Title: Characterizing NREM-REM Sleep Cycles in Children with Down Syndrome

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Introduction: Polysomnographic (PSG) technology has become the gold standard for measuring sleep and defining sleep architecture. However, PSG sleep studies often examine mean sleep parameters across the whole night of sleep. However, sleep is a dynamic process characterized by cyclic changes involving the alternation between two distinct states differing in behavioral and cortical activity. Therefore, it is also important to measure sleep with respect to individual sleep cycles and separate sleep states (i.e. REM and NREM sleep), particularly since each state may play its own unique role in learning and memory. Sleep disturbances are highly prevalent in populations with neurodevelopmental disabilities, contributing to neurological, medical and psychiatric comorbidities, along with learning and behavioral problems (Angriman et al., 2015). PSG measurements of sleep in children with Down syndrome (DS) show more fractured sleep, longer time spent in bed, lower sleep efficiency, less time in REM, and more movement compared to typically-developing children (Esbensen & Schwichtenberg, 2016). However, individual NREM-REM sleep cycles observed in a night of sleep have yet to be characterized in DS. Understanding the cyclic trends across the night, including sleep cycle architecture and transitions between sleep stages, may give further insight into how and where sleep deficits originate. Differences in secondary sleep architecture may also serve as predictors of cognitive ability or cognitive decline. For example, shortened average NREM-REM sleep cycle duration may be associated with increased risk of cognitive decline in normal elderly individuals (Suh et al., 2019). This poster will present PSG results used to examine trends in sleep architecture related to NREM-REM sleep cycles observed in children with DS.

Method: Ambulatory PSG recordings of a community-based sample of 43 children and young adults (7-22 years) with DS were used to further characterize sleep in this population (data from children was originally reported in Breslin et al., 2014). NREM-REM sleep cycles were defined based on criteria presented in Lopp et al. (2017) and Feinberg & Floyd (1979). A NREM-REM sleep cycle consisted of one NREM sleep episode >10 min followed by one REM sleep episode. A cycle began with the onset of NREM sleep (the first cycle measured from the first epoch of N2 sleep) and ended with the last epoch of the REM sleep episode. Periods of wake < 10 consecutive minutes were included in the duration of sleep episodes and NREM-REM sleep cycles. Participants were divided into four separate age groups to analyze changes in sleep architecture across development. Data from children with DS were compared to sleep cycle data presented in previous studies of typical children and adults (Lopp et al., 2017; Feinberg & Floyd, 1979).

Results: Younger adolescents with DS demonstrate similar NREM-REM sleep cycle trends observed in young typically developing children, while older adolescents and young adults with DS begin to show sleep cycle trends characteristic of typical adults. Averaged durations across all participants with at least 4 sleep cycles revealed a significantly longer first sleep cycle compared to cycles later in the night (p < 0.001). Sleep cycles 2 and 3 for children with DS showed no difference in duration, but there was a significant decrease in duration observed for cycle 4 (p = 0.005). Individual NREM sleep episode durations across the night followed an identical trend. However, the lengthy first NREM episode appears to be more pronounced in individuals with DS compared to what has been observed in typically developing children. This delayed transition into REM sleep results in increased REM sleep latency and a short first REM sleep episode. The duration of the first REM episode was significantly shorter than subsequent REM episodes (p < 0.001), while REM episodes 2-4 showed no significant difference in duration between themselves. NREM-REM cycle trends examined across specific age groups demonstrated similar findings for children aged 7-8 years, 9-11 years, and 12-14 years. Adolescents and young adults aged 15-22 years demonstrated no significant difference between the durations of sleep cycles 1 and 2, and instead showed a significant decrease in duration at sleep cycles 3 and 4.

Discussion: The overall goal of this project is to characterize NREM-REM sleep cycles across a night of sleep in adolescents and young adults with DS. While sleep cycle trends appear mostly consistent with typical individuals, exact durations of sleep cycles and separate NREM and REM sleep episodes may differ. Specifically, children with DS appear to have a long first NREM sleep episode. Measuring sleep parameters related to sleep cycles and sleep stage transitions provide a more detailed look at sleep deficits as well as new potential predictors of cognitive abilities and cognitive decline.
References:


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