doi.org/10.1113/jp284911
- Eckel, R. H., Depner, C. M., Perreault, L., Markwald, R. R., Smith, M. R., McHill, A. W., Higgins, J., Melanson, E. L., & Wright, K. P. (2015). Morning circadian misalignment during short sleep duration impacts insulin sensitivity. *Current Biology*, *25*(22), 3004–3010. https://doi.org/10.1016/j.cub.2015.10.011
- Hossain, Md. J., Al-Mamun, Md., & Islam, Md. R. (2024). Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused. *Health Science Reports*, *7*(3). https://doi.org/10.1002/hsr2.2004
- Klerman, E. B., Brager, A., Carskadon, M. A., Depner, C. M., Foster, R., Goel, N., Harrington, M., Holloway, P. M., Knauert, M. P., LeBourgeois, M. K., Lipton, J., Merrow, M., Montagnese, S., Ning, M., Ray, D., Scheer, F. A., Shea, S. A., Skene, D. J., Spies, C., ... Burgess, H. J. (2022). Keeping an eye on circadian time in clinical research and medicine. *Clinical and Translational Medicine*, *12*(12). https://doi.org/10.1002/ctm2.1131
- Lillioja, S., Mott, D. M., Spraul, M., Ferraro, R., Foley, J. E., Ravussin, E., Knowler, W. C., Bennett, P. H., & Bogardus, C. (1993). Insulin resistance and insulin secretory dysfunction as precursors of non-insulin-dependent diabetes mellitus: Prospective studies of Pima Indians. *New England Journal of Medicine*, *329*(27), 1988–1992. https://doi.org/10.1056/nejm199312303292703
- Roenneberg, T., Allebrandt, K. V., Merrow, M., & Vetter, C. (2012). Social Jetlag and obesity. *Current Biology*, *22*(10), 939–943. https://doi.org/10.1016/j.cub.2012.03.038
- Singer, M. E., Dorrance, K. A., Oxenreiter, M. M., Yan, K. R., & Close, K. L. (2022). The type 2 diabetes 'modern preventable pandemic' and replicable lessons from the covid-19 crisis. *Preventive Medicine Reports*, *25*, 101636. https://doi.org/10.1016/j.pmedr.2021.101636