

Supplementary Figures

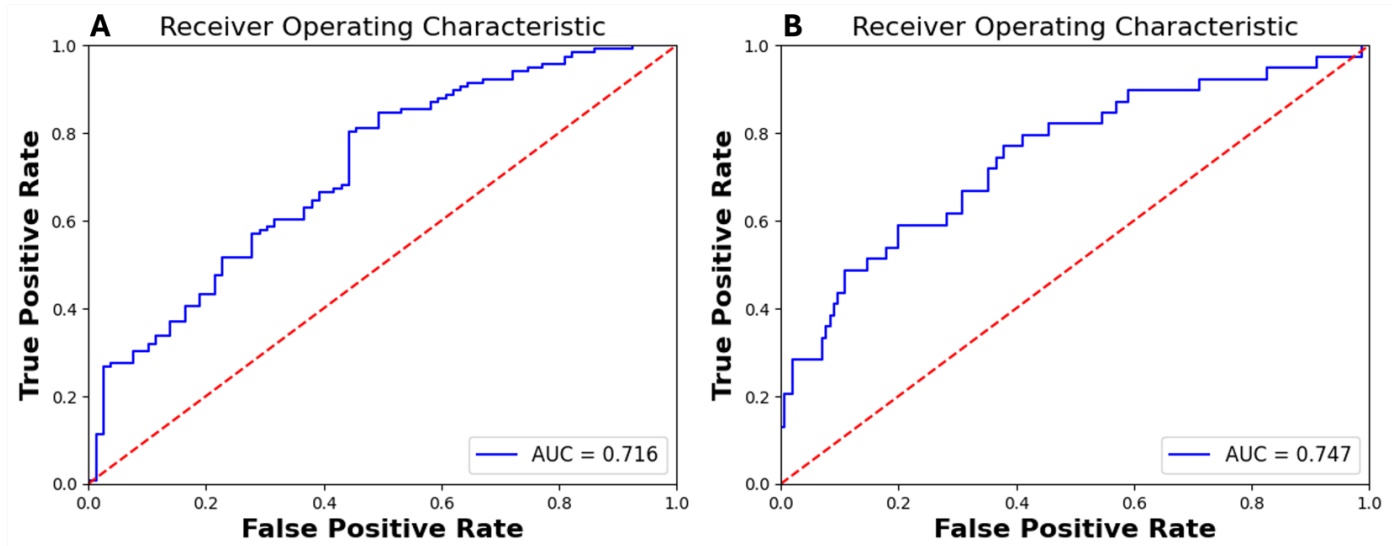


Figure S1: AUC for main logistic regression model to examine Relationship between wearable-derived TST and risk of CRP elevation after experimental interventions and baseline model before experimental interventions (N=195). Abbreviations: Area Under Receiver Operating Characteristic Curve (AUC).

Supplementary Tables

Table S1: Baseline characteristics of the study participants.

	Missing	Overall
N		195
Wearable-derived TST, hours	0	6.59 [5.92, 7.12]
Wearable-derived TIB, hours	0	7.77 [7.31,8.56]
PSQI sleep quality score	0	1.0 [0.0,1.0]
PSQI sleep latency,	0	1.0 [0.0,2.0]
PSQI sleep duration score	0	1.0 [0.0,1.0]
PSQI sleep efficiency score	5	0.0 [0.0,1.0]
PSQI sleep disturbance score	0	1.0 [1.0,1.0]
PSQI Sleep dysfunction score	0	0.0 [0.0,1.0]
PSQI sleep global score	5	6.0 [4.0,7.0]
CRP at baseline, mg/L	0	1.1 [0.5,2.5]
CRP at 2 days post intervention, mg/L	0	1.8 [0.7,3.3]
Changes of CRP from baseline, mg/L	0	0.2 [-0.1,1.0]
Elevation of CRP, n (%)	0	
No		79 (40.5)
Yes		116 (59.5)
Age, years	0	23.0 [21.0,27.0]
Sex, n (%)	0	
F		96 (49.2)
M		99 (50.8)
BMI, kg/m ²	0	25.0 [22.4,28.5]
Mean Steps	0	7522.8 [5790.8,9781.0]
Mean resting heart rate, bpm	2	55.2 [50.7,61.0]
Mean heart rate, bpm	2	62.8 [57.4,68.8]
Mean RMSSD, ms	2	57.2 [40.1,75.0]
Any comorbidities ^a , n (%)	0	
No		159 (81.5)
Yes		36 (18.5)
Psychological issues ^b , n (%)	0	
No		172 (88.2)
Yes		23 (11.8)
Vaccine group, n (%)	0	
Placebo		61 (31.3)
Typhim Vi		65 (33.3)
PPSV23		69 (35.4)

Definition of abbreviations: TST=Total Sleep Time; PSQI=Pittsburgh Sleep Quality Index; BMI = Body Mass Index; CRP = C-Reactive Protein; FFMI = fat free body mass index; IQR=The Interquartile Range; PPSV23=Pneumococcal Polysaccharide vaccine, Typhim Vi=Typhoid Vi Polysaccharide vaccine; RMSSD= root mean square of the successive differences

Data presented as n (%) or median [IQR] unless otherwise noted. ^aSubjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Psychological issues = anxiety, depression, mood disorder

Table S2: Spearman's correlation coefficients for associations between objective wearable-derived sleep metrics from Oura and subjective sleep score metrics from PSQI in each participant.

	Wearable-derived TST		Wearable-derived TIB		Wearable-derived SE	
	Spearman's ρ	p-value	Spearman's ρ	p-value	Spearman's ρ	p-value
Sleep quality	0.174	0.0153	0.201	0.0048	-0.0176	0.807
Sleep latency	0.010	0.166	0.122	0.087	-0.079	0.272
Sleep duration	-0.355	<0.001	-0.403	<0.001	0.0222	0.758
Sleep efficiency	-0.0482	0.509	0.0091	0.901	-0.120	0.0986
Sleep disturbance	0.131	0.068	0.195	0.0062	-0.0875	0.224
Sleep dysfunction	0.170	0.0173	0.176	0.0139	0.0506	0.482
Sleep global score	0.0132	0.857	0.0634	0.0634	-0.101	0.166

Definition of abbreviations: TST=Total Sleep Time; TIB = Total Time in Bed; SE = Sleep Efficiency; PSQI=Pittsburgh Sleep Quality Index

Table S3: Association of CRP with wearable-derived TST at baseline in multivariable logistic regression (N=195)

	Comparator	Odd Ratio	95% CI	P-value
Wearable-derived TST (< 6h)	< 6 h:>7 h	0.89	[0.28, 2.82]	0.84
Wearable-derived TST (>=6 h and <=7h)	<= 7h and >=6 h:>7 h	0.64	[0.26, 1.60]	0.34
Sex	Male: Female	0.69	[0.28, 1.66]	0.40
Comorbidities ^a	Yes: No	1.94	[0.74, 5.09]	0.18
Experimental Interventions ^b	Vaccine ^b : Placebo	1.80	[0.73, 4.39]	0.20
age	1 years	0.90	[0.82, 0.99]	0.03
BMI	1 point	1.17	[1.08,1.27]	0.0001
steps	1000 steps	0.98	[0.86, 1.12]	0.74

Definition of abbreviations: TST=Total Sleep Time; BMI = Body Mass Index; CRP = C-Reactive Protein; ^a Subjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Vaccine = PPSV23 or Typhim Vi

Table S4: Baseline characteristics of the study participants by wearable-derived TIB quartiles.

	1 st	2 nd	3 rd	4 th	P value
N	49	49	48	49	
Wearable-derived TIB, hours	6.8 [6.3,7.1]	7.5 [7.4,7.6]	8.1 [7.9,8.3]	8.9 [8.8,9.2]	<0.001
PSQI sleep quality score	1.0 [0.0,1.0]	1.0 [0.0,1.0]	1.0 [0.0,1.2]	1.0 [0.0,2.0]	0.051
PSQI sleep latency	1.0 [0.0,2.0]	1.0 [1.0,1.0]	1.0 [0.0,2.0]	1.0 [1.0,2.0]	0.244
PSQI sleep duration score	1.0 [1.0,2.0]	1.0 [1.0,1.0]	1.0 [0.0,1.0]	1.0 [0.0,1.0]	<0.001
PSQI sleep efficiency score	0.0 [0.0,1.0]	0.0 [0.0,1.0]	0.0 [0.0,1.0]	0.0 [0.0,1.0]	0.792
PSQI sleep disturbance score	1.0 [1.0,1.0]	1.0 [1.0,1.0]	1.0 [1.0,1.0]	1.0 [1.0,1.0]	0.021
PSQI Sleep dysfunction score	0.0 [0.0,0.0]	0.0 [0.0,1.0]	0.5 [0.0,1.0]	1.0 [0.0,1.0]	0.025
PSQI sleep global score	6.0 [4.0,7.0]	6.0 [4.0,7.0]	6.0 [4.0,7.0]	6.0 [4.2,8.0]	0.587
CRP at baseline, mg/L	1.2 [0.6,2.6]	0.8 [0.3,1.7]	1.5 [0.6,3.2]	1.1 [0.4,2.5]	0.081
CRP at 2 days post intervention, mg/L	2.2 [1.0,4.4]	1.2 [0.5,2.2]	2.1 [1.1,3.6]	1.8 [0.6,4.5]	0.009
Changes of CRP from baseline, mg/L	0.7 [0.1,2.0]	0.0 [-0.1,0.6]	0.0 [-0.3,0.9]	0.1 [-0.1,0.7]	0.011
Elevation of CRP, n (%)					0.027
No	11 (22.4)	22 (44.9)	24 (50.0)	22 (44.9)	
Yes	38 (77.6)	27 (55.1)	24 (50.0)	27 (55.1)	
Age, years	23.0 [22.0,26.0]	24.0 [22.0,28.0]	23.0 [20.8,27.0]	23.0 [20.0,25.0]	0.319
Sex, n (%)					<0.001
F	10 (20.4)	27 (55.1)	31 (64.6)	28 (57.1)	
M	39 (79.6)	22 (44.9)	17 (35.4)	21 (42.9)	
BMI, kg/m ²	25.0 [22.8,28.6]	24.3 [22.2,26.5]	25.9 [22.9,29.7]	24.3 [22.0,28.3]	0.11
Mean Steps	7642.9 [6434.4,9547.0]	8696.9 [6110.8,10346.1]	8131.1 [5409.5,10100.8]	6210.7 [5035.5,7803.4]	0.006
Mean resting heart rate, bpm	54.3 [51.7,60.0]	54.4 [50.2,60.7]	57.2 [50.4,61.7]	55.4 [51.8,62.2]	0.696
Mean heart rate, bpm	62.3 [57.8,67.8]	61.9 [56.5,68.1]	64.0 [56.9,69.6]	63.4 [58.1,70.3]	0.776
Mean RMSSD, ms	55.6 [40.9,71.6]	63.9 [51.7,79.1]	59.0 [40.6,80.4]	50.1 [35.3,66.2]	0.044

Any comorbidities ^a , n (%)					<0.001
No	46 (93.9)	46 (93.9)	33 (68.8)	34 (69.4)	
Yes	3 (6.1)	3 (6.1)	15 (31.2)	15 (30.6)	
Psychological issues ^b , n (%)					0.007
No	47 (95.9)	47 (95.9)	40 (83.3)	38 (77.6)	
Yes	2 (4.1)	2 (4.1)	8 (16.7)	11 (22.4)	
Vaccine group, n (%)					0.563
Placebo	13 (26.5)	17 (34.7)	13 (27.1)	18 (36.7)	
Typhim Vi	17 (34.7)	15 (30.6)	14 (29.2)	19 (38.8)	
PPSV23	19 (38.8)	17 (34.7)	21 (43.8)	12 (24.5)	

Definition of abbreviations: TIB=Total Time in Bed; PSQI=Pittsburgh Sleep Quality Index; BMI = Body Mass Index; CRP = C-Reactive Protein; FFMI = fat free body mass index; IQR=The Interquartile Range; PPSV23=Pneumococcal Polysaccharide vaccine, Typhim Vi=Typhoid Vi Polysaccharide vaccine; RMSSD= root mean square of the successive differences.

Data presented as n (%) or median [IQR] unless otherwise noted. ^aSubjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Psychological issues = anxiety, depression, mood disorder.

Table S5: Association of CRP triggered by interventions with wearable-derived TIB in multivariable logistic regression (N=195)

	Comparator	Odd Ratio	95% CI	P-value
Quartile 1 of Wearable-derived TIB	Quartile 1: Quartile 3	4.21	[1.57, 11.31]	0.004
Quartile 2 of Wearable-derived TIB	Quartile 2: Quartile 3	1.59	[0.64, 3.92]	0.31
Quartile 4 of Wearable-derived TIB	Quartile 4: Quartile 3	1.32	[0.54, 3.19]	0.54
Sex	Male: Female	0.65	[0.33, 1.28]	0.21
Comorbidities ^a	Yes: No	0.64	[0.27, 1.51]	0.31
Experimental Interventions ^b	Vaccine ^b : Placebo	2.80	[1.43, 5.48]	0.003
age	1 years	0.91	[0.84, 0.97]	0.01
BMI	1 point	1.05	[0.98, 1.12]	0.19
steps	1000 steps	0.96	[0.86, 1.06]	0.43

Definition of abbreviations: TIB=Total Time in Bed; BMI = Body Mass Index; CRP = C-Reactive Protein; ^a Subjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Vaccine = PPSV23 or Typhim Vi.

Table S6: Baseline characteristics of the study participants by subjective PSQI sleep duration component score.

	0 (<6 h)	1 (≤ 7 h)	2 (>7 h)	P value
N	51	124	20	
PSQI sleep quality score	1.0 [0.0,1.0]	1.0 [0.0,1.0]	1.0 [0.0,2.0]	0.337
PSQI sleep latency,	1.0 [0.0,2.0]	1.0 [0.8,2.0]	1.0 [0.0,2.0]	0.901
PSQI sleep duration score	0.0 [0.0,0.0]	1.0 [1.0,1.0]	2.0 [2.0,2.0]	<0.001
PSQI sleep efficiency score	0.0 [0.0,0.0]	0.0 [0.0,1.0]	1.0 [0.8,2.0]	<0.001
PSQI sleep disturbance score	1.0 [1.0,1.0]	1.0 [1.0,1.0]	1.0 [1.0,1.0]	0.992
PSQI Sleep dysfunction score	1.0 [0.0,1.0]	0.0 [0.0,1.0]	0.0 [0.0,0.0]	0.022
PSQI sleep global score	5.0 [3.2,6.0]	6.0 [4.8,7.0]	7.0 [6.0,9.5]	<0.001
CRP at baseline, mg/L	0.7 [0.5,3.4]	1.2 [0.5,2.5]	1.0 [0.5,1.7]	0.556
CRP at 2 days post intervention, mg/L	1.6 [0.6,5.1]	1.8 [0.7,3.1]	2.3 [1.1,3.5]	0.675
Changes of CRP from baseline, mg/L	0.0 [-0.1,0.8]	0.2 [-0.1,0.9]	0.9 [0.4,1.6]	0.016
Elevation of CRP, n (%)				0.009
No	25 (49.0)	52 (41.9)	2 (10.0)	
Yes	26 (51.0)	72 (58.1)	18 (90.0)	
Age, years	24.0 [22.0,28.0]	23.0 [20.8,27.0]	23.0 [20.0,25.0]	0.319
Sex, n (%)				<0.668
F	25 (49.0)	63 (50.8)	8 (40.0)	
M	26 (51.0)	61 (49.2)	12 (60.0)	
BMI, kg/m ²	24.1 [21.8,28.1]	25.0 [22.6,28.6]	26.8 [23.0,29.2]	0.196
Mean Steps	7422.9 [5732.3,9217.6]	7440.8 [5762.9,9889.5]	8018.5 [6138.2,10276.6]	0.629
Mean resting heart rate, bpm	54.2 [51.1,59.6]	55.8 [50.8,61.4]	59.3 [50.4,62.7]	0.504
Mean heart rate, bpm	61.6 [57.5,67.3]	63.5 [57.5,68.7]	65.3 [56.8,70.3]	0.613
Mean RMSSD, ms	61.4 [41.6,78.9]	56.1 [39.7,75.2]	50.4 [35.1,63.8]	0.323
Any comorbidities ^a , n (%)				<0.045
No	38 (74.5)	101 (81.5)	20 (100.0)	
Yes	13 (25.5)	23 (18.5)		
Psychological issues ^b , n (%)				0.153
No	46 (90.2)	106 (85.5)	20 (100.0)	
Yes	5 (9.8)	18 (14.5)		
Vaccine group, n (%)				0.888
Placebo	16 (31.4)	38 (30.6)	7 (35.0)	
Typhim Vi	19 (37.3)	41 (33.1)	5 (25.0)	
PPSV23	16 (31.4)	45 (36.3)	8 (40.0)	

Definition of abbreviations: PSQI=Pittsburgh Sleep Quality Index; BMI = Body Mass Index; CRP = C-Reactive Protein; FFMI = fat free body mass index; IQR=The Interquartile Range; PPSV23=Pneumococcal Polysaccharide vaccine, Typhim Vi=Typhoid Vi Polysaccharide vaccine; RMSSD= root mean square of the successive differences
Data presented as n (%) or median [IQR] unless otherwise noted. ^aSubjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Psychological issues = anxiety, depression, mood disorder.

Table S7: Association of CRP triggered by interventions with subjective PSQI sleep duration component score in multivariable logistic regression (N=195).

	Comparator	Odd Ratio	95% CI	P-value
Score 1	Score 1: Score 0	1.34	[0.66, 2.72]	0.42
Score 2	Score 2: Score 0	8.49	[1.65, 43.61]	0.01
Sex	Male: Female	0.88	[0.46, 1.68]	0.71
Comorbidities ^a	Yes: No	0.60	[0.27, 1.36]	0.22
Experimental Interventions ^b	Vaccine ^b : Placebo	3.03	[1.55, 5.94]	0.001
age	1 years	0.92	[0.86, 0.98]	0.02
BMI	1 point	1.04	[0.97, 1.11]	0.27
steps	1000 steps	0.95	[0.86, 1.06]	0.37

Definition of abbreviations: PSQI=Pittsburgh Sleep Quality Index; BMI = Body Mass Index; CRP = C-Reactive Protein;

^aSubjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Vaccine = PPSV23 or Typhim Vi.

Table S8: Association of CRP triggered by vaccination with wearable-derived TIB in the vaccine groups Typhim Vi and PPSV23 in multivariable logistic regression (N=134).

	Comparator	Odd Ratio	95% CI	P-value
Quartile 1 of wearable-derived TIB	Quartile 1: Quartile 3	5.13	[1.50, 17.58]	0.009
Quartile 2 of wearable-derived TIB	Quartile 2: Quartile 3	1.75	[0.59, 5.15]	0.31
Quartile 4 of wearable-derived TIB	Quartile 4: Quartile 3	2.11	[0.72, 6.13]	0.17
Comorbidities ^a	Male: Female	1.05	[0.46, 2.41]	0.91
Experimental Interventions ^b	Vaccine ^b : Placebo	0.71	[0.25, 2.02]	0.52
age	1 years	0.90	[0.83, 0.98]	0.01
BMI	1 point	1.02	[0.95,1.10]	0.60
steps	1000 steps	0.97	[0.85, 1.10]	0.62

Definition of abbreviations: TIB=Total Time in Bed; BMI = Body Mass Index; CRP = C-Reactive Protein; ^a Subjects were defined as having comorbidity if they reported any medical condition according to the Charlson Comorbidity Index (Charlson et al. 1987) and any additional comorbidities. ^b Vaccine = PPSV23 or Typhim Vi.