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Identifying diverse forms of (un)healthy sleep: Sleep profiles differentiate adults' psychological and physical well-being

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ABSTRACT

Rationale: Sleep health is best described by the co-occurrence of various dimensions (e.g., regularity, daytime alertness, satisfaction, efficiency, duration) but is rarely measured this way. Information is needed regarding common within-person patterns of sleep characteristics among adults and their relative healthiness.

Objective: To deepen understanding of healthy and unhealthy sleep, the present study aimed to uncover multi-dimensional sleep profiles in adults and their associations with a variety of psychological and physical well-being outcomes.

Methods: Survey data from 4622 adults who participated in the Midlife in the United States (MIDUS) project was used to identify latent sleep profiles across five core sleep dimensions. Adjusting for individual sleep dimensions and sociodemographic covariates, General Linear Models were used to test the associations of sleep profile membership with hedonic and eudemonic well-being and chronic physical conditions.

Results: Four latent sleep profiles were revealed, good sleepers, sufficient but irregular sleepers, nappers, and short, dissatisfied, and inefficient sleepers. The profiles differentially related to well-being outcomes above and beyond individual sleep dimensions and sociodemographic covariates. Good sleepers generally reported the best outcomes, and short, dissatisfied, and inefficient sleepers generally reported the worst outcomes.

Conclusion: Four common sleep profiles describe adults' holistic sleep experiences and predict a variety of well-being outcomes beyond other known predictors. In adulthood, healthy sleep may involve sufficient sleep across all dimensions whereas unhealthy sleep may involve insufficient sleep across three key dimensions: duration, satisfaction, and efficiency.

1. Introduction

Good sleep is one of the most important factors for well-being (Dement and Vaughan, 1999; Lopresti et al., 2013; Wickham et al., 2020). For instance, sufficient sleep duration is meta-analytically associated with lower risk of depression (Zhai et al., 2015), stroke (Cappuccio et al., 2011), and all-cause mortality (Gallicchio and Kalesan, 2009). Yet theoretical understanding of sleep health is complicated by its multidimensionality. Buysse (2014) suggests six dimensions indicative of optimal sleep health: regularity, satisfaction, alertness, timing, efficiency, and duration (Ru-SATED). Good sleep therefore theoretically involves the co-occurrence of a variety of positive quantitative (e.g., duration, regularity) and qualitative (e.g., satisfaction) characteristics. In this way, good sleep is not simply a function of achieving seven to 9 h (Hirshkowitz et al., 2015a, b) or subjectively satisfying sleep (Knutson et al., 2017) alone, for example, but rather each of these experiences and more in combination.

An emerging line of research shows that a composite score of sleep health, which tallies a person's sleep characteristics across Buysse's (2014) dimensions, predicts well-being across age groups, even beyond prediction by the separate dimensions. The utility of sleep composite scores was recently demonstrated in a study of adolescents wherein a higher composite healthy sleep score was consistently associated with lower depressive and anxiety symptoms, fewer social problems related to friends and family, and lower odds of obesity (Dong et al., 2019). Moreover, in a sample of middle-aged adults, a higher unhealthy composite score (i.e., pointing to problems with sleep) was associated with more perceived stress and chronic conditions (Lee and Lawson, 2021). Although these studies pave the way to examining an a priori sleep health score by demonstrating that more sleep problems are worse for

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health, they cannot capture the unique, differential relations specific sleep dimensions exhibit with health and well-being (Astill et al., 2012; Bassett et al., 2015; Fischer et al., 2020; Pilcher et al., 1997). An empirically-derived approach, however, can reveal more nuanced and diverse patterns of sleep health (Matricciani et al., 2018) that specify not only *how many* but *which* sleep issues co-occur and, in doing so, may provide more detailed prediction of well-being.

Supporting the need to identify diverse forms of sleep health, there is increasing evidence that sleep characteristics interact with each other. Specifically, the additive effects of sufficient sleep quantity and good sleep quality are repeatedly found for reducing risk of negative health outcomes such as hypertension (Lu et al., 2015), cardiovascular disease (Vgontzas et al., 2009), and type 2 diabetes (Lou et al., 2015). Further, sleep quantity and regularity also interact such that sufficiently long sleep does not protect against psychological strain unless achieved regularly (Barber et al., 2010). These findings suggest that the association between a given sleep characteristic and well-being may depend on other sleep characteristics that person also experiences. Person-centered approaches are needed to explore the co-occurrence of sleep characteristics within persons and the implications these within-person patterns (i.e., latent sleep profiles) have for health and well-being outcomes (Matricciani et al., 2018).

Several studies have identified sleep profiles, mostly in specifically targeted populations. These results offer early evidence that empirically-derived sleep profiles from a given sample are indicative of their health. For example, sleep profiles in children are associated with their food consumption, physical activity (Matricciani et al., 2020), quality of life (Magee et al., 2017), and body mass index (Lee et al., 2018; Magee and Blunden, 2020). Other studies have examined sleep profiles among community-dwelling older adults (Wallace, 2019), adults with major depressive disorder (Selvi et al., 2018), and, more broadly, Australian employees (Magee et al., 2016, 2019) and Australian parents (Matricciani et al., 2021). Thus far, however, there has been an underemphasis on understanding sleep profiles in general adulthood, even though this group offers a unique opportunity to identify more diverse forms of unhealthy sleep. Adults generally experience shorter sleep, irregularity in sleep timing between weekdays and weekends, longer time to fall asleep, and age-related disruptions to sleep quality (Ohayon et al., 2017). Further, although the nascent research literature on adult sleep profiles does consistently reveal an optimal profile (i.e., *good sleepers*) across samples and analysis methods (Magee et al., 2019; Matricciani et al., 2021; Selvi et al., 2018; Wallace, 2019), the number and nature of various suboptimal adult sleep profiles is highly inconsistent. Dedicated attention is needed to uncover healthy and, especially, unhealthy sleep profiles in adulthood and their implications for well-being.

Drawing on Buysse's (2014) framework of multidimensional sleep health, the present study aimed to provide more holistic understanding of how healthy and unhealthy sleep look during adulthood by considering within-person patterns of sleep characteristics. We used a large, nationally representative sample of adults to (1) identify common latent sleep profiles and (2) determine their associations with hedonic well-being (i.e., positive and negative affect, life satisfaction), eudemonic well-being (i.e., psychological well-being), and physical health (i.e., number of chronic physical conditions). Based on the previous research outlined above (Matricciani et al., 2021; Selvi et al., 2018; Wallace, 2019), we expected to identify a *good sleeper* profile that exhibits optimal sleep health across multiple dimensions; this group was expected to have comparatively positive well-being based on Buysse's framework. Because other relatively suboptimal sleep profiles in middle adulthood have not been consistently identified, we did not have a priori hypotheses about these potential subgroups but, rather, explored which suboptimal sleep profiles (i.e., those experiencing one or more undesirable sleep characteristics) emerged and their respective associations with well-being. In total, our examination of common sleep profiles in general adults and their associations with well-being outcomes may deepen scholarly understanding of sleep health and potentially inform better sleep health interventions.

2. Methods

2.1. Data

The present data was collected as part of the Midlife in the United States study (i.e., MIDUS II core and Milwaukee samples), which aimed to understand the relationship between aging and health. MIDUS II (M2) was conducted from 2004 to 2009 as a follow up to original MIDUS I survey and added an extensive sleep questionnaire (Ryff and Krueger, 2018). MIDUS II Milwaukee (MIL) was conducted from 2005 to 2006 for the purposes of adding racial diversity to the MIDUS II survey data by targeting African American participants. Out of 4963 individuals who participated in M2, 931 individuals did not complete self-administered questionnaire (SAQ) that included sleep questions. In MIL, 592 participants completed the SAQ. Combining M2 and MIL, 4624 people provided SAQ data. Two additional respondents were excluded due to missingness on all sleep variables, resulting in an analytic sample of 4622. The 933 respondents not included in the analytic sample did not differ in education ($t(5545) =$ -0.89, $p = .37$, $d = -0.03$) or self-rated health ($t(5535) = 0.09$, $p = .93$, $d = 0.003$) compared those in the analysis sample ($n = 4622$). The two groups did differ in age ($t(5552) =$ -8.29, $p < .001$, $d = -0.30$), sex ($\chi^2(1,5554) = 43.68$, $p < .001$, $\varphi =$ 0.09), and race ($\chi^2(1,5525) = 7.91$, $p = .005$, $\varphi = 0.04$), such that the analysis sample was slightly older ($M = 55.65$ vs. $M = 51.96$), had a slightly lower proportion of white participants (80.23% vs. 84.67%), and had a greater proportion of females (56.29% vs. 44.48%) compared to excluded sample; however, all effects were small in size (i.e., $d<|0.50|$ or $\varphi<|0.30|$).

2.2. Measures

2.2.1. Sleep health characteristics

Sleep was measured by self-report assessment of five dimensions that are critical for optimal functioning and health (Buysse, 2014): regularity, satisfaction/quality, alertness, efficiency, and duration. Sleep timing included in Buysse's dimensions was not captured in the M2 or MIL survey data. Sleep dimensions were assessed in general (e.g., "usually" or "during a usual week"), rather than over a specific period of time. Table 1 shows how each of these sleep dimensions was assessed. *Regularity* was calculated by taking the absolute value of typical workday/weekday sleep duration per main sleep period subtracted from typical non-workday/weekend sleep duration per main sleep period, such that high scores indicated greater irregularity in the hours slept across the week. *Satisfaction* ($\alpha = .80$) was calculated as an average of four items capturing frequency (5-point Likert-type scale from 1 = never to 5 = almost always) of feeling unrested during the day, trouble falling asleep, waking up during the night, and waking up too early in the morning. Most of these items captured insomnia symptoms, and higher scores indicated more dissatisfaction. Daytime *alertness* was operationalized as nap frequency, as captured by an item asking how many times in a usual week the respondent naps for 5 or more minutes; higher scores indicated more frequent naps and therefore less daytime alertness. *Efficiency* was captured by an item asking how long it takes the respondent to fall asleep at bedtime, such that higher scores indicated longer sleep onset latency (see Buysse, 2014) and less inefficient sleep. Finally, *duration* was captured by an item asking how much sleep the respondent usually gets at night (or in their main sleep period) on weekdays/workdays.

2.3. Eudemonic well-being

General psychological well-being ($\alpha = .89$). Psychological well-being was assessed using Ryff's (1989) 42-item Psychological Well-being Scale (1 = agree strongly to 7 = disagree strongly), which has been

Table 1
Sleep dimension measurement.

Sleep dimension	Item(s)	Scoring
RU Regularity	1. How much sleep do you usually get at night (or in your main sleep period) on weekdays or workdays? 2. How much sleep do you get at night (or in your main sleep period) on weekends or your nonworkdays?	Absolute value (Weekday sleep duration – weekend sleep duration) (i.e., higher score = more irregularity, in hours)
S Satisfaction	Please indicate how often you experience each of the following: 1. Feel unrested during the day, no matter how many hours of sleep you had. 2. Have trouble falling asleep 3. Wake up during the night and have difficulty going back to sleep 4. Wake up too early in the morning and be unable to go back to sleep	Average score (α =), with each item scales from 1 to 5 (i.e., higher score = more dissatisfaction)
A Alertness	1. During a usual week, how many times do you nap for 5 min or more?	Number of naps (i.e., higher score = less daytime alertness)
E Efficiency	1. How long does it usually take you to fall asleep at bedtime?	Sleep latency or time to get to sleep (i.e., higher score = greater inefficiency, in hours)
D Duration	1. How much sleep do you usually get at night (or in your main sleep period) on weekdays or workdays?	Sleep quantity on workdays, in hours

Note. Sleep timing (i.e., the "T" in "RUSATED"; Buysse, 2014) was not captured in the M2 or MIL survey data.

previously validated (Boylan and Ryff, 2015). The scale included six sub dimensions (i.e., autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance; see Gallagher et al., 2009; Ryff and Singer, 2006), scored as a sum of seven items within each sub dimension such that the maximum score for each dimension was 49; these scale scores were averaged to form a composite well-being score. Higher scores indicated better psychological well-being.

2.4. Hedonic well-being

Affect. Positive affect (α = 0.86) and negative affect (α = 0.80) were assessed using items primarily from the Positive and Negative Affect Schedule (PANAS, Watson et al., 1988). These scales have been previously validated (e.g., Boylan and Ryff, 2015; Elliot and Chapman, 2016). Participants rated the extent (1 = none of the time to 5 = all of the time) to which they experienced four positive affect items (e.g., "proud", "active") and five negative affect items (e.g. "upset", "irritable") over the past 30 days.

Life satisfaction (α = 0.65). Life satisfaction was assessed as a composite of satisfaction (0 = worst possible to 10 = best possible) with five key life dimensions, life overall, work, health, relationship with spouse/partner, and relationships with children, each assessed with one item within the present timeframe (i.e., "these days") (Prenda and Lachman, 2001). This scale has been previously validated (Boehm et al., 2015; Boylan and Ryff, 2015).

2.5. Physical well-being

Chronic physical conditions. Chronic health conditions were assessed via a checklist of 27 items (e.g., stroke, diabetes, high blood pressure, and thyroid disease; see supplemental Table 1 for full list of conditions). The original checklist of 30 items was slightly abridged to exclude sleep conditions, which overlap with the independent variables in the present study, and conditions not strictly related to physical health (i.e., substance abuse, emotional disorders). Respondents reported experiencing or being treated for each chronic condition over the past twelve months (yes or no), and we used the sum across the 27 conditions, consistent with previous studies (Keyes, 2005; Lee and Lawson, 2021).

2.6. Control variables

Several sociodemographic variables related to sleep and well-being were included as control variables. This choice was generally motivated by research showing not only that both sleep (e.g., Basner et al., 2014; Whinnery et al., 2014) and health/well-being (e.g., Chrouser Ahrens and Ryff, 2006; Ryff et al., 2021) differ across sociodemographic groups but that sleep, well-being, and sociodemographic variables are highly interconnected (e.g., Grandner, 2016; Jackson et al., 2015). Thus, a variety of sociodemographic variables measured in the MIDUS dataset were included as potential confounds: age, sex (0 = female, 1 = male), race (0 = non-White, 1 = White), education (continuous rating 1–12), marital status (0 = single, 1 = married/cohabiting), parental status (0 = non-parent, 1 = parent), work status (0 = nonworker, 1 = worker), and nontraditional work schedule (0 = standard daytime/weekday work schedule or nonworker, 1 = nonstandard). Sub-sample identifier (M2 = 0, MIL = 1) was also included as a control, given differences in sampling strategy.

2.7. Analytic strategy

Following calculation of descriptive statistics and correlations, latent profile analysis (LPA) was conducted to identify the ideal profile solution (i.e., the number of sleep profiles present) using robust maximum likelihood (MLR) in *MPlus* 7. Degree of missingness in the data was low (3.80% for sleep variables, 1.50% for well-being variables, and 5.05% for sociodemographic covariates) relative to other published research (see Peng et al., 2006). As mentioned, sleep inefficiency and irregularity were skewed. Thus, MLR was chosen because it can account for non-normal and missing data with greater efficiency and less bias than multiple imputation strategies, so long as sample size is not small (Yuan et al., 2012). The raw scores of the five sleep characteristics were used as indicators for the LPA. Model fit criteria were compared across various profile solutions (i.e., one-profile solution to six-profile solution) to determine the solution with best holistic fit (Nylund et al., 2007). Lower scores on Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Sample Size Adjusted Bayesian Information Criterion (SSA-BIC) indicate comparatively better fit. Entropy describes the distinctness of the profiles using estimated profile probability, ranging from 0 to 1, with a higher value indicating greater precision in profile classification. Significant Bootstrap Likelihood Ratio Test (BLRT) and Vuong-Lo-Mendell-Rubin Likelihood ratio test (VLMR-LRT) indicate the current model fits better than the prior model. Following identification of the best-fitting profile solution, each participant was assigned to a profile based on their highest membership probability. Finally, we used several General Linear Models in SPSS 27 (controlling for the previously mentioned sociodemographic covariates) to determine whether the sleep profile membership is associated with psychological well-being, positive affect, negative affect, life satisfaction, and number of chronic physical conditions.

3. Results

3.1. Descriptive results

The analysis sample ($N = 4622$) exhibited an approximately even sex distribution (56.30% female) but was majority white (80.23%) and educated (64.06% received schooling beyond high school). Participants were 55.65 years old on average ($SD = 12.45$); 74% of participants were in their 40s, 50s, or 60s, with the youngest participant being 30 and oldest being 85 (see Table 2 for additional details). Descriptive statistics and correlations are reported in Table 3. Overall, sleep variables were not highly correlated with each other ($.01 \leq |r| \leq 0.46$), indicating that each sleep dimension provides unique and independent information. Correlations among the well-being and chronic physical condition variables were also not high ($.10 \leq |r| \leq 0.40$) but were in the expected direction.

By checking the distribution of the sleep variables, we removed potential outliers (i.e., approximately the top 1% of responses) for two sleep variables that were skewed. Specifically, sleep inefficiency data was removed for 22 participants who reported taking longer than 3 h to fall asleep each night, and sleep irregularity data was removed for 40 participants who reported a difference between weekday and weekend sleep greater than 7 h.

3.2. Sleep profile identification

The model fit statistics for the one-profile through six-profile solutions are provided in Table 4. The AIC, BIC, and SSA-BIC values each reached a minimum at the four-profile solution, suggesting its superiority. Entropy was sufficient (i.e., >0.80, Clark & Muthén, n.d.)) for all solutions and therefore was not used in profile selection (Lubke and Muthén, 2007). As is sometimes the case with large sample sizes (Morin and Marsh, 2015), BLRT did not reach a point of non-significance and therefore did not point to any one solution as superior. LMR recommended the five-profile solution given that it reached a point of non-significance at the six-profile solution. Based on holistic evaluation of all model fit statistics, both the four- and five-profile solutions appeared viable and were therefore compared in terms of conceptual interpretability (Spurk et al., 2020). The comparison of the two solutions (see supplemental Table 2 and supplemental Fig. 1a and 1b) suggested that the five-profile solution did not add a qualitatively distinct profile to the four-profile solution. Further, the four-profile solution also emerged as superior when alternative clustering methods were used (i.e., latent class analysis described in the supplemental Tables 3-5 and supplemental Figure 2). As such, four sleep profiles were identified.

Fig. 1 displays the four sleep profiles identified by the LPA (depicted as z-scores for increased interpretation), with the raw mean sleep dimension scores for each profile included in Table 5. The first and most common profile (71.01%, n = 3282) was named *good sleepers* because it is characterized by age-appropriate optimal sleep duration ($M = 7.01$ h), the lowest sleep dissatisfaction and inefficiency, the least frequent naps, and little irregularity between weekday and weekend sleep (about a 30-min difference between the two on average). The second profile (19.19%, n = 887) was named *nappers* because it is primarily characterized by high nap frequency ($M = 6.10$ per week) and insufficient sleep duration ($M = 6.65$ h). The third profile (6.66%, n = 308) was named *short, dissatisfied, and inefficient* sleepers because it is characterized by the shortest ($M = 5.43$ h), most dissatisfying ($M = 4.00$ out of 5.00), and most inefficient sleep ($M = 1.75$ h between getting in bed and falling asleep). The fourth profile (3.14%, n = 145) was named *sufficient but irregular sleepers* because it is characterized by optimal sleep duration ($M = 7.03$) but highly irregular sleep between weekdays and weekends ($M = 5.98$ h difference between the two).

3.3. Associations between sleep profiles and psychological and physical well-being

Across the well-being outcomes, *good sleepers* exhibited the best well-being and *short, dissatisfied, and inefficient sleepers* exhibited the worst well-being. Both *sufficient but irregular sleepers* and *nappers* were typically in the middle. Fig. 2 summarizes the associations of sleep profiles with psychological and physical well-being indicators, with detailed differences described below and in Supplemental Table 6.

Psychological well-being. The sleep profiles significantly differed on psychological well-being ($F(3,4928) = 6.87$, $p<.001$); $\eta_p^2 = 0.01$). Equality of means tests specified *good sleepers* ($M = 35.80$) reported significantly higher psychological well-being than did *nappers* ($M = 34.55$), and both groups reported higher well-being than did *short, dissatisfied, and inefficient sleepers* ($M = 32.70$). *Sufficient but irregular sleepers* ($M = 34.23$) reported psychological well-being lower than *good sleepers*, similar to *nappers*, and lower than *short, dissatisfied, and inefficient sleepers*; however, these differences did not reach statistical significance. These differences in psychological well-being by sleep profiles were independent of sociodemographic characteristics. Those who were older ($\beta = .06$, $p < .001$), more educated ($\beta = 0.09$, $p < .001$), and were parents ($\beta = 0.04$, $p = .01$) reported higher psychological well-being.

Positive and negative affect. The sleep profiles did significantly differ on positive affect ($F(3,4220) = 41.24$, $p < .001$); $\eta_p^2 = 0.03$). Equality of means tests specified that *good sleepers* ($M = 3.77$) reported the highest positive affect, followed by *sufficient but irregular sleepers* ($M = 3.65$) and *nappers* ($M = 3.60$) who did not significantly differ from one another; finally, *short, dissatisfied, inefficient sleepers* reported the lowest positive affect ($M = 3.24$). The sleep profiles also significantly differed on negative affect ($F(3,4193) = 70.55$, $p < .001$); $\eta_p^2 = 0.05$). Equality of means tests specified that *good sleepers* ($M = 1.46$) reported the lowest negative affect, followed by both *sufficient but irregular sleepers* ($M = 1.64$) and *nappers* ($M = 1.58$) who again did not significantly differ from one another; finally, *short, dissatisfied, and inefficient sleepers* reported the highest negative affect ($M = 2.03$). Again, these associations were independent of sociodemographics. Higher positive affect was reported by

Table 2
Sample characteristics.

Category	%
Age	
30-39	9.91%
40-49	25.27%
50-59	27.91%
60-69	20.86%
70-79	12.96%
80-89	3.09%
Sex	
Male	43.70%
Female	56.30%
Race	
White	80.23%
Black	16.27%
Asian	0.28%
All other races	3.22%
Education	
Did not graduate high school	9.32%
High school degree	26.67%
Some college, no degree	21.60%
College degree	25.13%
> Bachelor's degree	17.29%
Marital status	
Unmarried	39.03%
Married or cohabitating	60.97%
Work status	
Nonworker (e.g., unemployed, retired)	48.36%
Worker	51.64%
Work schedule	
Nonstandard (i.e., works nights and/or weekends at least once per week)	27.03%
Standard (i.e., nonworker or worker with a traditional work schedule)	72.97%

$N = 4622$.

Table 3
Correlations and descriptive statistics.

	M	*SD*	1	2	3	4	5	6	7	8	9
1. Sleep irregularity	0.73	1.24									
2. Sleep dissatisfaction	2.54	0.92	.01								
3. Nap frequency	2.09	2.56	-.02	.10							
4. Sleep inefficiency	0.38	0.39	.05	.46	.02						
5. Sleep duration	6.83	1.36	-.07	-.32	-.10	-.22					
6. Psychological well-being	35.31	11.68	-.03	-.18	-.05	-.09	.05				
7. Positive affect	3.70	0.80	-.05	-.31	-.08	-.16	.11	.29			
8. Negative affect	1.53	0.66	.10	.38	.06	.26	-.15	-.25	-.40		
9. Life satisfaction	7.27	1.99	.01	-.12	-.02	-.12	.08	.10	.14	-.17	
10. # of chronic conditions	2.24	2.33	-.04	.27	.17	.18	-.12	-.19	-.19	.30	-.11

Note. $N = 4622$. Bold face font indicates a significant correlation ($p < .05$).

Table 4
Model fit statistics for latent profile solutions.

No. of profiles	Free parameters	LL	AIC	BIC	SSA-BIC	Entropy	LMR(*p*)	BLRT(*p*)
1	10	−34009	68037.5	68101.9	68070.1			
2	16	−32194	64420.2	64523.2	64472.4	.94	138.95 (p < .001)	−34008.73 (p < .001)
3	22	−30851	61745.8	61887.5	61817.5	.96	2634.39 (p < .001)	−32194.11 (p < .001)
4	28	−30329	60713.3	60893.6	60804.6	.90	1024.29 (p < .001)	−30850.90 (p < .001)
5	34	−29838	59743.3	59962.2	59854.2	.90	962.96 (p = .01)	−30328.64 (p < .001)
6	40	−29486	59052.9	59310.5	59183.4	.91	688.77 (p = .08)	−29836.65 (p < .001)

Note. $N = 4622$.

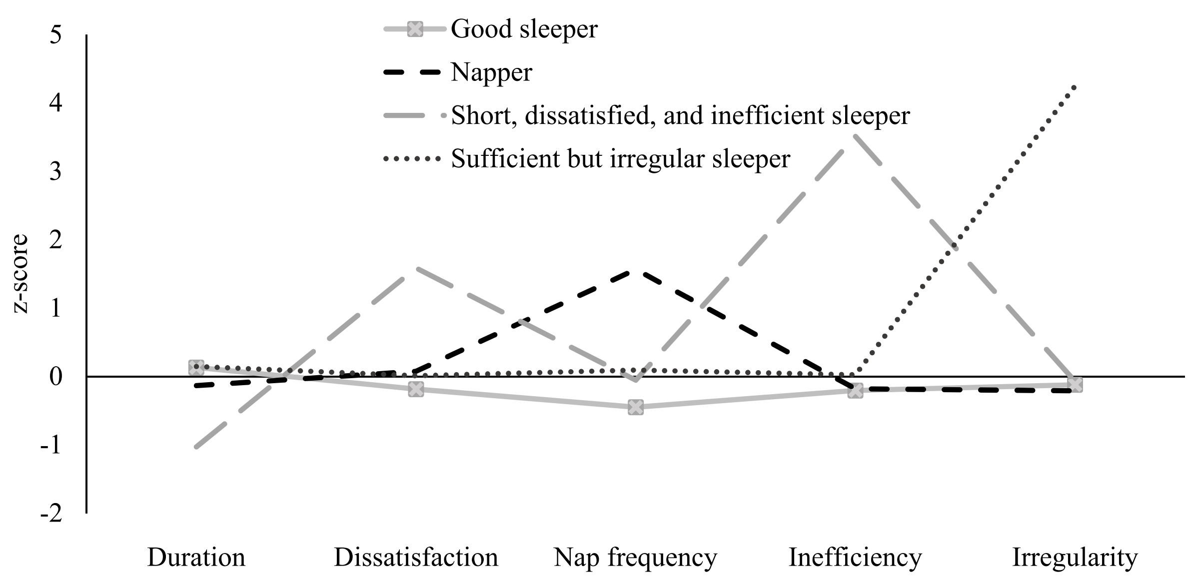

Fig. 1. *Z*-scores of the sleep facets across the four sleep profiles. *Note.* Raw scores on the sleep dimensions were used in the analyses, but z-scores are depicted in this figure for ease of interpretation. The x-axis at 0 therefore represents the sample mean.

Table 5
Raw mean sleep dimension scores for the four-profile solution.

Profile #	Profile Name	n (%)	Duration	Dissatisfaction	Nap Freq.	Inefficiency	Irregularity
1	Good sleeper	3282 (71.10%)	7.01	2.37	0.94	0.30	0.58
2	Napper	887 (19.19%)	6.65	2.61	6.10	0.31	0.47
3	Short, dissatisfied, and inefficient sleeper	308 (6.66%)	5.43	4.00	1.95	1.75	0.64
4	Sufficient but irregular sleeper	145 (3.14%)	7.03	2.55	2.33	0.39	5.98
			1,4 > 2>3[a]	3 > 2,4 > 1[a]	2 > 4>3 > 1[a]	3 > 4>1,2[a]	4 > 1,3 > 2[a]

Note. $N = 4622$. [a] = significant differences in mean facet scores across profiles.

those who were older (β = 0.15, $p < .001$), more educated (β = 0.07, $p < .001$), non-white (β = −0.07, $p < .001$), workers (β = 0.06, $p < .0001$), and parents (β = 0.05, $p = .002$); lower negative affect was reported by those who were older (β = −0.23, p < .001), male (β = −0.06, $p < .001$), more educated (β = −0.08, $p < .001$), white (β = −0.07, p < .001), and workers (β = −0.14, $p < .001$).

Life satisfaction. The sleep profiles did significantly differ on life satisfaction ($F(2,3839) = 8.50$, $p < .001$); $\eta_p^2 = 0.01$). Equality of means

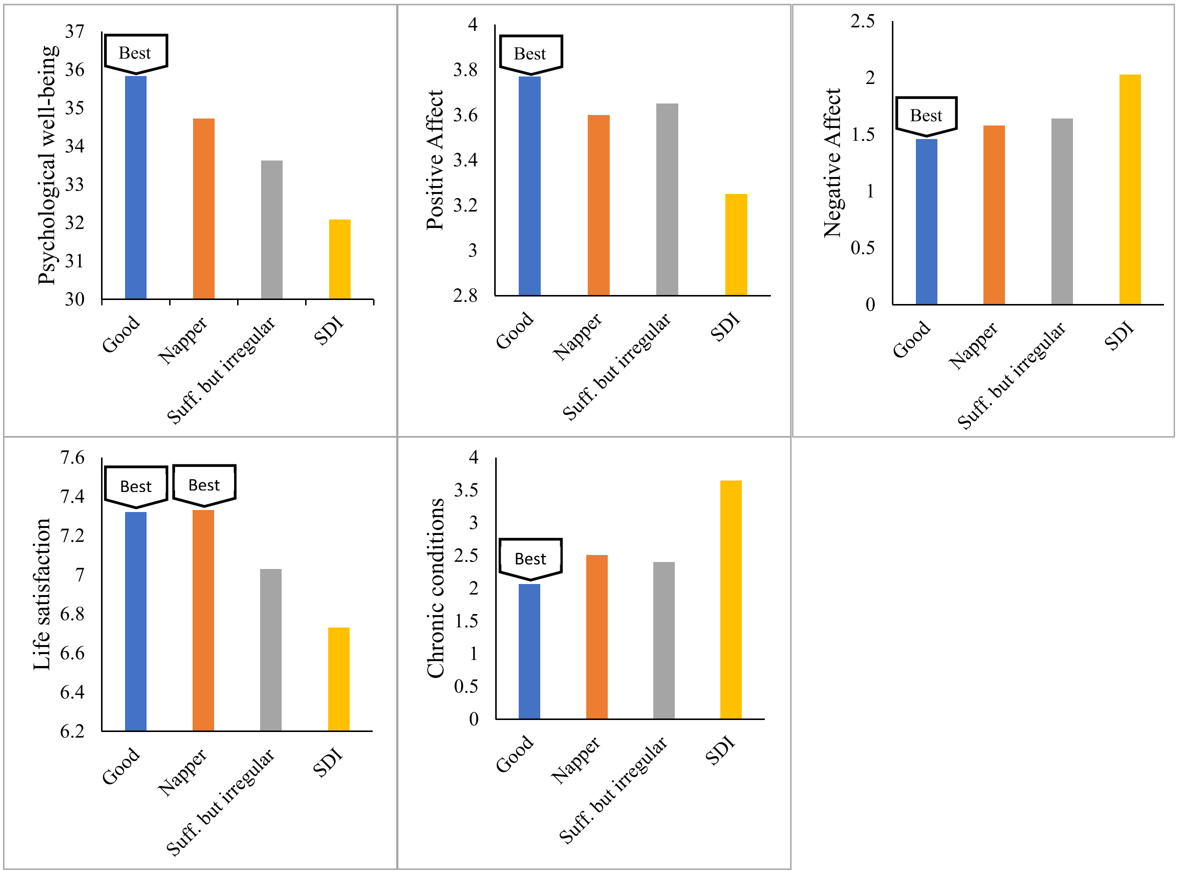

Fig. 2. Psychological and physical well-being averages for the four latent sleep profiles. *Note*. SDI = short, dissatisfying, and inefficient sleeper. Suff. but irregular = sufficient but irregular sleeper.

tests specified that *good sleepers* ($M = 7.32$) and *nappers* ($M = 7.33$) reported the highest life satisfaction but did not differ from one another; both *good sleepers* and *nappers* reported higher life satisfaction than did *short, dissatisfied, and inefficient sleepers* ($M = 6.73$). *Sufficient but irregular sleepers* ($M = 7.03$) reported life satisfaction lower than *good sleepers* and *nappers* and higher than *short, dissatisfied, and inefficient sleepers*, but these differences again did not reach statistical significance. These associations were independent of sociodemographics. Life satisfaction was positively associated with education ($\beta = 0.07, p < .001$), worker status ($\beta = 0.06, p < .001$), and parental status ($\beta = 0.05, p = .002$), but negatively associated with being white ($\beta = -0.07, p < .001$).

Chronic physical conditions. Lastly, the sleep profiles did significantly differ on the number of chronic conditions ($F(3,4231) = 46.45, p < .001$); $\eta_p^2 = 0.03$). Equality of means tests specified that *good sleepers* ($M = 2.07$) exhibited the fewest chronic conditions, followed by *nappers* ($M = 2.51$), followed finally by *short, dissatisfied, and inefficient sleepers* ($M = 3.65$). *Sufficient but irregular sleepers* ($M = 2.40$) exhibited significantly fewer chronic conditions than did *short, dissatisfied, and inefficient sleepers* but did not significantly differ from either *good sleepers* or *nappers*, putting them relatively in the middle. As before, these associations were independent of sociodemographics. A higher frequency of chronic conditions was reported by older participants ($\beta = 0.16$, $p < .001$) whereas a lower frequency was reported by males ($\beta = -0.09, p < .001$), more educated participants ($\beta = -0.11, p < .001$), white participants ($\beta = -0.10, p < .001$), workers ($\beta = -0.12, p < .001$), and those with nontraditional work schedules ($\beta = -0.04, p = .008$).

3.4. Supplemental analyses

To assess the unique property of sleep profiles' associations with psychological and physical well-being, we additionally tested (1) whether individual sleep variables were associated with the five well-being outcomes and (2) whether the sleep profiles incrementally predicted the outcomes when individual sleep characteristics were considered (see Supplemental Table 7). Almost all relations between individual sleep characteristics and the five outcomes were significant. Above and beyond each of the individual sleep characteristics, *good sleepers* largely emerged as superior (i.e., more desirable well-being) to (a) *short, dissatisfied and inefficient sleepers* on psychological well-being and number of chronic health conditions, (b) *nappers* and *short, dissatisfied, and inefficient sleepers* on positive affect, and (c) all three other profiles on negative affect and life satisfaction. In total, the four identified sleep profiles do seem to provide additional information above and beyond individual sleep characteristics for a variety of well-being outcomes, though to differing specificity depending on the outcome.

4. Discussion

The present study applied Buysse's (2014) multidimensional sleep health framework to identify four sleep phenotypes in a nationally representative sample of adults. In line with past research (Selvi et al., 2018; Matricciani et al., 2021; Wallace, 2019), a sizable *good sleeper* profile emerged, which exhibited sufficient standings on all five measured sleep characteristics. We also uncovered three new suboptimal sleep profiles: *sufficient but irregular sleepers, nappers,* and *short, dissatisfied, and inefficient sleepers*. The latent profile approach to sleep not only provided descriptive value by characterizing adults' multidimensional sleep experiences but predictive value of the resulting sleep phenotypes for a variety of psychological and physical well-being indicators, above and beyond sociodemographics and individual sleep dimensions. Overall, the present findings support the multidimensional sleep health perspective (Buysse, 2014) by identifying diverse forms of healthy and unhealthy sleep profiles among adults and their associations with psychological and physical well-being outcomes.

4.1. Diverse patterns of suboptimal sleep

As mentioned, we replicated previous findings that a *good sleeper* profile exhibits desirable standing across a variety of sleep dimensions (Selvi et al., 2018; Wallace, 2019) but also added to understanding of diversity in unhealthy sleep experiences by identifying three unique suboptimal sleep profiles. The *napper* profile that exhibited frequent daytime naps and somewhat short nighttime sleep duration ($M = 6.65$ h) was the most prevalent form of suboptimal sleep (19%) in our sample of adults. Another suboptimal profile, *sufficient but irregular sleepers* reported a large difference between sleep duration on weekdays and weekends despite sufficient sleep on weekdays. Irregular sleep is often a function of relatively long weekend sleep, which can compensate for some insufficiencies in weekday sleep (Im et al., 2017). Similarly, naps may at least partially compensate for insufficiencies in nighttime sleep (Faraut et al., 2017) As such, these two profiles indicate how an average adult in the U.S. may adjust to insufficient sleep during weekday nights, namely by taking daytime naps or by having longer weekend sleep. These profiles also reveal individual differences in the needed amount of sleep. Although 7 h of sleep per night is considered appropriate for an average healthy adult (Hirshkowitz et al., 2015a, b; Watson et al., 2015), some adults may need more sleep as evidenced in the *sufficient but irregular sleeper* profile.

The final suboptimal profile, *short, dissatisfied, and inefficient sleepers,* reported the co-occurrence of three negative sleep characteristics (short duration, high dissatisfaction, and inefficiency in the form of long sleep onset latency). One conceptual explanation for this sleep profile is that people who take longer to fall asleep (high inefficiency) inherently limit their available sleep time (short duration), both of which are likely dissatisfying and may lead to these three sleep experiences "hanging together". Also of note, this profile shares characteristics with insomniacs (Roth, 2007). Future research needs to examine whether this sleep profile relates to the progression of insomnia (e.g., early symptoms to clinical insomnia). Overall, these results (1) provide four phenotypes that clearly and holistically describe multifaceted sleep experiences in adults and (2) add details to knowledge of interrelations between key sleep facets.

4.2. Sleep profiles uniquely associate with psychological and physical well-being

Previous variable-centered research has identified sociodemographic factors (Coombs, 1991; Dorling, 2009; Schoenbaum and Waidmann, 1997) and individual sleep characteristics (Steptoe et al., 2008; Wickham et al., 2020) as core predictors of psychological and physical well-being. Using a more nuanced person-centered approach, our findings suggest that combinations of multiple sleep characteristics manifest as four novel phenotypes that are uniquely associated with psychological and physical well-being beyond sociodemographics and individual sleep characteristics. These results underscore past assertions that sleep characteristics often function differently together than they do individually (Barber et al., 2010; Lu et al., 2015) and demonstrate the added predictive value of considering multivariate sleep profiles for well-being specifically. The profile approach was especially effective in differentiating people's hedonic well-being (i.e., positive affect, negative affect, life satisfaction) beyond individual sleep characteristics and, at least for *good sleepers* versus *short, dissatisfied and inefficient sleepers*, in differentiating number of chronic physical conditions.

The present findings not only reinforce that studying multiple sleep characteristics simultaneously can improve statistical prediction of well-being but also clarify the relative (un)healthiness of said multidimensional patterns. Across various well-being indicators, our results generally rank *good sleepers* as comparatively superior, *nappers* and *sufficient but irregular sleepers* as relatively moderate, and *short, dissatisfied, inefficient sleepers* as inferior. These findings align with upon Buysse's (2014) definition of sleep health as "a multidimensional pattern" (p. 37) characterized by positive experiences on a variety of core sleep dimensions. Indeed, *good sleepers* demonstrated optimal standing on all measured sleep characteristics, and they indeed were the healthiest across all well-being outcomes examined in this study.

Our results also add nuance, though, to conceptualization of unhealthy sleep in Buysse's framework by demonstrating that suboptimal sleep patterns are not uniform in their unhealthiness. *Nappers* and *sufficient but irregular sleepers* are each definitionally suboptimal (i.e., insufficient on at least one of Buysse's sleep dimensions) and were often, in our results, empirically suboptimal compared to *good sleepers* on psychological and physical well-being outcomes. That being said, both *nappers* and *sufficient but irregular sleepers* typically reported better well-being than did the third suboptimal group, *short, dissatisfied, and inefficient sleepers*. The present findings therefore suggest that the experience of one or two suboptimal sleep experiences (specifically irregular weekday/weekend sleep duration alone or frequent naps with slightly short nighttime sleep) is less healthy than holistically sufficient sleep but that the unhealthiest sleep, at least of the patterns identified here, was characterized by the co-occurrence of three critical dimensions: short duration, low subjective quality or satisfaction, and inefficiency in the form of long sleep onset latency. Together, these three sleep experiences may be a core characteristic of unhealthy sleep in adults.

4.3. Limitations and future directions

Our results provide novel insights but should also be interpreted in the context of their limitations. First, sleep and psychological and physical well-being variables were collected at one time point, which limits our ability to determine the directionality between the variables. Indeed, sleep typically demonstrates bidirectional relations with such variables (Stewart et al., 2020; Zee and Turek, 2006). This study is a first step in identifying sleep profiles in a large, nationally representative sample of adults and those profiles' associations with well-being; further work is needed to uncover longitudinal associations following this initial study. To additionally increase rigor, future researchers could use latent transition analysis to determine when and why people may transition from one sleep profile to another over time. Second and relatedly, all sleep characteristics were measured via self-report measurement. Given mixed findings comparing self-reported sleep to objective sleep measurement (Girschik et al., 2012; Zinkhan et al., 2014), researchers should assess the generalizability of the presently identified profiles when measured via objective methods. Actigraphy methods, in particular, may be useful based on recent findings validating the multidimensional sleep health framework using actigraphy-measured facets (Wallace et al., 2021) and overcome potential recall bias and common-method bias between sleep and well-being outcomes (Podsakoff et al., 2003). Relatedly, even within self-report measurement, other sleep characteristics could be used to assess Buysse's (2014) RUSATED sleep dimensions (e.g., daytime sleepiness ratings to capture *alertness*). Finally, timing of sleep, the sixth sleep characteristic from Buysse's framework, should also be included in future studies.

Also notable when interpreting our results is the relative underrepresentation of *sufficient but irregular sleepers* in the present sample (3.14%). The nonsignificant differences between this profile and others on some well-being variables could be a function of its small size, rather than true lack of differences. Future research could target recruitment to enroll participants likely to belong to the *sufficient but irregular sleeper* profile, such as shift workers (Drake et al., 2004), to more concretely establish the profiles' relative rank on well-being.

5. Conclusion

Sleep health is multidimensional (Buysse, 2014), yet it is rarely studied using person-centered approaches that can capture constellations of these various dimensions. The present findings provide needed insight into which patterns of sleep characteristics are common in the adult population and the (un)healthiness of said patterns. We identified four latent sleep profiles in a large and nationally representative sample of U.S. adults: *good sleepers*, *nappers*, *sufficient but irregular sleepers*, and *short, dissatisfied, and inefficient sleepers*. These profiles were uniquely associated with psychological and physical well-being outcomes above and beyond sociodemographic characteristics and individual sleep characteristics. *Good sleepers* reported the best well-being levels; *nappers* and *sufficient but irregular sleepers* were generally mid-ranked relative to the other profiles; *short, dissatisfied, and inefficient sleepers* consistently reported the worst well-being. Healthy sleep may indeed manifest as optimal across all sleep dimensions, but unhealthy sleep may manifest as suboptimal scores across multiple sleep dimensions (duration, satisfaction, and efficiency in the case of adults) rather than one or two dimensions alone.

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Credit author statement

Claire E. Smith: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. Soomi Lee: Conceptualization, Methodology, Resources, Writing – review & editing, Project administration, Funding acquisition

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.114603.

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