

Supplementary Information for

Impact of light on well-being and mood in everyday life: A longitudinal study on timing, quantity, duration, and frequency of exposure

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1. Supplementary Tables

Database from daily questionnaires and actigraphy

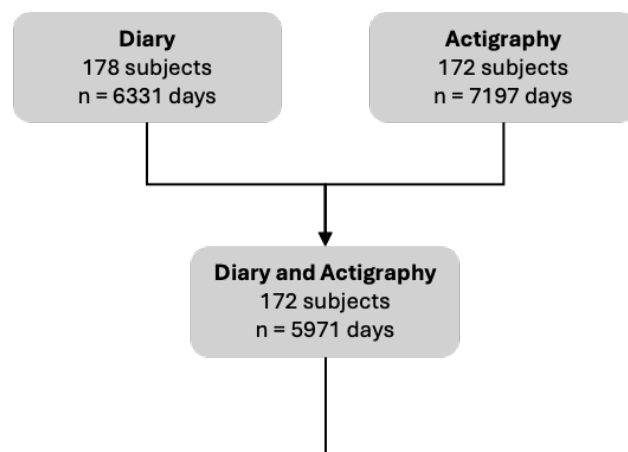


Table S1. Exclusion criteria applied to the database.

Exclusion criteria	Number of exclusions (5971 days)	Participants with day exclusions (n = 172)	Total after Exclusions (days)	Sample after Exclusions (n)
Days with more than 2 hours of missing data	217	101	5754	172
Sleep onset past sunrise	25	12	5729	172

Table S2. Between-subject coefficients (β_B) from a robust linear mixed-effects regression model of double increase median melanopic EDI exposure throughout the 24-hour day and daily mood-related symptoms (MRh-RD) and well-being scores (WHO-5) within 1-hour intervals on the 24-hour day.

timing interval (hh:mm)	MRh-RD															WHO-5			subjects (n)	days (n)			
	ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY							
	β_B	95% CI		β_B	95% CI		β_B	95% CI		β_B	95% CI		β_B	95% CI		β_B	95% CI						
		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper					
00:00 – 00:59	0.056	0.002	0.110	0.016	-0.022	0.054	0.010	-0.026	0.046	0.034	-0.009	0.076	-0.032	-0.075	0.011	-0.033	-0.071	0.005	-0.180	-0.311	-0.049	172	5657
01:00 – 01:59	0.060	-0.002	0.123	0.031	-0.013	0.075	-0.005	-0.047	0.037	0.025	-0.025	0.074	-0.032	-0.082	0.017	-0.028	-0.072	0.017	-0.179	-0.332	-0.026	172	5661
02:00 – 02:59	0.058	-0.016	0.131	0.026	-0.025	0.077	-0.004	-0.052	0.044	0.027	-0.030	0.084	-0.023	-0.080	0.035	-0.024	-0.076	0.028	-0.111	-0.291	0.069	172	5661
03:00 – 03:59	0.094	-0.006	0.195	0.042	-0.027	0.111	-0.017	-0.082	0.048	0.022	-0.055	0.100	-0.031	-0.108	0.047	-0.073	-0.143	-0.004	-0.252	-0.495	-0.008	172	5661
04:00 – 04:59	0.090	-0.024	0.205	0.055	-0.024	0.133	-0.072	-0.146	0.002	0.006	-0.082	0.094	-0.041	-0.129	0.046	-0.060	-0.139	0.018	-0.166	-0.444	0.112	172	5661
05:00 – sunrise	0.023	-0.120	0.165	0.063	-0.035	0.162	-0.113	-0.204	-0.021	-0.077	-0.187	0.032	-0.094	-0.202	0.015	-0.100	-0.197	-0.002	-0.284	-0.628	0.061	172	5661
sunrise – 07:59	-0.017	-0.071	0.037	0.002	-0.036	0.039	0.002	-0.033	0.037	-0.044	-0.085	-0.003	0.056	0.015	0.097	0.051	0.014	0.087	0.072	-0.058	0.202	172	5661
08:00 – 08:59	-0.032	-0.071	0.008	-0.006	-0.034	0.021	-0.008	-0.033	0.018	-0.054	-0.084	-0.024	0.046	0.016	0.076	0.046	0.019	0.073	0.118	0.023	0.213	172	5662
09:00 – 09:59	-0.040	-0.078	-0.002	-0.009	-0.036	0.018	-0.010	-0.035	0.015	-0.053	-0.082	-0.024	0.036	0.006	0.066	0.039	0.013	0.066	0.127	0.034	0.219	172	5661
10:00 – 10:59	-0.058	-0.100	-0.017	-0.028	-0.057	0.001	-0.013	-0.041	0.014	-0.057	-0.089	-0.025	0.031	-0.002	0.064	0.038	0.009	0.067	0.165	0.065	0.266	172	5660
11:00 – 11:59	-0.073	-0.121	-0.024	-0.030	-0.064	0.004	-0.017	-0.049	0.016	-0.062	-0.100	-0.025	0.033	-0.006	0.071	0.043	0.008	0.077	0.158	0.038	0.278	172	5660
12:00 – 12:59	-0.073	-0.133	-0.013	-0.024	-0.066	0.018	-0.013	-0.053	0.027	-0.074	-0.120	-0.029	0.033	-0.015	0.080	0.045	0.003	0.088	0.114	-0.035	0.263	172	5661
13:00 – 13:59	-0.078	-0.151	-0.004	-0.022	-0.074	0.029	-0.012	-0.061	0.036	-0.098	-0.153	-0.044	0.034	-0.024	0.092	0.056	0.004	0.107	0.153	-0.027	0.334	172	5659
14:00 – 14:59	-0.016	-0.093	0.061	0.002	-0.052	0.055	-0.011	-0.061	0.039	-0.074	-0.132	-0.017	0.023	-0.037	0.083	0.050	-0.003	0.102	0.121	-0.066	0.308	172	5659
15:00 – 15:59	-0.048	-0.121	0.024	-0.020	-0.070	0.030	-0.006	-0.053	0.042	-0.072	-0.126	-0.017	0.038	-0.019	0.094	0.047	-0.003	0.097	0.139	-0.037	0.315	172	5659
16:00 – 16:59	-0.068	-0.144	0.009	-0.026	-0.079	0.027	-0.003	-0.053	0.048	-0.064	-0.122	-0.007	0.048	-0.011	0.108	0.058	0.006	0.110	0.217	0.033	0.401	172	5661
17:00 – sunset	-0.060	-0.150	0.029	-0.015	-0.077	0.047	-0.014	-0.073	0.044	-0.071	-0.138	-0.003	0.045	-0.024	0.114	0.052	-0.009	0.113	0.186	-0.030	0.403	172	5655
sunset – 19:59	-0.026	-0.123	0.071	-0.010	-0.079	0.060	-0.006	-0.074	0.062	-0.002	-0.078	0.074	0.036	-0.044	0.116	0.012	-0.058	0.083	0.047	-0.193	0.287	168	5099
20:00 – 20:59	-0.008	-0.096	0.080	-0.003	-0.066	0.060	0.028	-0.033	0.090	0.021	-0.047	0.090	0.046	-0.026	0.118	0.035	-0.028	0.098	-0.054	-0.270	0.163	168	5092
21:00 – 21:59	0.036	-0.039	0.111	0.020	-0.033	0.074	0.034	-0.019	0.087	0.038	-0.022	0.097	0.011	-0.051	0.074	0.005	-0.050	0.060	-0.092	-0.278	0.093	168	5106
22:00 – 22:59	0.028	-0.030	0.086	0.021	-0.021	0.063	0.000	-0.042	0.041	0.029	-0.017	0.075	-0.040	-0.089	0.009	-0.032	-0.075	0.011	-0.103	-0.247	0.041	168	5101
23:00 – 23:59	0.021	-0.029	0.071	0.018	-0.019	0.054	-0.008	-0.043	0.027	0.015	-0.025	0.054	-0.039	-0.080	0.002	-0.035	-0.071	0.002	-0.108	-0.231	0.015	168	5096

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals between sunset and sunrise (night) were analyzed with next-day outcomes; intervals between sunrise and sunset (day) were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and wake-up time.

Significant associations ($p \leq 0.05$) are highlighted in bold.

Table S3. Within-subject coefficients (β_w) from a robust linear mixed-effects regression model of double increase median melanopic EDI exposure throughout the 24-hour day and daily mood-related symptoms (MRh-RD) and well-being scores (WHO-5) within 1-hour intervals on the 24-hour day.

timing interval (hh:mm)	MRh-RD																		WHO-5			subjects (n)	days (n)		
	ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY			WELL-BEING						
	β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI					
		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper				
00:00 – 00:59	-0.001	-0.007	0.005	-0.001	-0.005	0.004	0.004	0.000	0.008	0.015	0.009	0.020	-0.009	-0.014	-0.004	-0.005	-0.010	0.000	-0.007	-0.023	0.008	172	5657		
01:00 – 01:59	-0.002	-0.010	0.006	0.003	-0.003	0.009	-0.002	-0.007	0.003	0.025	0.018	0.032	-0.011	-0.017	-0.004	-0.013	-0.019	-0.007	-0.020	-0.040	-0.001	172	5661		
02:00 – 02:59	-0.009	-0.019	0.001	-0.001	-0.009	0.007	-0.002	-0.009	0.004	0.017	0.008	0.026	-0.004	-0.012	0.005	-0.009	-0.017	-0.001	-0.016	-0.041	0.010	172	5661		
03:00 – 03:59	-0.007	-0.019	0.005	0.002	-0.007	0.011	-0.002	-0.010	0.005	0.022	0.012	0.033	-0.014	-0.025	-0.004	-0.017	-0.027	-0.008	-0.026	-0.057	0.004	172	5661		
04:00 – 04:59	-0.003	-0.018	0.012	0.009	-0.003	0.020	-0.006	-0.015	0.004	0.027	0.013	0.040	-0.004	-0.017	0.008	-0.013	-0.025	-0.001	-0.035	-0.073	0.002	172	5661		
05:00 – sunrise	-0.008	-0.025	0.008	0.007	-0.006	0.020	-0.002	-0.013	0.008	-0.005	-0.020	0.010	-0.014	-0.028	0.000	-0.009	-0.022	0.004	-0.018	-0.060	0.024	172	5661		
sunrise – 07:59	0.004	-0.002	0.011	0.000	-0.006	0.005	0.002	-0.003	0.006	0.004	-0.002	0.010	0.003	-0.002	0.009	0.004	-0.001	0.010	0.007	-0.010	0.025	172	5661		
08:00 – 08:59	0.004	-0.001	0.009	-0.003	-0.007	0.001	0.002	-0.001	0.005	-0.003	-0.008	0.002	0.013	0.008	0.017	0.006	0.002	0.010	0.002	-0.011	0.015	172	5662		
09:00 – 09:59	0.008	0.003	0.014	-0.003	-0.008	0.001	0.002	-0.001	0.006	-0.002	-0.007	0.003	0.011	0.006	0.015	0.008	0.003	0.012	0.001	-0.012	0.015	172	5661		
10:00 – 10:59	-0.003	-0.008	0.003	-0.010	-0.014	-0.005	0.004	0.000	0.007	-0.008	-0.013	-0.003	0.012	0.008	0.017	0.014	0.009	0.018	0.035	0.020	0.049	172	5660		
11:00 – 11:59	-0.008	-0.015	-0.002	-0.009	-0.013	-0.004	0.002	-0.002	0.006	-0.013	-0.018	-0.007	0.012	0.007	0.018	0.017	0.012	0.022	0.053	0.037	0.069	172	5660		
12:00 – 12:59	-0.010	-0.017	-0.003	-0.009	-0.014	-0.004	0.000	-0.004	0.005	-0.015	-0.021	-0.009	0.011	0.005	0.017	0.017	0.011	0.022	0.059	0.041	0.076	172	5661		
13:00 – 13:59	-0.004	-0.011	0.003	-0.005	-0.010	0.000	-0.004	-0.009	0.000	-0.016	-0.023	-0.010	0.013	0.007	0.019	0.016	0.011	0.021	0.055	0.037	0.072	172	5659		
14:00 – 14:59	-0.004	-0.011	0.002	-0.002	-0.007	0.003	-0.002	-0.006	0.002	-0.015	-0.021	-0.010	0.015	0.010	0.020	0.018	0.013	0.023	0.052	0.036	0.068	172	5659		
15:00 – 15:59	-0.005	-0.011	0.001	-0.005	-0.010	0.000	-0.002	-0.006	0.002	-0.019	-0.025	-0.014	0.016	0.011	0.021	0.020	0.015	0.025	0.050	0.034	0.065	172	5659		
16:00 – 16:59	-0.004	-0.011	0.002	-0.008	-0.012	-0.003	0.001	-0.003	0.005	-0.023	-0.029	-0.018	0.018	0.012	0.023	0.022	0.017	0.027	0.066	0.050	0.082	172	5661		
17:00 – sunset	-0.005	-0.011	0.002	-0.009	-0.014	-0.004	0.000	-0.004	0.004	-0.023	-0.029	-0.017	0.018	0.012	0.023	0.022	0.017	0.027	0.055	0.038	0.072	172	5655		
sunset – 19:59	0.015	0.006	0.024	0.008	0.001	0.015	0.001	-0.005	0.006	-0.002	-0.010	0.006	0.011	0.004	0.019	0.005	-0.002	0.012	-0.005	-0.027	0.017	168	5099		
20:00 – 20:59	0.004	-0.004	0.012	0.000	-0.006	0.006	0.001	-0.004	0.006	0.001	-0.006	0.008	0.005	-0.001	0.012	0.004	-0.003	0.010	0.011	-0.009	0.031	168	5092		
21:00 – 21:59	0.001	-0.007	0.008	-0.001	-0.006	0.005	0.000	-0.005	0.005	0.004	-0.003	0.011	0.004	-0.002	0.010	0.005	-0.001	0.011	0.011	-0.008	0.030	168	5106		
22:00 – 22:59	-0.002	-0.009	0.004	-0.002	-0.007	0.003	0.001	-0.003	0.005	0.004	-0.002	0.010	-0.002	-0.007	0.004	0.003	-0.001	0.008	0.007	-0.009	0.023	168	5101		
23:00 – 23:59	-0.003	-0.009	0.003	0.001	-0.004	0.005	0.003	0.000	0.007	0.006	0.000	0.011	-0.007	-0.012	-0.002	-0.004	-0.008	0.001	0.012	-0.003	0.027	168	5096		

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals between sunset and sunrise (night) were analyzed with next-day outcomes; intervals between sunrise and sunset (day) were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and wake-up time.

Significant associations ($p \leq 0.05$) are highlighted in bold.

Table S4. Between-subject coefficients (β_B) from a robust linear mixed-effects regression model of double increase median melanopic EDI exposure within intervals in 30-minute increments preceding sleep onset and following wake-up time (each interval included the previous one) and daily mood-related symptoms (MRh-RD) and well-being scores (WHO-5).

interval related to sleep	MRh-RD															WHO-5			subjects (n)	days (n)			
	ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY							
	95% CI			95% CI			95% CI			95% CI			95% CI			95% CI							
	β_B	lower	upper	β_B	lower	upper	β_B	lower	upper	β_B	lower	upper	β_B	lower	upper	β_B	lower	upper					
since sunset	0.008	-0.080	0.095	0.006	-0.056	0.068	0.022	-0.038	0.081	0.033	-0.036	0.103	0.023	-0.047	0.093	0.010	-0.053	0.072	-0.044	-0.266	0.178	166	4809
3h	0.026	-0.045	0.097	0.016	-0.032	0.064	0.032	-0.014	0.078	0.050	-0.006	0.107	0.014	-0.042	0.071	0.012	-0.039	0.062	-0.021	-0.195	0.153	164	4262
2.5h	0.049	-0.022	0.121	0.037	-0.011	0.085	0.044	0.000	0.089	0.058	0.003	0.113	0.009	-0.048	0.066	0.005	-0.045	0.055	-0.041	-0.215	0.132	160	4093
2h	0.063	-0.001	0.126	0.041	-0.004	0.086	0.036	-0.006	0.078	0.047	-0.005	0.099	-0.010	-0.064	0.044	0.000	-0.047	0.048	-0.098	-0.256	0.060	156	3762
1.5h	0.019	-0.043	0.081	0.024	-0.016	0.065	0.026	-0.017	0.069	0.030	-0.022	0.083	0.005	-0.048	0.059	-0.010	-0.059	0.039	-0.061	-0.217	0.095	151	3382
1h	0.012	-0.046	0.071	0.029	-0.010	0.069	0.038	-0.002	0.079	0.049	-0.003	0.101	0.008	-0.044	0.060	-0.005	-0.053	0.043	-0.029	-0.178	0.120	145	2829
0.5h	0.024	-0.029	0.078	0.021	-0.018	0.059	0.013	-0.026	0.051	0.011	-0.038	0.059	-0.006	-0.053	0.042	-0.001	-0.045	0.042	-0.060	-0.201	0.081	139	2255
0.5h	0.033	-0.016	0.083	0.025	-0.009	0.059	0.010	-0.022	0.043	0.034	-0.004	0.072	0.024	-0.014	0.062	0.023	-0.010	0.057	0.007	-0.115	0.130	171	4982
1h	0.003	-0.049	0.054	0.006	-0.030	0.041	0.012	-0.021	0.046	0.019	-0.020	0.059	0.042	0.003	0.081	0.032	-0.002	0.067	0.064	-0.062	0.190	171	4980
1.5h	-0.008	-0.064	0.048	0.000	-0.039	0.039	0.019	-0.017	0.055	0.014	-0.029	0.057	0.061	0.018	0.103	0.046	0.009	0.084	0.045	-0.092	0.182	171	4975
2h	-0.019	-0.078	0.040	-0.004	-0.045	0.036	0.013	-0.026	0.051	0.001	-0.044	0.046	0.049	0.004	0.094	0.043	0.003	0.083	0.023	-0.121	0.167	171	4961
2.5h	-0.024	-0.090	0.041	-0.006	-0.052	0.039	0.010	-0.033	0.052	-0.001	-0.051	0.049	0.057	0.007	0.107	0.041	-0.003	0.086	0.057	-0.103	0.217	171	4954
3h	-0.029	-0.097	0.039	-0.006	-0.054	0.041	0.002	-0.043	0.047	-0.008	-0.060	0.045	0.058	0.005	0.110	0.042	-0.005	0.090	0.061	-0.106	0.229	171	4946
3.5h	-0.033	-0.105	0.039	-0.006	-0.056	0.044	-0.006	-0.053	0.042	-0.012	-0.068	0.043	0.050	-0.006	0.106	0.036	-0.014	0.086	0.063	-0.114	0.240	171	4934
4h	-0.035	-0.110	0.041	-0.007	-0.059	0.045	-0.013	-0.063	0.038	-0.016	-0.074	0.042	0.044	-0.016	0.103	0.028	-0.024	0.081	0.057	-0.127	0.241	171	4906
4.5h	-0.040	-0.118	0.038	-0.009	-0.063	0.045	-0.017	-0.069	0.035	-0.027	-0.087	0.034	0.039	-0.022	0.101	0.026	-0.028	0.080	0.064	-0.126	0.255	171	4877
5h	-0.053	-0.133	0.027	-0.012	-0.067	0.044	-0.019	-0.072	0.034	-0.042	-0.103	0.020	0.037	-0.026	0.101	0.028	-0.027	0.083	0.073	-0.122	0.268	171	4823
5.5h	-0.061	-0.144	0.023	-0.015	-0.073	0.043	-0.025	-0.080	0.031	-0.042	-0.106	0.022	0.033	-0.032	0.099	0.029	-0.028	0.086	0.085	-0.118	0.288	171	4761
6h	-0.061	-0.140	0.018	-0.015	-0.070	0.039	-0.031	-0.083	0.020	-0.047	-0.108	0.013	0.022	-0.040	0.085	0.025	-0.029	0.079	0.050	-0.143	0.243	171	4678
6.5h	-0.072	-0.152	0.008	-0.022	-0.076	0.032	-0.034	-0.086	0.018	-0.060	-0.122	0.001	0.016	-0.046	0.079	0.021	-0.033	0.076	0.068	-0.128	0.264	171	4580
7h	-0.068	-0.149	0.012	-0.017	-0.071	0.037	-0.034	-0.087	0.018	-0.063	-0.125	-0.001	0.016	-0.048	0.079	0.024	-0.032	0.079	0.040	-0.157	0.236	171	4426
7.5h	-0.077	-0.160	0.006	-0.025	-0.081	0.031	-0.035	-0.089	0.018	-0.066	-0.130	-0.002	0.014	-0.051	0.080	0.020	-0.036	0.077	0.038	-0.162	0.238	170	4197
8h	-0.096	-0.177	-0.016	-0.025	-0.081	0.031	-0.047	-0.100	0.007	-0.072	-0.134	-0.010	0.021	-0.045	0.087	0.027	-0.030	0.084	0.072	-0.123	0.267	166	3836
since sunset	-0.076	-0.160	0.009	-0.040	-0.096	0.016	-0.021	-0.076	0.033	-0.082	-0.144	-0.019	0.064	-0.002	0.131	0.064	0.004	0.124	0.116	-0.081	0.313	168	4069

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals between sunset and sunrise (night) were analyzed with next-day outcomes; intervals between sunrise and sunset (day) were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep.

Significant associations ($p \leq 0.05$) are highlighted in bold.

Table S5. Within-subject coefficients (β_w) from a robust linear mixed-effects regression model of double increase median melanopic EDI exposure within intervals in 30-minute increments preceding sleep onset and following wake-up time (each interval included the previous one) and daily mood-related symptoms (MRh-RD) and well-being scores (WHO-5).

		MRh-RD															WHO-5			subjects (n)	days (n)			
interval related to sleep		ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY			WELL-BEING				
		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI		β_w	95% CI			
			lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		lower	upper		
before sleep onset	since sunset	0.010	-0.001	0.021	0.002	-0.006	0.010	0.002	-0.005	0.009	0.001	-0.009	0.011	0.013	0.003	0.022	0.006	-0.003	0.015	0.011	-0.017	0.039	166	4809
	3h	-0.004	-0.011	0.004	-0.003	-0.009	0.003	0.000	-0.005	0.005	-0.003	-0.009	0.004	-0.002	-0.008	0.005	0.007	0.001	0.013	0.026	0.007	0.045	164	4262
	2.5h	-0.003	-0.010	0.005	0.000	-0.006	0.005	0.000	-0.004	0.005	0.000	-0.007	0.006	0.000	-0.006	0.006	0.006	0.000	0.012	0.022	0.004	0.040	160	4093
	2h	-0.002	-0.009	0.004	0.000	-0.005	0.006	0.002	-0.003	0.006	0.001	-0.005	0.007	0.002	-0.004	0.008	0.003	-0.003	0.008	0.015	-0.002	0.033	156	3762
	1.5h	-0.003	-0.010	0.003	0.000	-0.006	0.005	0.000	-0.004	0.005	-0.001	-0.007	0.005	-0.001	-0.007	0.004	0.002	-0.003	0.008	0.018	0.001	0.035	151	3382
	1h	-0.004	-0.011	0.003	-0.001	-0.006	0.005	0.000	-0.005	0.004	-0.003	-0.009	0.003	-0.002	-0.008	0.004	0.002	-0.003	0.008	0.013	-0.004	0.031	145	2829
	0.5h	0.001	-0.007	0.008	0.004	-0.002	0.010	-0.004	-0.009	0.001	-0.002	-0.008	0.005	-0.005	-0.011	0.002	-0.001	-0.007	0.004	0.008	-0.010	0.027	139	2255
after wake-up time	0.5h	0.000	-0.005	0.005	-0.004	-0.008	0.000	0.004	0.000	0.007	-0.001	-0.006	0.003	0.007	0.003	0.011	0.006	0.002	0.010	0.008	-0.004	0.021	171	4982
	1h	-0.002	-0.007	0.003	-0.005	-0.009	-0.001	0.003	0.000	0.007	-0.002	-0.007	0.003	0.009	0.005	0.014	0.005	0.001	0.009	0.008	-0.005	0.021	171	4980
	1.5h	-0.005	-0.011	0.001	-0.005	-0.010	-0.001	0.002	-0.001	0.006	-0.004	-0.009	0.002	0.009	0.005	0.014	0.007	0.002	0.011	0.018	0.004	0.033	171	4975
	2h	-0.005	-0.012	0.001	-0.007	-0.011	-0.002	0.001	-0.003	0.005	-0.009	-0.014	-0.003	0.011	0.006	0.016	0.009	0.005	0.014	0.029	0.014	0.044	171	4961
	2.5h	-0.005	-0.011	0.002	-0.009	-0.014	-0.003	0.002	-0.003	0.006	-0.013	-0.019	-0.007	0.010	0.005	0.016	0.013	0.007	0.018	0.038	0.021	0.055	171	4954
	3h	-0.003	-0.010	0.004	-0.008	-0.014	-0.003	0.001	-0.004	0.005	-0.015	-0.022	-0.008	0.011	0.005	0.017	0.013	0.008	0.019	0.046	0.028	0.064	171	4946
	3.5h	-0.003	-0.011	0.005	-0.009	-0.015	-0.003	0.001	-0.004	0.006	-0.018	-0.025	-0.011	0.010	0.003	0.016	0.016	0.010	0.022	0.048	0.029	0.068	171	4934
	4h	-0.005	-0.013	0.003	-0.011	-0.017	-0.004	0.002	-0.004	0.007	-0.022	-0.030	-0.015	0.011	0.004	0.018	0.019	0.012	0.026	0.060	0.039	0.080	171	4906
	4.5h	-0.006	-0.015	0.003	-0.012	-0.018	-0.005	0.000	-0.005	0.006	-0.028	-0.036	-0.020	0.011	0.004	0.019	0.021	0.014	0.028	0.066	0.044	0.088	171	4877
	5h	-0.007	-0.016	0.002	-0.011	-0.018	-0.004	0.001	-0.005	0.007	-0.031	-0.040	-0.023	0.014	0.006	0.022	0.023	0.016	0.031	0.071	0.047	0.094	171	4823
	5.5h	-0.006	-0.016	0.003	-0.010	-0.017	-0.002	0.002	-0.005	0.008	-0.031	-0.040	-0.022	0.014	0.005	0.022	0.023	0.015	0.031	0.075	0.050	0.099	171	4761
	6h	-0.007	-0.017	0.003	-0.011	-0.019	-0.003	0.004	-0.003	0.010	-0.033	-0.042	-0.023	0.015	0.006	0.023	0.025	0.016	0.033	0.088	0.062	0.114	171	4678
	6.5h	-0.005	-0.015	0.006	-0.010	-0.018	-0.002	0.004	-0.004	0.011	-0.035	-0.045	-0.025	0.016	0.007	0.025	0.027	0.018	0.035	0.084	0.057	0.112	171	4580
	7h	-0.003	-0.015	0.008	-0.008	-0.017	0.001	0.002	-0.005	0.010	-0.035	-0.046	-0.025	0.017	0.007	0.027	0.027	0.018	0.036	0.085	0.056	0.113	171	4426
	7.5h	-0.002	-0.014	0.010	-0.006	-0.015	0.004	0.001	-0.007	0.009	-0.036	-0.047	-0.026	0.021	0.011	0.031	0.027	0.018	0.037	0.073	0.043	0.103	170	4197
	8h	0.000	-0.013	0.013	-0.008	-0.018	0.001	0.000	-0.008	0.009	-0.037	-0.048	-0.025	0.023	0.012	0.033	0.027	0.017	0.037	0.076	0.044	0.109	166	3836
	since sunset	-0.007	-0.021	0.006	-0.013	-0.023	-0.003	0.001	-0.008	0.010	-0.038	-0.050	-0.026	0.034	0.023	0.045	0.037	0.027	0.048	0.112	0.079	0.145	168	4069

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals between sunset and sunrise (night) were analyzed with next-day outcomes; intervals between sunrise and sunset (day) were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep.

Significant associations ($p \leq 0.05$) are highlighted in bold.

Table S6. Percentage of days classified according to exposure duration thresholds of melanopic EDI minimal levels (250, 10, and 1 lux) in each time interval of the day.

Melanopic EDI (lx)	Interval of day	days (%)						
		≥ 1min	< 5min	< 15min	< 30min	< 60min	< 90min	< 120min
≥ 250	daytime (sunrise- sunset)	86.7	17.5	23.7	31.0	42.7	53.0	61.8
	1h after wakeup	40.3	74.3	87.1	95.5			
	2h after wakeup	63.3	50.8	65.6	78.5	93.1	98.7	
	3h after wakeup	73.9	37.3	50.8	63.6	81.5	91.2	96.9
≥ 10	nighttime, 3h before asleep	82.1	24.5	36.5	49.9	69.6	82.7	91.1
≥ 1	nighttime, during sleep	34.4	77.5	87.2	93.7	97.3	98.6	99.4

Melanopic EDI: melanopic equivalent daylight illuminance

Table S7. Between-subject coefficients from a robust linear mixed-effects regression model of melanopic EDI exposure duration thresholds in different intervals (3 hours before sleep, during nighttime while sleeping, and within 1 hour, 2 hours, and 3 hours after wakeup) assessed over a 7-day frequency with the 7-day average of mood-related symptoms (MRh-RD) and well-being scores (WHO-5).

melanopic EDI (lux)	exposure interval	duration (minutes)	MRh-RD															WHO-5			subjects (n)			
			ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY				WELL-BEING		
			estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p		estimate	se	p
≥ 10	3h pre- asleep	0	-0.035	0.134	0.794	0.021	0.108	0.845	-0.135	0.096	0.160	0.029	0.107	0.788	-0.035	0.111	0.752	-0.042	0.100	0.677	0.060	0.342	0.861	156
		≥30	-0.004	0.071	0.952	0.010	0.057	0.865	0.096	0.050	0.057	0.053	0.057	0.353	0.061	0.058	0.295	0.056	0.053	0.291	0.057	0.181	0.751	
		≥60	0.014	0.077	0.855	0.013	0.061	0.828	0.053	0.055	0.343	0.040	0.061	0.519	0.078	0.063	0.212	0.061	0.057	0.287	0.124	0.196	0.529	
		≥90	0.061	0.092	0.507	0.042	0.073	0.564	0.027	0.066	0.685	0.055	0.073	0.456	0.111	0.075	0.138	0.079	0.068	0.249	0.269	0.233	0.248	
		≥120	0.120	0.137	0.378	0.074	0.109	0.496	0.044	0.099	0.654	0.081	0.109	0.460	0.190	0.111	0.087	0.124	0.102	0.224	0.419	0.347	0.227	
≥ 1	sleep period	0	0.033	0.096	0.728	0.002	0.077	0.983	-0.113	0.068	0.095	0.002	0.076	0.981	-0.095	0.079	0.226	-0.103	0.072	0.149	-0.070	0.243	0.773	156
		≥15	0.270	0.150	0.072	0.309	0.123	0.012	0.000	0.109	1.000	0.045	0.120	0.708	-0.070	0.123	0.571	-0.117	0.111	0.291	-0.547	0.381	0.151	
		≥30	0.601	0.207	0.004	0.634	0.171	0.000	-0.087	0.153	0.569	0.247	0.168	0.142	-0.227	0.170	0.183	-0.221	0.155	0.154	-1.072	0.531	0.044	
≥ 250	1h after wake-up	0	0.030	0.082	0.717	0.028	0.064	0.663	-0.087	0.056	0.120	-0.133	0.063	0.035	-0.010	0.067	0.882	0.011	0.062	0.865	-0.201	0.203	0.323	161
		≥15	-0.113	0.127	0.373	-0.091	0.099	0.358	0.010	0.087	0.909	0.043	0.098	0.658	-0.001	0.103	0.991	-0.040	0.095	0.671	0.315	0.313	0.316	
		≥30	-0.344	0.241	0.153	-0.225	0.188	0.230	-0.054	0.167	0.748	-0.089	0.185	0.629	0.007	0.197	0.970	-0.089	0.180	0.622	0.573	0.597	0.337	
	2h after wake-up	0	0.078	0.085	0.360	0.040	0.066	0.552	-0.111	0.058	0.055	-0.052	0.066	0.429	-0.111	0.069	0.104	-0.068	0.063	0.284	-0.267	0.210	0.202	161
		≥30	-0.153	0.099	0.121	-0.105	0.077	0.170	-0.025	0.068	0.716	-0.013	0.076	0.859	0.033	0.080	0.677	0.009	0.074	0.905	0.293	0.243	0.229	
		≥60	-0.225	0.164	0.170	-0.131	0.128	0.305	-0.105	0.113	0.354	-0.102	0.126	0.417	0.004	0.133	0.978	-0.053	0.122	0.662	0.354	0.405	0.381	
		≥90	-0.788	0.482	0.102	-0.568	0.375	0.130	-0.255	0.335	0.447	-0.153	0.373	0.682	-0.241	0.394	0.541	-0.356	0.360	0.323	0.552	1.207	0.648	
	3h after wake-up	0	0.041	0.097	0.677	0.005	0.076	0.945	-0.135	0.066	0.041	-0.007	0.075	0.922	-0.114	0.079	0.146	-0.089	0.072	0.217	-0.230	0.241	0.338	161
		≥30	-0.112	0.081	0.166	-0.056	0.063	0.372	0.005	0.056	0.933	-0.042	0.062	0.492	0.073	0.065	0.261	0.065	0.060	0.276	0.189	0.199	0.343	
		≥60	-0.148	0.099	0.137	-0.093	0.077	0.227	0.009	0.068	0.899	-0.018	0.076	0.817	0.069	0.081	0.394	0.022	0.074	0.770	0.358	0.244	0.143	
		≥90	-0.215	0.141	0.127	-0.123	0.110	0.262	-0.015	0.097	0.880	-0.031	0.109	0.777	0.028	0.115	0.811	-0.034	0.106	0.748	0.233	0.349	0.505	
		≥120	-0.390	0.270	0.149	-0.255	0.211	0.227	-0.073	0.187	0.697	-0.122	0.208	0.556	0.014	0.221	0.950	-0.103	0.202	0.612	0.248	0.671	0.711	

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals “3h pre-asleep” and “sleep period” were analyzed with next-day outcomes; intervals “after wake-up” were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep. The models “3h pre-asleep” and “sleep period” were further adjusted for the relative ratio of melanopic EDI exposure durations within the entire daytime and the analyzed period at night (RDLE: relative duration of light exposure).

Significant associations ($p \leq 0.05$) are highlighted in bold.

Table S8. Within-subject coefficients from a robust linear mixed-effects regression model of melanopic EDI exposure duration thresholds in different intervals (3 hours before sleep, during nighttime while sleeping, and within 1 hour, 2 hours, and 3 hours after wakeup) assessed over a 7-day frequency with the 7-day average of mood-related symptoms (MRh-RD) and well-being scores (WHO-5).

melanopic EDI (lux)	exposure interval	duration (minutes)	MRh-RD															WHO-5			subjects (n)			
			ANXIETY			SADNESS			APPETITE			SLEEPINESS			CONCENTRATION			ENERGY				WELL-BEING		
			estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p	estimate	se	p		estimate	se	p
≥ 10	3h pre- asleep	0	-0.004	0.013	0.754	0.002	0.013	0.878	0.010	0.009	0.263	0.050	0.012	0.000	0.002	0.011	0.826	-0.010	0.010	0.341	-0.009	0.035	0.796	156
		≥30	-0.004	0.010	0.675	0.023	0.009	0.013	-0.004	0.006	0.491	0.020	0.009	0.021	-0.011	0.008	0.160	-0.011	0.008	0.147	0.092	0.025	0.000	
		≥60	-0.011	0.010	0.271	0.012	0.009	0.206	0.020	0.007	0.002	0.033	0.009	0.000	0.029	0.008	0.000	0.025	0.008	0.001	0.090	0.026	0.001	
		≥90	0.006	0.011	0.574	0.016	0.010	0.121	0.002	0.007	0.784	0.034	0.010	0.001	0.026	0.009	0.003	0.029	0.009	0.001	0.015	0.029	0.594	
		≥120	0.014	0.014	0.320	0.010	0.013	0.433	0.020	0.009	0.036	0.027	0.013	0.033	0.039	0.011	0.001	0.042	0.011	0.000	0.067	0.037	0.071	
≥ 1	sleep period	0	0.007	0.009	0.431	0.000	0.009	0.989	0.024	0.006	0.000	0.016	0.009	0.059	0.033	0.007	0.000	0.024	0.007	0.001	0.043	0.024	0.078	156
		≥15	0.029	0.013	0.028	0.069	0.012	0.000	-0.028	0.009	0.001	0.023	0.012	0.048	-0.033	0.010	0.001	-0.043	0.010	0.000	-0.107	0.034	0.002	
		≥30	0.033	0.018	0.066	0.079	0.017	0.000	-0.039	0.012	0.001	0.032	0.016	0.054	0.016	0.014	0.260	-0.022	0.014	0.121	-0.031	0.047	0.507	
≥ 250	1h after wake-up	0	0.038	0.008	0.000	0.025	0.008	0.002	-0.011	0.006	0.040	0.017	0.008	0.028	-0.034	0.007	0.000	-0.023	0.007	0.000	-0.127	0.022	0.000	161
		≥15	-0.050	0.011	0.000	-0.022	0.011	0.049	0.010	0.008	0.162	-0.038	0.010	0.000	0.008	0.009	0.378	0.017	0.009	0.051	0.175	0.030	0.000	
		≥30	-0.054	0.017	0.002	-0.037	0.017	0.026	0.025	0.011	0.027	-0.056	0.016	0.000	0.007	0.014	0.623	0.059	0.013	0.000	0.329	0.045	0.000	
	2h after wake-up	0	0.013	0.009	0.139	-0.002	0.008	0.858	-0.004	0.006	0.506	0.019	0.008	0.014	-0.015	0.007	0.028	-0.011	0.007	0.105	-0.037	0.022	0.095	161
		≥30	-0.038	0.009	0.000	-0.010	0.009	0.282	0.019	0.006	0.002	-0.026	0.009	0.002	-0.011	0.007	0.138	0.015	0.007	0.036	0.184	0.025	0.000	
		≥60	-0.046	0.015	0.002	-0.018	0.014	0.206	0.002	0.010	0.836	-0.045	0.013	0.001	0.013	0.011	0.258	0.033	0.011	0.003	0.274	0.038	0.000	
		≥90	-0.092	0.033	0.006	-0.057	0.032	0.075	0.004	0.022	0.868	-0.055	0.030	0.067	0.037	0.026	0.163	0.089	0.026	0.001	0.632	0.088	0.000	
	3h after wake-up	0	0.020	0.010	0.044	-0.011	0.009	0.223	-0.002	0.006	0.707	0.019	0.009	0.032	-0.023	0.008	0.003	-0.023	0.008	0.002	-0.083	0.026	0.001	161
		≥30	-0.058	0.021	0.006	-0.007	0.008	0.430	-0.007	0.006	0.232	-0.030	0.008	0.000	-0.005	0.007	0.485	0.008	0.007	0.255	0.161	0.023	0.000	
		≥60	-0.032	0.009	0.000	-0.027	0.010	0.007	0.011	0.007	0.115	-0.038	0.009	0.000	-0.011	0.008	0.181	0.007	0.008	0.362	0.256	0.027	0.000	
		≥90	-0.046	0.010	0.000	-0.036	0.012	0.004	0.001	0.008	0.885	-0.043	0.012	0.000	-0.007	0.010	0.506	0.027	0.010	0.007	0.287	0.034	0.000	
		≥120	-0.049	0.013	0.000	-0.033	0.021	0.104	0.032	0.014	0.023	-0.037	0.019	0.053	0.056	0.017	0.001	0.083	0.016	0.000	0.445	0.056	0.000	

Melanopic EDI: melanopic equivalent daylight illuminance; MRh-RD: Mood Rhythm Reduced Diary; WHO-5: Five-item World Health Organization Well-Being Index.

Intervals “3h pre-asleep” and “sleep period” were analyzed with next-day outcomes; intervals “after wake-up” were analyzed with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep. The models “3h pre-asleep” and “sleep period” were further adjusted for the relative ratio of melanopic EDI exposure durations within the entire daytime and the analyzed period at night (RDLE: relative duration of light exposure).

Significant associations ($p \leq 0.05$) are highlighted in bold.

2. Supplementary Figures

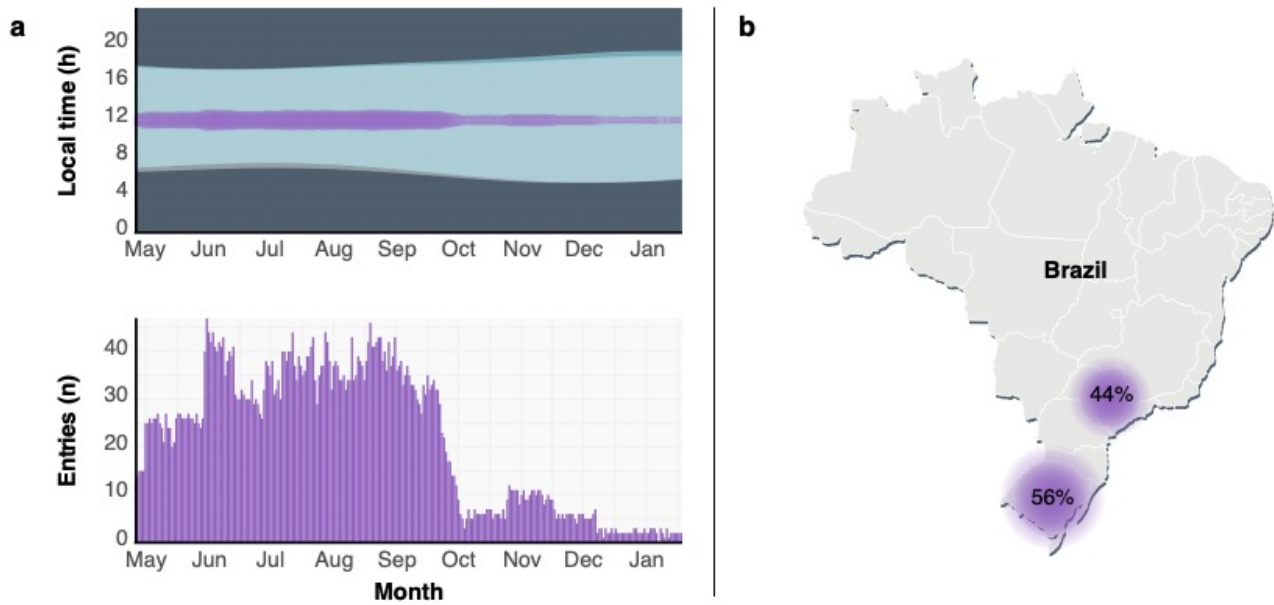


Figure S1. a) Photoperiods during data collection in Porto Alegre and São Paulo are shown above in light blue, with purple circles whose sizes correspond to the amount of entries per day (2020/2021). The histogram provides the same information in numbers. b) Percentage distribution of participants in Brazilian states: 56% refer to Rio Grande do Sul (South) and 44% to São Paulo (Southeast). $n = 172$.

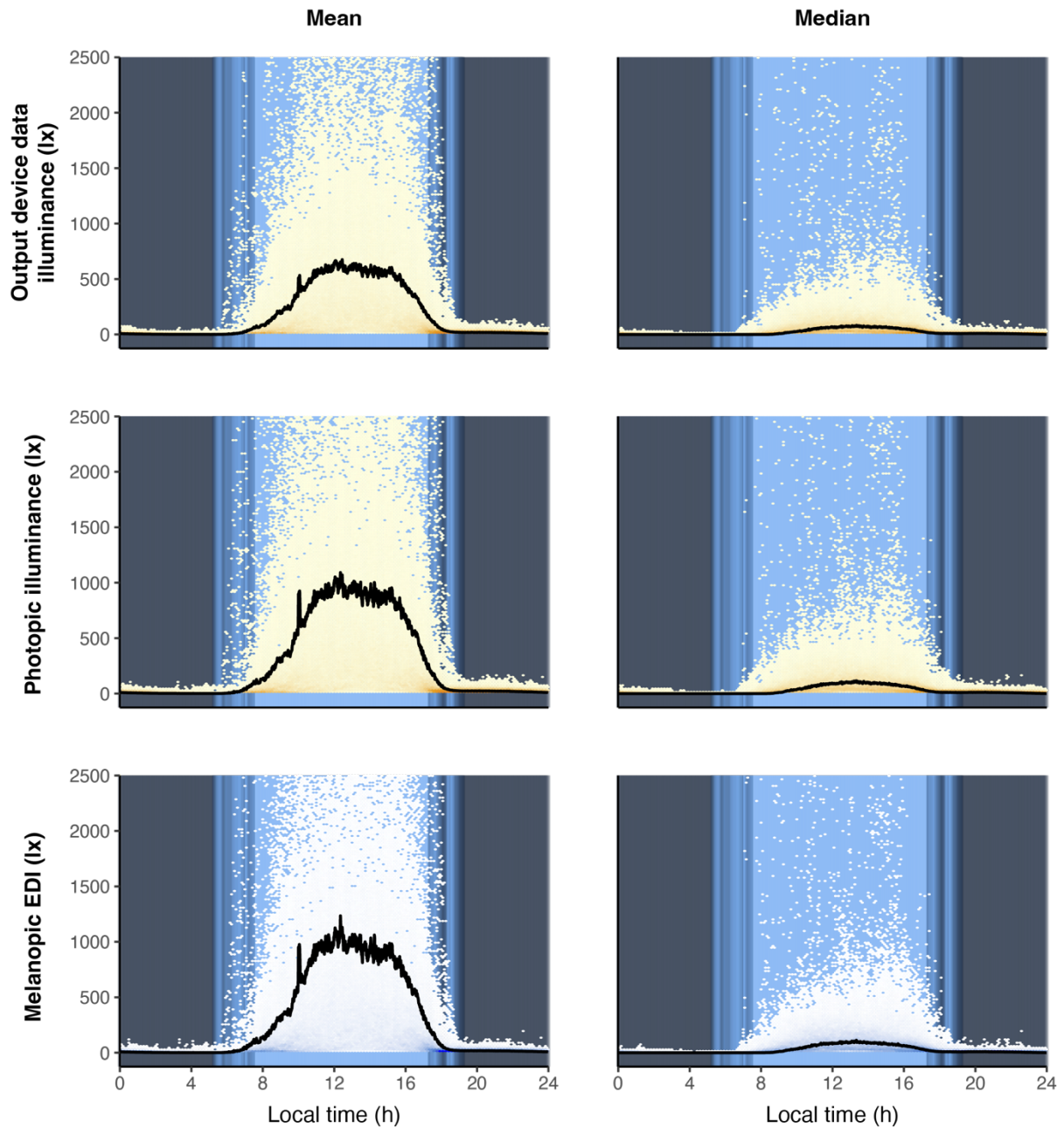


Figure S2. Profile of light exposure computed from the mean and median of participant light exposure at each minute of a 24h-day. Yellow-to-red dots represent the participant frequency (low to high) for the device output light variable (ActTrust) and photopic illuminance. White-to-blue dots represent the participant frequency (low to high) for the melanopic EDI variable. The black line indicates the sample profile (mean or median exposure). Photoperiods during data collection are shown in light blue, while nights are represented in dark gray (graph background).

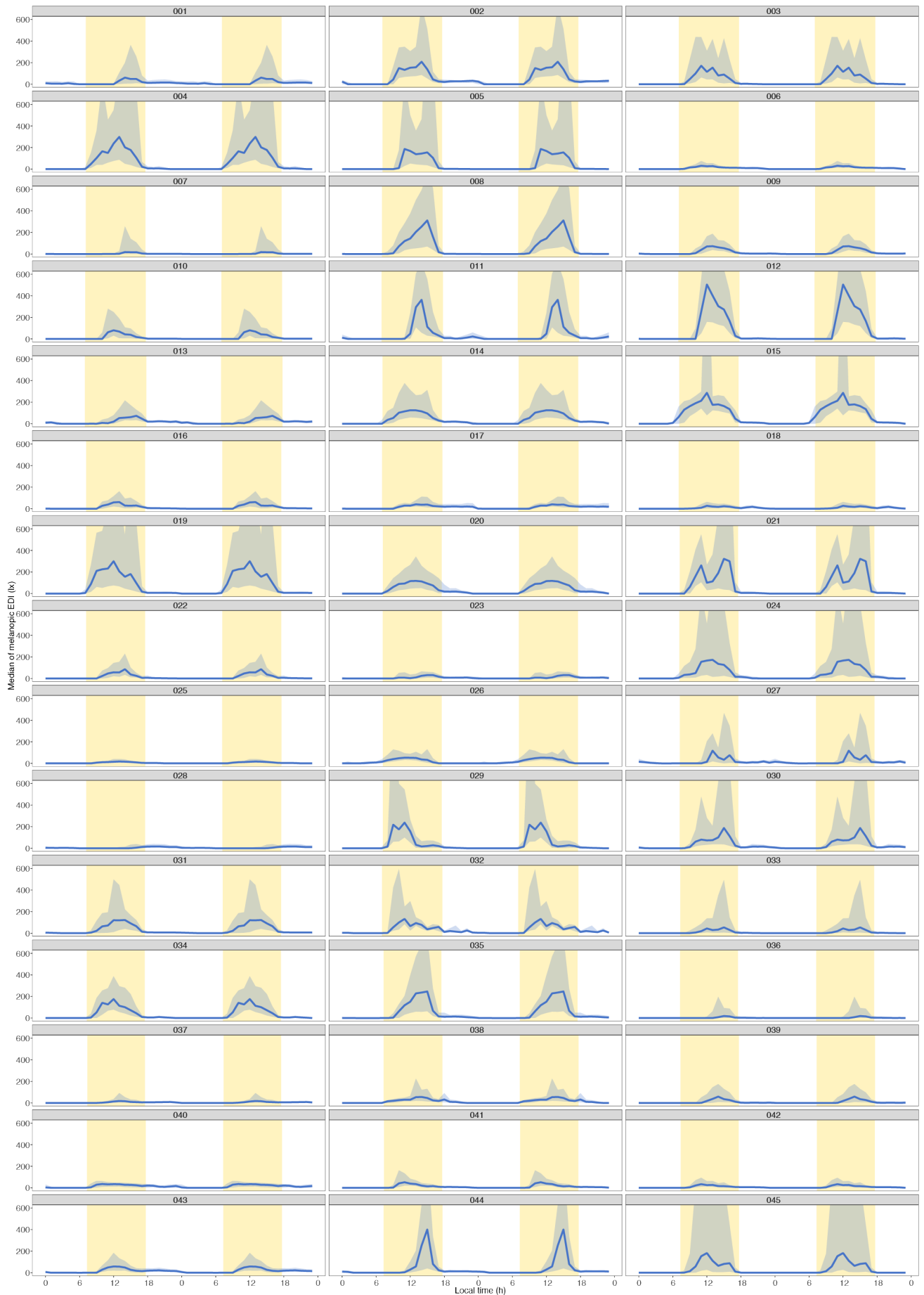


Figure S3a. Individual double-plotted daily melanopic EDI profiles by participant. Blue line: median melanopic EDI exposure across days; blue ribbon: interquartile range; yellow-shaded rectangles: period between sunrise and sunset (day).

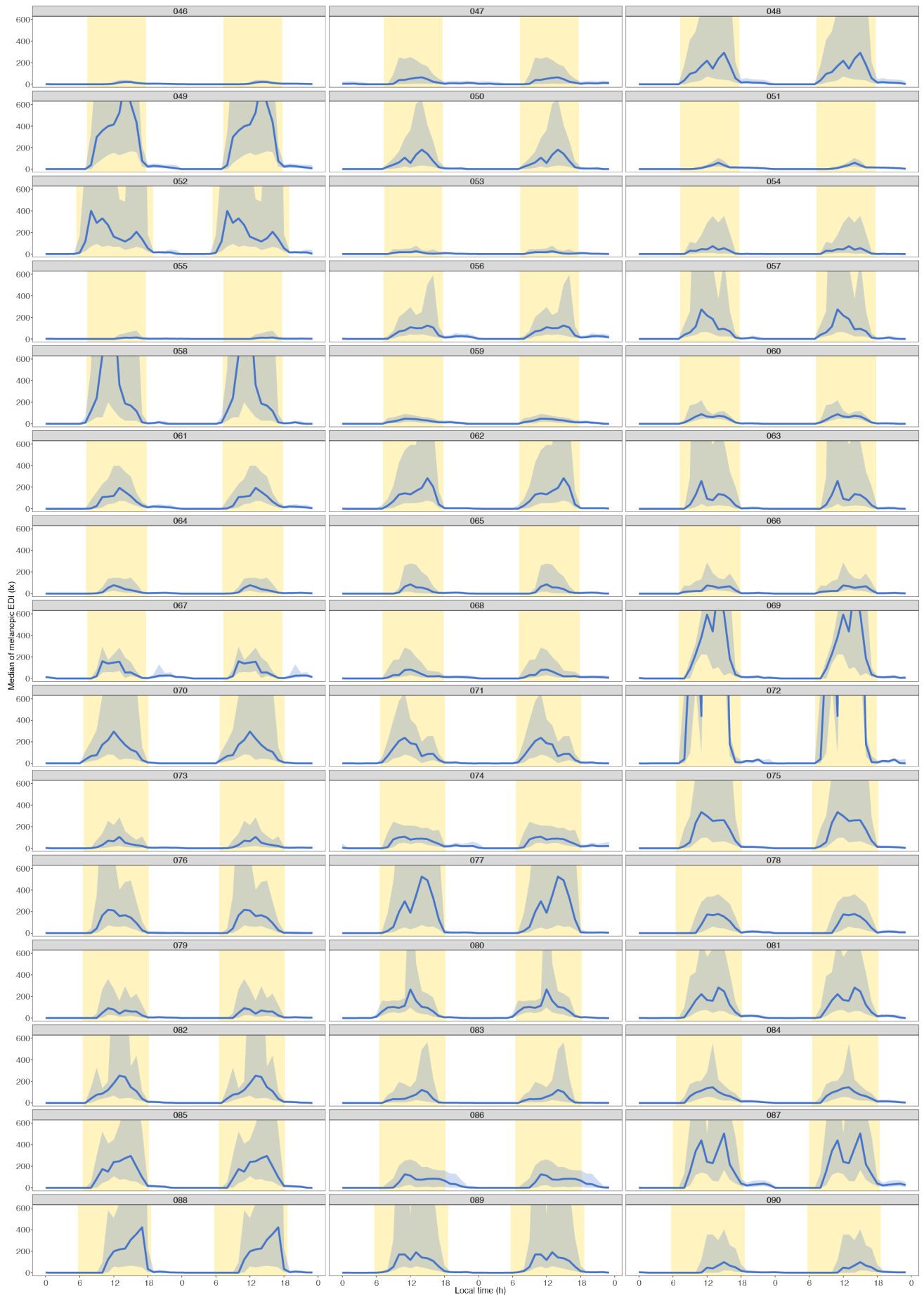


Figure S3b. Individual double-plotted daily melanopic EDI profiles by participant. Blue line: median melanopic EDI exposure across days; blue ribbon: interquartile range; yellow-shaded rectangles: period between sunrise and sunset (day).

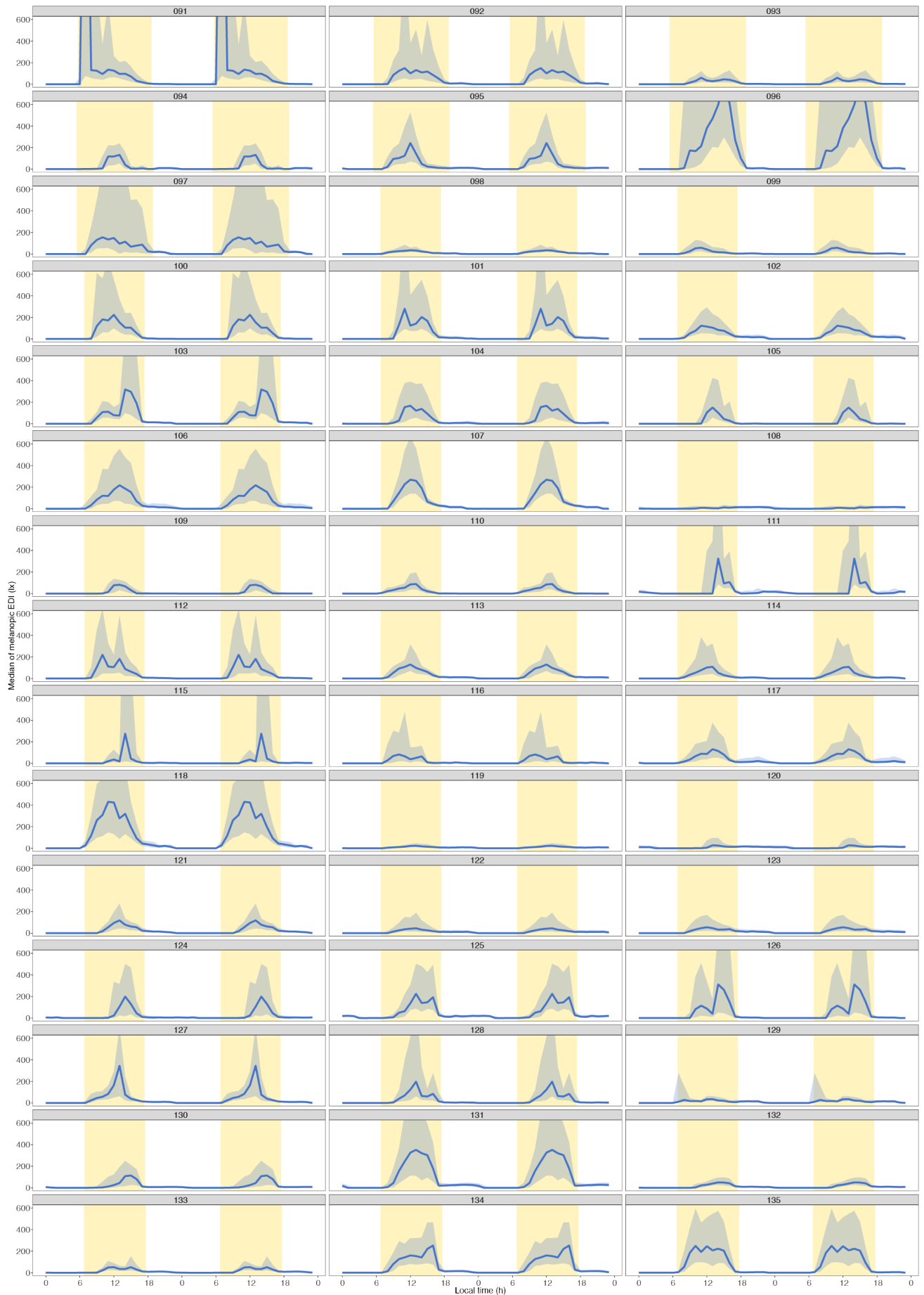


Figure S3c. Individual double-plotted daily melanopic EDI profiles by participant. Blue line: median melanopic EDI exposure across days; blue ribbon: interquartile range; yellow-shaded rectangles: period between sunrise and sunset (day).

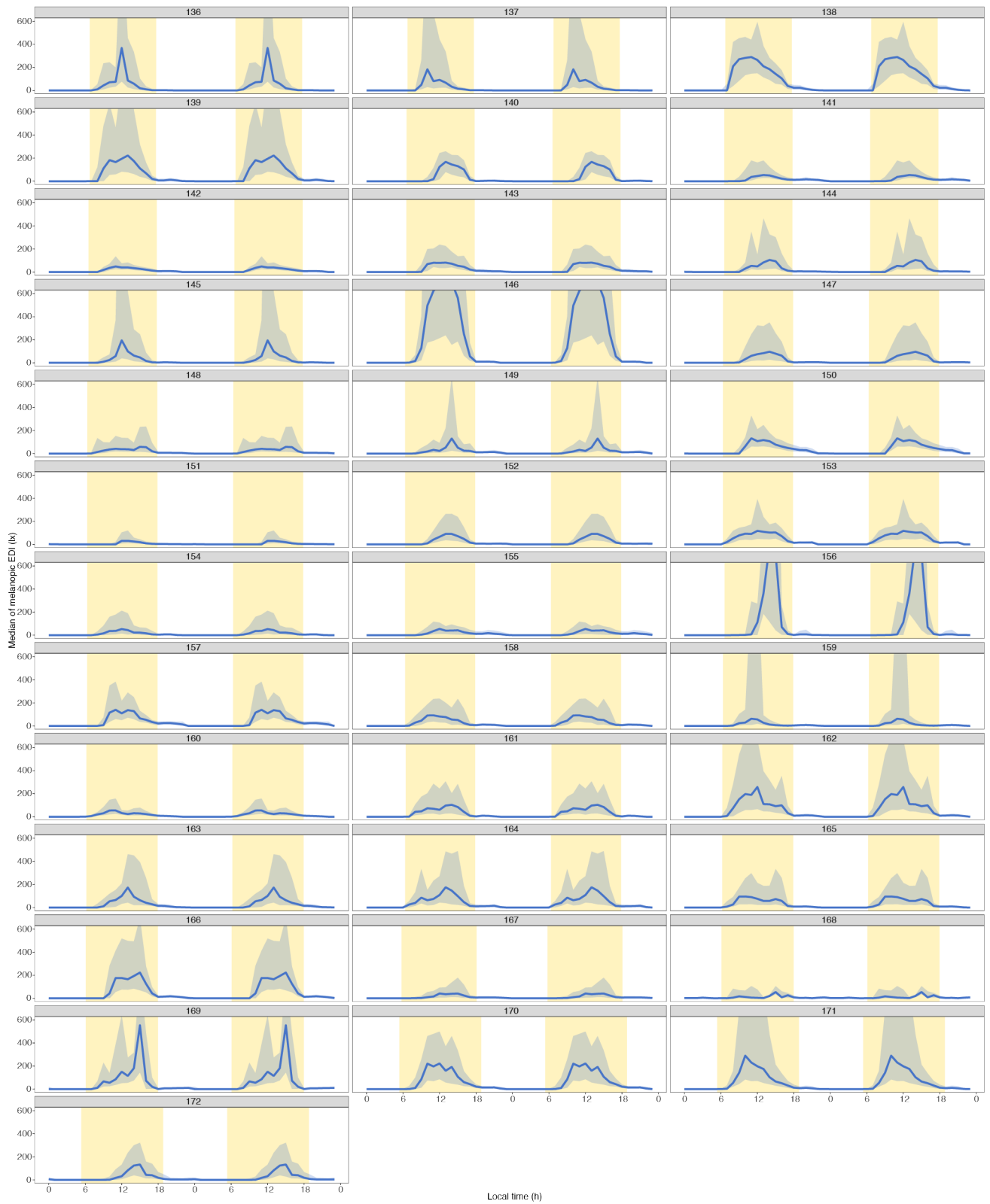


Figure S3d. Individual double-plotted daily melanopic EDI profiles by participant. Blue line: median melanopic EDI exposure across days; blue ribbon: interquartile range; yellow-shaded rectangles: period between sunrise and sunset (day).

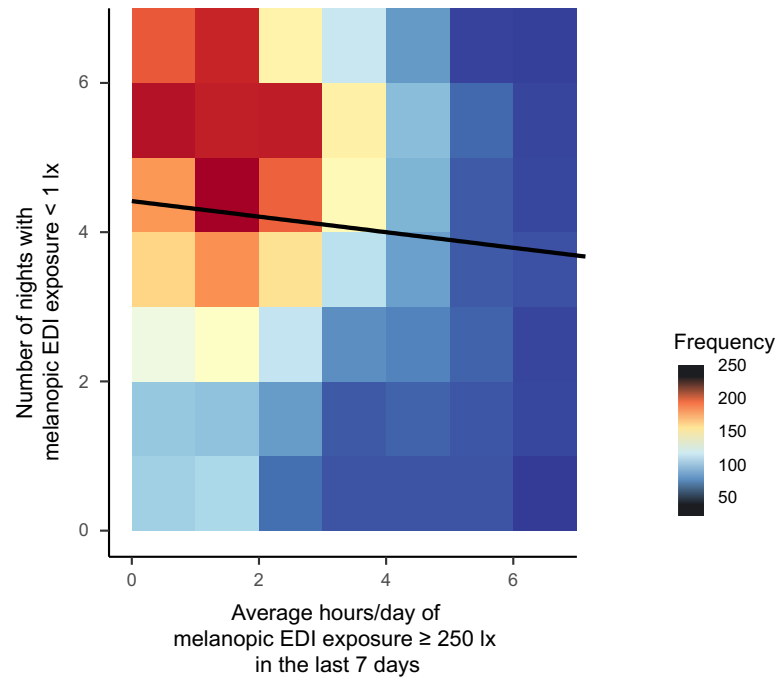


Figure S4. Relationship between melanopic EDI exposure at night and average daytime exposure duration. Participants with more nights without light exposure or exposed to melanopic EDI < 1 lx also have a lower average number of hours/day exposed to melanopic EDI ≥ 250 lx during daytime.

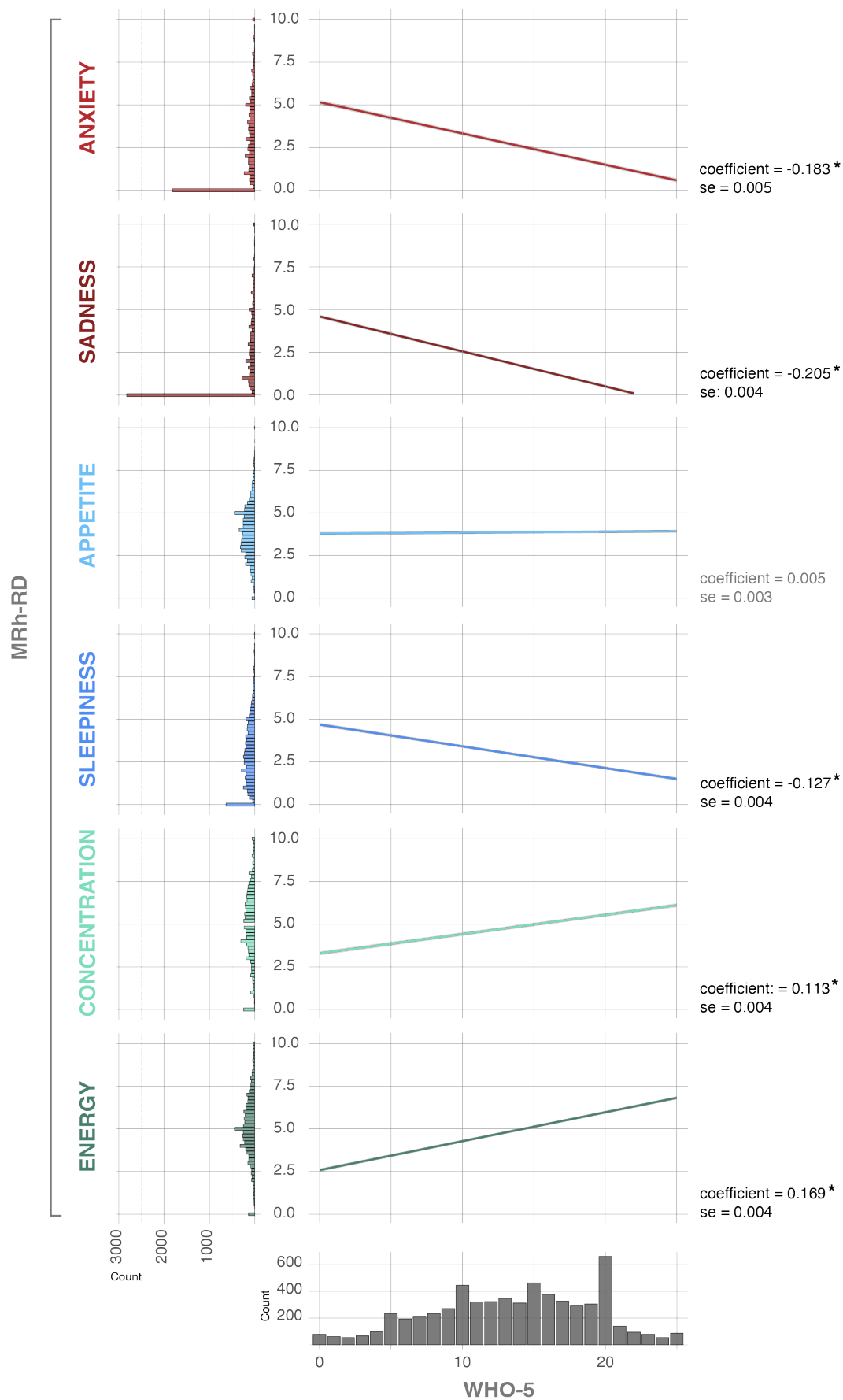


Figure S5. Relationship between the average of daily mood-related symptoms (MRh-RD: Mood Rhythm Reduced Diary) and daily well-being scores (WHO-5: Five-item World Health Organization Well-Being Index). Coefficients from the robust linear mixed-effects regression model (Rlmer). * Significant associations ($p \leq 0.05$).

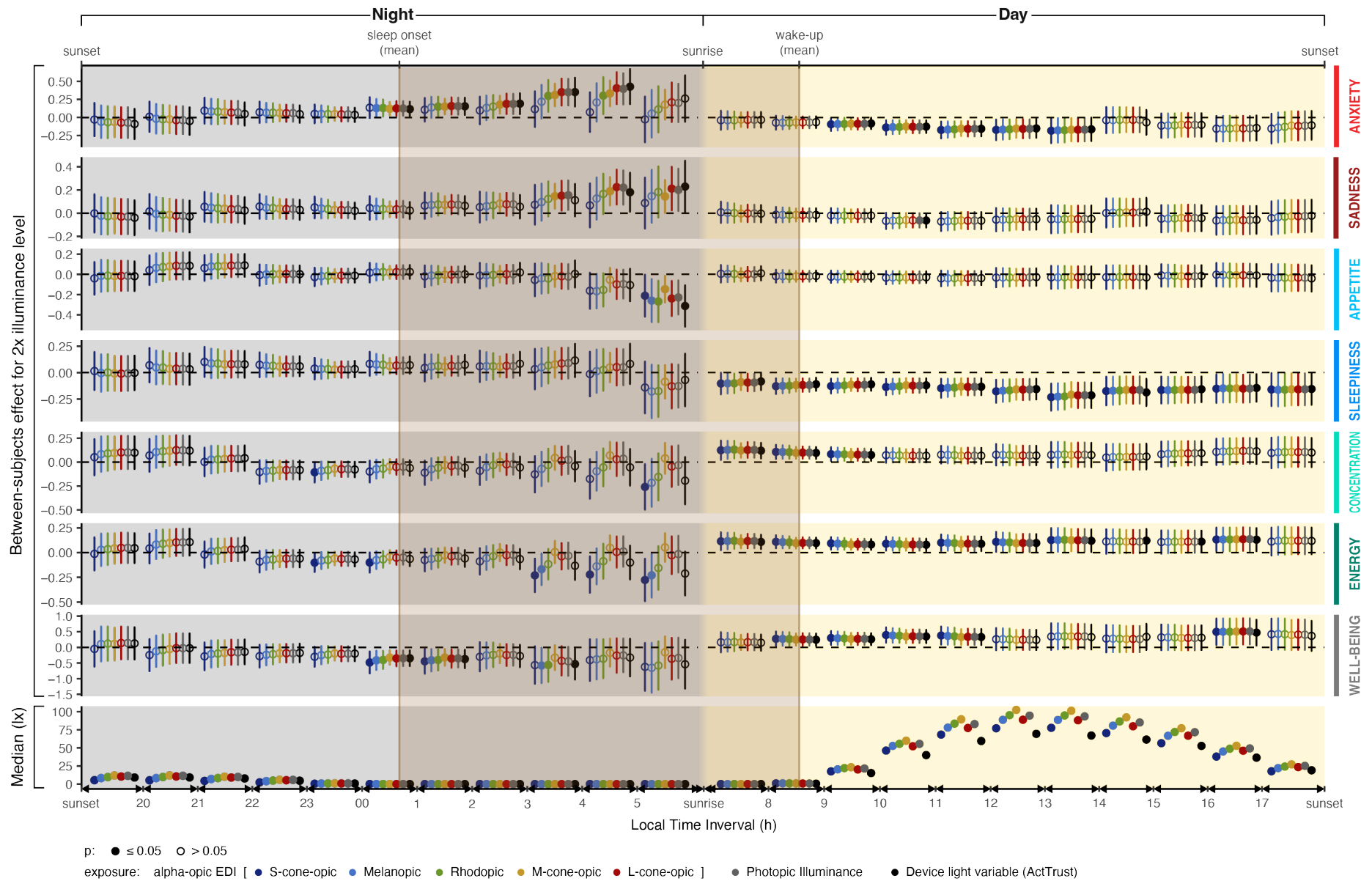


Figure S6. Between-subject coefficients from separate robust linear mixed-effects regression models for each hourly interval and outcome. Daily mood-related symptoms (MRh-RD: Mood Rhythm Reduced Diary) and well-being scores (WHO-5: Five-item World Health Organization Well-Being Index) were regressed on median light exposure (alpha-opic EDI, photopic illuminance, and device light variable from ActTrust) over the 24-hour day. Coefficients represent the effect of doubling light exposure. In the top seven plots, solid dots show coefficients of significant associations ($p \leq 0.05$) and whiskers represent their 95% confidence intervals. In the bottom plot, dots represent hourly median light exposure across subjects. Gray-shaded rectangles indicate the period between sunset and sunrise (night) and associations with next-day outcomes; yellow-shaded rectangles indicate the period between sunrise and sunset (day) and associations with same-day outcomes. The brown shaded area that comprises part of night and day in the figure represents the period between sleep time (00:45) and wake-up time (08:32) sample means. Analyses were adjusted for sex, age, and wake-up time. Note that the vertical axis scales differ between outcomes.

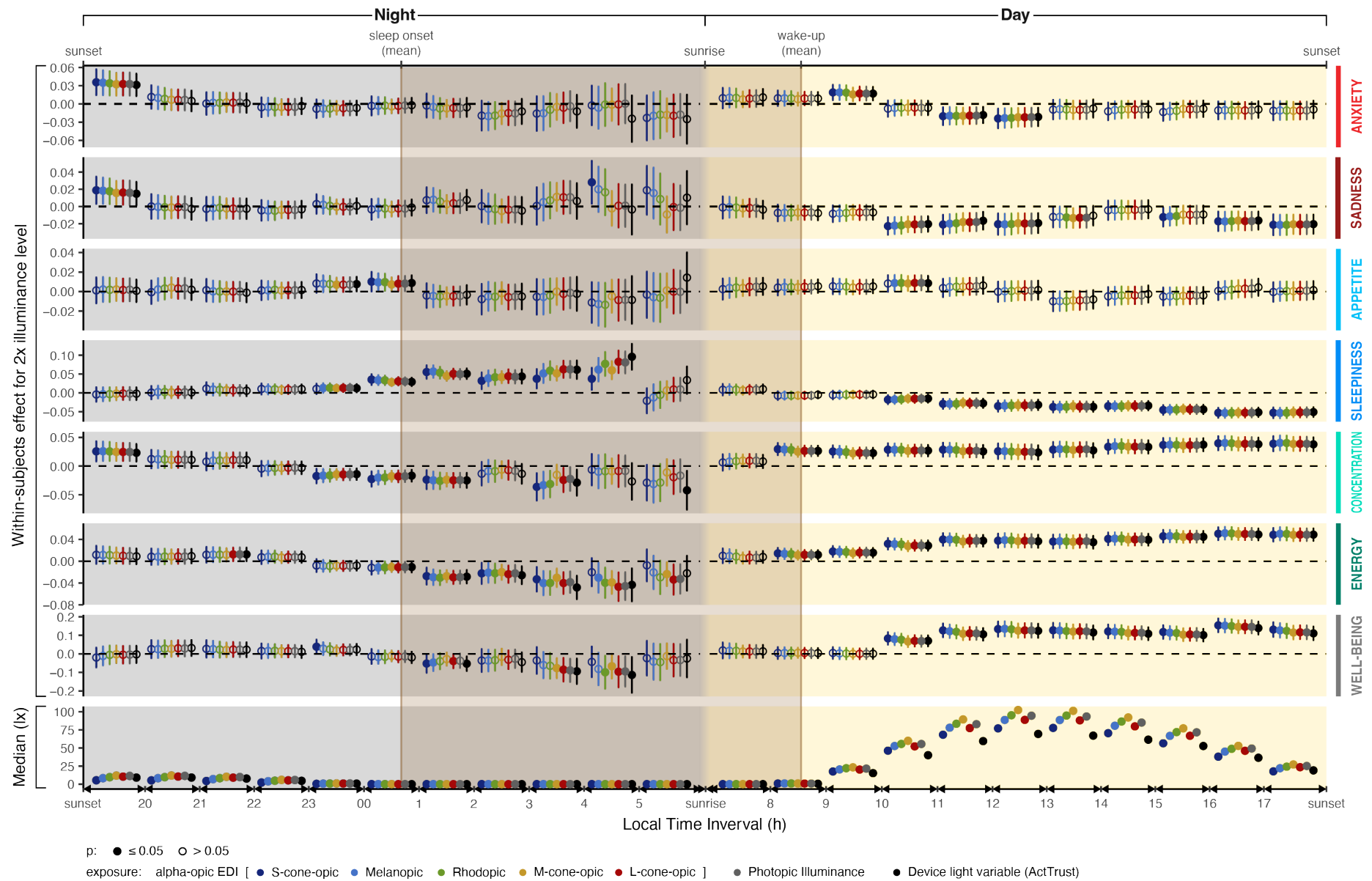


Figure S7. Within-subject coefficients from separate robust linear mixed-effects regression models for each hourly interval and outcome. Daily mood-related symptoms (MRh-RD: Mood Rhythm Reduced Diary) and well-being scores (WHO-5: Five-item World Health Organization Well-Being Index) were regressed on median light exposure (alpha-opic EDI, photopic illuminance, and device light variable from ActTrust) over the 24-hour day. Coefficients represent the effect of doubling light exposure. In the top seven plots, solid dots show coefficients of significant associations ($p \leq 0.05$) and whiskers represent their 95% confidence intervals. In the bottom plot, dots represent hourly median light exposure across subjects. Gray-shaded rectangles indicate the period between sunset and sunrise (night) and associations with next-day outcomes; yellow-shaded rectangles indicate the period between sunrise and sunset (day) and associations with same-day outcomes. The brown shaded area that comprises part of night and day in the figure represents the period between sleep time (00:45) and wake-up time (08:32) sample means. Analyses were adjusted for sex, age, and wake-up time. Note that the vertical axis scales differ between outcomes.

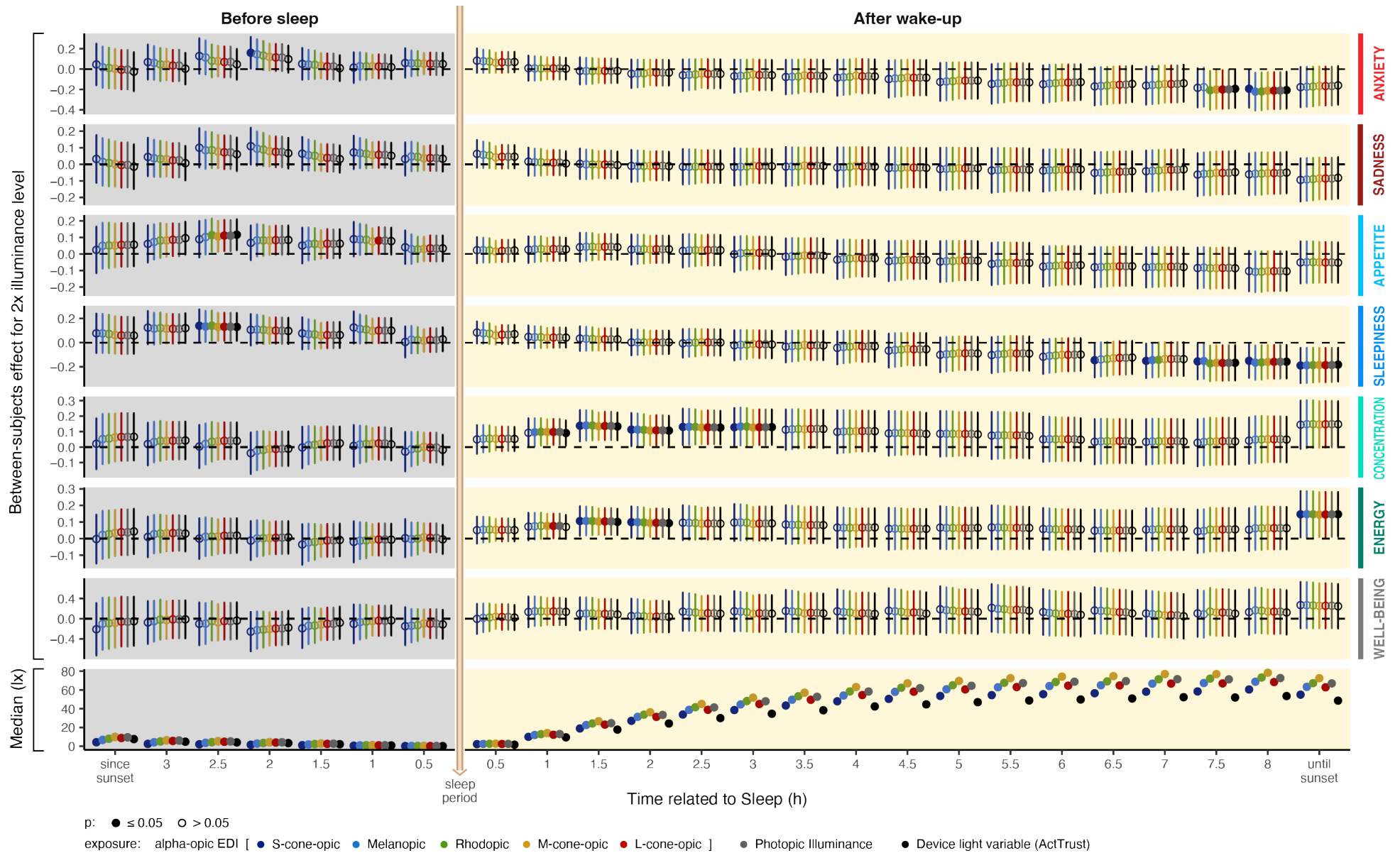


Figure S8. Between-subject coefficients from separate robust linear mixed-effects regression models for each interval (defined from the wake-up time and sleep onset) and outcome. Daily mood-related symptoms (MRh-RD: Mood Rhythm Reduced Diary) and well-being scores (WHO-5: Five-item World Health Organization Well-Being Index) were regressed on median light exposure (alpha-opic EDI, photopic illuminance, and device light variable from ActTrust) within intervals in 30-minute increments preceding sleep onset and following wake-up time (each interval included the previous one). Coefficients represent the effect of doubling light exposure. In the top seven plots, solid dots show coefficients of significant associations ($p \leq 0.05$) and whiskers represent their 95% confidence intervals. In the bottom plot, dots represent the interval median light exposure across subjects. Gray-shaded rectangles indicate the period between sunset and sleep onset (before sleep) and associations with next-day outcomes; yellow-shaded rectangles indicate the period between wake-up time and sunset (after wake-up) and associations with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep. Note that the vertical axis scales differ between outcomes.

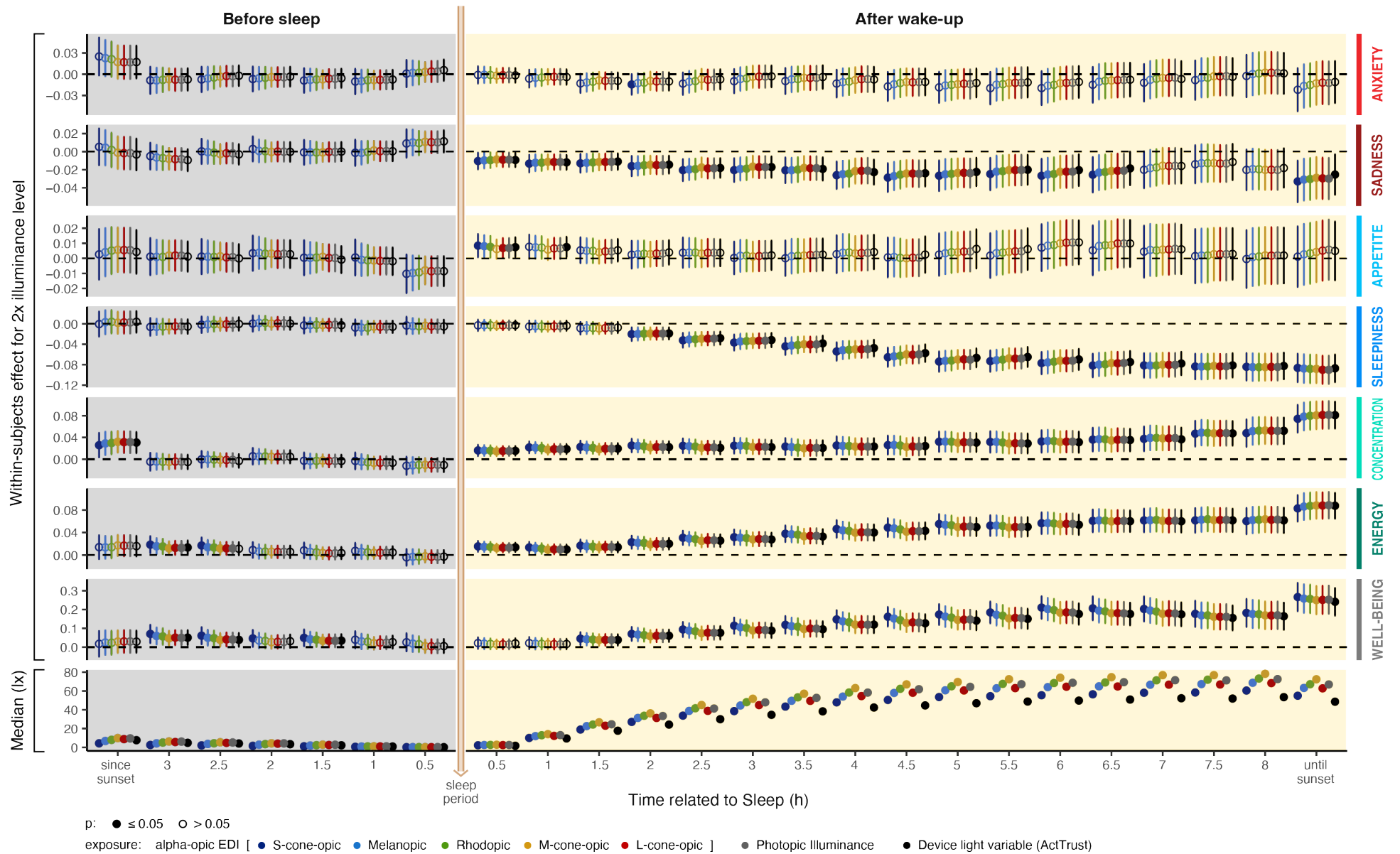


Figure S9. Within-subject coefficients from separate robust linear mixed-effects regression models for each interval (defined from the wake-up time and sleep onset) and outcome. Daily mood-related symptoms (MRh-RD: Mood Rhythm Reduced Diary) and well-being scores (WHO-5: Five-item World Health Organization Well-Being Index) were regressed on median light exposure (alpha-opic EDI), photopic illuminance, and device light variable from ActTrust) within intervals in 30-minute increments preceding sleep onset and following wake-up time (each interval included the previous one). Coefficients represent the effect of doubling light exposure. In the top seven plots, solid dots show coefficients of significant associations ($p \leq 0.05$) and whiskers represent their 95% confidence intervals. In the bottom plot, dots represent the interval median light exposure across subjects. Gray-shaded rectangles indicate the period between sunset and sleep onset (before sleep) and associations with next-day outcomes; yellow-shaded rectangles indicate the period between wake-up time and sunset (after wake-up) and associations with same-day outcomes. Analyses were adjusted for sex, age, and midpoint of sleep. Note that the vertical axis scales differ between outcomes.

3. Supplementary Methods

3.1 Calculation method of photopic illuminance and alpha-opic equivalent daylight illuminance for wrist sensor data

The photopic illuminance and the α -opic equivalent daylight (D65) illuminance (EDI) were calculated in three stages. The method entails the retrieval of the sensor's spectral bands, the combination of these spectral bands with photopic and α -opic action spectra, and the application of the photopic illuminance and α -opic EDI calculation method defined by the International Commission on Illumination (CIE). Calculations, curve data processing, and visualizations were carried out using QtiPlot software version 1.1.9.

Step 1: Retrieving sensor spectral bands

In the present study, the ActTrust wrist device produced by Condor Instruments Ltd was employed for the spectral retrieval. This device incorporates four types of light sensors with distinct spectral responses (B, G, R) and ambient light (clear). Figure S10 shows the response curves of the B, G, and R light sensors obtained from the manufacturer's datasheet, already corrected for the applied gain. The response curves of the BGR sensors exhibit overlap, so the intersection point between the BGR curves was defined as the boundary for retrieving the blue (b), green (g), and red (r) spectral bands used in the present analysis.

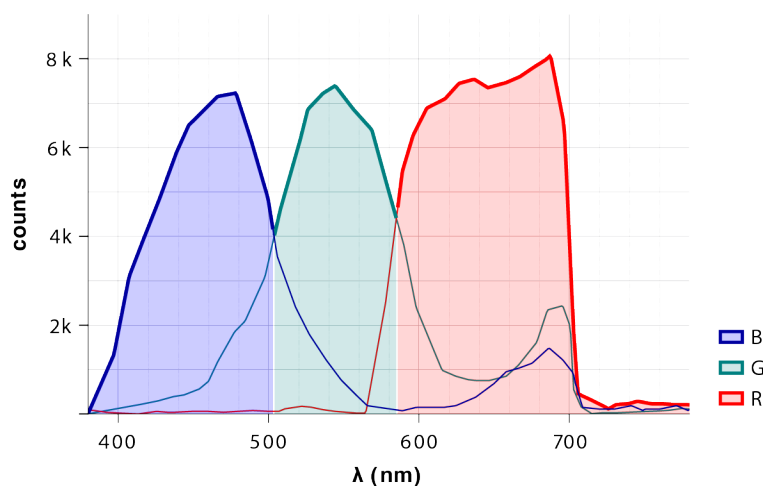


Figure S10. Response curves of the B, G, and R light sensors obtained from the manufacturer's datasheet used in ActTrust (Condor Instruments Ltd). Blue, green, and red areas represent the spectral bands defined by the intersection point between the curves.

We used integrals that account for the normalized response of each sensor within the defined wavelength ranges. The balanced contributions of each detector within the blue, green, and red spectral bands were calculated using the following expressions:

$$\begin{aligned} b_b &\equiv \frac{1}{\int_{s_b}} \int_b b(\lambda) d\lambda, \quad b_g \equiv \frac{1}{\int_{s_b}} \int_g b(\lambda) d\lambda, \quad b_r \equiv \frac{1}{\int_{s_b}} \int_r b(\lambda) d\lambda, \\ g_b &\equiv \frac{1}{\int_{s_g}} \int_b g(\lambda) d\lambda, \quad g_g \equiv \frac{1}{\int_{s_g}} \int_g g(\lambda) d\lambda, \quad g_r \equiv \frac{1}{\int_{s_g}} \int_r g(\lambda) d\lambda, \\ r_b &\equiv \frac{1}{\int_{s_r}} \int_b r(\lambda) d\lambda, \quad r_g \equiv \frac{1}{\int_{s_r}} \int_g r(\lambda) d\lambda, \quad r_r \equiv \frac{1}{\int_{s_r}} \int_r r(\lambda) d\lambda, \end{aligned}$$

where $b(\lambda)$, $g(\lambda)$, and $r(\lambda)$ represent the retrieved blue, green, and red spectral bands from Figure S10, and the $\int_b, \int_g, \int_r$ correspond to the integral performed within the respective spectral region and $\int_{s_i}$ the sensor response integral within the entire spectra between 380-780 nm.

The sensor responses [B,G,R] are linearly related to these spectral bands [b,g,r], according to:

$$\begin{bmatrix} B \\ G \\ R \end{bmatrix} = \begin{bmatrix} b_b & b_g & b_r \\ g_b & g_g & g_r \\ r_b & r_g & r_r \end{bmatrix} \begin{bmatrix} b \\ g \\ r \end{bmatrix} = Z \begin{bmatrix} b \\ g \\ r \end{bmatrix}.$$

Next, we obtain the inverse of matrix Z and apply it to [B,G,R] to get the desired values of [b,g,r]:

$$\begin{bmatrix} b \\ g \\ r \end{bmatrix} = \underbrace{\begin{bmatrix} 1.368 & -0.279 & -0.095 \\ -0.303 & 1.684 & -0.381 \\ 0.008 & -0.0901 & 1.083 \end{bmatrix}}_{Z^{-1}} \begin{bmatrix} B \\ G \\ R \end{bmatrix}.$$

This matrix transformation extracts the irradiance spectral band values from the sensor data [B,G,R] in $\mu\text{W}/\text{cm}^2$.

Step 2: Combining spectral bands with photopic and alpha-opic action spectra

The spectral multiplication of the sensor response curves [B, G, R] within the defined spectral bands [b, g, r] (Figure S10) with the values provided by the CIE of spectral luminous efficiency for photopic vision (DOI 10.25039/CIE.DS.dktna2s3) and of α -opic action spectra for ipRGC-influenced light effects (DOI 10.25039/S026.2018.TB) (Figure S11) determines the contribution of each sensor to the photopic and α -opic curves (Figure S12). Then, it can be calculated by:

$$p_{x\alpha}(\lambda) = s_x(\lambda) \cdot \alpha(\lambda),$$

where $p_{x\alpha}(\lambda)$ represents the sensor contribution in the spectral band x [b,g,r] to the photopic and α -opic curves at wavelength λ , $s_x(\lambda)$ is the sensor response curve, and $\alpha(\lambda)$ is the spectral luminous efficiency for photopic or the α -opic action spectra.

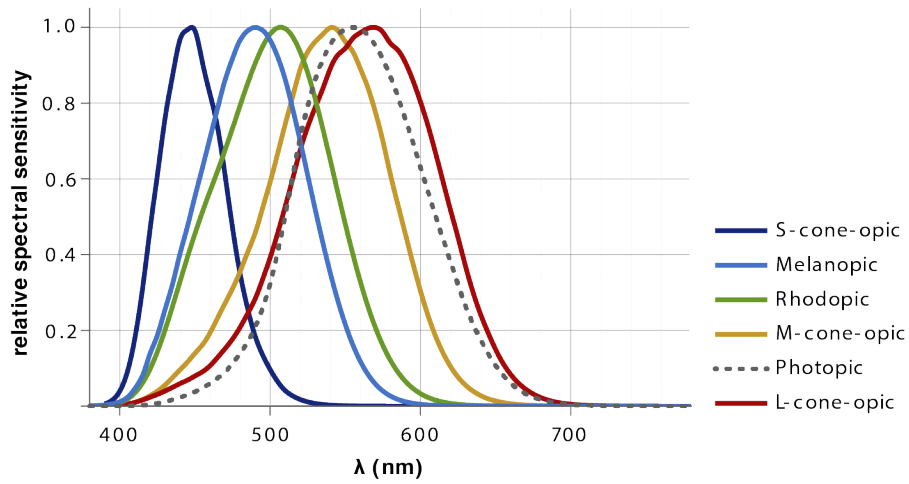


Figure S11. Curves of spectral luminous efficiency for photopic vision and of α -opic action spectra for ipRGC-influenced light effects (from the CIE, DOI 10.25039/CIE.DS.dktna2s3 and DOI 10.25039/S026.2018.TB)

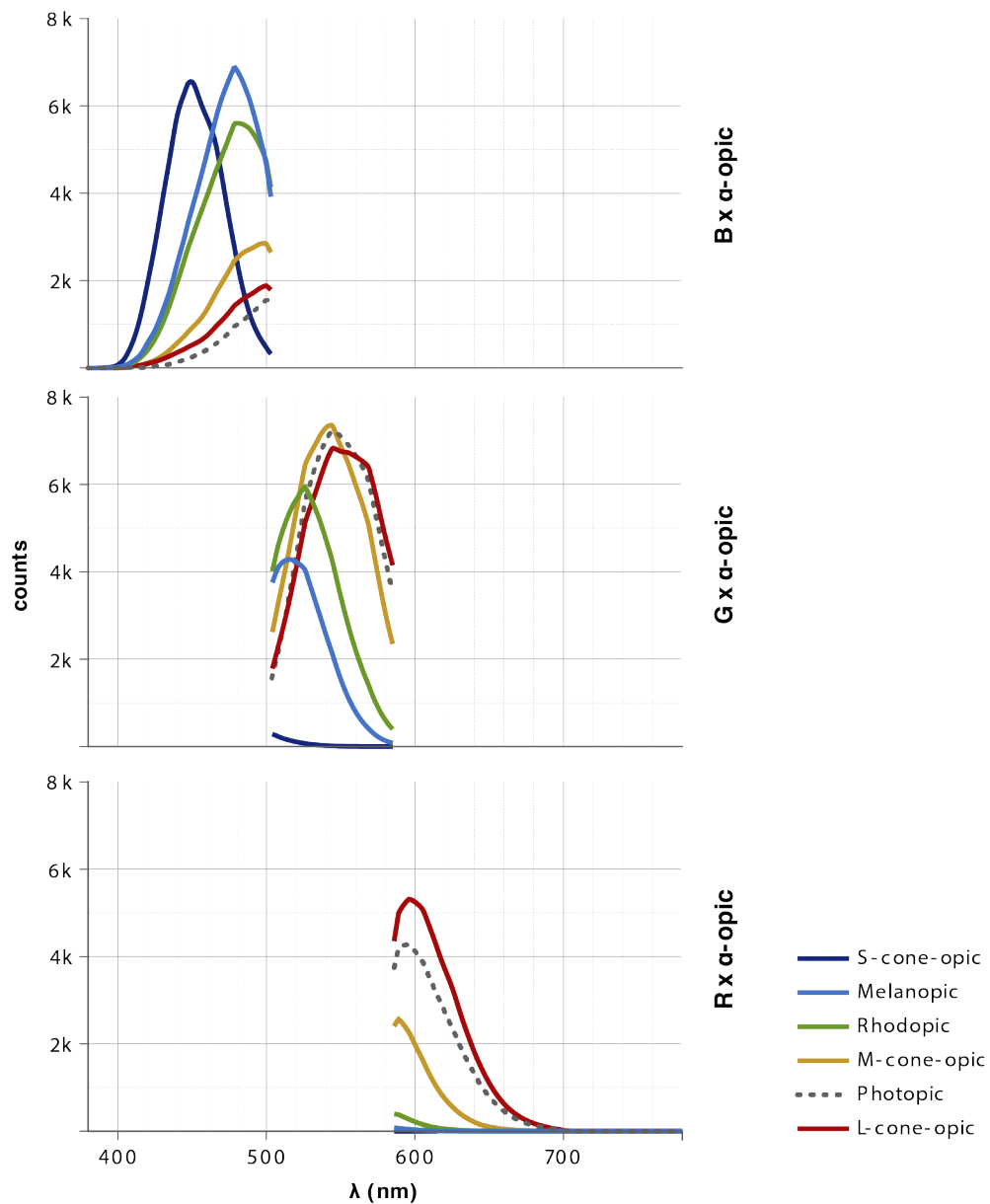


Figure S12. Contribution of each sensor to photopic and α -opic curves

The photopic and the α -opic irradiance $E_{\alpha x}$ for each spectral band is given by:

$$E_{\alpha x} = \left[\int_x d\lambda \cdot p_{x\alpha}(\lambda) / E_{\alpha} \right],$$

where $\int_x d\lambda \cdot p_{x\alpha}(\lambda)$ is the integral of the sensor contribution from the spectral band x , over its defined wavelength range, and the total irradiance E_{α} is the sum of the irradiances for each defined spectral band:

$$E_{\alpha} = E_{b\alpha} + E_{g\alpha} + E_{r\alpha}.$$

Based on the relationship between the following matrices,

$$\begin{bmatrix} \text{Phot-} \\ \text{S-cone-} \\ \text{M-cone-} \\ \text{L-cone-} \\ \text{Rhod-} \\ \text{Melan-} \end{bmatrix}_{opic} = E_{\alpha x} \begin{bmatrix} b \\ g \\ r \end{bmatrix} = E_{\alpha x} Z^{-1} \begin{bmatrix} B \\ G \\ R \end{bmatrix},$$

while the irradiance (E_{α}) can be derived from the calculation of contributions from the sensor data [B,G,R]:

$$E_{\alpha} = E_{\alpha x} Z^{-1} = \underbrace{\begin{bmatrix} 0.064 & 0.539 & 0.212 \\ 0.420 & 0.005 & 0 \\ 0.163 & 0.540 & 0.079 \\ 0.099 & 0.531 & 0.278 \\ 0.386 & 0.354 & 0.008 \\ 0.457 & 0.219 & 0.001 \end{bmatrix}}_{I_{\alpha x}} \underbrace{\begin{bmatrix} 1.368 & -0.279 & -0.095 \\ -0.303 & 1.684 & -0.381 \\ 0.008 & -0.0901 & 1.083 \end{bmatrix}}_{Z^{-1}} = \begin{bmatrix} -0.080 & 0.808 & 0.181 \\ 0.573 & -0.119 & 0.003 \\ 0.068 & 0.831 & 0.037 \\ -0.036 & 0.758 & 0.254 \\ 0.430 & 0.476 & -0.020 \\ 0.566 & 0.229 & -0.015 \end{bmatrix}.$$

This expression results in photopic and α -opic irradiance ($\mu\text{W}/\text{cm}^2$), representing the effective irradiance spectrally weighted by the spectral luminous efficiency and the α -opic action spectrum, respectively. To align with the CIE S 02:2018 Toolbox standards (DOI 10.25039/S026.2018.TB), a conversion of photopic irradiance from $\mu\text{W}/\text{cm}^2$ to W/m^2 and of α -opic irradiance from $\mu\text{W}/\text{cm}^2$ to mW/cm^2 is necessary ($1 \mu\text{W}/\text{cm}^2 = 10 \text{ mW}/\text{m}^2 = 0.01 \text{ W}/\text{m}^2$).

Step 3: Applying the photopic illuminance and the α -opic EDI calculation method defined by the CIE

To calculate the photopic illuminance (E_v), we apply the CIE standard calculation method:

$$E_v = K_m * \int \text{spectral irradiance} * V(\lambda) * d\lambda, \text{ where } K_m = 683 \text{ lm.W}^{-1}.$$

Also, following the CIE S 026:2018 toolbox, the calculation method for EDI was applied to α -opic values:

$$E_{v,\alpha}^{D65} = E_{\alpha} / K_{\alpha,v}^{D65},$$

where $K_{\alpha,v}^{D65}$ are fixed values of α -opic efficacy of luminance radiation for daylight (D65) as extracted from the toolbox:

S-cone-opic $\rightarrow 0.8173 \text{ mW}/\text{lm}$,

M-cone-opic $\rightarrow 1.4558 \text{ mW}/\text{lm}$,

L-cone-opic $\rightarrow 1.6289 \text{ mW}/\text{lm}$,

Rhodopic $\rightarrow 1.4497 \text{ mW}/\text{lm}$,

Melanopic $\rightarrow 1.3262 \text{ mW}/\text{lm}$.

3.2 Statistical procedures

The model code is available at https://github.com/fsbonatto/DS_ActLight.

The procedure adopted to develop the final model is described below:

Definitions

- $i = 1, \dots, 172$: subject index,
- $j = 1, 2, \dots, J$: collection day index,
- Y_{ij} : dependent variable value for subject i on day j ,
- X_{ij} : independent variable value for subject i on day j ,
- $\bar{X}_i$: mean value of the independent variable for subject i ,
- β_0 : overall intercept,
- β_W and β_B : within- and between-subject slopes.
- $u_{0i} \sim N(0, \sigma_{u_0}^2)$, : intercept random effect within-subject, with variance $\sigma_{u_0}^2$
- $u_{Wi} \sim N(0, \sigma_{u_w}^2)$, : slope random effect within-subject, with variance $\sigma_{u_w}^2$
- $\epsilon_{ij} \sim N(0, \sigma_{res}^2)$, : residual error, with variance σ_{res}^2 .

Given the definitions above, the relationship between exposures and outcomes was analyzed using the following random-intercept linear model:

$$Y_{ij} = (\beta_0 + u_{0i}) + (\beta_W + u_{Wi})(X_{ij} - \bar{X}_i) + \beta_B \bar{X}_i + \epsilon_{ij}, \quad (1)$$

where ϵ_{ij} , u_{0i} and u_{Wi} are mutually uncorrelated.

Steps to define the final model

Step 1: Selecting the random effects structure

Two different models were tested to define the random effects structure:

- Model A: Includes only the subject's intercept as a random effect (set $u_{Wi} = 0$ in Equation 1).
- Model B: Includes both the subject's intercept and slope as random effects:

If the iterative process for Model B failed to converge, Model A was used. When both models converged, the selection was based on the Bayesian Information Criterion (BIC).

In all cases, Model A showed a lower BIC compared to Model B. Thus, all subsequent models were constructed using only the subject's intercept as a random effect.

Step 2: Evaluating the functional form of the independent terms

After deciding to use the random-intercept-only model, the next step was to evaluate the functional relationship between the independent variable and the outcome. Four models were tested:

- Model 1: the independent variable is the light exposure data ($X_{ij} = L_{ij}$)
- Model 2: the independent variable is the logarithm of the light exposure data ($X_{ij} = \log(L_{ij})$)
- Model 3: the independent variable is categorical using quartiles as cut-off points on the light exposure data.
- Model 4: the independent variable is modeled using a restricted cubic spline of the light exposure data.

These models were compared using BIC.

Model 2 showed a better fit for all models that assessed the median light quantity in time intervals as the independent variable (analysis of quantity and timing). Model 1 provided a better fit when the independent variable was the number of days (analysis of duration, timing, and frequency).

Step 3: Fit robust linear mixed-effects regression models

After defining the functional form of the independent terms, the models were fitted using robust linear mixed-effects regression implemented through the `rlmer` function from the `robustlmm` R package. This approach was adopted to reduce the influence of outliers and deviations from model assumptions on parameter estimation.

Outlier handling: For the quantity and timing analyses, inspection of the melanopic EDI distribution revealed the presence of extreme values. Therefore, observations corresponding to the upper 1% of melanopic EDI values were excluded before model estimation.