

Robustness of the sex-specific 24-h movement behavior ranges for optimal mental health from repeated within-sex split-sample analyses

Robustness was evaluated using repeated within-sex random split-sample resampling conducted separately for males and females (100 simple random half-splits with different seeds within each sex). In each resample, the CoDA models (ilrs; robust estimators) were refit in the recommendation subset and used to predict mental health across a fixed sex-specific 10-min composition grid restricted to the empirically observed bounds (mean $\pm$ 3 SD). This yielded 7,349 unique time-use compositions for males (MVPA 10–110, LPA 140–390, SED 340–730, and SLP 460–730 min/day) and 6,715 for females (MVPA 10–100, LPA 140–390, SED 340–740, and SLP 470–740 min/day). The best overall mental health zone was defined as the overlapping region of the best 5% zones across depression, anxiety, and stress. For each resample, we computed the best-zone compositional center and its 25th and 75th percentiles for each component; the tables summarize these resample-specific estimates using their median, minimum, and maximum values. Smaller min–max ranges indicate greater stability. The sex-specific recommended durations from the primary analysis were consistent with the corresponding resampling-based envelopes, supporting that the proposed recommendations are not sensitive to the random split (males: MVPA 92 min [60–110], LPA 361 min [310–400], SED 372 min [350–480], and SLP 614 min [530–680]; females: MVPA 58 min [40–90], LPA 290 min [180–390], SED 445 min [400–560], and SLP 665 min [580–740]).

Table S3a. Robustness of the male-specific 24-h movement behavior ranges for optimal mental health across 100 within-sex split-sample resamples

Component	Statistic	Median	Min	Max
MVPA (min/day)	Center	90	60	100
	25th percentile (P25)	70	50	90
	75th percentile (P75)	100	90	110
LPA (min/day)	Center	340	280	360
	25th percentile (P25)	310	270	350
	75th percentile (P75)	360	300	380
SED (min/day)	Center	380	370	450
	25th percentile (P25)	360	350	390
	75th percentile (P75)	400	380	480
SLP (min/day)	Center	650	530	680
	25th percentile (P25)	610	570	660
	75th percentile (P75)	690	590	710

Note: MVPA, moderate-to-vigorous-intensity physical activity; LPA, light physical activity; SED,

sedentary behavior; SLP, sleep.

Table S3b. Robustness of the female-specific 24-h movement behavior ranges for optimal mental health across 100 within-sex split-sample resamples

Component	Statistic	Median	Min	Max
MVPA	Center	50	30	70
	25th percentile (P25)	20	10	40
	75th percentile (P75)	80	40	90
LPA	Center	280	230	340
	25th percentile (P25)	220	180	340
	75th percentile (P75)	330	220	380
SED	Center	390	370	480
	25th percentile (P25)	360	350	430
	75th percentile (P75)	460	420	560
SLP	Center	720	650	730
	25th percentile (P25)	700	557.5	720
	75th percentile (P75)	730	690	740

Note: MVPA, moderate-to-vigorous-intensity physical activity; LPA, light physical activity; SED, sedentary behavior; SLP, sleep.