BMI and blood pressure in young adults

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Abstract

This study examined whether circadian rhythm characteristics of blood pressure (BP) and heart rate (HR) of clinically healthy students are related to body mass index (BMI). ABPM for 2 to 8 days was carried out by 46 of 78 clinically healthy students 17-31 years of age in Almaty, Kazakhstan. Concomitantly with ABPM, 20 students also monitored their activity from which indices of stability (IS) and fragmentation (IV) were derived. The pulse-pressure product (DP=SBP.HR/100) was positively correlated with BMI (r=0.511, P<0.001), an association found in male but not in female students. A weak positive correlation of IV was found with the circadian period of SBP and HR. A larger fragmentation of the activity rhythm was also associated with a reduced circadian amplitude of DBP. The higher BP of students with a larger BMI may increase their CVD risk. Estrogens may protect young women as those monitored in our study.

Introduction

BP is a major focus of the global 2013-2020 action plan of the WHO to prevent and manage non-communicable diseases [1]. WHO calls for a 25% reduction in the global prevalence of raised BP, a leading risk factor of cardiovascular disease. Chronobiologic outcome studies have documented that abnormal patterns of BP and/or HR ***variability*** also increase CVD risk in the absence as well as in the absence of an elevated BP [2]. Overweight and obesity are a further risk factor of CVD and diabetes [1]. Chronobiological studies have documented that a calorie consumed in the morning differs from the same calorie consumed in the evening [3]. Sleep fragmentation has also been shown to negatively impact health [4]. It is thus important to assess circadian rhythms of physiological variables for making recommendations to maintain a healthy life.

Subjects and Methods

Ambulatory BP monitoring at 30-min intervals for 2 to 8 days was carried out by 46 of 78 clinically healthy students 17-31 years of age (mean ± SD: 21.2±3.2 years), mostly (97%) of Kazakh nationality (Asian ethnicity). Data were analyzed by cosinor to obtain estimates of the MESOR (rhythm-adjusted mean), 24-hour amplitude and acrophase (measures of the extent and timing of predictable change within a day) [5]. The circadian period was estimated by nonlinear least squares [6]. Concomitantly with ABPM, 20 students also monitored their activity from which indices of stability (IS) and fragmentation (IV) were derived [7]. BMI was determined as weight/(height)^2, expressed in kg/m^2. Circadian rhythm characteristics of BP and heart rate (HR) were linearly regressed as a function of BMI and of IS and IV.

Results

Height and weight of 78 students were measured. Students' age (in years) ranged from 17-19 (N=27), from 20-22 (N=25), from23-25 (N=20), and from 26-31 (N=6) (mean ± SD: 21.2±3.2 years). While most students (49 or 62.8%) had an acceptable BMI, 10 (12.8%) were underweight (16.0<BMI<18.5), 16 (20.5%) were overweight (25<BMI<30), and 3 (3.8%) were obese (BMI>30), Figure 1.

ABPM for 2-8 days was done by 44 students. On the average, SBP, DBP, and HR were within acceptable limits.

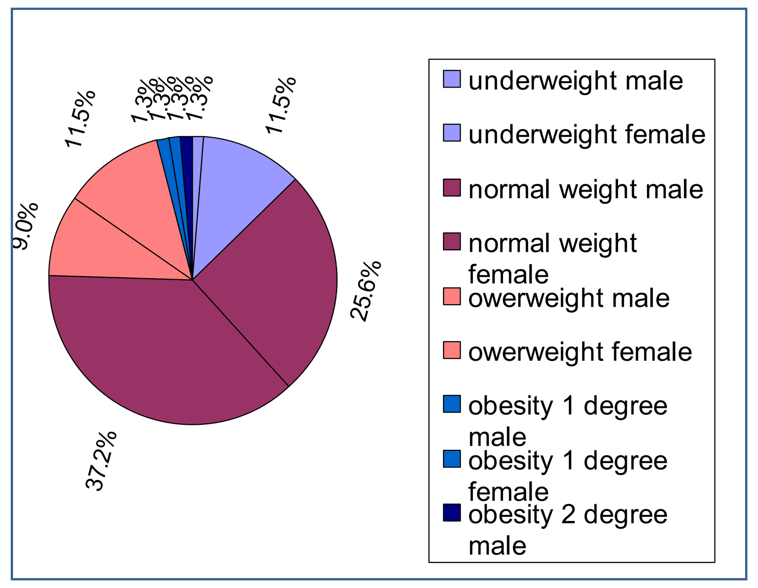
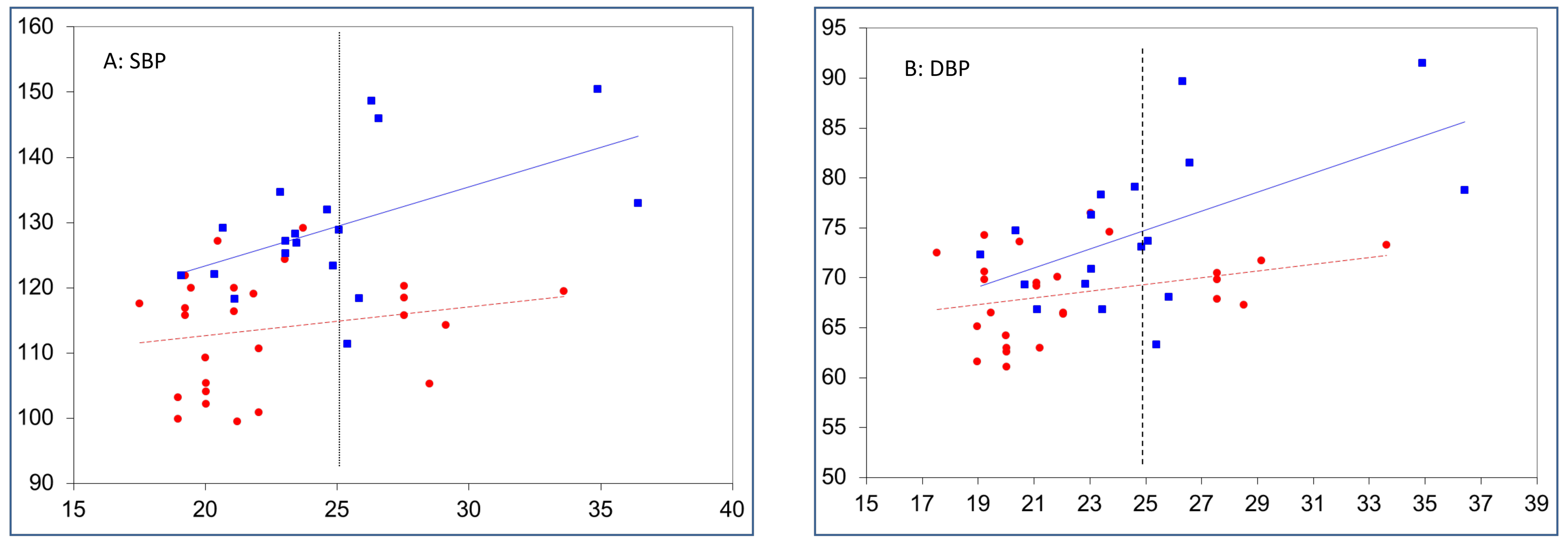
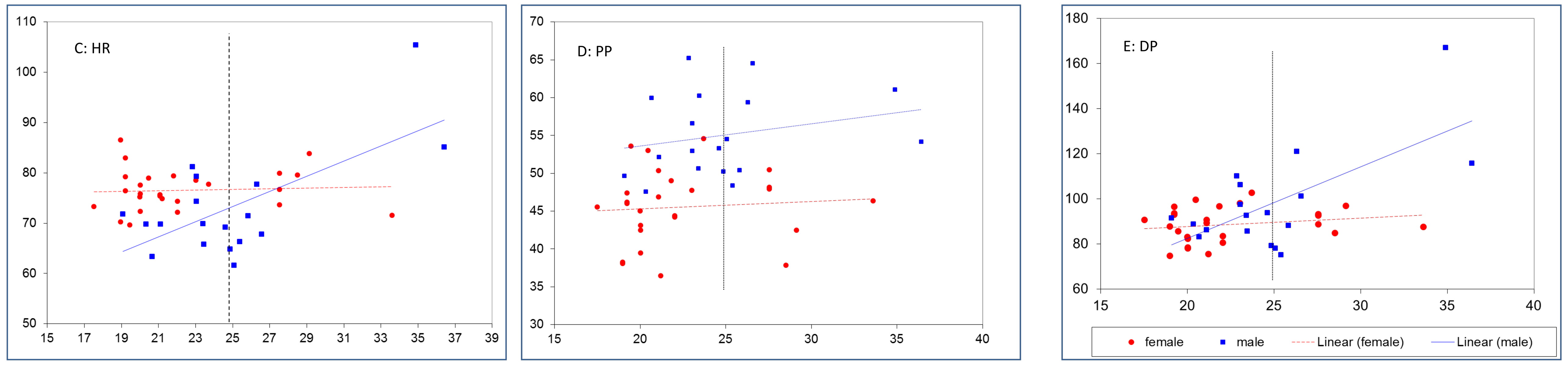


Figure 1: Body mass index of university students, N = 78, age 17-31 years.



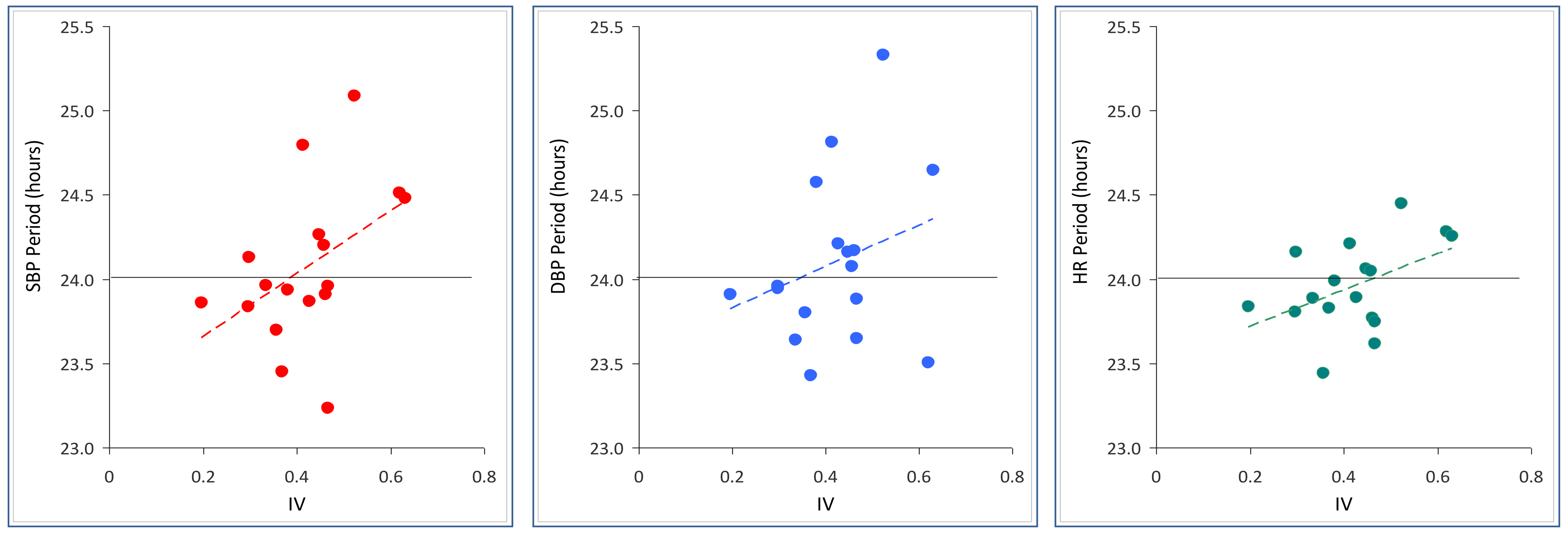


Figures 2-6: Gender differences of influence of BMI (abscissa) on SBP (A), DBP (B), HR (C), PP (D), and DP (E). Correlations of hemodynamic parameters with BMI in this age group is significant for male but not for female students.

Overall, the MESOR of SBP averaged (±SD) 120.1±12.1 mmHg, that of DBP 71.0±6.6 mmHg, and that of HR 75.1±7.4 beats/min; pulse pressure (PP) averaged 49.4±6.9 mmHg, and the pulse pressure product (DP) 92.4±15.5 mmHg.beats/min%.

DP correlated positively with BMI (r=0.511, P<0.001), both SBP (r=0.436, P=0.003) and HR (r=0.326, P=0.031) contributing to the relationship. DBP also correlates positively with BMI (r=0.503, P<0.001). PP was only weakly related to BMI (r=0.294, P=0.052), Figures 2-6. Associations of SBP, DBP, HR, and DP with BMI remained statistically significant only for male students (SBP: r=0.516, P=0.028; DBP: r=0.556, P=0.017; HR: r=0.658, P=0.003; DP: r=0.661, P=0.003), Figures 2-6.

A weak positive correlation of IV (but not IS) was found with the circadian period of SBP (r=0.451, P=0.069) and HR (r=0.460, P=0.063), Figures 7-9. IV was also weakly correlated with the absolute deviation from 24 hours of the period of SBP (r=0.443, P-0.075) and that of DBP (r=0.452, P=0.068). The circadian amplitude of DBP correlated negatively with IV (r=-0.604, P=0.010).



Figures 7-9: Length of circadian period depends to motion activity's rhythm fragmentation index

Discussion and Conclusion

A larger fragmentation of the activity rhythm is associated with a smaller circadian amplitude of DBP and a period longer than 24 hours of SBP and HR. The higher MESOR of SBP, DBP, HR, and DP of students with a larger BMI places them at a higher cardiovascular disease risk. The fact that these associations were found primarily in male but not in female students suggests that estrogens may protect young women. This possibility is in agreement with the lag in the incidence of cardiovascular morbidity/mortality observed in women as compared to men [8].

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