



Night-to-Night Variability in the Bedtime Routine Impacts Sleep in Toddlers

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INTRODUCTION

- The National Sleep Foundation recommends that toddler children get 11 to 14 hours of sleep at night (Hirshkowitz et al., 2015).
- Children who sleep less than recommended amounts display deficits in school performance, cognitive, and behavioral functioning (Dewald et al., 2010; Geiger et al., 2010; Paavonen et al., 2009).
- Consistent bedtime routines can improve children's sleep (Mindell et al., 2009), while irregular bedtime routines can have a negative impact on children's sleep (Sadeh et al., 2009; Staples et al., 2015).
- Sleep and bedtime routines are typically measured via parent report in daily logs (sleep diaries), and averaged across several days.
- No studies have examined whether sleep or bedtime routines in toddlers vary from night-to-night, thus making conclusions about relationships between sleep and bedtime routines based on averages tenuous.
- Therefore, the purpose of this study is to examine the night-to-night variability of bedtime routines and how it relates to the night-to-night variability of sleep in toddlers.

METHODS

Participants:

185 typically developing toddlers (86 female) aged 30 months and their primary caregivers (mostly mothers)

Measures:

- Toddler sleep:** Toddlers wore an actigraph for 2 weeks to record their nightly: true sleep, sleep efficiency, sleep latency, wake minutes, wake episodes. Parents reported sleep their children's sleep each night in a sleep diary.
- Demographics:** Parents reported on toddlers' gender and ethnicity via a demographic questionnaire.
- Bedtime Routines:** Parents reported on the bedtime routine each night for two weeks in a nightly sleep diary, including what time the routine started, what activities were included in the routine (e.g. bath, brush teeth, reading, etc.), and what time the child was in bed.

Statistical Analysis:

- Two measures of variability in the bedtime routine were calculated:
 - Routine Length Deviation-** the amount by which the bedtime routine for an individual night deviated from the average length of the bedtime routine across the 14 nights.
 - Routine Activity Deviation-** the amount by which the activities completed in a bedtime routine for an individual night deviated from the "normal" bedtime routine, with the normal routine including the activities that were completed on at least 10 of the 14 nights. Higher scores indicate more deviation from the normal routine.
- All variables were plotted and examined for indicators of variability in sleep and the bedtime routine.
- Plots indicated that children varied in how variable their nightly sleep and bedtime routines were (Figure 1 & 2). In addition, Figure 3 indicated that weekend bedtime routines varied more in relation to the weeknight bedtime routines. Thus, it was determined to run multilevel models separately for weeknights (Sun-Thur) and weekend nights (Fri-Sat).
- Gender and ethnicity were included as covariates in the multilevel models.

RESULTS

Figure 1- Trellis Plot of Nightly Sleep Minutes

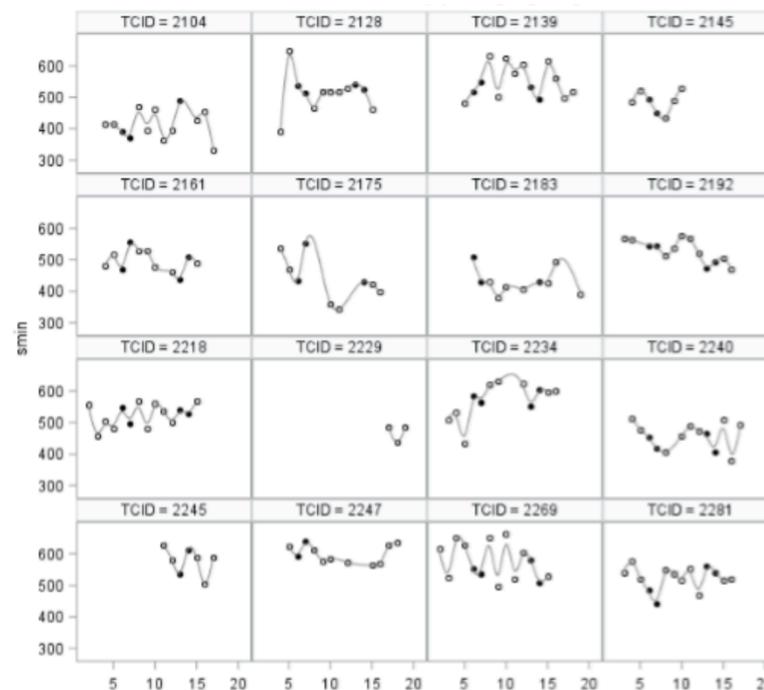


Figure 2- Trellis Plot of Nightly Routine Length

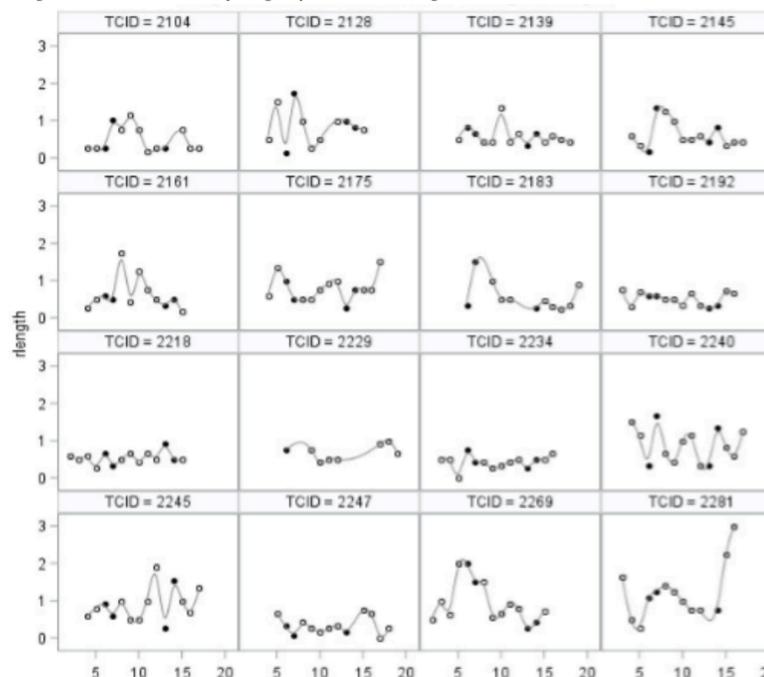
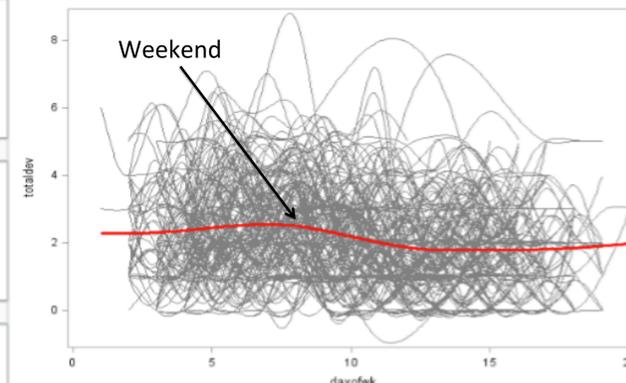


Figure 3- Spaghetti Plot of Nightly Routine Activity Deviation



Results from Multilevel Models

- Results of the multilevel models differed between weeknight and weekends:
- Routine length deviation predicted wake minutes and sleep latency on the weekends, but not on the weeknights.
 - Additionally, routine length deviation interacted with ethnicity to predict wake minutes on the weekends.
- Routine activity deviation predicted sleep minutes and sleep efficiency on weeknights, but not weekends.
 - Routine activity deviation also interacted with ethnicity to predict sleep minutes, sleep efficiency, and wake minutes on weeknights.
- Routine activity deviation predicted wake episodes on the weekends, but not weeknights, and interacted with ethnicity to predict wake episodes on the weekends.

IMPLICATIONS FOR POLICY AND PRACTICE

- Adequate sleep is related to daytime functioning in children, and improving the quality and quantity of children's sleep may improve their behaviors at home and school.
- Instituting a consistent bedtime routine would be seem to be a relatively easy way to improve children's sleep.

Table 1
Results from Multilevel Models

	Weeknight B (SE)	Weekend B (SE)
Level 1:		
γ_{00} wake minutes	73.19 (10.22)***	70.97 (5.61)***
γ_{10} routine length deviation	-2.92 (14.17)	19.95 (6.98)**
Level 2:		
γ_{01} gender	5.94 (7.82)	-0.64 (8.14)
γ_{02} ethnicity	0.03 (10.64)	4.37 (.62)***
γ_{11} routine length deviation*gender	-1.43 (10.27)	0.04 (2.83)
γ_{12} routine length deviation*ethnicity	-4.73 (14.88)	-6.05 (.30)***
Level 1:		
γ_{00} sleep latency	36.77 (4.31)***	21.57 (5.25)***
γ_{10} routine length deviation	-8.19	23.30*
Level 2:		
γ_{01} gender	1.88 (3.26)	3.49 (3.94)
γ_{02} ethnicity	-0.64 (4.49)	8.45 (5.48)
γ_{11} routine length deviation*gender	-0.65 (5.68)	-10.81 (8.20)
γ_{12} routine length deviation*ethnicity	2.45 (8.27)	-12.93 (12.23)
Level 1:		
γ_{00} sleep minutes	516.58 (14.25)***	504.43 (18.20)***
γ_{10} routine activity deviation	-8.81 (3.50)*	1.91 (5.76)
Level 2:		
γ_{01} gender	-11.28 (11.25)	-5.35 (14.39)
γ_{02} ethnicity	-5.54 (14.73)	-3.25 (18.86)
γ_{11} routine activity deviation*gender	1.96 (2.91)	0.30 (4.58)
γ_{12} routine activity deviation*ethnicity	8.46 (3.65)*	-2.52 (6.09)
Level 1:		
γ_{00} sleep efficiency	89.35 (1.97)***	84.33 (2.45)***
γ_{10} routine activity deviation	-1.04 (.45)*	1.1 (.82)
Level 2:		
γ_{01} gender	-0.73 (1.55)	-0.54 (1.99)
γ_{02} ethnicity	-1.74 (2.04)	1.88 (2.54)
γ_{11} routine activity deviation*gender	-0.16 (.38)	0.33 (.63)
γ_{12} routine activity deviation*ethnicity	1.19 (.47)*	-1.11 (.85)
Level 1:		
γ_{00} wake minutes	61.10 (11.5)***	88.90 (14.83)***
γ_{10} routine activity deviation	5.03 (2.64)	-4.29 (5.20)
Level 2:		
γ_{01} gender	2.82 (9.03)	-0.67 (11.64)
γ_{02} ethnicity	11.85 (11.87)	-7.28 (15.39)
γ_{11} routine activity deviation*gender	0.97 (2.19)	-0.80 (3.63)
γ_{12} routine activity deviation*ethnicity	-6.18 (2.75)*	3.98 (5.50)
Level 1:		
γ_{00} wake episodes	5.70 (1.24)***	7.46 (1.24)***
γ_{10} routine activity deviation	0.07 (.15)	-0.64 (.29)*
Level 2:		
γ_{01} gender	-0.17 (.97)	-0.09 (.99)
γ_{02} ethnicity	0.02 (1.29)	-1.52 (1.29)
γ_{11} routine activity deviation*gender	0.07 (.13)	-0.16 (.25)
γ_{12} routine activity deviation*ethnicity	-0.1 (.16)	0.72 (.32)*

*p < .05, **p < .01, ***p < .001

NEXT STEPS

- Identify the children for whom the bedtime routine matters most for optimal sleep outcomes
 - Some children may be "good" sleepers, regardless of bedtime routine
 - Other children may be temperamentally "difficult", and require consistent bedtime routines for optimal sleep
- Design an intervention to study whether implementing consistent bedtime routines for toddlers improves their daytime functioning at home or in the classroom