STUDY OF HYPERTENSION AMONG UTM STAFF USING ANALYSIS OF
HEART RATE VARIABILITY

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Specially dedicated to my beloved husband, mother, parents in law, children, lecturers and friends for the endless support, encouragement, great patience and best wishes throughout this period.

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ABSTRACT

The occurrence of hypertension around the globe is showing an alarming figure and calls for a mechanism for its early detection. Heart Rate Variability (HRV) analysis can possibly be used as a tool for detecting hypertension due to its appealing non-invasive and quantitative approach. Various research has been done on finding the relationship between HRV and hypertension and generally hypertension is often being related to a decrease in HRV values. However, the results remain inconsistent across measures of gender, age and many other factors. This research aimed to extract HRV features associated to hypertension and investigate the relationship between HRV and hypertension with focus on academic staff. It was carried out by acquiring ECG data from hypertensive and non-hypertensive subjects and extracting HRV signal. This was followed by extracting five time domain and three frequency domain features from the HRV signal. The HRV features were subsequently analysed using statistical approach namely the ROC test, Mann Whitney-U Test and the Spearman Correlation Coefficient Test. Results from the three test done shown that the parameter normalized low frequency (n.u. LF) value can be used to associate between HRV and hypertension. In conclusion, the hypertensive subjects have higher n.u. LF values as compared to the non-hypertensive subjects. However, the limitation of this study is that the number of subjects is relatively small. Therefore, in future, the analysis may be repeated for a larger database.

ABSTRAK

Peningkatan bilangan pesakit darah tinggi yang merisaukan di seluruh dunia memerlukan mekanisma untuk pengesanan awal bagi penyakit ini. Analisa kepelbagaian kadar denyutan jantung (HRV) berpotensi untuk menjadi alat pengesan penyakit darah tinggi kerana is menawarkan cara yang tidak memerlukan intervensi dan berdasarkan ciri kuantitatif. Pelbagai kajian telah dijalankan untuk mendapatkan hubungan di antara HRV dan penyakit darah tinggi. Lazimnya penyakit darah tinggi sering dikaitkan dengan nilai parameter HRV yang lebih rendah. Walau bagaimanapun, keputusan kajian-kajian tersebut tidak konsisten setelah mengambil kira faktor jantina, usia dan lain-lain lagi. Tujuan kajian ini adalah untuk mengenalpasti parameter HRV yang boleh dikaitkan dengan penyakit darah tinggi dan seterusnya menyiasat hubungan di antara penyakit darah tinggi dan HRV dengan berfokuskan subjek di kalangan kakitangan akademik. Kajian ini dimulakan dengan mendapatkan data elektrokardiogram (ECG) daripada subjek berpenyakit darah tinggi dan subjek yang tidak mempunyai penyakit darah tinggi dan mengekstrak signal HRV. Seterusnya, lima ciri domain masa dan tiga ciri domain frekuensi diekstrak daripada signal HRV tersebut. Setelah itu, parameter-parameter HRV tersebut diuji dengan ujian statistik iaitu ujian ROC, Mann Whitney-U dan ujian Spearman Rank Correlation. Keputusan daripada ketiga-tiga ujian tersebut mendapati parameter frekuensi rendah yang telah dinormalkan (n.u. LF) mungkin boleh mengaitkan di antara HRV dan penyakit darah tinggi. Kesimpulannya, pesakit darah tinggi mempunyai nilai n.u. LF yang lebih tinggi daripada individu yang tidak mempunyai penyakit darah tinggi. Walau bagaimanapun. kekurangan kajian ini adalah mempunyai jumlah subjek yang relatifnya sedikit. Oleh itu, pada masa hadapan, analisis ini boleh diulang ke atas pangkalan data yang lebih besar.

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LIST OF ABBREVIATIONS

AR	-	Autoregressive
ANOVA	-	Analysis of Variance
AUC	-	Area Under The Curve
BMI	-	Body Mass Index
BP	-	Blood Pressure
CWT	-	Continuous Wavelet Transform
DFT	-	Discrete Fourier Transform
DWT		Discrete Wavelet Transform
ECG	-	Electrocardiogram
FFT		Fast Fourier Transform
HF	-	High Frequency power
HRV	-	Heart Rate Variability
LF	-	Low Frequency power
LF/HF	-	Ratio of Low Frequency and High Frequency power
mmHG	-	Millimetres of Mercury
NN50	-	No. of adjacent RR intervals differing by more than 50 ms in entire ECG recording
n.u. LF	-	Normalized Low Frequency power
n.u. HF	-	Normalized High Frequency power
pNN50	-	NN50 count divided by total number of all RR intervals
PSD	-	Power Spectral Density
RMSSD	-	The root mean square successive difference of successive
	-	RR intervals
ROC	-	Receiver Operating Characteristic
SDNN	-	The standard deviation of the RR interval

STFT   -   Short Time Fourier Transform

TP   -   Total Power

UTM   -   Universiti Teknologi Malaysia

VLF   -   Very low frequency power

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CHAPTER 1

INTRODUCTION

This chapter introduces the background of this research including the problem statement, objectives, scope of the project and lastly the thesis organization.

1.1.   Background

Heart rate variability (HRV) analysis is a simple, practical and non-invasive instrument [1] that can investigate cardiac autonomic dysregulation in hypertension quantitatively [2] and noninvasively. HRV can indicate the status of the autonomic nervous system [3] and can even be linked to diseases, pathologic states and mortality [4][5]. A high variability in heart rate is a sign of good adaptability of the heart to changing circumstances hence indicating a healthy individual with well-functioning autonomic control mechanisms. Conversely, a lower variability of the heart rate often become an indicator of insufficient adaptability of the autonomic nervous system which implies the presence of physiological malfunction in an individual [6]. The normal variation of the heart rate is cause by the autonomic neural regulation of the heart and the circulatory system [3].

Technically, HRV can be defined as the variation of the period for consecutive heartbeat over time. HRV is measured using electrocardiogram (ECG) signal that will display a series of waves that present electrical events in the four chambers of heart and the conduction pathways within the heart [7].

The established clinical data based on various study done has reflected that the decreased in global HRV as a strong predictor of cardiac and/or arrhythmic mortality particularly for patients at risk after myocardial infarction or congestive heart failure [8]. HRV can decrease for a number of factors such as due to stress (emotional or physical) and can increase with rest [9]. Studies done has shown there is a decreased in HRV among hypertensive subjects [2][10]. Additionally, the data from the Framingham Heart Study done by Singh *et al*., [10] propose that normotensive men with lower HRV are expose to the greater risk of developing hypertension.

1.2.   Problem Statement

Hypertension has become an important global health concern due to its high prevalence [11] and detrimental health effect. It has been estimated that the total number of people having hypertension disease in the year 2000 was 972 million, with 333 million in the economically developed countries and another 639 million in the developing countries. This number is expected to escalate by approximately 60% to a total of 1.56 billion in year 2025 [12]. While in Malaysia, a survey on the Malaysian National Health and Morbidity done in 1996 for 21,391 individuals aged over 30 years old had shown the prevalence of hypertension was 24% [13]. This alarming figures justifies the importance of awareness, preventive and control of hypertension among the public. An early detection tool or mechanism for hypertension is also much desired as it can be one of the means to control hypertension occurrence.

HRV and hypertension are basically related to the human heart system. However, to date, there is still no clear temporal sequence that has been determined to associate between HRV and hypertension. The direct relation between HRV and hypertension or even blood pressure is still not conclusive yet. As HRV tool offers the much desirable non-invasive approach in diagnosing cardiac autonomic dysregulation, a study on the relation between HRV and hypertension would be beneficial to establish a practical association between the two variables. This is particularly important for the early detection of hypertension and may even be utilized to relate HRV with hypertension causal factors such as due to occupational stress.

1.3. Objective

The objectives of this project are:
1. To extract time domain and frequency domain HRV features associated to hypertension.
2. To investigate the relationship between HRV and hypertension.

1.4. Scope

Analysis of HRV is being carried out based on data being collected from the academic staff of Universiti Teknologi Malaysia (UTM) who had sought out treatment at UTM Health Centre in year 2015. The numbers of subjects are 30 for hypertensive subjects and 30 for non-hypertensive subjects. The subjects are being identified as having hypertension disease or not based on the record of the UTM Health Centre. The age of the subjects is within the range of 40 to 55 years old.

1.5.   Thesis Organisation

This thesis contains five chapters. Chapter 1 begins with the introduction of this project consisting of background, problem statement, objectives and the scope of this project.   Chapter 2 contains the literature review from various resources. Chapter 3 explains the methods used in this project. Chapter 4 discusses the results of this study. Lastly, chapter 5 concludes the finding of this research together with future recommendations.

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