



Full length article

## Infant sleep-wake behaviors at two weeks, three and six months



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### ABSTRACT

Although infant sleep-wake behavior presents several developmental changes during the first six months, literature lacks on reference values and few studies have explored the role of individual change and stability on infant sleep-wake behavior during the first six months. This study aimed (1) to describe infant sleep-wake behaviors during the 24-h period, day and night, at two weeks, three, and six months, (2) and to explore developmental changes and the role of individual change and stability on infant sleep-wake behaviors from two weeks to six months. Ninety-four primiparous mothers completed measures on infant sleep-wake behaviors at two weeks, three and six months. Significant developmental changes were found on infant sleep-wake behaviors from two weeks to six months. Two-week-old infants sleep 13.3 h, spend 8.7 h awake, awake 6.1 times, have 0.4 h of latency to sleep, and 3.2 h of longest sleep period. Three-month-old infants sleep 13.0 h, spend 9.2 h awake, awake 5.5 times, have 0.4 h of latency to sleep, and 5.2 h of longest sleep period. Six-month-old infants sleep 12.2 h, spend 10.0 h awake, awake 5.2 times, have 0.4 h of latency to sleep, and 5.6 h of longest sleep period. Significant individual change and stability were also found on infant sleep-wake behaviors from two weeks to six months. Despite significant developmental and individual changes, individual stability explains a significant amount of the variance on infant sleep-wake behaviors over the first six months of life.

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## 1. Introduction

The development of sleep-wake behavior is a major maturational process during the first year of life, associated with infant neurobehavioral organization, temperament and cognitive functioning (e.g., Henderson, France, Owens, & Blampied, 2010), and informing about infant health and well-being (e.g., Montgomery-Downs & Gozal, 2006; Scher, Zukerman, & Epstein, 2005; Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008). Sleep developmental problems affect between 15–35% of infants<sup>1</sup> and are major concerns to clinicians and parents (Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Mindell, Meltzer, Carskadon, & Chervin, 2009; Mindell, Sadeh, Wiegand, How, & Goh, 2010). However, only few studies provided reference values and little is known about individual change and stability on infant sleep-wake behaviors during the first six months of life (e.g., Freudigman & Thoman, 1993; Magee, Gordon, & Caputi, 2014; Scher, Epstein, & Tirosh, 2004).

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<sup>1</sup> Due to several cross-cultural differences in infant sleep-awake behaviors (Mindell et al., 2010), only data from occidental countries are presented.

One-month-old infants have averaged between 12.1 and 14.6 h of sleep time during the 24-h period (e.g., [Montgomery-Downs & Gozal, 2006](#); [Quillin, 1997](#); [Tikotzky & Sadeh, 2009](#)), ranging between 9 and 19 h ([Iglowstein, Jenni, Molinari, & Largo, 2003](#)). They have averaged 3.3 h of sleep during the day ([Montgomery-Downs & Gozal, 2006](#)), with a range of between 0.5 and 9 h ([Iglowstein et al., 2003](#); [Montgomery-Downs & Gozal, 2006](#)). They have averaged 5.7 h of sleep during the night ([Montgomery-Downs & Gozal, 2006](#)), ranging between 5 and 14 h (e.g., [Iglowstein et al., 2003](#); [Montgomery-Downs & Gozal, 2006](#)). One-month-old infants spend an average of 2.4 h awake during the night ([Tikotzky & Sadeh, 2009](#)). At 0–2 months, the average awake time during the night was 1.2 h ([Sadeh, Mindell, Luedtke, & Wiegand, 2009](#); [Teng, Bartle, Sadeh, & Mindell, 2012](#)). One-month-old infants have averaged 5.3 awakenings during the 24-h period ([Montgomery-Downs & Gozal, 2006](#)), between 3.1 and 3.3 awakenings during the day (e.g., [Matthey, 2001](#); [Montgomery-Downs & Gozal, 2006](#)), and between 2 and 4 during the night (e.g., [Burnham, Goodlin-Jones, Gaylor, & Ander, 2002](#); [Goodlin-Jones, Burnham, Gaylor, & Anders, 2001](#); [Montgomery-Downs & Gozal, 2006](#)). At 0–2 months, they wake 5.5 times during the 24-h period, 3.6 times during the day and 1.9 times during the night ([Mindell et al., 2010](#); [Sadeh et al., 2009](#)). Moreover, they have averaged 32 min of latency to sleep during the day ([Matthey, 2001](#)), and between 23 and 40.3 min during the night ([Matthey, 2001](#); [Tikotzky & Sadeh, 2009](#)). Infants were found to have a longest sleep period during the night of between 3 and 4.1 h at one month ([Anders & Keener, 1985](#); [Burnham et al., 2002](#); [Goodlin-Jones, Eiben, & Anders, 1997](#)), with an average of 3.6 h reported in a recent review ([Henderson, France, & Blampied, 2011](#)).

Different averages of sleep time during the 24-h period have been reported for three-month-old infants – from 12.8 to 13.6 h ([Bruni et al., 2014](#); [Galland, Taylor, Elder, & Herbison, 2012](#); [Harrison, 2004](#)), ranging from 10 to 19 h ([Iglowstein et al., 2003](#)). Three-month-old infants were found to sleep between 3.3 and 3.5 h during the day ([Bruni et al., 2014](#); [Tikotzky et al., 2015](#)), ranging from 1 to 8 h ([Iglowstein et al., 2003](#)). During the night, they averaged between 9.4 and 9.5 h ([Bruni et al., 2014](#); [Tikotzky et al., 2015](#)), ranging from 7 to 13 h ([Iglowstein et al., 2003](#)). At 3–5 months infants were found to be awoken, in average, 0.5 h during the night ([Mindell et al., 2010](#); [Sadeh et al., 2009](#); [Teng et al., 2012](#)). At three months, infants have averaged 3.4 awakenings/sleep periods during the day ([Bruni et al., 2014](#)), and between 2.5 and 2.9 times during the night (e.g., [Burnham et al., 2002](#); [Goodlin-Jones et al., 2001](#); [Tikotzky et al., 2015](#)). At 3–5 months, infants sleep between 4.2–4.4 periods during the 24-h period, between 2.9 and 3.1 during the day and between 1.2 and 1.3 during the night ([Mindell et al., 2010](#); [Sadeh et al., 2009](#); [Teng et al., 2012](#)). Three-month-old infants were found to have a longest sleep period during the night of between 4.7 and 6 h ([Anders, Halpern, & Hua, 1992](#); [Burnham et al., 2002](#); [Goodlin-Jones et al., 2001](#)). A recent review stated that the average longest sleep period during the night is 5.5 h at three months ([Henderson et al., 2011](#)).

Six-month-old infants sleep an average of between 12.6 and 14.2 h during the 24-h period, with their total sleep ranging between 6.5 and 18 h (e.g., [Blair et al., 2012](#); [Iglowstein et al., 2003](#); [Montgomery-Downs & Gozal, 2006](#)). They averaged between 2.3 and 3.1 h during the day ([Bruni et al., 2014](#); [Tikotzky et al., 2010, 2015](#)), ranging between 0.2 and 6.5 h ([Iglowstein et al., 2003](#); [Montgomery-Downs & Gozal, 2006](#)). During the night, six-month-old infants sleep an average of 9.5–11 h ([Bruni et al., 2014](#); [Iglowstein et al., 2003](#); [Tikotzky et al., 2010](#)), ranging from 5 to 15.5 h ([Iglowstein et al., 2003](#); [Montgomery-Downs & Gozal, 2006](#)). Six-month-old infants have averaged 0.7 h awake during the night ([Tikotzky & Sadeh, 2009](#)) and 0.4 h at 6–8 months ([Sadeh et al., 2009](#); [Teng et al., 2012](#)). Literature have been reported an average of 3.6 awakenings during the 24-h period at 6 months ([Montgomery-Downs & Gozal, 2006](#)), between 2.6 and 2.8 awakenings during the day (e.g., [Bruni et al., 2014](#); [Matthey, 2001](#); [Montgomery-Downs & Gozal, 2006](#)), and between 1 and 3.5 awakenings during the night (e.g., [Burnham et al., 2002](#); [Goodlin-Jones et al., 2001](#); [Montgomery-Downs & Gozal, 2006](#); [Tikotzky et al., 2015](#)). At 6–8 months, infants were found to have 3.7–3.9 sleep periods during the 24-h period, 2.5–2.6 during the day, and 1.3 during the night ([Mindell et al., 2010](#); [Sadeh et al., 2009](#); [Teng et al., 2012](#)). They have averaged 11 min of latency to sleep during the day ([Matthey, 2001](#)), and between 12 and 21.5 min during the night ([Matthey, 2001](#); [Tikotzky & Sadeh, 2009](#)). Moreover, at six months, infants have a longest sleep period during the night of between 4.8 and 7.1 h ([Anders & Keener, 1985](#); [Burnham et al., 2002](#); [Goodlin-Jones et al., 2001](#)). In their review, [Henderson et al. \(2011\)](#) also stated that the average longest sleep period during the night is 5.8 h at six months.

The association between infant sleep-awake behaviors during the day and the night has been poorly explored. Previous studies on infant sleep-awake behaviors during the day and the night have focused on differences. No differences were found on infant sleep-awake behaviors during the day before two months, namely on sleep hours and time out of the crib ([Ingersoll & Thoman, 1999](#)), while at three months sleep hours during the night are almost the double of sleep hours during the day ([Parmalee, Wenner, & Schulz, 1964](#)).

To discriminate between day and night and to concentrate sleep hours during the night and awake hours during the day are major developmental processes during the first year of infant's life ([Sadeh, 2000](#)). A significant decrease on the number of sleep hours during the 24-h period has been reported during the first six months (e.g., [Sadeh et al., 2009](#); [Teng et al., 2012](#); [Tikotzky & Sadeh, 2009](#)). Infants start to concentrate their sleep during the night, presenting a decrease on the number of sleep hours during the day ([Sadeh et al., 2009](#); [Teng et al., 2012](#); [Tikotzky et al., 2015](#)), accompanied by an increase on the number of sleep hours during the night (e.g., [Parmalee et al., 1964](#); [Sadeh et al., 2009](#); [Teng et al., 2012](#); [Matthey, 2001](#)).

Infants become able to get and return to sleep without help, presenting a significant decrease on the latency to sleep during the day and the night during the first six months ([Matthey, 2001](#); [Tikotzky & Sadeh, 2009](#)). During this period infants also become able to sleep through the night, presenting a significant increase on the longest sleep period ([Burnham et al., 2002](#); [Goodlin-Jones et al., 1997](#); [Teng et al., 2012](#)), accompanied by a decrease on the awakenings during the night (e.g., [Sadeh et al., 2009](#); [Teng et al., 2012](#); [Tikotzky & Sadeh, 2009](#)) and a decrease on the number of awake hours during the night (e.g., [Sadeh et al., 2009](#); [Teng et al., 2012](#); [Tikotzky & Sadeh, 2009](#)).

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