Extended Data

Extended Data Table 1. Summary of device ownership among cohort participants who provided their device information (n = 8,587). Note: Participants were allowed to report more than one device.

Fitbit Model	Type	Count
Charge 2	Wristband (2016)	1505
Versa 2	Smartwatch (2019)	1099
Charge 4	Wristband (2020)	979
Sense	Smartwatch (2020)	835
Charge 3	Wristband (2018)	794
Alta HR	Wristband (2017)	597
Versa	Smartwatch (2018)	597
Charge 5	Wristband (2021)	575
Versa 3	Smartwatch (2020)	484
Inspire 2	Wristband (2020)	398
Inspire HR	Wristband (2019)	390
Blaze	Smartwatch (2016)	296
Luxe	Wristband (2021)	282
Versa Lite	Smartwatch (2019)	225
Charge HR	Wristband (2015)	168
Ionic	Smartwatch (2017)	138
One	Clip (2012)	65
Surge	Smartwatch (2014)	58
Alta	Wristband (2016)	57
Flex	Wristband (2013)	53
Flex 2	Wristband (2016)	46
Inspire	Wristband (2019)	34
Zip	Clip (2012)	32
Charge	Wristband (2014)	27
Force	Wristband (2013)	<20
Ace 2	Wristband (2019)	<20
Ace 3	Wristband (2021)	<20
Classic	Clip (2009)	<20
Ultra	Clip (2011)	<20

Extended Data Table 2: Demographics of each group of clusters from the weekly patterns (columns in Figure 3B).

		Non-habitual low wear	Non-habitual high wear	Day Wear	Night Wear	Morning Gap	24 hr Wear	Other (Membership < 20)
Total N		4796	3682	1,387	38	143	146	46
Number of days	Mean days/person	174±122	630±106	489±165	607±141	673±98	548±128	512±181
Age	18-29	791	383	123	<20	<20	<20	<20
	30-39	892	666	223	<20	<20	36	<20
	40-49	764	611	239	<20	<20	39	<20
	50-64	1441	1181	507	<20	59	42	<20
	65+	890	834	293	<20	48	<20	<20
Sex at birth	Female	3427	2359	1008	<20	75	92	27
	Male	1247	1202	347	22	60-70	40-50	17
	Other/Unknown	122	121	32	<20	<20	<20	<20
Race	Asian	137	124	41	<20	<20	<20	<20
	Black or African American	253	124	112	<20	<20	<20	<20
	White	3861	3115	1090	32	122	107	37
	Other	174	108	36	<20	<20	<20	<20
	Unknown	371	211	108	<20	<20	<20	<20
Ethnicity	Not Hispanic or Latino	4274	3371	1253	35	130	125	42
	Hispanic or Latino	339	167	91	<20	<10	<20	<20
	Unknown/Other	183	144	43	<20	<10	<20	<20
Income	<50k	1124	592	206	<20	<20	21	<20
	50-75k	762	503	219	<20	24	29	<20
	75k-100k	690	558	220	<20	35	26	<20
	100-150k	929	809	306	<20	25	33	<20
	150-200k	415	442	156	<20	<20	<20	<20
	>200k	514	522	178	<20	<20	<20	<20
	Unknown	362	256	102	<20	<20	<20	<20

Extended Data Table 3. Chosen clinical outcomes based on the BRFSS, their corresponding question from BRFSS, and the list of Observational Medical Outcomes Partnership (OMOP) concept IDs used to define each clinical outcome.

Clinical Outcome	BRFSS Question	OMOP
Heart attack	(Ever told) (you had) heart attack, also called a myocardial infarction?	4329847
Angina	(Ever told) (you had) angina or coronary heart disease?	317576, 321318, 36712983
Stroke	(Ever told) (you had) a stroke.	197303, 36684840, 37395574, 37395575, 381316, 4045734, 40479572, 40480946, 40481354, 40481389, 40482266, 40482301, 40484101, 40484910, 4090122, 4110196, 4112022, 4116269, 42535112, 42535113, 42535114, 42535416, 42535417, 42535419, 42535459, 42535460, 42535461, 42535511, 42535512, 42539166, 42539195, 42539262, 43530623, 43530742, 43531610, 443465, 443525, 443551, 44782753, 44782781, 761785, 761789, 761790, 761792, 761793, 761794, 761795, 761796, 761797, 761798, 762340, 762344, 764721, 765568
Asthma	(Ever told) (you had) asthma?	317009
Skin cancer, not melanoma	(Ever told) (you had) skin cancer that is not melanoma?	138102, 435506
Cancer	(Ever told) (you had) melanoma or any other types of cancer?	443392
Chronic obstructive pulmonary disease (COPD)	(Ever told) (you had) C.O.P.D. (chronic obstructive pulmonary disease), emphysema or chronic bronchitis?	255573, 255841, 261325
Depressive disorder	(Ever told) (you had) a depressive disorder (including depression, major depression, dysthymia, or minor depression)?	433440, 440383
Kidney disease	Not including kidney stones, bladder infection or incontinence, were you ever told you had kidney disease?	198124
Arthritis	(Ever told) (you had) some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia? (Arthritis diagnoses include: rheumatism, polymyalgia rheumatica; osteoarthritis (not osteoporosis); tendonitis, bursitis, bunion, tennis elbow; carpal tunnel syndrome, tarsal tunnel syndrome; joint infection, etc.)	134453, 138845, 192885, 255348, 255891, 257628, 380094, 40405599, 4147145, 4180167, 42535223, 42535408, 42535409, 4291025, 4316217, 4344158, 440674, 443744, 760925, 762150, 762151, 80180, 80809, 81379
Type 2 diabetes mellitus	(Ever told) (you had) diabetes? (If ´Yes´ and respondent is female, ask ´Was this only when you were pregnant?´. If Respondent says pre-diabetes or borderline diabetes, use response code 4.)	201826

Extended Data Table 4. Chi-square test results for associations between wear behavior and clinical outcomes. The chi-square test statistics (χ^2), degrees of freedom (df), and p-values for

associations between wear behavior classifications and various clinical outcomes are reported. Significant and marginally significant results are bolded, and "S" denotes the use of Monte Carlo simulations to estimate p-values where applicable
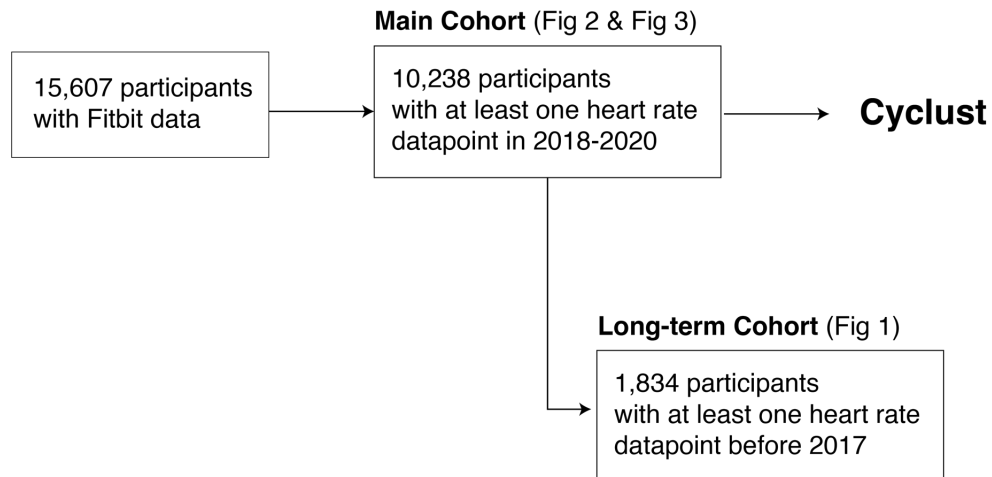
| | Non-habitual vs. Habitual | | | Non-habitual | | | Habitual | | | | | | | | |
| | | | | Low Wear vs. High Wear | | | Low Wear vs. High Wear | | | Wear Patterns | | | Wear Patterns and Weekday-Weekend Uniformity | | |
Clinical Outcomes	χ^2	p-value	df	χ^2	p-value	df	χ^2	p-value	df	χ^2	p-value	df	χ^2	p-value	df
Heart attack	0.00	0.9515	1	0.29	0.5927	1	0.00	1.0000	1	4.00	0.1229	S	9.45	0.3316	S
Angina	0.43	0.5131	1	0.72	0.3962	1	0.53	0.4652	1	2.63	0.2688	2	8.63	0.4553	S
Stroke	0.34	0.5784	S	0.37	0.5422	S	1.51	0.3785	S	0.84	1.0000	S	4.26	0.6943	S
Asthma	0.07	0.7966	1	3.55	0.0596	1	0.64	0.4254	1	4.69	0.0960	2	15.33	0.0822	9
Skin cancer, not melanoma	1.28	0.2585	1	0.64	0.4244	1	2.43	0.1192	1	0.21	0.9012	2	8.60	0.4748	9
Cancer	0.47	0.4924	1	4.75	**0.0293**	1	0.00	1.0000	1	1.67	0.4336	2	11.45	0.2461	9
Chronic obstructive pulmonary disease (COPD)	1.02	0.3127	1	0.70	0.4039	1	0.00	0.9623	1	7.81	**0.0223**	S	17.44	0.0603	S
Kidney Disease	0.03	0.8659	1	0.62	0.4313	1	5.11	**0.0238**	1	1.74	0.4190	2	10.08	0.3437	S
Depression	2.90	0.0884	1	18.12	**0.0000**	1	1.43	0.2324	1	2.33	0.3117	2	23.57	**0.0050**	9
Arthritis	0.15	0.7030	1	0.02	0.8827	1	0.45	0.5041	1	0.83	0.6604	2	11.70	0.2310	9
Type 2 diabetes mellitus	0.15	0.7004	1	0.60	0.4371	1	0.20	0.6533	1	1.63	0.4422	2	4.82	0.8558	S

Extended Data Table 5. Prevalence of clinical outcomes across wear behavior groups. This table presents the prevalence rates (%) of key clinical outcomes across wear behavior groups (e.g., inconsistent vs. consistent wear) and further subgroups (e.g., high vs. low wear levels, and wear patterns such as Day Wear, Morning Gap, and All-Day Wear). Weekday-weekend uniformity is described as the row number, counted from the bottom of Figure 3B, where 0 represents the pattern with the lowest difference between weekday and weekend wear patterns, and 3 represents the highest difference. We denote the combination of wear pattern and weekday-weekend uniformity as "abbreviated wear pattern" – "weekday-weekend uniformity." For example, "DW-0" denotes the Day Wear pattern with the lowest weekday-weekend uniformity

Clinical Outcomes (%)	Inconsistent (N=4529)	Low Wear Level (N=2595)	High Wear Level (N=1934)	Consistent (N=990)	Day Wear (DW) (N=784)	DW-3 (N=481)	DW-2 (N=164)	DW-1 (N=90)	DW-0 (N=49)	Morning Gap (MG) (N=76)	MG-3 (N=44)	MG-0 (N=32)	All Day Wear (AD) (N=87)	AD-3 (N=14)	AD-2 (N=10)	AD-1 (N=38)	AD-0 (N=25)
Heart attack	2.23	2.35	2.07	2.32	1.79	2.08	1.83	0	2.04	3.95	4.55	3.12	4.6	0	0	5.26	8
Angina	7.71	8.02	7.29	8.38	7.78	8.73	8.54	2.22	6.12	11.84	11.36	12.5	11.49	14.29	20	10.53	8
Stroke	0.38	0.31	0.47	0.51	0.51	0.42	0.61	0	2.04	0	0	0	0	0	0	0	0
Asthma	17.07	18	15.82	16.67	16.58	15.38	17.68	20	18.37	11.84	6.82	18.75	24.14	21.43	0	34.21	20
Skin cancer, not melanoma	40.72	40.19	41.42	42.73	43.62	45.74	40.85	41.11	36.73	42.11	36.36	50	41.38	35.71	70	42.11	32
Cancer	17.02	15.95	18.46	16.06	16.2	18.71	14.63	8.89	10.2	18.42	18.18	18.75	11.49	7.14	20	15.79	4
Chronic obstructive pulmonary disease (COPD)	4.08	4.32	3.77	3.33	2.68	2.49	3.05	0	8.16	5.26	2.27	9.38	8.05	7.14	10	7.89	8
Kidney Disease	12.78	13.14	12.31	12.53	11.22	10.19	15.85	6.67	14.29	15.79	18.18	12.5	13.79	7.14	10	13.16	20
Depression	24.64	27.01	21.46	22.02	21.56	17.67	21.34	36.67	32.65	22.37	22.73	21.88	28.74	35.71	30	31.58	20
Arthritis	41.73	41.62	41.88	41.01	41.2	43.66	42.68	31.11	30.61	38.16	45.45	28.12	36.78	28.57	50	36.84	36
Type 2 diabetes mellitus	10.58	10.25	11.01	10.1	9.82	9.98	12.2	6.67	6.12	14.47	13.64	15.62	10.34	14.29	10	10.53	8

Extended Data Figure 1. Inclusion criteria for main cohort and long-term cohort.
The flow diagram describes the inclusion criteria applied to define the Main Cohort and the Long-Term Cohort used for visualization and clustering using Cyclust.

Main Cohort (Fig 2 & Fig 3)

| 15,607 participants with Fitbit data | → | 10,238 participants with at least one heart rate datapoint in 2018-2020 | → | **Cyclust** |

Long-term Cohort (Fig 1)

1,834 participants with at least one heart rate datapoint before 2017

Extended Data Figure 2: Mean overall wear fraction of the long-term cohort (N=1,834) on federal holidays, and on the same day of the week in the 4 weeks preceding and following each holiday. Federal holidays included Martin Luther King Jr. Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving, and Christmas. On each holiday, the population has a tendency to wear their devices less compared to the same day of the week in the vicinity of the holiday. Only MLK Jr day has a different trend, but being in early January, this is attributable to the increase in wear at the beginning of every year.
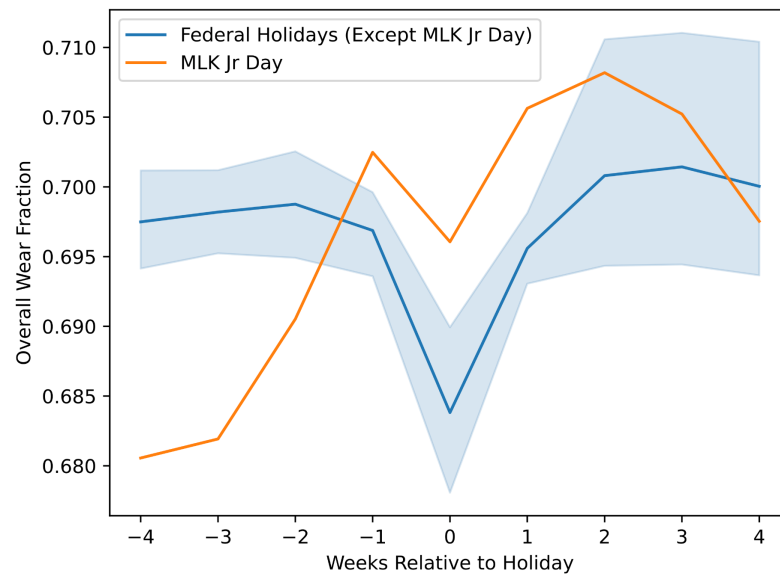
Extended Data Figure 3: Grouping similar circadian patterns that were originally separated by the unsupervised agglomerative clustering algorithm. The final clusters presented in Figure 2B are a result of merging each of the boxed clusters together and recalculating the centroid. It should be noted that the non-habitual groups present in Figure 2B were excluded from this analysis.
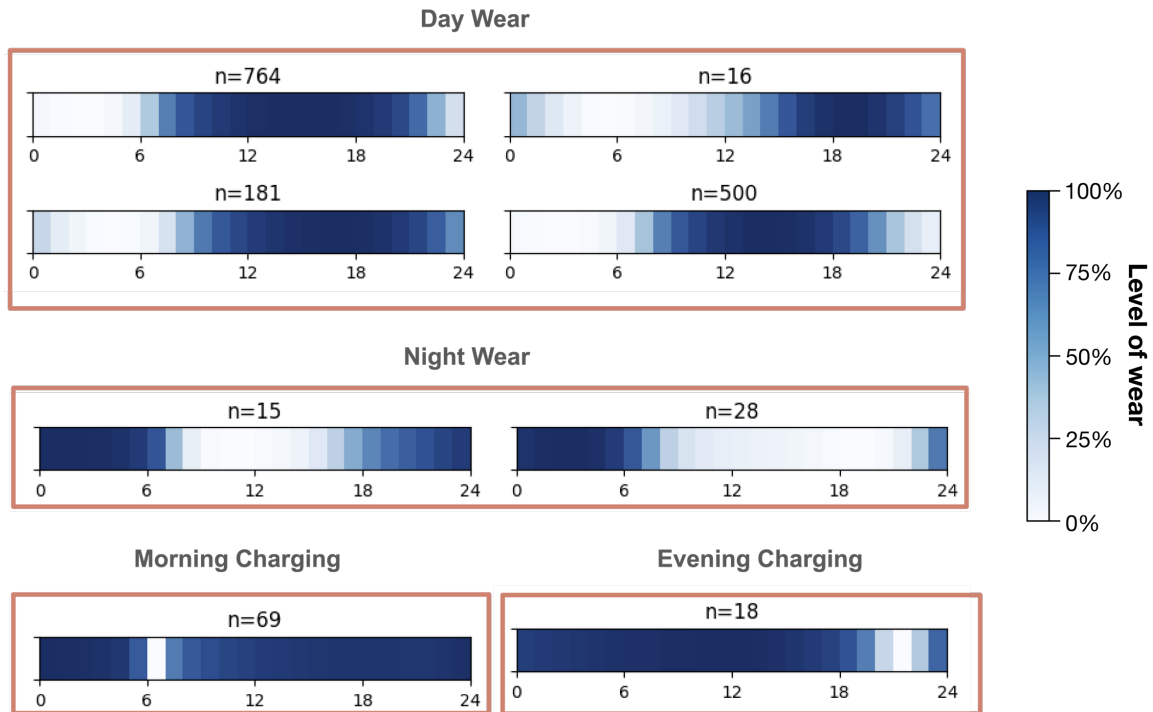
Extended Data Figure 4: Algorithm steps for extracting circadian and weekly wear patterns. First, a binary indicator vector for whether the watch is worn is generated at a 15-minute resolution, then down-sampled to hour-level fractional wear. Next the vector is reshaped into a matrix such that each day occupies one row in the matrix. For the circadian wear pattern, this matrix is aggregated along the day axis to get the average wear level at each hour of the day, then normalized to mean 0 and standard deviation 1. For the weekly wear pattern, the matrix is further reshaped into a tensor which is a stack of matrices that each represent one week of days. The tensor is then aggregated along the week axis to get the average wear level at every given hour of the day on every day of the week.
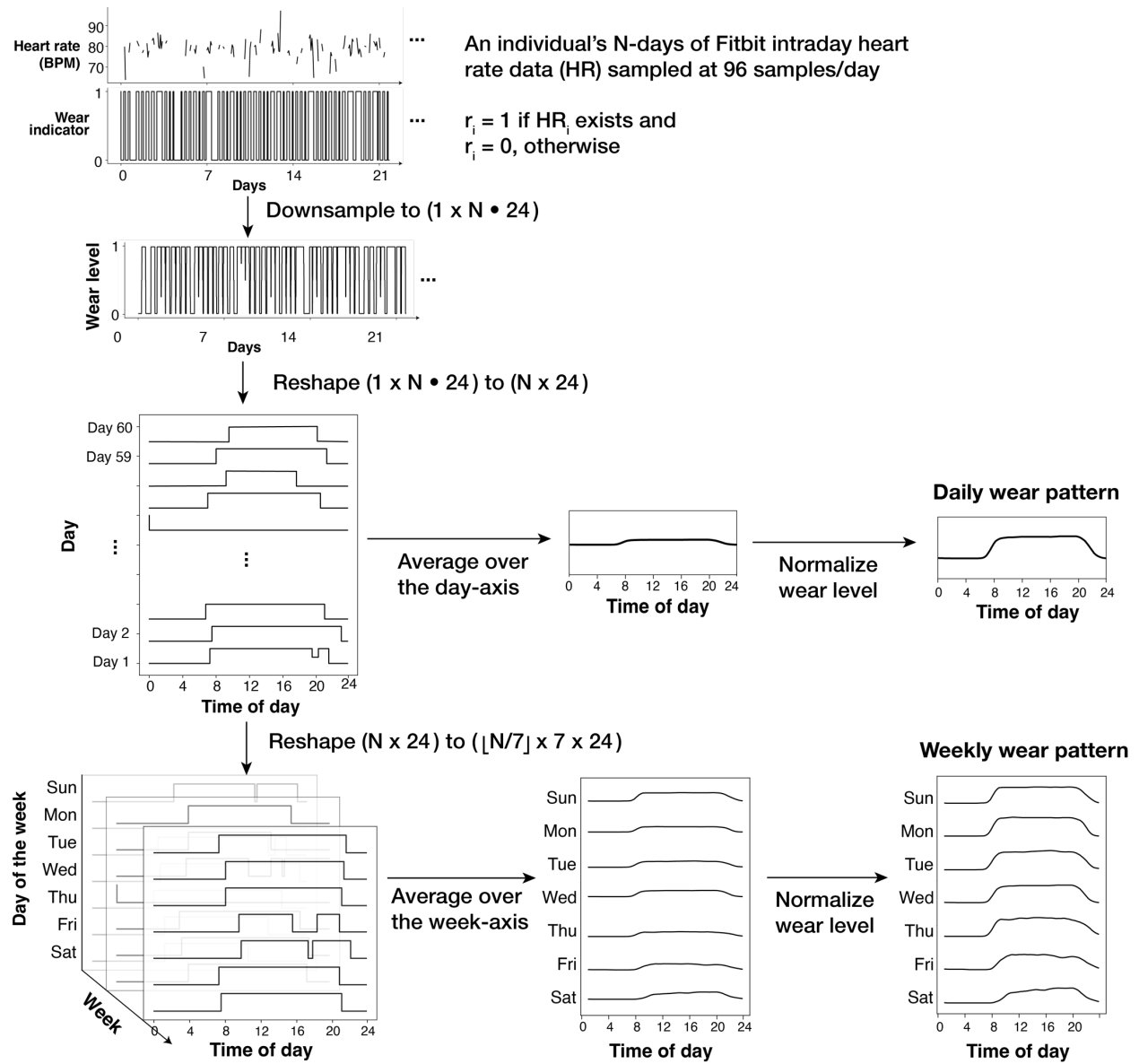
Extended Data Figure 5. Weekday-weekend consistency. The circadian and weekly consistency metrics are defined as the difference between the maximum and minimum values in an individual's circadian or weekly pattern vector (prior to normalization), respectively. Examples include: **(A)** an individual with high average wear level (more wear than non-wear days) but low consistency due to the differences in their timing and duration of wear; **(B)** an individual with low average wear levels (more non-wear than wear days) and low consistency; **(C)** an individual with high average wear levels and high consistency from wearing their device at consistent times; and **(D)** an individual with high weekly consistency from consistently wearing their device at similar times across all days of the week.