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Sleep budgets in a globalizing world: biocultural interactions influence sleep sufficiency among Egyptian families

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Abstract

Declines in self-reported sleep quotas with globalizing lifestyle changes have focused attention on their possible role in rising global health problems such as obesity or depression. Cultural factors that act across the life course and support sleep sufficiency have received scant attention, nor have the potential interactions of cultural and biological factors in age-related changes in sleep behavior been systematically investigated. This study examines the effects of cultural norms for napping and sleeping arrangements along with sleep schedules, age, and gender on sleep budgets among Egyptian households. Data were collected in 2000 from 16 households with 78 members aged 3–56 years at two sites in Egypt (Cairo and an agrarian village). Each participant provided one week of continuous activity records and details of each sleep event. Records showed that nighttime sleep onsets were late and highly variable. Napping was common and, along with wake time flexibility, played a key role in maintaining sleep sufficiency throughout the life course into later middle age. Cosleeping was prevalent and exhibited contrasting associations with reduced duration and sufficiency of both nocturnal and total sleep, and with earlier, more regular, and less disrupted sleep. Daily sleep quotas met published guidelines and showed age-related changes similar to existing reports, but differed in how they were achieved. Cultural norms organizing sleep practices by age and gender appear to tap their intrinsic biological properties as well. Moreover, flexibility in how sleep was achieved contributed to sleep sufficiency. The findings suggest how biocultural dynamics can play key roles in sleep patterns that sustain favorable sleep quotas from infancy onwards in populations pursuing globalizing contemporary lifestyles.

Keywords

Egypt; Time use diary; Adolescence; Pediatric sleep; Child development; Insomnia; Sleep ecology; Aging

Introduction

Reductions in self-reported sleep quotas with globalizing lifestyle changes have drawn attention to their potential role in escalating health problems such as obesity or depression. Sources for concern include findings that up to 40% of American adults report sleeping less than seven hours daily (Cappuccio, D'Elia, Strazzullo, & Miller, 2010a). Accumulating evidence furthermore suggests that increasing numbers of young people are going to bed later and getting by on less than optimal sleep in most areas of the globalizing world (Crowley, Acebo, & Carskadon, 2007; Dollman, Ridley, Olds, & Lowe, 2007; Gradisar, Gardner, & Dohnt, 2011; Matricciani, Olds, & Petkov, 2011a). Although widespread claims

that child sleep is diminishing likely are inflated (Matricciani, Olds, & Williams, 2011b), a recent meta-analysis detected an overall decline of well over an hour in nightly sleep during the previous century, albeit with substantial regional variation including increases in several countries (Matricciani et al., 2011a). Contradicting the concerns based on self reported sleep, large scale multinational studies using time use methods do not find changes in sleep budgets over the past several decades in European and North American samples (Gershuny, 2000).

Determining the status and epidemiology of “sleep famine” is urgent, given the consequences of sleep deprivation. Although the actual functions of sleep and metrics for sleep adequacy remain elusive, accumulating evidence links sleep to memory (Dieckelmann & Born, 2010), cognitive and emotional function (Albrecht, 2010; Banks & Dinges, 2007; Gujar, McDonald, Nishida, & Walker, 2011; Tononi, 2005), and physical and mental health including obesity (Leproult & Van Cauter, 2010) and depression (Harvey, 2008). Sleep deficits and poor sleep are known to impair attention and task performance along with executive functioning and emotion regulation (Durmer & Dinges, 2005). Reinforcing the import of such insights, the average daily sleep quota reported by adult Americans declined from 8 to 6.8 hours between 1982–2008 (National Sleep Foundation, 2009), shirking the recommended seven to nine hours, depending on age and other factors. Both long and short sleep, and changes in sleep amounts have been prospectively associated with increased mortality risk in U.S. adults (Ferrie, Shipley, Cappuccio, Brunner, Miller, Kumari et al., 2007; Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002). Similarly, a multinational study of young adults at 27 universities in 24 countries found poorer self-reported health in both short and long sleepers (Steptoe, Peacey, & Wardle, 2006).

The mental and physical health consequences of insufficient sleep have mobilized growing concern among sleep scientists and health professionals over the apparent epidemic of sleep deprivation (Carskadon, 2011b; Foster & Wulff, 2005; McGlinchey, Talbot, Chang, Kaplan, Dahl, & Harvey, 2011). Leading sleep researchers have concluded that “Reduced sleep time in industrialized societies is primarily related to lifestyle” (Basner & Dinges, 2009, p. 747). Work or school time, followed by television, have been identified as prime culprits (Basner, Fomberstein, Razavi, Banks, William, Rosa et al., 2007; Knutson, Van Cauter, Rathouz, DeLeire, & Lauderdale, 2010). If lifestyle is the problem, then culture and its pervasive role in organizing daily lives must be considered as a central factor in sleep. Students of infant, child, and adolescent sleep have led the way in recognizing the significance of sleep practices, values, beliefs, and conditions. Attention to culture and sleep ecology emerged first from work in anthropology (McKenna, 1986; McKenna, Mosko, Dungy, & McAninch, 1990; Worthman & Melby, 2002), and has been taken up in pediatric and developmental sleep science (Jenni & O’Connor, 2005; Owens, 2005). The emerging comparative literature on infant and child sleep documents wide variation in patterns and amounts of sleep not only between Asian-Pacific and predominantly Caucasian regions (Mindell, Sadeh, Wiegand, How, & Goh, 2010b), but also within regions such as Europe (Hense, Barba, Pohlabein, De Henauf, Marild, Molnar et al., 2011). The latter eight-country study of night sleep in children ages 2–9 concluded that “regional affiliation, including culture and environmental characteristics, seems to overlay individual determinants of sleep duration” (Hense et al., 2011, p. 633). This work suggests both that universal sleep norms likely are unhelpful (Hense et al., 2011; Jenni & Werner, 2011), and that comparative research can identify common sources of sleep difficulty (Mindell, Sadeh, Kohyama, & How, 2010a). Thus, sleep ecology is poised to inform stubborn questions about sleep and sleep problems as the work expands across the life course to include adolescents, adults and elderly.

As the comparative study of sleep ecology proceeds, greater attention to the following are needed: sleeping conditions, both social and physical; improved accuracy and completeness

of sleep measures beyond summary self report; inclusion of social units such as families rather than just individuals; and trajectories across the life course. In this report, we present time use data from a case study of sleep and activity patterns in a sample of urban and rural Egyptian families. We evaluate three interrelated hypotheses. 1. Contemporary Egyptian families do not meet sleep quotas suggested from sleep norms, particularly in urban Cairo. 2. Practices of napping enhance and cosleeping erode sleep adequacy. 3. Late bedtimes, age, and gender are prime factors in sleep insufficiency.

Measures and norms for sleep

Two social science survey methods for assessing sleep budgets are summary self-report and activity diaries. Summary self reports ask respondents when they typically have gone to bed and gotten up, and how many hours a night they have slept over a designated period, such as the previous month (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). Summary self-reports are employed in large-scale national surveys such as those in Great Britain or the U.S. (Groeger, Zijlstra, & Dijk, 2004; National Sleep Foundation, 2009). Data from these surveys are widely disseminated and inform both scientific and popular discourse (Baker, Wolfson, & Lee, 2009; Mindell, Meltzer, Carskadon, & Chervin, 2009). The U.S. surveys show progressive declines in amount of sleep and base shared perceptions that insufficient and poor sleep are becoming increasingly common (Foster & Wulff, 2005). By contrast, the British data do not indicate changes in amount slept between 1969 and 2003, although reported fatigue and sleep problems are high in both U.K. and U.S. (Bliwise, 1996; Groeger et al., 2004).

Activity diaries tap time demands and tell a different story than do sleep surveys. Extensive 24-hour activity studies detect no temporal decline in sleep quotas: for example, the American Time-Use Survey shows daily sleep averaged about 8 hours between 1965 – 2007 and actually increased to 8.6 in 2003 – 2007 (Robinson & Michelson, 2010).

Advantageously, activity diaries neither highlight a focal activity (sleep) nor trigger strong social desirability responses, yield more a complete picture of trade-offs (work vs. sleep), capture napping, and are used in large-scale inventories by many countries (Fisher & Robinson, 2010). Multinational diary data document national differences in sleep time that probe shared biological and varied cultural bases for sleep behaviors. For example, reports that women sleep more than men recently have been shown in cross-cultural studies to reflect sociological rather than innate differences in sleep need (Glorieux & Minnen, 2009).

Evaluation of temporal or population differences in sleep budgets and patterns is challenging. Absolute amount slept may be only weakly related to need for and quality of sleep. Sleep need clearly varies among individuals (Van Dongen, Vitellaro, & Dinges, 2005), and in the absence of a reliable indicator for sleep sufficiency, norms for how much sleep is necessary remain elusive (Buysse & Ganguli, 2002). Empirical, much less developmental, evidence for sleep sufficiency is scarce and bases for recommendations from sleep organizations are thin. Still, popular clinical views of sleep need and how it should be met fuel perceptions of sleep difficulty and insomnia if these norms are not achieved (Worthman, 2008). Hence, cross-cultural sleep research increasingly is advocated to examine cultural assumptions and help disentangle the environmental factors influencing sleep behaviors and their consequences, including the role of cultural norms and values (Bliwise, 2008; Cappuccio, Miller, & Lockley, 2010b; Jenni & O'Connor, 2005).

Napping

Traditions of customary afternoon naps, or siesta, are common among societies located within 30° of the equator (Webb & Dinges, 1989). In such “siesta cultures”, prevalence of adults who nap four or more times a week ranges around 60–80% (Dinges, 1989).

Investigation of the effects of napping has focused less on these contexts, than on shift workers, occupations requiring sustained wakefulness, and the elderly. Naps provide well-documented benefits for redressing sleep loss and maintaining alertness during shift work or extended operations (transcontinental flight crews, medical residents) (Caldwell, Caldwell, & Schmidt, 2008). For example, a 15-minute nap can mitigate fatigue-related performance loss for nearly 7 hours, and timing in the circadian rhythm does not influence the benefit (Driskell & Mullen, 2005). By contrast with data documenting functional benefits from napping, the relationship of naps with mortality in aging is subject to ongoing debate. Evidence linking napping with coronary mortality among middle aged or elderly has endorsed both protective (Burazeri, Gofin, & Kark, 2003; Kalandidi, Tzonou, Toupadaki, Lan, Koutis, Drogari et al., 1992; Naska, Oikonomou, Trichopoulou, Psaltopoulou, & Trichopoulos, 2007) and risk enhancing effects (Bursztyn, Ginsberg, & Stessman, 2002; Campos & Siles, 2000; Tanabe, Iso, Seki, Suzuki, Yatsuya, Toyoshima et al., 2010). Establishing the causal direction in the relationship between napping and health risk proves difficult (Lan, Lan, Wen, Lin, & Chuang, 2007; Masa, Rubio, Pérez, Mota, de Cos, & Montserrat, 2006), for longer daily sleep (> 8 hours) *per se* is associated with increased adult mortality from coronary heart disease (Mesas, López-García, León-Muñoz, Guallar-Castillón, & Rodríguez-Artalejo, 2010; Qureshi, Giles, Croft, & Bliwise, 1997).

Cosleeping

How we sleep may matter as much or more than how *much* we sleep. Accumulating evidence suggests the significance of social contexts in sleep behavior and quality (Worthman, 2011), and indicates that sleep practices of the Western societies most represented in sleep science, including solitary sleep from infancy onward, are unusual (McKenna, Ball, & Gettler, 2007). Cosleeping pervades the ethnographic record (Barry & Paxson, 1971; Worthman & Melby, 2002) and may qualify as the most intimate behavior that can be shared by partners of all genders and ages. Sleep hours spent with others can be companionable, antagonizing disaffection and reducing social isolation (Cacioppo, Hawkley, Berntson, Ernst, Gibbs, Stickgold et al., 2002), buffering stress and arousal to levels compatible with sleep (Sadeh, Keinan, & Daon, 2004), and contributing to sleep quality that promotes mental and physical health (Bursztyn & Stessman, 2005).

By contrast, literature on infant and child sleep paints a negative view of cosleeping and promotes the stance that sleep is better done alone. In a recent 16-country study of parenting behaviors and infant nighttime sleep, cosleeping and co-rooming were associated with reduced sleep duration and quality (Mindell et al., 2010a). Bed sharing in children may reflect distress or difficulty rather than the reverse, especially among populations where cosleeping is normative only for married couples (Forbes, Weiss, & Folen, 1992; Hayes, Parker, Sallinen, & Davare, 2001). Bed sharing in an urban Chinese sample, for example, was more likely with crowding or child ill health (Liu, Liu, & Wang, 2003). Curiously, cosleeping is rarely assessed in studies of determinants of sleep amount or quality in adults (Cacioppo et al., 2002; Chatzitheochari & Arber, 2009; Lauderdale, Knutson, Yan, Rathouz, Hulley, Sidney et al., 2006). Clearly, the context-specific costs and benefits of cosleeping remain an open area for investigation.

Sleep norms and practices among Egyptians

In a previous analysis, we documented sleep practices in our Egyptian samples and reported that sleep behavior (onset, arousals, duration) was strongly predicted by ethnographically-identified cultural factors, most particularly bed-sharing habits, and age and gender norms (Worthman & Brown, 2007). Total sleep averaged 8.4 hours and followed the expected bimodal sleep pattern, with common daytime napping and late evening bedtimes. All participants reported histories of routine napping, and most sleep events involved

cosleeping. Sleep histories endorsed a pervasive customary preference for co-sleeping, which was regarded as expectable, protective, comforting, and integral to foundational relationships and family life. Participants universally recalled routine co-sleeping and breastfeeding during infancy followed by cosleeping in early childhood. The great majority also reported cosleeping or co-rooming through middle and late childhood, as well as through adulthood. Indeed, customary practices aimed to provide sleep partners for persons of all ages, constrained by rules of sexual propriety that reduce the feasibility of reliably doing so for adolescents and single young adults. Hence, established patterns of co-sleeping and co-rooming were most likely to be disrupted during adolescence and unmarried young adulthood, if there was no age-and-gender-appropriate sleeping partner available. In sum, among Egyptian families, we found that culture drives sleep patterns and quality, sleep is social, and family relationships form the context for sleep.

Methods

Study sites

A convenience sample of 16 families was recruited in two locales, urban (Cairo) and village (Mahallat Marhum, Tanta District, Lower Egypt). Participating families were recruited by word of mouth in the village, and through direct solicitation and fliers at workplaces or civic organizations in the city such that households differed by occupation, social status, and neighborhood of residence. Households were excluded from participation if an infant under age two years, chronic illness, or sleep medication use was present. A previous report contains background ethnographic, ecological, and sociological information about our study sites (Worthman & Brown, 2007). Briefly, Egyptians commonly follow biphasic sleep practices once prevalent among circum-Mediterranean peoples. They eat the main meal of the day around mid-afternoon, nap in the late afternoon, resume work, study or other activities, go to bed after midnight, and arise after dawn. The urban and rural subsamples tap contrasting living conditions and lifestyles. Densely populated Cairo had about 17.3 million inhabitants in 2001. Families inhabit small apartments or even single rooms, sleeping together on sofas or platform beds around the walls and on mats in the center of the room. Our study participants occupied apartments or semi-detached dwellings. The city is thoroughly electrified and media, including television and internet, are pervasive. Paid labor, particularly in the government and military sector, is common. Class markedly influences degree of crowding, noise, pollution, and conveniences such as electric fans. In this urban setting, we anticipated less cosleeping, high media use with late bedtimes and more sleep deprivation, napping, and constraint from work schedules.

By contrast, the agrarian village of Mahallat Marhum was much smaller (~60,000 inhabitants), inhabited largely by households that farmed on a part- or full-time basis. The village is situated in the densely settled fertile Nile delta of Lower Egypt, where farming has supported large populations for millennia. Nucleated families occupy separate floors of multi-story family compounds in non-detached homes. Farming families commonly sleep in one room, with parents and children on the platform bed, and adolescents either on floor mats or divans, or in separate rooms. In such villages, electrical supply can be erratic, air conditioning uncommon, and TV and other electronic media rather less ubiquitous. Under such conditions, we expected prevalent cosleeping, scheduling constraint from farming demands, and common napping.

Participating households at the two sites were relatively affluent and educated, and comparable by numbers of residents (5.0, SD 1.5) and bedrooms (2.6, SD 0.7), beds (2.9, SD 1.3), and persons per bedroom (2.0, SD 0.6) and bed (2.0, SD 0.8). Employment was universal among male household heads in occupations ranging from trades in Cairo or landed farming in the village to professions at both sites. Compared to Lower Egyptian

urban and rural families in a national sample from 2000, our samples had equivalent family size but more education and involvement in paid labor, and less crowding, including fewer persons per sleeping room (El-Zanaty & Way, 2001).

Procedures

Focal families each contributed one week of data during the period of July 3 – August 4, 2000, a time of summer heat and starting school vacation that we selected to represent family schedules free of schooling constraints. Measures, conducted largely in Arabic by teams of American and Egyptian researchers, assessed sleep habits, beliefs, architecture, and conditions using observation, questionnaire, structured and unstructured interview, physiologic recording, and activity diary methods. This report concentrates on sleep records and quality. Information on domestic conditions (number of rooms, bedrooms, beds) is drawn from interview and direct observation. On average, we saw each family four times for visits lasting around 1.5 hours. Research was conducted and consent obtained under permits from the Egyptian Ministry of Health and from the Institutional Review Board of Emory University. Families received a \$50 honorarium for their time.

Activity diaries and debriefing

Using prospective activity diaries and debriefing methods previously reported in detail, we collected continuous 24-hour activity records to capture sleep bouts for all household members throughout a 7-day period (Worthman & Brown, 2007). Participants recorded ten categories of activity (e.g., work, eat, sit/rest, sleep) in 15-minute time blocks. A household member was designated to help facilitate collection of complete records through reminders and organizing recording materials. All facilitators and most participants were literate. Interviewers visited and systematically debriefed participants about their records on the second, fifth, and eighth day from onset of activity recording. Specifics on location, companions, and arousals (recalled awakening) were elicited for each identified sleep event. Such debriefing served the dual purpose of correcting data recording gaps or errors, and collecting ethnographic information on sleep practices and attitudes. We note limitations to the activity record method we used, including recall bias, differential access to household members, and the cognitive burden of tracking time or activity, particularly in large and very busy families. The need to train participants and for multiple follow-up visits adds to the investigator and participant burden.

Analysis

Analyses for this report draw upon the daily activity schedules and sleep event records. To accommodate a daily activity schedule punctuated by five prayer times, running from dawn (~4:30 AM) to evening (9:30 PM), the sleep day was defined as the 24-hour interval from 4:00 AM to 4:00 AM on adjacent days. Days where this interval was incompletely recorded were excluded from analysis (60 sleep events excluded), leaving 469 complete sleep days comprising 612 total sleep events that are the subject of this analysis. The final dataset was gender balanced (47.4% of events from males). Total sleep per day was summed from all events that began during each sleep day. Sleep events that started between 12:00 PM and 8:00 PM were defined as afternoon naps. Those that started between 8:00 PM and 5:00 AM were defined as nighttime sleep bouts. Consequently, highly shifted or erratic sleep patterns could result in no or two bouts of nighttime sleep on a given sleep day. Number of sleep bouts was calculated as the total occurring during the sleep day. Cosleeping was calculated as the proportion of night bouts with bed sharing because the great majority of sleep (76%) occurred in the night bout.

Performance of analysis employed STATA 12.0 with weights for unbalanced repeated individual measures as appropriate. Clock time is presented in 24-hour format. Given

limited availability of evidence-based norms for sleep need combined with clinical and popular concern over adequacy, we combined two sources for scoring sleep sufficiency. One provides reference values published in *Pediatrics* based on longitudinal data for total daily sleep in 493 Swiss children from birth to 16 years, intended for use by health care professionals (Iglowstein, Jenni, Molinari, & Largo, 2003). The other is a table delineating sleep need by age from the widely influential National Sleep Foundation (2012) in the U.S. Night sleep bouts and total day's sleep duration were scored for sleep adequacy (0 inadequate; 1 adequate) using age-graded cut-offs combined from the comparable values in these sources, as follows: ages 3–5, 11.5 hours; 6–10, 10.5 hours; 10–17, 9 hours; >17, 8 hours. These conservative estimates of sufficiency do not take individual differences in sleep need into account. This report excludes our data for 2-year-olds to match age ranges in published norms.

Homogeneity of variance was tested with Brown and Forsythe's modification of Levene's formula using median rather than mean to reduce effects of heteroscedasticity. Data analysis included logistic regression models where the outcome variable was either sufficiency of the nighttime sleep bout or sufficiency of the total daily sleep. Predictor variables were sleep bouts per day, cosleeping, and times the night bout began and ended. Regressions included control variables for individual and household characteristics. For individuals, these included age, sex, and number of sleep arousals. For households, control variables were location (urban or village) and household size (number of residents); other measures of crowding (persons per room or per bedroom) yielded equivalent results to household size. Regressions also included clustering by household.

Findings

Sleep patterns and co-sleeping

Summary data on sleep patterns, quality, and co-sleeping are reported by gender, age, and site in Table 1. These data show an overall pattern of mid-late afternoon napping and late night bedtimes with moderate morning times of arising and high rates of cosleeping. Bedtimes average well past midnight (00:45) and waketimes are rather late (08:32). Males went to bed later but got up no later than females, cosleepers went to bed later at night and arose later next morning than non-cosleepers, and villagers both went to bed and arose earlier than Cairenes. The urban-village differences are attributable to schedule constraints of farm demands for earlier rising. Sleep schedules change markedly with age: night bed times are earliest among children under 10 and latest among young adults, while morning wake times averaged latest for adolescents and earliest in later middle age. Number of arousals, a crude inverse index of sleep quality, was greater in females than males, varied markedly with age, and was much lower among co-sleepers and villagers. Both children ages 3–6 and adults ages 30–39 (all are parents) reported an average of one arousal per night. Afternoon naps were not so patterned by gender, age, co-sleeping, or site, although villagers napped earlier than urbanites, in accord with their overall differences in sleep schedule. Cairenes had more variability than villagers in bedtimes (urban CV 13.7%, village 12.2%, $F 5.9 (1,426)$, $p .001$) and night sleep (urban CV 31.9%, village 25.1%, $F 5.9 (1,426)$, $p .001$), but not total daily sleep.

Cosleeping involves sharing a bed with one or more partners, and comprised 77% of all bouts of night sleep and 46% of afternoon naps. Cosleepers had earlier and less variable nocturnal bed-and waketimes, and reported far fewer arousals than non-cosleepers. Rates of cosleeping at night varied sharply by age, and were lowest among adolescents and young unmarried adults. Cosleep night bouts began and ended earlier than non-cosleep events. Villagers moreover were more likely to cosleep at night (86%) than were city dwellers (67%, Pearson $\chi^2 19.7$, $p < .001$). Naps, on the other hand, were less likely to involve

cosleeping, most particularly among older children and adolescents who napped alone and less frequently than all other ages (27.3% vs. 53.8% of days, Pearson χ^2 34.9, $p < .001$). Cosleeping during naps was much less common among villagers than Cairenes (34% vs. 55%, Pearson χ^2 57.6, $p = .03$), and for villagers, cosleeping was less common during naps than night sleep (34% vs. 86%, Pearson χ^2 57.6, $p < .001$). As a group, cosleepers had less variance than solitary sleepers for bedtimes (cosleep CV 12.8%, solitary 14.4%, F 8.3 (1,426), $p = .004$), waketimes (cosleep CV 25.6%, solitary 33.5%, F 6.1 (1,392), $p = .01$), length of night sleep (cosleep CV 25.6%, solitary 31.6%, F 8.2 (1, 391), $p = .004$), and total daily sleep (cosleep CV 26.1%, solitary 28.9%, F 6.7 (197, 193), $p = .01$).

Hypothesis 1: Daily sleep quotas and sufficiency

Turning to our first hypothesis, we test whether Egyptians in our sample do not meet sleep quotas, particularly urban residents (see Table 2). The late and variable sleep times of the participants, particularly Cairenes, might suggest that sleep would be curtailed and deficits common. Indeed, based on duration of night sleep alone, sleep averaged $M = 7.6$, $SD = 2.2$ hours, was unrelated to gender or locale, and showed the expected decline with age, F (1, 387) = 80.3, $p < .001$, $R^2 = .17$. However, night sleep was not the only significant source of sleep time: an average of $M = 1.4$, $SD = 0.6$ bouts of sleep occurred daily. Nap frequency varied by age and site. When naps occurred, they contributed an average $M = 1.8$, $SD = 1.0$ hours that was equivalent for gender and site, though duration varied by age group. Such supplementation increased total daily sleep to an average $M = 8.4$, $SD = 2.6$ hours, which also did not vary by gender or site, but did decline with age, F (1, 387) = 39.1, $p < .001$, $R^2 = .09$. Predictably, total hours of sleep on days with naps exceeded that on days without, with nap: $M = 9.0$, $SD = 3.4$; without nap: $M = 7.9$, $SD = 2.1$, t (557) = 4.3, $p < .0001$.

Consequently, evaluation of daily sleep budget and sufficiency is strongly influenced by whether naps were included or not. Using age-graded scores for sleep sufficiency based on published western norms (Iglowstein et al., 2003; National Sleep Foundation, 2012), we found that consideration of night sleep alone resulted in criteria being met on only 20% of days. Rates of night sleep sufficiency did not vary by gender, but differed sharply by age group (F (1, 315) = 11.8, $p = .001$, $R^2 = .03$) and locale (urban 27.8%, village 11.5%, Pearson χ^2 13.1, $p < .001$). Addition of naps in the measure of total daily sleep dramatically changed the picture, more than doubling the rate of sleep sufficiency to 44.7% of all days. Rates did not vary by age, but were lower in men than women (men 41.2%, women 48.7%, Pearson χ^2 13.1, $p < .001$) and much lower in villagers than city dwellers (village 35.6%, urban 52.0%, Pearson χ^2 13.1, $p < .001$). Note that the cut-offs we used for sleep sufficiency by age were rather conservative for adults (8 hours/day). Relaxing that criterion to 7 hours/day for adults aged 30–60 resulted in universal sleep adequacy in that age group, eliminated the differences by gender, cosleeping, and site, and raised the sample average sleep adequacy to 68.1%.

Hypothesis 2: Napping enhances and cosleeping erodes sleep adequacy

These findings refute the first hypothesis and take us to the second, that napping supports and cosleeping erodes sleep adequacy. The above findings show that the sleep budget heavily depends on napping. Habitual cosleeping, on the other hand, is associated with shorter night bouts and less total sleep, as well as much lower rates of adequate sleep. As noted above, the difference in adequacy dissolves if the cut-off for adults is shifted to 7 hours/day (cosleeping 69.7%, non-cosleeping 63.3%, Pearson χ^2 1.3, $p = .3$).

Hypothesis 3: Bed and wake times, age, and gender are prime factors in sleep sufficiency

We conducted a set of logistic regressions to test the third hypothesis, that late bedtimes and early waketimes, along with age and gender, are key determinants of sleep sufficiency.

Analyses testing the first two hypotheses already have shown that number of sleep bouts and cosleeping affect this outcome, so both also were included as explanatory variables. In Table 3, we report results from two logistic regressions of these sleep behaviors against the norm-based score for sleep sufficiency, either nightly or total, using attributes of the sleeper and the setting as control variables and clustering by household. Results yield three key findings. First, bed- and waketimes each influence sleep sufficiency scores: later sleep onset negatively and later wake times positively influence this outcome. Second, cosleeping was negatively related to sufficiency scores, at night and in total. The effect was moderate: a single bout of cosleeping reduced the likelihood of a day's sleep being rated sufficient by 17% ($-.30 - .04$, $\chi^2 6.2$, $p = .01$). Third, the most powerful determinant of sufficiency scores was number of bouts per day. From contrast analysis that conditioned for bed- and wake times, cosleeping, and the control variables, we ascertained that addition of one nap increased the daily odds of achieving sleep sufficiency by 36% ($.24 - .48$, $\chi^2 33.1$, $p < .001$). Findings show that, in this context, the usual sleep/wake times are secondary to the practice of napping in determining total sleep.

We note the absence of association between our control variables with the probability of sleep sufficiency. Any effects on sufficiency scores of all these factors at the level of individual and setting were negligible relative to the target sleep behaviors, namely bouts, cosleeping, and sleep times. Thus, the large urban-village differences in scored sufficiency rates reflected aggregate behavioral differences in sleep habits, napping, cosleeping, and rise and wake times. Likewise, age, gender, and sleep quality did not exert effects independent of the behavioral variables. Therefore, bed/wake times are prime factors in sufficiency, but age and gender are not.

Discussion

With a rising tide of concern over possible epidemics of sleep deprivation and their deleterious health effects, sleep ecology has an important scientific role to play by enriching inquiry into these important matters in sleep science and medicine with integrated social science research (Worthman, 2011). First is the debated question of how much people actually sleep. Time use diaries yield more accurate estimates of sleep timing and quantity that do not support the sleep declines from retrospective reports (Robinson & Michelson, 2010). This study used daily time use diaries and in-home interviews to derive a 24-hour account that captures not only night bouts of sleep, but also those during the day. Median total daily sleep for the sample is 8.0 hours; amounts show the expected differences by age and are slightly lower than that reported in multinational diary data for adults (Robinson & Michelson, 2010). The majority of sleep studies document or consider nocturnal bouts of sleep only, even for ages or cultures where napping is frequent (Hense et al., 2011; Mesas et al., 2010; Sekine, Chandola, Martikainen, McGeoghegan, Marmot, & Kagamimori, 2005). Following this approach would reduce median daily sleep for the study sample to 7.5 hours, or 3.5 hours less per week. Napping occurred on 31% of days and contributed significantly to total sleep budgets of children and adults. The exception was adolescents, who rarely napped and for whom nocturnal sleep duration therefore was key. That the diary method captured more sleep is suggested by the difference between our finding and that from self reports in a much larger sample of Egyptian children aged 6–10, giving average total sleep duration, $M 8.96$, $SD 1.20$ hours, compared to our mean of 9.4 (About-Khadra, 2009).

Second, is the problem of inferring sleep sufficiency from sleep quantity. Cross-cultural studies consistently identify marked population differences in sleep budgets, and often find that sleep duration in non-western groups is shorter than published norms (Mindell et al., 2010b; Robinson & Michelson, 2010). Although the most recent analyses reflect this variation and indicate that narrow universal norms may not be a fruitful approach to

understanding sleep diets (Cappuccio et al., 2010a; Hense et al., 2011), public understanding of how much to sleep (the proverbial 8 hours for adults) and public health discourse on sleep insufficiency suggest the cultural force of perceived norms. In the present analysis, we have applied published American and European values for children and adolescents (Hense et al., 2011; Iglowstein et al., 2003) and adults (National Sleep Foundation, 2012) to gauge the effects on sleep sufficiency of using such norms, and as a heuristic in testing for factors that enhance sleep budgets. Absence of set bedtimes, late nocturnal sleep onsets, availability of media, and urban living might be expected to erode the sleep budgets of our sample. The findings did not fully support this expectation. Rather, nearly half the sample met published norms; over two-thirds did so when the cut-off for adult sleep sufficiency was relaxed to 7 hours. Nevertheless, findings of shorter sleep in children under 10 in this and other studies in the Middle East as well as South and East Asia (About-Khadra, 2009) suggest a need to evaluate possible sources of variation in sleep efficiency or need early in life. Note that our findings may be influenced by study timing, during school vacation.

Third, is the need to test for effects of cultural factors on sleep. We directly assessed the impact on sleep budgets of specific cultural practices, napping and cosleeping. Napping emerged as a major feature in sleep budgets and the prime determinant of sleep sufficiency. This finding concurs with the reported impact of naps on total sleep time in Saudi school children (BaHammam, Bin Saeed, Al-Faris, & Shaikh, 2006) and supports the need to track napping in studies on sleep budget and health risk (Owens, Buysse, Hall, Kamarck, Lee, Strollo et al., 2010). We note in passing that Egyptian place their nap at the flat part of the diurnal sleepiness curve, right before the evening trough and therefore when post-nap sleep inertia (grogginess) is less (Broughton, 1994). As hypothesized, late bed times were secondary negative predictors of sufficient sleep; however, late wake times were secondary positive predictors of sufficiency that point to the importance of flexible sleep/wake times. Culturally determined forms of labor and subsistence powerfully shape daily schedules. We cannot evaluate the effects of employment *per se* due to sample size and variations in occupational schedules (farmers vs. doctors), or of school participation, because the study occurred during vacation. However, villagers, many of whom were farmers, had earlier bed- and waketimes, longer night bouts, fewer naps and arousals, and less variable sleep patterns than Cairenes, yielding lower rates of sleep sufficiency. Effects of paid labor schedules on sleep have been heavily studied, but those of traditional forms of subsistence such as farming or herding have not and merit attention.

Turning to the effects of bed sharing, cosleeping was habitual and widespread in this population, and had substantial negative associations with duration and sufficiency of both nocturnal and total sleep. Such findings confirm existing literature suggesting that cosleeping erodes sleep. We propose an alternate possibility, that normative cosleeping in the absence of intervening risks such as poverty, illness, or overcrowding may enhance sleep efficiency and reduce sleep need. In these Egyptian families, sleep with a partner appeared to be more regular, compact, and undisturbed: co-sleeping was associated with earlier, less variable onset of night sleep; shorter, less variable length of nighttime sleep; and less sleep disturbance represented by reported arousals. As sleep ecology expands our understanding of relationships of sleep contexts to sleep, there is a need to examine their relationship not simply to quantity but also to quality of sleep. These questions can be addressed with existing methods.

Finally, commonly observed effects of age on sleep sufficiency were not manifested in this sample, due largely to the practice of napping along with flexible sleep and wake times. Adolescents in particular exhibit vulnerability to sleep deprivation and dysregulation related to demands and distractions such as unscheduled bedtimes, rigid wake times, media use, and schoolwork (Adam, Snell, & Pendry, 2007; Carskadon, 2011a; Knutson & Lauderdale,

2009). Hence, adolescence appears to be a developmentally sensitive window for the effects of sleep-eroding factors on sleep loss and its consequences for function and health. In that vein, it is striking that scored sleep sufficiency among the adolescents in this study did not differ from other age groups during school vacation. These findings may not apply during school session, when both children and adolescents are widely reported to manifest sleep curtailment and wide weekday-weekend oscillations in sleep patterns (Carskadon, 2011a; Sadeh, Gruber, Raviv, Sadeh, Gruber, & Raviv, 2003). The present data underscore the importance of schedule flexibility and options for opportunistic sleep (napping) for robust sleep budgets at all ages.

Limitations

This exploratory study has noteworthy limitations. First, the sample of families is small, non-randomly recruited, and comprised of largely middle class inhabitants of densely settled locales. Second, timing of data collection in a single month during early summer and the transition from school year to summer vacation can scarcely capture the seasonal or calendrical effects on sleep patterns in this region (BaHamman, 2003). Such transitional periods capture family function during change, but represent neither sleep patterns during stable school routines or vacation periods, nor families with infants or without resident children. Third is the use of self reports, which relied on a designated family record-minder and close monitoring by the field team. Time use diaries correspond closely with gold standard actigraphic measures (Tremaine, Dorrian, & Bluncern, 2010), but the possibility remains that unknown cultural factors influence the reports. Fourth, our basis for scoring sleep sufficiency is at best heuristic. Fifth is the limited measure of sleep quality, lack of objective measures of sleepiness, and the absence of mental or physical health assessments that curtail our ability to link sleep behaviors to functional outcomes in this sample. Sleep problems are not absent among Egyptians, and merit investigation (About-Khadra, 2009).

Conclusion

Sleep, like diet, represents the intersection of biology and culture. It meets basic biological needs that vary individually and shift across the life course, while culture structures how and how well those needs are understood and met. Humans are social, and social units define the contexts of daily life. Thus, the study of sleep across the life course, in social settings such as families, and in contrasting cultures provides a window onto biocultural interactions in sleep and their potential relationships to sleep physiology, functionality, and dysfunction or distress. Cultural practices that differ from those of populations commonly represented in sleep research can nonetheless be compatible with achieving adequate sleep. Our findings demonstrate this is the case for lifetime habitual napping and cosleeping among Egyptians. We found both a clearly positive role for naps in sleep budgets, and a curious link of cosleeping with shorter sleep that yet is also earlier, more regular, and less disturbed. Together, these practices support the maintenance of strong sleep budgets among Egyptians throughout the early and middle life course, a remarkable achievement given the presence of innovations known to erode sleep (media, electricity), particularly during adolescence. Among Egyptians, agrarian and urban lifestyle differences resulted in subtle, unexpected reductions in villagers' sleep budgets relative to Cairenes that draw attention to the impact of traditional forms of labor on sleep. Moving forward, comparative sleep ecology doubtless will discover additional cultural influences on sleep that will not only help illuminate its role in health and functioning, but also identify the pathways whereby structural factors (family, labor, housing, school) shape the roots of well-being through sleep.

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Table 1
Sleep patterns in Egyptian families (means and standard deviations) and by gender, age, sleeping arrangement, and site (n=612)

	Night						Day					
	onset			offset			onset			offset		
	n of obs	mean time	SD, hours	mean time	SD, hours	mean n	n of obs	mean time	SD, hours	mean time	SD, hours	% of bouts
All	612	0:45	1.8	8:32	2.6	0.7	1.1	15:45	1.5	17:29	1.8	46
Gender												
Female	301	0:24	1.7	8:32	2.5	0.8	1.1	15:48	1.7	17:24	1.6	51
Male	311	1:02	1.8	8:36	3.0	0.6	1.2	15:38	1.4	17:29	2.1	42
Age, years												
3-5	15	23:04	1.8	8:56	2.6	1.0	2.1	15:42	0.9	17:45	1.3	92
6-10	58	23:02	1.0	8:15	2.8	0.6	0.8	15:00	1.5	16:36	1.6	0
11-19	147	1:03	1.8	9:31	2.2	0.6	1.1	15:41	2.2	17:28	2.4	0
20-29	111	1:50	1.6	9:06	3.3	0.7	1.0	16:00	1.7	18:30	1.5	53
30-39	62	0:59	1.8	8:36	3.0	1.0	1.3	15:34	0.9	17:04	1.1	38
40-60	219	0:21	1.5	7:38	2.9	0.5	0.9	16:00	1.4	17:16	1.9	50
Co-sleep												
Yes	422	0:20	1.6	7:52	1.9	0.7	1.3	15:44	1.5	17:29	1.8	—
No	190	1:31	1.8	9:57	2.8	1.1	2.3	15:58	1.2	17:29	2.0	—
Site												
Urban	351	1:35	1.8	9:10	3.0	1.1	1.5	16:10	1.5	17:52	2.0	55
Village	261	0:05	1.6	7:47	2.1	0.4	0.6	15:19	1.4	14:56	1.5	34

Significance:

* p < .05;

** p < .01;

*** p < .001

Table 2

Sleep duration, frequency, and sufficiency by age, gender, and site (n=594)

	Sleep duration						Bouts		Sleep sufficiency	
	night			day			total daily		per cent	total daily
	mean hours	SD	mean hours	SD	mean hours	SD	per day	SD		
All	7.6	2.2	1.8	1.0	8.4	2.6	1.4	0.6	20.2	44.7
Gender										*
Male	7.5	2.0	1.7	0.9	8.2	2.6	1.3	0.6	19.3	41.2
Female	7.7	2.0	1.9	1.1	8.7	3.1	1.4	0.6	21.2	48.7
Age, years	***		*		***		***		**	
3–5	8.5	2.2	2.0	0.7	10.4	2.2	1.5	0.7	17.7	42.1
6–10	8.5	2.1	1.7	0.1	9.4	1.6	1.3	0.5	11.1	32.4
10–19	8.3	1.5	1.9	1.4	8.8	2.2	1.1	0.4	31.5	45.5
20–29	7.0	2.7	2.3	1.0	7.8	3.1	1.4	0.6	24.4	53.0
30–39	7.2	2.2	1.6	0.9	8.1	2.6	1.3	0.6	14.8	45.0
40–60	6.5	1.8	1.4	1.0	7.5	2.1	1.5	0.7	9.4	41.4
Co-sleep	**				**				***	***
Yes	7.4	21.9	1.7	0.9	7.9	2.1	1.4	0.6	13.8	37.6
No	8.0	2.2	1.8	1.1	8.6	2.2	1.3	0.5	32.7	60.0
Site							*		***	***
Urban	7.4	2.3	1.8	1.3	8.3	2.3	1.4	0.6	27.8	52.0
Village	7.6	1.8	1.7	0.6	8.1	2.1	1.3	0.5	11.5	35.6

Significance:

* p < .05;

** p < .01;

*** p < .001

Table 3

Logistic regressions testing for associations of night time or total daily sleep sufficiency with sleep behaviors, individual characteristics, and household conditions

	Night sleep sufficiency		Total sleep sufficiency	
	Coefficient	<i>p</i>	Coefficient	<i>p</i>
<i>Explanatory variables</i>				
Sleep onset, PM	−1.270	.02	−1.098	.03
Sleep offset, AM	1.214	.03	1.307	.007
Bouts/day	—	—	1.941	<.001
Cosleeping	−1.489	.05	−1.258	.03
<i>Control variables</i>				
Age	−0.107		0.057	
Gender	0.327		0.091	
Sleep arousals	−0.264		0.073	
Household size	0.067		0.071	
Location	1.265		0.552	
N of observations	338		300	
Pseudo R ²	0.57		0.43	

Coefficients express the likelihood of sufficient sleep as values for a predictor variable increase above its mean. Regressions include clustering by household.