

Table S1. Pearson correlation coefficients between rest-activity rhythm parameters, NHANES 2011 – 2014

	F Statistic	Amplitude	Mesor	Amplitude:Mesor	Acrophase	Interdaily stability	Intradaily variability
F Statistic	1	0.14	0.17	0.23	-0.15	0.72	-0.45
Amplitude		1	0.48	0.75	0.00	0.10	-0.23
Mesor			1	0.04	0.00	0.18	-0.29
Amplitude:Mesor				1	-0.01	0.17	-0.32
Acrophase					1	-0.21	0.01
Interdaily stability						1	-0.43
Intradaily variability							1

Table S2. Associations (Beta and 95% CI) between quintiles of rest-activity rhythm characteristics and level of ALT, AST, ALP, GGT, albumin and bilirubin, NHANES 2011 – 2014

	ALT, log(U/L) median (IQR)	Beta (95% CI)	AST, log(U/L) median (IQR)	Beta (95% CI)	ALP, log(U/L) median (IQR)	Beta (95% CI)	GGT, log(U/L) median (IQR)	Beta (95% CI)	Albumin, g/dL median (IQR)	Beta (95% CI)	Bilirubin, log(mg/dL) median (IQR)	Beta (95% CI)
F Statistic												
Q1	3.0 (2.8, 3.4)	0.06 (-0.002, 0.11)	3.1 (2.9, 3.3)	0.05 (-0.01, 0.10)	4.2 (4.0, 4.4)	0.08 (0.04, 0.12)	3.0 (2.7, 3.5)	0.14 (0.06, 0.23)	4.2 (4.0-4.5)	-0.11 (-0.15, -0.06)	-0.5 (-0.7, -0.2)	-0.03 (-0.08, 0.02)
Q2	3.0 (2.8, 3.4)	0.09 (0.03, 0.14)	3.1 (2.9, 3.3)	0.04 (-0.004, 0.08)	4.2 (4.0, 4.4)	0.04 (0.004, 0.09)	3.0 (2.6, 3.4)	0.14 (0.07, 0.22)	4.3 (4.1-4.5)	-0.05 (-0.09, -0.01)	-0.5 (-0.7, -0.2)	-0.05 (-0.12, 0.01)
Q3	3.0 (2.8, 3.3)	0.02 (-0.02, 0.07)	3.1 (2.9, 3.3)	0.01 (-0.02, 0.05)	4.2 (4.0, 4.3)	0.03 (-0.01, 0.06)	2.9 (2.6, 3.4)	0.07 (0.01, 0.13)	4.3 (4.0-4.5)	-0.06 (-0.11, -0.02)	-0.5 (-0.7, -0.2)	-0.002 (-0.05, 0.05)
Q4	3.0 (2.8, 3.3)	0.01 (-0.04, 0.06)	3.1 (2.9, 3.3)	-0.002 (-0.04, 0.03)	4.1 (3.9, 4.3)	-0.01 (-0.04, 0.03)	2.9 (2.6, 3.3)	0.03 (-0.03, 0.10)	4.3 (4.1-4.5)	-0.02 (-0.06, 0.02)	-0.5 (-0.7, -0.2)	0.0004 (-0.03, 0.03)
Q5	3.0 (2.8, 3.3)	ref.	3.1 (2.9, 3.3)	ref.	4.1 (3.9, 4.3)	ref.	2.9 (2.6, 3.3)	ref.	4.3 (4.1-4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
P trend		0.004		0.02		<0.001		<0.001		<0.001		0.04
Amplitude												
Q1	3.0 (2.8, 3.3)	0.04 (-0.01, 0.09)	3.1 (2.9, 3.3)	0.04 (-0.01, 0.08)	4.2 (4.0, 4.4)	0.04 (0, 0.09)	3.0 (2.7, 3.5)	0.12 (0.02, 0.21)	4.2 (4.0- 4.4)	-0.09 (-0.14, -0.04)	-0.5 (-0.7, -0.2)	-0.04 (-0.09, 0.01)
Q2	3.0 (2.8, 3.3)	0.05 (0.005, 0.09)	3.1 (2.9, 3.3)	0.02 (-0.02, 0.06)	4.2 (4.0, 4.3)	0.02 (-0.02, 0.05)	3.0 (2.6, 3.4)	0.08 (0.01, 0.15)	4.3 (4.0-4.5)	-0.04 (-0.09, 0.001)	-0.5 (-0.7, -0.2)	-0.03 (-0.09, 0.03)
Q3	3.0 (2.8, 3.3)	0.03 (-0.02, 0.08)	3.1 (2.9, 3.3)	0.01 (-0.02, 0.05)	4.1 (4.0, 4.3)	0.0001 (-0.04, 0.04)	2.9 (2.6, 3.3)	0.03 (-0.06, 0.12)	4.3 (4.1-4.5)	-0.02 (-0.05, 0.01)	-0.5 (-0.7, -0.2)	-0.01 (-0.05, 0.03)
Q4	3.0 (2.8, 3.3)	0.01 (-0.04, 0.06)	3.1 (2.9, 3.3)	-0.004 (-0.03, 0.03)	4.1 (4.0, 4.3)	0.005 (-0.04, 0.05)	2.9 (2.6, 3.3)	0.02 (-0.06, 0.09)	4.3 (4.1-4.5)	-0.01 (-0.05, 0.02)	-0.5 (-0.7, -0.2)	0.01 (-0.04, 0.06)
Q5	3.0 (2.8, 3.3)	ref.	3.1 (2.9, 3.3)	ref.	4.1 (4.0, 4.3)	ref.	2.9 (2.6, 3.4)	ref.	4.3 (4.1-4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
P trend		0.04		0.09		0.03		0.004		0.002		0.06
Mesor												
Q1	3.0 (2.8, 3.4)	0.04 (-0.02, 0.1)	3.1 (2.9, 3.3)	0.02 (-0.02, 0.07)	4.2 (4.0, 4.4)	0.02 (-0.02, 0.06)	3.0 (2.7, 3.5)	0.08 (-0.01, 0.17)	4.2 (4.0, 4.5)	-0.04 (-0.09, 0.01)	-0.5 (-0.7, -0.2)	-0.01 (-0.07, 0.05)
Q2	3.0 (2.8, 3.3)	0.01 (-0.04, 0.06)	3.1 (2.9, 3.3)	-0.001 (-0.03, 0.03)	4.2 (4.0, 4.4)	-0.01 (-0.06, 0.04)	2.9 (2.6, 3.4)	0.004 (-0.07, 0.08)	4.3 (4.1, 4.5)	-0.01 (-0.04, 0.02)	-0.5 (-0.7, -0.2)	0.02 (-0.04, 0.08)
Q3	3.0 (2.8, 3.3)	0.02 (-0.03, 0.08)	3.1 (2.9, 3.3)	0.02 (-0.02, 0.06)	4.2 (4.0, 4.3)	-0.01 (-0.06, 0.03)	3.0 (2.6, 3.4)	0.06 (-0.02, 0.13)	4.3 (4.1, 4.5)	0.001 (-0.04, 0.04)	-0.5 (-0.7, -0.2)	0.02 (-0.04, 0.08)
Q4	3.0 (2.8, 3.3)	0.01 (-0.04, 0.07)	3.1 (2.9, 3.3)	0.03 (-0.02, 0.07)	4.2 (4.0, 4.3)	-0.02 (-0.06, 0.02)	2.9 (2.6, 3.3)	-0.01 (-0.09, 0.07)	4.3 (4.1, 4.5)	0.01 (-0.02, 0.05)	-0.5 (-0.7, -0.2)	0.06 (0.01, 0.12)
Q5	3.0 (2.8, 3.3)	ref.	3.1 (2.9, 3.3)	ref.	4.2 (4.0, 4.3)	ref.	2.9 (2.6, 3.3)	ref.	4.3 (4.1, 4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
P trend		0.25		0.74		0.22		0.049		0.04		0.21
Amplitude:Mesor												
Q1	3.0 (2.8, 3.4)	0.04 (-0.01, 0.09)	3.1 (2.9, 3.3)	0.06 (0.01, 0.10)	4.2 (4.0, 4.4)	0.04 (-0.003, 0.08)	3.0 (2.7, 3.5)	0.10 (0.01, 0.20)	4.2 (4.0, 4.4)	-0.09 (-0.13, -0.04)	-0.5 (-0.7, -0.2)	-0.02 (-0.06, 0.03)
Q2	3.0 (2.8, 3.3)	-0.01 (-0.06, 0.04)	3.1 (2.9, 3.3)	-0.003 (-0.04, 0.03)	4.2 (4.0, 4.3)	0.005 (-0.03, 0.04)	2.9 (2.6, 3.3)	-0.01 (-0.08, 0.07)	4.3 (4.1, 4.5)	-0.002 (-0.04, 0.04)	-0.5 (-0.7, -0.2)	-0.01 (-0.06, 0.04)
Q3	3.0 (2.8, 3.3)	-0.01 (-0.06, 0.04)	3.1 (2.9, 3.3)	-0.01 (-0.05, 0.02)	4.1 (4.0, 4.3)	-0.005 (-0.04, 0.03)	2.9 (2.6, 3.3)	-0.01 (-0.09, 0.08)	4.3 (4.1, 4.5)	-0.01 (-0.04, 0.02)	-0.5 (-0.7, -0.2)	-0.01 (-0.05, 0.03)
Q4	3.0 (2.8, 3.3)	-0.02 (-0.07, 0.02)	3.1 (2.9, 3.3)	-0.004 (-0.04, 0.03)	4.1 (4.0, 4.3)	-0.01 (-0.04, 0.03)	2.9 (2.6, 3.4)	-0.02 (-0.11, 0.06)	4.3 (4.1, 4.5)	0.004 (-0.03, 0.03)	-0.5 (-0.7, -0.2)	0.03 (-0.01, 0.07)
Q5	3.0 (2.8, 3.3)	ref.	3.1 (2.9, 3.3)	ref.	4.1 (4.0, 4.3)	ref.	2.9 (2.6, 3.4)	ref.	4.3 (4.1, 4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
P trend		0.09		0.046		0.04		0.04		0.003		0.09
Acrophase												
Q1	3.0 (2.8, 3.3)	ref.	3.1 (2.9, 3.3)	ref.	4.2 (4.0, 4.3)	ref.	2.9 (2.6, 3.3)	ref.	4.3 (4.1, 4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
Q2	3.0 (2.8, 3.3)	-0.01 (-0.05, 0.04)	3.1 (2.9, 3.3)	-0.005 (-0.05, 0.04)	4.2 (4.0, 4.3)	-0.02 (-0.05, 0.02)	2.9 (2.6, 3.4)	-0.02 (-0.09, 0.06)	4.3 (4.1, 4.5)	-0.01 (-0.05, 0.03)	-0.5 (-0.7, -0.2)	-0.03 (-0.08, 0.03)
Q3	3.0 (2.8, 3.3)	-0.02 (-0.06, 0.03)	3.1 (2.9, 3.3)	-0.01 (-0.04, 0.01)	4.2 (4.0, 4.3)	-0.02 (-0.06, 0.03)	2.9 (2.6, 3.4)	-0.02 (-0.09, 0.06)	4.3 (4.1, 4.5)	0.001 (-0.03, 0.03)	-0.5 (-0.7, -0.2)	-0.01 (-0.06, 0.04)
Q4	3.0 (2.8, 3.4)	-0.04 (-0.09, 0.01)	3.1 (2.9, 3.3)	-0.03 (-0.06, 0.01)	4.2 (4.0, 4.4)	-0.03 (-0.06, 0.01)	2.9 (2.6, 3.4)	-0.04 (-0.12, 0.04)	4.3 (4.0, 4.5)	-0.01 (-0.05, 0.03)	-0.5 (-0.7, -0.2)	-0.03 (-0.09, 0.02)
Q5	3.0 (2.8, 3.4)	0.03 (-0.03, 0.08)	3.1 (3.0, 3.3)	0.01 (-0.03, 0.04)	4.2 (4.0, 4.4)	0.02 (-0.01, 0.06)	3.0 (2.7, 3.4)	0.04 (-0.04, 0.13)	4.3 (4.1, 4.5)	-0.03 (-0.07, 0.02)	-0.5 (-0.7, -0.2)	-0.01 (-0.07, 0.04)
P trend		0.84		0.62		0.50		0.54		0.08		0.78
Interdaily stability												
Q1	3.1 (2.8, 3.4)	0.02 (-0.04, 0.07)	3.1 (2.9, 3.3)	0.03 (-0.02, 0.07)	4.2 (4.0, 4.4)	0.06 (0.02, 0.1)	2.9 (2.6, 3.4)	0.05 (-0.04, 0.14)	4.3 (4.0, 4.5)	-0.09 (-0.13, -0.05)	-0.5 (-0.7, -0.2)	-0.03 (-0.1, 0.03)
Q2	3.0 (2.8, 3.4)	0.01 (-0.05, 0.08)	3.1 (2.9, 3.3)	0.02 (-0.03, 0.07)	4.1 (3.9, 4.3)	0.03 (0, 0.07)	2.9 (2.6, 3.4)	0.06 (-0.01, 0.14)	4.3 (4.1, 4.5)	-0.05 (-0.09, 0)	-0.5 (-0.7, -0.2)	-0.01 (-0.06, 0.03)
Q3	3.0 (2.8, 3.3)	-0.01 (-0.05, 0.04)	3.1 (2.9, 3.3)	-0.01 (-0.04, 0.03)	4.1 (3.9, 4.3)	0.01 (-0.03, 0.05)	3.0 (2.6, 3.4)	0.03 (-0.04, 0.09)	4.3 (4.1, 4.5)	-0.07 (-0.12, -0.03)	-0.5 (-0.7, -0.2)	-0.01 (-0.05, 0.03)
Q4	3.0 (2.8, 3.3)	-0.03 (-0.08, 0.02)	3.1 (2.9, 3.3)	-0.02 (-0.05, 0.02)	4.1 (4.0, 4.3)	0.02 (-0.03, 0.06)	2.9 (2.6, 3.3)	-0.02 (-0.09, 0.04)	4.3 (4.1, 4.5)	-0.02 (-0.05, 0.02)	-0.5 (-0.7, -0.2)	-0.03 (-0.07, 0.02)
Q5	3.0 (2.8, 3.3)	ref.	3.1 (3.0, 3.3)	ref.	4.1 (4.0, 4.3)	ref.	2.9 (2.6, 3.3)	ref.	4.3 (4.1, 4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
P trend		0.23		0.07		0.001		0.048		<0.001		0.36
Intradaily variability												
Q1	3.0 (2.8, 3.4)	ref.	3.1 (3.0, 3.3)	ref.	4.2 (4.0, 4.4)	ref.	2.9 (2.6, 3.4)	ref.	4.3 (4.1, 4.5)	ref.	-0.5 (-0.7, -0.2)	ref.
Q2	3.0 (2.8, 3.3)	0.01 (-0.05, 0.06)	3.1 (2.9, 3.3)	-0.01 (-0.05, 0.02)	4.1 (4.0, 4.3)	0 (-0.04, 0.04)	2.9 (2.6, 3.3)	-0.01 (-0.08, 0.06)	4.3 (4.1, 4.5)	-0.01 (-0.04, 0.03)	-0.5 (-0.7, -0.2)	0.02 (-0.03, 0.07)
Q3	3.0 (2.8, 3.3)	0.02 (-0.03, 0.07)	3.1 (2.9, 3.3)	0.01 (-0.04, 0.05)	4.2 (4.0, 4.3)	0 (-0.04, 0.05)	2.9 (2.6, 3.3)	-0.01 (-0.08, 0.07)	4.3 (4.1, 4.5)	-0.01 (-0.04, 0.02)	-0.5 (-0.7, -0.2)	0.02 (-0.03, 0.08)
Q4	3.0 (2.8, 3.4)	0.04 (-0.01, 0.1)	3.1 (3.0, 3.3)	0.03 (-0.01, 0.07)	4.1 (3.9, 4.3)	-0.02 (-0.06, 0.03)	2.9 (2.6, 3.4)	0.05 (-0.01, 0.11)	4.3 (4.1, 4.5)	-0.04 (-0.09, 0)	-0.5 (-0.7, -0.2)	0.02 (-0.05, 0.09)
Q5	3.0 (2.8, 3.3)	0.03 (-0.03, 0.08)	3.1 (2.9, 3.3)	0.03 (-0.02, 0.08)	4.1 (3.9, 4.3)	0.01 (-0.02, 0.05)	2.9 (2.6, 3.3)	0.04 (-0.03, 0.11)	4.3 (4.1, 4.5)	-0.04 (-0.07, 0)	-0.4 (-0.7, -0.2)	0.02 (-0.04, 0.07)
P trend		0.09		0.045		0.65		0.07		0.01		0.59

Regression results presented as log-transformed liver enzyme levels.

Results based on model 2 adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase; CI, confidence interval

Table S3. Associations (Beta and 95% CI) between quintiles of rest-activity rhythm characteristics and level of ALT, AST, ALP, GGT, albumin and bilirubin, model 3 and 4, NHANES 2011 – 2014

	ALT, log(U/L)		AST, log(U/L)		ALP, log(U/L)		GGT, log(U/L)		Albumin, g/dL		Bilirubin, log(mg/dL)	
	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4
F Statistic												
Q1	0.04 (-0.02, 0.1)	0.02 (-0.04, 0.08)	0.04 (-0.01, 0.1)	0.04 (-0.02, 0.1)	0.08 (0.04, 0.11)	0.07 (0.03, 0.11)	0.12 (0.04, 0.2)	0.09 (-0.003, 0.18)	-0.1 (-0.15, -0.05)	-0.08 (-0.12, -0.03)	-0.03 (-0.08, 0.03)	-0.01 (-0.07, 0.05)
Q2	0.08 (0.02, 0.14)	0.06 (0.003, 0.12)	0.03 (-0.01, 0.08)	0.03 (-0.01, 0.08)	0.04 (-0.003, 0.08)	0.03 (-0.01, 0.08)	0.12 (0.04, 0.21)	0.1 (0.02, 0.18)	-0.04 (-0.09, 0.0002)	-0.03 (-0.07, 0.01)	-0.05 (-0.11, 0.01)	-0.04 (-0.1, 0.03)
Q3	0.02 (-0.03, 0.06)	-0.002 (-0.05, 0.05)	0.01 (-0.03, 0.05)	0.01 (-0.03, 0.05)	0.03 (-0.01, 0.06)	0.02 (-0.02, 0.06)	0.06 (-0.003, 0.12)	0.03 (-0.03, 0.1)	-0.06 (-0.1, -0.01)	-0.04 (-0.09, 0.003)	0.001 (-0.05, 0.06)	0.01 (-0.05, 0.07)
Q4	0.01 (-0.04, 0.05)	-0.01 (-0.05, 0.04)	-0.003 (-0.04, 0.03)	-0.004 (-0.04, 0.03)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.03)	0.03 (-0.04, 0.09)	0.01 (-0.05, 0.07)	-0.02 (-0.06, 0.02)	-0.01 (-0.04, 0.02)	0.001 (-0.03, 0.03)	0.01 (-0.03, 0.04)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.01	0.07	0.03	0.04	<0.001	<0.001	0.002	0.01	0.001	0.003	0.14	0.35
Amplitude												
Q1	0.02 (-0.03, 0.07)	0.01 (-0.04, 0.06)	0.03 (-0.02, 0.08)	0.03 (-0.02, 0.09)	0.03 (-0.01, 0.08)	0.03 (-0.02, 0.08)	0.09 (-0.01, 0.18)	0.07 (-0.02, 0.17)	-0.08 (-0.13, -0.03)	-0.07 (-0.12, -0.02)	-0.04 (-0.09, 0.02)	-0.03 (-0.08, 0.03)
Q2	0.04 (-0.01, 0.09)	0.03 (-0.02, 0.08)	0.02 (-0.02, 0.06)	0.02 (-0.02, 0.06)	0.01 (-0.02, 0.04)	0.01 (-0.03, 0.04)	0.06 (-0.02, 0.13)	0.05 (-0.03, 0.12)	-0.04 (-0.08, 0.01)	-0.03 (-0.07, 0.02)	-0.03 (-0.09, 0.03)	-0.02 (-0.08, 0.04)
Q3	0.02 (-0.02, 0.07)	0.02 (-0.02, 0.07)	0.01 (-0.02, 0.05)	0.01 (-0.02, 0.05)	-0.002 (-0.04, 0.04)	-0.003 (-0.05, 0.04)	0.02 (-0.07, 0.12)	0.02 (-0.07, 0.11)	-0.01 (-0.05, 0.02)	-0.01 (-0.04, 0.02)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.03)
Q4	0.01 (-0.04, 0.06)	0.01 (-0.04, 0.05)	-0.005 (-0.04, 0.03)	-0.004 (-0.04, 0.03)	0.004 (-0.04, 0.05)	0.003 (-0.04, 0.05)	0.01 (-0.06, 0.09)	0.01 (-0.07, 0.09)	-0.01 (-0.05, 0.02)	-0.01 (-0.05, 0.03)	0.01 (-0.04, 0.06)	0.01 (-0.04, 0.07)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.13	0.31	0.15	0.14	0.07	0.14	0.03	0.06	0.005	0.01	0.08	0.16
Mesor												
Q1	0.03 (-0.03, 0.09)	0.01 (-0.05, 0.08)	0.02 (-0.03, 0.07)	0.02 (-0.03, 0.07)	0.01 (-0.03, 0.06)	0.01 (-0.04, 0.05)	0.06 (-0.03, 0.14)	0.04 (-0.06, 0.13)	-0.03 (-0.08, 0.02)	-0.02 (-0.06, 0.03)	-0.01 (-0.07, 0.06)	0.01 (-0.06, 0.07)
Q2	-0.0002 (-0.05, 0.05)	-0.01 (-0.06, 0.04)	-0.003 (-0.03, 0.03)	-0.003 (-0.03, 0.03)	-0.01 (-0.06, 0.03)	-0.02 (-0.07, 0.03)	-0.01 (-0.08, 0.07)	-0.01 (-0.09, 0.06)	-0.005 (-0.04, 0.03)	0.001 (-0.03, 0.04)	0.02 (-0.04, 0.08)	0.03 (-0.03, 0.09)
Q3	0.02 (-0.03, 0.07)	0.01 (-0.04, 0.07)	0.02 (-0.02, 0.06)	0.02 (-0.02, 0.06)	-0.02 (-0.06, 0.03)	-0.02 (-0.06, 0.03)	0.05 (-0.03, 0.13)	0.04 (-0.04, 0.11)	0.004 (-0.04, 0.05)	0.01 (-0.03, 0.05)	0.02 (-0.04, 0.08)	0.03 (-0.03, 0.09)
Q4	0.01 (-0.04, 0.07)	0.02 (-0.04, 0.07)	0.03 (-0.02, 0.07)	0.03 (-0.02, 0.08)	-0.02 (-0.07, 0.02)	-0.02 (-0.07, 0.03)	-0.02 (-0.1, 0.07)	-0.01 (-0.09, 0.08)	0.01 (-0.02, 0.05)	0.01 (-0.03, 0.05)	0.07 (0.01, 0.12)	0.06 (0.01, 0.12)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.46	0.99	0.95	0.98	0.35	0.60	0.14	0.44	0.05	0.21	0.24	0.54
Amplitude:Mesor												
Q1	0.03 (-0.02, 0.07)	0.03 (-0.03, 0.08)	0.05 (-0.001, 0.1)	0.06 (0.001, 0.11)	0.03 (-0.01, 0.08)	0.04 (-0.01, 0.08)	0.08 (-0.02, 0.17)	0.08 (-0.02, 0.18)	-0.08 (-0.12, -0.03)	-0.07 (-0.12, -0.02)	-0.01 (-0.06, 0.03)	-0.01 (-0.06, 0.04)
Q2	-0.02 (-0.07, 0.03)	-0.01 (-0.06, 0.04)	-0.005 (-0.04, 0.03)	-0.004 (-0.04, 0.04)	0.003 (-0.03, 0.03)	0.003 (-0.03, 0.04)	-0.02 (-0.1, 0.06)	-0.01 (-0.09, 0.07)	0.002 (-0.04, 0.04)	0.002 (-0.04, 0.05)	-0.01 (-0.06, 0.04)	-0.01 (-0.06, 0.04)
Q3	-0.01 (-0.06, 0.04)	-0.003 (-0.05, 0.05)	-0.02 (-0.05, 0.02)	-0.01 (-0.05, 0.02)	-0.01 (-0.04, 0.03)	-0.005 (-0.05, 0.04)	-0.02 (-0.1, 0.07)	-0.004 (-0.09, 0.08)	-0.01 (-0.04, 0.02)	-0.01 (-0.04, 0.02)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.03)
Q4	-0.02 (-0.07, 0.02)	-0.02 (-0.07, 0.03)	-0.005 (-0.04, 0.03)	-0.003 (-0.04, 0.03)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.03)	-0.03 (-0.11, 0.06)	-0.02 (-0.11, 0.07)	0.01 (-0.03, 0.04)	0.002 (-0.03, 0.04)	0.03 (-0.01, 0.07)	0.03 (-0.01, 0.07)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.25	0.24	0.07	0.06	0.07	0.11	0.12	0.12	0.01	0.02	0.19	0.24
Acrophase												
Q1	0.02 (-0.03, 0.06)	0.01 (-0.04, 0.06)	0.01 (-0.01, 0.04)	0.01 (-0.01, 0.04)	0.02 (-0.03, 0.06)	0.01 (-0.04, 0.06)	0.02 (-0.07, 0.1)	0.01 (-0.07, 0.09)	-0.001 (-0.03, 0.03)	0.003 (-0.03, 0.04)	0.01 (-0.04, 0.06)	0.02 (-0.04, 0.07)
Q2	0.01 (-0.04, 0.06)	0.01 (-0.04, 0.06)	0.01 (-0.03, 0.05)	0.01 (-0.04, 0.05)	-0.001 (-0.04, 0.04)	-0.002 (-0.04, 0.04)	-0.001 (-0.1, 0.1)	-0.01 (-0.11, 0.09)	-0.01 (-0.04, 0.02)	-0.01 (-0.04, 0.02)	-0.01 (-0.07, 0.05)	-0.01 (-0.07, 0.05)
Q3	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q4	-0.02 (-0.09, 0.04)	-0.02 (-0.09, 0.05)	-0.01 (-0.05, 0.02)	-0.01 (-0.05, 0.03)	-0.01 (-0.06, 0.03)	-0.02 (-0.06, 0.03)	-0.03 (-0.13, 0.07)	-0.03 (-0.13, 0.07)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.03)	-0.02 (-0.07, 0.03)	-0.02 (-0.07, 0.03)
Q5	0.04 (-0.02, 0.1)	0.03 (-0.03, 0.09)	0.02 (-0.02, 0.06)	0.02 (-0.03, 0.06)	0.04 (0.003, 0.07)	0.03 (-0.003, 0.07)	0.05 (-0.06, 0.16)	0.05 (-0.06, 0.15)	-0.02 (-0.07, 0.02)	-0.02 (-0.07, 0.03)	0.002 (-0.06, 0.06)	0.005 (-0.06, 0.07)
P trend	0.98	0.84	0.53	0.55	0.59	0.62	0.73	0.54	0.35	0.35	0.55	0.51
IS												
Q1	0.01 (-0.05, 0.07)	0.004 (-0.06, 0.07)	0.02 (-0.02, 0.07)	0.03 (-0.03, 0.08)	0.06 (0.02, 0.09)	0.05 (0.02, 0.09)	0.03 (-0.05, 0.12)	0.03 (-0.06, 0.13)	-0.08 (-0.12, -0.04)	-0.07 (-0.11, -0.03)	-0.03 (-0.1, 0.04)	-0.02 (-0.09, 0.05)
Q2	0.01 (-0.06, 0.08)	-0.005 (-0.08, 0.07)	0.02 (-0.03, 0.07)	0.02 (-0.03, 0.07)	0.03 (-0.005, 0.07)	0.03 (-0.01, 0.06)	0.05 (-0.03, 0.13)	0.04 (-0.05, 0.12)	-0.04 (-0.09, 0.002)	-0.03 (-0.07, 0.01)	-0.01 (-0.05, 0.03)	-0.001 (-0.05, 0.04)
Q3	-0.02 (-0.06, 0.03)	-0.02 (-0.07, 0.03)	-0.01 (-0.05, 0.03)	-0.01 (-0.05, 0.04)	0.01 (-0.03, 0.05)	0.004 (-0.04, 0.05)	0.01 (-0.06, 0.08)	0.01 (-0.06, 0.08)	-0.07 (-0.11, -0.02)	-0.06 (-0.1, -0.02)	-0.01 (-0.05, 0.04)	-0.01 (-0.05, 0.04)
Q4	-0.04 (-0.09, 0.01)	-0.03 (-0.08, 0.01)	-0.02 (-0.06, 0.02)	-0.01 (-0.05, 0.02)	0.02 (-0.03, 0.06)	0.02 (-0.03, 0.06)	-0.03 (-0.1, 0.03)	-0.03 (-0.09, 0.04)	-0.01 (-0.04, 0.02)	-0.01 (-0.04, 0.02)	-0.03 (-0.07, 0.02)	-0.02 (-0.07, 0.03)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.37	0.60	0.10	0.11	0.003	0.01	0.09	0.18	0.001	0.002	0.46	0.75
IV												
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.004 (-0.05, 0.06)	0.01 (-0.05, 0.07)	-0.01 (-0.05, 0.02)	-0.01 (-0.05, 0.03)	-0.004 (-0.05, 0.04)	-0.002 (-0.04, 0.04)	-0.02 (-0.09, 0.05)	-0.01 (-0.08, 0.06)	-0.01 (-0.04, 0.03)	-0.01 (-0.04, 0.03)	0.02 (-0.03, 0.07)	0.02 (-0.03, 0.07)
Q3	0.02 (-0.03, 0.07)	0.02 (-0.03, 0.07)	0.01 (-0.04, 0.05)	0.01 (-0.04, 0.05)	0.001 (-0.05, 0.05)	-0.00 (-0.05, 0.05)	-0.02 (-0.1, 0.06)	-0.01 (-0.09, 0.07)	-0.002 (-0.03, 0.03)	-0.004 (-0.03, 0.03)	0.03 (-0.03, 0.09)	0.02 (-0.04, 0.08)
Q4	0.04 (-0.02, 0.1)	0.04 (-0.02, 0.09)	0.02 (-0.02, 0.07)	0.03 (-0.02, 0.07)	-0.02 (-0.07, 0.02)	-0.02 (-0.07, 0.03)	0.03 (-0.03, 0.1)	0.04 (-0.02, 0.09)	-0.04 (-0.08, 0.004)	-0.04 (-0.08, 0.005)	0.02 (-0.05, 0.09)	0.02 (-0.05, 0.1)
Q5	0.01 (-0.04, 0.07)	0.02 (-0.03, 0.07)	0.03 (-0.02, 0.08)	0.03 (-0.02, 0.08)	0.01 (-0.02, 0.04)	0.01 (-0.02, 0.04)	0.01 (-0.05, 0.08)	0.03 (-0.05, 0.1)	-0.03 (-0.07, 0.01)	-0.03 (-0.06, 0.01)	0.02 (-0.04, 0.08)	0.03 (-0.03, 0.09)
P trend	0.25	0.18	0.07	0.06	0.98	1.00	0.23	0.18	0.045	0.04	0.46	0.36

Regression results presented as log-transformed liver enzyme levels.

Model 3: adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C, hepatitis E and diabetes status.

Model 4: adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C, hepatitis E and BMI.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase; CI, confidence interval; IS, Interdaily stability; IV, Intradaily variability

Table S4. Associations (OR and 95% CI) between quintiles of rest-activity rhythm characteristics and abnormal levels of ALT, AST, ALP, GGT, albumin and bilirubin, adjusting for physical activity and sleeping duration, NHANES 2011 – 2014

	ALT	AST	ALP	GGT	Albumin	Bilirubin
F statistic						
Q1	1.02 (0.57, 1.84)	1.41 (0.87, 2.27)	1.84 (0.70, 4.81)	1.78 (1.06, 2.97)	3.61 (1.38, 9.46)	1.78 (0.93, 3.43)
Q2	1.31 (0.79, 2.16)	1.34 (0.90, 1.99)	1.15 (0.42, 3.15)	1.68 (0.94, 2.98)	1.78 (0.63, 4.97)	1.05 (0.44, 2.52)
Q3	1.00 (0.69, 1.45)	0.81 (0.52, 1.27)	0.81 (0.43, 1.52)	1.04 (0.68, 1.59)	1 (0.32, 3.06)	1.26 (0.57, 2.77)
Q4	0.79 (0.47, 1.31)	0.90 (0.55, 1.48)	0.31 (0.10, 0.92)	1.05 (0.68, 1.63)	1.36 (0.47, 3.91)	0.9 (0.4, 2.04)
Q5	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.26	0.04	0.04	0.02	0.02	0.26
Amplitude						
Q1	1.18 (0.67, 2.07)	1.50 (0.81, 2.77)	2.03 (0.61, 6.75)	1.50 (0.88, 2.57)	1.5 (0.49, 4.59)	1.92 (0.81, 4.57)
Q2	1.34 (0.81, 2.22)	1.17 (0.70, 1.96)	1.27 (0.46, 3.52)	1.28 (0.81, 2.03)	0.76 (0.26, 2.19)	0.95 (0.28, 3.23)
Q3	1.01 (0.59, 1.75)	1.12 (0.65, 1.91)	0.73 (0.25, 2.17)	1.10 (0.65, 1.85)	0.51 (0.16, 1.65)	1.96 (0.74, 5.15)
Q4	0.89 (0.46, 1.74)	0.80 (0.40, 1.62)	2.04 (0.84, 4.91)	1.10 (0.63, 1.91)	0.61 (0.21, 1.78)	2.03 (0.83, 4.96)
Q5	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.11	0.06	0.49	0.05	0.4	0.047
Mesor						
Q1	1.12 (0.66, 1.89)	1.23 (0.65, 2.32)	1.09 (0.43, 2.74)	0.94 (0.50, 1.75)	0.81 (0.22, 3.03)	1.41 (0.54, 3.72)
Q2	0.91 (0.54, 1.54)	0.84 (0.45, 1.57)	0.58 (0.23, 1.45)	0.71 (0.44, 1.12)	1.03 (0.27, 3.89)	1.39 (0.57, 3.39)
Q3	1.26 (0.86, 1.84)	1.27 (0.77, 2.11)	0.58 (0.29, 1.15)	0.96 (0.58, 1.61)	1.18 (0.49, 2.84)	0.56 (0.21, 1.44)
Q4	1.08 (0.71, 1.64)	1.13 (0.65, 1.96)	0.47 (0.19, 1.14)	0.84 (0.56, 1.26)	0.98 (0.38, 2.5)	1.19 (0.49, 2.9)
Q5	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.98	0.89	0.66	0.62	0.5	0.97
Amplitude:Mesor						
Q1	1.34 (0.84, 2.13)	1.65 (1.05, 2.60)	1.73 (0.69, 4.37)	1.50 (0.95, 2.39)	1.29 (0.5, 3.34)	1.72 (0.71, 4.21)
Q2	1.12 (0.72, 1.73)	0.94 (0.59, 1.52)	1.58 (0.74, 3.39)	0.81 (0.51, 1.27)	0.52 (0.21, 1.31)	1.28 (0.45, 3.63)
Q3	1.01 (0.61, 1.67)	0.88 (0.53, 1.45)	1.12 (0.44, 2.84)	0.99 (0.63, 1.57)	0.55 (0.22, 1.39)	1.56 (0.68, 3.57)
Q4	0.98 (0.58, 1.67)	1.00 (0.66, 1.52)	1.31 (0.46, 3.68)	0.88 (0.53, 1.47)	0.45 (0.2, 0.99)	2.08 (0.74, 5.85)
Q5	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.12	0.07	0.15	0.09	0.33	0.12
Acrophase						
Q1	ref.	ref.	ref.	ref.	ref.	ref.
Q2	1.02 (0.64, 1.63)	0.99 (0.57, 1.72)	1.1 (0.54, 2.24)	0.98 (0.61, 1.58)	1.02 (0.44, 2.36)	0.96 (0.36, 2.55)
Q3	0.89 (0.55, 1.44)	0.95 (0.61, 1.46)	0.68 (0.28, 1.65)	0.95 (0.54, 1.67)	1.38 (0.55, 3.48)	1.94 (0.79, 4.76)
Q4	0.93 (0.59, 1.46)	0.97 (0.63, 1.50)	0.64 (0.31, 1.34)	0.86 (0.52, 1.41)	1.21 (0.51, 2.85)	1.3 (0.51, 3.32)
Q5	0.91 (0.55, 1.53)	1.06 (0.65, 1.74)	0.93 (0.54, 1.60)	1.14 (0.72, 1.79)	1.52 (0.75, 3.1)	1.73 (0.71, 4.18)
P trend	0.55	0.84	0.20	0.82	0.43	0.03
Interdaily stability						
Q1	0.77 (0.44, 1.35)	1.35 (0.82, 2.21)	2.21 (0.96, 5.11)	1.52 (0.91, 2.55)	3.63 (1.27, 10.35)	1.63 (0.72, 3.69)
Q2	0.93 (0.51, 1.68)	1.28 (0.75, 2.18)	1.06 (0.42, 2.7)	1.35 (0.79, 2.32)	1.53 (0.46, 5.06)	2.64 (0.95, 7.29)

Q3	0.8 (0.48, 1.34)	0.97 (0.58, 1.62)	1.08 (0.49, 2.37)	1.04 (0.66, 1.63)	2.51 (0.79, 7.99)	1.75 (0.82, 3.74)
Q4	0.72 (0.48, 1.08)	0.79 (0.55, 1.15)	1.1 (0.45, 2.72)	0.95 (0.59, 1.53)	1.67 (0.5, 5.52)	1.23 (0.5, 3.01)
Q5	ref.	ref.	ref.	ref.	ref.	ref.
P trend	0.63	0.08	0.11	0.047	0.006	0.03
Intradaily variability						
Q1	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.9 (0.52, 1.56)	0.88 (0.51, 1.51)	0.76 (0.34, 1.73)	0.92 (0.64, 1.34)	1.41 (0.48, 4.15)	2.41 (0.62, 9.32)
Q3	1.01 (0.57, 1.8)	1.05 (0.58, 1.89)	1.1 (0.49, 2.44)	0.91 (0.59, 1.41)	1.14 (0.36, 3.57)	2.88 (0.87, 9.51)
Q4	1.17 (0.66, 2.09)	1.01 (0.54, 1.89)	0.61 (0.26, 1.44)	1.13 (0.8, 1.6)	2.49 (0.72, 8.66)	5.49 (1.25, 24.01)
Q5	0.84 (0.53, 1.32)	1.36 (0.72, 2.56)	1.98 (0.72, 5.46)	1.11 (0.69, 1.79)	2.26 (0.74, 6.91)	3.04 (0.68, 13.61)
P trend	0.93	0.26	0.18	0.37	0.03	0.02

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L for AST, >113 IU/L for ALP, >65 IU/L in men or >36 IU/L in women for GGT, <3.7 g/dL for albumin, and >1.3 mg/dL for bilirubin

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C, hepatitis E, physical activity and sleeping duration

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S5. Associations (OR and 95% CI) between quintiles of F statistic and abnormal levels of ALT, AST, ALP, GGT, albumin and bilirubin, after removing night shift worker proxied by L5MD, NHANES 2011 – 2014

Abnormal levels of liver enzymes	F Statistic					P trend
	Q1	Q2	Q3	Q4	Q5	
F statistic, median (IQR)	189 (140, 230)	325 (294, 354)	453 (421, 481)	599 (560, 651)	851 (764, 999)	
ALT						
N (%)^b	128 (11)	136 (12)	136 (11)	99 (8.1)	122 (9.8)	
OR (95% CI)						
Model 1	1.22 (0.84, 1.79)	1.3 (0.89, 1.89)	1.12 (0.83, 1.52)	0.82 (0.56, 1.19)	ref.	0.04
Model 2	1.2 (0.71, 2.02)	1.37 (0.83, 2.24)	1.12 (0.76, 1.64)	0.85 (0.53, 1.36)	ref.	0.12
Model 3	1.08 (0.62, 1.86)	1.26 (0.75, 2.12)	1.05 (0.69, 1.58)	0.82 (0.51, 1.3)	ref.	0.27
Model 4	1.04 (0.58, 1.87)	1.23 (0.74, 2.05)	1.02 (0.68, 1.55)	0.81 (0.49, 1.32)	ref.	0.34
AST						
N (%)^b	157 (14)	149 (11)	111 (8.2)	100 (8.4)	102 (8.7)	
OR (95% CI)						
Model 1	1.6 (1.18, 2.16)	1.3 (0.98, 1.73)	0.9 (0.66, 1.21)	0.93 (0.68, 1.28)	ref.	0.001
Model 2	1.44 (0.92, 2.25)	1.35 (0.93, 1.95)	0.84 (0.57, 1.24)	0.92 (0.6, 1.4)	ref.	0.04
Model 3	1.31 (0.83, 2.08)	1.27 (0.86, 1.87)	0.8 (0.53, 1.19)	0.89 (0.59, 1.36)	ref.	0.09
Model 4	1.38 (0.83, 2.27)	1.3 (0.88, 1.93)	0.82 (0.54, 1.24)	0.91 (0.58, 1.41)	ref.	0.07
ALP						
N (%)^b	65 (5.9)	43 (3.6)	30 (2.2)	19 (0.8)	30 (2.2)	
OR (95% CI)						
Model 1	3.16 (1.9, 5.25)	1.74 (0.88, 3.43)	1.09 (0.72, 1.67)	0.37 (0.17, 0.8)	ref.	<0.001
Model 2	2.55 (1.48, 4.41)	1.53 (0.72, 3.24)	1.02 (0.61, 1.7)	0.32 (0.11, 0.93)	ref.	<0.001
Model 3	2.24 (1.27, 3.94)	1.39 (0.64, 3)	0.95 (0.57, 1.61)	0.3 (0.1, 0.89)	ref.	0.001
Model 4	2.44 (1.31, 4.55)	1.39 (0.63, 3.09)	0.95 (0.54, 1.67)	0.25 (0.08, 0.77)	ref.	0.001
GGT						
N (%)^b	160 (14)	143 (12)	127 (7.9)	103 (7.5)	86 (6.8)	
OR (95% CI)						
Model 1	2.5 (1.76, 3.55)	2.02 (1.32, 3.09)	1.29 (0.94, 1.77)	1.16 (0.82, 1.64)	ref.	<0.001
Model 2	2.31 (1.44, 3.72)	1.99 (1.15, 3.43)	1.2 (0.81, 1.78)	1.17 (0.77, 1.78)	ref.	0.002
Model 3	2.08 (1.3, 3.33)	1.83 (1.04, 3.22)	1.13 (0.75, 1.7)	1.12 (0.74, 1.69)	ref.	0.004
Model 4	1.97 (1.15, 3.35)	1.75 (0.97, 3.18)	1.07 (0.7, 1.66)	1.1 (0.71, 1.7)	ref.	0.01
Albumin						
N (%)^b	73 (5.5)	39 (2.9)	29 (1.5)	26 (2)	11 (1.1)	
OR (95% CI)						
Model 1	6.33 (2.94, 13.67)	2.96 (1.35, 6.51)	1.56 (0.65, 3.71)	2.02 (0.86, 4.71)	ref.	<0.001
Model 2	4.45 (1.76, 11.23)	2.35 (0.95, 5.85)	1.17 (0.41, 3.3)	1.4 (0.52, 3.78)	ref.	0.002
Model 3	3.99 (1.54, 10.33)	2.12 (0.82, 5.48)	1.08 (0.36, 3.24)	1.34 (0.49, 3.62)	ref.	0.003
Model 4	3.71 (1.33, 10.32)	1.87 (0.68, 5.17)	0.99 (0.32, 3.1)	1.25 (0.43, 3.64)	ref.	0.01
Bilirubin						

N (%)^b	45 (4.4)	24 (2.3)	31 (3)	33 (2.5)	30 (2.6)	
OR (95% CI)						
Model 1	1.48 (0.9, 2.42)	0.83 (0.4, 1.72)	1.04 (0.56, 1.94)	0.92 (0.48, 1.76)	ref.	0.29
Model 2	1.55 (0.83, 2.89)	0.84 (0.37, 1.89)	1.04 (0.51, 2.12)	0.8 (0.37, 1.69)	ref.	0.25
Model 3	1.52 (0.8, 2.9)	0.83 (0.37, 1.87)	1.02 (0.49, 2.14)	0.79 (0.36, 1.73)	ref.	0.27
Model 4	1.65 (0.83, 3.28)	0.89 (0.39, 2.05)	1.1 (0.5, 2.45)	0.84 (0.36, 1.94)	ref.	0.19

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L for AST, >113 IU/L for ALP, >65 IU/L in men or >36 IU/L in women for GGT, <3.7 g/dL for albumin, and >1.3 mg/dL for bilirubin

^bPercentage weighted using sample weights.

Model 1: adjusted for age and gender.

Model 2: adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Model 3: adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C, hepatitis E and diabetes status.

Model 4: adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C, hepatitis E and BMI.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase; IQR, interquartile range; CI, confidence interval; OR, odds ratio

Table S6. Associations (OR and 95% CI) between quintiles of rest-activity rhythm characteristics and abnormal levels of ALT, AST, ALP and GGT, stratified by alcohol drinking status, NHANES 2011 – 2014

	ALT		AST		ALP		GGT	
	Never/former/light	Moderate/heavy	Never/former/light	Moderate/heavy	Never/former/light	Moderate/heavy	Never/former/light	Moderate/heavy
F statistic								
Q1	1.22 (0.73, 2.04)	1.19 (0.45, 3.11)	1.34 (0.79, 2.25)	1.66 (0.77, 3.55)	1.84 (1.11, 3.05)	7.61 (1.54, 37.73)	2.36 (1.51, 3.68)	1.67 (0.65, 4.26)
Q2	1.53 (0.91, 2.58)	1.18 (0.45, 3.06)	1.25 (0.82, 1.9)	1.48 (0.75, 2.91)	1.33 (0.66, 2.7)	0.56 (0.05, 6.4)	1.97 (1.18, 3.29)	1.74 (0.67, 4.51)
Q3	1.13 (0.72, 1.75)	0.98 (0.52, 1.84)	0.81 (0.47, 1.4)	0.83 (0.43, 1.6)	0.79 (0.42, 1.48)	1.97 (0.19, 20.63)	1.14 (0.8, 1.63)	1.17 (0.56, 2.48)
Q4	1.03 (0.67, 1.58)	0.34 (0.13, 0.88)	1.06 (0.67, 1.67)	0.5 (0.23, 1.08)	0.33 (0.12, 0.9)	0.29 (0.01, 6.69)	1.42 (1.004, 2.02)	0.61 (0.26, 1.42)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.35		0.24		0.32		0.52	
Amplitude								
Q1	1.2 (0.76, 1.91)	1.48 (0.55, 3.93)	1.17 (0.65, 2.09)	2.05 (0.81, 5.21)	4.01 (2.21, 7.28)	1.21 (0.17, 8.68)	1.72 (1.08, 2.73)	1.99 (0.71, 5.54)
Q2	1.34 (0.95, 1.88)	1.9 (0.6, 5.97)	0.94 (0.6, 1.46)	1.64 (0.6, 4.46)	2.28 (1.14, 4.53)	0.63 (0.1, 4.14)	1.16 (0.75, 1.8)	2.5 (0.97, 6.45)
Q3	1.1 (0.71, 1.7)	0.93 (0.38, 2.31)	0.9 (0.58, 1.4)	1.65 (0.57, 4.76)	1.4 (0.51, 3.83)	0.15 (0.02, 1.37)	1.19 (0.7, 2.02)	1.16 (0.35, 3.85)
Q4	0.92 (0.51, 1.65)	0.82 (0.26, 2.57)	0.78 (0.42, 1.45)	0.8 (0.32, 1.98)	3.88 (1.88, 7.98)	0.06 (0.004, 0.87)	1.21 (0.76, 1.95)	0.93 (0.33, 2.64)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.30		0.19		0.68		0.26	
Mesor								
Q1	1.42 (0.85, 2.39)	0.99 (0.36, 2.71)	1.17 (0.74, 1.85)	1.32 (0.52, 3.37)	1.53 (0.82, 2.84)	1.46 (0.25, 8.44)	1.47 (0.91, 2.37)	1.12 (0.49, 2.59)
Q2	0.96 (0.51, 1.81)	1.44 (0.6, 3.5)	0.71 (0.41, 1.26)	1.27 (0.61, 2.64)	0.65 (0.26, 1.65)	0.75 (0.08, 6.79)	0.91 (0.61, 1.36)	0.96 (0.38, 2.43)
Q3	1.28 (0.85, 1.93)	1.8 (0.79, 4.11)	1.24 (0.77, 1.99)	1.36 (0.71, 2.63)	0.76 (0.39, 1.48)	0.11 (0.01, 0.84)	1.15 (0.72, 1.83)	1.21 (0.55, 2.69)
Q4	1.05 (0.7, 1.57)	1.4 (0.54, 3.67)	1.11 (0.68, 1.81)	1.11 (0.49, 2.47)	0.44 (0.18, 1.09)	0.77 (0.14, 4.14)	0.92 (0.57, 1.51)	0.92 (0.5, 1.68)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.70		0.67		0.52		0.36	
Amplitude:Mesor								
Q1	1.2 (0.72, 2.01)	2.49 (0.995, 6.24)	1.38 (0.86, 2.23)	2.64 (1.13, 6.18)	2.6 (1.03, 6.59)	1.75 (0.31, 9.95)	1.43 (0.81, 2.54)	2.8 (1.17, 6.7)
Q2	1.17 (0.76, 1.78)	1.2 (0.42, 3.38)	0.93 (0.57, 1.52)	0.96 (0.32, 2.94)	3.08 (1.61, 5.88)	0.07 (0.01, 1)	0.81 (0.49, 1.32)	1.24 (0.48, 3.2)
Q3	1.04 (0.64, 1.69)	0.84 (0.37, 1.93)	0.75 (0.48, 1.18)	1.2 (0.49, 2.91)	1.92 (0.75, 4.91)	0.2 (0.03, 1.36)	1.03 (0.66, 1.62)	0.93 (0.31, 2.76)
Q4	1 (0.62, 1.62)	1.11 (0.31, 4)	1.07 (0.69, 1.66)	0.67 (0.23, 1.96)	2.47 (0.85, 7.17)	0 (0, 0)	0.95 (0.55, 1.66)	0.96 (0.3, 3.02)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.18		0.17		0.84		0.10	
Acrophase								
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.94 (0.57, 1.55)	1.31 (0.43, 3.96)	1.14 (0.64, 2.02)	0.7 (0.25, 1.92)	1.06 (0.51, 2.19)	1.35 (0.32, 5.68)	1.11 (0.66, 1.87)	0.61 (0.3, 1.23)
Q3	0.81 (0.48, 1.36)	1.44 (0.53, 3.88)	0.92 (0.5, 1.71)	0.97 (0.32, 3)	0.6 (0.25, 1.44)	1.04 (0.11, 9.63)	0.92 (0.55, 1.53)	0.95 (0.4, 2.23)
Q4	0.91 (0.57, 1.45)	1.13 (0.4, 3.21)	1.2 (0.75, 1.94)	0.53 (0.19, 1.49)	0.78 (0.38, 1.63)	0 (0, 0)	0.97 (0.6, 1.55)	0.75 (0.34, 1.68)
Q5	0.87 (0.51, 1.47)	1.33 (0.59, 3.01)	1.11 (0.67, 1.85)	1 (0.34, 2.94)	1.01 (0.63, 1.62)	0.75 (0.14, 4.13)	1.19 (0.75, 1.91)	1.27 (0.57, 2.79)
P _{interaction}	0.45		0.66		0.59		0.51	
Interdaily stability								
Q1	0.83 (0.49, 1.4)	1.17 (0.47, 2.94)	1.29 (0.77, 2.16)	1.71 (0.63, 4.65)	2.5 (1.44, 4.34)	4.8 (1.02, 22.67)	2 (1.19, 3.36)	1.58 (0.7, 3.57)
Q2	0.95 (0.52, 1.74)	1.27 (0.42, 3.84)	1.27 (0.69, 2.33)	1.33 (0.67, 2.65)	1.17 (0.58, 2.35)	1.59 (0.16, 15.32)	1.36 (0.88, 2.11)	2.04 (0.89, 4.71)
Q3	0.9 (0.56, 1.47)	0.86 (0.3, 2.47)	1.04 (0.62, 1.74)	0.84 (0.3, 2.4)	1.16 (0.66, 2.05)	1.5 (0.22, 10)	1.17 (0.8, 1.7)	1.31 (0.7, 2.45)
Q4	0.8 (0.53, 1.21)	0.55 (0.2, 1.54)	0.8 (0.5, 1.26)	0.79 (0.28, 2.24)	1.41 (0.6, 3.34)	0.14 (0.01, 1.81)	1.07 (0.69, 1.65)	0.91 (0.43, 1.94)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.20		0.88		0.30		0.69	
Intradaily variability								
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	1.03 (0.63, 1.7)	0.82 (0.36, 1.85)	0.76 (0.4, 1.46)	1.15 (0.58, 2.29)	0.8 (0.38, 1.69)	0.74 (0.1, 5.32)	1.25 (0.81, 1.92)	0.69 (0.34, 1.43)
Q3	1.07 (0.69, 1.65)	1.38 (0.49, 3.92)	0.9 (0.54, 1.49)	1.35 (0.43, 4.19)	1.24 (0.51, 3)	0.57 (0.17, 1.94)	1.28 (0.82, 1.99)	0.72 (0.3, 1.74)
Q4	1.23 (0.78, 1.93)	1.95 (0.7, 5.45)	0.83 (0.49, 1.38)	1.53 (0.53, 4.49)	0.56 (0.28, 1.13)	1.59 (0.28, 8.85)	1.3 (0.81, 2.08)	1.81 (0.95, 3.45)

Q5	0.92 (0.62, 1.35)	1.54 (0.54, 4.43)	1.29 (0.74, 2.23)	1.29 (0.52, 3.18)	2.33 (1.22, 4.46)	2.9 (0.55, 15.17)	1.56 (1.03, 2.36)	1.37 (0.47, 3.98)
P _{interaction}	0.42		0.90		0.62		0.86	

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L in men and women for AST, >113 IU/L in men and women for ALP and >65 IU/L in men or >36 IU/L in women for GGT

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Light drinker were classified as having average daily drinking volume of me <1 for men and <0.5 for women; moderate drinker as 1 to 2 for men and 0.5 to 1 for women; heavy drinker as ≥2 for men and ≥1 for women.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S7. Associations (OR and 95% CI) between quintiles of rest-activity rhythm characteristics and abnormal levels of ALT, AST, ALP and GGT, stratified by BMI, NHANES 2011 – 2014

	ALT <25	25-30	>=30	AST <25	25-30	>=30	ALP <25	25-30	>=30	GGT <25	25-30	>=30
F statistic												
Q1	2.04 (0.79, 5.29)	0.96 (0.34, 2.72)	0.87 (0.47, 1.61)	2.04 (0.67, 6.2)	1 (0.49, 2.01)	1.31 (0.76, 2.24)	12.37 (1.95, 78.61)	1.11 (0.4, 3.06)	1.96 (0.85, 4.52)	1.61 (0.57, 4.57)	1.59 (0.92, 2.77)	1.54 (0.77, 3.08)
Q2	0.96 (0.4, 2.26)	1.02 (0.44, 2.38)	1.59 (0.91, 2.78)	1.33 (0.54, 3.27)	0.88 (0.49, 1.57)	1.45 (0.85, 2.48)	5.69 (1.35, 23.98)	0.3 (0.11, 0.83)	1.6 (0.5, 5.08)	1.29 (0.59, 2.86)	0.96 (0.45, 2.02)	1.93 (0.97, 3.83)
Q3	1.56 (0.71, 3.45)	1.23 (0.67, 2.27)	0.75 (0.43, 1.31)	1.08 (0.42, 2.81)	0.7 (0.39, 1.24)	0.77 (0.44, 1.34)	2.84 (0.8, 10.11)	0.98 (0.46, 2.08)	0.39 (0.13, 1.17)	0.96 (0.46, 2.03)	1.15 (0.61, 2.15)	0.84 (0.48, 1.49)
Q4	0.69 (0.23, 2.05)	0.59 (0.26, 1.3)	0.9 (0.5, 1.61)	0.67 (0.23, 1.95)	0.8 (0.39, 1.64)	0.88 (0.46, 1.68)	1.29 (0.27, 6.14)	0.21 (0.05, 0.82)	0.23 (0.06, 0.84)	0.96 (0.31, 2.97)	0.83 (0.33, 2.09)	1.14 (0.7, 1.84)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.59			0.70			0.65			0.74		
Amplitude												
Q1	1.14 (0.39, 3.32)	1.31 (0.64, 2.69)	0.95 (0.56, 1.59)	1.27 (0.5, 3.26)	1.01 (0.5, 2.04)	1.24 (0.58, 2.66)	1.6 (0.28, 9.08)	3.06 (0.48, 19.35)	1.89 (0.98, 3.63)	1.34 (0.47, 3.8)	0.9 (0.46, 1.76)	1.79 (0.99, 3.22)
Q2	1.45 (0.58, 3.62)	1.69 (0.77, 3.69)	1.14 (0.76, 1.72)	0.9 (0.38, 2.13)	1.62 (0.77, 3.38)	0.84 (0.44, 1.62)	0.43 (0.06, 2.97)	4.82 (0.99, 23.41)	0.64 (0.21, 1.98)	1.47 (0.51, 4.24)	1.11 (0.57, 2.13)	1.27 (0.68, 2.39)
Q3	0.79 (0.33, 1.92)	1.18 (0.58, 2.4)	0.87 (0.46, 1.65)	0.8 (0.3, 2.12)	1.6 (0.82, 3.14)	0.74 (0.36, 1.5)	0.25 (0.05, 1.29)	1.18 (0.22, 6.43)	0.6 (0.2, 1.78)	1.21 (0.42, 3.51)	0.73 (0.32, 1.68)	1.27 (0.71, 2.25)
Q4	0.75 (0.29, 1.93)	1.06 (0.5, 2.22)	0.72 (0.36, 1.43)	0.66 (0.29, 1.49)	1.24 (0.58, 2.67)	0.49 (0.21, 1.17)	0.64 (0.07, 6.25)	4.38 (0.97, 19.72)	1.38 (0.52, 3.63)	1.64 (0.6, 4.47)	0.67 (0.29, 1.54)	1.13 (0.58, 2.21)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.27			0.72			0.94			0.53		
Mesor												
Q1	1.35 (0.5, 3.61)	1.62 (0.82, 3.22)	0.96 (0.57, 1.6)	1.1 (0.47, 2.55)	1.4 (0.77, 2.52)	1.01 (0.65, 1.58)	9.95 (1.84, 53.63)	1.05 (0.35, 3.18)	1.07 (0.51, 2.22)	0.71 (0.32, 1.55)	1.21 (0.56, 2.62)	0.98 (0.52, 1.84)
Q2	1.11 (0.38, 3.25)	0.82 (0.34, 2)	1.04 (0.61, 1.75)	1 (0.5, 1.99)	0.71 (0.33, 1.54)	0.85 (0.42, 1.71)	5.39 (0.63, 46.4)	0.32 (0.08, 1.29)	0.45 (0.18, 1.15)	0.87 (0.32, 2.35)	0.48 (0.22, 1.04)	0.83 (0.48, 1.45)
Q3	0.99 (0.38, 2.56)	1.85 (0.95, 3.6)	1.13 (0.67, 1.92)	0.92 (0.32, 2.65)	1.57 (0.83, 2.96)	1.17 (0.54, 2.5)	2.84 (0.44, 18.29)	0.83 (0.24, 2.8)	0.37 (0.17, 0.79)	0.71 (0.22, 2.22)	1.21 (0.57, 2.59)	1.03 (0.58, 1.84)
Q4	1.06 (0.32, 3.46)	1.35 (0.72, 2.56)	0.88 (0.5, 1.56)	1.17 (0.54, 2.54)	1.23 (0.58, 2.58)	1.02 (0.5, 2.1)	2.49 (0.43, 14.5)	0.71 (0.2, 2.55)	0.31 (0.12, 0.84)	0.88 (0.28, 2.79)	0.84 (0.41, 1.74)	0.87 (0.55, 1.37)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.57			0.64			0.36			0.63		
Amplitude:Mesor												
Q1	1.46 (0.55, 3.85)	1.69 (0.86, 3.34)	0.92 (0.53, 1.59)	1.56 (0.73, 3.32)	1.7 (0.74, 3.89)	1.32 (0.68, 2.57)	1.13 (0.21, 6.06)	6.36 (0.85, 47.63)	1.32 (0.51, 3.44)	1.28 (0.48, 3.42)	1.52 (0.73, 3.15)	1.66 (0.82, 3.38)
Q2	0.87 (0.32, 2.31)	1.18 (0.57, 2.46)	0.92 (0.53, 1.59)	0.68 (0.31, 1.5)	1.24 (0.59, 2.61)	0.78 (0.39, 1.58)	0.54 (0.09, 3.31)	6.72 (0.93, 48.67)	1.18 (0.42, 3.27)	1.03 (0.36, 3.01)	0.65 (0.3, 1.4)	0.98 (0.52, 1.86)
Q3	1.07 (0.5, 2.32)	0.92 (0.42, 2.04)	0.92 (0.53, 1.59)	0.82 (0.42, 1.61)	0.99 (0.41, 2.4)	0.78 (0.38, 1.61)	0.34 (0.05, 2.19)	2.91 (0.4, 21.23)	1.06 (0.41, 2.72)	1.43 (0.55, 3.71)	0.7 (0.33, 1.47)	1.04 (0.57, 1.89)
Q4	0.84 (0.3, 2.36)	1.36 (0.62, 2.98)	0.92 (0.53, 1.59)	0.67 (0.24, 1.91)	1.71 (0.87, 3.33)	0.67 (0.37, 1.19)	0.48 (0.05, 4.91)	4.04 (0.51, 31.97)	1.23 (0.34, 4.48)	0.75 (0.22, 2.54)	1.11 (0.57, 2.14)	0.84 (0.39, 1.84)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.47			0.63			0.62			0.66		
Acrophase												
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.48 (0.21, 1.13)	0.82 (0.38, 1.78)	1.48 (0.9, 2.45)	0.56 (0.25, 1.25)	0.74 (0.31, 1.78)	1.67 (0.97, 2.89)	0.28 (0.08, 1)	1.08 (0.41, 2.79)	1.56 (0.56, 4.36)	0.69 (0.28, 1.7)	0.59 (0.3, 1.17)	1.45 (0.89, 2.35)
Q3	0.36 (0.15, 0.87)	0.98 (0.49, 1.95)	1.34 (0.67, 2.65)	0.27 (0.12, 0.6)	0.86 (0.39, 1.92)	2 (1.04, 3.85)	0.88 (0.23, 3.36)	0.29 (0.09, 0.97)	1.05 (0.33, 3.29)	0.75 (0.33, 1.69)	1.19 (0.52, 2.69)	0.87 (0.5, 1.49)
Q4	0.63 (0.28, 1.43)	0.93 (0.49, 1.8)	1.45 (0.81, 2.62)	0.44 (0.18, 1.1)	0.98 (0.47, 2.02)	1.8 (0.86, 3.79)	0.86 (0.23, 3.21)	0.49 (0.15, 1.66)	0.69 (0.3, 1.62)	0.55 (0.2, 1.49)	0.51 (0.2, 1.33)	1.37 (0.87, 2.16)
Q5	0.69 (0.23, 2.12)	0.85 (0.36, 2)	1.2 (0.67, 2.15)	0.71 (0.28, 1.82)	0.93 (0.47, 1.84)	1.68 (0.84, 3.36)	0.65 (0.25, 1.67)	0.6 (0.27, 1.36)	1.34 (0.54, 3.28)	0.51 (0.22, 1.19)	1.41 (0.67, 2.95)	1.49 (0.96, 2.3)
P interaction	0.31			0.15			0.44			0.04		
Interdaily stability												
Q1	1.2 (0.41, 3.57)	0.8 (0.33, 1.97)	0.79 (0.4, 1.57)	2.98 (0.99, 8.96)	0.9 (0.41, 1.94)	1.33 (0.71, 2.5)	10.38 (1.8, 59.99)	1.25 (0.38, 4.11)	4.64 (1.57, 13.72)	0.83 (0.4, 1.73)	1.6 (0.84, 3.06)	1.71 (0.86, 3.41)
Q2	1.34 (0.55, 3.27)	0.85 (0.39, 1.88)	1 (0.51, 1.97)	1.77 (0.78, 4.05)	0.92 (0.49, 1.74)	1.28 (0.64, 2.54)	7.52 (0.86, 66.07)	0.25 (0.09, 0.66)	2.52 (0.65, 9.84)	1.08 (0.43, 2.73)	1.3 (0.56, 3.04)	1.34 (0.78, 2.29)
Q3	0.51 (0.19, 1.32)	0.75 (0.35, 1.62)	1.02 (0.62, 1.67)	1.47 (0.49, 4.42)	0.71 (0.36, 1.41)	0.96 (0.51, 1.82)	5.71 (1.18, 27.66)	0.44 (0.17, 1.12)	1.86 (0.53, 6.57)	1 (0.41, 2.43)	0.8 (0.4, 1.59)	1.18 (0.7, 1.97)
Q4	0.72 (0.26, 2.01)	0.65 (0.33, 1.29)	0.84 (0.51, 1.38)	0.84 (0.33, 2.15)	0.64 (0.32, 1.28)	0.99 (0.64, 1.53)	1.39 (0.24, 7.9)	0.49 (0.15, 1.55)	2.55 (0.74, 8.78)	0.32 (0.12, 0.9)	0.98 (0.54, 1.76)	1.25 (0.66, 2.34)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.94			0.28			0.61			0.68		
Intradaily variability												
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.97 (0.32, 2.99)	1.53 (0.66, 3.55)	0.68 (0.38, 1.22)	0.74 (0.33, 1.67)	1.04 (0.46, 2.33)	0.57 (0.28, 1.16)	0.38 (0.12, 1.26)	0.72 (0.2, 2.55)	1.05 (0.33, 3.27)	1.28 (0.51, 3.23)	1.22 (0.52, 2.86)	0.64 (0.4, 1.05)
Q3	1.66 (0.69, 3.98)	1.3 (0.62, 2.75)	0.99 (0.55, 1.79)	0.85 (0.36, 2.01)	0.94 (0.48, 1.82)	1.04 (0.57, 1.91)	0.83 (0.22, 3.2)	0.74 (0.18, 3.08)	1.21 (0.64, 2.28)	1.12 (0.62, 2.02)	0.83 (0.41, 1.67)	1.05 (0.6, 1.84)
Q4	2.16 (0.91, 5.11)	1.53 (0.77, 3.06)	0.97 (0.55, 1.71)	1.23 (0.55, 2.73)	0.93 (0.5, 1.73)	0.74 (0.37, 1.47)	2.16 (0.44, 10.53)	0.4 (0.13, 1.31)	0.66 (0.21, 2.09)	1.55 (0.8, 3)	1.15 (0.54, 2.44)	1.06 (0.6, 1.89)

Q5	1.51 (0.51, 4.43)	1.38 (0.63, 3.04)	0.68 (0.38, 1.23)	2 (0.89, 4.52)	1.11 (0.6, 2.06)	0.85 (0.41, 1.76)	4.13 (1, 17.05)	1.34 (0.44, 4.05)	2.82 (1.13, 7.03)	0.84 (0.36, 1.95)	1 (0.52, 1.94)	1.24 (0.65, 2.37)
P _{interaction}	0.06			0.01			0.63			0.34		

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L in men and women for AST, >113 IU/L in men and women for ALP and >65 IU/L in men or >36 IU/L in women for GGT

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S8. Associations (OR and 95% CI) between rest-activity rhythm characteristics quintiles and abnormal levels of ALT, AST, ALP and GGT, stratified by diabetes status, NHANES 2011 – 2014

	ALT		AST		ALP		GGT	
	With diabetes	Without diabetes	With diabetes	Without diabetes	With diabetes	Without diabetes	With diabetes	Without diabetes
F statistic								
Q1	0.68 (0.3, 1.57)	1.11 (0.65, 1.88)	2.01 (0.95, 4.29)	1.07 (0.68, 1.67)	1.72 (0.54, 5.49)	2.32 (1.15, 4.68)	2.93 (1.39, 6.17)	1.43 (0.86, 2.37)
Q2	0.97 (0.38, 2.51)	1.32 (0.79, 2.21)	1.63 (0.73, 3.63)	1.02 (0.69, 1.52)	1.71 (0.4, 7.32)	1.02 (0.41, 2.55)	2.11 (1.09, 4.11)	1.52 (0.91, 2.51)
Q3	0.73 (0.22, 2.46)	1.08 (0.72, 1.62)	1.21 (0.52, 2.81)	0.68 (0.43, 1.08)	0.62 (0.2, 1.95)	0.99 (0.49, 2.01)	2.03 (0.8, 5.12)	0.9 (0.58, 1.39)
Q4	0.45 (0.19, 1.09)	0.82 (0.5, 1.35)	0.72 (0.3, 1.77)	0.84 (0.56, 1.26)	0.32 (0.04, 2.32)	0.36 (0.14, 0.9)	1.52 (0.68, 3.39)	0.96 (0.64, 1.46)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.50		0.18		0.70		0.26	
Amplitude								
Q1	1.13 (0.36, 3.54)	0.98 (0.62, 1.54)	2.43 (0.77, 7.7)	0.89 (0.53, 1.48)	2.59 (1.02, 6.53)	2.24 (1, 5.02)	1.94 (1.05, 3.58)	1.25 (0.79, 1.99)
Q2	1.14 (0.39, 3.34)	1.3 (0.79, 2.15)	1.87 (0.73, 4.81)	0.88 (0.55, 1.39)	1.21 (0.29, 5.11)	1.39 (0.57, 3.37)	1.13 (0.56, 2.28)	1.34 (0.89, 2.01)
Q3	0.78 (0.2, 3.08)	0.96 (0.65, 1.41)	1.63 (0.44, 5.96)	0.9 (0.59, 1.37)	1.04 (0.35, 3.05)	0.54 (0.2, 1.48)	0.79 (0.29, 2.17)	1.14 (0.69, 1.89)
Q4	0.63 (0.15, 2.76)	0.87 (0.48, 1.56)	0.69 (0.13, 3.63)	0.76 (0.45, 1.29)	3.1 (1.09, 8.83)	1.55 (0.69, 3.5)	0.79 (0.31, 2.02)	1.11 (0.66, 1.88)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.73		0.01		0.56		0.21	
Mesor								
Q1	2.03 (0.89, 4.64)	1.05 (0.65, 1.68)	1.2 (0.55, 2.61)	1.04 (0.65, 1.69)	3.49 (1.22, 9.99)	0.94 (0.45, 1.96)	0.99 (0.38, 2.57)	1.01 (0.58, 1.73)
Q2	1.13 (0.43, 2.96)	1.01 (0.67, 1.52)	0.59 (0.21, 1.65)	0.89 (0.52, 1.52)	1.25 (0.35, 4.44)	0.42 (0.17, 1)	0.44 (0.18, 1.05)	0.85 (0.56, 1.3)
Q3	2.55 (1.14, 5.74)	1.13 (0.81, 1.58)	1.57 (0.51, 4.85)	1.12 (0.77, 1.64)	0.8 (0.22, 2.91)	0.58 (0.27, 1.25)	0.94 (0.46, 1.92)	1.05 (0.7, 1.57)
Q4	1.94 (0.8, 4.68)	0.94 (0.63, 1.38)	1.53 (0.6, 3.93)	1.04 (0.6, 1.78)	0.64 (0.16, 2.54)	0.48 (0.2, 1.17)	0.59 (0.25, 1.39)	0.94 (0.59, 1.49)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.75		0.55		0.03		0.71	
Amplitude:Mesor								
Q1	1.12 (0.45, 2.79)	1.22 (0.77, 1.95)	2.96 (1.08, 8.13)	1.11 (0.65, 1.9)	1.3 (0.33, 5.18)	2.4 (1.01, 5.68)	1.45 (0.78, 2.68)	1.5 (0.94, 2.41)
Q2	1.05 (0.41, 2.65)	1.07 (0.7, 1.64)	1.63 (0.59, 4.55)	0.78 (0.48, 1.25)	1.47 (0.58, 3.71)	1.87 (0.84, 4.19)	0.72 (0.36, 1.43)	0.9 (0.58, 1.41)
Q3	0.92 (0.29, 2.95)	0.98 (0.63, 1.53)	1.38 (0.39, 4.92)	0.77 (0.48, 1.23)	1.15 (0.34, 3.86)	1.2 (0.53, 2.75)	0.6 (0.29, 1.24)	1.14 (0.74, 1.77)
Q4	0.66 (0.2, 2.25)	1.03 (0.67, 1.58)	1.44 (0.49, 4.23)	0.88 (0.62, 1.26)	1.86 (0.28, 12.55)	1.21 (0.43, 3.35)	0.48 (0.2, 1.2)	1.03 (0.64, 1.66)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.69		0.01		0.05		0.40	
Acrophase								
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	1.15 (0.62, 2.12)	1.04 (0.62, 1.75)	1.85 (0.83, 4.1)	0.83 (0.47, 1.47)	1.02 (0.34, 3.07)	1.13 (0.52, 2.43)	1.81 (0.92, 3.55)	0.8 (0.48, 1.35)
Q3	0.73 (0.3, 1.74)	0.97 (0.57, 1.64)	1.54 (0.63, 3.76)	0.81 (0.51, 1.28)	1.26 (0.43, 3.65)	0.43 (0.17, 1.05)	1.53 (0.7, 3.35)	0.8 (0.49, 1.31)
Q4	1.1 (0.63, 1.9)	0.97 (0.59, 1.57)	1.81 (0.87, 3.75)	0.82 (0.53, 1.25)	0.81 (0.36, 1.85)	0.62 (0.24, 1.58)	1.44 (0.8, 2.6)	0.74 (0.44, 1.26)
Q5	0.51 (0.27, 0.93)	1.08 (0.61, 1.9)	0.76 (0.38, 1.52)	1.06 (0.64, 1.77)	1.21 (0.46, 3.2)	0.81 (0.47, 1.41)	1.67 (0.89, 3.15)	1.1 (0.69, 1.74)
P _{interaction}	0.66		0.99		0.13		0.01	
Interdaily stability								
Q1	0.48 (0.21, 1.08)	0.87 (0.52, 1.46)	1.31 (0.66, 2.57)	1.22 (0.77, 1.94)	5.63 (1.56, 20.37)	2.03 (1.05, 3.94)	2.27 (1.09, 4.74)	1.26 (0.79, 2.04)
Q2	0.6 (0.24, 1.51)	1.06 (0.59, 1.9)	1.59 (0.83, 3.05)	1.05 (0.64, 1.72)	2.66 (0.57, 12.49)	0.87 (0.35, 2.18)	1.24 (0.7, 2.2)	1.28 (0.81, 2.03)
Q3	1.1 (0.57, 2.11)	0.71 (0.41, 1.23)	1.42 (0.67, 2.99)	0.73 (0.44, 1.22)	4.7 (1.25, 17.66)	0.67 (0.29, 1.52)	1.51 (0.87, 2.62)	0.9 (0.59, 1.37)
Q4	0.56 (0.24, 1.29)	0.76 (0.49, 1.17)	0.74 (0.31, 1.74)	0.77 (0.49, 1.21)	3.02 (0.77, 11.86)	0.8 (0.32, 2.02)	0.66 (0.34, 1.3)	0.95 (0.6, 1.5)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P _{interaction}	0.39		0.59		0.16		0.09	
Intradaily variability								
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	1.04 (0.4, 2.68)	0.84 (0.52, 1.35)	0.74 (0.23, 2.38)	0.76 (0.48, 1.19)	5.84 (1.17, 29.09)	0.45 (0.2, 1.01)	1.52 (0.66, 3.5)	0.84 (0.64, 1.08)
Q3	1.05 (0.44, 2.48)	1.07 (0.61, 1.88)	0.88 (0.38, 2.02)	0.95 (0.55, 1.65)	4.59 (0.9, 23.45)	0.67 (0.28, 1.6)	1.48 (0.67, 3.28)	0.87 (0.59, 1.28)
Q4	1.19 (0.45, 3.13)	1.19 (0.66, 2.14)	1.04 (0.41, 2.66)	0.8 (0.44, 1.46)	2.72 (0.7, 10.65)	0.52 (0.21, 1.27)	1.4 (0.7, 2.81)	1.15 (0.84, 1.57)

Q5	0.76 (0.3, 1.93)	0.87 (0.55, 1.37)	1.04 (0.4, 2.7)	1.08 (0.7, 1.65)	10.89 (3.81, 31.11)	1.28 (0.62, 2.64)	2.56 (1.39, 4.71)	0.82 (0.54, 1.24)
P _{interaction}	0.73		0.58		0.04		0.04	

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L in men and women for AST, >113 IU/L in men and women for ALP and >65 IU/L in men or >36 IU/L in women for GGT

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S9. Associations (OR and 95% CI) between rest-activity rhythm characteristics quintiles and abnormal levels of ALT, AST, ALP, and GGT, stratified by sessions attended, NHANES 2011 – 2014

	ALT			AST			ALP			GGT		
	Morning	Afternoon	Evening	Morning	Afternoon	Evening	Morning	Afternoon	Evening	Morning	Afternoon	Evening
F statistic												
Q1	1.36 (0.75, 2.47)	0.99 (0.48, 2.06)	0.78 (0.25, 2.47)	1.51 (0.81, 2.79)	1.45 (0.75, 2.82)	0.56 (0.2, 1.6)	2.15 (0.87, 5.28)	2.11 (0.98, 4.52)	4.03 (0.29, 56.67)	2.29 (1.34, 3.94)	1.64 (0.92, 2.94)	1.09 (0.25, 4.82)
Q2	1.73 (0.93, 3.19)	1.05 (0.56, 1.96)	0.98 (0.39, 2.49)	1.44 (0.76, 2.74)	1.07 (0.63, 1.82)	0.81 (0.36, 1.81)	1.69 (0.6, 4.8)	0.96 (0.38, 2.4)	1.16 (0.08, 16.99)	2.51 (1.38, 4.59)	0.86 (0.46, 1.62)	2.31 (0.52, 10.15)
Q3	0.89 (0.58, 1.35)	1.43 (0.78, 2.63)	1 (0.37, 2.69)	0.68 (0.36, 1.29)	1.09 (0.59, 2)	0.59 (0.25, 1.39)	0.83 (0.32, 2.14)	0.79 (0.34, 1.81)	1.89 (0.12, 28.65)	1.28 (0.73, 2.24)	0.95 (0.54, 1.69)	1.34 (0.31, 5.72)
Q4	0.64 (0.31, 1.31)	1.27 (0.65, 2.48)	0.39 (0.16, 1)	1.09 (0.44, 2.69)	0.92 (0.51, 1.66)	0.32 (0.11, 0.94)	0.37 (0.13, 1.07)	0.39 (0.12, 1.23)	0 (0, 0)	1.56 (0.86, 2.81)	0.69 (0.37, 1.28)	1.42 (0.47, 4.27)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.16			0.32			0.24			0.52		
Amplitude												
Q1	1.36 (0.75, 2.49)	0.62 (0.33, 1.2)	2.65 (1, 7)	1.45 (0.82, 2.58)	0.94 (0.4, 2.18)	0.82 (0.37, 1.81)	2.12 (0.78, 5.75)	2.96 (0.92, 9.5)	3.13 (0.13, 77.53)	1.54 (0.85, 2.79)	1.86 (0.97, 3.57)	1.06 (0.32, 3.53)
Q2	1.2 (0.67, 2.15)	1.25 (0.67, 2.35)	3.28 (1.42, 7.61)	1.21 (0.72, 2.02)	0.89 (0.42, 1.92)	1.15 (0.36, 3.62)	1.3 (0.49, 3.44)	1.31 (0.34, 4.97)	8.15 (0.14, 485.77)	1.13 (0.62, 2.09)	1.57 (0.85, 2.89)	2.27 (0.79, 6.55)
Q3	0.96 (0.45, 2.05)	0.78 (0.45, 1.36)	2.05 (0.82, 5.13)	0.94 (0.53, 1.67)	1.12 (0.58, 2.18)	0.71 (0.28, 1.76)	0.69 (0.23, 2.11)	0.62 (0.14, 2.77)	4.64 (0.11, 202.84)	0.95 (0.56, 1.61)	1.52 (0.8, 2.88)	0.88 (0.22, 3.48)
Q4	0.75 (0.35, 1.64)	0.7 (0.37, 1.32)	2.14 (0.67, 6.87)	0.76 (0.34, 1.68)	0.6 (0.3, 1.21)	1.12 (0.42, 3)	1.87 (0.72, 4.86)	1.53 (0.35, 6.62)	17.31 (0.26, 1154.48)	1.04 (0.57, 1.88)	0.84 (0.45, 1.54)	2.23 (0.71, 7.01)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.41			0.15			0.17			0.62		
Mesor												
Q1	1.69 (1.01, 2.83)	0.85 (0.52, 1.41)	1.28 (0.39, 4.2)	1.47 (0.82, 2.62)	0.94 (0.58, 1.51)	1.09 (0.34, 3.52)	1.85 (0.73, 4.72)	1.11 (0.66, 1.87)	1.74 (0.22, 14.03)	1.58 (0.98, 2.55)	0.93 (0.57, 1.54)	0.66 (0.18, 2.37)
Q2	1.29 (0.79, 2.11)	0.93 (0.45, 1.93)	0.69 (0.23, 2.05)	1.02 (0.54, 1.92)	0.76 (0.35, 1.66)	0.69 (0.23, 2.05)	0.69 (0.25, 1.89)	0.38 (0.1, 1.41)	2.8 (0.31, 25.01)	1.19 (0.71, 1.99)	0.64 (0.33, 1.24)	0.33 (0.09, 1.12)
Q3	2.02 (1.03, 3.93)	0.85 (0.49, 1.46)	1.24 (0.44, 3.5)	2.05 (1.07, 3.92)	0.83 (0.4, 1.7)	0.82 (0.2, 3.33)	0.48 (0.18, 1.28)	0.73 (0.29, 1.85)	0 (0, 0)	1.73 (0.82, 3.63)	0.6 (0.34, 1.06)	1.1 (0.32, 3.79)
Q4	1.48 (0.81, 2.72)	0.76 (0.46, 1.24)	0.95 (0.33, 2.71)	1.49 (0.88, 2.55)	1.05 (0.54, 2.03)	0.6 (0.19, 1.93)	0.63 (0.24, 1.69)	0.24 (0.08, 0.74)	4.78 (0.49, 46.83)	1.29 (0.69, 2.4)	0.62 (0.31, 1.24)	0.76 (0.25, 2.31)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.65			0.30			0.15			0.63		
Amplitude:Mesor												
Q1	1.45 (0.96, 2.19)	0.97 (0.46, 2.03)	2.26 (0.98, 5.22)	1.63 (0.9, 2.96)	1.19 (0.53, 2.71)	1.48 (0.53, 4.16)	1.59 (0.51, 4.91)	3.1 (0.98, 9.8)	0.83 (0.11, 6.15)	1.4 (0.82, 2.38)	2.19 (1.13, 4.24)	1.71 (0.59, 5.01)
Q2	1.42 (0.91, 2.21)	0.83 (0.44, 1.59)	1.44 (0.73, 2.85)	1.41 (0.75, 2.67)	0.67 (0.33, 1.36)	0.36 (0.13, 1.02)	1.62 (0.6, 4.37)	2.23 (0.6, 8.35)	2.97 (0.18, 48.74)	0.9 (0.52, 1.56)	1.08 (0.56, 2.06)	0.84 (0.24, 2.88)
Q3	0.94 (0.52, 1.7)	0.82 (0.42, 1.61)	2.61 (1.35, 5.05)	0.78 (0.37, 1.66)	0.94 (0.44, 1.97)	0.96 (0.38, 2.43)	0.97 (0.36, 2.62)	1.61 (0.3, 8.65)	5.41 (0.5, 58.6)	0.92 (0.56, 1.52)	1.62 (0.88, 3.01)	0.53 (0.17, 1.66)
Q4	1.31 (0.78, 2.22)	0.71 (0.38, 1.35)	1.03 (0.33, 3.21)	1.16 (0.63, 2.14)	0.8 (0.39, 1.65)	0.93 (0.4, 2.13)	1.45 (0.35, 5.96)	1.56 (0.35, 6.91)	0.52 (0.03, 9.03)	0.91 (0.55, 1.5)	1.29 (0.59, 2.78)	0.47 (0.14, 1.61)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.91			0.24			0.17			0.72		
Acrophase												
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	1 (0.61, 1.63)	0.97 (0.49, 1.91)	1.1 (0.52, 2.32)	0.77 (0.38, 1.56)	1.19 (0.6, 2.37)	1.28 (0.43, 3.84)	0.93 (0.36, 2.39)	1.61 (0.62, 4.2)	0.6 (0.18, 2.05)	1.3 (0.78, 2.17)	0.7 (0.31, 1.57)	0.4 (0.16, 1.02)
Q3	1.01 (0.58, 1.75)	0.87 (0.42, 1.8)	0.74 (0.24, 2.27)	0.8 (0.49, 1.32)	1.22 (0.59, 2.51)	0.81 (0.32, 2.11)	0.48 (0.21, 1.11)	1.14 (0.29, 4.42)	0.14 (0.01, 3.7)	0.79 (0.41, 1.54)	0.9 (0.47, 1.73)	1.43 (0.52, 3.94)
Q4	1.02 (0.64, 1.64)	0.91 (0.41, 2.04)	0.87 (0.27, 2.79)	0.94 (0.58, 1.53)	1.12 (0.54, 2.33)	0.84 (0.32, 2.22)	0.26 (0.11, 0.65)	1.28 (0.53, 3.13)	1.4 (0.22, 9)	0.95 (0.55, 1.65)	0.66 (0.3, 1.45)	1.23 (0.47, 3.2)
Q5	1.06 (0.62, 1.82)	0.81 (0.41, 1.6)	0.78 (0.25, 2.42)	0.92 (0.53, 1.59)	1.13 (0.54, 2.38)	1.12 (0.3, 4.23)	1.04 (0.55, 1.97)	0.93 (0.4, 2.15)	0.16 (0.01, 2.73)	1.18 (0.64, 2.16)	0.92 (0.57, 1.49)	2.66 (1.07, 6.62)
P interaction	0.99			0.51			0.28			0.31		
IS												
Q1	0.99 (0.54, 1.81)	0.64 (0.32, 1.26)	0.9 (0.37, 2.21)	1.5 (0.85, 2.63)	1.04 (0.59, 1.82)	1.42 (0.55, 3.61)	3.33 (1.25, 8.88)	1.74 (0.82, 3.69)	8.83 (0.42, 185.35)	1.92 (1.15, 3.22)	1.48 (0.71, 3.11)	1.03 (0.24, 4.42)
Q2	1.01 (0.55, 1.86)	0.94 (0.51, 1.74)	1.03 (0.39, 2.73)	1.01 (0.59, 1.73)	1.47 (0.81, 2.66)	0.96 (0.43, 2.18)	1.02 (0.34, 3.03)	1.17 (0.47, 2.9)	1.29 (0.09, 18.38)	1.53 (0.87, 2.7)	0.97 (0.49, 1.89)	2.43 (0.59, 10.05)
Q3	0.8 (0.41, 1.54)	0.9 (0.44, 1.86)	0.76 (0.25, 2.28)	1.12 (0.56, 2.22)	0.75 (0.33, 1.7)	0.88 (0.34, 2.26)	1.69 (0.63, 4.51)	0.76 (0.27, 2.09)	0.53 (0.01, 26.62)	1.32 (0.81, 2.14)	0.84 (0.43, 1.61)	1.19 (0.28, 5.13)
Q4	0.73 (0.37, 1.47)	0.87 (0.44, 1.71)	0.78 (0.38, 1.57)	0.86 (0.5, 1.48)	0.79 (0.36, 1.74)	0.69 (0.25, 1.86)	1.45 (0.46, 4.61)	0.6 (0.24, 1.5)	5.78 (0.42, 78.72)	1.14 (0.55, 2.39)	0.83 (0.41, 1.67)	1.06 (0.32, 3.44)
Q5	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
P interaction	0.95			0.55			0.20			0.65		
IV												
Q1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Q2	0.82 (0.37, 1.81)	0.81 (0.46, 1.43)	1.54 (0.67, 3.51)	0.93 (0.44, 1.98)	0.67 (0.39, 1.14)	0.74 (0.24, 2.29)	0.79 (0.29, 2.12)	0.9 (0.25, 3.27)	0.05 (0, 0.64)	0.77 (0.44, 1.36)	1.5 (0.86, 2.59)	0.57 (0.19, 1.67)
Q3	1.18 (0.56, 2.49)	0.99 (0.55, 1.8)	1.65 (0.65, 4.22)	1.05 (0.52, 2.12)	0.87 (0.48, 1.55)	1.31 (0.52, 3.29)	0.98 (0.49, 1.99)	1.06 (0.23, 4.85)	1.12 (0.08, 15.67)	0.94 (0.6, 1.49)	1.18 (0.69, 2.01)	0.87 (0.26, 2.92)
Q4	1.33 (0.61, 2.93)	0.99 (0.51, 1.91)	1.86 (0.86, 4.01)	0.89 (0.44, 1.8)	0.76 (0.41, 1.41)	1.53 (0.67, 3.51)	0.66 (0.25, 1.76)	0.83 (0.24, 2.86)	0.27 (0.03, 2.53)	0.97 (0.53, 1.77)	1.65 (0.98, 2.79)	1.16 (0.47, 2.85)

Q5	1.04 (0.55, 1.96)	0.65 (0.36, 1.15)	1.62 (0.7, 3.72)	1.07 (0.57, 1.99)	1.18 (0.63, 2.22)	1.22 (0.56, 2.65)	2.26 (0.89, 5.74)	2.8 (1.45, 5.42)	0.17 (0.01, 5.2)	1.16 (0.64, 2.12)	1.55 (0.86, 2.79)	0.62 (0.13, 2.9)
P _{interaction}	0.59			0.62			0.09			0.58		

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L in men and women for AST, >113 IU/L in men and women for ALP and >65 IU/L in men or >36 IU/L in women for GGT

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S10. Associations (OR and 95% CI) between impaired rhythmicity score and abnormal levels of liver enzymes, albumin, and bilirubin, stratified by diabetes status, NHANES 2011 – 2014

Impaired rhythmicity score	ALT	AST	ALP	GGT	Albumin	Bilirubin
0	ref.	ref.	ref.	ref.	ref.	ref.
1	1.18 (0.79, 1.76)	1.15 (0.81, 1.62)	1.51 (0.75, 3.02)	1.38 (0.99, 1.92)	1.26 (0.66, 2.42)	0.91 (0.46, 1.8)
2	1.08 (0.72, 1.61)	1.31 (0.88, 1.95)	1.57 (0.79, 3.11)	1.75 (1.21, 2.52)	2.7 (1.57, 4.66)	1.35 (0.75, 2.43)
3+	1.22 (0.75, 2)	1.58 (0.88, 2.86)	3.77 (2.17, 6.56)	1.86 (1.19, 2.9)	4.65 (2.55, 8.46)	1.35 (0.7, 2.61)
P _{trend}	0.31	0.08	0.001	0.002	<0.001	0.21

Abnormal levels defined as >47 IU/L in men or >30 IU/L in women for ALT, >33 IU/L in men and women for AST, >113 IU/L in men and women for ALP and >65 IU/L in men or >36 IU/L in women for GGT

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase

Table S11. Associations (OR and 95% CI) between rest-activity rhythm characteristics quintiles and abnormal liver enzyme score, NHANES 2011 – 2014

	Abnormal liver enzyme score
F statistic	
Q1	1.7 (1.34, 2.17)
Q2	1.46 (1.18, 1.8)
Q3	0.98 (0.79, 1.2)
Q4	0.88 (0.71, 1.09)
Q5	ref.
P _{trend}	<0.001
Amplitude	
Q1	1.75 (1.28, 2.39)
Q2	1.3 (0.99, 1.71)
Q3	1.24 (0.98, 1.57)
Q4	1.15 (0.86, 1.54)
Q5	ref.
P _{trend}	0.72
Mesor	
Q1	1.37 (1.07, 1.76)
Q2	0.97 (0.77, 1.21)
Q3	1.1 (0.86, 1.42)
Q4	0.99 (0.78, 1.27)
Q5	ref.
P _{trend}	0.78
Amplitude:Mesor	
Q1	1.73 (1.27, 2.37)
Q2	1.11 (0.86, 1.44)
Q3	1.1 (0.84, 1.45)
Q4	1.18 (0.89, 1.56)
Q5	ref.
P _{trend}	0.14
Acrophase	
Q1	ref.
Q2	0.97 (0.78, 1.22)
Q3	1.03 (0.8, 1.32)
Q4	0.98 (0.78, 1.24)
Q5	1.14 (0.89, 1.47)
P _{trend}	0.36
Interdaily stability	
Q1	1.59 (1.18, 2.13)
Q2	1.34 (0.97, 1.85)
Q3	1.11 (0.85, 1.46)
Q4	0.92 (0.72, 1.18)
Q5	ref.
P _{trend}	<0.001
Intradaily variability	
Q1	ref.
Q2	0.95 (0.75, 1.21)

Q3	1.09 (0.82, 1.45)
Q4	1.5 (1.18, 1.92)
Q5	1.43 (1.16, 1.77)
P _{trend}	<0.001

Abnormal liver enzyme score represents the number of abnormal levels of ALT, ASLP, AST, GGT, albumin, and bilirubin, range from 0 to 3+.

Results obtained by ordered logistic regression.

Model adjusted for age, gender, race and ethnicity, education, household income, marital status, smoking, alcohol, hepatitis B, hepatitis C and hepatitis E.

Abbreviations: NHANES, National Health and Nutrition Examination Survey; ALT, alanine aminotransferase; AST, aspartate aminotransferase; ALP, alkaline phosphatase; GGT, gamma glutamyl transaminase