

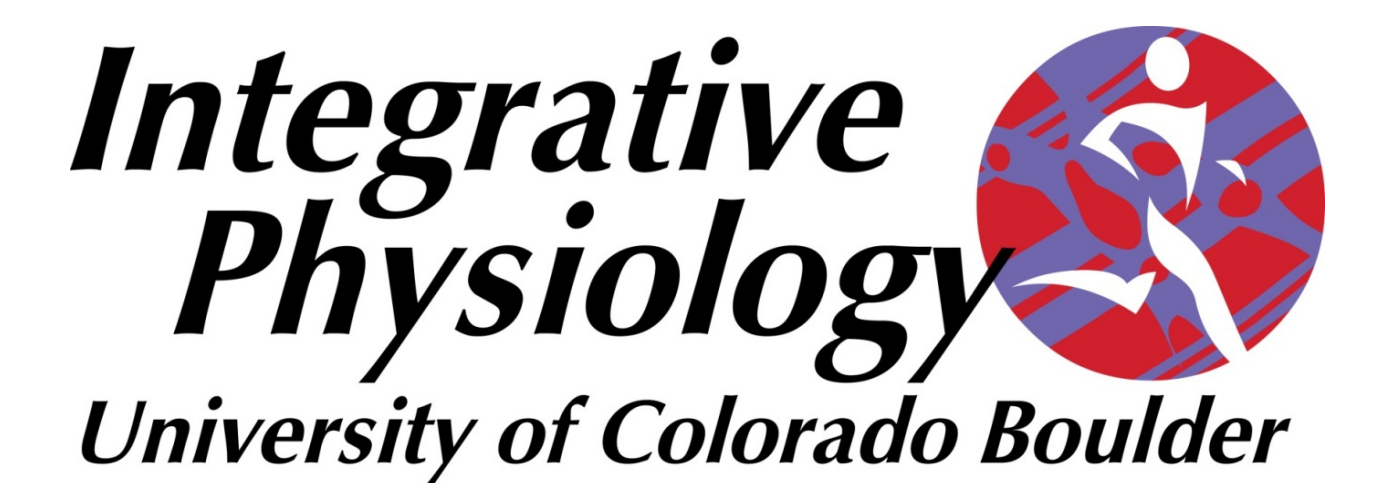
CORRESPONDENCE BETWEEN ACTIGRAPHY AND PSG MEASURES OF SLEEP ONSET LATENCY IN YOUNG CHILDREN

Hannah J. Craven¹, Ronald Seifer^{2,3}, Monique K. LeBourgeois^{1,2}

¹Sleep and Development Laboratory, Department of Integrative Physiology, University of Colorado, Boulder, CO, USA

²Department of Psychiatry and Human Behavior, The Warren Alpert Medical School of Brown University, Providence, RI, USA

³Bradley/Hasbro Children's Research Center, East Providence, RI, USA



INTRODUCTION

Actigraphy is a non-invasive, objective measure of sleep useful for long periods of data collection in field settings [1,2]. Currently, sleep onset latency (SOL) is not an established measure with adequate validity for research purposes in young children [3].

This study evaluated the validity of actigraphy as a measure of SOL in young children by making comparisons with polysomnography (PSG), the gold standard.

METHODS

Eight healthy children (3 males) were studied at three longitudinal time points (2.5-3.0 years, 3.5-4.0 years, 5.5-6.0 years).

Children wore Actiwatch 64 wrist actigraphs (1 min epochs; medium sensitivity) while following a strict sleep schedule (≥ 12.5 h time in bed) for at least 5 days prior to each of five randomly-ordered, home-based, PSG recordings (Figure 1).

Sleep assessments occurred after 4h, 7h, 10h, 13h, and 16h of prior wakefulness. Visual sleep stage scoring used 30-sec epochs from C3/A2. Lights-out was marked concurrently on PSG and actigraphy recordings with event markers. Sleep-onset was scored as the first epoch of stage 2 sleep for PSG and the first of three consecutive epochs of scored sleep after lights out for actigraphy [4]. Concordance was assessed with Bland-Altman plots [5].

Figure 1. Actogram of a subject showing the timing of the 5 different PSG recordings (4h, 7h, 10h, 13h, 16h prior wakefulness). Note: \blacktriangledown = event marker (lights-out); **PSG**=corresponding PSG data; **blue** = scored sleep; **indigo** = SOL.

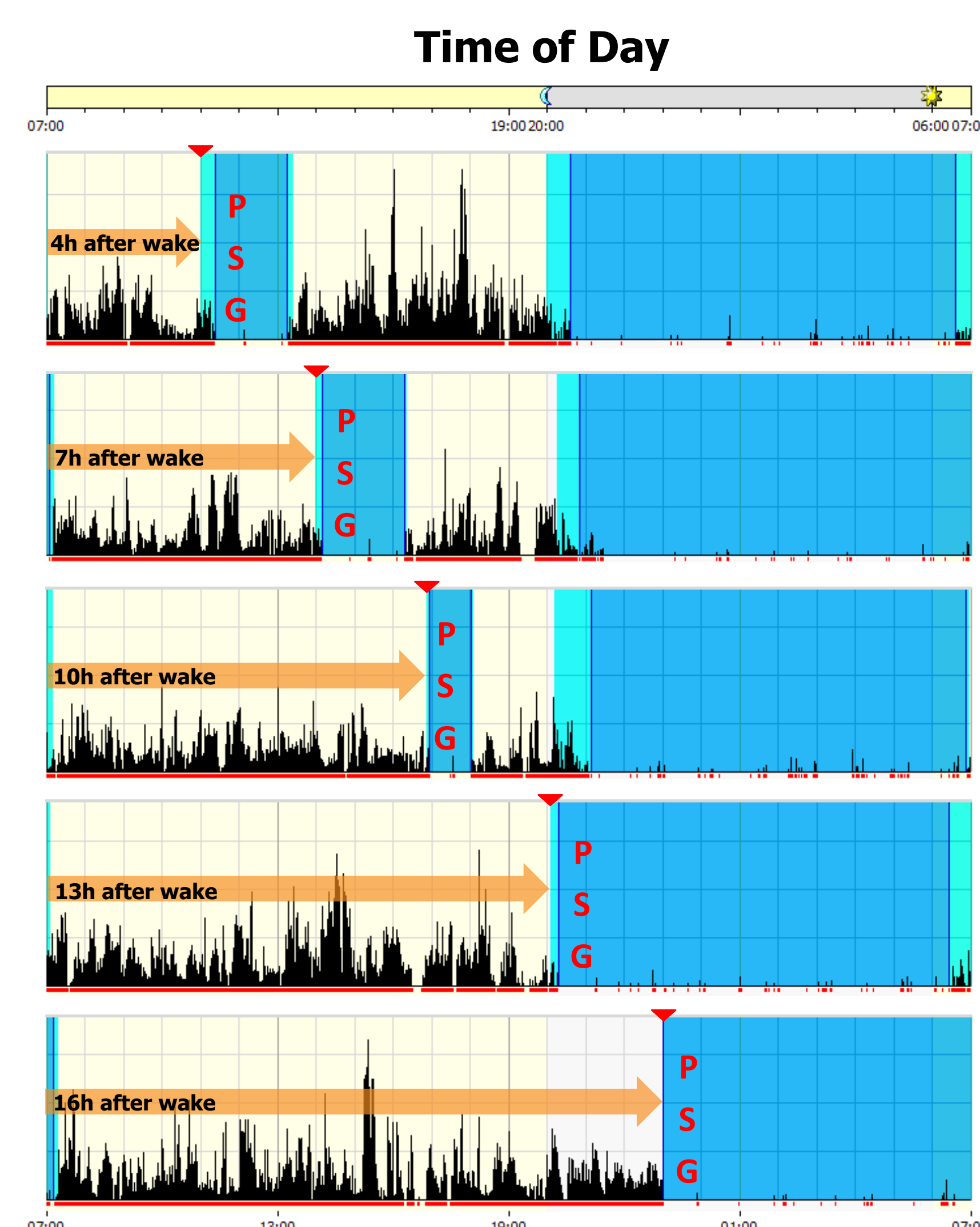


Figure 2. Bland-Altman plots: Systematic bias towards actigraphic underestimation of sleep onset latency decreases with increasing sleep pressure.

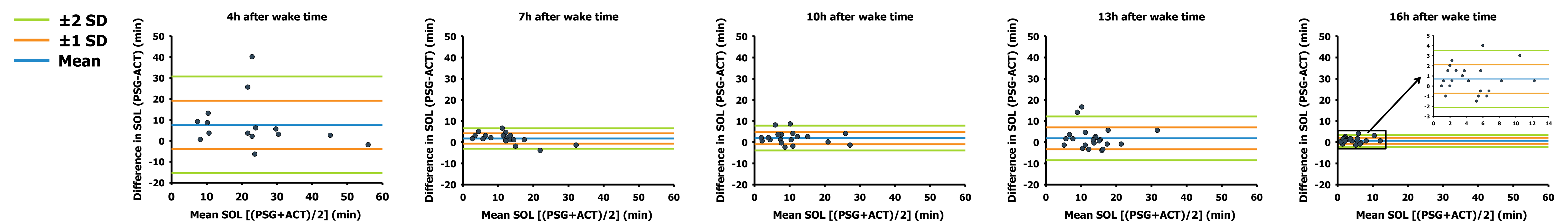
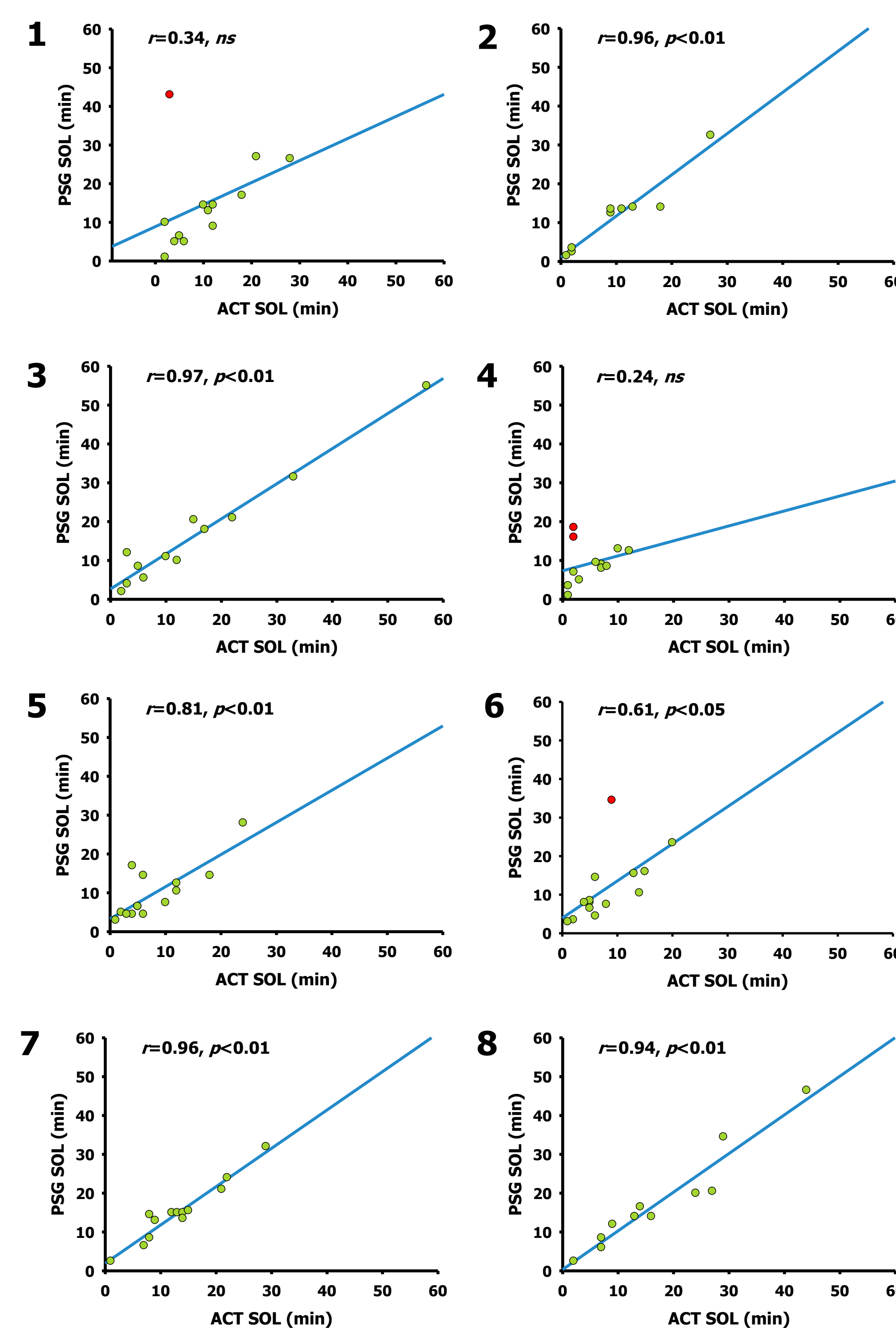


Figure 3. Scatterplots of associations between PSG and ACT measures SOL for 8 individual subjects. Note: Individual points on scatterplots in red indicate instances when ACT underestimated SOL as compared to PSG.



RESULTS

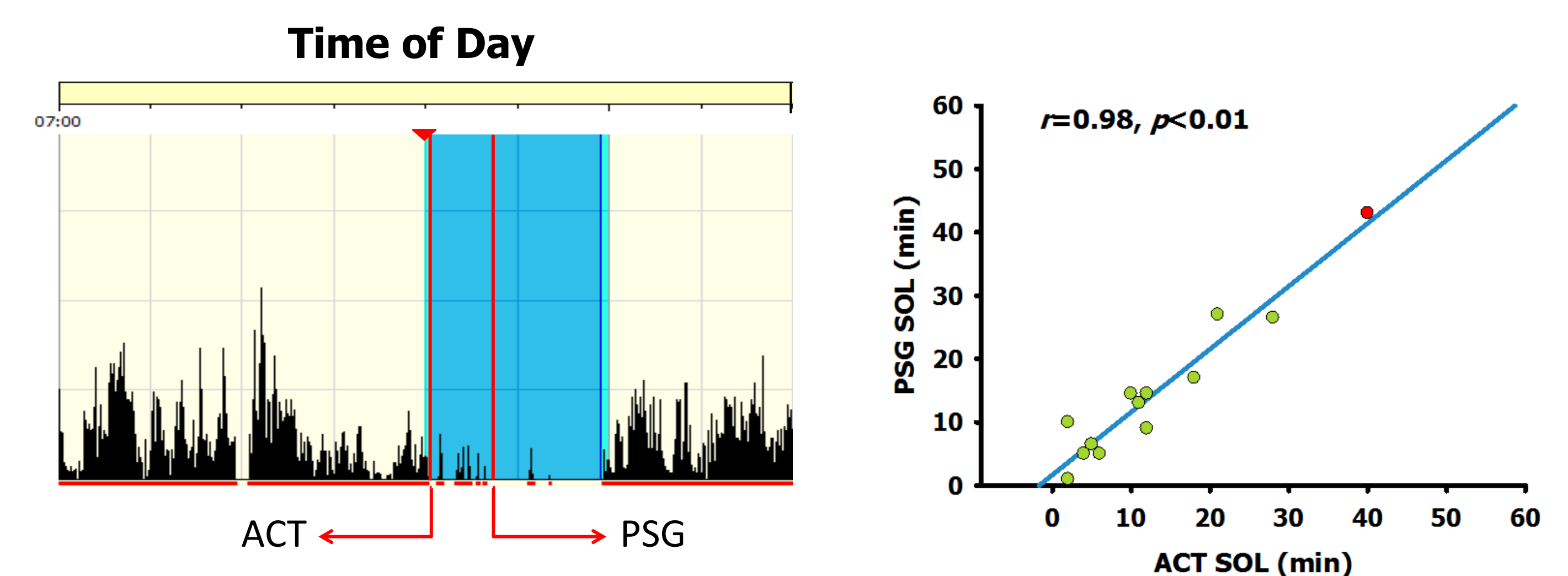
There were 9-14 sleep periods per participant for which both ACT and PSG were available (daytime nap and nighttime sleep). Agreement between the two measures can be seen using the Bland-Altman concordance technique [5] (Figure 2).

We performed correlations between PSG and actigraphy measures of SOL, covarying prior wakefulness and age at assessment (nested within subject). The median partial correlation was $r=0.88$ ($p<0.01$), with a range of $r=0.24$ to $r=0.97$ (Figure 3).

DISCUSSION

These results indicate adequate validity of ACT for SOL when scored with strict methods [4]. Of the 8 subjects, 5 showed high concordance between ACT and PSG. Correlations were very low in 2 subjects. When 3-5 epochs of scored sleep after lights-out is followed by a longer interval (≥ 15 min) of scored wakefulness, SOL is underestimated by ACT (Figure 4). We propose further analyses (a) evaluating alternate scoring methods for estimating sleep onset in young children for sleep periods occurring at different levels of sleep pressure and (b) determining how many nights of ACT are needed for reliable measurement of SOL.

Figure 4. Subject 1 actogram (left panel): Example of when the ACT-estimated SOL failed to agree with PSG (ACT SOL=3 min, PSG SOL=43 min). Subject 1 scatterplot (right panel): Example of association with one possible alternate scoring rule (ACT SOL=40 min, PSG SOL=43 min). Note: \blacktriangledown = event marker (lights-out).



References: [1] Meltzer, L.J., C.M. Walsh, J. Traylor, and A.M.L. Westin, Direct Comparison of Two New Actigraphs and Polysomnography in Children and Adolescents. *SLEEP*, 2012. 35(1): p.159-166. [2] Weiss, A.R., N.L. Johnson, N.A. Berger, and S. Redline, Validity of Activity-Based Devices to Estimate Sleep. *JCSM*, 2010. 6(4): p. 336-342. [3] Insana, S.P., D. Gozal, and H.E. Montgomery-Downs, Invalidation of one actigraphy brand for identifying sleep and wake among infants. *Sleep Medicine*, 2010. 11: p. 190-196. [4] Sadeh, A., J. Alster, D. Urbach, and P. Lavie, Actigraphically based automatic bedtime sleep-wake scoring: Validity and clinical applications. *Journal of Ambulatory Monitoring*, 1989. 2(3): p. 209-216. [5] Altman, D.G., and J.M. Bland, Measurement in Medicine: The Analysis of Method Comparison Studies. *The Statistician*, 1983. 32: p. 307-317.

Acknowledgements: Funding from NIH K01-MH074643, R01-MH086566, & Sepracor, Inc. (LeBourgeois) and NIH IM5D 1544512.