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Section 2 Chapter 23

Sleep Disorders and Excessive Sleepiness

Long sleepers

Catherine S. Fichten and Eva Libman

The central thesis of this chapter is that long sleep, defined here as 8 or more hours of sleep during the night, is part of the natural variability of sleep duration. Our review of the literature revealed few studies directly targeting the topic of sleepiness in healthy habitual long sleepers in comparison to midrange sleepers. Therefore, our review includes studies of "extended" long sleep and findings flowing from the U-shaped relationship between sleep length and mortality. We also review pertinent biological factors associated with long sleep and long sleepers. And, of course, we review the few studies of sleepiness in healthy long sleepers who do not have insomnia. In this way, as we examine relevant studies, we focus mainly on the journey to ultimately formulate an integrated position on sleepiness in long sleepers.

Terminology: what we are and are not exploring in this chapter

We plan to examine sleepiness in habitual long sleepers and to discuss sleepiness related to long sleep. To do this, we need to clarify concepts such as how long is long sleep, who are the long sleepers, and what we mean by sleepiness. We will be using the terms "long sleeper" and "long sleep" to refer to different concepts, which are discussed below. We will not discuss studies with a specific focus on children, narcolepsy, hypersomnia, excessive daytime sleepiness, or insomnia. Neither will we deal with relationships among various measures of sleepiness. All of these topics are treated elsewhere in this volume.

Long sleep and long sleepers

A common definition of long sleep is sleeping 8 h or more at night [1], a sleep duration recently reported in a Sleep America Poll by 28% of the population [2]. In contrast, midrange sleep has typically been defined as somewhere between 7 and 7.9 h [2]. These are the definitions of long and midrange sleep that we will use whenever possible. Nevertheless, studies in the literature vary considerably in what they mean by long sleep, which has been variously defined as nocturnal sleep or sleep during a 24-h period of 8, 9 or 10 h or more [3–5].

Measurement issues

Sleep length in much of the literature is based on some form of self-report in epidemiological studies or on a sleep questionnaire or diary. These usually inquire about typical total sleep time during the night, sometimes separating nocturnal sleep time on weekday/workday nights from sleep experienced on weekend/non-workday nights [2, 6, 7]. However, many studies report on total daily sleep [8], which may or may not include naps, adding an additional twist to the long sleeper and long sleep definitions. Also, several studies refer to long sleep on weekend/non-workday nights in the presence of possible sleep deprivation during weekdays/workdays [2].

Some studies use polysomnography (PSG) or actigraphy to measure total sleep times [9–13]. While actigraphy grossly underestimates sleep onset latency, it provides a reasonable approximation of self-reported total sleep times; PSG, on the other hand, is typically administered in a sleep laboratory and provides somewhat lower estimates of total sleep times than home sleep [14, 15].

In several studies, sleepiness is evaluated in the context of constant environmental conditions, where small numbers of participants are sleep-derived and/or allowed to experience "extended" (i.e. long) sleep, and where sleep duration and phase advance/delay are manipulated [16–18]. However, there are few such

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

studies, and those that do exist use relatively small sample sizes. In addition, total sleep time in these studies is often confounded by circadian factors, such as wake up times which can be up to 3 h after usual awakening times [19].

Confounds: hypersomnia, insomnia and "sleeping too much"

Much of the recent literature dealing with long sleep duration is concerned with *hypersomnia*. This is characterized in the three most commonly used diagnostic systems by a combination of prolonged nighttime sleep episodes, frequent daytime napping, and excessive daytime sleepiness (EDS) [20]. Because hypersomnia refers to extraneous aspects that are not related to sleep duration, we will not include this condition in our review.

It is noteworthy that the literature shows that many individuals described as long sleepers also experienced *insomnia* and poor sleep quality [7]. This appears to occur because such individuals, in addition to experiencing long sleep times, also spend long times in bed, resulting in fragmented, poor quality sleep, low sleep efficiency and insomnia characterized by lengthy sleep onset and nocturnal wake times [3].

Insomnia for research purposes is usually defined as difficulty initiating or maintaining sleep (DIMS), consisting of more than 30 minutes of undesired wakefulness at least 3 times per week [21]. This is the definition that we will use, wherever possible, in this chapter. Although the DIMS definition usually makes reference to distress or dysfunction related to poor sleep [22], and although the research definition includes a problem duration of a minimum of 6 months, these are rarely measured in epidemiological research. Nonrefreshing sleep is also considered a form of insomnia in some nosologies [23]. Since we believe this phenomenon to be sufficiently distinct from both DIMS and daytime sleepiness, it will not be a focus of this chapter.

Focus on healthy, insomnia-free long sleepers

Because we are interested in discussing the relationship between sleep duration and sleepiness, we will exclude consideration of insomnia, hypersomnia and "sleeping too much" whenever possible. We will include self-reported nocturnal sleep duration based on both single questions and sleep diary scores along with behavioral and physiological measures. Where possible, we will refer to nocturnal sleep rather than total daily sleep times (which may include naps). We will also be looking at sleep during typical weekdays/workdays when possible and will be considering sleep during weekends/non-work days separately, as these can reflect not only habitual sleep but also extended sleep after possible sleep deprivation as well as phase-shifted sleep. It is evident from the foregoing that our ultimate aim is to shed light on sleepiness in nocturnal long sleep and in habitual long sleepers who do not have a sleep disorder and in the absence of sleep deprivation or phase-shifted sleep.

In this chapter whenever possible, long sleepers will be individuals who habitually sleep 8 h or more at night and midrange sleepers will be those who habitually sleep between 7 and 7.9 h at night. Similarly, long sleep will refer to 8 or more hours of nocturnal total sleep time and midrange duration sleep will be 7–7.9 h. When possible, we will exclude studies which deal with insomnia, hypersomnia and "sleeping too much."

Sleepiness

Measurement issues

When sleepiness is discussed in the context of sleep duration, numerous subjective and objective measures are used. These include such self-report measures as the Stanford Sleepiness Scale [24], the Epworth Sleepiness Scale [25], and the Karolinska Sleepiness Scale [26]. Among objective measures, there are polysomnography (PSG), actigraphy and electroencephalogram (EEG) based measures of both sleepiness and wakefulness [27], the Multiple Sleep Latency Test (MSLT) and the Multiple Wakefulness Test (MWT) as well as other, less popular, options [28]. In addition, there are visual analogue scales and single items (e.g. Are you sleepy in the daytime: often to never [29]) that are frequently used in epidemiological studies. Some of these ask about the impact of sleepiness on daytime functioning [7] and activities [2]. Several studies use behavioral measures of vigilance to measure alertness [30]. Of course, such a multiplicity of measures can yield discrepant results.

There are a variety of conceptual difficulties related to measuring the presence of sleepiness versus the absence of alertness [27]. In addition, there are problems related to the confounding of daytime sleepiness and fatigue on questionnaires [31]. It is not yet clear whether "feeling sleepy" can be reliably distinguished from "feeling fatigued." Nevertheless, most

P1: SFN Trim: 246mm × 189mm Top: 3.5 mm Gutter: 13 mm
CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

studies show that fatigue and sleepiness, when the latter is assessed by measures that evaluate sleep propensity (e.g. Epworth Sleepiness Scale, [25]; Empirical Sleepiness Scale, [31]) are not closely related. Although the theoretical relevance and clinical implications of examining each of these concepts independently has been highlighted in recent research [31–33] we will, nevertheless, also note findings on long sleep and fatigue.

Confound: excessive daytime sleepiness

In our literature search, we found many studies of "*excessive daytime sleepiness*." However, as Ohayon's [34] review indicates, this concept is both problematic and poorly defined. Therefore, we will not evaluate studies where this is the key criterion of sleepiness.

Notwithstanding the above-mentioned difficulties, we will interpret findings using each author's measures, except that we will not include those studies where the only term used is "excessive daytime sleepiness."

Studies flowing from the U-shaped relationship between sleep duration and mortality

Here we review studies conducted through a pathology lens, where long sleepers frequently include individuals in poor physical or psychological health, who are often older and experience poor nocturnal sleep quality, including insomnia.

Sleep duration and morbidity/mortality

Analyses of the data from the 1959 American Cancer Society study were an early source for the famous U-shaped curve with respect to sleep duration; this showed that people who slept for 7 h had the lowest mortality [35]. This U-shaped relationship between sleep duration and mortality proved exceedingly robust [3, 36]. For example, a recent study of over 1 000 000 American adults reported that while sleep durations below 6.5 h and above 7.5 h were both associated with increased mortality risk, most of the increased risk was associated with longer sleep [37]. This finding applied to all age categories and both sexes, and the analyses controlled for over 30 potential confounds in the areas of demographics, habits, health factors and medication use. A subsequent report of over 100 000 Japanese adults [38], which further controlled for symptoms of stress and depression, also supported the long sleep/increased mortality link. Other analyses indicated that sleeping more (and less) than 7.0–7.9 h predicted higher mortality, even when reported insomnia and use of sleeping pills were controlled [39]. Studies such as these quickly resulted in long sleepers being referred to as individuals who experience "*excessive sleep*" [36], or sleep that is longer than the "mythical healthy midrange."

Once this link was established, some researchers were tempted to make the interpretative leap that midrange sleep is healthy [40], that long sleep is pathological, and that long sleepers should be transformed into midrange sleepers to reduce their risk for excess morbidity/mortality. As an illustration of this sequence, a recent review [36] presented a detailed evaluation of the long sleep/mortality association, which then led to the proposal of a rationale to "treat" sleep duration in long sleepers with sleep restriction, thereby molding them to approximate the mythical healthy midrange. Recently, such a sleep restriction study was, in fact, carried out [12] in a randomized controlled trial that examined the influence of restricted time in bed on a range of health-related variables. The findings indicate that experimentally restricted time in bed resulted in diminished sleep time that was generally "well-tolerated" by the participants: there were no significant changes on multiple measures of mood, quality of life or performance. There appeared to be neither deterioration nor improvement on two questionnaire measures of daytime sleepiness (Stanford Sleepiness Scale [24], Epworth Sleepiness Scale [25]) or on self-reported daytime naps.

In addition to their correlational nature, there are several further important limitations inherent in epidemiological studies of long sleep and long sleepers. The technique, while able to study very large samples, employs survey and self-report techniques to measure sleep duration. Such measures may better reflect time in bed than actual sleep time [3]. Therefore the observed morbidity/mortality may be associated with reasons for extended time in bed rather than habitual sleep duration, per se. In addition, possible explanations for the observed findings are threefold: (a) long sleep, per se, can cause sleepiness; (b) a third variable, such as sleep deprivation, long bed times, insomnia, depression or negative affectivity, can cause both long (including extended) sleep and sleepiness; and (c) sleepiness can cause long sleep (i.e. reverse

P1: SFN Trim: 246mm × 189mm Top: 3.5 mm Gutter: 13 mm
CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

causation – see Faubel *et al.* [5] for a discussion of these possibilities).

Sleep quality, insomnia, sleepiness, and behavioral and socio-psychological correlates of sleep duration

Most epidemiological studies investigating sleepiness and the behavioral and psychological characteristics of long sleepers have examined the extremes of sleep duration relative to each other; few have focused specifically on differences between long and midrange sleepers. In this context, epidemiological studies have reported that long sleepers have an increased likelihood of depression, anxiety/worry, medication use, lack of activity, lower socioeconomic status, medical, dietary, heart, breathing, and sleep problems [41]. Long sleepers are also more likely to be under 25 and over 65 [6], although some investigators have found that total sleep time decreases with age in a more or less linear manner [42]. As for sex differences, some studies reported that men sleep longer than women [5, 42, 43], others reported that women sleep more than men [44, 45], while still others reported no sex difference in sleep duration [1].

Although epidemiological studies spanning approximately 50 years have reported negative health and psychological outcomes associated with both short and long sleep lengths, only a few of these studies directly or indirectly addressed nighttime sleep quality and daytime sleepiness in these populations. Some studies reported no difference in sleepiness between long and midrange sleepers [1]. Nevertheless, most indicate more sleep fragmentation and daytime sleepiness among long sleepers relative to midrange sleepers [7, 37, 46], a higher incidence of DIMS and non-refreshing sleep [7], and a higher incidence of feeling “non-energetic” and “tired” or having feelings of “exceptional tiredness” [44]. A recent Japanese study also found that sleepiness was associated with long sleep, but only on weekends/non-working days, and only in one of two different large Japanese companies [47].

In contrast with such large-scale study findings, an elaborately designed laboratory investigation compared small samples of healthy young adults who were long and midrange sleepers [30]. The author reported that long sleepers had lower scores on ratings of depression and anger-hostility and higher scores on ratings of cheerfulness, energy and activation, as measured by an adjective checklist. In addition, longer sleepers functioned with better speed and accuracy on a vigilance task. Although daytime sleepiness was not directly examined in this study, one might speculate that the cheerful, energetic and well-functioning long sleepers were probably not simultaneously experiencing daytime sleepiness or fatigue.

Biological factors associated with long sleep, long sleepers and sleepiness

Physiological basis of sleep duration

It has been hypothesized that individual differences in habitual sleep duration have a physiological basis. Existing empirically supported models of sleep regulation postulate that duration and timing of sleep are regulated by an interaction between a circadian pacemaker, which programs daily cycles in sleep propensity, and a sleep homeostat, which tracks increases in sleep pressure [48–50]. Each component is controlled by a separate brain mechanism; these components may differ between individuals and affect habitual sleep duration.

A third factor, process W, was recently proposed [51] to account for the drop in alertness in the first few hours after awakening. Brain mechanisms have also been described for the wake drive or arousal factor [52]. A four-process model of sleep and wakefulness was proposed a decade later [25]. This model incorporates a sleep drive, which consists of the circadian and homeostatic components of the two-process model, a wake drive, which is composed of chronobiological factors, and environmental factors such as posture, physical activity, and the soporific/alerting nature of a situation.

Circadian aspects and properties of sleep in long sleepers

In an early laboratory investigation of night time sleep, Taub [30] showed that healthy young adult habitually long sleepers (9.5–10 h of nocturnal sleep) had higher daytime body temperature, more REM and Stage 2 sleep, and a larger number of awakenings than habitual midrange sleepers (7–8 hours of nocturnal sleep). However, the two groups did not differ on sleep onset latency or wakefulness after sleep onset. He also found that the average daily level of oral temperature was

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

significantly lower in midrange than long sleepers. Results such as these suggest that circadian factors are implicated in habitual long sleep.

A series of important studies conducted more recently by Aeschbach and colleagues [9, 10] investigated circadian factors in carefully selected small samples of habitually long (>9 h) and short (<6 h) sleepers under constant environmental conditions. Aeschbach and colleagues showed that markers of "the biological night" indicate that sleep duration in long sleepers is due to delayed offset in the morning, and not to advanced onset in the evening [10]. For example, the nocturnal interval of high plasma melatonin levels was longer in long than in short sleepers; the interval of low body temperature was longer, as was the nocturnal interval of increasing plasma cortisol levels. They also demonstrated that long sleepers initiate sleep closer to the circadian body temperature peak than short sleepers (i.e. long sleepers have less tolerance to sleep pressure than short sleepers) [9]. Aeschbach and colleagues concluded that differences in the circadian pacemaker's program contribute to habitual sleep length because the pacemaker programs a longer biological night in long sleepers than in those who sleep for shorter periods [10].

Genetic aspects

A large study of monozygotic (MZ) and dizygotic (DZ) same-sex twin pairs showed that total sleep times are more closely related in MZ than in DZ pairs [53]. In their thoughtful review, Taheri and Mignot [54] indicated that EEG studies on smaller samples confirm the discrepancy between MZ and DZ twins, and concluded that genetic factors influence sleep duration though circadian factors.

The studies reviewed above suggest that not only are habitual long sleepers physiologically programmed, but also that long sleep is a heritable characteristic.

Consequences of extended sleep

Since there are few studies that explore directly the characteristics of habitual long sleepers across the lifespan, here we include findings on the physiological and psychological effects of artificially extending nocturnal sleep (i.e. exploring sleep that is experimentally lengthened) and on weekend/non-workday "catch-up" sleep.

Dubbed the "Rip Van Winkle Effect" [55], there is a commonly observed phenomenon when adults sleep longer than usual: they often report persistent feelings of fatigue, lethargy, sleepiness and irritability which can persist several hours after wakening [19]. These feelings of sleepiness and fatigue may then lead to an increased desire to sleep, thereby perpetuating the cycle of longer sleep and more sleepiness.

This phenomenon was studied in a student population [19], where it was found that the experience of "sleeping late" is related to feeling worn out, lethargic, irritable, and "having difficulty getting going." But are these experiences due to extended sleep, per se? Because this study [19] confounded extended sleep with other variables, it is difficult to ascertain whether the findings are due to long sleep time, prior sleep deprivation or circadian factors, such as substantially later than habitual wake times.

It is possible, in experimental settings, to increase sleep duration by 2–3 h through increasing time in bed. In one such study of extended sleep in healthy young adults whose habitual sleep length was 7–8 h, the consequences of extending sleep to between 9 and 11 h were reports of increased daytime sleepiness and worsened mood [18]. In addition, performance deficits were observed, including slowed reaction times, lowered vigilance and increased difficulty with mathematical tasks. Although this study eliminated the confound of prior sleep deprivation, it is still not possible to conclude that extending sleep results in greater sleepiness and poorer daytime outcomes because this study continued to confound total nocturnal sleep time with circadian factors.

In a more conclusive, tightly controlled experimental study of ad lib sleep extension in healthy habitual midrange sleeper (7–8 h per night) young adults, Taub [17] showed that an extension of habitual nocturnal sleep by an average of 2.1 h was associated with more time spent in REM and Stage 2 sleep and that it had adverse effects on daytime fatigue and sleepiness (as well as decrements in performance). These negative results on extended long sleep stand in contrast with Taub's [30] earlier findings on habitual long sleepers (9.5–10 h of nocturnal sleep with no experimentally induced sleep extension) who, despite longer Stage 2 and REM sleep, experienced significantly higher energy and activation than midrange sleepers (7–8 h of nocturnal sleep) on questionnaire measures. Such findings suggest that there are no adverse consequences to long sleep in healthy long sleepers when this is their habitual sleep/wake pattern. The subjective and objective adverse effects were only evident when "oversleeping" took place (i.e. extended sleep). These

P1: SFN Trim: 246mm × 189mm Top: 3.5 mm Gutter: 13 mm
CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

negative effects of extended sleep held true for both midrange and long sleeper participants [16, 17, 56].

Additional support for the notion that habitual long sleep is different from extended sleep was provided by Ohayon in his large-scale study [57]. This showed that the likelihood of having non-refreshing sleep (a possible proxy for daytime sleepiness) was associated with shorter nocturnal sleep time and with longer extra sleep on weekends/non-workdays. This is similar to the findings reported by Taub and Berger [16, 56], who demonstrated that all deviations from one's habitual sleep/wake pattern (i.e. sleep deprivation, sleep extension and sleep phase shifting relative to one's habitual sleep period), regardless of whether individuals are habitually long or midrange sleepers, negatively affect performance and mood. All result in more fatigue, greater sleepiness and less energy than habitual sleep. Based on their findings, they concluded that these negative effects were primarily due to disruption of an established circadian sleep–wake pattern, and that sleeping fewer, more, or different hours than one typically does are all associated with sleepiness.

Thus, the literature shows that "extended sleep" is not a proxy for habitual long sleep. Even though the two have some similar characteristics (e.g. longer Stage 2 and REM sleep durations in both habitual and extended long sleep than in habitual midrange sleep [17, 30], Aeschbach et al.'s [10] data on sleep-related physiological characteristics suggest that the circadian pacemaker programs a longer biological night in long sleepers, compared with those who sleep for shorter periods.

Sleepiness in healthy habitually long and midrange sleepers without insomnia

A second look at our own data

In an article entitled, "Long sleepers sleep more and short sleepers sleep less: a comparison of older adults who sleep well" [58], we showed that differences between long and short sleepers reported in the literature on sleep-related, personality and daytime factors disappeared once we excluded individuals with DIMS insomnia from consideration. Since we had not looked at midrange sleepers in this investigation, we reanalyzed the sleepiness and fatigue data for this chapter.

It can be seen in Table 23.1 that we did not find significant differences between older ($n = 54$, mean age = 71) good habitual long (=>8 h nocturnal sleep time) and midrange (7–7.9 h) sleepers on either the Stanford Sleepiness Scale [24] or the single-item fatigue measure administered in our investigation. As a replication, we also reanalyzed data from our study of college students, where we used the same measures [59]. Here, we were surprised to find that midrange and long sleepers differed significantly on sleepiness. What could account for the difference between the college student and older adult samples? Was the difference due to measurement error or power issues? After considerable detective work, we found a much simpler explanation: our older adult data set included only *good* sleepers, while the college student findings were derived from an unselected sample. The discrepancy, we realized to our chagrin, was due to a failure to exclude participants with insomnia! Once this was done, it can seen in Table 23.1 that the findings on 33 college students (mean age = 20) replicate the "no significant differences" finding obtained on older adults.

But non-significant findings are not very compelling. Therefore, we reanalyzed sleepiness and fatigue data from 30 older (mean age = 63) midrange and long sleeper adults from our current research on individuals diagnosed with sleep apnea (a primary sleep disorder that is associated with fragmented sleep) who had not yet initiated treatment [32]. Here we also used the Stanford Sleepiness Scale [24] as well as some different measures to evaluate fatigue and sleepiness. Nevertheless, as can be seen in Table 23.1, we again found no significant differences after filtering the data to rule out participants with insomnia.

As an additional check on our findings, we correlated Stanford Sleepiness Scale [24] scores with total nocturnal sleep time in all three samples. The results, presented in Table 23.1, again show small and non-significant correlations. In addition, both long and midrange sleepers reported going to bed between 10:45 PM and 11:45 PM; there was no consistent or significant relationship between total sleep time and bed time among the three samples. Although not significant, the difference in sleep times is more readily reflected in arising times, since arising time in all three samples of midrange sleepers was earlier than in the three long sleeper samples. This is consistent with Aeschbach *et al.*'s [10] findings, and represents a behavioral reflection of the sleep onset and offset data in biological studies of long and short sleepers.

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Table 23.1 Comparisons on demographic, daytime, and lifestyle variables of short and long sleepers: means, standard deviations and test results

	Older adults sample ($n = 54$) [58]				College student sample sample ($n = 33$) [59]				Sleep apnea sample ($n = 30$) [32]			
Total sleep time:	**Long sleeper > = 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**	**Long sleeper > = 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**	**Long sleeper > = 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**
Demographic variables												
Sex[3]												
Number of females	16	24	$\xi^2(1, 54) = .58$	0.446	9	7	$\xi^2(1, 33) = .75$	0.387	9	7	$\xi^2(1, 30) = .26$	0.183
Eight Number of males	4	10			7	10			11	3		
Age												
Mean	69.53	71.24	$t(50) = -.97$	0.338	19.00	20.06	$t(31) = -1.25$	0.223	63.45	61.10	$t(28) = -.56$	0.581
SD	5.82	6.35			1.93	2.84			12.15	7.43		
N	19	33			16	17			20	10		
Sleep variables												
Total Nocturnal Sleep Time (TST)												
Mean	8.20	7.15	$t(52) = 12.78$	0.000	8.52	7.12	$t(31) = 9.71$	0.000	8.78	7.05	$t(28) = -3.33$	0.002
SD	0.40	0.23			0.55	0.22			1.62	0.16		
N	20	34			16	17			20	10		
Total Nocturnal Sleep Time Needed												
Mean									8.58	7.70	$t(28) = 1.38$	0.179
SD									1.96	0.54		
N									20	10		
Usual bed time (PM)												
Mean	23.06	23.21	$t(52) = -.68$	0.500	23.78	23.66	$t(31) = -.65$	0.519	22.74	23.23	$t(28) = -.96$	0.343
SD	0.49	0.80			1.47	0.98			1.31	1.30		
N	20	34			16	17			20	10		
Usual time up (AM)												
Mean	7.84	7.37	$t(52) = 2.00$	0.051	8.14	7.52	$t(29) = 1.32$	0.198	8.31	7.73	$t(28) = -.79$	0.434
SD	0.62	0.93			1.68	0.81			2.13	1.27		
N	20	34			14	17			20	10		

(*cont.*)

Table 23.1 (*cont.*)

	Older adults sample ($n = 54$) [58]				College student sample sample ($n = 33$) [59]				Sleep apnea sample ($n = 30$) [32]			
Total sleep time:	**Long sleeper >= 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**	**Long sleeper >= 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**	**Long sleeper >= 8 h**	**Midrange sleeper 7–7.9 h**	**Test**	**Sig. *p* =**
Daytime functioning variables												
Stanford Sleepiness Scale[1] (1–7) ([24])												
Mean	2.00	1.74	$t(52) = .69$	0.494	2.06	2.56	$t(30) = 1.44$	0.160	3.50	2.95	$t(26) = -.93$	0.362
SD	1.75	1.08			0.93	1.03			1.58	1.34		
N	20	34			16	16			18	10		
Sleepy during the day[1] (10 = very sleepy)												
Mean									5.10	5.15	$t(28) = .05$	0.958
SD									2.37	2.56		
N									20	10		
Empirical Sleepiness Scale[1,2] (0–18) [31]												
Mean									5.25	5.00	$t(28) = -0.15$	0.878
SD									4.44	3.56		
N									20	10		
Q Subscale: Sleepy[1,2]												
Mean									20.04	19.74	$t(28) = -0.53$	0.603
SD									1.53	1.41		
N									18	10		
Empirical Fatigue Scale[1,2] (3–18) [31]												
Mean									10.10	9.50	$t(28) = -.37$	0.711
SD									4.13	4.14		
N									20	10		
Fatigue attributed to sleep problems (days/wk)												
Mean	0.80	0.56	$t(52) = .54$	0.590	2.19	2.41	$t(31) = .44$	0.663				
SD	2.14	1.13			1.42	1.50						
N	20	34			16	17						

Note. TST and the difference between Usual bed time and Usual time up are not equal because all scores are based on estimates by the subjects.

Note. Correlation between TST and SSS for Students $r(32) = -.27$, $p = .143$; for Older Adults $r(52) = .14$, $p = .321$; for Sleep Apnea Sample $r(26) = .29$, $p = .141$.

[1] Higher scores indicate greater sleepiness or fatigue.

[2] The Empirical Sleepiness Scale consists of 6 items from the Epworth Sleepiness Scale. The Empirical Fatigue Scale consists of three 6-point Likert-scaled items [31]. The Q Subscale: sleepy is a composite measure of sleep items [32, 64].

[3] Because Chi-square tests on the proportion of male and female subjects showed no significant differences, data for males and females are combined.

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

In summary, all of our own results indicate that habitual long and midrange sleepers do not differ on sleepiness or fatigue *provided they do not have diagnosable DIMS insomnia*. This led us to review findings on long sleepers and sleepiness conducted by others in studies where the research was not carried out with a pathology focus.

What others' studies show

Investigations conducted outside the U-shaped pathology lens have also found that long sleepers who do not have insomnia are no sleepier than midrange sleepers. A series of studies on a large sample of college students from Daniel Taylor's lab at the University of North Texas also show that long sleep is not pathological. For example, findings on 951 undergraduates indicate that total nocturnal sleep time, based on 1 week of daily sleep diary, was weakly and *negatively* related to Epworth Sleepiness Scale scores, even when participants with insomnia were not excluded from the sample [60]. In addition, total sleep time was positively related to better sleep quality. These results indicate that the longer participants reported sleeping, the *less* sleepy they felt and the *better* the quality of their sleep. Similarly, sleep diary data from 315 midrange and 269 long sleeper college students who did not experience DIMS insomnia [61] show that long sleepers (= >8 h nocturnal sleep time) experienced significantly *less* sleepiness, *less* fatigue and *better* sleep quality than midrange (7–7.9 h) sleepers (see Table 23.2). In addition, the number of hours of sleep that students indicated needing to function at their best during the day (long sleepers $M = 8.7$ h, midrange $M = 8.5$ h) was closer to being met for long than for midrange sleepers ($M = 8.6$ h, $M = 7.5$ h, respectively). That approximately 8–.5 h of sleep per night is most desirable is not restricted to college students. Consistent with this view are findings from a representative sample of the Sleep in America Poll [2, p. 12], which show that 29% of respondents, the largest group, indicated needing between 8 and 9 h of sleep to function at their best during the day.

Other studies on college as well as adult non-clinical populations also failed to show the U-shaped relationship. For example, another study of college students [62] also found *negative* correlations between total sleep time and Stanford Sleepiness Scale [24] as well as Epworth Sleepiness Scale [25] scores. Similarly, in healthy middle-aged to older adults with no sleep complaints, the correlations between total nocturnal sleep times and these two measures of sleepiness were also small and *negative* [63]. In addition, an older study on sleep duration and sleepiness in a community sample of middle-aged adults failed to find significant differences between those who reported long (>8 h) and midrange duration (6–8 h) of nocturnal sleep [1]: this was true of both males and females.

Such findings suggest that if there is, indeed, a relationship between sleepiness and total sleep time in otherwise healthy individuals with no insomnia, that this relationship is small, negative and, if anything, that habitual long sleepers are likely to feel less not more sleepy than midrange sleepers.

Summary, conclusions and recommendations

Is long sleep associated with sleepiness? Yes

The literature shows that extended sleep (i.e. occasional long sleep, which has circadian ramifications), even in good sleepers, can be associated with sleepiness. In addition, if comorbidities such as insomnia, negative affectivity, psychological and medical disorders are not ruled out, then self-reported habitual long sleep is frequently related to daytime sleepiness. However, long sleep in these individuals is likely to be associated both with physical and psychological disorders, as well as with disproportionately long bed times, which also appear to be associated with sleepiness. Among these individuals, the hypothesis that it is long bed time, rather than long sleep time, that is related to sleepiness, needs further investigation. There is also the possibility that these daytime sleepiness findings are related not so much to nocturnal sleep but to 24-h sleep time, which incorporates daytime napping.

Because so many of the studies were conducted with a pathology lens, and because the U-shaped distribution is so ingrained in the literature, studies which fail to find the predicted U-shaped relationship are seen as deficient in some way, and limitations sections often provide lengthy explanations for why this relationship was not found. Moreover, non-significant results rarely see print.

Are habitual long sleepers especially sleepy? No

On the other hand, studies conducted without the pathology lens and those where insomnia, a

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

Table 23.2 Sleepiness, fatigue, and sleep quality in college students without insomnia

	Midrange sleepers (7–7.9 h)		Long sleepers (≥8 h)		Test	
	M	(SD)	M	(SD)	F	$p =$
Total sleep time (TST) (minutes)	450.71	(17.54)	518.90	(34.62)	939.73	0.001
Ideal amount of sleep desired	507.25	(64.37)	521.43	(64.99)	6.98	0.008
Minimum amount of sleep needed	351.67	(82.86)	370.00	(85.75)	6.88	0.009
Sleep quality[1]	7.20	(1.39)	7.42	(1.32)	3.94	0.048
Epworth Sleepiness Scale (25)[2]	8.80	(3.38)	8.15	(3.62)	4.91	0.027
Multidimensional fatigue Inventory: general fatigue [65][2]	11.63	(3.28)	10.54	(3.20)	16.50	0.001

Note. Based on a significant multivariate analysis of variance. Data were provided by: Taylor and Bramoweth [61].
[1] Sleep Quality is a self-report 1–10 scale with higher scores indicating higher sleep quality.
[2] Higher scores indicate greater sleepiness or fatigue.

comorbidity of most psychiatric conditions, has been removed, typically show either no significant differences between midrange and long sleepers or show that long sleepers are *less* sleepy. These studies also demonstrate that long sleepers get as much sleep as they would like, unlike midrange sleepers, who would like to sleep substantially longer. Moreover, phase delay, phase advance, and extended sleep have a similar impact on habitual long sleepers and on those who habitually sleep less, although it is possible that naturally long sleepers may be especially vulnerable to negative effects of sleep loss.

Conclusions and recommendations

Our review of the many indirect and few direct findings related to sleepiness in long sleepers has led us to believe that sleep length is simply a manifestation of natural variability in sleep need that is normally distributed in the population, in a manner similar to an individual's height, for example. Consistent with this view are conclusions from a recent laboratory study which took into account both variability in sleep need as well as vulnerability to sleep loss [27]. Based on their findings, the authors suggested that the daily mean sleep need is 8.2 h with a huge standard deviation: 2.6 h. Such a finding would appear to eliminate the category of "long sleeper" all together and put sleep length on a continuum. That this is a reasonable way to proceed is suggested by findings of the most recent Sleep in America Poll [2], which provides the following breakdown of total sleep times 28% of adults report sleeping 8 h or more; 20% report sleeping less than 6 h; 23% 6 to less than 7 h; and 28% 7 to less than 8 h.

Might life circumstances induce more daytime sleepiness in habitual long sleepers than in their midrange sleep counterparts? Possibly. One can predict, for example, from the similar bedtimes of long sleepers and their counterparts who sleep for shorter periods, as well as from data indicating that shorter sleepers appear to tolerate homeostatic pressure better than long sleepers, that long sleepers might experience more daytime sleepiness when they must chronically cope with the 9 to 5 schedule of the working world. But how would the four-process model of sleep, with its addition of environmental and motivational factors, alter such a prediction? These remain outstanding questions for future research in the relatively unexplored field of individual differences in sleepiness and habitual sleep duration across the lifespan.

References

1. **Bliwise D L**, **King A C**, **Harris R B**. Habitual sleep durations and health in a 50–65 year old population. *J Clin Epidemiol*, 1994; **47**:35–41.
2. **National Sleep Foundation**. 2009 Sleep in American Poll: Summary of findings. Retrieved 2 November 2009, from http://www.sleepfoundation.org/sites/default/files/2009%20Sleep%20in%20America%20SOF%20EMBARGOED.pdf..

P1: SFN Trim: 246mm × 189mm Top: 3.5 mm Gutter: 13 mm
CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

3. **Grandner M A**, **Drummond S P A**. Who are the long sleepers? Towards an understanding of the mortality relationship. *Sleep Med Rev*, 2007; **11**:341–60.
4. **Chen J C**, **Brunner R L**, **Ren H**, *et al.* Sleep duration and risk of ischemic stroke in postmenopausal women. *Stroke*, 2008; **39**:3185–92.
5. **Faubel R**, **Lopez-Garcia E**, **Guallar-Castillon P**, *et al.* Sleep duration and health-related quality of life among older adults: a population-based cohort in Spain. *Sleep*, 2009; **32**:1059–68.
6. **Basner M**, **Fomberstein K M**, **Razavi F M**, *et al.* American time use survey: sleep time and its relationship to waking activities. *Sleep*, 2007; **30**:1085–95.
7. **Grandner M A**, **Kripke D F**. Self-reported sleep complaints with long and short sleep: a nationally representative sample. *Psychosom Med*, 2004; **66**:239–41.
8. **Vincent N**, **Cox B**, **Clara I**. Are personality dimensions associated with sleep length in a large nationally representative sample? *Compr Psychiatry*, 2009; **50**:158–63.
9. **Aeschbach D**, **Postolache T T**, **Sher L**, *et al.* Evidence from the waking electroencephalogram that short sleepers live under higher homeostatic sleep pressure than long sleepers. *Neuroscience*, 2001; **102**:493–502.
10. **Aeschbach D**, **Sher L**, **Postolache T T**, *et al.* A longer biological night in long sleepers than in short sleepers. *J Clin Endocrinol Metab*, 2003; **88**:26–30.
11. **Anderson C**, **Platten C R**, **Horne J A**. Self-reported 'sleep deficit' is unrelated to daytime sleepiness. *Physiol Behav*, 2009; **96**:513–17.
12. **Youngstedt S D**, **Kline C E**, **Zielinski M R**, *et al.* Tolerance of chronic 90-minute time-in-bed restriction in older long sleepers. *Sleep*, 2009; **32**:1467–79.
13. **Goldman S E**, **Stone K L**, **Ancoli-Israel S**, *et al.* Poor sleep is associated with poorer physical performance and greater functional limitations in older women. *Sleep*, 2007; **30**:1317–24.
14. **Creti L**, **Libman E**, **Baltzan M**, *et al.* Impaired sleep in chronic fatigue syndrome: how is it best measured? *J Health Psychol*, 2010; **15**:596–607.
15. **Libman E**, **Creti L**, **Baltzan M**, *et al.* Sleep apnea and psychological functioning in chronic fatigue syndrome. *J Health Psychol*, 2009; **14**:1251–67.
16. **Taub J M**, **Berger R J**. Performance and mood following variations in the length and timing of sleep. *Psychophysiology*, 1973; **10**:559–70.
17. **Taub J M.** Effects of ad lib extended-delayed sleep on sensorimotor performance, memory and sleepiness in the young adult. *Physiol Behav*, 1980; **25**:77–87.
18. **Taub J M**, **Globus G G**, **Phoebus E**, *et al.* Extended sleep and performance. *Nature*, 1971; **233**:142–43.
19. **Globus G G**. A syndrome associated with sleeping late. *Psychosom Med*, 1969; **31**:528–35.
20. **Kaplan K A**, **Harvey A G**. Hypersomnia across mood disorders: a review and synthesis. *Sleep Med Rev*, 2009; **13**:275–85.
21. **Lichstein K L**, **Durrence H H**, **Taylor D J**, *et al.* Quantitative criteria for insomnia. *Behav Res Ther*, 2003; **41**:427–45.
22. **Fichten C**, **Libman E**, **Bailes S**, *et al.* Characteristics of older adults with insomnia. In: Lichstein K L, Morin C M, Eds. *Treatment of Late Life Insomnia*. New York, NY: Sage, 2000: 37–80.
23. **Amercian Psychiatric Association**. *Diagnostic and statistical manual of mental disorders [Text Revision]* (4th ed.). Arlington, VA: Amercian Psychiatric Association, 2000.
24. **Hoddes E**, **Zarcone V**, **Smythe H**, *et al.* Quantification of sleepiness – new approach. *Psychophysiology*, 1973; **10**:431–36.
25. **Johns M W**. A new method for measuring daytime sleepiness – the Epworth Sleepiness Scale. *Sleep*, 1991; **14**:540–45.
26. **Akerstedt T**, **Gillberg M**. Subjective and objective sleepiness in the active individual. *Int J Neurosci*, 1990; **52**:29–37.
27. **Van Dongen H P A**, **Rogers N L**, **Dinges D F**. Sleep debt: theoretical and empirical issues. *Sleep Biol Rythms*, 2003; **1**:5–13.
28. **Cluydts R**, **De Valck E**, **Verstraeten E**, *et al.* Daytime sleepiness and its evaluation. *Sleep Med Rev*, 2002; **6**:83–96.
29. **Saarenpaa-Heikkila O**, **Laippala P**, **Koivikko M**. Subjective daytime sleepiness and its predictors in Finnish adolescents in an interview study. *Acta Paediatr*, 2001; **90**:552–57.
30. **Taub J M**. Behavioral and psychological correlates of a difference in chronic sleep duration. *Biol Psychol*, 1977; **5**:29–45.
31. **Bailes S**, **Libman E**, **Baltzan M**, *et al.* Brief and distinct empirical sleepiness and fatigue scales. *J Psychosom Res*, 2006; **60**:605–13.
32. **Bailes S**, **Libman E**, **Baltzan M**, *et al.* Fatigue: the forgotten symptom of sleep apnea. Available from: sally.bailes@mail.mcgill.ca. 2009.
33. **Hossain J L**, **Ahmad P**, **Reinish L W**, *et al.* Subjective fatigue and subjective sleepiness: two independent

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

consequences of sleep disorders? *J Sleep Res*, 2005; **14**:245–53.

34. **Ohayon M M**. From wakefulness to excessive sleepiness: what we know and still need to know. *Sleep Med Rev*, 2008; **12**:129–41.
35. **Hammond E C**. Some preliminary findings on physical complaints from a prospective-study of 1,064,004 men and women. *Am J Public Health Nations Health*, 1964; **54**:11–23.
36. **Youngstedt S D**, **Kripke D F**. Long sleep and mortality: rationale for sleep restriction. *Sleep Med Rev*, 2004; **8**:159–74.
37. **Kripke D F**, **Garfinkel L**, **Wingard D L**, *et al.* Mortality associated with sleep duration and insomnia. *Arch Gen Psychiatry*, 2002; **59**:131–36.
38. **Tamakoshi A**, **Ohno Y**. Self-reported sleep duration as a predictor of all-cause mortality: results from the JACC Study, Japan. *Sleep*, 2004; **27**:51–54.
39. **Kripke D F**, **Simons R N**, **Garfinkel L**, *et al.* Short and long sleep and sleeping pills. Is increased mortality associated? *Arch Gen Psychiatry*, 1979; **36**: 103–16.
40. **Horne J**. Short sleep is a questionable risk factor for obesity and related disorders: statistical versus clinical significance. *Biol Psychol*, 2008; **77**:266–76.
41. **Patel S R**, **Malhotra A**, **Gottlieb D J**, *et al.* Correlates of long sleep duration. *Sleep*, 2006; **29**:881–89.
42. **Ohayon M M**, **Carskadon M A**, **Guilleminault C**, *et al.* Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep*, 2004; **27**:1255–73.
43. **Habte-Gabr E**, **Wallace R B**, **Colsher P L**, *et al.* Sleep patterns in rural elders: demographic, health, and psychobehavioral correlates. *J Clin Epidemiol*, 1991; **44**:5–13.
44. **Kronholm E**, **Harma M**, **Hublin C**, *et al.* Self-reported sleep duration in Finnish general population. *J Sleep Res*, 2006; **15**:276–90.
45. **Natale V**, **Adan A**, **Fabbri M**. Season of birth, gender, and social–cultural effects on sleep timing preferences in humans. *Sleep*, 2009; **32**:423–26.
46. **Kripke C**, **Brunner R**, **Freeman R**, *et al.* Sleep complaints of postmenopausal women. *Clin J Women's Health*, 2001; **1**:8.
47. **Fukasawa K**, **Aikawa H**, **Okazaki I**, *et al.* Perceived sleepiness of non-shift working men in two different types of work organization. *J Occup Health*, 2006; **48**:230–38.
48. **Borbely A A**. A two process model of sleep regulation. *Hum Neurobiol*, 1982; **1**:195–204.
49. **Daan S**, **Beersma D G**, **Borbely A A**. Timing of human sleep: recovery process gated by a circadian pacemaker. *Am J Physiol*, 1984; **246**:R161–83.
50. **Dijk D J**, **Czeisler C A**. Contribution of the circadian pacemaker and the sleep homeostat to sleep propensity, sleep structure, electroencephalographic slow waves, and sleep spindle activity in humans. *J Neurosci*, 1995; **15**:3526–38.
51. **Folkard S**, **Akerstedt T**. Towards a model for the prediction of alertness and/or fatigue on different sleep/wake schedules. In: Oginski A, Polorki J, Rutenfranz J, Eds. *Contemporary advances in shift-work research: Theoreticsl and practical aspects in the late eighties*. Krakow: Medical Academy, 1987: 231–40.
52. **Lin J S**. Brain structures and mechanisms involved in the control of cortical activation and wakefulness, with emphasis on the posterior hypothalamus and histaminergic neurons. *Sleep Med Rev*, 2000; **4**:471–503.
53. **Heath A C**, **Kendler K S**, **Eaves L J**, *et al.* Evidence for genetic influences on sleep disturbance and sleep pattern in twins. *Sleep*, 1990; **13**:318–35.
54. **Taheri S**, **Mignot E**. The genetics of sleep disorders. *Lancet Neurol*, 2002; **1**:242–50.
55. **Taub J M**, **Berger R J**. Extended sleep and performance – Rip Van Winkle Effect. *Psychon Sci*, 1969; **16**:204–05.
56. **Taub J M**, **Berger R J**. Altered sleep duration and sleep period time displacements: effects on performance in habitual long sleepers. *Physiol Behav*, 1976; **16**:177–84.
57. **Ohayon M M**. Prevalence and correlates of nonrestorative sleep complaints. *Arch Intern Med*, 2005; **165**:35–41.
58. **Fichten C S**, **Libman E**, **Creti L**, *et al.* Long sleepers sleep more and short sleepers sleep less: a comparison of older adults who sleep well. *Behav Sleep Med*, 2004; **2**:2–23.
59. **Alapin I**, **Fichten C S**, **Libman E**, *et al.* How is good and poor sleep in older adults and college students related to daytime sleepiness, fatigue, and ability to concentrate? *J Psychosom Res*, 2000; **49**:381–90.
60. **Vatthauer K**. Psychological, demographic, academic, and sleep predictors of academic performance in college students. Unpublished thesis: University of North Texas. Available November 2009, from KarlynVatthauer@my.unt.edu; 2009.
61. **Taylor D J**, **Bramoweth A D**. Long sleepers in a sample of college students. Unpublished raw data available from AdamBramoweth@my.unt.edu. 2009.

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CUUK1187-23 cuuk1187/Thorpy Design: Med 246 ISBN: 978 0 521 19886 8 August 23, 2010 19:48

62. **Pilcher J J**, **Ginter D R**, **Sadowsky B**. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *J Psychosom Res*, 1997; **42**:583–96.

63. **Pilcher J J**, **Schoeling S E**, **Prosansky C M**. Self-report sleep habits as predictors of subjective sleepiness. *Behav Med*, 2000; **25**:161–68.

64. **Bailes, S**, **Baltzan, M**, **Rizzo, D**, *et al*. The Sleep Symptoms Checklist: useful for screening but not diagnosis. *Sleep*, 2008; **31**(Abstract Supplement), #0514, p. A171.

65. **Smets E M A**, **Garssen B**, **Bonke B**, **De Haes J C J M**. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. *J Psychosom Res*, 1995, **39**:315–25.