Towards Virtual Populations: Sex-Specific Modelling of Arterial Pulse Waves and Pressure-Volume Loops

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Background: Arterial pulse waves (PWs) are rich in information about cardiovascular (CV) health and can be measured peripherally via wearables worn in daily life. Various algorithms have been developed to assess CV health from PWs, but their validation requires comprehensive and diverse datasets that are expensive to collect *in vivo*. Our aim was therefore to simulate peripheral PWs and corresponding cardiac pressure-volume (PV) loops, providing peripherally measurable signals alongside central cardiovascular signals, for two virtual subjects: a 47-year-old man and a 47-year-old woman.

Methods: PWs and PV loops were simulated using a closed loop model developed by coupling a 1D arterial circulation model (116 arterial segments) with a 0D, elastance-driven heart model (4 chambers) and 0D models of the venous and pulmonary circulation. Model parameters for the male and female virtual subjects were calibrated using *in vivo* data from subjects aged 45 to 49 years old with no history of CV disease in the UK Biobank.

Results: PWs (pressure, blood velocity, luminal area, photoplethysmogram) were generated for all 116 arterial segments, and PV loops were generated for all four heart chambers for the male and female virtual subjects. The virtual subjects were verified by comparing their *in silico* PWs and PV loops with *in vivo* PWs and PV loops respectively. Good agreement was observed, with sex-based differences in blood pressures and PV loops reproduced.

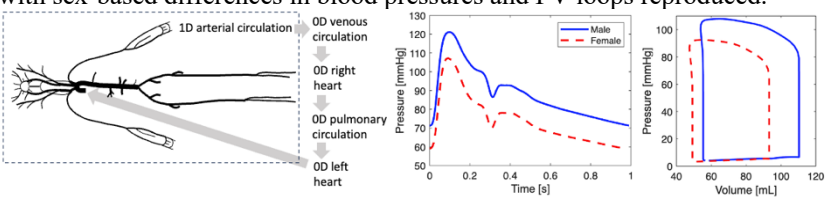

Figure. Left: Closed loop model; Middle: Male and female in silico finger pressure waves; Right: Male and female in silico left ventricular pressure-volume loops.

Conclusion: We generated and validated arterial PWs and PV loops for sex-specific virtual subjects based on *in vivo* data from the UK Biobank. Future work will produce large, sex- and age-specific virtual populations, which will be made freely available as a resource for further research.