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E-Cigarette Use and Subclinical Cardiac Effects

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E-cigarettes deliver with each inhalation a bolus of poorly-characterized small molecules that have been linked to direct lung injury, can cross the alveolar-capillary barrier, and cause potential harm to other end-organs.

To understand the possible cardiac effects, we studied N=35 adults free of chronic disease (age 28±5 years, 26% female): self-reported non-smoking controls, exclusive e-cigarette users (mean e-cigarette use 3±2 years), and exclusive tobacco cigarette smokers (mean smoking history 9±3 years). Following overnight inhalant abstinence, participants underwent myocardial contrast echocardiography (MCE) to quantify myocardial blood volume (MBVol), microvascular flux rate (□), and blood flow (MBF).[1] We fit acoustic intensity timeplots to the function $y=MBVol*(1-e^{\beta t})$, with y representing acoustic intensity at time (t) and β denoting mean rate at which blood passes through microcirculation; we calculated myocardial blood flow (MBF)=(MBVol)*(β). We conducted MCE before and after isometric handgrip exercise stress (Figure),[2] which normally increases myocardial work and coronary endothelial-dependent vasodilation. We used Wilcoxon rank sum test for between-group and Wilcoxon signed-rank test for within-group comparisons (STATA v15.1). Our institutional review board approved all protocols; all participants provided written informed consent.

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DISCLOSURES

None.

DEDICATION

We dedicate this work to memory of Dr. Ronald G. Victor.

A prepublished version of the letter can be found at Medrxiv: https://www.medrxiv.org/content/10.1101/2020.01.16.20017780v1.

All de-identified study data are available at biodatacore.org\projects\circres2020.

At rest, MBVol was higher in tobacco users than in non-smoking controls (P=0.048) and there were otherwise no between-group differences in MBVol, β, or MBF. Under normal conditions, modest exercise stress induces physiologic increases in MBF by augmenting β with smaller degrees of increase in MBVol (Figure). Accordingly, in non-smoking controls, we observed a post-stress increase in β and MBF (95±13 to 153±16 IU/s, P=0.005). In tobacco users, stress also increased β, to a smaller degree than in controls, but induced no change in MBVol or MBF (102±13 to 118±14 IU/s, P=0.18). In e-cigarette users, stress induced no change in MBVol, β, or MBF (74±8 to 70±8 IU/s, P=0.51). E-cigarette use compared to tobacco smoking was associated with lower $MBF_{post\text{-}stress}$ in males but higher $MBF_{post\text{-}stress}$ in females; however, the sex interaction was not significant (P=0.07). There was no effect modification by age or body mass index.

We found evidence of coronary microvascular endothelial dysfunction in e-cigarettes users that was at least similarly severe when compared to conventional cigarette smokers. We observed these effects in apparently healthy young adults, and despite e-cigarette use being only recently popularized and conventional cigarette users having a longer prior tobacco exposure. In conventional smokers, blunting of the myocardial perfusion response to stress corresponded with a relative inability to augment blood volume – in the setting of increased blood volume at baseline, potentially related to longer-standing tobacco exposure. By contrast, in e-cigarette users, blunting of the myocardial perfusion response to stress corresponded with inability to augment both myocardial blood flow and volume. Although unmeasured in this study, our findings in e-cigarette users could be related to oxidative stress, myocardial diastolic dysfunction, and variability in vape device- or user-related factors. Further studies are needed, including those using higher-resolution imaging techniques, to further investigate e-cigarette effects on cardiac and vascular physiology. While the longer-term cardiovascular effects of e-cigarette use remain unclear, our findings support the need for ongoing investigations into their safety profile.

Acknowledgments

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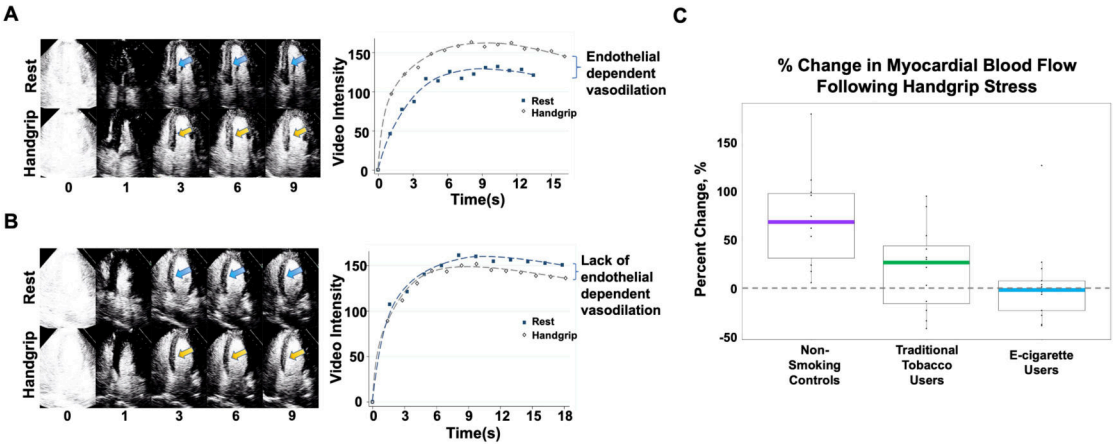

Figure.

30-year-old healthy non-smoker, myocardial contract echocardiography shows increase in septal myocardium perfusion (**A**); in a 33-year-old apparently healthy e-cigarette user, post-stress perfusion is blunted, indicating impaired endothelial-dependent vasodilation (**B**). Across our study sample (**C**), blunted post-stress myocardial blood flow in e-cigarette users was comparable to that seen in conventional cigarette users, driven more by attenuated myocardial flux rate than blood volume response (for details, see biodatacore.org\projects\circres2020).