

Increased Arterial Stiffness After Acute Exercise in Young Healthy Smokers

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Introduction: Cigarette smoking is arguably the most important and well-established behavioural risk factor for cardiovascular disease. Smoking has been found to have both acute and chronic direct effects on the body's vessels, causing stiffening of the arteries. Previous studies have shown that long standing smokers have stiffer arteries at rest. However, the effect of smoking on the ability of the vascular system to respond to physical stress, such as acute exercise (termed 'vascular reserve'), in young healthy smokers has not been investigated. Moreover, it has also not been studied whether non-smoking men and women exhibit different vascular reserve. The purpose of this study was to assess the a) effect of smoking, both acute and chronic, and sex, on the arterial stiffness at rest and the vascular reserve in young healthy individuals, b) reproducibility of our results using applanation tonometry.

Methods: Healthy smokers (n=13) and non-smokers (n=30) were recruited. Arterial stiffness parameters [augmentation index, carotid-femoral pulse wave velocity (cfPWV), and carotid-radial pulse wave velocity (crPWV)] were measured, using a non-invasive, highly reproducible technique (applanation tonometry) at rest, and 5-, 10-, and 15-minutes following a Bruce protocol treadmill exercise test to exhaustion. Smokers performed the protocol on 3 separate days, after: a) 12-h of smoking abstinence, b) chewing nicotine gum, and c) smoking 1 cigarette. The intra- and inter-operator reproducibility was assessed using the Bland and Altman method.

Results: Smokers (12h abstinence) have higher cfPWV than non-smokers at baseline (6.27 ± 0.23 vs. 5.69 ± 0.11 , $P < 0.05$) and at 5-, 10-, and 15-minutes post-exercise. Augmentation index and crPWV were not different at baseline or post-exercise between these groups. Augmentation index increased post-exercise in all 3 smoking visits. However, it only returned to baseline at 15-minutes post-exercise after 12h abstinence and remained higher after smoking 1 cigarette and chewing nicotine gum ($P < 0.05$). Furthermore, at 15-minutes post-exercise augmentation index remained higher in the smoking group compared to nicotine group (4.54 ± 2.45 vs. -1.69 ± 2.18 , $P < 0.05$). Between male and female non-smokers, the augmentation index significantly increased in men compared to women at 5-, 10-, and 15-minutes post-exercise ($P < 0.05$). These differences were not significant at baseline.

Reproducibility studies: 98.2% of values fell inside the tolerance interval (mean ± 1.96 SD) with an intra-operator difference of -0.15 ± 0.62 m/s for cfPWV; inter-operator difference was -0.21 ± 0.73 m/s.

Discussion: Arterial stiffness is increased in young healthy smokers at baseline and after acute exercise. Smoking 1 cigarette or chewing nicotine gum blunts recovery (impaired vascular reserve). There was very good reproducibility of our results. Importantly, we showed that even light smoking in young healthy individuals is detrimental to arterial function, affecting the ability of the vascular bed to respond to increased demands (vascular reserve). Additionally, men and women may also respond differentially to increased demands.

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