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Effect of Split Aerobic Exercise Sessions on Circadian Rhythm Variation of Double Product

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ABSTRACT

Recently double product (DP)has been considered as a useful index in context of sport science and cardiovascular health. DP or rate product ratio (RPR) equals Systolic Blood Pressure (SBP) multiplied by Resting Hear Rate (RHR). The aim of present study was to investigate the circadian rhythm variation of DP after1 (60 minutes) and 2 split exercise sessions (2×30 minutes) a day. Fourteen healthy males volunteered to participate in present study from University of Tabriz. Two groups of subjects in a crossover design were randomly distributed as group I (one session a day, twice a day) and vice versa for group II. Having completed the test (treadmill running with an intensity of 70 per cent of Maximum Heart Rate), RHR and SBP were measured every two hours for 24 hours. After one-week break, the procedure repeated for two groups vice versa and 24-hour measurement of RHR and SB.P was carried out. For analysis for data, repeated measure (ANOVA) was used. Each variables demonstrated a normal circadian rhythm. There were significant variations in circadian mean values for SBP (101.3±12.5 , 93. 9±4.5 , P=0.009) and RHR (91.9±10.9 , 96.7±6.8 , P=0.03) in 1 and 2 split session of exercise a day respectively. There was not significant changes in circadian rhythm of DP (72.05±1.47 U and equaled 73.88±12.16 U) in 1 an d 2 split session of exercise a day respectively although mean values from 20:00 to 08:00 in the morning were higher in 2 split sessions than 1 session. One aerobic exercise session compared to two split sessions a day with the same total time of exercise a day may not change circadian rhythm of double product within 24 hours following aerobic exercise. Split exercise sessions could be substituted for one session a day or the other way round without any extra overload on cardiac muscle. If the blood pressure is the main center of medical attention, split exercise sessions may be of value since the circadian rhythm of systolic blood pressure in this case is lower than 1 session a day.

Key words: circadian rhythm, double product, aerobic treadmill running, split exercise sessions

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INTRODUCTION

Circadian rhythms and specifically their regulations by exercise are a basic quality of human physiology, which have been extensively scrutinized in sport field [1]. It is commonly known that, in healthy humans, double product (DP) is an important parameter in context of cardiovascular health and it is calculated as heart rate (HR) multiplied by systolic blood pressure (SBP) [2-3]. DP also known as rate product ratio (RPR), is a noninvasive tool to observe and measure cardiac afterload since blood pressure (BP) is a key determinant [3]. DP likewise known as rate-pressure product has been extensively investigated in numerous studies because it could bring forth valuable information from cardiac workload, left ventricular hypertrophy and indirect measure of myocardial oxygen uptake

[4-5]. HR and BP increase during the day and decrease during the night, because of sleep-wake or rest-exercise changes [1-2]. As the existence of circadian rhythms of HR and BP is proved, this could be meant that DP has its specific circadian rhythm too. Additionally, recently published studies demonstrated that DP is a very useful tool for researchers to assess cardiovascular health in the context of exercise and sport science [6-7-8]. Nowadays, popularity of split exercise sessions (SES) is progressively increasing from professional sport fields to general population who are seeking healthy life [9-10-11-12]. Variables such as HR and BP are mediated by exercise throughout the 24 hour-period and there is an interaction between them, which puts forward DP. However, there are scant data, which investigated the circadian rhythm of DP and its variation following one and two SES [8-14]. SES compared to one session (with same total duration, intensity) in relationship with DP has not been studied yet and there are questions remained for those who observe effect of SES on DP, keeping BP normal. It is of utmost importance to observe the cardiac workload throughout day-night cycle to make sure whether there is any change between one and two SES[11-12-13].Thus, the main aim of present research is to investigate the effect of one and two SES a day with same intensity and total duration on circadian rhythm variation of DP in healthy young males.

MATERIALS AND METHODS

2-1 Database and Selection.

A quasi-experimental study was conducted on 20 healthy males at University of Tabriz. All subjects volunteered to participate in present study and had already been examined medically and confirmed with no history of chronic diseases, smoking, alcohol drinking, travelling beyond time zones and intensive activity. Prior to study conduction, all subjects gave their consent inform and ethical committee approval of Tabriz University received according to Helsinki declaration, 2008.

2-2 Measurement and Data Collection.

Participants attended the laboratory and descriptive data including VO_{2max} (Bruce maximal protocol), body mass, height and BMI (Table 1). All procedures were conducted in Tabriz university gym wherein light levels were controlled at approximately 200 lux, and temperature at 20 Ċ. Pre exercise BP and HR were measured by mercury sphygmomanometer and HR monitor polar (Polar T31 Coded Transmitter). Following exercise protocols, Resting BP and HR values were measured for 3 times at each time of day throughout the study and mean values were obtained to put in the analysis and statistical process.

Table 1– physiologic and characteristics of subjects in 2 groups (mean±SD)

Variable(s)	Vo_{2max} (mlo2 per Kg body weight . min)	BMI	Age	Height (M)	Weight (Kg)
Group 1	56.52±6.88	21.96±0.35	22.5±1.1	1.78±0.06	72.4±7.3
Group 2	55.74±7.32	21.38±0.41	22.8±1.7	1.75±0.03	71.4±5.6

BP (systolic and diastolic) and HR values were recorded after calculating the average value of 3 times of repetitive measuring and therefore DP calculated as HR (beat.min$^{-1)}$ multiplied by systolic BP (mmHg). By considering the relationship between HR and systolic BP, DP has also a circadian rhythm throughout that 24-hour a day. DP values were recorded the same as HR and BP every 2 hours following experimental protocols from 10:00 (first time of day, 30 minutes after exercise protocols) up to next day at 10_{AM} . Participants were divided into 2 groups (Group 1 and Group 2). Group 1 performed 60 minute treadmill running with intensity of 70 per cent of MHR ($08:30_{AM}$ to $09:30_{AM}$) while group 2 performed 2×30 minutes treadmill running ($09:00_{AM}$ to $09:30_{AM}$ and 19:00 to $07:30_{PM}$) with the same intensity (Figure 1). All participants were under 24 hour observation and HR, BP and DP were measured every 2 hours (12 times of day). After one week washout phase group 1 performed SES and group 2 performed single session treadmill running and 24 observation completed following protocols.

2-3 Statistical Analysis.

Data were analyzed by SBPPSS 17. Descriptive statistic including mean and standard deviation were calculated (table 2). Kolmogorov – Smirnov test was not significant thus indicating that all data were normal (P>0/05). In order to assess significant changes between two protocols, ANOVA test was used. All data are presented in tables 3, 4 and 5 for DP, HR and Systolic BP respectively. The significance level for this research was P=0/05.

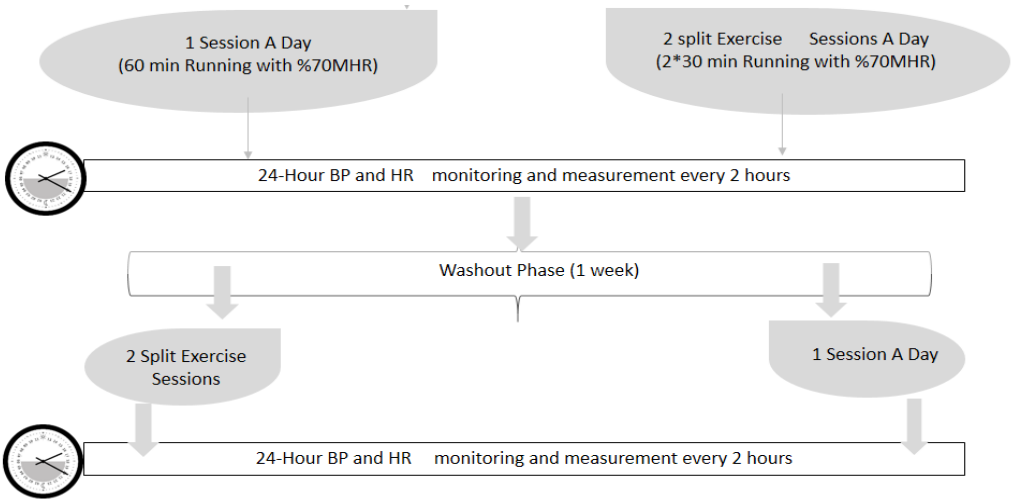

Figure 1 – study design

2-4 Results.

Study results revealed that there was not any significant variation in circadian rhythm of DP between one (72.05±1.47 unit) and two split exercise sessions (73.88±12.16 unit) (Figure 2). Unlikely the circadian rhythms of HR (97 beat per minute and 92 beat per minute in 1 and 2SES respectively, P=0.03, $F_{1, 12}$ =5.008) and systolic BP (117.6 mmHg and 105.6 mmHg in 1 and 2SES respectively, P=0.009, $F_{1, 12}$ = 9.18) showed significant variations (10.2%lower systolic BP and 5% higher HR values for SES compared with one session) (figures 3 and 4). However, mean values of DP from 20:00 to 08:00 were higher in SES than 1 session (figure 2).

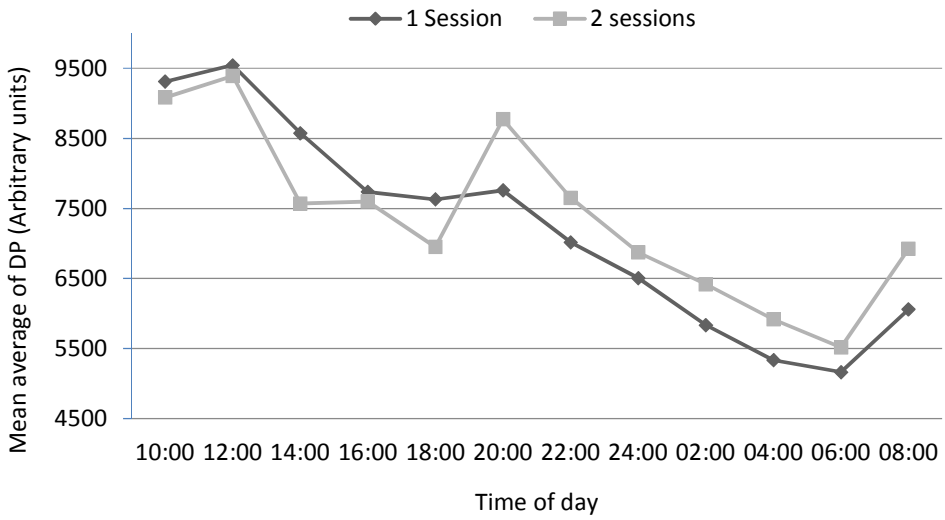

Figure 2- Mean values for DP in 12 time of day.

RESULTS AND DISCUSSION

Present study gives several clues from both perspectives of medical science and sport performance. As discussed previously, two main parameters of DP are HR and systolic BP, therefore any change in each parameter could influence DP and/or HR could interact with systolic BP. First, in accordance with previous works, our study

indicated that the post-exercise hypotension (mainly systolic BP) remains an effective preventative tool for cardiovascular diseases and lowering BP [15-16]. Our trial demonstrated the hypotensive effect of aerobic exercise in both one ES and two SES, but this effect was distinct in SES within 24 hour a day. The mechanism behind this may be act in a way that skeletal muscle afferents take a primary role in post exercise resetting of the baroreflex via discrete receptor changes within the nucleus tractus solitaire [16]. On the other hand prolonged post exercise vasodilatation following exercise (skeletal muscle contraction) is primarily the result of histamine H_1 and H_2 receptor activation [17]. The second one is the most expected reason for circadian rhythm variation of systolic BP. On the other hand, post exercise HR fluctuation and the circadian rhythm of HR, in our trial, exhibited a significant difference between one and two SES from which the latter showed a 5% increase in resting HR within 24 hour a day. Data collected from Myllymeeky et al. (2012), indicated that resting HR after exercise, called post exercise recovery increased due to aerobic exercise with an intensity of 70% MHR and the values obtained from circadian rhythm of HR were higher when compared with non-exercise status [20]. This is in consonance with our findings supporting that exercise bouts could delay HR values of circadian rhythm to resume their resting rhythm. Unlikely, studies conducted by Al Haddad et al (2011) and Armstrong et al (2012) stand in a contradictory route when compared with our finding [18-19]. In current study, it is observed that two SES with similar duration and intensity, compared with one exercise session could increase resting HR values within 24 hour a day and such increase stems from sympathetic activation (autonomic nervous system), hyperthermia and increased levels of catecholamine [18-19-21]. The latter may increase resting metabolic rate and thus consuming more calories during resting stats [22]. Regarding to DP, there are remarkable points to be mentioned. First, as a pioneering studies conducted yet, we found out that DP does have a circadian rhythm. In the second place, DP values of one and two SES are not different. This could be interpreted as healthy and safe exercise prescription for those who are contemplating an exercise plan for normotensive state , weight control as well as not putting cardiovascular system under pressure (the more DP values, the more cardiac work load is produced) [4-5-22]. In order to obtain a wide scope of DP circadian rhythm and exercise, particularly SES or distributed exercise sessions, further researches have to be conducted.

CONCLUSION

This study indicated that circadian rhythm of DP is not different when one exercise session is compared with two SES a day even though mean values related to circadian rhythm of systolic BP and HR are lower and higher in two SES than one session a day respectively. This finding might be of utmost importance regarding cardiovascular health. Based on results of this study, exercise plan could be split into two sessions for those who need to keep their BP lower and increase their resting metabolic rate without increasing myocardial work load with equal values of DP for one (60 minute treadmill running with an intensity of 70% MHR) and two SES (2×30 minutes morning and evening with an intensity of 70% MHR).

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