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Digital Health

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: Natarajan A, Pantelopoulos A, Emir-Farinas H, Natarajan P. Heart rate variability with photoplethysmography in 8 million individuals: a cross-sectional study. *Lancet Digit Health* 2020; **2:** e650–57.

Appendix

I. Data collection and cleaning:

The output of a PPG device is the Interbeat Interval (IBI) tachogram, i.e. the time between peaks of blood volume. The Interbeat Intervals (IBI) are susceptible to noise due to motion artifacts, electronic noise, missed heart beats, etc. It is essential to clean the IBI field if it is to be a faithful representation of the RR interval tachogram measured by ECG.

Fig. S1 shows a flow chart of the data cleaning process. Data are simultaneously obtained from the PPG sensor and the accelerometer. If motion is detected above 0.01G then the data are considered to be invalid, and automatically deleted. If no significant motion is detected, the PPG data are converted to a series of RR intervals and assembled into blocks of non-overlapping 5 minutes. Each 5 minute window is then examined to ensure data quality. Firstly, we ensure sufficient coverage: The expected number of RR intervals in a 5 minute window is 5 minutes / ⟨RR⟩. The coverage may then be defined as the ratio of the number of measured RR intervals to the expected number. If the coverage drops below a pre-set threshold of 70%, the entire 5 minute window of data is discarded.

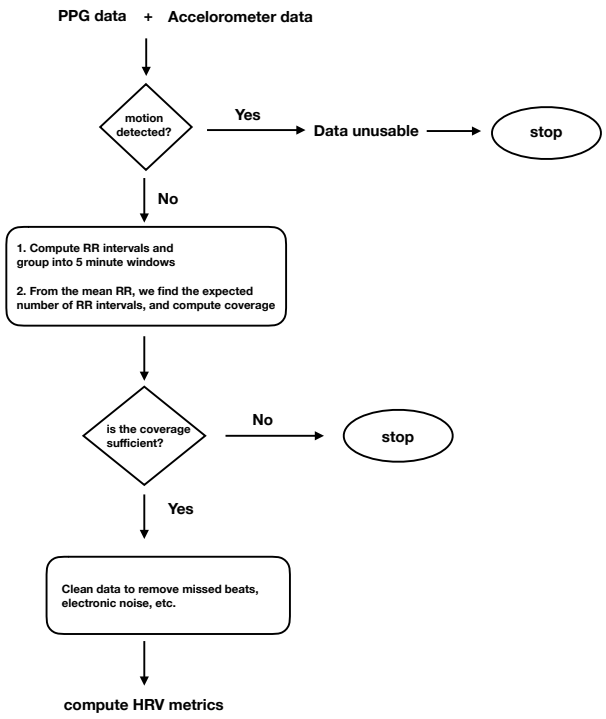

Fig. S1: Flowchart showing the steps in the data cleaning process.

The RR data are cleaned to remove missed heart beats and electronic noise. To clean the data, we first create a "median template" by replacing each data point with the median of values in a window of size k (for example, if k = 3, we simply compare each point with its two immediate neighbors, and replace it with the median, end points are treated separately). The median filtered template resembles a low pass filtered version of the data. We compute the residual time series by subtracting the median filtered template from the input

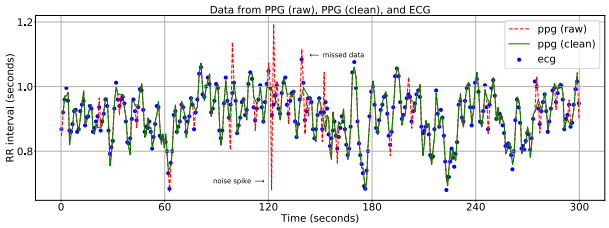

Fig. S2: RR intervals for a 5 minute interval. The dashed red line shows the raw PPG data, while the solid green line shows the data after cleaning. The blue dots are data from ECG. If the cleaning threshold is too mild, we run the risk of missing noise spikes which causes an anomalously high value of RMSSD and HF power. If the cleaning is too aggressive, some data points are erroneously considered noise, and skipped, resulting in a deficit in RMSSD and HF power.

RR time series. Noise spikes are prominently visible in the residual plot, and can be flagged. The flagged datapoints are then deleted from the original data, and the median template is discarded. A secondary filtration stage checks the Δ RR sequence for noise spikes that may have been missed by the main stage, and further cleans the RR data.

Time domain and Frequency domain HRV metrics are computed using the cleaned RR interval data for each 5 minute blocks. Finally the HRV metrics are collected into 1 hour bins, and the median over individual blocks is reported. We require there to be at least three 5 minute blocks of data in a 1 hour window in order to report the HRV for that hour. The graphical domain metrics (Poincare S1 and S2) are computed from 1 hour of data.

Fig. S2 shows a 5 minute window with raw PPG data (dashed red lines), cleaned PPG data (solid green lines), as well as ECG data (blue dots). If the cleaning algorithm is too aggressive, it results in some data points being mistakenly identified as noise and removed, thus reducing power at high frequencies. On the other hand, if the cleaning is too conservative, we run the risk of missing noise spikes resulting in excess power at high frequencies. The parameters involved in the cleaning algorithm are fine tuned by comparing the HRV metrics computed using the cleaned RR intervals with the HRV metrics computed with ECG data.

Fig. S3 shows the comparison between PPG and ECG derived RMSSD. PPG (with Fitbit devices) and ECG (single lead, chest strap) data were simultaneously obtained from 14 subjects (normal sinus rhythm, users were at rest). Data were collected with approval from an Institutional Review Board (Solutions IRB, Protocol ID# 2017/03/6), using Fitbit Ionic and Surge devices.

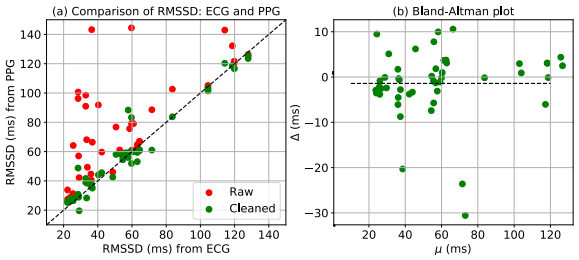

Fig. S3: Plot (a) shows the comparison between RMSSD derived from PPG and ECG data – The green dots show cleaned data, while the red dots are raw data. Plot (b) shows the Bland-Altman plot. The mean of the differences is -1.4ms and the standard deviation is 7.5ms.

From these subjects, we obtained 48 samples of data consisting of 5 minutes per sample. We used data from each sample with PPG and ECG coverage where the RMMSD computed from ECG data is in the range 20ms – 150ms. The subjects consisted of both 8 male and 6 female, with a mean age of 27.9 years and a standard deviation of 10.9 years. All participants provided informed consent. The signal coverage was between 98-99% with ECG and between 91-97% with PPG.

Fig. S3(a) shows the RMMSD measured by PPG plotted against RMSSD measured using ECG. The red dots indicate measurements made with the raw data, while the green dots are measurements made with the cleaned data. The Pearson correlation between the cleaned RMMSD and the ECG data is 0.97, while the Pearson correlation between the raw RMSSD and the ECG data is 0.52. Fig. S3(b) shows the Bland-Altman plot comparing the ECG derived RMSSD and the PPG derived RMSSD computed using the cleaned data. Δ is the difference between ECG derived and cleaned PPG derived RMSSD, while μ is the mean of the two values. The average of Δ over all measurements is -1.4 ms, indicating a small negative bias. The standard deviation of Δ is 7.5 ms. A few outliers are visible even with the cleaned data. In practice, we attempt to reduce the influence of outliers by reporting the median of all computations made in a 1 hour window. We only report HRV when the RMSSD is well above 7.5ms, i.e. we set a lower threshold of about 20ms. Only the laboratory based data were validated against the ECG recordings, and not the data acquired from the 8.2M participants discussed in the text.

Our cleaning algorithm does not make an assumption about noise levels. We define noise by the prominence, i.e. the value in relation to its neighboring points. Since very noisy samples can affect the prominence, we choose to discard these samples. We discard the data in a time window if the fraction of

noise spikes exceeds 10% of the window size. For the remainder of the paper, we will describe HRV metrics derived from the cleaned PPG data.

II. HRV Metrics:

We consider the following well known HRV metrics:

I. SDRR: The SDRR is the standard deviation of the IBI measured over a time window of 5 minutes. Let the peaks of the blood volume occur at times T_0, T_1, T_2, $\cdots$. The IBI are the differences between successive beats, defined as:

$$I_n = T_n - T_{n-1}, \qquad (1)$$

i.e. the IBI field is the first difference of the PPG waveform. The standard deviation of each 5 minute sequence of I_n is computed. The SDRR measures medium to long term variations in the heart rate. SDRR correlates with the total power since the variance in the time domain equals the total power in the frequency domain. In the literature, this quantity is often termed SDNN which implies that ectopic beats are filtered out. Since we do not do this, we prefer the term SDRR.

II. RMSSD: The RMSSD is the root mean squared (RMS) value of the successive differences of the I_n. The successive differences ΔI_n are defined as:

$$\Delta I_n = I_n - I_{n-1}. \qquad (2)$$

Since the ΔI_n is the second difference of the PPG waveform (or the first difference of the IBI), it preferentially contains high frequency variations. The RMSSD is the RMS value of the ΔI_n (i.e. the square root of the mean of the square of the samples), measured over a time window of 5 minutes. The RMSSD measures short to medium term variations in the heart rate, and correlates with HF power.

III. LF Power: The LF band measures power in the frequency range 0.04 Hz - 0.15 Hz (corresponding to physiological processes that act on timescales 6.7s - 25s), and captures both sympathetic and parasympathetic activity.

IV. HF Power: The HF band measures power in the frequency range 0.15 Hz - 0.4 Hz (corresponding to physiological processes that act on timescales 2.5s - 6.7s), and is a probe of the parasympathetic nervous system. The respiration induced sinus arrhythmia is usually contained in the HF band.

V. Poincare S_1: The standard deviation measured along the minor axis of the Poincare ellipse is called S_1, and is a measure of short term variability.

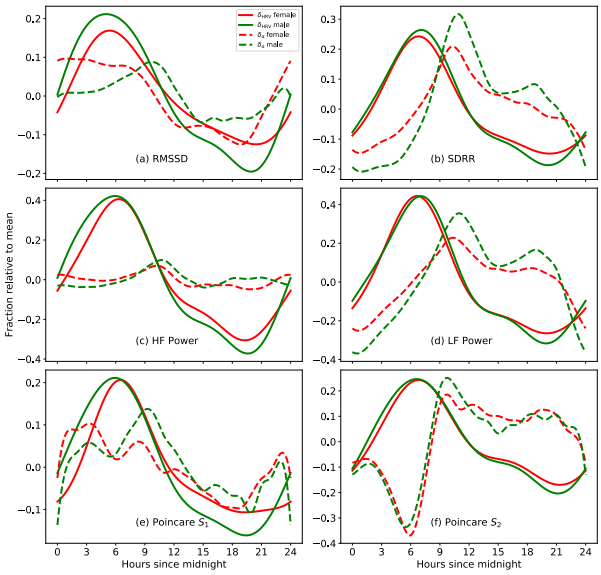

Fig. S4: Daily variation of the time dependent scaling parameters.

VI. Poincare S_2: The standard deviation measured along the major axis of the Poincare ellipse is called S_2, and is a measure of long term variability.

III. Scaling relations:

In this section, we take a closer look at the scaling of HRV with age, gender, and time of day. We parametrize the HRV by the following power law form:

$$HRV(age, g, t) = HRV_{30}(g, t) \ \left[\frac{age}{30\ \mathrm{yr}}\right]^{\alpha(g,t)} \quad \text{(S1)}$$

where *t* is the time of day in hours from midnight, '*age*' is the age in years, and *g* is the gender. *HRV* is the HRV metric being studied, which could be HF power, LF power, RMSSD, SDRR, S_1, or S_2. Note that the dependence on the time of day and the age are not separable, i.e. the power law exponent α is a function of the time of day. The time dependence of α means that the decline in HRV with age is different at different times of the day. Let us expand the time dependent terms in Eq. S1, i.e. HRV_{30} and α as follows:

$$HRV_{30}(g,t) = HRV_0(g)[1 + \delta_{\mathrm{H}}(g,t)]$$

$$\alpha(g,t) = \alpha_0(g)[1 + \delta_\alpha(g,t)] \quad \text{(S2)}$$

$HRV_0(g)$ and $\alpha_0(g)$ are mean values (over 24 hours) and are gender dependent. Table S1 gives the values of $\alpha_0(g)$ and $HRV_0(g)$ and for various HRV metrics. Together with the time dependent terms, one can compute the HRV given the gender, age, and time of day. Fig. S4 shows the diurnal modulation of $\delta_{\mathrm{H}}(g,t)$ and $\delta_\alpha(g,t)$. The plots for $\delta_{\mathrm{H}}(g,t)$ are sufficiently close to sinusoidal that we can approximate $\delta_{\mathrm{H}}(g,t)$ using the first 3 Fourier components (see Table S2):

$$\delta_{\mathrm{H}}(g,t) = \Sigma_{n=1}^{3}[a_n(g)\cos\left(\frac{nt}{24\ \mathrm{hr}}\right) + b_n(g)\sin\left(\frac{nt}{24\ \mathrm{hr}}\right)] \quad \text{(S3)}$$

In all cases, b_1 is the dominant term, describing a sinusoid with a period of 24 hours. The other terms are corrections to the sinusoidal variation. Table S1 gives the value of typical HRV metrics for a 30 yr old person. More accurate estimates can be obtained by accounting for the time dependent term δ_α (t) as shown in Fig. S4. Typically HRV numbers for other ages can be obtained from Eq. S2 and Eq. S3, and from Table S1 and Table S2.

IV. HRV benchmark tables

We provide benchmark tables to estimate RMSSD, SDRR, HF power, LF power, Poincare S_1, Poincare S_2, and LF/HF, for male and female users, for various ages, at 6am-7am and at 6pm-7pm. The time and frequency domain metrics (RMSSD, SDRR, LF, HF, LF/HF) are computed over 5 minute time windows. The median of all 5 minute window measurements within a 1 hour interval is reported. The graphical domain metrics (Poincare S_1 and S_2) are computed over a 1 hour interval.

V. Geographical distribution.

Participants in this study were located all over the world, with 77 countries having over a 1,000 subjects each. These countries are as follows, in alphabetical order of their Alpha-2 code:
AE,AR,AT,AU,BE,BG,BH,BR,CA,CH,CL,CN,CO,CR,CZ,DE,DK,DO,EC,EE,EG,ES,FI,FR,GB,GG,GR,GT,HK,HR,HU,ID,IE,IL,IM,IN,IS,IT,JE,JM,JP,KE,KR,KW,LB,LT,LU,LV,MT,MX,MY,NG,NL,NO,NZ,PA,PE,PH,PK,PL,PR,PT,QA,RO,RU,SA,SE,SG,SK,TH,TR,TT,TW,UA,US,VN,ZA

HRV Features - Variation of scaling parameters with age

Metric	Gender		α_0	HRV_0
RMSSD	Female		-0.666	43.7 ms
RMSSD	Male		-0.804	44.8 ms
SDRR	Female		-0.524	54.7 ms
SDRR	Male		-0.566	61.5 ms
HF	Female		-1.480	537.1 ms^2
HF	Male		-1.653	515.6 ms^2
LF	Female		-1.045	917.0 ms^2
LF	Male		-1.006	1195.8 ms^2
S_1	Female		-0.664	32.2 ms
S_1	Male		-0.810	32.6 ms
S_2	Female		-0.337	88.4 ms
S_2	Male		-0.416	98.6 ms

Table S1: The scaling parameters $\alpha_O(g)$ and $HRV_O(g)$.

HRV Features - Variation with time of day

Metric	Gender	a_1	a_2	a_3	b_1	b_2	b_3
RMSSD	Female	-0.009	-0.029	-0.003	0.137	0.022	0.001
RMSSD	Male	0.012	-0.02	0.011	0.196	0.035	0.011
SDRR	Female	-0.047	-0.051	0.01	0.173	-0.012	-0.007
SDRR	Male	-0.052	-0.044	0.019	0.2	-0.01	-0.001
HF	Female	-0.02	-0.06	0.025	0.323	0.015	-0.02
HF	Male	0.021	-0.046	0.033	0.382	0.044	0.005
LF	Female	-0.06	-0.098	0.022	0.317	-0.014	-0.016
LF	Male	-0.067	-0.073	0.043	0.335	-0.015	-0.004
S_1	Female	-0.035	-0.05	0.003	0.137	-0.010	-0.015
S_1	Male	0.007	-0.03	0.009	0.181	0.0130	0.0
S_2	Female	-0.063	-0.061	0.010	0.170	-0.002	-0.002
S_2	Male	-0.059	-0.056	0.009	0.193	0.014	0.007

Table S2: Variation of time dependent scaling parameters: The first 3 Fourier components from Eq. S3 are shown.

HRV Features - Time Domain

Time of day	Age (yr)	RMSSD (female)			RMSSD (male)			SDRR (female)			SDRR (male)		
		(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)
6am - 7am	20-21	66 (43)	56	37 - 85	74 (43)	66	45 - 96	81 (35)	76	56 - 101	91 (37)	88	66 - 114
6am - 7am	25-26	57 (38)	48	32 - 73	61 (39)	54	35 - 79	73 (33)	68	50 - 91	82 (36)	79	57 - 103
6am - 7am	30-31	53 (34)	45	31 - 67	56 (33)	49	34 - 71	69 (30)	65	49 - 86	79 (33)	75	57 - 98
6am - 7am	35-36	47 (31)	41	29 - 60	49 (29)	43	31 - 62	64 (28)	61	46 - 79	73 (30)	70	54 - 91
6am - 7am	40-41	42 (27)	37	26 - 52	43 (26)	38	27 - 54	59 (25)	56	43 - 73	68 (28)	65	50 - 85
6am - 7am	45-46	37 (23)	33	24 - 46	38 (23)	34	25 - 48	54 (23)	51	40 - 66	64 (27)	61	47 - 78
6am - 7am	50-51	34 (22)	31	22 - 42	34 (21)	31	23 - 42	51 (22)	49	38 - 63	59 (25)	56	42 - 72
6am - 7am	55-56	33 (20)	29	22 - 40	32 (23)	29	21 - 39	49 (21)	47	36 - 61	55 (25)	52	40 - 68
6am - 7am	60-61	31 (22)	28	21 - 38	31 (26)	27	20 - 37	46 (21)	44	34 - 57	52 (26)	49	37 - 64
6pm - 7pm	20-21	49 (35)	41	28 - 62	53 (36)	45	30 - 66	58 (27)	54	40 - 73	66 (29)	63	46 - 82
6pm - 7pm	25-26	41 (29)	34	24 - 51	41 (30)	34	23 - 53	51 (24)	46	35 - 63	55 (27)	52	37 - 70
6pm - 7pm	30-31	40 (28)	34	24 - 50	38 (26)	33	23 - 47	49 (23)	46	35 - 60	54 (24)	51	39 - 67
6pm - 7pm	35-36	36 (24)	31	22 - 44	34 (24)	29	21 - 42	45 (20)	42	32 - 55	49 (22)	46	35 - 60
6pm - 7pm	40-41	33 (21)	29	21 - 40	30 (20)	26	19 - 37	41 (18)	39	30 - 50	45 (20)	42	32 - 55
6pm - 7pm	45-46	31 (20)	27	20 - 38	27 (18)	24	18 - 34	38 (17)	36	28 - 46	41 (19)	39	30 - 51
6pm - 7pm	50-51	29 (20)	26	19 - 35	25 (17)	22	16 - 31	36 (16)	35	27 - 44	38 (17)	36	27 - 46
6pm - 7pm	55-56	27 (18)	25	18 - 33	24 (20)	21	16 - 29	34 (16)	33	26 - 42	35 (17)	33	25 - 43
6pm - 7pm	60-61	26 (18)	24	18 - 32	24 (25)	21	15 - 28	32 (15)	30	24 - 39	34 (19)	31	24 - 41

Table S3: Typical values for time domain HRV features: The RMSSD distribution is more skewed than the SDRR distribution and this is reflected in the difference between the mean and the median.

HRV Features - Frequency Domain

Time of day	Age (yr)	HF (female)			HF (male)			LF (female)			LF (male)		
		(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)
6am - 7am	20-21	1311 (1729)	759	359 - 1566	1352 (1632)	868	448 - 1665	1875 (1808)	1372	737 - 2395	2265 (1909)	1749	991 - 2925
6am - 7am	25-26	971 (1360)	543	250 - 1147	970 (1403)	582	269 - 1169	1568 (1586)	1120	570 - 2014	1954 (1793)	1486	779 - 2551
6am - 7am	30-31	822 (1151)	474	232 - 962	779 (1105)	488	251 - 922	1418 (1446)	1018	547 - 1798	1816 (1585)	1406	793 - 2341
6am - 7am	35-36	657 (1001)	375	189 - 749	599 (845)	375	195 - 710	1209 (1232)	859	471 - 1530	1600 (1442)	1227	694 - 2055
6am - 7am	40-41	497 (852)	290	150 - 567	464 (753)	286	151 - 543	1015 (1055)	721	397 - 1282	1389 (1330)	1048	588 - 1788
6am - 7am	45-46	379 (616)	225	118 - 432	366 (679)	221	118 - 411	842 (920)	593	331 - 1048	1176 (1145)	876	490 - 1502
6am - 7am	50-51	313 (734)	190	101 - 356	283 (703)	171	92 - 317	728 (831)	508	288 - 893	990 (1054)	709	392 - 1242
6am - 7am	55-56	280 (636)	170	91 - 314	245 (701)	138	75 - 255	659 (841)	450	254 - 794	853 (1107)	586	321 - 1033
6am - 7am	60-61	251 (761)	146	79 - 270	243 (932)	116	64 - 214	576 (861)	374	210 - 670	759 (1166)	469	259 - 858
6pm - 7pm	20-21	698 (1060)	359	167 - 781	710 (1027)	397	188 - 803	1071 (1085)	733	394 - 1343	1339 (1304)	999	538 - 1681
6pm - 7pm	25-26	478 (812)	235	108 - 515	436 (774)	214	90 - 482	820 (961)	524	273 - 1015	1035 (1208)	690	331 - 1312
6pm - 7pm	30-31	419 (711)	214	106 - 445	381 (977)	192	97 - 400	761 (871)	504	279 - 924	971 (955)	698	390 - 1232
6pm - 7pm	35-36	327 (586)	173	87 - 348	285 (629)	145	73 - 292	628 (763)	418	231 - 749	809 (882)	558	310 - 1012
6pm - 7pm	40-41	254 (509)	142	75 - 270	216 (657)	112	58 - 225	524 (696)	351	199 - 612	675 (774)	457	246 - 831
6pm - 7pm	45-46	213 (522)	119	63 - 223	172 (383)	93	48 - 175	440 (619)	293	167 - 508	557 (659)	375	202 - 673
6pm - 7pm	50-51	184 (644)	104	55 - 192	136 (336)	74	39 - 139	383 (531)	254	145 - 446	455 (623)	302	164 - 540
6pm - 7pm	55-56	160 (477)	90	49 - 165	129 (473)	63	34 - 116	334 (497)	221	125 - 380	386 (580)	244	131 - 437
6pm - 7pm	60-61	143 (463)	79	44 - 145	135 (520)	57	32 - 106	292 (482)	186	107 - 325	358 (722)	204	110 - 373

Table S4: Typical values for frequency domain HRV features. Presented are mean, median, and the range from the 25^{th} to the 75^{th} percentile, across gender and age ranges.

HRV Features - Graphical Domain

Time of day	Age (yr)	Poincare S_1 (female)			Poincare S_1 (male)			Poincare S_2 (female)			Poincare S_2 (male)		
		(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)
6am - 7am	20-21	50 (32)	43	27 - 66	56 (31)	51	34 - 72	120 (50)	115	84 - 148	141 (57)	134	103 - 171
6am - 7am	25-26	43 (28)	37	23 - 57	45 (29)	40	25 - 59	113 (51)	107	77 - 141	128 (60)	121	86 - 160
6am - 7am	30-31	40 (25)	35	22 - 52	40 (25)	36	23 - 53	112 (50)	106	77 - 137	125 (61)	116	83 - 154
6am - 7am	35-36	37 (24)	31	21 - 46	35 (22)	31	20 - 45	109 (51)	101	73 - 134	120 (62)	109	77 - 149
6am - 7am	40-41	33 (20)	28	19 - 41	31 (20)	27	18 - 40	104 (48)	96	70 - 127	115 (61)	104	72 - 143
6am - 7am	45-46	29 (20)	25	17 - 36	28 (20)	24	16 - 35	99 (47)	91	66 - 122	112 (61)	99	69 - 140
6am - 7am	50-51	27 (20)	23	16 - 33	25 (19)	21	15 - 30	98 (49)	89	64 - 122	105 (59)	92	64 - 131
6am - 7am	55-56	25 (19)	22	15 - 30	24 (19)	20	14 - 28	98 (51)	87	63 - 121	104 (58)	90	63 - 129
6am - 7am	60-61	24 (19)	21	15 - 29	25 (30)	19	14 - 27	95 (51)	84	60 - 118	103 (58)	89	62 - 131
6pm - 7pm	20-21	37 (25)	31	20 - 46	39 (28)	32	20 - 49	90 (41)	83	61 - 109	102 (46)	93	70 - 127
6pm - 7pm	25-26	31 (22)	25	17 - 37	30 (23)	23	15 - 37	82 (39)	74	54 - 100	90 (45)	81	59 - 113
6pm - 7pm	30-31	30 (21)	24	17 - 36	29 (20)	24	16 - 34	81 (38)	74	54 - 100	91 (44)	84	62 - 110
6pm - 7pm	35-36	27 (18)	23	16 - 32	26 (20)	21	14 - 30	77 (35)	70	52 - 93	83 (38)	76	55 - 103
6pm - 7pm	40-41	24 (17)	21	15 - 28	22 (19)	18	13 - 26	71 (34)	64	48 - 87	76 (38)	69	50 - 94
6pm - 7pm	45-46	23 (17)	20	14 - 27	20 (15)	17	12 - 23	68 (32)	62	46 - 83	72 (36)	65	47 - 88
6pm - 7pm	50-51	21 (14)	18	13 - 25	18 (13)	15	11 - 21	64 (31)	58	44 - 77	67 (32)	60	45 - 83
6pm - 7pm	55-56	20 (15)	17	13 - 23	18 (15)	14	11 - 20	63 (31)	57	42 - 76	64 (32)	57	43 - 79
6pm - 7pm	60-61	19 (14)	16	12 - 22	18 (22)	14	10 - 19	61 (29)	54	41 - 74	61 (31)	55	40 - 75

Table S5: Typical HRV values for graphical domain Poincare S_1 and S_2 features.

HRV Features - Sympathovagal balance

Time of day	Age (yr)	LF / HF (female)			LF / HF (male)		
		(mean)(std dev)	(med)	(25p-75p)	(mean) (std dev)	(med)	(25p-75p)
6am - 7am	20-21	2.175 (1.59)	1.765	1.124 - 2.748	2.505 (1.89)	2.007	1.239 - 3.170
6am - 7am	25-26	2.486 (1.86)	2.004	1.258 - 3.149	3.207 (2.61)	2.500	1.504 - 4.097
6am - 7am	30-31	2.608 (1.94)	2.091	1.313 - 3.316	3.547 (2.68)	2.827	1.744 - 4.560
6am - 7am	35-36	2.798 (2.13)	2.230	1.391 - 3.558	3.991 (3.00)	3.198	1.951 - 5.116
6am - 7am	40-41	3.045 (2.29)	2.431	1.513 - 3.870	4.432 (3.28)	3.583	2.164 - 5.744
6am - 7am	45-46	3.257 (2.49)	2.593	1.602 - 4.135	4.819 (3.60)	3.877	2.359 - 6.230
6am - 7am	50-51	3.378 (2.61)	2.674	1.650 - 4.281	5.125 (3.93)	4.103	2.508 - 6.608
6am - 7am	55-56	3.351 (2.59)	2.641	1.625 - 4.257	5.202 (3.98)	4.148	2.509 - 6.708
6am - 7am	60-61	3.282 (2.58)	2.581	1.572 - 4.164	5.071 (3.95)	4.021	2.404 - 6.534
6pm - 7pm	20-21	2.441 (1.69)	2.021	1.260 - 3.117	3.000 (2.08)	2.480	1.579 - 3.801
6pm - 7pm	25-26	2.653 (1.87)	2.208	1.401 - 3.371	3.840 (2.80)	3.141	1.953 - 4.952
6pm - 7pm	30-31	2.794 (1.91)	2.334	1.487 - 3.544	4.228 (2.90)	3.545	2.218 - 5.511
6pm - 7pm	35-36	2.887 (1.99)	2.385	1.544 - 3.705	4.547 (3.01)	3.845	2.467 - 5.817
6pm - 7pm	40-41	2.971 (2.05)	2.471	1.595 - 3.770	4.794 (3.32)	4.003	2.550 - 6.118
6pm - 7pm	45-46	2.970 (2.08)	2.471	1.592 - 3.716	4.785 (3.38)	4.000	2.504 - 6.078
6pm - 7pm	50-51	2.970 (2.05)	2.500	1.607 - 3.729	4.871(3.47)	4.028	2.524 - 6.203
6pm - 7pm	55-56	2.913 (1.99)	2.409	1.571 - 3.677	4.623 (3.31)	3.803	2.360 - 5.917
6pm - 7pm	60-61	2.815 (1.98)	2.313	1.512 - 3.521	4.287 (3.23)	3.482	2.165 - 5.504

Table S6: Sympathovagal balance: The LF/HF ratio is the estimate of the relative strengths of the sympathetic and parasympathetic branches.