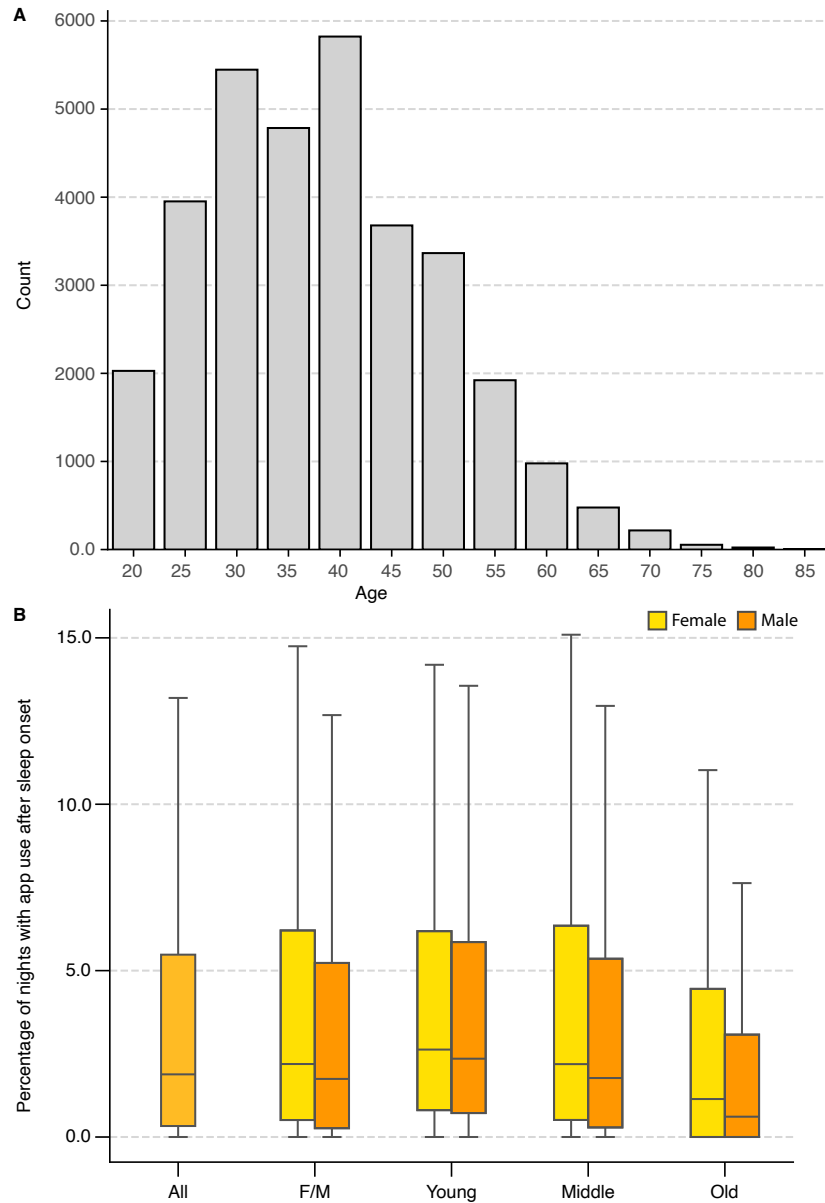
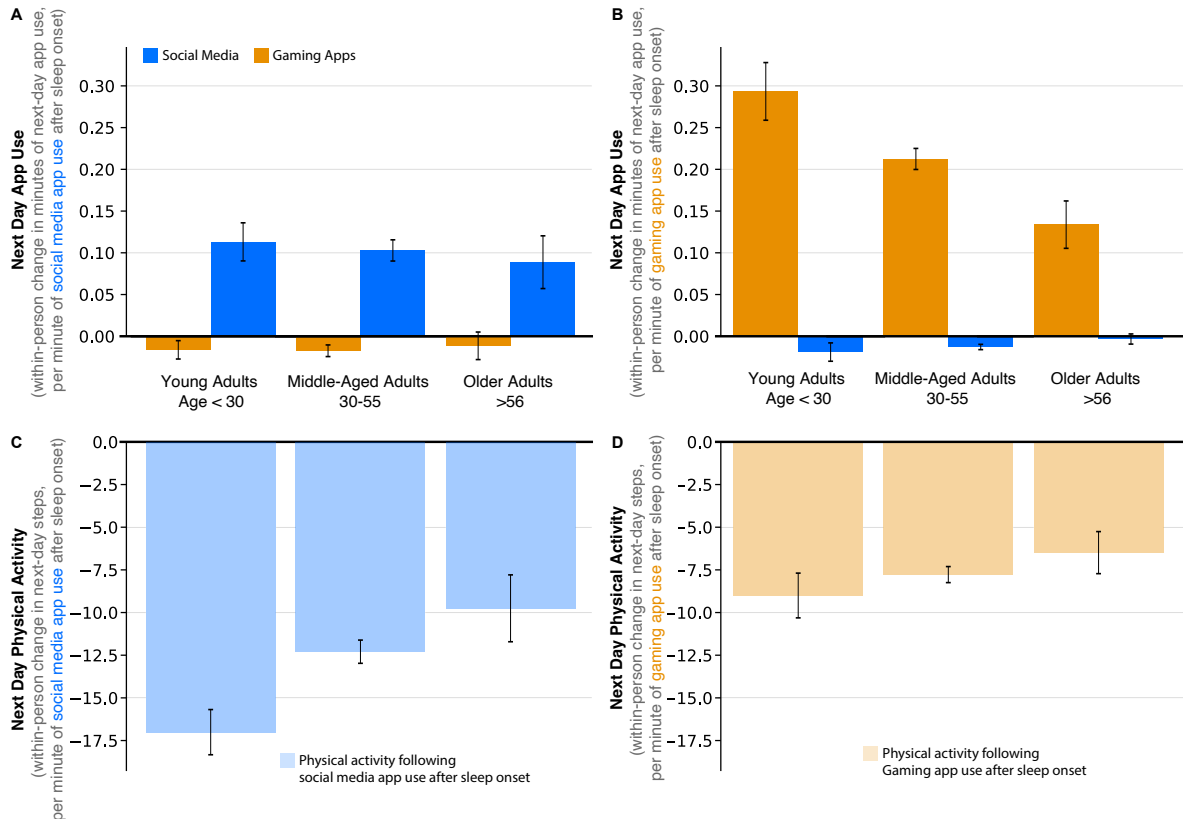


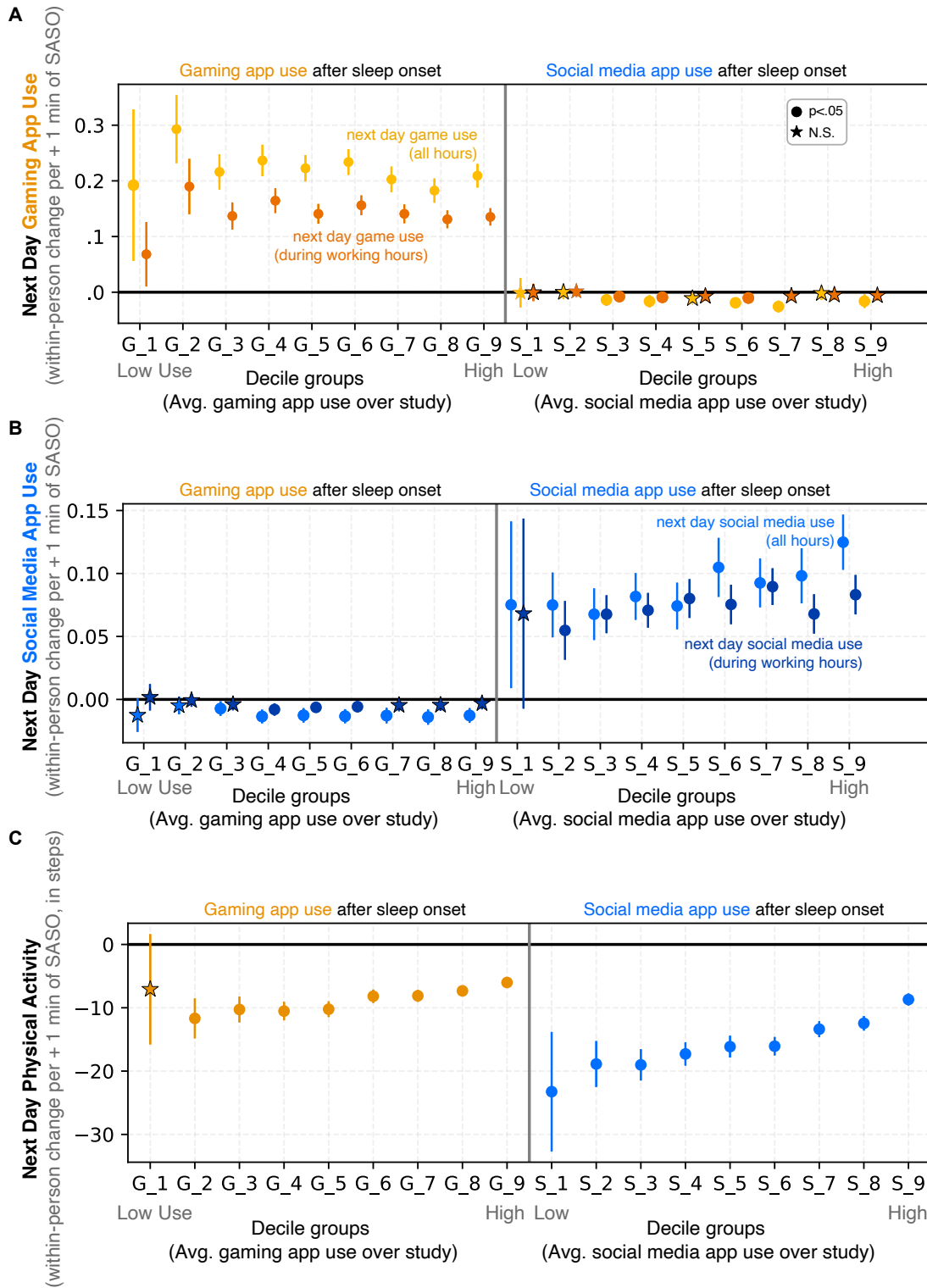
Supplementary Material



Supplementary Figure 4: **Sample age distribution and average frequency of smartphone app use during the sleep period across age groups and by sex.** **A**, Histogram depicting the count of participants by age group for the subset of the sample with demographic category data. **B**, Boxplots describing the distribution of the person-average percentage of nights with SASO by age group and sex. Yellow boxes represent females, and orange boxes represent males.



Supplementary Figure 5: **Smartphone app use during the sleep period is associated with larger reductions in next day physical activity for young adults.** **A**, More social media app use during the sleep period is consistently associated with increased next-day social media app use (blue) across age groups. Bars depict 95% confidence intervals. **B**, An increase in gaming app use after sleep onset is associated with greater next day gaming app use (orange) for young adults. **C-D**, Subgroup coefficient plots of the within-person relationship between app category use during the sleep period and next day physical activity, stratified by age group. Across all age groups, social media app use is associated with larger declines in next day physical activity than the reduction in steps associated with prior night gaming app use, with more pronounced increases for younger adults (Supplementary Tables 13-14)



Supplementary Figure 6: Associated digital and physical behavioral changes following a night with app use after sleep onset persist across levels of habitual app use. Fixed effects regression coefficient estimates describing the relationship between app category-specific SASO and next day **A** gaming app use, **B** social media use, **C** and physical activity stratified by each decile group of G gaming and S app usage over the study period. An outlined star indicates that the result is non-significant at $\alpha = 0.05$

Supplementary Table 1: Sample size for each country

Country	# Adults	Country	# Adults	Country	# Adults	Country	# Adults	Country	# Adults
JP	10903	CH	257	BG	67	CY	<50	LY	<50
DE	3686	IR	223	LT	<50	KE	<50	GP	<50
TW	3123	ID	207	EC	<50	IM	<50	SD	<50
GB	2761	ZA	207	NZ	<50	UG	<50	GE	<50
RU	1932	BR	206	LV	<50	IQ	<50	LI	<50
SE	1658	IN	199	IL	<50	MA	<50	FJ	<50
FR	1620	AR	199	PE	<50	PK	<50	TM	<50
KR	1300	HU	178	GT	<50	KH	<50	SC	<50
ES	1278	MY	175	KZ	<50	BD	<50	BF	<50
CN	1258	EE	172	HR	<50	AD	<50	MN	<50
PL	950	CO	168	RS	<50	ZM	<50	BZ	<50
FI	619	UA	155	EG	<50	AL	<50	GL	<50
IT	593	VN	129	JO	<50	MT	<50	MV	<50
US	592	CA	125	NG	<50	AZ	<50	PY	<50
HK	483	BE	120	LU	<50	NP	<50	PR	<50
CZ	453	SG	113	LB	<50	AO	<50	FO	<50
NL	423	CL	102	DZ	<50	AM	<50	CM	<50
AU	410	IE	97	SI	<50	SR	<50	TG	<50
NO	370	RO	97	BO	<50	NC	<50	ME	<50
MX	354	BY	96	IS	<50	KG	<50	MC	<50
TR	350	GR	95	LK	<50	ZW	<50	LS	<50
DK	334	SA	88	TN	<50	MU	<50	GH	<50
TH	297	SK	77	UY	<50	UZ	<50	PG	<50
AT	291	PH	75	MM	<50	NA	<50	MQ	<50

Supplementary Table 2: Prevalence – Percentage of Adults with Any App Use After Sleep Onset, by Country

Country	% Adults w/ SASO	Country	% Adults w/ SASO
Saudi Arabia	90.9	Estonia	73.8
Mexico	86.2	Bulgaria	73.1
Belarus	85.4	Czechia	73.1
Philippines	85.3	Vietnam	72.9
South Korea	85.3	France	72.8
Turkey	85.1	Spain	72.2
Canada	84.0	Germany	71.2
Japan	83.5	Poland	71.2
Ukraine	83.2	Slovakia	70.1
Thailand	82.8	India	69.8
Taiwan	82.5	Romania	69.1
Chile	82.4	Italy	68.3
Colombia	82.1	Austria	66.3
China	81.6	Brazil	65.0
Australia	81.5	Switzerland	62.6
South Africa	80.7	Belgium	61.7
Malaysia	80.6		
Ireland	80.4		
Indonesia	80.2		
Netherlands	79.2		
United States	78.0		
Hong Kong	77.6		
Hungary	77.5		
Singapore	77.0		
Iran	76.7		
Argentina	76.4		
Russia	75.4		
Norway	75.4		
Greece	74.7		
Finland	74.3		
Denmark	74.3		
Sweden	74.2		
United Kingdom	73.9		

Supplementary Table 3: Rate – Avg. Percentage of Nights with App Use After Sleep Onset, by Country

Country	Avg % Nights w/ SASO	Country	Avg % Nights w/ SASO
Saudi Arabia	5.4	Netherlands	3.3
South Korea	5.4	Colombia	3.3
Japan	5.3	Czechia	3.3
Philippines	5.0	Hungary	3.3
Chile	5.0	Vietnam	3.2
Mexico	4.9	Brazil	3.2
Canada	4.8	Argentina	3.1
Taiwan	4.7	Germany	3.1
Indonesia	4.6	Finland	3.1
Thailand	4.5	France	3.0
Ireland	4.3	India	3.0
Malaysia	4.2	Russia	2.9
China	4.2	Bulgaria	2.9
Hong Kong	4.1	Switzerland	2.8
Ukraine	4.1	Spain	2.7
South Africa	4.1	Poland	2.6
United States	4.1	Belarus	2.5
Australia	3.9	Greece	2.5
Turkey	3.8	Austria	2.5
United Kingdom	3.7	Estonia	2.5
Denmark	3.7	Italy	2.3
Singapore	3.7	Belgium	1.9
Sweden	3.6		
Norway	3.6		
Iran	3.4		
Romania	3.4		
Slovakia	3.4		

Supplementary Table 4: Duration – Avg. App Use After Sleep Onset Session Length (Minutes), by Country

Country	Avg SASO Duration (Min)	Country	Avg SASO Duration (Min)
South Korea	23.7	Germany	16.8
Ireland	22.7	United States	16.8
Japan	22.5	Spain	16.8
Ukraine	21.5	France	16.6
Taiwan	21.2	Sweden	16.5
Czechia	20.1	South Africa	16.5
Switzerland	20.0	Bulgaria	16.4
Thailand	19.9	Russia	16.4
China	19.9	Belarus	16.2
Canada	19.8	Turkey	15.8
Hong Kong	19.7	Denmark	15.8
Indonesia	19.0	Hungary	15.7
Malaysia	18.6	Singapore	15.7
Romania	18.3	Austria	15.4
Vietnam	18.2	Norway	15.4
Mexico	18.2	Colombia	15.2
Saudi Arabia	17.8	Finland	15.2
Australia	17.4	Argentina	15.1
Philippines	17.3	Chile	15.1
Netherlands	17.3	Italy	14.9
Slovakia	17.1	Greece	14.9
United Kingdom	17.1	Estonia	14.3
Poland	14.2	Belgium	13.0
India	13.6	Brazil	12.9
Iran	11.8		

Supplementary Table 5: Average SASO Metrics by World Bank Regions

World Bank Regions	% Adults w/ SASO	Avg % Nights w/ SASO	Avg SASO Duration (Min)
East Asia and Pacific	80.9	4.4	19.4
North America	81.0	4.5	18.3
Europe and Central Asia	73.8	3.1	16.7
Sub-Saharan Africa	80.7	4.1	16.5
Latin America and Caribbean	78.4	3.9	15.3
Middle East and North Africa	83.8	4.4	14.8
South Asia	69.8	3.0	13.6

Supplementary Table 6: Net Change in Percentage of Adults with Any SASO, by Country 2018-2015

Country	% Adults w/ SASO	Country	% Adults w/ SASO
Belarus	+26.4	United Kingdom	+5.6
Greece	+24.4	Austria	+5.4
Hungary	+24.1	Romania	+4.5
Bulgaria	+22.2	Iran	+4.1
Brazil	+19.5	Chile	+4.0
Ukraine	+18.7	United States	+3.7
Netherlands	+17.5	Estonia	+3.2
India	+14.4	Mexico	+2.9
Germany	+12.6	Russia	+2.7
Czechia	+12.6	Thailand	+1.5
Switzerland	+12.2	Slovakia	+1.4
Sweden	+11.6	South Africa	+0.9
Canada	+11.1	Saudi Arabia	+0.6
Belgium	+10.4	Finland	+0.4
Japan	+10.1	Turkey	0.0
Australia	+9.3	Malaysia	-0.3
China	+8.7	Poland	-0.8
Italy	+8.0	Argentina	-1.2
Hong Kong	+7.8	Taiwan	-3.7
Colombia	+7.7	Indonesia	-5.0
Spain	+6.5	Ireland	-5.2
South Korea	+6.4	Vietnam	-11.0
Denmark	+6.2	Singapore	-14.8
Norway	+6.1	Philippines	-18.7
France	+6.0		

Supplementary Table 7: Net Change in Avg. Percentage of Nights with SASO, by Country 2018-2015

Country	Avg % Nights w/ SASO	Country	Avg % Nights w/ SASO
India	+3.2	Spain	+0.5
Canada	+3.0	Finland	+0.4
Romania	+2.4	Japan	+0.4
Australia	+2.4	Czechia	+0.4
Belarus	+2.3	France	+0.2
Vietnam	+2.2	Russia	+0.1
United States	+2.1	Malaysia	+0.1
Mexico	+1.8	United Kingdom	+0.1
South Korea	+1.6	Taiwan	-0.0
Hungary	+1.5	Italy	-0.0
Colombia	+1.5	Denmark	-0.1
Hong Kong	+1.5	Indonesia	-0.2
Switzerland	+1.5	Chile	-0.2
Norway	+1.3	Netherlands	-0.3
Argentina	+1.3	Austria	-0.4
Greece	+1.3	Brazil	-0.4
Bulgaria	+1.2	South Africa	-0.7
China	+1.1	Belgium	-1.1
Estonia	+1.1	Saudi Arabia	-1.3
Turkey	+1.1	Ukraine	-1.7
Germany	+0.9	Slovakia	-1.8
Sweden	+0.9	Singapore	-1.9
Thailand	+0.8	Philippines	-3.1
Iran	+0.8	Ireland	-5.3
Poland	+0.5		

Supplementary Table 8: Net Change in Avg. SASO Duration in Minutes by Country, 2018-2015

Country	Avg SASO Length (min)	Country	Avg SASO Length (min)
Switzerland	+16.4	France	+1.9
Australia	+12.2	Philippines	+1.7
Romania	+10.7	Indonesia	+1.5
Argentina	+8.7	Chile	+1.0
Hungary	+6.5	India	+0.5
Ukraine	+6.0	Finland	+0.5
Vietnam	+5.8	Greece	+0.4
Canada	+5.8	Malaysia	+0.1
United States	+5.4	China	+0.1
Saudi Arabia	+5.3	South Korea	+0.1
Belarus	+5.1	Netherlands	-0.3
Norway	+4.9	Colombia	-1.0
Thailand	+4.2	Denmark	-1.1
Mexico	+4.0	Russia	-1.2
Germany	+3.5	Brazil	-1.6
Italy	+3.3	Bulgaria	-1.8
Sweden	+2.9	Czechia	-2.0
Estonia	+2.9	Iran	-2.1
Poland	+2.8	Singapore	-2.2
Spain	+2.7	South Africa	-4.8
United Kingdom	+2.5	Slovakia	-4.8
Hong Kong	+2.5	Austria	-6.2
Japan	+2.4	Belgium	-8.5
Turkey	+2.2	Ireland	-20.2
Taiwan	+2.1		

Supplementary Table 9: Avg. Net Change in SASO Metrics by World Bank Regions, 2018-2015

World Bank Regions	% Adults w/ SASO	Avg % Nights w/ SASO	Avg SASO Duration (Min)
South Asia	+14.4	+3.2	+0.5
Europe and Central Asia	+9.3	+0.3	+1.1
North America	+7.4	+2.5	+5.6
Latin America and Caribbean	+6.6	+0.8	+2.2
Middle East and North Africa	+2.4	-0.3	+1.6
Sub-Saharan Africa	+0.9	-0.7	-4.8
East Asia and Pacific	-0.8	+0.4	+2.5

Supplementary Table 10: Flexible FE Model Specifications

Dependent Variables: Model:	Social.duration.day (1)	Social.duration.work.day (2)	Game.duration.day (3)	Game.duration.work.day (4)	steps (5)	steps.per.hour (6)
<i>Variables</i>						
cut_game_duration(0,5]	-0.5424*** (0.0693)	-0.1300*** (0.0391)	5.580*** (0.1356)	2.238*** (0.0714)	-243.4*** (9.927)	-1.924*** (0.6048)
cut_game_duration(5,10]	-0.8680*** (0.1129)	-0.2179*** (0.0640)	8.546*** (0.2695)	3.320*** (0.1423)	-298.4*** (16.38)	-4.306*** (1.007)
cut_game_duration(10,15]	-1.126*** (0.1243)	-0.2629*** (0.0712)	10.55*** (0.3336)	4.377*** (0.1778)	-329.2*** (19.15)	-5.629*** (1.166)
cut_game_duration(15,20]	-1.156*** (0.1387)	-0.4757*** (0.0837)	11.00*** (0.3795)	4.229*** (0.2097)	-322.8*** (21.71)	-4.900*** (1.341)
cut_game_duration(20,25]	-0.9882*** (0.1637)	-0.3183*** (0.0968)	12.58*** (0.4384)	5.089*** (0.2485)	-358.4*** (24.13)	-5.964*** (1.489)
cut_game_duration(25,30]	-1.226*** (0.1767)	-0.3608*** (0.1072)	15.73*** (0.5538)	6.337*** (0.3103)	-388.0*** (26.96)	-8.413*** (1.675)
cut_game_duration(30,35]	-1.182*** (0.2205)	-0.2117 (0.1292)	15.65*** (0.6317)	6.194*** (0.3464)	-426.0*** (30.64)	-9.503*** (1.907)
cut_game_duration(35,40]	-1.729*** (0.2293)	-0.2629** (0.1339)	18.06*** (0.7379)	6.594*** (0.4111)	-431.5*** (33.69)	-9.867*** (2.110)
cut_game_duration(40,45]	-1.368*** (0.2464)	-0.4008*** (0.1492)	19.94*** (0.8169)	7.591*** (0.4488)	-388.3*** (36.75)	-8.016*** (2.267)
cut_game_duration(45,50]	-1.426*** (0.3012)	-0.3986** (0.1794)	21.59*** (0.9518)	8.742*** (0.5199)	-532.4*** (42.57)	-14.97*** (2.667)
cut_game_duration(50,55]	-0.7959** (0.3412)	-0.1624 (0.1840)	21.65*** (1.073)	8.341*** (0.6337)	-487.7*** (47.31)	-12.13*** (2.969)
cut_game_duration(55,60]	-2.305*** (0.3695)	-0.6464*** (0.2105)	23.35*** (1.227)	8.474*** (0.7203)	-548.3*** (49.85)	-14.85*** (3.139)
cut_game_duration(60,Inf]	-1.731*** (0.1727)	-0.3991*** (0.0936)	30.75*** (0.7959)	11.20*** (0.3908)	-614.2*** (26.29)	-19.14*** (1.595)
cut_social_duration(0,5]	3.110*** (0.0826)	1.295*** (0.0417)	-0.9104*** (0.0721)	-0.2048*** (0.0386)	-253.2*** (8.151)	-0.3831 (0.4931)
cut_social_duration(5,10]	3.161*** (0.1219)	1.384*** (0.0666)	-1.246*** (0.1147)	-0.2890*** (0.0636)	-346.2*** (12.54)	-2.415*** (0.7719)
cut_social_duration(10,15]	3.988*** (0.1601)	1.868*** (0.0958)	-1.597*** (0.1419)	-0.3874*** (0.0769)	-380.6*** (15.25)	-2.919*** (0.9473)
cut_social_duration(15,20]	4.080*** (0.2104)	1.783*** (0.1190)	-1.545*** (0.1701)	-0.2887*** (0.0964)	-455.3*** (18.65)	-5.656*** (1.170)
cut_social_duration(20,25]	4.971*** (0.2618)	2.038*** (0.1510)	-1.889*** (0.2074)	-0.6083*** (0.1128)	-470.5*** (22.56)	-5.821*** (1.435)
cut_social_duration(25,30]	5.710*** (0.3465)	2.462*** (0.1901)	-1.842*** (0.2326)	-0.8149*** (0.1327)	-472.4*** (25.72)	-4.840*** (1.634)
cut_social_duration(30,35]	6.556*** (0.4090)	2.378*** (0.2340)	-2.169*** (0.2860)	-0.6898*** (0.1588)	-533.6*** (30.81)	-7.534*** (1.972)
cut_social_duration(35,40]	7.622*** (0.5208)	3.179*** (0.3006)	-2.563*** (0.3432)	-0.5269*** (0.2002)	-605.5*** (36.29)	-10.01*** (2.353)
cut_social_duration(40,45]	7.697*** (0.5950)	2.976*** (0.3531)	-2.266*** (0.3624)	-0.4242** (0.2005)	-648.2*** (40.52)	-14.37*** (2.576)
cut_social_duration(45,50]	9.750*** (0.7520)	3.871*** (0.4389)	-1.964*** (0.4583)	-0.7374*** (0.2562)	-672.5*** (47.90)	-12.83*** (3.085)
cut_social_duration(50,55]	10.24*** (0.8371)	4.489*** (0.5028)	-2.939*** (0.5362)	-0.7717** (0.3045)	-651.0*** (52.19)	-10.64*** (3.443)
cut_social_duration(55,60]	11.66*** (1.090)	4.973*** (0.6176)	-3.358*** (0.5999)	-0.8184** (0.3771)	-600.0*** (62.06)	-10.04** (3.941)
cut_social_duration(60,Inf]	15.87*** (0.7921)	6.285*** (0.3999)	-1.770*** (0.3542)	-0.6243*** (0.1824)	-708.2*** (37.27)	-17.20*** (2.280)
cut_books_duration(0,5]	-0.5099*** (0.1322)	-0.1049 (0.0716)	-1.268*** (0.1847)	-0.2977*** (0.0843)	-207.7*** (20.30)	-0.7059 (1.284)
cut_books_duration(5,10]	-1.241*** (0.3064)	-0.2565 (0.1715)	-2.151*** (0.4651)	-0.7056*** (0.2145)	-223.8*** (43.38)	-1.786 (2.761)
cut_books_duration(10,15]	-1.539*** (0.3293)	-0.5402*** (0.1968)	-1.567*** (0.5822)	-0.5444* (0.3005)	-267.9*** (57.49)	-4.917 (3.621)
cut_books_duration(15,20]	-0.3881 (0.4448)	0.0831 (0.2844)	-3.372*** (0.7224)	-1.009*** (0.3653)	-209.7*** (72.95)	-1.150 (4.318)

Supplementary Table 11: Flexible FE Model Specifications (Output Continued)

Dependent Variables: Model:	Social_duration_day (1)	Social_duration_work_day (2)	Game_duration_day (3)	Game_duration_work_day (4)	steps (5)	steps.per.hour (6)
<i>Variables</i>						
cut_books_duration(20,25]	-1.872*** (0.5044)	-0.6272** (0.3182)	-2.716*** (0.8467)	-0.8410** (0.4214)	-164.0** (77.11)	4.464 (4.873)
cut_books_duration(25,30]	-2.008*** (0.5731)	-1.044*** (0.2709)	-1.703* (1.007)	-0.8667 (0.5536)	-296.6*** (84.34)	-3.402 (5.430)
cut_books_duration(30,35]	-1.295** (0.5529)	-0.1384 (0.3458)	-1.795* (1.038)	-0.8537 (0.5325)	-407.0*** (93.04)	-14.29** (5.945)
cut_books_duration(35,40]	-0.7554 (0.7030)	-0.8341** (0.3634)	-2.473* (1.328)	-0.4703 (0.7189)	-277.4*** (104.6)	-4.069 (6.550)
cut_books_duration(40,45]	-1.003 (0.6773)	-0.6244* (0.3561)	-3.821*** (1.338)	-1.069 (0.7574)	-295.6** (115.8)	-3.268 (7.842)
cut_books_duration(45,50]	-1.191 (0.8101)	-1.055** (0.5097)	-4.549*** (1.447)	-1.997*** (0.6792)	-402.4*** (119.2)	-8.663 (7.628)
cut_books_duration(50,55]	-2.017** (0.9548)	-0.6634 (0.5323)	-3.357* (1.801)	-0.6679 (0.9031)	-476.5*** (134.9)	-14.30* (8.612)
cut_books_duration(55,60]	-1.127 (0.9773)	-0.3002 (0.6190)	-5.339*** (1.768)	-2.157** (0.8583)	-336.7** (162.8)	-2.618 (10.75)
cut_books_duration(60,Inf]	-2.190*** (0.4396)	-0.8913*** (0.2383)	-3.403*** (1.032)	-0.8538 (0.5420)	-580.4*** (76.44)	-17.38*** (4.953)
cut_video_duration(0,5]	-0.1063 (0.1175)	-0.0635 (0.0662)	-0.8150*** (0.1436)	-0.2188*** (0.0826)	-223.7*** (15.77)	-3.871*** (0.9536)
cut_video_duration(5,10]	-0.4954** (0.2297)	-0.3320** (0.1342)	-1.242*** (0.2797)	-0.3815** (0.1489)	-220.7*** (29.50)	-4.203** (1.848)
cut_video_duration(10,15]	-0.1998 (0.2169)	-0.1567 (0.1258)	-0.5362** (0.2644)	0.0822 (0.1492)	-202.9*** (27.02)	-4.941*** (1.687)
cut_video_duration(15,20]	-0.4427 (0.2790)	-0.1311 (0.1650)	-1.148*** (0.3480)	-0.3110* (0.1861)	-158.9*** (35.58)	-1.097 (2.224)
cut_video_duration(20,25]	-0.5445* (0.3127)	-0.4011** (0.1789)	-0.7025* (0.4057)	-0.1832 (0.2181)	-224.3*** (41.27)	-5.646** (2.572)
cut_video_duration(25,30]	-0.0158 (0.2448)	0.1083 (0.1367)	-0.8748*** (0.3192)	-0.1945 (0.1702)	-167.9*** (33.39)	-2.595 (2.077)
cut_video_duration(30,35]	-0.3607 (0.3555)	-0.0237 (0.2101)	-0.6446 (0.4647)	-0.0417 (0.2484)	-263.6*** (47.42)	-6.506** (2.926)
cut_video_duration(35,40]	0.0109 (0.4042)	0.3089 (0.2422)	-0.5894 (0.5082)	-0.0557 (0.2681)	-167.9*** (52.36)	-0.6817 (3.244)
cut_video_duration(40,45]	-0.4229 (0.3141)	-0.1978 (0.1858)	-0.8886** (0.4263)	-0.0408 (0.2479)	-154.1*** (44.82)	-1.373 (2.790)
cut_video_duration(45,50]	-0.2743 (0.4338)	-0.4495* (0.2337)	-1.583*** (0.5988)	-0.5388 (0.3324)	-311.5*** (59.69)	-8.008** (3.774)
cut_video_duration(50,55]	0.6286 (0.5371)	0.3463 (0.3179)	-0.1361 (0.7270)	0.3468 (0.4022)	-266.7*** (66.95)	-8.238* (4.236)
cut_video_duration(55,60]	-0.3928 (0.3880)	0.1650 (0.2588)	-0.3294 (0.5322)	0.1132 (0.2820)	-242.9*** (54.63)	-7.324** (3.384)
cut_video_duration(60,Inf]	-0.0126 (0.1955)	0.0641 (0.1092)	-0.2272 (0.3132)	0.2643 (0.1739)	-364.6*** (28.63)	-11.39*** (1.732)
diff_mid_sleep	-0.0054*** (0.0004)	-0.0007*** (0.0002)	-0.0058*** (0.0005)	-8.54×10^{-5} (0.0003)	-6.805*** (0.0845)	-0.2813*** (0.0046)
<i>Fixed-effects</i>						
user_index	Yes	Yes	Yes	Yes	Yes	Yes
date	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>						
Observations	10,861,107	7,905,759	10,861,107	7,905,759	10,861,107	10,861,107
Adjusted R ²	0.62503	0.40099	0.58277	0.34739	0.42028	0.40924

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***, 0.01, **, 0.05, *, 0.1

Regression parameters from flexible FE models estimating the relationship between different durations of app category use (in 5min bins) during the sleep period and next-day 1) social media app duration, 2) social media app duration during working hours, 3) game app duration, 4) game app duration during working hours, 5) total steps taken, 6) steps taken/hr.

Supplementary Table 12: Linear FE Model Specifications

Dependent Variables: Model:	Social_duration_day (1)	Social_duration.work_day (2)	Game_duration_day (3)	Game_duration.work_day (4)	steps (5)	steps_per_hour (6)
<i>Variables</i>						
Game_duration	-0.0152*** (0.0016)	-0.0023*** (0.0009)	0.3288*** (0.0074)	0.1233*** (0.0035)	-8.081*** (0.2542)	-0.1989*** (0.0146)
Social_duration	0.1816*** (0.0063)	0.0752*** (0.0032)	-0.0165*** (0.0029)	-0.0019 (0.0015)	-13.49*** (0.3773)	-0.2149*** (0.0206)
Books_duration	-0.0218*** (0.0038)	-0.0084*** (0.0021)	-0.0358*** (0.0090)	-0.0086* (0.0047)	-7.705*** (0.6684)	-0.1859*** (0.0433)
Video_duration	0.0036** (0.0016)	0.0027*** (0.0009)	-0.0008 (0.0024)	0.0037*** (0.0014)	-4.236*** (0.2393)	-0.0998*** (0.0143)
diff_mid_sleep	-0.0049*** (0.0004)	-0.0005** (0.0002)	-0.0048*** (0.0005)	0.0004 (0.0003)	-6.967*** (0.0845)	-0.2825*** (0.0046)
<i>Fixed-effects</i>						
user_by_season	Yes	Yes	Yes	Yes	Yes	Yes
date	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>						
Observations	10,861,107	7,905,759	10,861,107	7,905,759	10,861,107	10,861,107
Adjusted R ²	0.62487	0.40085	0.58234	0.34703	0.41993	0.40923

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***, 0.01, **, 0.05, *, 0.1

Regression parameters from linear FE models estimating the relationship between duration of app category use during the sleep period (per minute increase) and next-day 1) social media app duration, 2) social media app duration during working hours, 3) game app duration, 4) game app duration during working hours, 5) total steps taken, 6) steps taken/hr.

Supplementary Table 13: Age Stratified Linear Fixed Effects Models

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Age group</i>	<i>Variables</i>			
<30	Books_duration	-0.0356** (0.0173)	-0.0528*** (0.0117)	-7.8331*** (1.5356)
<30	Game_duration	0.2934*** (0.0176)	-0.0189*** (0.0056)	-9.0014*** (0.6689)
<30	Video_duration	-0.0019 (0.0057)	-0.0032 (0.0049)	-4.7963*** (0.5426)
<30	Social_duration	-0.0163*** (0.0056)	0.1131*** (0.0116)	-17.0090*** (0.6757)
<30	diff_mid_sleep	-0.0041*** (0.0007)	-0.0061*** (0.0007)	-7.1839*** (0.1041)
<i>Fit statistics</i>				
Observations		1360283	1360283	1360283
Adjusted R ²		0.57393	0.62837	0.39457
<i>Age group</i>	<i>Variables</i>			
30-55	Books_duration	-0.0180** (0.0085)	-0.0168*** (0.0040)	-7.0338*** (0.6676)
30-55	Game_duration	0.2124*** (0.0064)	-0.0128*** (0.0016)	-7.7768*** (0.2400)
30-55	Video_duration	-0.0035 (0.0027)	0.0011 (0.0019)	-3.6623*** (0.2782)
30-55	Social_duration	-0.0174*** (0.0036)	0.1028*** (0.0065)	-12.2942*** (0.3471)
30-55	diff_mid_sleep	-0.0048*** (0.0004)	-0.0045*** (0.0003)	-7.0478*** (0.0478)
<i>Fit statistics</i>				
Observations		6247280	6247280	6247280
Adjusted R ²		0.64540	0.66598	0.44124

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Supplementary Table 14: Age Stratified Linear Fixed Effects Models (Continued)

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Age group</i>	<i>Variables</i>			
>55	Books_duration	-0.0291 (0.0316)	0.0004 (0.0144)	-5.7368*** (2.1717)
>55	Game_duration	0.1337*** (0.0145)	-0.0033 (0.0031)	-6.4893*** (0.6288)
>55	Video_duration	-0.0011 (0.0060)	0.0013 (0.0039)	-4.4503*** (0.6579)
>55	Social_duration	-0.0114 (0.0084)	0.0887*** (0.0161)	-9.7524*** (0.9997)
>55	diff_mid_sleep	-0.0057*** (0.0009)	-0.0006 (0.0005)	-5.5543*** (0.1234)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		990155	990155	990155
Adjusted R ²		0.68397	0.64464	0.50043

Clustered (useruuid) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Regression parameters from age group stratified linear FE models estimating the relationship between duration of app category use during the sleep period (per minute increase) or midsleep deviation, and next-day 1) game app duration, 2) social media app duration, 3) total steps taken.

Supplementary Table 15: Habitual App Use Stratified Linear Fixed Effects Models (1=Low, 9=High)

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Decile group</i>	<i>Variables</i>			
1	Books_duration	-0.0039 (0.0170)	0.0173 (0.0175)	-28.6380** (13.8922)
1	Game_duration	0.1923*** (0.0694)	-0.0125* (0.0068)	-7.0748 (4.4410)
1	Video_duration	0.0079 (0.0084)	0.0056 (0.0072)	-3.5431 (4.3356)
1	Social_duration	-0.0008 (0.0135)	0.0751** (0.0338)	-23.2464*** (4.8094)
1	diff_mid_sleep	-0.0006 (0.0005)	-0.0014*** (0.0004)	-6.5346*** (0.1954)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		419342	419342	419342
Adjusted R ²		0.43069	0.44251	0.48802
<i>Decile group</i>	<i>Variables</i>			
2	Books_duration	0.0037 (0.0108)	0.0198 (0.0152)	-12.1845*** (3.0304)
2	Game_duration	0.2928*** (0.0312)	-0.0048 (0.0036)	-11.6754*** (1.6065)
2	Video_duration	-0.0021 (0.0076)	-0.0022 (0.0051)	-4.7599*** (1.4667)
2	Social_duration	0.0000 (0.0064)	0.0750*** (0.0131)	-18.8778*** (1.8470)
2	diff_mid_sleep	-0.0013*** (0.0004)	-0.0017*** (0.0003)	-6.6996*** (0.1190)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1169190	1169190	1169190
Adjusted R ²		0.47481	0.53584	0.45632

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Supplementary Table 16: Habitual App Use Stratified Linear Fixed Effects Models (Output Continued)

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Decile group</i>	<i>Variables</i>			
3	Books_duration	-0.0137 (0.0088)	0.0094 (0.0180)	-2.3358 (2.7490)
3	Game_duration	0.2160*** (0.0161)	-0.0073** (0.0030)	-10.2754*** (1.0362)
3	Video_duration	0.0028 (0.0047)	0.0024 (0.0032)	-3.8028*** (0.8401)
3	Social_duration	-0.0136*** (0.0052)	0.0676*** (0.0104)	-19.0172*** (1.2605)
3	diff_mid_sleep	-0.0035*** (0.0005)	-0.0028*** (0.0004)	-6.7221*** (0.1010)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1528480	1528480	1528480
Adjusted R ²		0.51922	0.56455	0.44602
<i>Decile group</i>	<i>Variables</i>			
4	Books_duration	0.0059 (0.0126)	-0.0107 (0.0069)	-7.1032*** (1.6657)
4	Game_duration	0.2366*** (0.0144)	-0.0135*** (0.0028)	-10.5272*** (0.7406)
4	Video_duration	0.0050 (0.0043)	0.0029 (0.0028)	-4.3127*** (0.7437)
4	Social_duration	-0.0163*** (0.0056)	0.0817*** (0.0094)	-17.2909*** (0.9370)
4	diff_mid_sleep	-0.0009 (0.0006)	-0.0018*** (0.0004)	-7.2426*** (0.0995)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1583652	1583652	1583652
Adjusted R ²		0.53945	0.58412	0.43433

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Supplementary Table 17: Habitual App Use Stratified Linear Fixed Effects Models (Output Continued)

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Decile group</i>	<i>Variables</i>			
5	Books_duration	-0.0355** (0.0176)	-0.0029 (0.0090)	-8.4768*** (1.6519)
5	Game_duration	0.2226*** (0.0122)	-0.0126*** (0.0029)	-10.2249*** (0.6314)
5	Video_duration	-0.0047 (0.0041)	0.0046 (0.0032)	-3.6005*** (0.6629)
5	Social_duration	-0.0111* (0.0057)	0.0742*** (0.0094)	-16.1393*** (0.8766)
5	diff_mid_sleep	-0.0029*** (0.0007)	-0.0027*** (0.0005)	-6.9888*** (0.1003)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1453696	1453696	1453696
Adjusted R ²		0.57272	0.59945	0.42682
<i>Decile group</i>	<i>Variables</i>			
6	Books_duration	0.0063 (0.0203)	-0.0193** (0.0086)	-9.1976*** (1.8421)
6	Game_duration	0.2338*** (0.0118)	-0.0134*** (0.0029)	-8.1814*** (0.5387)
6	Video_duration	0.0047 (0.0044)	0.0037 (0.0032)	-5.1500*** (0.5906)
6	Social_duration	-0.0190*** (0.0048)	0.1049*** (0.0119)	-16.0677*** (0.7403)
6	diff_mid_sleep	-0.0036*** (0.0008)	-0.0042*** (0.0006)	-7.0485*** (0.1008)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1378844	1378844	1378844
Adjusted R ²		0.58662	0.61901	0.43797

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Supplementary Table 18: Habitual App Use Stratified Linear Fixed Effects Models (Output Continued)

Dependent Variables: Model:		Game_duration_day (1)	Social_duration_day (2)	Steps (3)
<i>Decile group</i>	<i>Variables</i>			
7	Books_duration	-0.0293** (0.0131)	-0.0243** (0.0112)	-4.7890*** (1.5281)
7	Game_duration	0.2026*** (0.0117)	-0.0128*** (0.0031)	-8.1119*** (0.4830)
7	Video_duration	-0.0109** (0.0049)	0.0008 (0.0034)	-4.3981*** (0.5325)
7	Social_duration	-0.0257*** (0.0054)	0.0925*** (0.0099)	-13.3786*** (0.6440)
7	diff_mid_sleep	-0.0054*** (0.0009)	-0.0045*** (0.0007)	-6.7716*** (0.1042)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1218959	1218959	1218959
Adjusted R ²		0.60413	0.63520	0.42381
<i>Decile group</i>	<i>Variables</i>			
8	Books_duration	-0.0414*** (0.0139)	-0.0340*** (0.0081)	-7.7662*** (1.1544)
8	Game_duration	0.1825*** (0.0111)	-0.0140*** (0.0031)	-7.3299*** (0.4182)
8	Video_duration	-0.0026 (0.0049)	-0.0007 (0.0041)	-4.0085*** (0.4538)
8	Social_duration	-0.0019 (0.0060)	0.0982*** (0.0112)	-12.4537*** (0.5845)
8	diff_mid_sleep	-0.0050*** (0.0012)	-0.0076*** (0.0009)	-7.5168*** (0.1142)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1076304	1076304	1076304
Adjusted R ²		0.62771	0.66217	0.43668

Clustered (useruuid) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Supplementary Table 19: Habitual App Use Stratified Linear Fixed Effects Models (Output Continued)

Dependent Variables:		Game_duration_day	Social_duration_day	Steps
Model:		(1)	(2)	(3)
<i>Decile group</i>	<i>Variables</i>			
9	Books_duration	-0.0403** (0.0158)	-0.0234*** (0.0068)	-6.4536*** (0.9116)
9	Game_duration	0.2093*** (0.0109)	-0.0128*** (0.0030)	-6.0078*** (0.3339)
9	Video_duration	-0.0030 (0.0051)	-0.0060 (0.0037)	-3.2909*** (0.3963)
9	Social_duration	-0.0161** (0.0063)	0.1248*** (0.0112)	-8.6957*** (0.4781)
9	diff_mid_sleep	-0.0099*** (0.0015)	-0.0122*** (0.0010)	-6.8215*** (0.1137)
<i>Fixed-effects</i>				
user_by_season		Yes	Yes	Yes
date		Yes	Yes	Yes
<i>Fit statistics</i>				
Observations		1029494	1029494	1029494
Adjusted R ²		0.66505	0.69756	0.45130

Clustered (useruuid) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Regression parameters from habitual app use decile group stratified linear FE models estimating the relationship between duration of app category use during the sleep period (per minute increase) or midsleep deviation, and next-day 1) game app duration, 2) social media app duration, 3) total steps taken by each level of baseline average app use over the study period.