SUPPLEMENTARY INFORMATION

METHODS

Participants. All participants were mentally and physically healthy. The average (± SD) body mass index was 21.4 ± 2.7 kg/m^2 in women and 22.8 ± 2.4 kg/m^2 in men (p=0.18). Screening procedures consisted of medical and psychological examinations, and routine blood and urine analyses. Exclusion criteria included any sleep disorders, history of shift work or jet lag within the past 3 months, any medical conditions, drug abuse, and cigarette smoking. The participating women had regular menstrual cycles between 26-31 days, were nulliparous, not currently breast feeding, and free of hormonal contraceptives or gynecological pathology. A total of 6 women had never been on oral contraceptives and 3 of them had taken them ≥3 years before entering the study. The prior use of contraceptives was not documented for 2 women but at least 1 month elapsed between the time of recruitment and the laboratory experiment. Moreover, these two women had regular ovulatory cycles prior to enrolment and during the experiments as confirmed by plasma and urinary progesterone levels, respectively. All female participants were studied selectively during the follicular phase of the menstrual cycle. They entered the laboratory during days 5-9 after menses. Eight of the 11 women were also studied during the mid-luteal phase of their menstrual cycle (subjects no. 1-8; SI Appendix, Table S2; lab entry during days 19-23 after menses). For all 11 women, plasma progesterone was measured around day 21 of their menstrual cycle to confirm ovulation prior to lab entry. At that time, plasma progesterone was on average (± SEM) 40.36 ± 5.06 nmol/L. As reported previously in the 8 women studied at both phases of the menstrual cycle (1), urinary progesterone levels increased significantly during the ML phase compared to the MF

phase, further confirming ovulatory cycles. During the week prior to admission, participants were asked to refrain from all prescription or non-prescription drugs as well as caffeine and alcohol. Chronotype was evaluated using the Horne-Östberg Morningness-Eveningness Questionnaire (2). There was no significant difference in the mean Morningness-Eveningness scores between sexes (women: 49.4 ± 15.7, men: 47.1 ± 6.8; $p = 0.66$), which is within the range of neither type (i.e. nor morning type neither evening type, range = 42-52, details in SI Appendix, Table S1). Prior to the study, participants maintained a regular 8-h sleep schedule based on their usual sleep schedule and agreed upon by the subject and the researcher for at least 2 weeks. Compliance to the schedule was confirmed by a sleep-wake log for at least 2 weeks prior to laboratory entry, and calls to the laboratory at wake/bed-times, and wrist-worn actigraphy (Actiwatch, Mini-Mitter, Bend, OR, USA) the week preceding laboratory admission. The experimental protocol was aligned based on the subject reported sleep/wake schedule the week prior to laboratory entry.

Study design. A total of 26 participants spent 5-6 days in an individual time isolated room. The protocol began with 1 or 2 baseline sleep periods according to each participant's habitual sleep times preceding laboratory entry (1 baseline sleep period: 10 women, 5 men; 2 baseline sleep periods: 1 woman, 10 men; SI Appendix, Table S2). To explore sex-differences in baseline nocturnal sleep, data from the sleep period immediately preceding the USW procedure were used for all subjects.

Upon awakening after the last sleep period, subjects underwent a 72-h USW procedure **(**SI Appendix, Fig. S1 and Table S2). Details of the 72-h USW procedure were previously described for subjects no. 1-8 (1), and for subjects no. 10, 11 and 22-26 (3).

Eleven participants (1 woman and 10 men, subjects no. 9 and 12-21; SI Appendix, Table S2) participated in an unpublished study. For participants 12-15, blood pressure (BP) was taken 1 time during each wake period of the USW procedure. For participants 9 and 16-21, BP was measured 1 time during each nap and 6 times during each wake period of the USW procedure. This study also involved a procedure of controlled sitting and standing during the wake periods of the last 24 h of the USW procedure. As these events could mask the expression of circadian rhythms, the last 24 h of CBT, melatonin, sleep and alertness assessment was excluded for these participants. Otherwise, participants remained in a semi-recumbent position throughout the USW procedure, and iso-caloric snacks were provided during every wake episode.

Measures and data processing.

Samples from 4 participants (subjects no. 1-4) were assayed with melatonin kits from Stockgrand Ltd, Guilford, Surry, UK, co-efficient of variation: 8.5%, lower limit of detection: 0.2pg/ml. Samples from 4 participants (subjects no. 5-8) were assayed with melatonin kits from Buhlman, Alpco Diagnostics, Windham, NH, USA, mean intra and interassay co-efficient of variation: 7.9% and 9.8%, respectively, lower limit of detection: 0.2pg/ml. Saliva samples from 18 participants (subjects no. 9-26) were assayed using the LDN Melatonin Direct Assay Kit by Rocky Mountain Diagnostics, Colorado Springs, CO, USA, intra and interassay coefficient of variation: 9.9-12.3% and 9.6%-16.2%, respectively, lower limit of detection: 0.2 pg/ml. Melatonin data determined by the Stockgrand Ltd kit were reanalyzed using the LDN Melatonin Direct Assay Kit and a strong correlation was observed between kits ($n=14$, $r=0.91$; $p<0.0001$; $y= 0.7159_X + 9.259$). The samples initially analyzed with the Stockgrand Ltd kit were mathematically

converted into the concentration of the LDN Melatonin Direct Assay kit. Due to lack of remaining samples, the samples from 4 participants (subjects no. 5-8; SI Appendix, Table S2) determined by the Buhlman kit could not be similarly reanalyzed and were therefore excluded from the current analyses. Sample concentrations below the lower limit of detection were assigned a value of zero.

Sleep was polysomnographically recorded at a sampling rate of 250 Hz or 512 Hz (using Harmonie, Natus Medical Inc., Montreal, Qc, Canada; see SI Appendix, Table S2) with a high- and low-pass filter at 0.3 Hz and 35 Hz, respectively. During the first nocturnal sleep period, apneas and hypopneas were screened according to the criteria recommended by the American Academy of Sleep Medicine (4) and periodic leg movements (PLMs) in sleep were screened in accordance with Coleman's criteria (5) as previously reported. The sleep period immediately preceding the USW procedure was not available for 2 men (subjects no. 15 and 17) and 2 women (subjects no. 4 and 5) during their ML phase due to technical problems. In 6 participants (subjects no. 16-21, SI Appendix, Table S2), an automatic BP measurement cuff was inflated once per nap episode after the first 24 h of the USW procedure. Inflation of BP cuff could sometimes create short arousals. The presence of arousals associated with the BP cuff was visually investigated during all naps on the PSG. Criteria for sleep arousals associated with the BP cuff inflation were at least one 30-sec epoch scored as wake following inflation of the BP cuff, and criteria for arousals on the heart rate recordings were at least one 30-sec epoch with elevated heart rate following inflation of the BP cuff. This occurred 15 times in total and lasted $\leq$ 2.5 minutes in all cases. If observed, the corresponding PSG epochs (from the arousal epoch to 3 minutes post-arousal) were removed from the analyses. These

events were distributed throughout all circadian phases and a Rayleigh test confirmed that they were not grouped at a specific time of day.

PSG data were visually scored by three trained scorers. The inter-rater reliability for these three scorers was 92%. Sleep efficiency (SE) was calculated by dividing the total sleep time by the time in bed. Sleep onset latency (SOL) was defined as the time interval between lights off and the first occurrence of at least two consecutive epochs of stage 1 sleep or any occurrence of deeper sleep stages. SOL was given a value of 60 minutes if no sleep occurred during a nap episode. REM sleep onset latency (ROL) was the time interval between sleep onset and the first occurrence of an epoch of REM sleep. ROL was given a value of 60 minutes if no REM sleep occurred during a nap episode.

Data and statistical analysis. Statistical analyses were performed with SAS software version 9.2 (SAS Institute Inc., Cary, NC, US) and IBM SPSS Statistics version 20 (IBM Corporation, Armonk, NY, US). Normal distribution of data was verified using the Shapiro-Wilk test. Outliers were analyzed with a Grubbs' test at a significant level of 0.01.

The mesor is a measure of the average levels throughout the day, amplitude corresponds to half of the peak-to-trough difference of the first harmonic, and phase corresponds to the time of a representative point of the rhythm (such as the maximum or the minimum). The fitted CBT minimum obtained during the first day of the USW protocol was assigned a circadian phase of 0° and this reference was used to assign a circadian phase from 0° to 360° for all outcome parameters throughout the USW procedure. Data were then averaged into 30° circadian bins and folded every 360° (24 h) yielding a complete circadian cycle for each subject. To explore the variation of sleep,

alertness, melatonin, and CBT throughout the USW procedure, the circadian mesor, amplitude, and phase were calculated. The model is described as follows:

$$y_{ijk} = b_{0j} + \beta_{0i} + A_j \cos\left(\tau_{ijk} - \phi_j\right) + \varepsilon_{ijk} \qquad \text{(Eq. 1)}$$

where y_{ijk} denotes the k^{th} value for a given parameter for the i^{th} participant of the j^{th} sex at the time since lights on or circadian degree τ_{ijk}. The Y-intercept is described by b_{0j} and β_{0i} (fixed and random effects, respectively). The amplitude of the 24-h rhythm in each state is described by A_j. The corresponding phase of peak level (or acrophase) of this rhythm is described by ϕ_j. The residual error is assumed to be normally distributed $\varepsilon_{ijk} \sim N(0,\sigma^2)$ and independent. Student t test statistic was used to test whether fixed effect values were different from zero. Rhythms were considered significant if their amplitude was significantly different from zero. Differences in mesor, amplitude, and phase between sexes were tested using F statistics as part of our non-linear mixed effect analysis. Each parameter was tested for significance at the level of $p < 0.05$ and values are expressed as mean ± standard error of the mean (SEM, except for demographic data: ± SD).

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Table S1. Demographic information

Subject	*Gender*	*Age*	*BMI*	*Chronotype*
1	F	22.70	23.09	66 (moderate morning)
2	F	23.70	22.41	55 (intermediate)
3	F	27.57	23.38	32 (moderate evening)
4	F	27.77	26.49	50 (intermediate)
5	F	30.77	19.60	38 (moderate evening)
6	F	23.97	20.03	56 (intermediate)
7	F	25.21	20.70	57 (intermediate)
8	F	29.58	17.63	70 (definite morning)
9	F	20.78	21.20	57 (intermediate)
10	F	30.21	17.78	46 (intermediate)
11	F	21.92	23.46	16 (definite evening)
Women (average ± SD)		*25.83 ± 3.51*	*21.43 ± 2.66*	*49.4 ± 15.7*
12	M	23.00	19.39	43 (intermediate)
13	M	20.00	25.90	38 (moderate evening)
14	M	29.00	23.50	n/a
15	M	22.00	28.30	47 (intermediate)
16	M	28.51	22.40	59 (moderate morning)
17	M	20.00	21.80	51 (intermediate)
18	M	18.88	20.75	45 (intermediate)
19	M	21.64	22.28	41 (moderate evening)
20	M	21.04	20.91	52 (intermediate)
21	M	21.28	21.07	46 (intermediate)
22	M	19.39	23.44	57 (intermediate)
23	M	29.09	24.92	47 (intermediate)
24	M	27.81	21.02	53 (intermediate)
25	M	26.44	25.51	35 (moderate evening)
26	M	22.93	21.20	45 (intermediate)
Men (average ± SD)		*23.40 ± 3.72*	*22.83 ± 2.42*	*47.1 ± 6.8*

Table S2. Protocol details.

No	Lab entry	# SP	Time of CBT minimum	PSG sleep recording			Saliva	Mood
				Habitual bedtime	Habitual waketime	Montage / Freq.	Freq.	Freq.
1	2004-06-17	1	04:23	00:05	08:00	Grass / 250 Hz	2x/WP (+5, +55min)	1x/WP (+30min)
2	2005-03-10	1	03:17	23:28	07:28	Grass / 250 Hz		
3	2005-12-01	1	06:40	01:29	09:29	Grass / 250 Hz		
4	2006-02-26	1	06:04	23:30	07:29	Grass / 250 Hz		
5	2006-06-17	1	06:02	00:58	08:48	Grass / 250 Hz		
6	2006-06-29	1	05:27	01:37	08:55	Grass / 250 Hz		
7	2006-07-23	1	01:54	23:59	07:59	Grass / 250 Hz		
8	2006-10-24	1	04:37	23:17	07:17	Grass / 250 Hz		
9	2011-07-20	2	04:57	23:58	07:58	Grass / 512 Hz	1x/WP (+55min)	3x/WP (+15, +30, +50min)
10	2007-03-13	1	05:47	01:30	09:30	Lamont / 250 Hz	2x/WP (+5, +55min)	1x/WP (+30min)
11	2008-06-26	1	04:46	00:30	08:30	Lamont / 250 Hz		
Women (average ± SEM)			*04:55 ± 0:24*	*00:24 ± 0:15*	*08:18 ± 0:14*			
12	2010-07-11	2	04:59	00:58	08:58	Grass / 512 Hz	1x/WP (+55min)	3x/WP (+15, +30, +50min)
13	2010-08-02	2	05:27	00:05	08:05	Grass / 512 Hz		
14	2010-08-08	2	05:44	00:00	08:00	Grass / 512 Hz		
15	2010-08-09	2	05:08	01:01	09:01	Grass / 512 Hz		
16	2011-06-13	2	04:28	00:05	08:05	Grass / 512 Hz		
17	2011-07-19	2	04:23	23:00	07:00	Grass / 512 Hz		
18	2011-06-26	2	06:35	00:04	08:04	Grass / 512 Hz		
19	2011-07-19	2	06:53	01:00	09:00	Grass / 512 Hz		
20	2011-07-26	2	05:27	00:04	08:04	Grass / 512 Hz		
21	2011-08-08	2	05:45	01:34	09:34	Grass / 512 Hz		
22	2007-06-23	1	04:23	23:35	07:35	Lamont / 250 Hz	2x/WP (+5, +55min)	1x/WP (+30min)
23	2008-07-08	1	06:31	00:00	08:00	Lamont / 250 Hz		
24	2008-07-18	1	03:16	23:00	07:00	Lamont / 250 Hz		
25	2008-08-02	1	04:46	00:00	08:00	Lamont / 250 Hz		
26	2009-02-25	1	06:31	00:00	08:00	Lamont / 250 Hz		
Men (average ± SEM)			05:21 ± 0:15	00:10 ± 0:11	08:10 ± 0:11			

WP: Wake period.

SP: number of baseline nocturnal sleep periods preceding the USW procedure.

Saliva and mood: The sampling frequency and time since lights on during WP is indicated.

Participants 1-8 were part of another study which examined women during the mid-follicular and mid-luteal phases of their menstrual cycle (SI Appendix, reference 1). Melatonin samples for participant 5-8 were not included in the analyses. See SI for details.

Participants 10, 11, 22-26 were part of another study which looked at the circadian variation of heart rate variability (SI Appendix, reference 3).

Participants 9, 12-21 were part of an unpublished study on the circadian variation of blood pressure (BP). In this protocol, participants had 2 baseline sleep periods, followed by a 72-h USW procedure, the last 24 h of which involved postural changes. This last 24 h section was not included in the analyses. See SI Appendix for details.

Table S3. Sex differences in sleep measures during the baseline nocturnal sleep episode.

Nocturnal sleep	Women (MF)	Men	p-values
TST (min)	433.5 ± 5.7	420.7 ± 10.3	0.364
SE (%)	93.0 ± 1.2	88.5 ± 2.1	0.113
SOL (min)	12.5 ± 3.4	13.6 ± 3.6	0.802
ROL (min)	97.3 ± 12.8	123.4 ± 15.3	0.305
Stage 1 sleep (min)	14.0 ± 3.5	34.8 ± 7.3	0.031
Stage 1 sleep (%)	3.3 ± 0.9	8.4 ± 1.9	0.036
Stage 2 sleep (min)	259.4 ± 16.1	232.8 ± 20.1	0.416
Stage 2 sleep (%)	59.6 ± 3.3	55.2 ± 4.3	0.533
SWS (min)	57.4 ± 12.0	78.2 ± 19.7	0.453
SWS (%)	13.5 ± 3.0	18.5 ± 4.4	0.432
NREM sleep (min)	330.7 ± 6.3	345.8 ± 10.1	0.202
NREM sleep (%)	76.4 ± 1.6	82.2 ± 1.2	0.009
REM sleep (min)	102.8 ± 7.4	74.9 ± 5.5	0.008
REM sleep (%)	23.6 ± 1.6	17.8 ± 1.2	0.009

Women were studied during the MF phase. Data from the baseline sleep period immediately preceding the USW procedure were considered in these between sex analyses. All values are mean ± SEM.

Table S4. Circadian parameters of sleep measures, alertness, CBT and melatonin during the USW procedure aligned by the CBT minimum.

	Variables Aligned on CBT minimum					
	Mesor		*Amplitude*		*Acrophase (deg.)*	
	Women (MF)	*Men*	*Women (MF)*	*Men*	*Women (MF)*	*Men*
Sleep recording						
SE (%)	53.1 ± 13.8	43.7 ± 12.3	33.7 ± 2.2	31.6 ± 1.9	24.2 ± 3.7*	40.2 ± 3.4*
SOL (min)	36.3 ± 6.5	30.6 ± 5.8	16.1 ± 1.5	16.4 ± 1.2	206.8 ± 5.2	213.2 ± 4.4
ROL (min)	39.8 ± 9.3	49.0 ± 8.2	15.3 ± 1.7	11.2 ± 1.4	214.0 ± 6.2	218.9 ± 7.2
Stage 1 (min)	2.8 ± 0.3	3.7 ± 0.3	1.3 ± 0.3	1.9 ± 0.2	38.0 ± 11.2	62.6 ± 6.5
Stage 2 (min)	17.4 ± 1.1*	12.5 ± 0.9*	9.6 ± 0.9	7.6 ± 0.8	27.2 ± 5.6*	44.3 ± 6.0*
SWS (min)	3.9 ± 0.7*	6.7 ± 0.6*	3.0 ± 0.8	3.9 ± 0.6	350.1 ± 14.2	16.2 ± 9.4
REM (min)	5.2 ± 0.6	4.7 ± 0.5	6.9 ± 0.8	6.2 ± 0.7	33.1 ± 6.7	42.8 ± 6.4
NREM (min)	22.1 ± 0.9*	19.3 ± 0.8*	11.7 ± 1.3	9.8 ± 1.5	27.9 ± 6.6	35.2 ± 6.9
TST (min)	29.3 ± 1.1	27.4 ± 1.0	20.3 ± 1.4	18.9 ± 1.2	24.3 ± 3.9*	40.3 ± 3.6*
Alertness (0-10)	6.4 ± 0.3	7.1 ± 0.3	1.8 ± 0.1*	1.3 ± 0.1*	192.4 ± 4.8*	208.9 ± 5.7*
CBT (°C)	37.10 ± 0.03	37.11 ± 0.03	0.31 ± 0.01	0.30 ± 0.01	186.3 ± 2.4	192.0 ± 2.1
Melatonin (pg/ml)	9.7 ± 2.5	9.9 ± 1.3	3.1 ± 0.6	4.9 ± 0.5	339.1 ± 10.9	327.4 ± 5.6

Women were studied during the MF phase. All circadian rhythms were significant ($p \leq 0.0005$).

* indicates sex difference ($p < 0.05$). All values are mean ± SEM.

Table S5. Diurnal parameters of sleep measures, alertness, CBT and melatonin during the USW procedure aligned by the time since lights on.

	Variables Aligned on Lights On					
	Mesor		*Amplitude*		*Acrohase (h)*	
	Women (ML)	*Men*	*Women (ML)*	*Men*	*Women (ML)*	*Men*
Sleep recording						
SE (%)	50.4 ± 2.3	45.5 ± 1.6	33.2 ± 2.3	31.3 ± 1.8	23.0 ± 0.3*	0.0 ± 0.2*
SOL (min)	25.8 ± 14.1	28.3 ± 11.0	19.6 ± 1.5	17.9 ± 1.1	11.0 ± 0.3*	12.1 ± 0.2*
ROL (min)	50.6 ± 13.5	49.2 ± 8.7	12.1 ± 1.7	12.2 ± 1.2	11.8 ± 0.5	12.9 ± 0.4
Stage 1 (min)	2.2 ± 0.4*	3.9 ± 0.3*	1.1 ± 0.3*	2.3 ± 0.2*	1.3 ± 0.9	1.4 ± 0.3
Stage 2 (min)	20.8 ± 5.9	12.5 ± 1.0	10.2 ± 1.0	8.0 ± 0.8	22.9 ± 0.4*	0.3 ± 0.4*
SWS (min)	2.6 ± 0.7*	6.6 ± 0.5*	2.0 ± 0.7	3.5 ± 0.6	19.7 ± 1.3	21.9 ± 0.6
REM (min)	5.0 ± 0.6	4.3 ± 0.5	7.5 ± 0.8	6.0 ± 0.7	23.4 ± 0.4	0.4 ± 0.5
NREM (min)	25.7 ± 13	22.8 ± 7.0	12.5 ± 1.4	13.1 ± 1.1	22.6 ± 0.4*	23.9 ± 0.3*
TST (min)	30.4 ± 10.7	27.3 ± 7.5	19.9 ± 1.4	18.8 ± 1.1	22.9 ± 0.3*	0.0 ± 0.2*
Alertness (0-10)	6.4 ± 0.4	7.1 ± 0.3	1.6 ± 0.1*	1.2 ± 0.1*	10.3 ± 0.3*	11.8 ± 0.4*
CBT (°C)	37.31 ± 0.06*	37.08 ± 0.04*	0.22 ± 0.01*	0.30 ± 0.01*	9.5 ± 0.2*	10.1 ± 0.1*
Melatonin (pg/ml)	9.2 ± 2.8	10.0 ± 1.6	5.7 ± 0.8	4.9 ± 0.5	20.8 ± 0.5	20.2 ± 0.4

Women were studied during their ML phase. All diurnal rhythms were significant ($p \leq 0.009$).

* indicates sex difference ($p < 0.05$). All values are mean ± SEM.

Table S6. Sex differences in sleep measures during the baseline nocturnal sleep episode.

Nocturnal sleep	Women (ML)	Men	p-values
TST (min)	423.2 ± 6.5	420.7 ± 10.3	0.878
SE (%)	89.5 ± 1.6	88.5 ± 2.1	0.766
SOL (min)	16.0 ± 2.7	13.6 ± 3.6	0.677
ROL (min)	99.8 ± 19.1	123.4 ± 15.3	0.378
Stage 1 sleep (min)	11.9 ± 1.6	34.8 ± 7.3	0.052
Stage 1 sleep (%)	2.8 ± 0.4	8.4 ± 1.9	0.066
Stage 2 sleep (min)	269.8 ± 10.5	232.8 ± 20.1	0.247
Stage 2 sleep (%)	63.9 ± 2.6	55.2 ± 4.3	0.208
SWS (min)	44.8 ± 5.6	78.2 ± 19.7	0.276
SWS (%)	10.6 ± 1.2	18.5 ± 4.4	0.249
NREM sleep (min)	314.6 ± 6.8	345.8 ± 10.1	0.064
NREM sleep (%)	74.4 ± 1.6	82.2 ± 1.2	0.002
REM sleep (min)	96.2 ± 8.5	74.9 ± 5.5	0.047
REM sleep (%)	22.7 ± 1.9	17.8 ± 1.2	0.038

Women were studied during the ML phase. Data from the baseline sleep period immediately preceding the USW procedure were considered in these between sex analyses. All values are mean ± SEM.

Table S7. Circadian rhythm parameters of sleep measures, alertness, CBT and melatonin during the USW procedure aligned by the CBT minimum.

	Variables Aligned on CBT minimum					
	Mesor		*Amplitude*		*Acrophase (deg.)*	
	Women (ML)	*Men*	*Women (ML)*	*Men*	*Women (ML)*	*Men*
Sleep recording						
SE (%)	49.4 ± 13.8	43.7 ± 12.3	34.4 ± 2.6	31.6 ± 1.9	29.9 ± 4.3	40.2 ± 3.4
SOL (min)	29.0 ± 7.0	30.6 ± 5.8	20.4 ± 1.8	16.4 ± 1.2	209.1 ± 4.9	213.2 ± 4.4
ROL (min)	50.1 ± 8.2	49.0 ± 8.2	12.3 ± 1.9	11.2 ± 1.4	217.8 ± 8.4	218.9 ± 7.2
Stage 1 (min)	2.3 ± 0.3*	3.7 ± 0.3*	1.2 ± 0.3	1.9 ± 0.2	59.8 ± 13.8	62.6 ± 6.5
Stage 2 (min)	19.7 ± 1.2*	12.5 ± 0.9*	11.6 ± 1.1*	7.6 ± 0.8*	33.9 ± 5.0	44.3 ± 6.0
SWS (min)	3.1 ± 0.8*	6.7 ± 0.6*	2.7 ± 0.9	3.9 ± 0.6	345.1 ± 19.7	16.2 ± 9.4
REM (min)	5.7 ± 0.8	4.7 ± 0.5	5.5 ± 0.9	6.2 ± 0.7	34.9 ± 9.1	42.8 ± 6.4
NREM (min)	22.8 ± 1.3*	19.3 ± 0.8*	13.5 ± 1.6	9.8 ± 1.5	25.4 ± 6.6	35.2 ± 6.9
TST (min)	29.6 ± 1.4	27.4 ± 1.0	20.5 ± 1.6	18.9 ± 1.2	30.0 ± 4.5	40.3 ± 3.6
Alertness (0-10)	6.3 ± 0.4	7.1 ± 0.3	1.8 ± 0.2*	1.3 ± 0.1*	199.4 ± 5.8	208.9 ± 6.0
CBT (°C)	37.31 ± 0.06*	37.11 ± 0.03*	0.23 ± 0.02*	0.30 ± 0.01*	190.4 ± 4.0	192.0 ± 2.1
Melatonin (pg/ml)	8.6 ± 2.6	9.9 ± 1.3	4.6 ± 0.9	4.9 ± 0.5	330.2 ± 11.6	327.4 ± 5.6

Women were studied during the ML phase. All circadian rhythms were significant ($p \leq 0.009$).

* indicates sex difference ($p < 0.05$). All values are mean ± SEM.

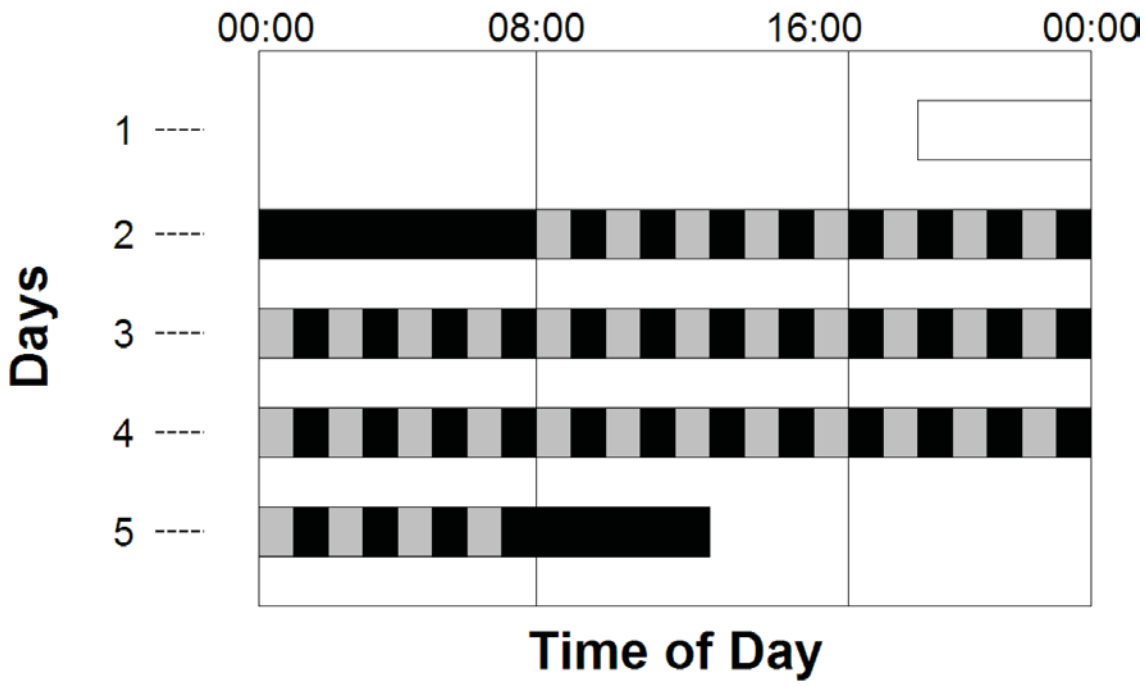

Figure S1: Ultradian sleep-wake cycle (USW) procedure. White bars represent waking episodes in ~150 lux, gray bars represent waking episodes in dim light (<10 lux), and black bars represent sleep opportunities in total darkness. The procedure illustrated above is adapted for a participant with a hypothetical habitual sleep period from 00:00 to 08:00. and one baseline sleep period.

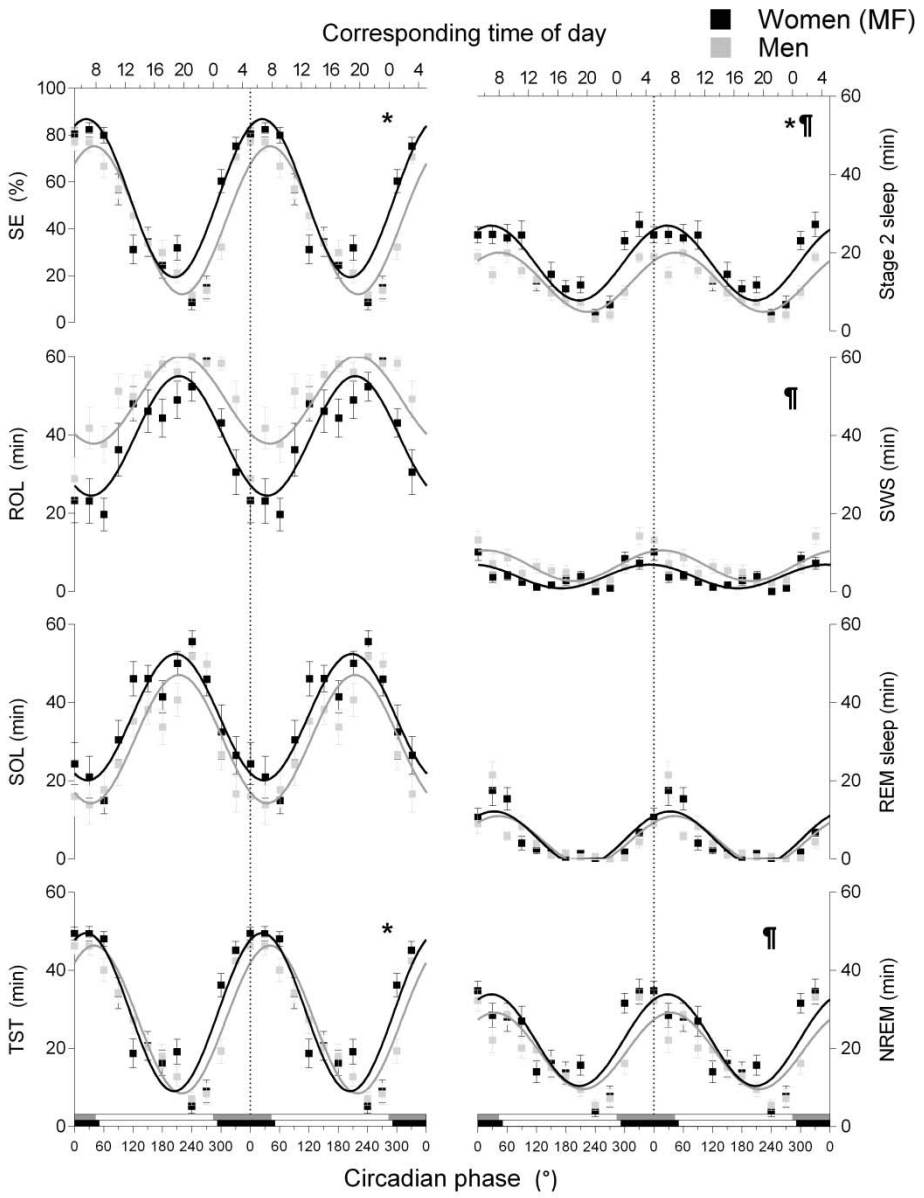

Figure S2. Circadian variation of sleep measures during the USW procedure aligned by the CBT minimum. Women were studied during their MF phase. Data are double-plotted over two circadian cycles for illustrative purposes. The vertical dotted line corresponds to the CBT minimum. Bottom X axes represent the circadian phase and top X axes represent the corresponding clock time. Bars along the X axes represent the time of projected habitual nocturnal sleep episodes for women (black) and men (gray). All circadian rhythms were significant ($p \leq 0.0005$). ¶ indicates sex differences in mesor ($p < 0.05$) and * in phase ($p < 0.05$). All values are mean ± SEM.

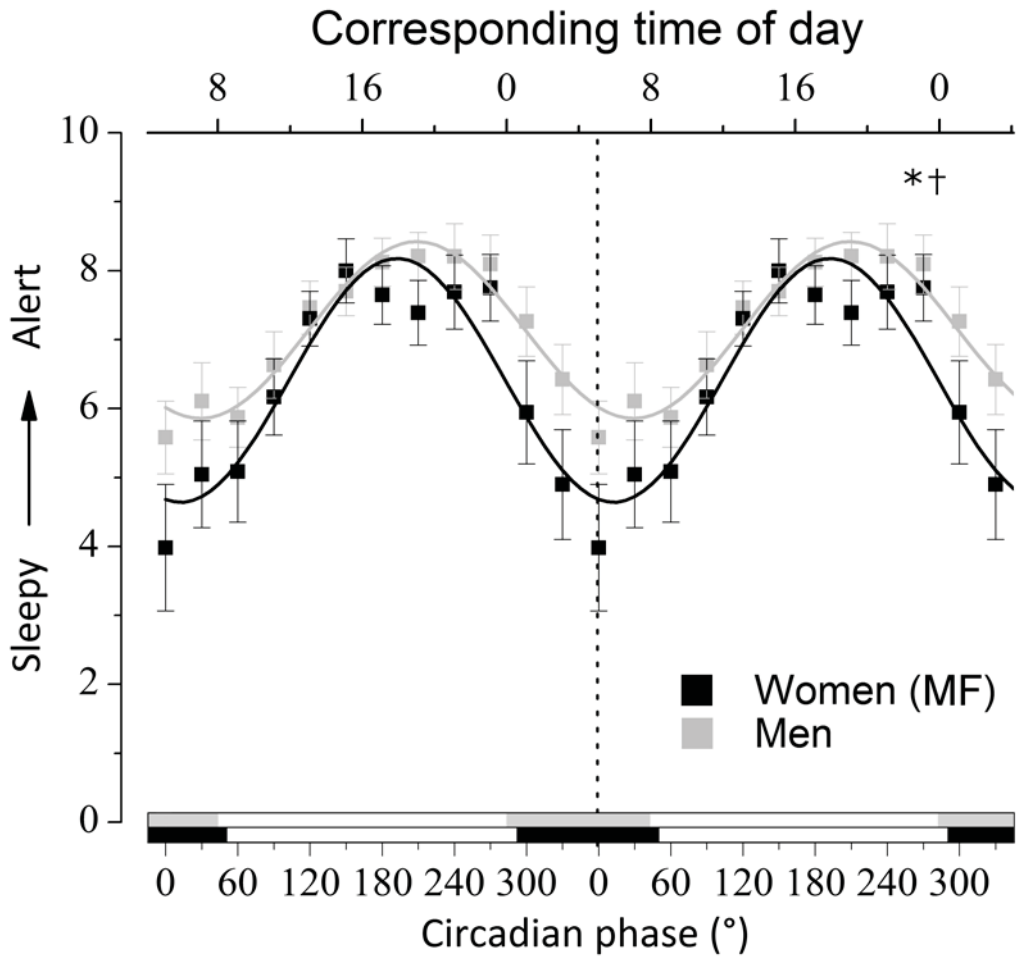

Figure S3. Circadian variation of subjective alertness during the USW procedure aligned by the CBT minimum. Women were studied during their MF phase. Data are double-plotted over two circadian cycles for illustrative purposes. The vertical dotted line corresponds to the CBT minimum. Bottom X axis represents the circadian phase and top X axis represents the corresponding clock time. Bars along the X axis represent the time of projected habitual nocturnal sleep episodes for women (black) and men (gray). All circadian rhythms were significant ($p<0.0001$). * indicates sex differences in phase ($p<0.05$) and † in amplitude ($p<0.05$). All values are mean ± SEM.

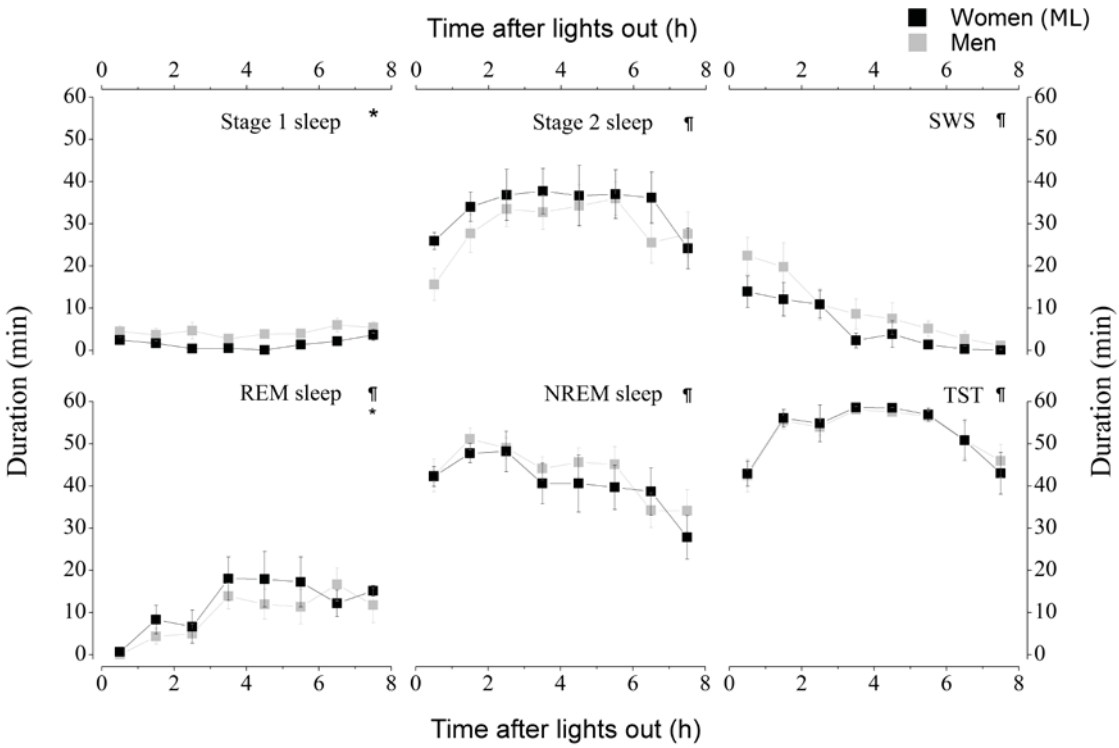

Figure S4. Sex differences nocturnal baseline sleep periods. Women were studied during their ML phase. X axes represent the time after lights out and Y axes represent the time spent in the corresponding sleep stage for each 1h-bin. * indicates sex differences ($p<0.05$), ¶ indicates time effects ($p<0.05$). All values represented as mean ± SEM.

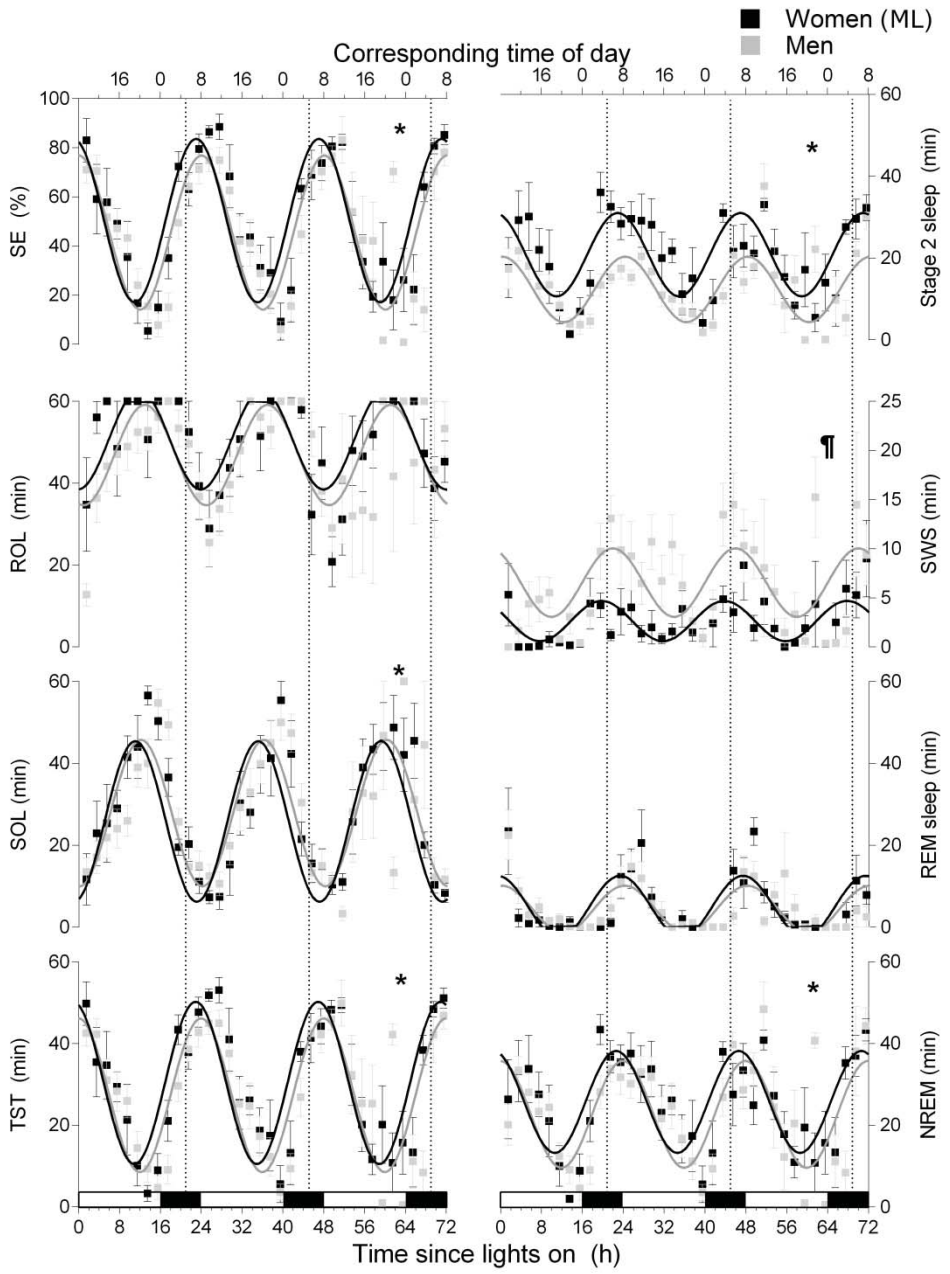

Figure S5: Diurnal variation of sleep measures during the USW procedure aligned by the time since lights on. Women were studied during their ML phase. The vertical dotted line corresponds to the CBT minimum. Bottom X axis represents the time since lights on and top X axis represents the corresponding clock time. Black bars along the X axis represent the time of projected habitual nocturnal sleep episodes. All diurnal rhythms were significant ($p \leq 0.009$). ¶ indicates sex differences in mesor ($p < 0.05$) and * in phase ($p < 0.05$). All values are means ± SEM.

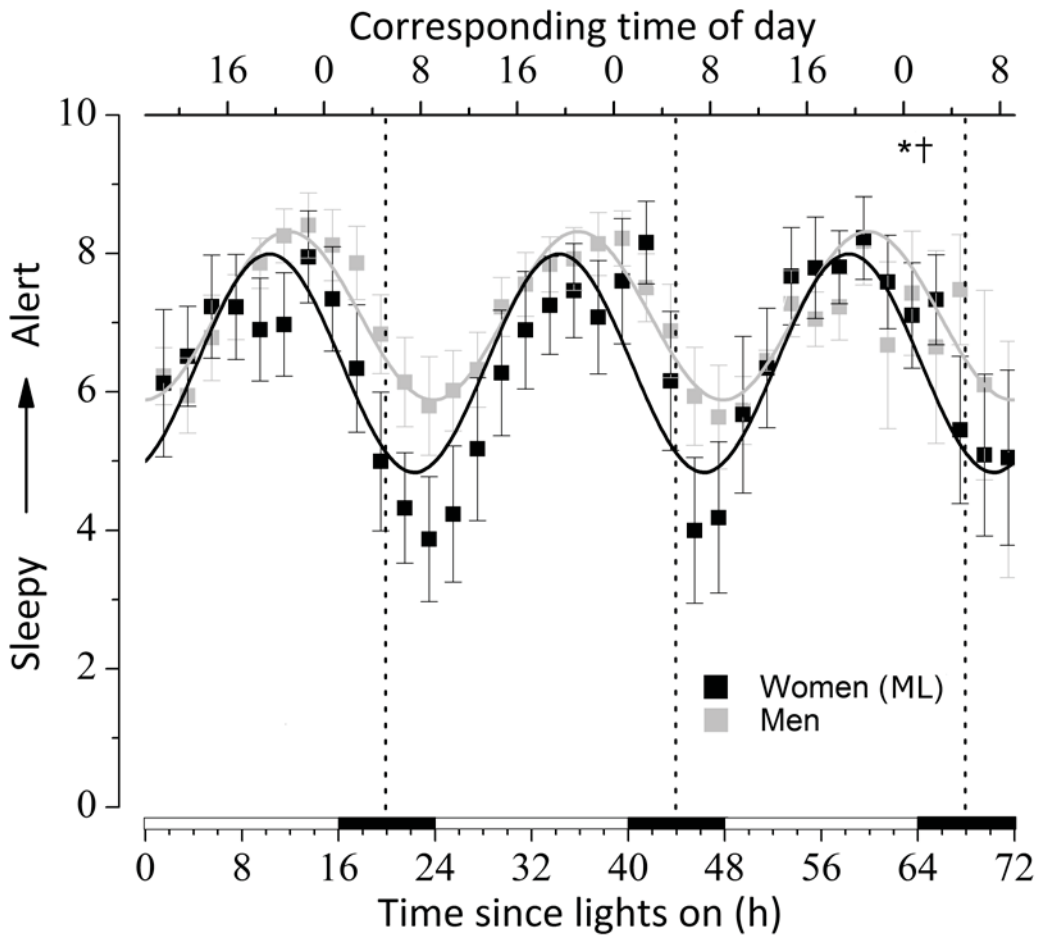

Figure S6: Diurnal variation of subjective alertness during the USW procedure aligned by the time since lights on. Women were studied during their ML phase. The vertical dotted line corresponds to the CBT minimum. Bottom X axis represents the time since lights on, and top X axis represents the corresponding clock time. Black bars along the X axis represent the time of projected habitual nocturnal sleep episodes. All diurnal rhythms were significant ($p<0.0001$). * indicates sex differences in phase and † in amplitude ($p<0.05$). All values are means ± SEM.

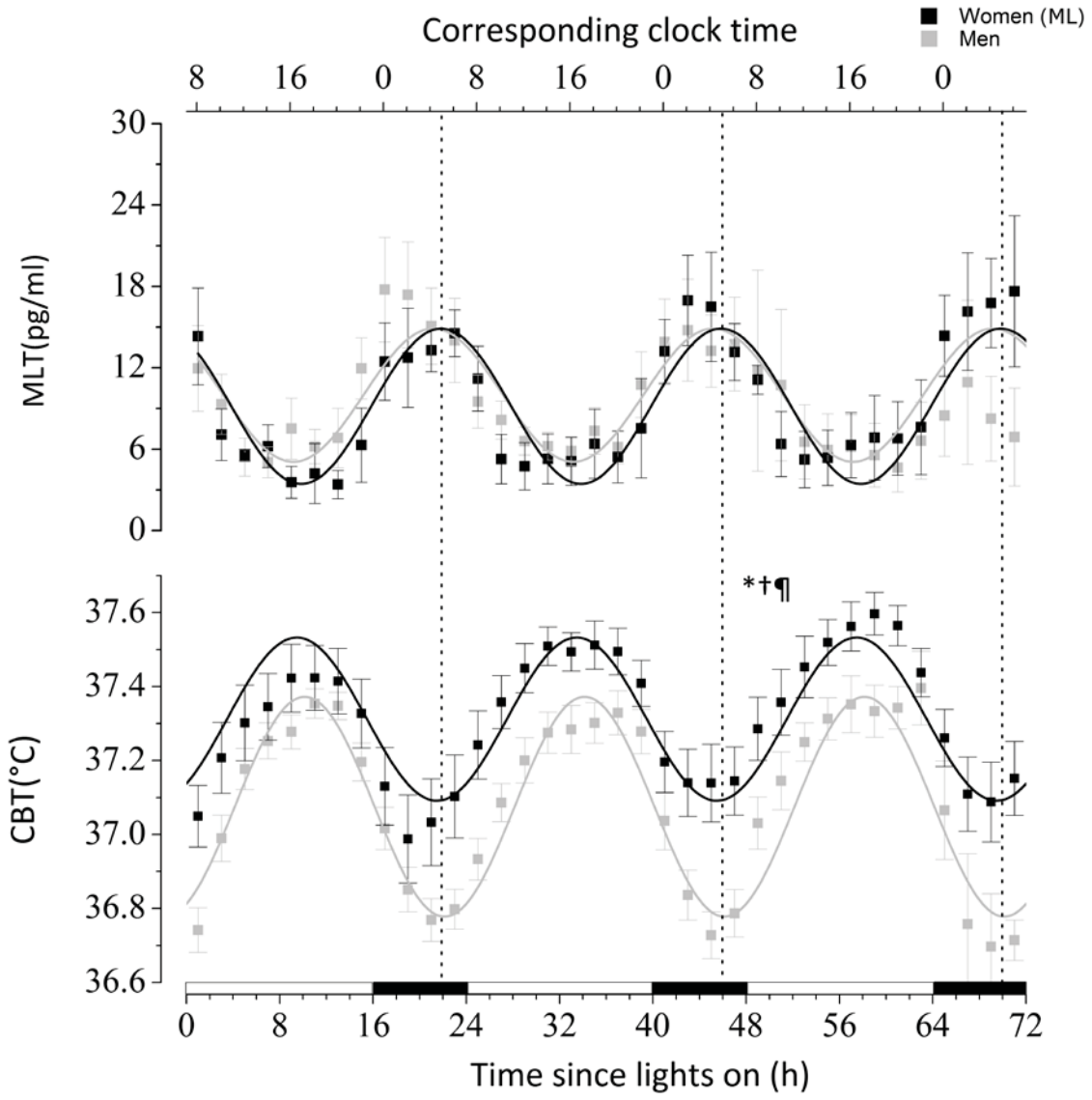

Figure S7: Diurnal variation of salivary melatonin and CBT during the USW procedure aligned by the time since lights on. Women were studied during their ML phase. The vertical dotted line corresponds to the CBT minimum. The bottom X axis represents time since lights on and the top X axis represents the corresponding clock time. Black bars along the X axis represent the time of projected habitual nocturnal sleep episodes. All diurnal rhythms were significant ($p<0.0001$). ¶ indicates sex differences in mesor ($p<0.05$), * in phase ($p<0.05$) and † in amplitude ($p<0.05$). All values are means ± SEM.

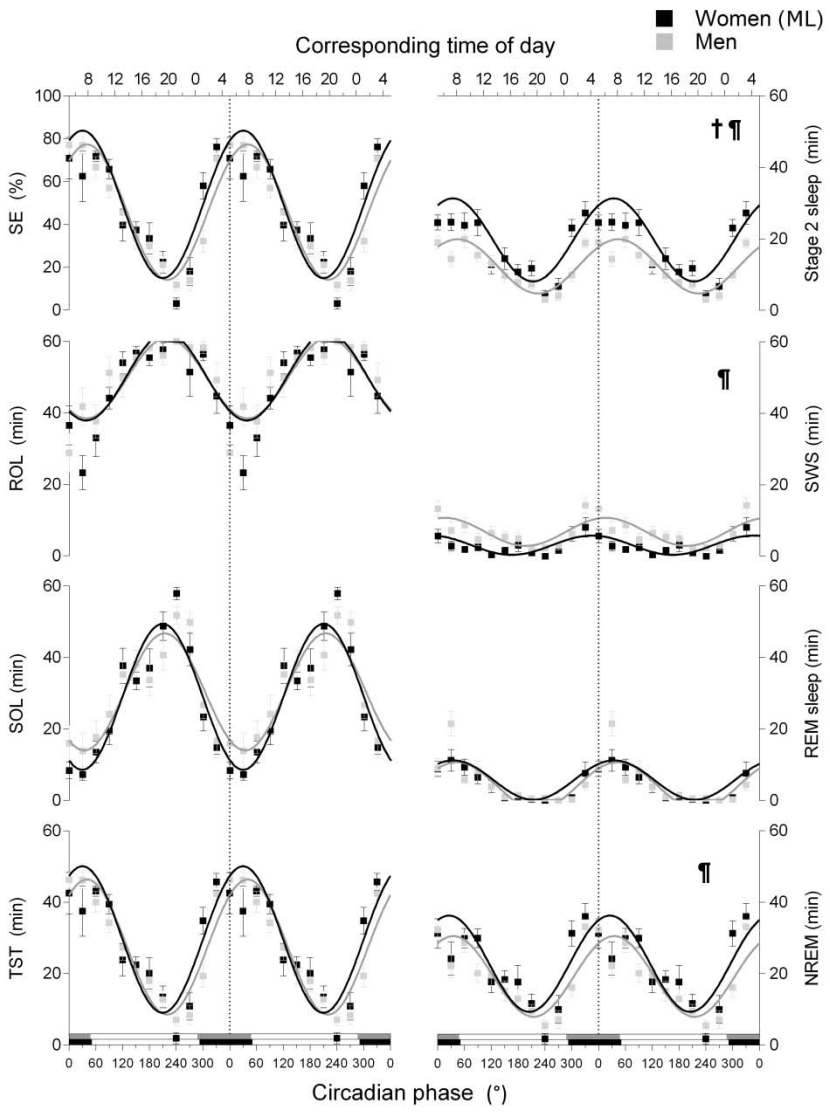

Figure S8. Circadian variation of sleep measures during the USW procedure aligned by CBT minimum. Women were studied during their ML phase. Data are double-plotted over two circadian cycles for illustrative purposes. The vertical dotted line corresponds to the CBT minimum. Bottom X axes represent the circadian phase and top X axes represent the corresponding clock time. Bars along the X axes represent the time of projected habitual nocturnal sleep episodes for women (black) and men (gray). All circadian rhythms were significant ($p \leq 0.009$). ¶ indicates sex differences in mesor ($p < 0.05$) and † in amplitude ($p < 0.05$). All values are mean ± SEM.

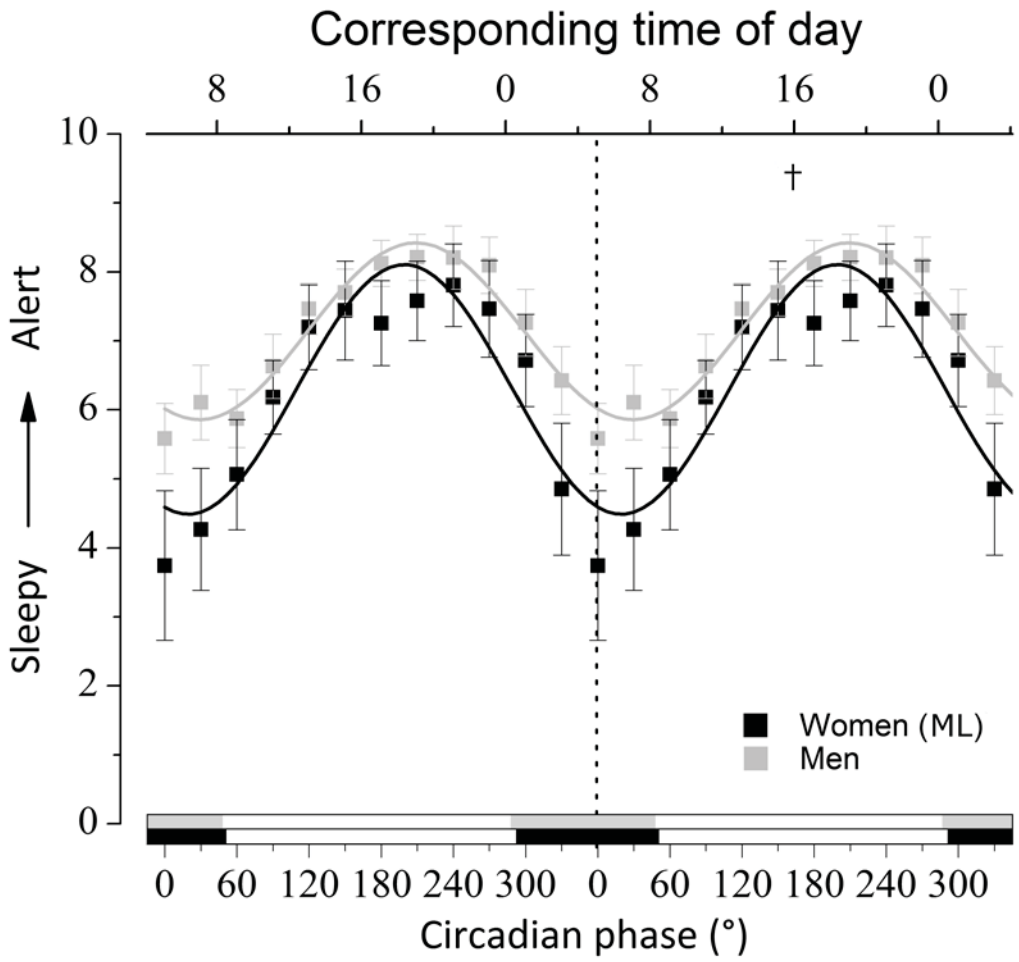

Figure S9. Circadian variation of subjective alertness during the USW procedure aligned by the CBT minimum. Women were studied during their ML phase. Data are double-plotted over two circadian cycles for illustrative purposes. The vertical dotted line corresponds to the CBT minimum. Bottom X axis represents the circadian phase and top X axis represents the corresponding clock time. Bars along the X axis represent the time of projected habitual nocturnal sleep episodes for women (black) and men (gray). All circadian rhythms were significant ($p<0.0001$). † indicates sex differences in amplitude ($p<0.05$). All values are mean ± SEM.