

# TOWARDS A MULTI-SCALE COMPUTATIONAL TOOL FOR ASSESSING THE CARDIOVASCULAR RISK IN OBESE CHILDREN

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Childhood obesity is considered one of the major challenges of our century, reaching epidemic rates. Although primarily a dietary disease, obesity is known to advance endothelial dysfunction [1], an early manifestation of atherosclerotic lesions that cause most cardiovascular diseases. Early vascular damage can be assessed clinically in various ways, for example with measurements of the aortic and carotid intima-media thickness (IMT), and flow-mediated dilatation (FMD) of the brachial, radial, and femoral arteries [2]. However, the altered haemodynamic environment in high-risk patients is not yet clearly understood and the flow-related mechanisms that contribute to early vascular changes have not been analysed. This work will discuss the design of a multi-scale computational tool for assessing such early signs in children and adolescents. It will also present a model of FMD that attempts to clarify some of these aspects. Solutions to the time-dependent, incompressible Navier-Stokes equations are based on high-fidelity finite volume and hybrid Cartesian/immersed-boundary (HCIB) methods [3] that overcome several of the shortcomings of conventional computational fluid dynamic methods and provide increased spatial flow analysis. The codes have previously been validated and used extensively in various applications. Implementation of wall motion is particularly easy with HCIB methods, which are inherently capable of handling arbitrarily large body motions and allow for effective solutions of wall configuration. The model provides an evaluation of the haemodynamic shear stresses, a common indicator of early atherosclerotic lesion localisation. Future work will include multi-scale modelling that combines high-resolution 3D blood flow computations, with macroscopic and microscopic features of the vascular environment. Further haemodynamic metrics, such as the time-averaged wall shear stress (TAWSS), the oscillatory shear index (OSI), and the transverse WSS will also be assessed, in conjunction with patient data.

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## REFERENCES

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