Chronotype and Type 2 Diabetes Risk in Preadolescents

Magdalena Dumin MD[1], Katie O'Sullivan MD[1], Eve Van Cauter, PhD[1,2], Dorit Koren, MD[1]

1 Section of Adult and Pediatric Endocrinology, Diabetes and Metabolism, University of Chicago, Chicago, IL

2 Sleep, Metabolism, and Health Center, University of Chicago, Chicago, IL

Background

- Chronotype: individual preference in timing of sleep and eating
- Late chronotype associations:

Adults:

- Higher body mass index (BMI), later mealtimes
- Higher risk incident T2DM, higher hemoglobin A1c (HbA1c)
- Greater risk of hypertension

Adolescents:

- Higher BMI, increased portion size, lower dietary restraint
- Low HDL cholesterol

- No known studies have focused on the link between sleep chronotype and insulin/glucose metabolism in children on the cusp of puberty or in early puberty stages.

Objective/Hypothesis

- Objective: To examine the associations between chronotype and risk factors for type 2 diabetes in normal-weight (NW) and obese (OB) children ages 10-13 years.
- Hypothesis: Late chronotype associates with increased insulin resistance and reduced glucose tolerance in preadolescents.

Design/Methods

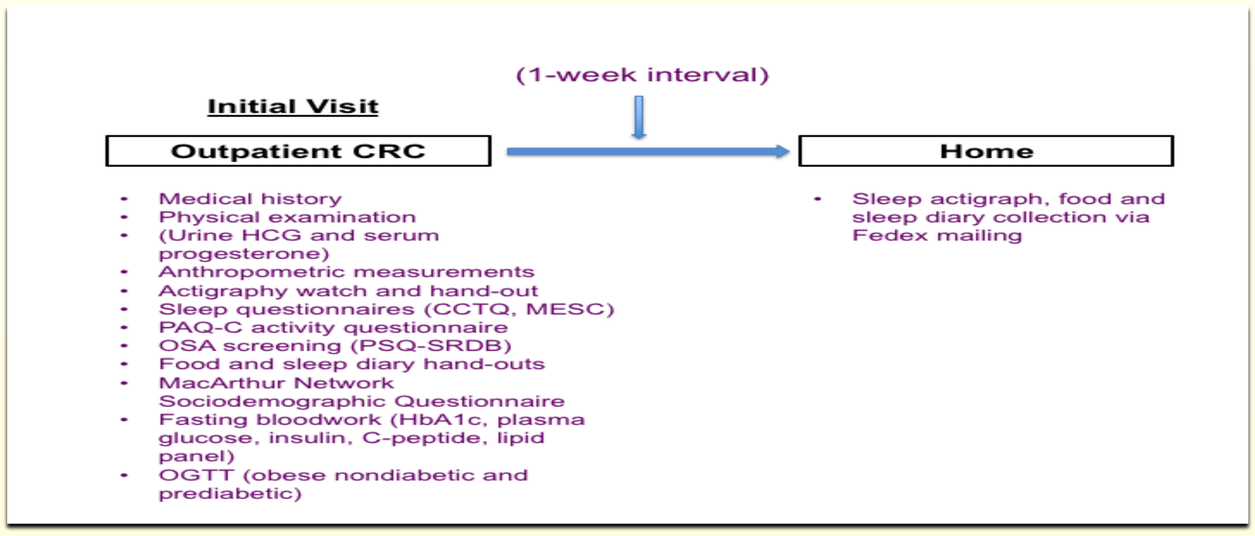
Table 1.

Inclusion Criteria	Exclusion Criteria

• Age 10-13 yo
• BMI > 95th %ile for age and sex (OB)
  • Normoglycemic: Fasting glc <100, 2-hr glc <140, HbA1c <5.7%
  • Prediabetic: Fasting glc 100-125, 2-hr glc 140-199, HbA1c 5.7-6.4%
• BMI 5-85th %ile for age and sex (NW)
  • Normoglycemic: Fasting glc <100, 2-hr glc <140, HbA1c <5.7%
	• Known type 1 or 2 diabetes
	• Known sleep disorders
	• Conditions affecting sleep or glycemia
	• Medications impacting sleep, insulin sensitivity, or weight
	• Pregnancy

- Mid-sleep time on free days (MSF), a measure of chronotype, was assessed via 1-week actigraphy and administration of Children's ChronoType Questionnaire (CCTQ) and Morningness-Eveningness Scale for Children (MESC).

Figure 1.



Results

Table 2: Demographic, anthropometric, and metabolic characteristics.

	NW (5)	OB (5)	P-value
Age (yrs)	11.52 ± 0.65	11.33 ± 0.4	0.92
Sex	20% female; 80% male	80% female, 20% male	0.058
Race	40% AA; 60% Caucasian	40% AA; 20%Caucasian; 40% unknown	0.22
Ethnicity	100% not Hispanic	40% Hispanic; 60% not Hispanic	0.11
Tanner Stage	80% prepubertal	20% prepubertal	0.91
Weight (kg)	**34.99 ± 3.08**	**68.93 ± 12.18**	0.003**
BMI (kg/m2)	**17.32 ± 1.3**	**29.88 ± 2.84**	<0.005**
BMI z-score	**-0.2 ± 0.7**	**2.2 ± 0.29**	<0.005**
Waist Circ (cm)	**59.49 ± 3.2**	**97.52 ± 9.28**	<0.005**
Systolic BP	**105.4 ± 7.67**	**115.8 ± 9.91**	0.10
Diastolic BP	**62.8 ± 7.67**	**56.0 ± 4.53**	0.13
FPG (mg/dL)	**89.2 ± 6.69**	**90.2 ± 7.79**	0.83
FPI (ul/mL)	**4.22 ± 2.6**	**20.89 ± 6.44**	0.002**
HbA1c (%)	**5.34 ± 0.21**	**5.46 ± 0.29**	0.47
HOMA-IR	**0.93 ± 0.61**	**4.7 ± 1.66**	0.004**

Values represent number (%), mean ± SD; *=p<0.05, **=p<0.01

Results Continued

Table 3: Baseline sleep and chronotype data.

	NW (5)	OB (5)	P-value
Time in Bed (TIB)	**8.34 ± 0.98**	**8.91 ± 1.04**	0.43
Total Sleep Time (TST)	**8.34 ± 0.98**	**8.91 ± 1.04**	0.43
Wake Time	**06:34 ± 0.32**	**07:14 ± 1.15**	0.25
Bed Time (HS)	**22:10 ± 0.83**	**22:26 ± 1.23**	0.71
Sleep Efficiency	**92.08 ± 2.78**	**86.61 ± 3.78**	0.04*
WASO	**19.23 ± 4.33**	**32.9 ± 12.84**	0.03*
MSF (actigraphy)	**02:37 ± 0.93**	**03:11 ± 0.89**	0.40
CCTQ MSF	**02:36 ± 0.55**	**03:24 ± 1.52**	0.30
CCTQ CT score	**80% morning, 20% evening**	**60% morning, 40% evening**	0.72
CCTQ M/E score	**25.2 ± 4.27**	**28.6 ± 8.68**	0.46
CCTQ chronotype	**40% morning, 60% neutral**	**40% morning , 20% neutral, 40% evening**	0.22
MESC score	**32.8 ± 6.3**	**34.8 ± 5.5**	0.61
MESC chronotype	**80% morning, 20% neutral**	**80% morning, 20% neutral**	1.0

Values represent number (%), mean ± SD; *=p<0.05, **=p<0.01

Table 4: Sleep characteristics and metabolic outcome correlations.

	Weight (kg)	BMI (kg/m2)	HbA1c	HOMA-IR
MSF (act)	**0.357 (0.35)**	**0.206 (0.60)**	**0.500 (0.17)**	**0.155 (0.72)**
CCTQ MSF	**0.624 (0.054)**	**0.401 (0.25)**	**0.629 (0.052)**	**0.585 (0.098)**
CCTQ CT score	**0.168 (0.64)**	**0.146 (0.69)**	**0.637 (0.047)***	**0.231 (0.55)**
CCTQ M/E score	**0.587 (0.07)**	**0.389 (0.27)**	**0.746 (0.01)***	**0.613 (0.08)**
MESC score	**0.107 (0.77)**	**0.234 (0.52)**	**-0.752 (0.01)***	**0.144 (0.71)**
HS (all)	**0.285 (0.46)**	**0.023 (0.95)**	**0.790 (0.01)***	**0.085 (0.84)**
HS weekdays (WD)	**0.187 (0.66)**	**-0.096 (0.82)**	**0.900 (0.002)****	**0.043 (0.93)**
HS weekends (WE)	**0.048 (0.90)**	**-0.108 (0.78)**	**0.662 (0.052)**	**-0.243 (0.56)**
TIB (all)	**0.112 (0.77)**	**0.281 (0.46)**	**-0.839 (0.005)****	**0.256 (0.54)**
TIB (WD)	**0.016 (0.97)**	**0.270 (0.52)**	**-0.795 (0.02)***	**0.179 (0.70)**
TIB (WE)	**-0.085 (0.83)**	**-0.012 (0.98)**	**-0.842 (0.004)****	**0.080 (0.85)**
TST	**-0.356 (0.37)**	**-0.205 (0.60)**	**-0.567 (0.11)**	**-0.185 (0.66)**
Sleep efficiency	**-0.444 (0.23)**	**-0.520 (0.15)**	**0.156 (0.69)**	**-0.345 (0.40)**
WASO	**0.387 (0.30)**	**0.666 (0.05)**	**-0.350 (0.36)**	**0.376 (0.36)**

*=p<0.05, **=p<0.01

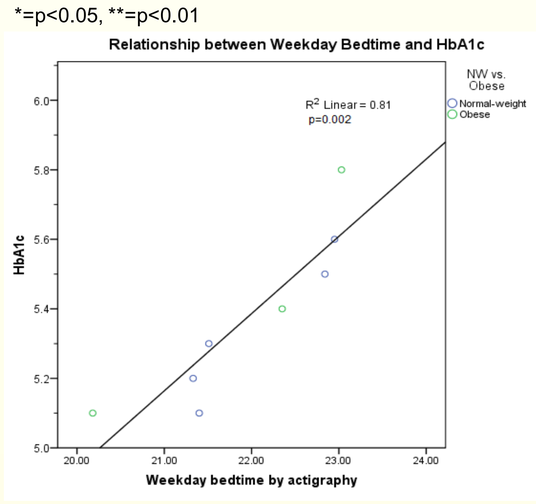


Figure 2: Later overall (r=0.624, p=0.011) and weekday (r=0.81, p=0.002) bedtimes positively associated with HbA1c.

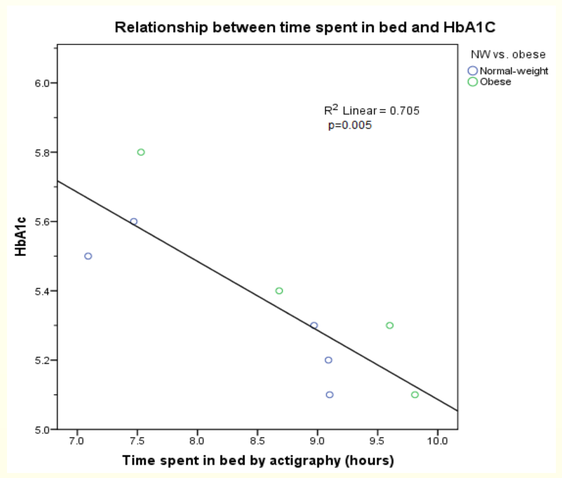


Figure 3: Overall time in bed negatively associated with HbA1C (r=0.705, p=0.005).

Discussion

- Sleep parameters similar between NW and OB.
- No significant associations between MSF by actigraphy and anthropometric or metabolic outcomes.
- HbA1c positively associated with:
  - higher CCTQ chronotype score
  - lower MESC score
  - overall time in bed
  - later bedtimes overall and on weekdays
- Later weekday bedtime predicted a higher HbA1c independently of time spent in bed.

- **Preliminary fndings suggest:**
  - **late chronotype in preadolescents may have a deleterious glycemic impact independent of bedtime duration**
  - **advancing bedtimes may reduce glucose levels and lower risk of type 2 diabetes in preadolescents**
- Limitations of this study include:
  - small sample size
  - potential poor compliance with actigraphy and sleep diaries
  - potential actigraphy malfunction
  - wide variation in sleep patterns in preadolescents.

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Magdalena Dumin

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