DEVELOPMENT OF A SYSTEM TO ANALYZE PHYSIOLOGICAL PARAMETERS THAT ARE INFLUENCED BY ENDOTHELIAL DYSFUNCTION TO ASSESS RISKS OF DIABETES

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Master of Philosophy

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Thesis submitted in partial fulfillment of the requirements for the degree
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DECLARATION

I declare that this is my own work and this Thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The supervisors should certify the Thesis with the following declaration.

The above candidate has carried out research for the Master of Philosophy Thesis under our supervision. We confirm that the declaration made above by the student is true and correct.

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ABSTRACT

Vasodilatory Endothelial Dysfunction (VED) is identified as a precursor to cardiovascular diseases (CVDs) and atherosclerosis. Therefore, early detection of VED is important to prevent the development of severe CVDs and prescribe lifestyle changes or make clinical interventions. Though coronary angiography is the gold standard to detect VED, specialized devices have provided alternative means of detecting VED non-invasively. With these, they have detected VED in patients who are already diagnosed with CVD or Diabetes Mellitus (DM). Here, we investigated early detection of VED under four subject categories: individuals with pre-diabetes (PDM); healthy individuals with CVD risk factors (HRF); individuals with DM; and individuals with CVD. Non-invasively measured physiological parameters were used to detect VED. We developed a custom-made device to record non-invasive physiological parameters from the distal end of upper limbs namely, Digital Body Temperature, Peripheral Arterial Tone, Photo Plethysmography and Peripheral Bio-impedance. Multiple indices which represent unique features of these parameters were calculated considering both long-term and short-term variations. Using these, the performance of this device was validated against the flow-mediated dilation (FMD) procedure in a preliminary study with 10 volunteers (age range: 35 - 60 years): 5 healthy subjects (control) and 5 CVD patients with/without DM. Then the clinical study was conducted with 69 participants (age range: 35-60 years) with all the subject categories: healthy (n=9), HRF (n=15), PDM (n=6), type 2 DM (n=15), CVD with/without DM (n=24). CVD risk factors identified for the HRF category were physical inactivity, unhealthy diet, smoking, alcohol consumption, body mass index, and family history of CVD. Participants with type-1 DM, liver cirrhosis, renal failure, thyroid disease, spinal cord injuries, and finger deformities were excluded from the study. In the preliminary study, an unpaired t-test performed between FMD readings and indices derived from parameters calculated from the custom-made device validated device performance. In the clinical study, the ANOVA analysis showed promising results ($p<0.05$) in distinguishing long-term trend variations and short-term variations of VED-associated physiological parameters in test subjects diagnosed with CVD or DM along with preclinical stages compared to the healthy conditions. Thereby, we have demonstrated that it may be possible to detect the early development of CVD in preclinical stages through monitoring these VED-associated physiological parameters.

Keywords: Vasodilatory Endothelial Dysfunction, Cardiovascular diseases, Risk factors, Pre-Diabetes, Peripheral Bio-impedance

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES