DIURNAL VARIATION IN POST-EXERCISE RESPONSE OF BLOOD PRESSURE: CIRCADIAN OR SLEEP-RELATED MECHANISMS?

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It is well-known that sudden cardiac events peak in the morning. The rise in blood pressure (BP) due to waking and the increase in physical activity has been linked to the peak in cardiac events. The response of ambulatory BP to everyday physical activities is highest in the morning compared to other times of day (Jones et al. 2006). All participants in that study slept normally at night therefore, it was difficult to separate any circadian influence on BP response from the effects of sleep per se. In two separate experiments, we (i) examined if the post-exercise response of BP is highest in the morning when prior sleep is controlled, and (ii) explored the links between circadian variations in BP response and other haemodynamic variables.

In experiment (i), six active, healthy males, aged 31±7 years, slept for 3.5 h prior to the first test-time at either 04:00 h or 16:00 h. Participants then performed four 30-min bouts of semi-supine cycling (60% $\dot{V}$O$_{2\text{peak}}$) separated by 2-hour intervals. Five minutes before, and 20-min after, each exercise bout, participants remained seated on the ergometer whilst 5-min averages of BP and heart rate were recorded. In experiment (ii), twelve active, healthy males, aged 27±6 years, cycled at 08:00 h and 16:00 h for 30 min at 70% $\dot{V}$O$_{2\text{peak}}$. Blood pressure and heart rate were measured as in experiment (i) alongside recordings of stroke volume, cardiac output, total peripheral resistance (TPR), core body temperature and skin blood flow. Changes from pre-exercise baseline were calculated. Data were analysed using general linear models and are described as mean±SD.

In experiment (i), an increase in mean arterial pressure (MAP) of 10±15 mm Hg was found 15 min after the exercise at 04:00 h. In contrast, post-exercise MAP at 16:00 h after daytime sleep was not increased 0±8 mm Hg (condition x time of day x exercise time; $P=0.001$). Importantly, less marked increases or even decreases in post-exercise MAP were observed at other times of day. In experiment (ii), the mean post-exercise change in MAP of 3±9 mm Hg at 08:00 h was, again, different from the -7±7 mm Hg mean change following exercise at 16:00 h ($P=0.026$). Unlike at 08:00 h, the BP response remained lower than baseline for the entire post-exercise period following exercise at 16:00 h. The post-exercise mean change in TPR was 0.1±5.4 mm Hg l$^{-1}$ min$^{-1}$ at 08:00 h compared to -4.2±2.7 mm Hg l$^{-1}$ min$^{-1}$ at 16:00 h ($P=0.024$). The mean change in cardiac output was 0.8±1.5 ml min$^{-1}$ at 08:00 h compared 1.9±0.8 ml min$^{-1}$ at 16:00 h ($P=0.011$).

These findings show that early morning exercise is associated with a rise, rather than a decrease in BP in the post-exercise period. New evidence is presented that this diurnal variation in BP response cannot be attributed to sleep-related mechanisms, but is mediated more by an endogenous mechanism in the cardiovascular system, probably involving diurnal variation in TPR. We advise that exercise very early in morning should be avoided by people for whom minimization of BP reactivity is important (e.g. cardiac patients).

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