Constructing an Alternative Non-Communicable Diseases (NCDs) Surveillance Indicator in Malaysia

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DECLARATION

The research described in this Master thesis, entitled "Constructing an Alternative Non-Communicable Diseases (NCDs) Surveillance Indicator in Malaysia" is to the best of the author's knowledge that of the author except where due reference is made. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Non-communicable diseases (NCDs) is a leading cause of death that has reached epidemic proportions worldwide. Hence, it is vital to target the major risks that cause an increased prevalence of NCDs, particularly in Malaysia. In this study, a composite leading indicator, which included six sub-pillars and 29 sub-components, was employed, by adopting the indicator construction procedure outlined by the Conference Board (2000). A weighting scheme—both equal weighted and PCA-weighted—was applied to both sub-pillars and sub-components, where the set of weightages were derived from the loading factor of the PCA. In short, the objective of this study is to develop an alternative non–communicable diseases (NCDs) surveillance indicator to target risks prevalence. The findings show that the leading characteristics were successfully determined. Chronologies for the series were determined and the average leading quarters and directional accuracy were acquired. Then, binomial testing was performed to evaluate the accuracy of the computed equal-weighted and PCA-weighted approach, NCDRI, to forecast the direction of fluctuations. Later, NCDRI was selected and subsequently subjected to an econometric analysis to model the relationship between NCDs risks and macroeconomic variables. This study also presented an empirical discussion of the interactions between NCDs risks, human capital development, and economic growth.

Keywords: Non-communicable diseases, risks, composite indicator

Membina Indikator Alternatif bagi Pengawasan Penyakit Tidak Berjangkit (NCDs) di Malaysia

ABSTRAK

Penyakit tidak berjangkit (NCDs) adalah penyebab utama kematian dan mencapai proporsi epidemik di seluruh dunia. Ia adalah penting untuk mensasarkan faktor risiko utama yang mempengaruhi jumlah kelaziman oleh NCDs di Malaysia. Dalam kajian ini, satu petunjuk utama komposit termasuk enam sub- tunggak dan 29 sub-komponen telah digunakan dengan menggunakan prosedur pembinaan petunjuk yang digariskan oleh Lembaga Persidangan (2000). Skim pemberat untuk kedua-dua bukan berwajaran dan pemberat PCA digunakan kepada kedua-dua sub-tunggak dan sub-komponen di mana set berat yang diperoleh dari faktor pemuatan PCA. Secara ringkasnya, objektif kajian ini adalah untuk membangunkan indikato ralternatif bagi pengawasan penyakit tidak berjangkitan (NCDs). Keputusan untuk mensasarkan kelaziman faktor risiko dengan ciri-ciri utama telah berjaya menentukan indikator bagi kajian ini. Kronologi bagi siri ini telah ditentukan dan purata suhuan utama dan hubungan telah dicapai. Ujian binomal telah dijalankan untuk menilai ketepatan pengiraan pemberat indiKator berwajaran yang setara dan pendekatan pembarat PCA, NCDRI dalam meramalkan arah turun naik inflasi. Seterusnya, NCDRI akan dipilih dan tertakluk kepada analisis ekonometrik untuk memodelkan hubungan antara risiko NCDs dan pembolehubah makroekonomi. Kajian ini juga membentangkan perbincangan empirikal mengenai interaksi antara risiko NCDs, pembangunan modal insan dan pertumbuhan ekonomi.

***Kata kunci**: Penyakit tidak berjangkit, risiko-risiko, penunjuk komposit*

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LIST OF ABBREVIATIONS

TOB	Tobacco
SMK	Smoking
DRU	Drug use
ALC	Alcohol beverages
DIR	Dietary risks
LPA	Low physical activity
DOC	Total number of doctors
BEDS	Total number of beds
EXP	Per capita expenditure on health
VAC	Coverage of 7 vaccines
NUR	Total number of nurses
HSP	Total number of hospitals
MCM	Family with modern contraception
ESI	Coverage on Essential Service Index
GPI	School enrolment, gender parity index
RGDP	Real GDP per capita
HSR	Human sex ratio
POU	Prevalence of undernourishment
POB	Prevalence of obesity
POO	Prevalence of overweight
PCAN	Prevalence of cancers
PSTROKE	Prevalence of stroke
PDBT	Prevalence of diabetes mellitus
INM	Infant mortality rate
MEM	Maternal mortality rate
PEM	Perinatal mortality rate
NEM	Neonatal mortality rate
TOM	Toddler mortality rate
CPIH	Consumer price index on healthcare

CHAPTER 1

INTRODUCTION

1.1 Introduction

Non-Communicable Diseases (NCDs) is a leading cause of death that has reached epidemic proportions worldwide. Based on data from the World Health Organisation (WHO, 2017), NCDs are defined as chronic diseases, which tend to have a long duration of diagnosis and are the result of a combination of genetic, physiological, environmental, and behavioural factors. These diseases could occur in all groups of age, gender, region, or country. Contrary to popular opinion, the data shows that almost half of the disease burden that strikes the hardest on the world's low-and-middle-income countries consists of NCDs (WHO, 2017). To date, WHO (2017) evidenced that the 15 million people that died from NCDs were between the ages 30 and 69 and were from the working-age population. Among the various types of NCDs, cardiovascular diseases contributed to the most NCDs deaths i.e. 17.7 million people every year, followed by cancer (8.8 million), respiratory diseases (3.9 million), and diabetes (1.6 million). Unfortunately, these diseases are exacerbated by a variety of motives prevalent in society such as the speedy unplanned urbanisation in a nation, population ageing, growth in the number of fast-food chains, and the globalisation of unhealthy diets.

Concerns have arisen around the challenges of the dual burden of Communicable and Non-Communicable diseases while still retaining the affordability and accessibility of

healthcare for all. Risk factors that could be averted are the causes of most NCDs as compared to unpreventable risk factors. The Global Health Observatory (GHO) data showed that four behavioural practices which are harmful use of tobacco, low physical activity, dietary risk, and the alcohol consumption were the main reasons for the rise in NCDs. These practices cause metabolic or physiological changes (WHO, 2018). The different intensities of risk factors causing NCDs highlight the need for every country to have its own risk factor indicator to better capture the effects of these diseases. According to the recent Global Burden of Disease study, nearly 12 million deaths were due to dietary risk, 6.5 million were due to harmful use of tobacco, 1.8 million were due to alcohol and drug consumptions, and 1.6 million deaths were attributed to physical inactivity in 2015 (Singh et al., 2017). It is therefore clear that the rising prevalence of NCDs is one of the key challenges faced by the current healthcare industry, as it correspondingly amounts to increased mortality levels in a country. Therefore, before drafting any policies, policymakers need to recognise the trend and outlook of NCDs movement in a country, in this case, Malaysia, so that the burden of NCDs on households and the society can be lessened. Furthermore, all sectors, be it healthcare, finance, education, agriculture, public infrastructure, etc., must collaborate to come out with comprehensive tactics to address this issue.

1.2 Background of the Study

1.2.1 Defining Non-Communicable Diseases (NCDs)

NCDs are defined as chronic diseases in which the patients are diagnosed with a long duration of the disease. These diseases can be a result of a combination of genetic,

physiological, environmental, and behavioural factors. These diseases normally follow a prolonged course and therefore require long-term treatment, but a complete cure or full recovery is rarely achieved.

Table 1: Differences between NCDs and CDs

Differences	Communicable Diseases (CDs)	Non-Communicable Diseases (NCDs)
Definition	The disease spread from person to another, they are 'catching' disease and can be spread through the air, water, etc.	The diseases which does not spread from one person to another through any mode.
Causes	Caused by pathogens and considered as highly infectious and vectors play the major role in spreading disease from one person to another.	Caused due to allergy, illness, malnutrition or abnormalities in cell proliferation, changes in lifestyle, environment play a significant role.
Infecting agent	Bacteria and virus.	No infectious agent.
Example	Tuberculosis, AIDS, Typhoid, Cholera, Malaria.	Cancer, Rickets, Allergies, Kwashiorkor, Diabetes, Heart disease, etc.
Inheritance	This disease cannot be inherited from one generation to another.	This disease can be inherited.
Treatment	Treated by conventional methods.	Treated conservatively or surgically.
Type	Acute (develops quickly).	Chronic (develops slowly and last for long period).

Source: Bio Differences (2017)

Table 1 shows the differences between Non-Communicable Diseases (NCDs) and Communicable Diseases (CDs). There are a few types of NCDs, which are cardiovascular diseases, cancer, chronic respiratory diseases, diabetes, chronic neurologic disorders, and others. Of these diseases, the major types of NCDs that cause the most deaths are cardiovascular diseases (heart attacks and stroke), cancers, chronic respiratory diseases

(chronic obstructive pulmonary disease and asthma) and diabetes (WHO, 2018). However, NCDs are different from Communicable Diseases (CDs). The latter can be defined as diseases that can spread from one person to another through a variety of ways such as contact with blood or by breathing. The types of CDs include HIV/AIDS, Hepatitis A and B, Flu, Ebola, and others.

1.2.2 Defining Risk Factors

A risk factor refers to any of the attributes, characteristics, or exposure of an individual that increases the likelihood of his or her developing a disease or injury (WHO, 2018). It can also be defined as an aspect of personal behaviour or lifestyle, exposure to an environment, or a hereditary characteristic that is associated with an increase in the occurrence of a disease, injury, or other health conditions (Centres for Disease Control and Prevention, 2006). NCDs risk factors are divided into two: modifiable risk factors and non-modifiable risk factors. A modifiable risk factor is a behavioural risk factor that can be modified or controlled by the self or via intervention to reduce the chances of diagnosis of the disease. There are four main modifiable risk factors prioritised by WHO, which are physical inactivity, tobacco use, alcohol use, and unhealthy diets. However, a risk factor that cannot be reduced or controlled by self-control or intervention is known as non-modifiable factors such as age, gender, race, and family genetics issues.

1.3 Overview of Non-Communicable Diseases (NCDs) Trends

1.3.1 Non-Communicable Diseases from a Global Perspective

NCDs have become an extremely important public health concern around the world. This disease epidemic is driven by powerful forces that impact every region of the world. The magnitude of these diseases is continuing to rise, especially in low- and medium-income countries. These countries are transforming from a traditional society to a speedy and unplanned urbanised one. The globalisation of marketing and trade, rapid urbanisation, and population ageing have resulted in increased cases of NCDs. This transformation has led to lifestyles characterised by unhealthy diets, physical inactivity, and alcohol and tobacco consumption. Unhealthy lifestyles are always associated with common modifiable risk factors of chronic diseases such as hypertension, diabetes, stroke, and obesity, as each of these factors has the individual potential to affect and take control. For example, unhealthy diets and a lack of physical activity will lead to high blood pressure and high blood glucose, while indirectly increasing the risk of diabetes and obesity.

The data shows that, each year, 15 million people die from NCDs between the ages of 30 and 69, the range of the most productive period of life (WHO, 2018). It is expected that, by 2020, in developing countries, non-communicable diseases (NCDs) will account for 69% of all deaths, with cardiovascular diseases taking the lead. Amongst all these NCDs, cardiovascular diseases, cancer, diabetes, and chronic lung diseases are the four main contributors to the most to deaths. This data is important for a country’s economic growth

because a large proportion of the country's population will face both ageing and premature death.

1.3.2 Non-Communicable Diseases in Developing Countries

The low-and middle-income regions are expected to bear the strongest effect of NCDs. This NCDs epidemic also disproportionately affects people in the lower socioeconomic group. WHO evidenced that 15 million of all deaths were caused by NCDs, and, of these deaths, over 80% were estimated to occur in low- and middle-income countries (WHO, 2018). To curb these deadly diseases, the government of a nation must make further efforts to strengthen its healthcare policies. Many countries have put in the effort to curb and reduce this deadly disease, however, an absolute increase in the potential impact of the disease on these countries' healthcare system, economy, and society is still observed. For example, evidence has shown that although Nigeria did its part in reducing the population-adjusted burden of diabetes by 14.5% between 2000 and 2015, the total burden of disease still increased by 26.7% over the same period (Pulvermacher, 2017).

It is undeniable that the lower socioeconomic group will aggravate the poverty issue in a society, leading to insufficient budgets for living costs, so that these households will tend to reduce their daily spending on unnecessary goods only to fulfil their basic needs. Likewise, with the unhealthy lifestyle and diet practices among households, children and the elderly are at risk of being directly exposed to NCDs. Furthermore, without a proper budget allocation for the nation's healthcare services and infrastructure, none of the parties will be able to effectively collaborate or practise the drafted policies. This is because, with limited

financial resources, the government must allocate its budget wisely for the healthcare system while still investing in adequate healthcare infrastructure.

1.3.3 Non-Communicable Diseases in Malaysia

The behaviours of individuals are vital factors that cause the pattern of risk factors of NCDs. Multiple risk factors can be traced back to individual behaviours. According to the Global Status Report by WHO, health-damaging behaviours such as smoking, heavy alcohol drinking, inadequate fruit and vegetable consumption, and physical inactivity are the leading risk factors that contribute to multiple health conditions and diseases. It is not surprising, therefore, that the incidence of NCDs in Malaysia and the factors that caused NCDs have risen significantly. Malaysia is expected to stabilise and enhance its economic growth. In doing so, many of its on-going efforts will change the socio-economic determinants of the healthcare sector such as economic transition, globalisation of trade and business, unhealthy lifestyles, expansion in unhealthy products, changes in socio-demographic pattern, and population ageing. These changes and transformations will increase the exposure of the people to NCDs. Also, the Malaysian National Health and Morbidity Survey (NHMS), which monitors NCDs risk factors, indicated a three-fold rise in the prevalence of obesity, from 4.4% in 1996 to 15.1% in 2011 for adults aged 18 years and above. This data equates to approximately 2.5 million Malaysians meeting the criteria for obesity in 2011.

Besides, in 2014, NCDs are estimated to account for 73% of the total deaths in Malaysia (WHO, 2014). In this case, these deaths include people in the economically productive age of 30 to 60 years—a loss of which will have extraordinary implications for

the economy of a country. Ordinarily, modifiable risk factors underline the major NCDs including unhealthy diets, consumption of tobacco, harmful use of alcohol, insufficient physical activity, obesity, raised blood pressure, and so on. As programmes and policies to improve health worldwide become more widespread, there is a need for more comprehensive, credible, and critical assessments to periodically monitor population health and the success, or otherwise, of these policies and programmes.

The global healthcare sector is being plagued by low and stagnant government spending and high out-of-pocket expenditure. Each country in its endeavour to progress seeks to push through a massive process of development and change, and health is an important part of that process (Hameed, 2014). As the population keeps on growing, governments around the world are becoming increasingly aware of the need to provide the most suitable medical infrastructure to promote optimum health. However, the healthcare industry is continuously facing excessively increasing costs, declining profitability, administrative inefficiency, and steep regulatory compliance. According to the Malaysian National Health Accounts (2016), the total health expenditure in Malaysia was in the range of RM8,277 million in 1997 and increased to RM52,609 million in 2015, as shown in Figure 1. Thus, the government will need to decide and allocate its budget wisely due to limited financial resources. Meanwhile, this invisible epidemic is an underappreciated cause of poverty and hinders the economic development of a country. This burden is burgeoning among people, families, and communities. Despite the rapid growth of NCDs, much of the human and social impact caused every year by NCDs that lead to deaths could be averted through public awareness, cost-effective policies, and feasible intervention.

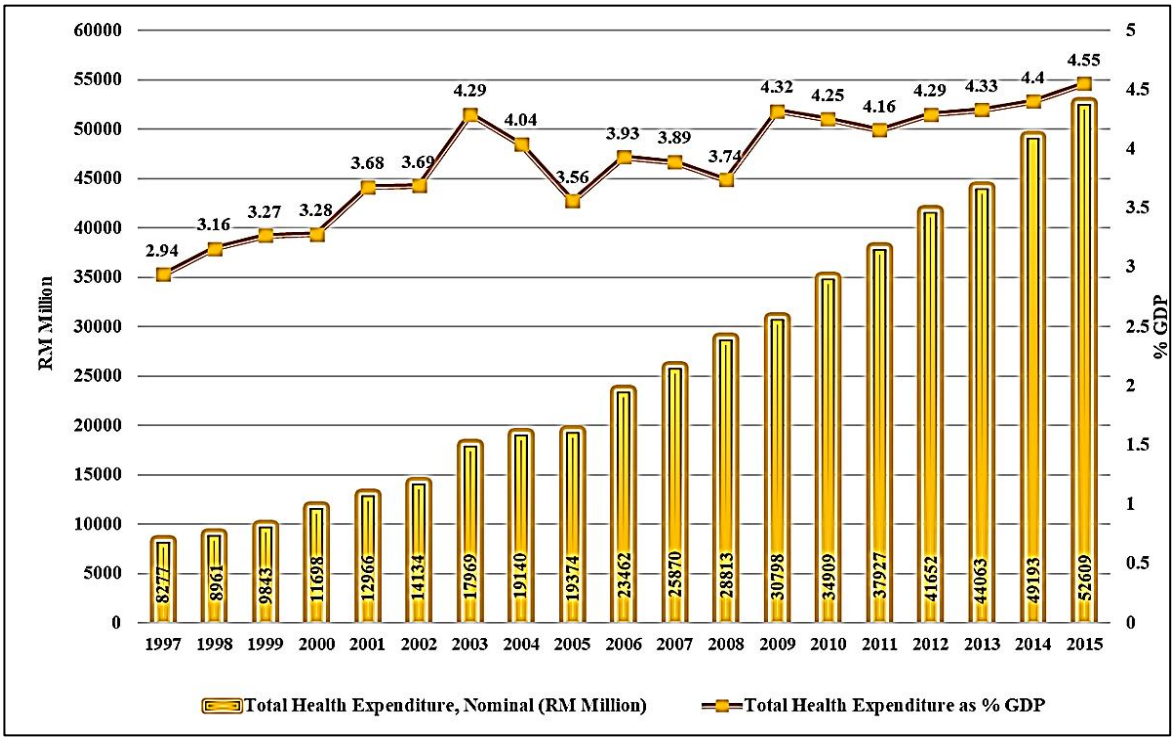

Figure 1: Trend for Total Expenditure, 1997-2015

Source: MNHA Health Expenditure Report)

1.4 Overview of Healthcare System in Malaysia

1.4.1 Development of the Healthcare System in Malaysia

Healthcare in Malaysia, without a doubt, has undergone tremendous positive changes compared to its state ten to fifteen years ago. The stable economic growth and political climate in Malaysia during the last three decades have greatly contributed to the improved socio-economic status of its population and has led to significant lifestyle and dietary changes. In any country, health improvement and human capital are pivotal components towards achieving sustainable development and economic growth. It is believed that healthcare services are expanded as a post-independence priority, particularly for the

economically disadvantaged and rural population (Heng Leng & Barraclough, 2007). In Malaysia, the healthcare system has changed from relying on traditional remedies to meeting the emerging needs of the population. Since the Independence of Malaysia in 1957, there has been a major reorganisation of the healthcare services in the country.

According to Castro (2009), Malaysia's healthcare has experienced an essential transformation, i.e. transformation from a three-tier primary healthcare model developed for the public sector in the late 1950s to a sub-centre tier abolished in 1970, up to the present (Table 2). Presently, the healthcare system comprises health clinics with a comprehensive range of primary medical care services and community clinics with services largely limited to maternal and child health. The Malaysian healthcare system consists of tax-funded and government-run universal services and a fast-growing private sector. The country's Ministry of Health (MOH) provides government-run universal services and is the main provider of healthcare services to the public. There are three levels of organisational structure in the MOH, which are Federal, State, and District that are decentralised to ensure cost-effectiveness. The private health sector provides health services, mainly in urban areas, through physician clinics and private hospitals with a focus on curative care. Furthermore, private companies run diagnostic laboratories and some ambulance services to make sure that healthcare services can be provided in time and with efficiency. A schematic overview of the healthcare system in Malaysia is shown in Table 2.

The UN Development Programme has hailed Malaysia as a shining example for other developing countries. Deemed essential to the Malaysian economy, the government has prioritised healthcare spending to the tune of RM26.58 billion, which is a 9.5 % or a RM1.7

billion increase compared to the 2017 budget allocated by the government in 2018. This effort aims to boost the health of Malaysians and the quality of healthcare in the country. Therefore, the goal to achieve under "Vision 2020" is to have a world-class healthcare system that is affordable and accessible to the people of the country. To accomplish this goal, the *Eleventh Malaysia Plan 2016-2020* was implemented. This plan provides an overarching framework for Malaysia's development in which health is identified as a key component. The healthcare sector has identified four national strategies to enhance targeted support, particularly for underserved communities, improve system delivery for better health outcomes, expand its capacity to increase accessibility, and intensify collaborations with the private sector and NGOs to increase public health awareness.

Table 2: Structure of government primary healthcare

Structure	Level of Service	Staff	Services
Three-tier system (1956-1970)	Main health centre (1:50 000)	Doctor, dentist	Priority outpatient care, dental care
	Health sub centre (1:10 000)	Medical assistants and staff nurses	Outpatient screening Maternal and Child Health care
	Midwife clinics (1:2000)	Midwife	Home delivery and home visits
Two-tier system	Health clinic (1:20 000)	Doctor, dentist, pharmacist, assistant medical officer, public health nurses, assistant pharmacy officer	Outpatient services, dental care, MCH care, health promotion, family planning
	Community clinic (1:4000)	Community nurse, midwife	MCH care, home care, family planning

Source: Ministry of Health, WHO, (2017)

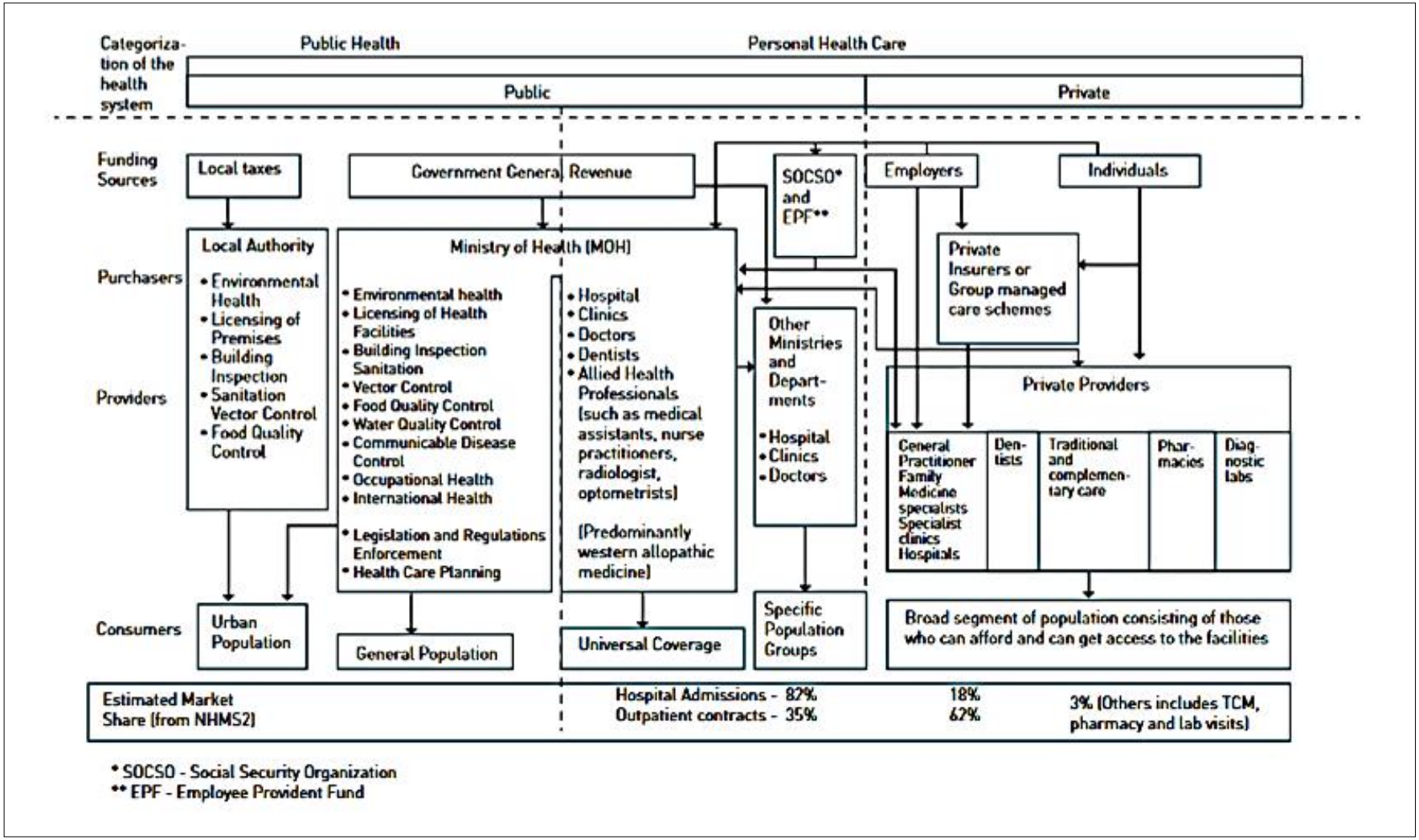

Figure 2: Schematic overview of the Malaysian health system (MOH,2017)

Source: Ministry of Health, (2017)

1.4.2 The Response of Malaysia's Healthcare System to NCDs

In the last two decades, the prevalence of NCDs risk factors has risen substantially in Malaysia. On top of that, Malaysia has devoted much development and significant capacity and resources to many aspects of health, particularly for communicable disease control and maternal and child health. The total out-of-pocket expenditure for health in 2017 was 39%, and yet Malaysia has one of the lowest incidence rates of catastrophic health expenditure among middle-income countries (WHO, 2017). However, there is an urge to examine the sustainability of the healthcare system to ensure that it performs well in the future and remains affordable and feasible for all sectors to apply. First, the Malaysian Ministry of Health responded by implementing "The National Strategic Plan for Non-Communicable Diseases (NSP-NCD) 2010-2014", and the "NCD Prevention 1Malaysia" (NCDP-1M) programme.

The NCDP-1M is a nation-wide programme under Strategy 1 of the National Strategic Plan for Non-Communicable Diseases (NSP-NCD) 2010-2014. This programme underlines the Prevention and Promotion of NCDs risk factors and the ways to keep a healthy lifestyle. Besides, this programme helps address the Healthcare sector's Strategy plan by engaging the community as a partner in coping with NCDs. The NCDP-1M aims to accomplish a screening process for NCDs risk factors for the wider population. With this effort, risk factors could be perceived at their earliest stage. In this programme, obesity is used as the main entry point for NCDs risk factor intervention. To gain better support for the implementation of this programme, the Ministry of Health published a series of NCDs Community-based Intervention Training Modules. In these Modules, 6 types of NCDs risk

factors were emphasised, which are physical activity, eating behaviour, reducing weight, smoking cessation, stress management, and consumption of alcohol. Participants who fulfil the criteria for NCDs risk factors are invited to participate in a semi-structured intervention programme designed by Community Health Volunteers, with technical support from the Ministry of Health staff. In this way, intervention activities can be integrated into community activities and culture.

Another factor attributed to the successful implementation of NCDP-1M is that the main programme outcomes of NCDP-1M are also the personal key performance indicators of the Ministry's Deputy Director-General of Health (Public Health). This ensures that continuous support and due attention are given to the programme at the highest levels of the Ministry. A summary of data from NCDP-1M is also relayed to the relevant community, to provide incentives, and to ensure sustainability through a continuous commitment from the community (Mustapha et al., 2014).

1.5 The Impacts of Non-Communicable Diseases (NCDs) on Socio-economic Development

NCDs have a vital economic consequence, not only towards individuals and households but also towards the development of the nation. Expeditious increases in NCDs are expected to negatively affect households and social welfare and increase the rate of poverty in low- and middle-income countries, as most of these households have limited resources regardless of financial status or property possession. When one of the family members in these households is exposed to NCDs, the household resources will quickly deplete. Hence, direct and indirect

costs will be incurred either in the short term or long term, as per the patient's diagnosis. Those who often require long-term and high-cost treatment will force their household into poverty as consumption increases, savings reduce, and investment in capital or property also reduces.

Furthermore, people with short-and long-term disability may not only reduce the supply and labour productivity in their workplace while curbing human capital accumulation, but the gross domestic product growth per capita and growth across per capita income will also be diminished, as the disease may affect workers' enthusiasm and endurance. From the country perspective, other than morbidity, NCDs will also weaken the life expectancy levels and economic growth of a nation by depleting the labour quality and quantity. As a result, the national output or national income e.g. Gross Domestic Product (GDP) and Gross National Income (GNI) will both be affected. Likewise, the foreign direct investment into the country will also be affected, as foreign investors will have less confidence to invest in the country.

On the other hand, the impact of NCDs will be more significant for underdeveloped and developing countries compared to developed countries. Technology development and medical infrastructure in low- and middle-income countries are still weak, causing patients to face constraints to cure their disease. Medical treatments and medicine imported from other countries will relatively increase direct and indirect medical costs. Besides, it will also lengthen the duration of treatment for the patient. In contrast, a country with healthy residents will ultimately see its effect on the overall national productivity level. Good health can also increase an individual's economic opportunities and increase the economic growth

rates of a nation. At the same time, the confidence level of foreign investors will also increase. A lack of affordable and sustainable healthcare is a problem affecting the global population. It is thus incumbent upon the country to draft out plans for affordable and sustainable healthcare that account for current economic conditions. It is believed that a balance should be struck between the county's budget allocation and disease prevention.

1.6 Efforts in Combating Non-Communicable Diseases (NCDs)

Numerous governments around the world have developed national healthcare policies, strategies, and action plans to prevent and control NCDs. NCDs are preventable. Specifically, heart disease, diabetes, stroke, over a third of cancers, and chronic respiratory disease could be prevented by practising a healthy lifestyle. The right vision and knowledge should be able to tackle these problems. For example, in the 2011 Political Declaration on NCDs, several instruments were built as a parameter to monitor the growing threat of NCDs. Multi-sectoral and national frameworks were used to capture NCDs and their risk factors that are assumed to contribute the most to the diseases. It is believed that with the efforts implemented by these governments, deadly diseases can be controlled, and the public will be educated on how to prevent NCDs. However, a positive outcome will not be achieved if these instruments or frameworks vary in objective or scope. Therefore, WHO endorses and recommends global efforts to rely on and work with concrete objectives, goals, budgets, priorities, and timetables, along with an integrated and cohesive monitoring framework (WHO, 2018).

Furthermore, in conjunction with member states, WHO, the private sector, intergovernmental organisations, and UN organisations, the 66th World Health Assembly

endorsed the WHO Global Action Plan for the Prevention and Control of NCDs 2013-2020 to reinforce national efforts addressing the burden of NCDs. In this global plan, paradigm alteration was presented via a guideline and option for policy enforcement (WHO, 2018). This Plan is expected to have the utmost impact on the number of premature deaths caused by NCDs, by reducing it by 25%. It also aims to achieve nine voluntary global targets by the year 2025. The WHO Global Strategy to Reduce Harmful Use of Alcohol, the WHO Global Strategy on Diet, Physical Activity, and Health, the WHO Set of Recommendations on the Marketing of Food and Non-alcoholic Beverages to Children, and the WHO Global Strategy for Infant and Young Child Feeding were among the efforts taken by WHO FCTC to tackle the world's biggest killers of people around the world (WHO, 2013).

1.7 Challenges in Combating Non-Communicable Diseases (NCDs)

Despite more awareness campaigns being conducted, the rate of NCDs has not reduced. Health awareness programs are becoming a well-established practice around the world, nations, and societies; yet, people are still a key vulnerability. The data shown does not synchronise with the outcomes of these awareness programmes. People absorb all healthcare knowledge but maintain the same lifestyle and unhealthy practises. The willingness of people to practise is the main challenge in coping with the behavioural risk factors for NCDs. Healthcare organisations and governments have tried hard to narrow the gap between healthcare infrastructure and the health of the people. Nevertheless, with rapid urbanisation and globalisation, people are increasingly exposed to diseases, especially the younger age group and groups with low immunisation.

The impact of NCDs on society is substantial. The government should consider the burden of NCDs not just by showing concern and examining the cost and expenditure of the healthcare system, but also the economic losses as a whole. For instance, productivity level, economic output, life expectancy, quality of life after diagnosis, and survival are the factors that should also be considered alongside healthcare cost and expenditure. Productivity level is a measure of the efficiency of a person, a business, or a nation. It can be calculated by converting inputs that can be a resource to produce an output. In Malaysia, the productive age span of labour ranges from 18 years old to 65 years old. This group is the main contributor to premature death. Besides, employment rate, absenteeism, and disability-adjusted life years (DALYs) should also be considered. Therefore, a comprehensive overview of the abovementioned impacts can be achieved.

Limited research has been conducted in developing countries due to limited resources in gathering the information and validating the collective information. A lack of data sources in supporting the research on NCDs is a major issue. Effective solutions and policies are always associated with reliable information, data, and steadfast evidence. Cost-effective interventions can result in higher and more valuable outcomes for public health. Action should be taken to improve a country's healthcare data source and data stream to better reflect efforts from the government and to assist policymakers to act on these interventions. In conclusion, it is extremely important for a country to identify the prevalence of NCDs that affect and burden individuals, society, and the nation. WHO has promoted and advocated that every country should propose an integrated and cohesive monitoring framework that includes objectives, goals, budgets, priorities, and timetables. This framework can leave a positive impact if applied together with other nations' efforts.

1.8 Problem Statement

The system of surveillance indicators has received much interest from policymakers, governments, medical providers, and investors around the world. Despite the depth of NCDs studies undertaken in various countries, the use of composite indicators in NCDs surveillance is limited, and so too the case of Malaysia. As previously mentioned, in the National Strategic Plan for non-communicable disease (NCDP-NCD) 2010-2014, one of its weaknesses is a lack of indicators that could better evaluate each criterion. Besides, there is no specific focus or specific measurement for each of the outlined strategies to tackle this deadly disease. Although WHO, as well as national health authorities around the globe, have strongly advocated the need to analyse and monitor NCDs risk factors, no attempt has been made to develop NCDs surveillance from a composite context. Countries have been encouraged to propose their own NCDs risk factor surveillance indicators to curb and prevent their peoples from being exposed to this deadly disease. If not, insightful awareness, screening, and guidance for the people to change their lifestyle to avoid NCDs can never be conveyed clearly to the general public.

Furthermore, policymakers and healthcare providers are particularly uncertain about the prominence of NCDs risk factors among the citizens of Malaysia. More importantly, without accurate prevalence estimates, all NCDs interventions and initiatives to reduce NCDs occurrences can only be built on limited ideas of the exact epidemiological knowledge of NCDs. Moreover, without a proper framework to estimate the cumulative NCDs risk factors, it will certainly be challenging for a country to evaluate the effectiveness of its healthcare policy measures.

In the past, NCDs surveillance programs have relied on passive reporting, in which reports were received from physicians and other healthcare providers. For diseases and conditions in which laboratory confirmation is routinely obtained, laboratory-based reporting has virtually replaced traditional provider-based reporting in many jurisdictions, because case ascertainment is far more complete. However, even when supplemented by laboratory-based reports, the reporting on traditional passive surveillance systems remains incomplete. Despite this limitation, these data remain valuable because they are used primarily for monitoring trends in disease occurrence rather than for initiating public health action in response to each case (Roush, 2011). Nonetheless, as for public health per se, the timely identification of NCDs prevalence is essential for the future development of the country, as health is an indispensable element of a nation's productivity and wellbeing. Bearing in mind that NCDs pose a substantial economic and financial burden to the nation, the present study is motivated to extend the framework of composite indicators into an NCDs prevalence study by constructing an alternative NCDs surveillance indicator for the case of Malaysia.

1.9 Research Objective

1.9.1 General Objective

The objective of this study is to develop an alternative non–communicable diseases (NCDs) risk indicator for targeting NCDs risk prevalence in Malaysia.

1.9.2 Specific Objectives

To explore the potential ability of the composite NCDs risk indicator in estimating NCDs risk prevalence in Malaysia, the specific aims of this study are:

i. To construct a composite NCDs Risk Indicator with an equal weighting approach and a PCA-weighted approach;
ii. To examine the leading power of the constructed NCDs Risk Indicators in forecasting NCDs risk prevalence in Malaysia;
iii. To examine the directional accuracy of the constructed NCDs Risk Indicators in forecasting NCDs risk prevalence in Malaysia; and
iv. To establish the cyclical characteristics and causal relationship between the NCDs Risk Indicators and the selected macroeconomic variables.

1.10 Significance of the Study

In this contemporary, as well as highly dynamic socio-economic environment, a high degree of Non-Communicable Diseases (NCDs) health problems pose both direct and indirect hindrances to a country. Thus, the potential effect of NCDs surveillance indicators appears to be a fatal weakness on country growth, as it requires much consideration and effort on behalf of the public or the government. In this case, this study enables policymakers to target and implement functional interferences to avoid serious consequences of upsurges in NCDs risk factors in Malaysia via the construction of a non-communicable diseases (NCDs) risk indicator. The risk indicator with leading characteristics can predict the

movement of NCDs prevalence, which serves as an early signalling tool for policymakers and public health sectors.

Moreover, indicators with a weighting scheme will help target the key NCDs risk factors and the proportion of each risk factor. It provides the opportunity to compare empirically between the forecasting ability and the predictive accuracy of the equal-weighted and PCA-weighted indicators in predicting the movement of NCDs prevalence. Given this contribution, policymakers and public health sectors will be able to focus on the main risk factor and optimise their resources to prevent the people from being exposed to more risk factors. Furthermore, besides the robust information on NCDs prevalence provided by the constructed NCDRI, the government will also be able to determine the level of synchronisation between macroeconomic activities and the NCDs risk factors. In line with the macroeconomic activities, the indicator can benefit policymakers and the government in determining the movement as a result of macroeconomics activities, as government spending or budget allocations will be less affected by the time-consuming new allocations that also require much effort to implement.

In brief, this study developed a composite indicator that will benefit policymakers and public health sectors, enabling them to draft focused and effective policies to reinforce the political commitment to tackle these deadly diseases. The Constructed NCDRI can serve as a forecasting tool that indicates the prevalence of NCDs in Malaysia and for monitoring the turning points of each movement. Additionally, the constructed NCDRI can contribute empirical justifications to the extent of determining the interactions between NCDs risk and

macroeconomic variables. Lastly, the indicator enables the empirical examination of the relationship between NCDs risk, human capital development, and economic growth.

1.11 Organization of the study

The overall structure of the study takes the form of five chapters and their sequences are organized as follows. Chapter One discuss the background of the study, problem statement as well as the objectives if this study while Chapter Two provides reviews on non–communicable diseases (NCDs) risks and development of the composite indicator for NCDs monitoring. The next chapter presents the framework of the study, empirical models and the methods that employed. Subsequently, Chapter Four discussed the empirical findings and interpretations. The final chapter will be Chapter Five which illustrates the conclusion and policy implication.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter aims to present a review of the previous literature that is related to this study. This study proposes to develop an alternative non-communicable diseases (NCDs) surveillance indicator in the context of Malaysia which will crucially be able to better estimate the prevalence of NCDs as well as more effectively predict the need for public health interventions, whilst improving monitoring practices. In this chapter, the literature review focuses on the theoretical framework of the risk factors related to NCDs. Meanwhile, the methodologies that were put forward in previous research are clearly shown, together with the resulting findings. The last section of this chapter acts as a summary and draws an overall conclusion for Chapter Two.

2.2 Review on Non–Communicable Diseases (NCDs) Risks

In recent years, much research has been devoted to understanding the epidemiology and surveillance of NCDs around the world. To this extent, the WHO STEPwise approach to non-communicable disease surveillance has been adapted to design risk factor surveillance approaches from an NCDs surveillance framework based on the various study's objectives. NCDs have become the leading cause of death in the world. Several research studies have examined the risk factors of NCDs worldwide. Behaviours that impact health status, such as,

excessive alcohol consumption, smoking and tobacco consumption, insufficient consumption of fruits and vegetables, the pattern of diet and physical inactivity are the leading risk factors that contribute to multiple health conditions and chronic diseases.

The findings reported in the study of Xu, Ying, et al., (2013) regarding Chinese women, suggested eight risk factors for chronic NCDs, where five were behavioural factors and three were biological, as defined by the WHO global monitoring framework. Face-to-face interviews were conducted using the Chronic Disease and Risk Factor Surveillance (CCDRFS) survey which was a nationally representative surveillance survey in China. The risk factors pointed out in this study were the raised up of blood glucose, blood pressure and cholesterol, use of alcohol, smoking status, inadequate fruit and vegetables consumptions, level of physical activity and overweight and obesity. Of the eight risk factors highlighted, the insufficient intake of fruit and vegetables contributed to the highest prevalence at more than 51.7% and this was followed in descending order by the other risk factors; being overweight and obesity, raised blood pressure, physical inactivity, raised total cholesterol, raised blood glucose, current smoking status and alcohol consumption. Besides that, the results indicated that all of the risk factors, except for physical inactivity, were strongly correlated with age, marital status and education. It indicated a significant increase with age and the highest prevalence among women who were separated, divorced or widowed, and the prevalence declined with higher educational levels.

The study by Wesonga et al., (2016) reported that besides the endogenous factors, there were important causal impacts on the risk factors of NCDs, such as region, residence status, land tenure system and behavioural characteristics. The study was conducted by

analysing data from a population-based survey which was adapted from the WHO STEPwise approach to surveillance. In this study, over 90% of the respondents exhibited at least one risk factor, such high proportions could have a significant influence on productivity levels. Furthermore, the results indicated potential increases in the burden on the country's healthcare system and curbs economic development. The study also reported that there was a significant direct relationship between the number of NCDs risk factors with body mass index, systolic blood pressure, but an inverse relationship with the consumption of fruit and vegetables.

The WHO STEPwise approach to surveillance has brought benefits by generating legitimised and internationally comparable data about the prevalence of NCDs. In the study of Esteghamati et al., (2009) which aimed to construct an indicator of Iran prevalence of non-communicable health issues and the risk factors that caused NCDs. They reported that socio-demographic factors, such as advanced urbanisation, being female and feebleness were significantly correlated to an increment in the prevalence of diabetes. The results of the study were extracted from the third national Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD-2007) and the complex sample survey analysis was performed using SPSS 16 for Microsoft Windows. A sample analysis plan was defined based on the clusters which the strata by age group, sex, and residential area and the determined weights. The results indicated that the prevalence of diabetes was about 47.1% in the 25-64 years old age. The rates of risk factors will often show patterns that vary considerably within middle income countries and which are practiced unevenly by socioeconomic groups.

Health and education are two very important and correlated components of the human capital of a country. A country's level of poverty and its income level can be measured by its health status and the level of education. This is because these will affect the income distribution and level of poverty. Several studies thus far have indicated that the education level in various countries is likely to reflect upon physical inactivity, smoking, and the self-reported diagnoses of hypertension (Mpofu et al., 2016). In the study, a weighted prevalence was calculated using the dependent variables of the risk factors of NCDs which were clustered into behavioural or biological categories and independent variables which were the self-reported racial group, educational level and health insurance status. The results showed significant differences among all of the behavioural and biological NCDs risk factors by education level and insurance status, except for binge drinking. Furthermore, women with a low education level, less than a college or university level, indicated that they were linked to physical inactivity, smoking, imbalance consumption of fruit and vegetables, being overweight and self-reported diagnosed hypertension, which would be attributed to the disease being recently diagnosed in the sample. Besides this, females contributed 9.2%, compared to males who contributed 7.5%.

The population of a country which is socioeconomically disadvantaged in terms of education or income level tend to face a worse situation when dealing with the prevalence of the risk factors for NCDs. For example, Marins et al., (2007) demonstrated a solid and inverse association of the education level with an index of cardiovascular risk factors in Brazil. An index of cardiovascular towards risk factors was constructed, taking into account information on well-known risk factors, such as being overweight, the location of the fat, smoking, hypertension, alcohol consumption and an inactive daily lifestyle, while the level

of schooling and per capita income were used as independent variables. In this study, logistic regression models were used to evaluate the association between the risk index and the socioeconomic variables, such as per capita income, location of residence and the level of education that controlled for the age of the subjects. The results showed that the linkage between education and the CVD risk index was significant and had an inverse connection. It also found that the level of income had an inverse connection with the prevalence of NCDs in a country. A possible explanation for this inverse association may be that higher income groups consume more healthy food, thus, promoting a healthier diet.

Besides, infant mortality and children's health in United States indicated a strong link and was correlated to family income and maternal education according to Braveman et al., (2010). Those with the lowest income and who were least educated were consistently the least healthy, but for most indicators, even groups with intermediate income and education levels were less healthy than the wealthiest and most educated. In this study, the level of each indicator was calculated based on education or income. Next, for the indicators examined with the National Health Interview Survey (NHIS), the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS) data, weighted age-adjusted prevalence rates were estimated to account for the complex sample designs. Meanwhile, different levels of indicator were examined both by household income as a percentage of the federal poverty level and by the number of years of educational attainment for all of the indicators, except infant mortality.

In low and middle-income countries, data has proved that socioeconomic inequalities were one of the risk factors of NCDs. The results presented different patterns among risk

factors, gender and country income groups from the magnitude and direction of socioeconomic inequalities. According to Hosseinpoor et al., (2012), the study drew attention to smoking and low fruit and vegetable consumption, which were significantly higher among the lower socioeconomic groups. In this study, wealth and education levels were used to compare with four risk factors which were daily smoking status, low fruit and vegetable consumption, physical inactivity and heavy episode alcohol drinking. Hosseinpoor et al. derived the data from the World Health Survey 2002-2004 by stratifying the data into sex and low or middle-income country status. The strongest legitimate relative inequalities were reported for current daily smoking status, especially the inequality in the education level. Among both risk factors, current daily smoking and low fruit and vegetable consumption were significantly accounted for in the poorest wealth quintile rather than in the richest. However, when comparing education-related inequality, current daily smoking and low fruit and vegetable consumption indicated regular inequality in both gender and country income groups.

Differences in social and biological factors will tend to contribute to the prevalence of NCDs risk factors by gender and age group. Males and females have different levels of exposure to the risk factors of NCDs. Understanding how gender and age are associated with the prevalence of the risk factors of NCDs is extremely important in designing future intervention programs by targeting particular ages and genders. In the study by Khademi et al., (2017) a standardised questionnaire for risk factors surveillance towards NCDs, derived from the WHO STEPwise approach was used. The results showed that the percentage of people with 3 to 5 types of risk factors would increase with age and this figure was significantly contributed to by the male group. On the other hand, the present study found a

significantly higher contribution of the female group to the category of having low levels of physical activity than the male group. Besides, followed by age group, older females were reported to be less active than males across all of the regions.

The prevalence of diabetes increases with growing age and weight. Furthermore, the prevalence of diabetes was significant and contributed a higher rate among urban residents than among rural residents (Yang, Dou, & Song, 2010). The relationship between economic development and urbanisation was addressed in this study. When comparing economically developed regions to intermediately developed and underdeveloped regions, the age and gender-adjusted prevalence of diabetes did not show significant inequality between urban and rural areas, whereas, the prevalence of diabetes and the levels of risk factors were higher among urban residents than rural residents. The sample collecting process was stratified according to various geographic regions, economic development status, the level of urbanisation and ruralisation. The provinces were selected from geographic regions and cities without random picking which was important in getting the accurate estimation.

Furthermore, in a study conducted by Abegunde et al., (2007) on low-income and middle-income countries, it was stated that the age-specific death rate for chronic diseases remained higher and was more significant among low and middle-income countries than for the higher income countries. Unpredictability remains regarding the comparative burden of disease and injuries around the world, especially for those regions with incomplete data regarding the registration of deaths. Unpredictability in the assessment of the death rates for chronic disease is much higher for countries with incomplete data on the registration of deaths, and for countries without useable death registration data, respectively than those with

death registration data. Besides, the study stated that, in 2005, women contributed more highly than men to the estimated age-standardised death rates for chronic disease for 15 of the selected countries with complete death registration data and that the figure will increase if nothing is done to deal with deadly diseases.

Moreover, a STEPwise survey which composed of three steps for the assessment of the risk factors of NCDs' was conducted by Thakur et al., (2016) to gather information on behavioural risk factors, physical measurements and blood and urine sampling. The study developed a state-specific approach to NCDs risk factor data by adopting the WHO STEPwise surveillance approach (STEPS) to generate estimates for a national NCDs monitoring framework indicator. The results from the study stated that the prevalence of alcohol in the state was significant among adults in the 18-44 age group, with the majority in urban areas compared to those staying in rural areas. Besides, examining gender differences, men contributed more greatly in the prevalence of tobacco consumption, alcohol consumption and raised blood pressure (BP) than women, whereas, females contributed more greatly to physical inactivity and obesity problems.

There is a statistically highly significant correlation between monthly out of pocket expenditure and the number of chronic diseases contracted by patients. Research carried out by Ghandour (2015) found, using a descriptive cross-sectional method, that was carried out on patients with chronic diseases and who were suffering from more than one NCDs. The results showed that 44.5% of the participants spent 500 – 1000 Egyptian pounds per month for the treatment and follow up services related to their chronic diseases (Diabetes Mellitus, hypertension and dyslipidemia) while 49.3% of them spent less than 500 pounds per month,

whilst 6.2% of the patients reported that they spent more than 1000 pounds per month. Besides, the study showed that there were not any significant statistical differences between out of pocket monthly expenses with income level and gender.

The catastrophic health expenditure and impoverishment rates among households who had at least one member with a chronic disease were 14.6% and 7.6%, respectively in Vietnam (Minh & Tran, 2012). The study assessed the household financial burden associated with chronic non-communicable diseases in a rural district of Vietnam. From the study, it was shown that chronic NCDs already influence a large number of the population of Vietnam by the high prevalence of self-reported chronic NCDs in both the studied households and for individuals (29.3% and 33.4%, respectively). When compared with the households whose members were free from NCD's (4.2% and 2.3%, respectively), these rates were significantly higher. Besides, the odds of experiencing catastrophic health expenditure and impoverishment among the households with NCDs sufferers were 3.2 and 2.3 times greater than that of other households. Moreover, elderly people and the poor and vulnerable in the population were hugely affected by the financial burden of these chronic diseases.

Moreover, a study on disease-specific out of pocket and catastrophic health expenditure on hospitalisation in India reported that the highest out-of-pocket expenditure on hospitalisation was caused by NCD's and followed by heart diseases (Kastor & Mohanty, 2018). Among all of the examined diseases, cancer caused the highest level of catastrophic health expenditure and distress financing, however, more than one-third of inpatients reported distressed financing for heart diseases, neurological disorders, etc. In almost all countries, the development of health systems that are responsive to the challenge of the

prevention and treatment of NCDs is a priority (Atun et. al, 2013). From the study, it was noted that in terms of NCDs, the health systems in low-income and middle-income countries initially need to focus on the key modifiable risk factors of; tobacco use, unhealthy diet, physical inactivity, and the harmful use of alcohol, at both the individual and population levels. More to the point, mobile technologies and health systems have been cooperated effectually to capture individual and health-related data. However, there are still some good examples of integrated service delivery, yet, this area still has some unexploited opportunities to create further synergies and to integrate NCDs activities with other health programmes.

Besides, economic downturns will lead to a reduction in a country's health spending on people in need, in particular among the poor and vulnerable groups. Over the coming decades, both developing and industrialised countries will face sharp rises in health expenditure, as well as other long-term health care challenges, because of their ageing populations. The study by Wang in 2015, aimed to evaluate the ideal level of health care expenditure in a developing country. In fact, a growth in the level of health spending in government will improve the health of the workforce. The findings proved that an appropriate level of spending on health care support and infrastructure could support economic development. Empirical evidence indicates that when the ratio of health spending to GDP is less than an optimal level of 7.55%, increases in health spending effectively will lead to better economic performance (Wang, 2015).

2.3 Review on Development of the Composite Indicator for NCDs Monitoring

Indicators have been used extensively in various fields of study and show a beneficial role in recognizing movements or trends, and contributing on setting priorities, the formulation of policy and monitoring the progress. Besides that, a complex array of health information can be simplified by the application of indicators. In this respect, they can be important in informing the public and decision-makers about key health and environmental problems, and the actions required for their management. Since health, the environment and development problems differ in various parts of the world, so do the priorities with respect to their management, thus, the types of indicators developed worldwide will also differ, according to the level of decision-making, and the use for which the indicators are intended. A priori, it would be better if these risk factors are amassed into a composite index as the outcomes will be more meaningful in many ways.

Despite their expanding use, composite indicators are defined as the aggregation of elemental performance indicators into a single index and have been used extensively in the public sector to create league tables (Jacobs & Goddard, 2007). In the study, data were used on the composite performance measures from two key public services which were healthcare and local government. All of the indicators were added up for each hospital and local authority and an equal weight was applied to each indicator. Furthermore, a composite index was created, and a ranking was made, based on the index. In England, government policy has emphasised the use of composite indicators which entails adding up a number of indicators to form an aggregate indicator. Composite indicators can be used in various

sectors, such as health, social services, education, universities, local government and other service areas (Freudenberg, 2003 and Protocol, 2009).

Notwithstanding this, several attempts have been made to investigate the risk factor indicators of NCD's, however, there has been no attempt made to elicit the surveillance of NCDs indicator in a composite context. Composite indicators should be developed and used along with descriptive analysis for each specific indicator and such a study was carried out by Prinja et al., (2016). In the study, a composite indicator was developed to measure Universal Healthcare Coverage. Each of the indicators was arranged in a composite context because they had a similar direction which pulled them together. Principal component analysis (PCA) and regression modelling were carried out and all of the 10 original indicators were composed into different combinations. After that, component loadings were used as weights in the linear equation with corresponding variables. Furthermore, a second set of weights were used to estimate each of the principal components in the observed data explained by them.

One multi-country study which aimed to generate a composite indicator used crude arithmetic methods to aggregate individual indicators into a single composite coverage indicator (CGI) (Prinja et al., 2017). Besides that, another study used robust statistical methods to aggregate individual indicators and to generate a composite indicator (Leegwater, Wong, & Avila, 2015). In the study, internally consistent indicators were selected and implemented into a component analysis. The index developed in the present study can help in offering a more practical, sustainable and credible measure of healthcare services from the use of an extensive amount of available data. Besides, the study of Wesonga (2016),

proposed that policy should provide measurable indicators for each NCDs risk factor. Upon that, in this study, a composite indicator of dependent variables was created which accounted for a number of NCDs risk factors. Furthermore, these variables were used to categorise and generate an index for a number of NCDs risk factors in order to provide an indication, both in magnitude and direction of the burden of the cumulative risk factor to the general population and also to the economic growth of the country.

Furthermore, Becker et al., (2017) defined composite indicators as tools to assess the performance of countries on human development, sustainability, innovation, competitiveness or other complex phenomena which do not have a direct relationship in measure, and which are not uniquely defined. Composite indicators have many functions, they can be used in policy monitoring, communication to the public and to develop rankings. Besides, in the studies, composite indicators have contributed in terms of their simplicity and the force of their rankings. Composite indicators provide an overall simple picture of various complex dimensions in a way that eases the evaluation and comparison and rankings of the variables based on their standards. The level of ranking drives behaviours and changes. The successful targetting of prevention efforts against NCDs relies on the detection of each risk factor, based on its rating, that can help in tackling these deadly diseases.

2.4 A Remarks

Most of the journals and articles used cross-sectional methods, employing questionnaire surveys, in the design of their analyses. To the best of the author's knowledge, no studies have, hitherto, explored the development of a composite indicator of NCDs. As a result, no insightful awareness, screening and guidance for people to change their lifestyles to avoid NCDs has until now been conveyed clearly to the public. The policymakers and healthcare providers in Malaysia have been uncertain about the prominence of the risk factors of NCDs among the nation's citizens. More importantly, without accurate prevalence estimates, all of the interventions and initiatives to reduce the occurrences of NCDs can only be based upon limited facts regarding the exact epidemiology of NCDs.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses the theoretical considerations and the analytical procedures needed to construct a composite Non-Communicable Diseases (NCDs) risk indicator (NCDRI) and to forecast out-of-sample risk factors prevalent in Malaysia. This chapter encompasses fourteen sections. Firstly, Section 3.1 is the introduction of methodology, Section 3.2 discusses the conceptual framework of economic impacts caused by diseases while Section 3.3 reviews the theoretical framework that discusses the concepts and theory used in this study. This is followed by Section 3.4 which discusses the NCDs causation pathway. Other than that, Section 3.5 discusses on the framework of non-communicable diseases risk indicator (NCDRI) a brief description of all of the risk factor components, including exposure, morbidity, mortality, cost indicators, the determinants of health and health system response. Later, the non-communicable diseases risk indicator (NCDRI) construction procedure, adopted from Burns and Mitchell (1946), is presented in Section 3.6 whereas Section 3.7 discusses the cycle extraction and detrending procedures utilised, including the Christiano-Fitzgerald (CF) filter. The turning point dating algorithm that was used to analyse the movement of the cycle turns is detailed in Section 3.8. In particular, the peaks and troughs together with the weighting methodology used for the weighted-NCDRI are discussed in Section 3.9. Furthermore, Section 3.10 presents an evaluation of the directional accuracy of the constructed indicators and empirical analysis of the NCDRI and selected macroeconomic

variables. Further, two variants of empirical analysis will be carried out to examine the characteristics of the relationships between NCDRI and selected macroeconomic variables and the analysis on HDI, NCDRI and macroeconomic determinants before the remarks.

3.2 Conceptual Framework of Economic Impact Caused by Diseases

Economic performance and health performance are interlinked. Wealthier nation has healthier population to contribute in economic growth because diseases show a vital economic consequence, not only towards individuals and households but also towards the development of the nation. There are several channels through which diseases can affect the economy of a nation and this includes, for instance, the plague of expanding communicable diseases and the public awareness towards infectious diseases will leads to the changes in forms of social and economic interaction. For example, during the outbreak season of communicable disease, the level of social interaction will be reduced due to people be more aware to interact with each other and avoid the overcrowded places. Situation evolve the reduction of economic activities and by extension affected the economy. It shows an inter-linked relationship between households and firms. For example, diseases and injury triggered the reduction in labour productivity and performance in the workplace due to the reduction of vigorous and effective labour supply. Consequently, less income can be earned, and it potentially led to further drops in gross domestic products (GDP).

As depicted in Figure 3, it presents a concise and simplified system of the flow of income framework which demonstrate the interaction between the economic impact of disease towards households, firms and government. Labour and capital that supply by

households by way of an input to produce goods and services for firms. Meanwhile, in return, employees get their wages and rents and used to consume the goods and services that provided by firms. Without forgo, household also provide labour to the government for the production of public goods. In addition, households serve as financing mediator for government activities by paying the taxes in both direct and indirect ways while an additional further function that related to savings and investment which become the investment to firm's productive activities and the development of future capital stock. However, there are other circumstances that may affect the movement of loans and debt while household was diagnosed with disease. Household economic capability might be challenged to such an extent that it is forced to resort to loans and debt.

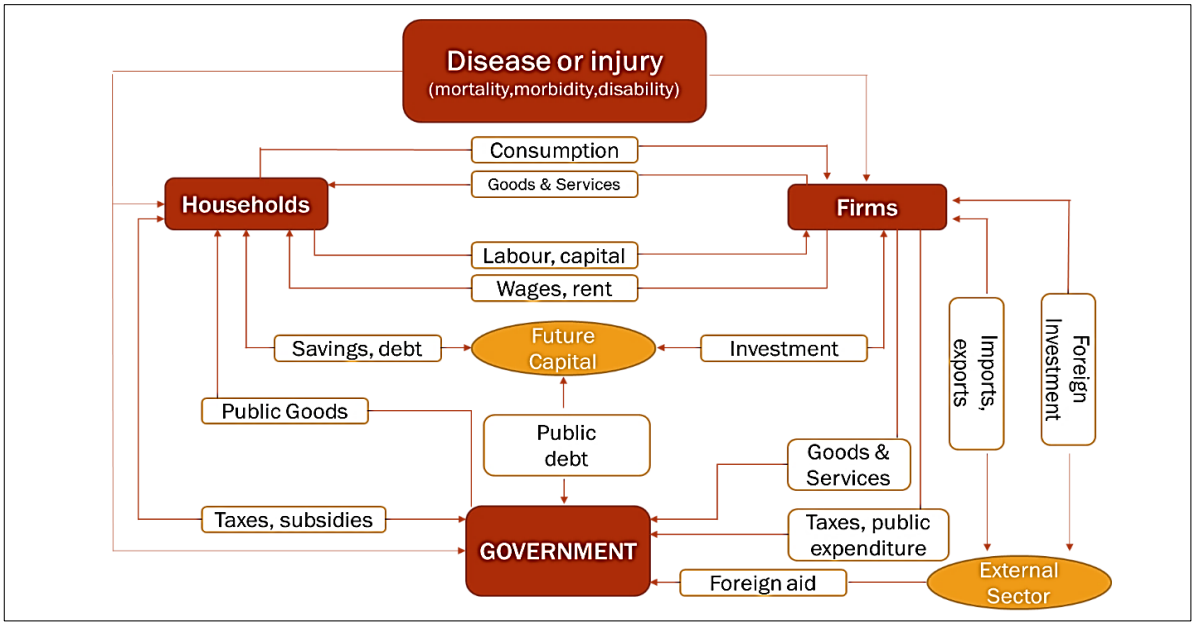

Figure 3: Conceptual Framework for Identifying the Economic Impact of Disease

Likewise, various circumstances possibly will happen on firms and governments. For example, firms might be net borrowers or net lenders while governments might also run surplus and deficits and this formation present the dynamic part of the framework which make the capital stock be the important determinant of output in future periods. For its part,

the government generates revenue through the collection of direct and indirect taxes, loans and any foreign ais made available by the external sector. Then, the received income uses to purchase mandatory goods and services from the firms for the production of public goods. Lastly, closing the circular flow of income is the external sector, which in addition to foreign aid also makes direct transactions with the private sector and make investments in production.

3.3 Theoretical Framework of Non-Communicable Diseases (NCDs) Monitored in the Global Healthcare Sector

In the year 2011, the WHO established a global monitoring framework to empower global tracking of progress in the prevention and monitoring of major NCDs. The aim of the framework was to achieve data comparability over time and between countries, especially between low and middle-income countries.

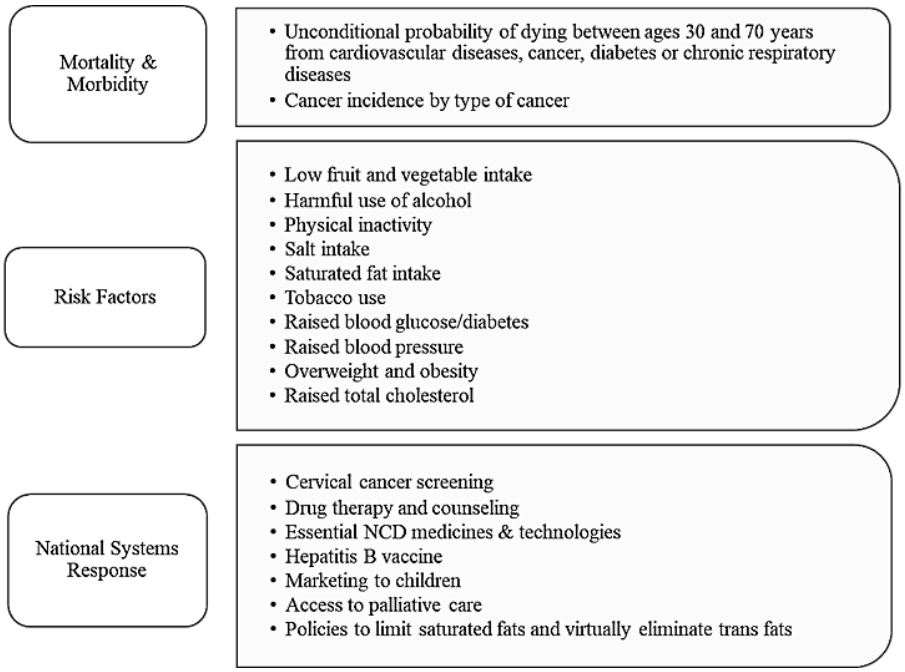

Figure 4: Global Monitoring Framework, 25 Indicators

Source: World Health Organization, (2011)

The framework encompasses twenty-five indicators (see, Figure 4) which encourages countries to develop their own frameworks by adopting the global NCDs risk factor targets and indicators. Furthermore, this global monitoring framework enables the global tracking of progress in the prevention and control of major NCDs, as well as their risk factors. It is branched into three major components of NCDs risk factors which are; monitoring exposure (risk factors), monitoring outcomes (morbidity and mortality) and assessing national health system capacity (McQuestion, 2006).

3.4 The Non-Communicable Diseases (NCDs) Causation Pathway

The causation pathway for Non-Communicable Diseases (NCDs) is a cause-effect process which shows how an outcome is brought into being, as shown in Figure 5. The steps in the pathways link all of the potential risk factors to the, cause serving as surrogate indicators for policymakers or healthcare providers to prevent the rise of deaths by NCDs by the use of intervention and policy. NCDs can be avoided and controlled by the practice of; healthy diet, regular physical activity and reducing the consumption of alcohol and tobacco. This is because these common risk factors give rise to intermediate risk factors, such as raised blood sugar, raised blood pressure, abnormal blood lipids and being overweight. In turn, these intermediate risk factors predispose individuals to NCDs, such as cardiovascular disease, cancer, stroke, diabetes and chronic respiratory diseases. Besides, there are five strategic action areas along an intervention pathway that corresponds to the NCDs causation pathway.

First, is the environmental level which can be controlled through policy and regulatory intervention. Second, lifestyle intervention which has an emphasis on the level of

common and intermediate risk factors in the population. Thirdly, clinical intervention which considers the levels of recently diagnosed and established diseases. Advocacy is the fourth action area which provides; social mobilisation, public education and outreach, risk communication and advocacy for policy changes that are relevant to the NCDs. Lastly, surveillance, research and evaluation were implemented through a STEPwise survey, as recommended by the WHO.

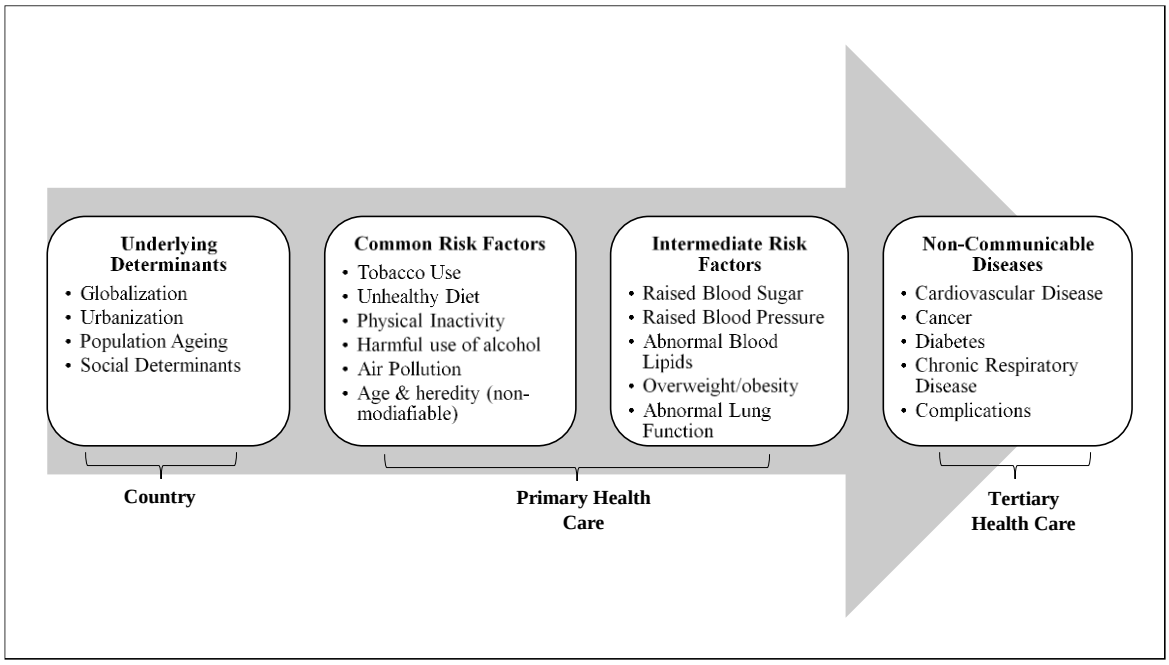

Figure 5: Causation Pathway for Non-Communicable Diseases (NCDs)

Source: World Health Organization, (2010)

3.5 Framework of Non-communicable Diseases Risk Indicator (NCDRI)

In line with the WHO's initiative in combating the epidemic of NCDs, the present study is motivated to develop a country-level NCDs monitoring and tracking framework to provide a clearer picture of the movement of the risk of NCDs in Malaysia. To achieve this aim, six

(6) pillars, namely; behaviour risk, morbidity, mortality, cost indicators, the determinants of health and health system response have been identified, based on the WHO's global monitoring framework, as well as the NCDs causation pathway. The sub-components that make up each individual pillar will be recognised following the ideology of indicator construction proposed by the Conference Board (2000). Each of the pillars will be assigned with weights to reflect their relative significance towards the evolvement of the prevalence of NCDs in Malaysia. Concisely, Figure 6 demonstrates the framework of the Non-Communicable Diseases Risk Indicator (NCDRI) development adopted in the present study while a detailed discussion of the identified pillars will be enclosed in the following sub-sections.

3.5.1 Interaction of Behavioural Risk with NCDs

Tobacco use, a major preventable cause of premature death and diseases, kills 6 million people worldwide annually. Based on the global survey by the WHO (2015), tobacco use, or tobacco consumption comprised the highest risk factors among all of the other risk factors. Besides, tobacco use will also curb global economic growth due to the estimated US$ 1.4 trillion in the cost of healthcare, as a result of diseases related to tobacco use, this in turn, directly increases the financial burden on households and governments. In 2008, the cost of curing tobacco-related diseases, such as lung disease, asthma stroke and coronary heart diseases was 922 million in US$, which is commensurate with the expenses of an integrated national programme for economic development in a rural area (Wipfli, 2012). Malaysia has a lot of smokers in its population. According to the WHO, 36% of deaths in Malaysia are due to cardiovascular diseases. It is believed that smoking is a huge contributor to this

statistic as half of the total strains of the top cancers among cancers of the trachea, bronchus and lung, and mouth and or oropharynx are attributed to smoking. In 2015, approximately 22.8% (4,991,458) of the Malaysian population aged 15 years and above were smokers, 43.0%(4.85 million) of men and 1.4% (143,566) of women smoked manufactured cigarettes, hand-rolled and smokeless cigarettes (NHMS, 2015). Action has been taken to scale down the rate of tobacco use in the country. For example, demand reduction policies were implemented towards consumers by increasing tobacco taxes and cooperating with society in enforcing a comprehensive ban on tobacco consumption, promotion and smoking in public areas.

Together with tobacco use, diet and physical inactivity and the consumption of alcohol are among the four most important risk factors for NCDs. The Global Information System on Alcohol and Health (GISAH) is an essential tool for assessing and monitoring the health situation and trends related to alcohol consumption, alcohol-related harm, and country's policy responses. Besides, the OECD Health Statistics reported that alcohol consumption among adults in the years 2000 and 2013 showed a major increase. The misuse of alcohol represents one of the causes of NCDs. Apart from that, heavy alcohol consumption can lead to poverty where more money is spent on alcohol, which in turn, may cause financial problems in households. Excessive alcohol consumption could lead to low labour productivity which may result in unemployment and thus, affected household's being unable to pay their daily expenses and loans. Alcohol consumption is the leading risk factor of death for males in the age group of 15 to 59, which is also the age range of the most productive age group. Global data shows that 6.2% of all male deaths are attributed to alcohol as compared to 1.1% of female deaths. The adverse effects of alcohol have been

demonstrated in many disorders, including liver cirrhosis, mental illness, several types of cancer and pancreatitis. Alcohol use is also strongly related to social consequences, such as injuries and fatalities as a result of drunk driving, aggressive behaviour, family disruptions and reduced industrial productivity (Stockwell et al., 2000). Malaysia has been grouped under a low alcohol consumption band with a high percentage of abstinence over the past years. However, statistics have shown an increase in the prevalence of current alcohol drinkers from 11.1% in 2006 to 11.6% in 2011 (Rozanim, 2012).

The major risk factors for one NCDs will influence other NCDs. Furthermore, some of the NCDs risk factors will tend to occur in groupings, for example; physical inactivity is often caused by smoking or an imbalanced diet. It is believed that people who are physically active generally live longer and have a lower risk of heart disease, stroke, type 2 diabetes, depression, cancers and obesity (National Coordinating Committee on Food and Nutrition, 2010). The lifestyle of Malaysian's has been changed inevitably by the accelerated phase of industrialisation and urbanisation in recent decades. Changes in dietary habits and a sedentary lifestyle are known to be associated with changes in health and the increased prevalence of chronic diseases in the population. Besides, the rapid growth of the fast food industry has added another dimension to the change in the food consumption pattern of Malaysians. According to the WHO, physical inactivity is the fourth leading risk factor for death. It can be proven by the study of (Lee et al., 2012). Besides, physical inactivity caused between 6-10 % of all deaths from major NCDs and the prevalence of physical inactivity worldwide increased from 23.3 % in 2012 to 31.1 % in 2016. The WHO, as well as the Malaysian Dietary Guidelines, recommend that people should engage in at least 150 minutes of moderate physical activity per week. A lower level of physical activity is closely

correlated with obesity and NCDs. On the other hand, people who are involved in physical activity will frequently benefit more by maintaining mental and cognitive health and by building their confidence in ongoing engagement in daily achievements. Labour productivity will increase when workers are in good health, thus increasing the per capita Gross Domestic Product (GDP) and Gross National Income (GNI).

NCDs which include; diabetes and obesity, are major challenges for health and the physical development of the population, especially for developing countries. It is believed that adequate nutrition is important as a determinant of good health and the physical development of the population. The rapid growth of the fast food industry has added another dimension to the change in the food consumption patterns of Malaysians. People who consume high levels of saturated fats, trans-fatty acids, sugars and salty food without sufficient physical activity will have a high risk of being exposed to NCDs. High morbidity and mortality represent both direct and indirect effects on the nation. Human capital and labour productivity will be directly affected due to unhealthy workers. Meanwhile, the economy of the country will indirectly face losses caused by gaps in education and the lower skill-levels of the workforce. These issues will essentially push back the development of the country. In 2014, 39% of adults worldwide aged 18 years and older were classified as being overweight (Gil, de Victoria, & Olza, 2015).

3.5.2 Interaction of Determinants of Health with NCDs

There is a well-known large and persistent association between education and health. Education has important social impacts on the health of a country. Healthcare along with

education can be fundamental to a society's development and its prosperity. This relationship has been observed in many countries and over a number of time periods and for a wide variety of health measures (Cutler & Lleras-Muney, 2006). Besides, when considering the comparison between education and the income level on health, empirical investigations repeatedly find that the effect of education on health is greater than the effect of income (Feinstein, Sabates, Anderson, Sorhaindo, & Hammond, 2006). It is believed that education is relatively important in enhancing the well-being and healthy lifestyles of individuals by reducing the costs of healthcare, lost earnings and human suffering. In another way, education also promotes a healthy lifestyle and nurtures human development within friends and family, whilst greater risks of future chronic disease are linked with low education level. Understanding the mechanism by which education affects health is, therefore, important for policymakers. It may be more cost-effective to tap that mechanism to increase educational attainment for people.

Over the last decade, several research studies have been carried out to examine the relationship between gender and health, including how differences in gender impact specific health conditions. Males and females are identical in most respects however, there are significant differences in biology and behaviour between the genders. The differences in gender will influence the development and the course of risk factors and conditions, such as obesity, cardiovascular diseases and mental health problems. Globally, in high-income countries, heart disease is the leading cause of death among women. 18% of women die from heart disease, which is often considered a 'male disease'. The anxiety regarding NCD's is expected to increase substantially in the coming decades, especially in low and middle-income countries. NCDs impact heavily on women's lives as social and cultural values

regarding health revolve around men's experiences, therefore, making women's experiences less visible. This is very apparent from research carried out as well as in the field of NCDs prevention, treatment and long-term management. Although women, on average, live longer than men, they are in poorer health for many of those years as a result of NCDs. Women's lives are also impacted when NCDs cause illnesses in family members, because women frequently sacrifice paid work, personal income and financial security, to provide care for others (Australian Women's Health Network, 2014). Besides, among women, the risk exposures to NCD's include; pregnancy, and women with low socioeconomic status.

Income is the driving force in comparing the health disparities in the gap between the rich and the poor. Income is another very important factor that interacts in a number of important ways with education as an influence on health. It is believed that health can be improved by increasing the income levels of the poorest members in society, in turn, scaling down the level of health inequality. Greater income equality seems to create a healthier society. A possible explanation for this inverse association is that higher income groups consume more healthy food and promote a healthy diet. Besides, in terms of the psychosocial aspects, mental problems will increase when people worry and stress about not having enough financial support in their daily life. Furthermore, people with a higher income level will tend to have improved living circumstances and this may motivate a healthier lifestyle. Undoubtedly, long term ill health conditions can influence economic outcomes by reducing employment opportunities and productivity levels. However, data can be a catalyst for a country to improve and, thus, it is important to understand the data on the determinants of health.

3.5.3 Interaction of Healthcare Cost with NCDs

The WHO Health Financing Strategy for the Asia Pacific Region (2010-2015) was used as the framework to evaluate the Malaysian healthcare financing system in terms of the provision of universal coverage for the population, and the Malaysian National Health Accounts (2015) provided the latest Malaysian data on health spending. In tandem, the health financing policies need to infuse an element of cost-effectiveness to better manage the purchase of new medical supplies and equipment. The total health expenditure of Malaysia in 1997 to 2015 was in the range of RM8,277 million in 1997 to RM52,609 million in 2015. However, it is important to note that private expenditure overtook public expenditure in 2004, and by 2008 private health expenditure accounted for a share of 53.8% compared to government health spending of 46.2%. In 2015, among all of the sources of healthcare financing, private household out-of-pocket (OOP) expenses contributed RM19,852 million or a 38 % share of total health expenditure. Higher government spending is widely promoted and regarded as a way to lessen the consumption of private healthcare services that could lead to high out-of-pocket expenses (OOP), as it generally relates to the provision of an adequate public infrastructure and health service delivery at a subsidised cost.

3.5.4 Interaction of Morbidity with NCDs

Cancer has a major impact on economic development and society across the world. Based on the available cancer statistics, countries can obtain a guideline of the burden that cancer will cause to society over time. Cancer is one of the leading causes of morbidity and mortality worldwide, with approximately 8.8 million deaths in 2015 (WHO, 2018). The

burden from NCDs on the members of society at the most economically productive age groups in developing countries has been expeditiously increasing. In 2015, globally, around 56.4 million people died. 39.5 million of these deaths, or 70%, were due to NCDs. According to Global Health Observatory (GHO) data, the leading causes of NCDs deaths in 2015 were cardiovascular diseases (17.7 million deaths), cancers (8.8 million deaths), and respiratory diseases (3.9 million deaths). The risk of dying from targeted NCDs is important for a country in order to scale down its burden from mortality.

The Malaysian National Cancer Registry Report (MNCR) 2007-2011 reported a total of 103,507 new cancer cases during the period of 2007 to 2011, of which 46,794 (45.2%) were reported in males and 56,713 (54.8%) in females. Among the top three cancers reported among Malaysian's were breast cancer, colorectal cancer and lung cancer. On top of cancer, diabetes mellitus is another important cause of rising morbidity. Diabetes mellitus is a group of metabolic diseases characterised by high blood sugar levels that result from defects in insulin secretion. It is a chronic and lifelong condition which will affect the body's ability to use energy in daily life.

In general, there are three major types of diabetes which are type 1 diabetes, type 2 diabetes and gestational diabetes. Type 1 diabetes is also known as insulin-dependent diabetes mellitus (IDDM) which is usually diagnosed most often in younger age groups. While type 2 Diabetes is referred to as non-insulin dependent diabetes mellitus (NIDDM) and comprises the majority of 90% of people with diabetes around the world aged 40 (NADI, 2009). In Malaysia, diabetes mellitus (DM) is a major public health concern that has been shown to be closely related to increased premature and preventable mortality. Heart disease,

stroke, weight gain, hypertension are the risk factors associated with getting diabetes. Based on the National Health and Morbidity Survey 2011, the prevalence of diabetes in Malaysia has increased over a period of 5 years, which was from 11.6% in 2006 to 15.2% in 2011. Conversely, being overweight and obesity are strongly associated with the prevalence and incidence of heart disease, diabetes, asthma and arthritis (Dobson et al., 2012).

Furthermore, stroke and heart disease has started to become a major public health problem, especially in developing countries. This can be attributed to the urbanisation of the populations which expands the prevalence of daily lifestyle diseases, increases life expectancy and the adoption of a modern lifestyle (Tharakan, 2012). According to the WHO, in 2014, the number of stroke deaths in Malaysia reached 15,497, which was 12.19% of the total deaths and the Ministry of Health (MOH) stated that stroke was the third largest cause of mortality around the world and was ranked 4th in Malaysia. Action has been taken to restrain the incidence of strokes. The National Stroke Registry has been developed which aims to coordinate and improve the country's stroke care, as well as to generate useful data on the various aspects related to strokes in Malaysia. During the third National Health and Morbidity Survey (NHMS) in 2006, the prevalence of strokes was estimated to be 0.3% among Malaysians. However, the situation became worse, as reported in the fourth NHMS survey in 2011, where the prevalence of strokes was reported to have increased to 0.7%. (Tsioufis et al., 2015). There are many challenges and obstacles in curbing strokes in the country which relate to broader socioeconomic issues. From the social aspect, patients often suffer from depression, thus, indirectly increasing social issues, such as marital problems, unemployment, poverty and so on. Inevitably, the incidence of strokes will entail economic

impacts, possibly reducing the employment rate, reduced business activities and increased financial insecurity in households.

3.5.5 Interaction of Mortality with NCDs

According to the International Agency for Research on Cancer (IARC), mortality due to cancer stood at 20,100 deaths in 2008 and increased to 21,700 deaths in 2012. Of the 56.4 million global deaths in 2015, 39.5 million, or 70%, were due to NCDs. The burden of these diseases is rising disproportionately among lower income countries and populations. In 2015, over three-quarters of the deaths due to NCDs, accounting for 30.7 million lives lost, occurred in low and middle -income countries About 48% of these deaths occurred before the age of 70 in these countries. Among the leading causes of NCDs related deaths in 2015 were cardiovascular diseases (17.7 million deaths, or 45% of all NCDs related deaths), cancers (8.8 million, or 22% of all NCDs related deaths), and respiratory diseases, including asthma and chronic obstructive pulmonary disease (3.9 million). Diabetes caused another 1.6 million deaths (WHO, 2016). The number of deaths per 100,000 population are influenced by the age distribution of the population of a country. In 2013 and 2014, the death pyramid showed that male deaths were higher than females in every age group except for those aged 80 years and above. As a reference, female deaths recorded the highest level at the age of 85 years and above (Department of Statistics, 2015).

3.5.6 Interaction of Health System Response with NCDs

Malaysia aspires to achieve “developed” country status by 2020. In this context, the current supply of human resources for health (HRH) is still considered low compared to developed nations. It can be seen that the number of nurses has increased greatly over the last decades and the number of dentists, doctors and pharmacists has kept increasing with population growth (WHO, 2013). However, even though the ratios of doctors and nurses compared to the population are still lower than in the OECD countries, Malaysia does not rely on expatriate HRH, except in the case of short-term measures to fulfil the gaps for specific skills. Besides, the shift in the epidemiological picture towards NCDs and increased longevity has led to a greater emphasis on higher-level skills in the HRH workforce. For example, there has been a recent emphasis on multi-skilled team approaches that require an increased focus on the workforce of health professional. Referring to the national budget in 2017, health was apportioned RM 25 billion from the country’s total budget with a budget increase of RM1.7 billion (9.50%) in the 2018 budget. Furthermore, the Ministry of Health has emphasised an increasing awareness regarding NCDs (Ministry of Finance Malaysia, 2018).

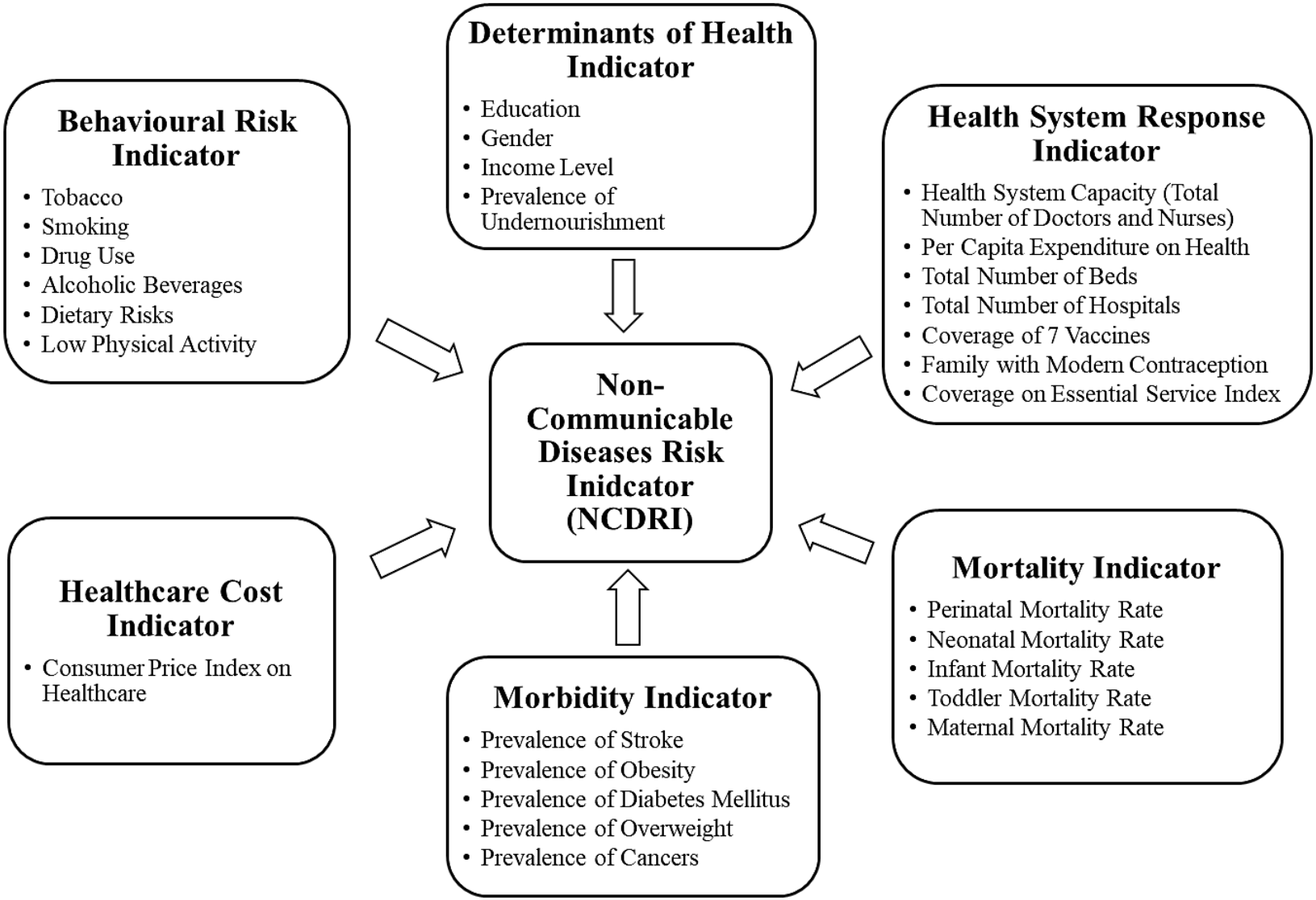

Figure 6: Framework of Non-Communicable Diseases Risk Indicator (NCDRI)

3.6 Non-Communicable Diseases Risk Indicator (NCDRI) Construction Procedure

It is desirable to understand the facts before attempting to explain them; hence, this study has gone through the indicator construction process. The most prominent example of this type of work was carried out by Burns and Mitchell (1946). The early emphasis on the consistent pattern of movement among various variables over the movement cycle led directly to the creation of composite leading, coincident, and lagging indexes. Hence, after adopting and adapting from the work of Burns and Mitchell (1946), this indicator can be a very effective method when used in indicator analysis. The corresponding five-step procedure and formulas were carried out in the present study:

i. Compute the month - to- month changes, where i = 1, …, n for each component as a symmetric percentage change formula based on the symmetric percentage change formula below:

$$r_{i,t} = \frac{X_{i,t} - X_{i,t-1}}{X_{i,t} + X_{i,t-1}} * 200$$

Note that if the composite involves a series in percentage form, then the simple arithmetic difference will be applied.

ii. Calculate the standardisation factor (w_i) by inverting the standard deviation of the month – to – month changes for each of the components series ($r_{i,t}$) and performing an adjustment by multiplying $r_{i,t}$ and w_i to yield the monthly contribution of each component series $(c_{i,t})$.

iii. Adding the adjusted symmetric changes across the components for each month to obtain the sum of the adjusted monthly contributions,

$$S_{t=} \sum_{i=1}^{n} c_{i,t}$$

iv. Then, based on the symmetric percentage change formula, derive the preliminary index recursively by letting the initial index value be equal to 100. The index value of the subsequent month will be:

$$I_2 = \frac{200 + S_2}{200 - S_1} * I_1$$

v. Finally, rebase the base year of 2010 on the preliminary index.

3.6.1 Selection of Reference Series

Like many developing nations, where statistical capacity building in healthcare is yet to be realised to its full potential, the NCDs epidemic is typically observed via the total number of deaths from NCDs, the mortality rate due to NCDs and the limited statistical estimates of the prevalence of NCDs and the incidence of NCDs reported by the Ministry of Health (MOH), Malaysia and the World Health Organization (WHO). To the best of the author's knowledge, the prevalence of NCDs is thus far the best available reference to reflect the trend of the risks of NCDs in Malaysia as it describes the number of citizens in the population who are at risk from noncommunicable diseases. In other words, the prevalence of NCDs

reflects the proportion of a particular population that is found to be affected by NCDs. Specifically, the prevalence encompasses the number of cases of a disease during a period of time (period prevalence) and the number of cases of a disease occurring at a particular point in time (point prevalence).

Besides, prevalence is eloquently the most appropriate reference series because it proclaims the number of cases as a fraction of the total population at risk. Additionally, the prevalence of NCDs can be characterized according to different subgroups of the population in a country. Thus, the total prevalence of NCDs on a quarterly basis in Malaysia was selected as the reference series covering the period from 1991 to 2017.

3.6.2 Component Series Selection

As in most indicator-based studies, the first stage of the NCDRI construction involved the selection of a set of appropriate representative series or component series that could jointly represent the indicator. In this study, the component series which consist of leading characteristics were chosen in constructing the NCDRI. To ensure the accuracy and persistence of the empirical evidence, the indicator construction guidelines proposed by the Conference Board (2000) were used as the main guiding principles in the process of selecting the component series. The present study compiled relevant health-related data from a variety of reliable sources which consisted of; the CEIC Database, the World Development Indicators (WDI) by The World Bank, the World Health Organization (WHO), the Food and Agriculture Organization of the United Nation Statistics (FAOSTAT), the UNESCO Institute for Statistics and the Ministry of Health (MOH) Malaysia. After the data was

compiled, a cross-correlation analysis was carried out to examine the degree of association between the reference series and the selected component series. The component series that showed a strong correlation with the reference series was selected and vice-versa, the component series that indicated a weak correlation was eliminated as it was less likely to contribute significant predictive ability towards the construction of the NCDRI.

3.7 Cycle Extraction and Detrending Procedures

In the present study, cycle extraction and detrending is conducted via the Christiano–Fitzgerald (CF) filter, which is a band pass filter proposed by Christiano Fitzgerald (2003). The CF filter uses the entire time series for the formulation of the filtered series. The CF filter deals with a larger class of time series than the Baxter-King (BK) filter and this asymmetric filter can converge in the long run to the optimal filter. In fact, the CF filter performs better than the BK filter in real-time applications. The CF filter approximation can be computed as follows:

$$C_t = B_{0y_t} + B_{1y_{t-1}} + \cdots + B_{T-1-t}y_{T-1} + \dot{B}_{T-t}y_T + B_1y_{t-1} + \cdots + B_{t-2}y_2 + \dot{B}_{t-1}y_1$$

$$\text{Where} \quad B_j = \frac{\sin(jb) - \sin(ja)}{\pi j}, \quad j \geq 1$$

$$B_0 = \frac{b-a}{\pi}, \; a = \frac{2\pi}{P_u}, \; b = \frac{2\pi}{P_1}$$

$$\dot{B}_k = -\frac{1}{2}B_0 - \sum_{j=1}^{k-1} B_j$$

From the approximation equation above, the parameters P_u andP_1 are the cut–off cycle length in months. In other words, cycles longer than P_1 and shorter than P_u will be conserved in cyclical term, C_t.

3.8 Turning Point Dating Algorithm

In indicator construction, the determination of turning points is another important aspect of analysing the movement of the cyclical turns, particularly the peaks and troughs. Bry and Boschan (1971) proposed an intuitive and easily implemented algorithm using a non–parametric approach to detect the lowest and highest values in economic activity. In the present study, quarterly data has been presented and tested, in order to fill the quarterly gaps of observations, the Bry and Boschan Quarterly (BBQ) algorithm was employed (Harding & Pagan, 2002). The complete steps and decision rules are detailed as follows:

i. Determination of the extremes and substitution of values.
ii. Determination of cycles in 12 months moving average (extremes replaced).
    - Identification of points higher (or lower) than 5 months on either side.
    - Enforcement of the alternation of turns by selecting the highest of multiple peaks (or lowest of multiple troughs).
iii. Determination of corresponding turns in the Spencer curve (extremes replaced)
    - Identification of highest (or lowest) values $\pm$ 5 months of the selected turn in the 12-month moving average.
    - Enforcement of a minimum cycle duration of 15 months by eliminating lower peaks and higher troughs or shorter cycles.

iv. Determination of corresponding turns in a short-term moving average of 3 to 6 months, depending on the months of cyclical dominance (MCD).

- Identification of the highest (or lowest) values within $\pm$ 5 months of a selected turn in the Spencer curve.

v. Determination of turning points in unsmoothed series.

- Identification of the highest (or lowest) values $\pm$ 4 months or MCD term, whichever is larger, of the selected turn in the short-term moving average.
- Elimination of turns within 6 months of the beginning and end of the series.
- Elimination of peaks (or troughs) at both ends of the series which are lower (or higher) than values closer to the end.
- Elimination of cycles whose duration is less than 15 months.
- Elimination of phases whose duration is less than 5 months.

vi. Statement of final turning points.

Since this study applies quarterly frequency of data, so an analogue to the first step of the BBQ procedure is to put *K* = 2, where $\{\Delta_2 y_t > 0, \Delta y_t > 0, \Delta y_{t+1,} < 0, \Delta_2 y_{t+2,} < 0\}$, as this ensures that y_t is a local maximum relative to the two quarters (6 months) on either side of y_t. Subsequently, a turning point in a graph at time *t* requires that the derivative sign changes at *t*. Hence, Δy_t becomes a measure of the derivative y_t in respect of *t*, which afterwards will lead to the use of the sequence $\{\Delta y_t > 0, \Delta y_{t+1} < 0\}$ as the signalling peak.

3.9 Weighting Methodology for Weighted-NCDRI

This study constructed a number of non-parametric NCDRIs that accounted for the issues of weighting the pillars and components. The first constructed NCDRI model did not impose any weighting scheme on the pillars and components to reflect the nature and relative contribution to the prevalence of NCDs. The absence of a weighting or an equal-weighting scheme ruled out their possibility that certain pillars and components may influence the prevalence of NCDs. This variation would pose substantial bias in the collective information content of the composite NCDRI.

Hence, it was meaningful to establish a set of weighting schemes by means of principal component analysis (PCA) by assigning an appropriate weight for each of the pillars and components. Contributions were made by each pillar and component when it is able to reflect the relative significance of the impact to a movement of the prevalence of NCDs. Therefore, the first weighting scheme was only imposed on the sub-pillars and was named NCDRI2 while the second weighting scheme was applied on both the sub-pillars and sub-components and named NCDRI3.

Each of the principal components PC_i is a new variable computed as a linear combination of the original or standardised variables. The weights are given by using the coefficients of the first principal component. The formula of weights, based on the PCA is shown below:

$$PC_i = w_1x_1 + w_2x_2 + \ldots + w_kx_k$$

3.10 Evaluation of Directional Accuracy

After the NCDRI is constructed, it is important to determine the reliability of its prediction accuracy and to compare the forecast direction with the actual direction by undergoing directional accuracy testing. In this study, the NCDRIs constructed using the different weighting schemes were subjected to directional accuracy testing (DAR) while binomial testing served as additional testing to identify if the indicator held forecasting ability. In summary, the cyclical changes will be categorised into three scenarios; large predicted growth, no significant changes and a large predicted decline with the exclusion of small predicted changes using a threshold point of 5 %. Hence, the directional accuracy rate can be calculated based on the formula below:

$$\text{Directional Accuracy Rate (DAR)} = \frac{C_s}{N_s} \text{ x } 100$$

Where C_s is the number of correct predictions for significant large changes, and N_s refers to the total number of significant large changes in NCDPRE. The directional accuracy involves binomial distribution testing that measures the probability of obtaining an accurate prediction by setting it as 0.5 within a fixed number of tests. Furthermore, to conduct the binomial testing, the null hypothesis states the probability of an accurately forecasted direction which is followed by the percentage of the forecasting model, 50%. There are two distinct conclusions that may occur during the rejection of the null hypothesis. From the outcome of the DAR, the null hypothesis is rejected if the DAR falls below 50%, or else the forecasting model is independent and can be accounted for as a reliable prediction indicator.

3.11 Empirical Analysis of the Characteristics of the Relationships Between NCDRI and Selected Macroeconomic Variables

3.11.1 Correlation Analysis

Correlation is a bivariate analysis that measures the strength of the association between two variables and the direction of the relationship. In terms of the strength of the relationship, the value of the correlation coefficient varies between +1 and -1. A value of ± 1 indicates a perfect degree of association between the two variables. As the correlation coefficient value goes towards 0, the relationship between the two variables will be weaker. The direction of the relationship is indicated by the sign of the coefficient; a + (positive) sign indicates a positive relationship and a – (negative) sign indicates a negative relationship.

3.11.2 Concordance Analysis of Turning Points

There are a number of methods for measuring business cycle synchronisations. The most popular are based on the Harding-Pagan concordance index (Harding & Pagan, 2002) and correlation analysis. A concordance index is used to measure the proportion of time when two business cycles are in the same phase, which may be either an upturn or a downturn. If the index is a perfect concordance or the index is equal to 1, it states that there is a perfect concordance between the series and inversely. Binary variable sy,t can be defined as below when the turning points of a variable y has been identified.

$$S_{y,t} = \begin{Bmatrix} 1\ if\ y\ is\ in\ expansion\ at\ t \\ 0\ otherwise \end{Bmatrix}$$

Subsequently, we proceed in the same fashion with x, by defining $S_{x,t}$. The concordance index between x and y, c_{xy}, is then defined as the average number of periods where x and y are identified simultaneously in the same phase, and is expressed as follows:

$$c_{xy} = \frac{1}{T}\sum_{t=1}^{T}\left[s_{x,t}s_{y,t} + (1 - s_{x,t})(1 - s_{y,t})\right]$$

Thus, c_{xy} is equal to 1 if x and y are always in the same phase and to 0 if x and y are always in opposite phases. A value of 0.5 indicates the lack of any systematic relationship in the dynamics of the two variables. To test the hypothesis that two cycles are synchronised, the linear model below is estimated.

$$c_{xy} = 1 + 2\rho_s\sigma_{s_x} + 2\mu_{s_x}\mu_{s_y} - \mu_{s_x} - \mu_{s_y}$$

According to the equation above, cxy and ρs are linked in such a way that either of these two statistics can be studied to the same effect. To calculate ρs, Harding and Pagan estimate the linear relationship:

$$\left(\frac{s_{y,t}}{\sigma_{s_y}}\right) = \eta + \rho_s\left(\frac{s_{x,t}}{\sigma_{s_x}}\right) + u_t$$

Where η is a constant and ut an error term. The estimation procedure of Equation (1.2) must be robust to possible serial correlation in the residuals, as ut inherits the serial correlation properties of syt under the null hypothesis ρs = 0. The ordinary least squares method augmented by the Newey-West HAC procedure is therefore used here.

3.12 Empirical Analysis of NCDRI and Selected Macroeconomic Variables

3.12.1 Augmented Dickey-Fuller (ADF) Unit Root Test

Before proceeding to the cointegration method, it is essential to verify whether there are non-stationary on the time series variables and have achieved a unit root or stationarity without a unit root. The order of integration of the variable is verified after the unit root test has been applied. Variables which achieve stationarity in their level form were indicated as I(0) variables, whereas variables that achieve stationarity after taking the first difference indicated as I(1) variables. The choice of the significant variable is based on the critical value at the 1%, 5%, and 10% significance levels.

The Augmented Dickey-Fuller (ADF) test was developed by Dickey and Fuller in 1981 and it has been adopted to test for the stationarity properties of time series data (Dickey & Fuller, 1981). The test result is sensitive to lagged length, p. According to Gujarati and Porter (2009), the ADF test adjusts the Dickey-Fuller test to take care of possible serial correlation between the error terms by adding the lagged different terms of the regression. In other words, it assumes that the error term is correlated. In the ADF test, the tau statistic is used to compare with its corresponding critical value and to examine the stationarity of the variables. First differencing is used when the variables have a unit root or are non-stationary at level. There are three difference null hypotheses for the empirical model which are; a constant, a constant and a linear time trend, or neither in the test regression. The regression for the ADF test can be expressed as follows (Gujarati and Porter, 2009):

No constant, no trend : $\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_{i\,\Delta} y_{t-i} + \varepsilon_t$

Constant, no trend : $\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_{i\,\Delta} y_{t-i} + \varepsilon_t$

Constant with trend : $\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_{i\,\Delta} y_{t-i} + \varepsilon_t$

Where Δ is the first-difference operator, β_1 is the constant term referred to as drift, β_2 signifies the coefficient of the time trend, δ is the coefficient presenting process root, p indicates the optimal lag length, Y_t denotes the vector for all of the time series variables, t represents a linear deterministic trend or time trend and ε_t is a pure white noise error term with zero mean and a constant variance. The null and alternative hypotheses for the ADF test are shown below:

H_0: $\alpha = 0$ (The variable has a unit root, which means that the variables are non-stationary)

H_a: $\alpha \neq 0$ (The variable has no unit root, which indicates that there are stationary variables)

The null hypothesis is rejected when the computed absolute value of the tau statistic is greater than the absolute critical tau value at a significance level and the series is significant. When the null hypothesis is rejected, it means that the variable does not contain a unit root and it is stationary. On the contrary, if the absolute tau statistic is smaller than the absolute critical tau value at a significance level, therefore, we can indicate that we fail to reject the null hypothesis as the variable is insignificant.

3.12.2 Johansen and Juselius Cointegration Test

Cointegration analysis was carried out to examine the existence of a cointegrating vector among the variables. There are several types of cointegrating test, which include; Johansen procedures and the autoregressive distributed lag (ARDL) test. In this study, the JJ test is carried out to test whether there is a long-run relationship between the variables or series. The Johansen cointegration test was developed by Johansen and Juselius in 1991 (Johansen & Juselius, 1990). It is a multivariate cointegration test which permits more than one cointegrating relationship. Therefore, after detecting the stationarity properties of the variables, where all of the variables are integrated of order one, I(1) in the unit root test, then the Johansen and Juselius test is conducted, which is used to examine the existence of cointegration between the series. The presence of cointegration allows one to estimate if a meaningful and stable long-run relationship occurs between the selected variables.

In accordance with this, Johansen and Juselius (1990) stated that the different critical values obtained by the test were due to different treatments of the constant and trend terms. The general equation or model for each test is shown as follows:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i-1}^{k-1} \Pi_i \Delta x_{t-i} + \varepsilon_t$$

Where x_t means the (4 x 1) vector of non-stationary I(1) variables, Π and Πi is a (4 x 1) constant vector, ε_t is independent and an error term with the non-singular covariance matrix of Ω and zero mean, t is the time series which equal to 1, 2, 3,…, k is the lag length,

and Δ is the difference operator. According to Hjalmarsson and Osterholm (2007), there are two different likelihood ratio tests that the Johansen cointegration test uses. The two types of test that used to determine the number of cointegrating vectors are the trace test and the maximum eigenvalue test. The general equation for each test (Hjalmarsson & Osterholm, 2007) is shown as follows:

$$J_{trace} = -T \sum_{i=r+1}^{n} In\left(1-\hat{\lambda}_i\right)$$

$$J_{max} = -TIn\left(1-\hat{\lambda}_{r+1}\right)$$

Where *T* is the number of observations or the sample size, *n* is the number of variables, $\hat{\lambda}_i$ is the i_{th} largest canonical correlation, and $\hat{\lambda}_{r+1}$ is the largest estimated eigenvalue at r + 1. The hypothesis for using the Johansen trace test is shown below:

H0: λi = 0 (The variables are not cointegrated)

H1: λ i ≠ 0 (The variables are cointegrated)

The hypotheses for using the Johansen max eigenvalue test are:

H0: r cointegrating vectors (The variables are not cointegrated)

H1: r + 1 cointegrating vectors (The variables are cointegrated)

In general, the null hypothesis shows that there is no cointegration between the variables or known, as among the variables, there is no long-run relationship, while the alternative hypothesis indicates that there is a cointegration vector which means that there is

a long-run relationship between the variables. In this sense, the rejection rule is that the null hypothesis can be rejected when the critical value is smaller than the trace test r maximum eigenvalue test statistic at the significance level. When the null hypothesis is rejected, it indicates that the variables are cointegrated and that there is a long run relationship. However, if the test statistic is less than the critical value, then the null hypothesis fails to be rejected. We can, therefore, conclude that the variables are not cointegrated and that there is no long-run relationship between the variables.

3.12.3 Vector Error Correction Model (VECM) Granger Causality Test

The Granger causality test will be carried out in the later section to investigate the causality between the selected variables. This test gives the result of the causality direction between variables. The decision on whether VAR causality or VECM causality is applied can be made by using the result of the Johansen and Juselius cointegration test. If cointegration is detected, the Granger causality test must be performed in the VECM to avoid the misspecification problem (Granger, 1988). It indicates the presence of a long-run equilibrium relationship, at least in one direction which may be either a unidirectional or bidirectional causality among them (Granger, 1986).

The Granger causality test is very sensitive to the number of lags used in the analysis (Gujarati & Porter, 2009). According to Asteriou and Hall (2007), the Granger causality test for the case of two variables x and y involves, as a first step, the estimation of the following simple VAR model:

$$y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, y_{t-i} + \sum_{j=1}^{m} \beta_{2i}\, x_{t-j} + \varepsilon_t$$

$$x_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, x_{t-i} + \sum_{j=1}^{m} \beta_{2i}\, y_{t-j} + \varepsilon_t$$

Where β_0 is constant, ε_t is the error term, y_{t-i} and x_{t-i} are the heterogeneous coefficients. The null and alternative hypotheses for the Granger causality test are written below:

H_0 = Granger causality does not exist (X does not Granger Cause Y or Y does not Granger Cause X)

H_a = Granger causality does exist (X does Granger Cause Y or Y does Granger Cause X)

The rejection rule for the Granger causality test is when the computed F-test statistic is greater than the critical F-value, the null hypothesis will be rejected. There are several possibilities for x and y while testing the direction, which include; unidirectional causality (from independent variable x to dependent variable y), unidirectional causality (from dependent variable y to independent variable x), bi-directional causality, and no direction of causality or independence. The four different cases for x and y in the regression model are shown below:

1. Unidirectional causality from x to y occurs when the lagged x is statistically different from zero as a group and the lagged y is not statistically different from zero.

2. Unidirectional causality from y to x occurs when the lagged y is statistically different from zero as a group and the lagged x is not statistically different from zero.
3. Bi-directional causality from x to y or y to x occurs when both x and y or y and x terms are statistically different from zero.
4. Independence occurs when both sets of x and y terms are not statistically significantly different from zero in each of its regression.

3.13 Data Description

As in most indicator-based studies, the first stage of the NCDRI construction involved the selection of a set of representative series or component series that could jointly represent the indicator of each risk factor. There is an initiative to compute a composite indicator which summarises the fundamental information of each individual series. Variables with leading characteristics towards the NCDs prevalence will be divided as pillars to better describe the NCDs risk factors.

To ensure the accuracy and persistence of the empirical analysis, data from a variety of reliable sources, such as the CEIC Database, the World Development Indicators (WDI) by The World Bank, the World Health Organization (WHO), Food and Agriculture Organization of the United Nation Statistics (FAOSTAT), UNESCO Institute for Statistics and the Ministry of Health (MOH) Malaysia are compounded. The period of the analysis spans from 1991 to 2017, a duration of approximately 26 years. Besides, to better capture the fluctuation of the business cycle, quarterly data are employed in the present analysis.

An interpolation technique is applied to obtain quarterly data for the time series that without data on a quarterly basis. There are two methods applied in this study which are interpolation technique and cubic spline interpolation. Above that, to obtain series with high frequency, interpolation technique will be applied to obtain quarterly data from yearly basis (Gandolfo, 1981). While, cubic spline interpolation is a useful technique to interpolate between known data points due to its stable and smooth characteristics. In reference to McKinley and Levine., (1999), cubic spline interpolation is valuable because it has smaller error than some other interpolating polynomials such as Lagrange polynomial and Newton polynomial. Hence, in this study, both interpolation technique will be adopted for volume data and point data.

Table 3: List of Selected Components Series

	List of Components Series
BRI	Behavioural Risk Indicator
TOB	Tobacco
SMK	Smoking
DRU	Drug use
ALC	Alcohol
DIR	Dietary risks
LPA	Low Physical Activity
COSTI	Cost Indicator
CPIH	Consumer Price Index (CPI) on healthcare
DOHI	Determinants of Health Indicator
GPI	School enrolment, primary (gross), gender parity index (GPI)
RGDP	Real GDP per Capita (MYR)
HSR	Human Sex Ratio
POU	Prevalence of undernourishment
MOBI	Morbidity Indicator
POB	Prevalence of obesity among adults, BMI $\geqslant$ 30
POO	Prevalence of overweight
PCAN	Prevalence of top 5 cancers

Table 3 continued

	List of Components Series
PSTROKE	Prevalence of stroke
PDBT	Prevalence of diabetes
HSRI	Health System Response Indicator
DOC	Total Number of Doctors
BEDS	Total Number of Beds
EXP	Current health expenditure per capita (current RM)
VAC	Coverage of 7 vaccines in target population (%)
NUR	Total Number of Nurse
HSP	Total Number of Hospitals
MCM	Family with modern contraception method (%)
ESI	Coverage on Essential Service Index
MOTI	Mortality Indicator
INM	Infant Mortality Rate (per 1000 livebirths)
MEM	Maternal Mortality Rate (per 1000 livebirths)
PEM	Perinatal Mortality Rate (per 1000 total births)
NEM	Neonatal Mortality Rate (per 1000 livebirths)
TOM	Toddler Mortality Rate (per 1000 toddler population)

3.14 A Remarks

In conclusion, this study commences with a proper framework adopted from the WHO and develops a country-level NCDs framework to provide a clearer picture of the movement of the risk of NCDs in Malaysia. After the process of the selection of the component series and the reference series, the study proceeded with the construction of a composite indicator, namely the NCDRI which involved the selection of a set of appropriate representative series. Subsequently, cycle extraction and detrending procedures were carried out using the Christiano–Fitzgerald (CF) filter. The turning points were determined by using the Bry and Boschan technique to analyse the movement of the cycle turns, particularly the peaks and troughs. A weighting scheme, adopted from Principal Component Analysis (PCA), is

applied to the constructed NCDRI and the directional accuracy tested to identify if the indicator holds forecasting ability. Next, an empirical analysis of the characteristics of the relationships between the characteristics of the relationships between NCDRI with the selected macroeconomic variables and the analysis on HDI, NCDRI and macroeconomic determinants is presented. To provide a better understanding, a concise flow chart of the analytical procedure is presented in Figure 7.

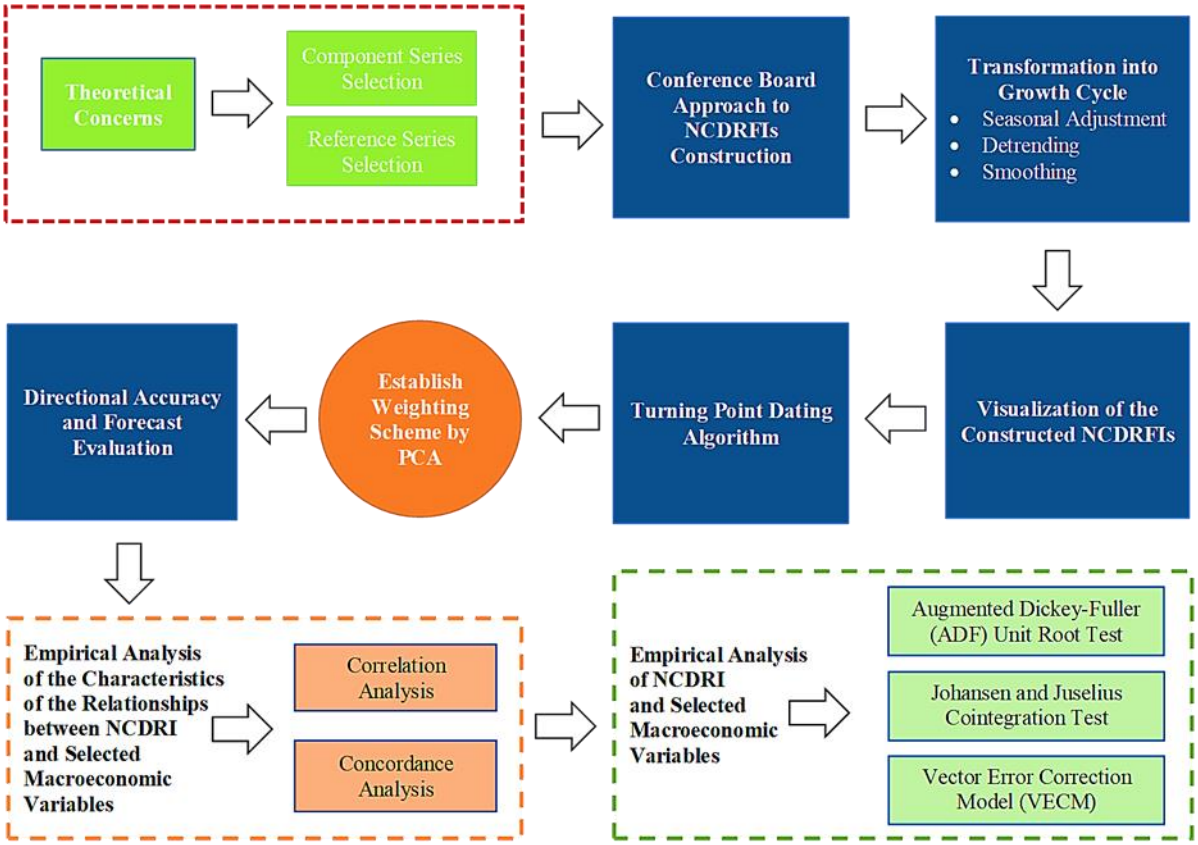

Figure 7: Flow chart of analytical procedure

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In line with the theoretical building of each methodological aspect, as outlined in the previous chapter, this chapter presents the empirical findings and discussions of the study. The structure of this chapter has been divided into several sub-sections, starting with the results of the construction of the non-communicable diseases risk indicator (NCDRI), an alternative forward-looking measure of the prevalence of NCDs in Malaysia. Besides, a comparative analysis on the equal weighted NCDRI and PCA-weighted NCDRIs will be presented, followed by a discussion on the predictive ability and directional accuracy of the NCDRIs developed in the present study. The most parsimonious variant of the NCDRI will be decided and subsequently subjected to econometric analysis to model the relationship between the risk of NCDs and macroeconomic variables. In the final stage, this chapter also presents an empirical discussion on the interactions of the risk of NCDs, human capital development and economic growth.

4.2 Results of Non-Communicable Diseases Risk Indicator (NCDRI) Construction

This section presents a detailed empirical discussion on the non-communicable diseases risk indicator (NCDRI) construction, covering the outcomes of the selection of both the reference series and component series to the analysis of the constructed NCDRI, on both the equal weighted and the PCA-weighted NCDRIs. Given that prior studies on the monitoring and tracking of NCDs are clearly limited, there appears to be no clear consensus on the single

best representation of risk factors for NCDs in Malaysia, besides the limited publicly available statistics on the prevalence of NCDs and deaths attributed to NCDs. Therefore, selecting a suitable reference series that best reflects the cyclical movement of the risk of NCDs in Malaysia is the foremost step in this study.

4.2.1 Selection of Reference Series

As depicted in Figure 8, the movement of the epidemic of NCDs, as proxied by the degree of prevalence of NCDs, followed a cyclical process, where the cyclical process captured the underlying movement of the risk factors of NCDs in Malaysia. The extracted cyclical process of the prevalence of NCDs has translated the epidemic of NCDs into 6 important episodes, consisting of 3 peaks and 3 troughs across the study period. Among others, some of the episodes where NCDs eased worth noting occurred during the periods of 1997, 2006 and 2015, where the prevalence of NCDs slipped to their lowest points, this marked a significant rebound in the population's health status as well as suggesting a notable reduction in the health-related risk factors for NCDs. In this regard, one of the most significant milestones of the nation's healthcare policies in relation to the prevention and control of NCDs was the introduction of the Control of Tobacco Products Regulations in 1993, a public health policy that aimed to enforce pictorial and other related health messages on any cigarette products. Moreover, thanks to the triumph of fiscal policy over the healthcare sector, the epidemic of NCDs was greatly eased towards the end of 1997 with the tightening of tobacco control legislation through the raising of tobacco taxes. Malaysia's government revised tobacco taxation following the WHO benchmark by setting the excise duty (as a percentage of cigarette prices) at a minimum of 70% of the retail price. A study

by Nabilla et al., (2007) claimed that raising tobacco taxation increased the prices of cigarette products by 10%, resulting in a drop-in cigarette consumption by 3.8% in 2004.

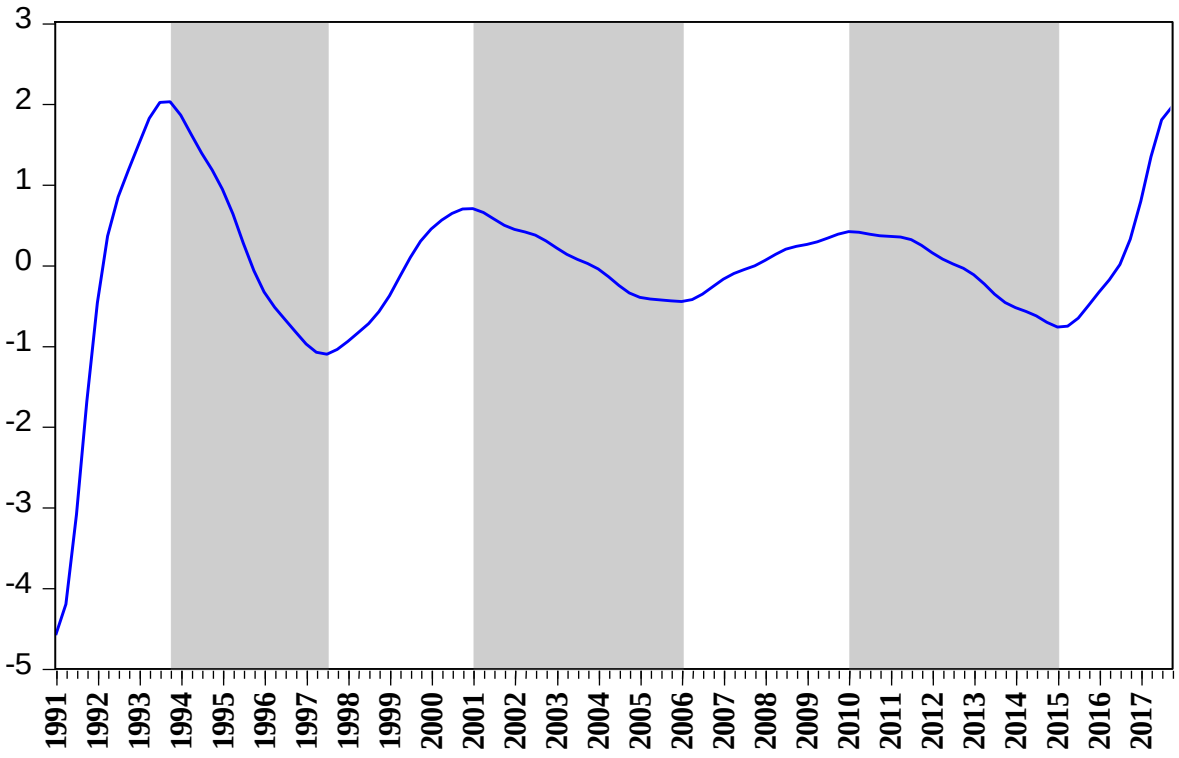

Figure 8: Total Number of Prevalence by NCDs (NCDPRE) from 1990Q1 to 2017Q4

Furthermore, the national wellness policy was another important policy response to the epidemic of NCDs. Sustaining an optimal level of wellness for the population has always been a crucial healthcare goal in Malaysia. The national wellness policy provided a paradigm shift from treating diseases to maintaining wellness. In other words, the policy focus for public health transformed towards fostering the development of health-oriented behaviors and lifestyles from the elimination of symptoms or diseases. The rationale was that nearly two-thirds of the disease burden was due to chronic NCDs which were contributed to by the behaviour and lifestyle of individuals. At the same time, these chronic NCDs are jointly

responsible for a huge proportion of deaths and disabilities in all countries, including Malaysia. On account of this, the MOH, Malaysia commenced promoting early self-risk assessment in the community and has placed a great emphasis in promoting wellness and the maintenance of healthy behaviours by enhancing primary healthcare, targeting prevention, the timely treatment of diseases as well as the enhancement of citizen's well-being. In line with this wellness policy, health risk assessment plays a key role in the promotion of health and disease prevention, and it is critically encouraged to assess an individual's health status, risks, and habits. For instance, a routine medical examination was introduced for public servants aged 40 and above to encourage regular medical check-ups.

On the other hand, being overweight and obesity are on the rise in many low- and middle-income countries, including Malaysia. The prevalence of being overweight and obesity among adults (18 years and above) were 30.0% and 17.7% respectively in 2015 when compared to 16.6% and 4.4% respectively in 1996 (NHMS 1996), where the prevalence of being overweight and obesity has increased by 80.7% and 30.2% respectively in just under two decades. Being overweight and obesity can lead to serious and potentially life-threatening conditions, such as cardiovascular disease, diabetes, strokes and other chronic diseases and the condition becomes worse when there is no intervention. In light of this issue, the National Nutrition Policy of Malaysia (2005) and the National Plan of Action for Nutrition of Malaysia (NPANM) 2006-2015 have been putting in place to promote healthy lifestyles. Primarily, besides having enough food for the household, true food security must be kept in mind. The availability of food that is shared among households must be of sufficient variety, quality and safety in order to make sure that each of the household members is in good health after the food is consumed. Likewise, nutrition improvements

implemented through nutrition planning and development, nutrition promotion, nutrition rehabilitation and nutrition surveillance are essential. Nutrition promotion encompasses promoting infant and young child nutrition, adolescent nutrition, nutrition in institutions and adult nutrition through healthy eating and nutrition for the elderly and those with special needs.

All in all, the health policy decisions discussed above are crucial policy responses towards the progress of NCDs prevention and control in Malaysia and the effectiveness of these policies has been well-documented in many national public health assessments for the monitoring of NCDs at the national level. Conjointly, these few key health policy decisions have resulted in the reduction of the prevalence of NCDs, signifying a significant easing of the risk of the impact of the epidemic of NCDs. More to the point, it is also crucial to note that the falling prevalence of NCDs pertaining to key health policy decisions has always been offset by the outbreak of crises or economic downturns. This is because the bottoming-out process of the risk of NCDs has recurrently marked the onset of a critical downturn in economic activity or a nationwide financial crisis, such as the Asian Financial Crisis in 1997 and the Subprime Mortgage Crisis in 2007.

4.2.2 Component Series Selection

The findings of the cross-correlation analysis between the reference series, NCDPRE and the selected component series NCDRI is presented in Table 4 on a raw data basis. As presented in Table 4, the findings of the cross-correlation analysis showed that most of the selected components series had a strong degree of correlation with the reference series as the

correlation coefficient was above 0.9 in most of the cases, implying that most of the selected component series was likely to establish a significant strength of association with the prevalence of NCDs. In addition, a strong correlation between the reference series and the component series helps to ensure the presence of a relationship between the prevalence of NCDs and the selected component series, though the relationship could be positive (procyclical) or negative (countercyclical) by nature. However, as the aim of the present study is to develop an NCDRI with leading ability, therefore, having a set of component series that portray a procyclical feature towards the prevalence of NCDs is a crucial requirement to be fulfilled. Succinctly, the selected component series of the NCDRI are not merely correlated well with the prevalence of NCDs but also exhibit procyclical behaviour towards the prevalence of NCDs.

After finalising the list of the component series, each of the component series was assigned into its respective pillar based on the NCDs causation pathway and the WHO's global monitoring framework. Particularly, tobacco consumption, smoking, drug use, alcoholic beverages, dietary risks and low physical activity were included in the behavioural risks pillar, meanwhile, the level of education, gender, the income level and the prevalence of undernourishment were grouped in the aspect of the determinants of health. Besides, health system capacity was represented by the number of doctors, the number of nurses, the total number of beds and the total number of hospitals, while current health expenditure, the coverage of vaccines, modern contraception methods and essential services were used to represent the health system response towards NCDs.

Table 4: Results of Correlation Analysis between Selected Component Series and NCDs Prevalence

BRI		HSRI		DOHI	
TOB	0.96	DOC	0.93	GPI	0.70
SMK	0.96	BEDS	0.98	RGDP	0.95
DRU	0.97	EXP	0.94	HSR	0.90
ALC	0.74	VAC	0.91	POU	0.70
DIR	0.95	NUR	0.94		
LPA	0.95	HSP	0.70		
		MCM	0.99		
		ESI	0.99		
MOBI		**MOTI**		**COSTI**	
POB	0.97	INM	0.82	CPIH	0.98
POO	0.99	MEM	0.60		
PCAN	0.95	PEM	0.60		
PSTROKE	0.95	NEM	0.78		
PDBT	0.99	TOM	0.95		

On the other hand, the consumer price index on healthcare was used to proxy the cost pillar in the NCDRI. The morbidity pillar captured the prevalence of obesity, the prevalence of being overweight, the prevalence of the top 5 cancers, the prevalence of strokes and the prevalence of diabetes. Lastly, the infant mortality rate, the maternal mortality rate, the perinatal mortality rate, the neonatal mortality rate and the toddler mortality rate made up the mortality pillar of the NCDRI.

4.3 Weighting Scheme on PCA-weighted NCDRI

In the process of identifying the weighting scheme of the weighted-NCDRI, principle component analysis (PCA) was adopted to derive the optimal weight of the pillars as well as the sub-components of the pillars. The respective weights are summarised in Figure 9 and these weighting schemes were used to develop two variants of PCA-weighted NCDRIs.

Specifically, the first variant of the PCA-weighted NCDRI is a partially PCA-weighted model where weight is assigned on each of the pillars in the indicator, whereas, in the second variant of the PCA-weighted NCDRI, a complete PCA weighting scheme was applied on both the pillars and the sub-components. The former was termed as "NCDRI2" while the latter as "NCDRI3". Figure 9 summarises the weights assigned on each of the pillars that make up NCDRI2 and NCDRI3.

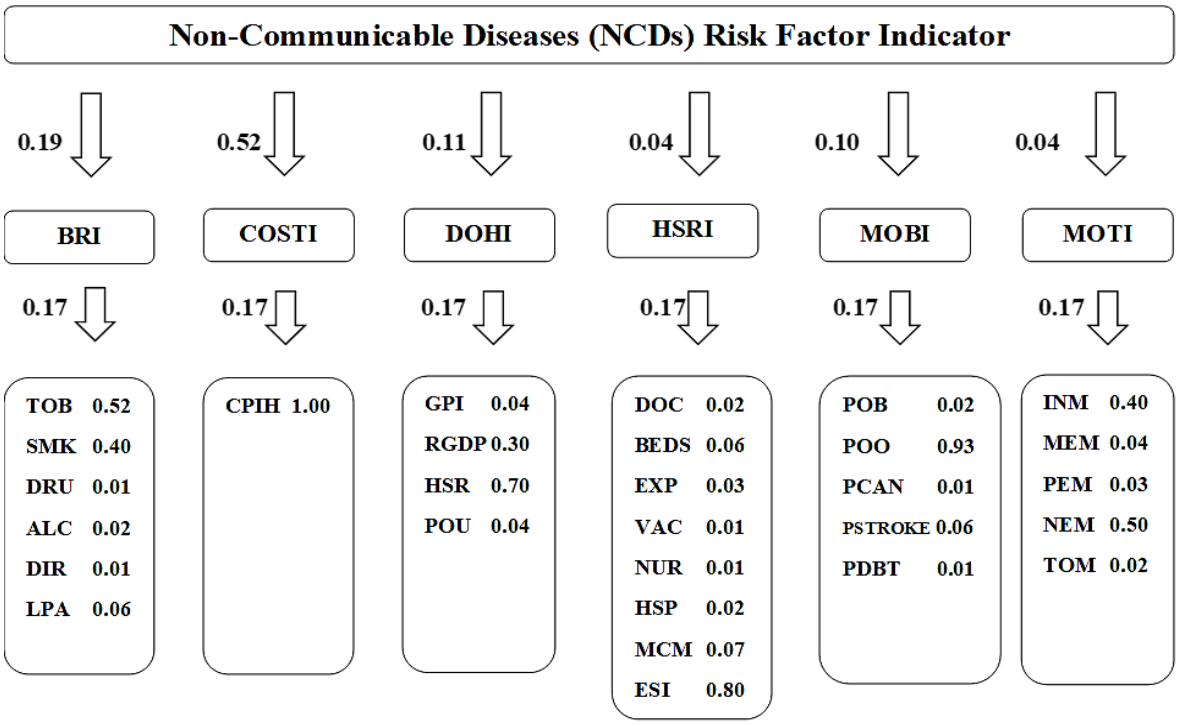

Figure 9: Weighting Scheme on PCA-weighted NCDRI2 and NCDRI3

The cost indicator was given the highest relative importance towards the prevalence of NCDs as 0.52 or 52 % was assigned to the cost pillar, followed by the behavioural risk indicator that made up 0.19 (or 19 %) of the indicators. On the other hand, the determinants of health were the third important aspect, followed by morbidity, health system response, and the mortality pillar. In this case, the weighting scheme also signified that the cost and

behaviour aspects were two crucial elements of the risk of NCDs that play a vital role in explaining the driving forces behind the trends of the prevalence of NCDs in Malaysia.

In addition, NCDRI3, where the pillars' weight remains similar with that of the NCDRI2, however, the relative importance of the sub-components (items) in each pillar was established to test the possibility of enhancing the PCA-weighted NCDRI. In this regard, the NCDRI3, which carried a complete weight assignment from PCA revealed that tobacco consumption carried the most weight in the behavioural risk pillar, while smoking came next, followed by other behavioural and lifestyle risks, such as low physical activity, alcohol consumption and dietary risks.

4.4 Cyclical Movement of the Reference Series and the Constructed NCDRI

This subsection continues with a discussion on the decomposition of the cyclical reference series and component series. After looking at the cross-correlation analysis of the selected component and reference series, we proceeded with the composite indicator construction for each of the sub-pillars. A step-based procedure for indicator construction, proposed by the Conference Board (2000), was used to compile and compose the selected component series into a composite indicator. As mentioned, the framework of this study was divided into 6 sub-pillars which when pulled together formed a non-communicable disease risk indicator. After obtaining the constructed NCDRI, the cyclical process for both the equal weighted and weighted NCDRI was established based on the CF filtering procedure proposed by Christiano and Fitzgerald (2003) to detrend the seasonally adjusted time-series into trend. It would be more meaningful to establish a weighting scheme in which the loading factors were given by principal component analysis (PCA).

The discussion will start with the cyclical decomposition of LNCDPRE and LNCDRIE (Equal Weight) by the CF Filter followed by the cyclical decomposition of LNCDPRE and LNCDRI2 by the CF Filter where weight is applied on the sub-pillars. Lastly, as shown by LNCDRI3 where weight is applied on both the sub-pillars and the sub-components by the CF Filter. First and foremost, an equally weighted NCDRI for both sub-pillars and sub-components was developed and named NCDRIE and determined the cyclical decomposition with the reference series that can be referred to in Figure 11. From the graphical illustration shown in Figure 11, we can observe that after the CF filtering procedure, the cyclical process of the equally weighted NCDRI was very smooth, due to the smoothing out of the irregular components and noise. Besides, the figure shows that the constructed NCDRIE was leading ahead by a few quarters from the turning points of the NCDPRE.

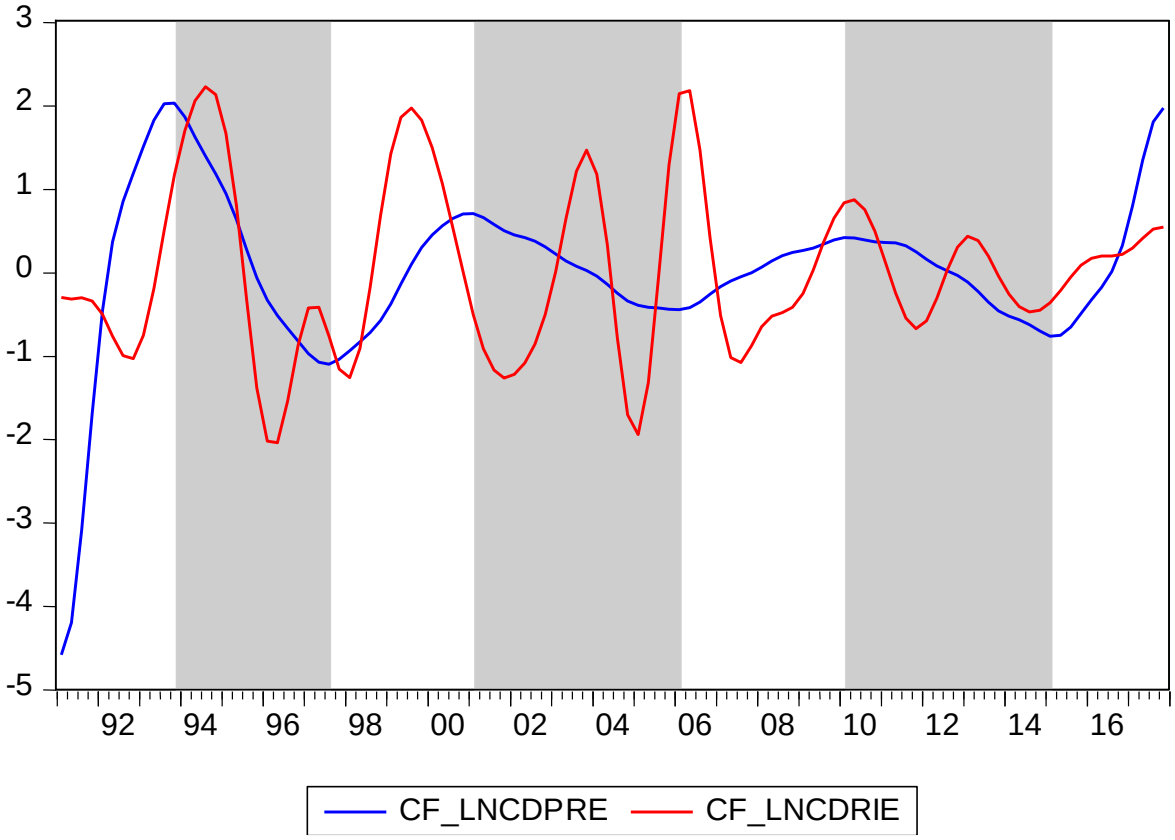

Figure 10: Cyclical Decomposition of LNCDPRE and LNCDRIE by CF Filter

Subsequently, a weighted NCDRI was then derived using principal component analysis and we labelled it as NCDRI2. It was built on a set weighting that was derived from the loading factors of the PCA. From the graphical illustration shown in Figure 12, the relatively comprehensible cyclical development of the CF-filtered PCA-weighted NCDRI against the reference series NCDPRE indicated it to be an improved alternative in tracing the movement of the prevalence of NCDs in Malaysia. We can see that the PCA-weighted NCDRI2 was leading ahead in 2013: Q3 and that the cyclical fluctuations were rather smooth and that the recurrent rise and fall were articulated against the reference series, NCDPRE. This finding inferred that the PCA-weighted NCDRI2 has the capability to trace the movements if compared to the equally weighted, NCDRIE.

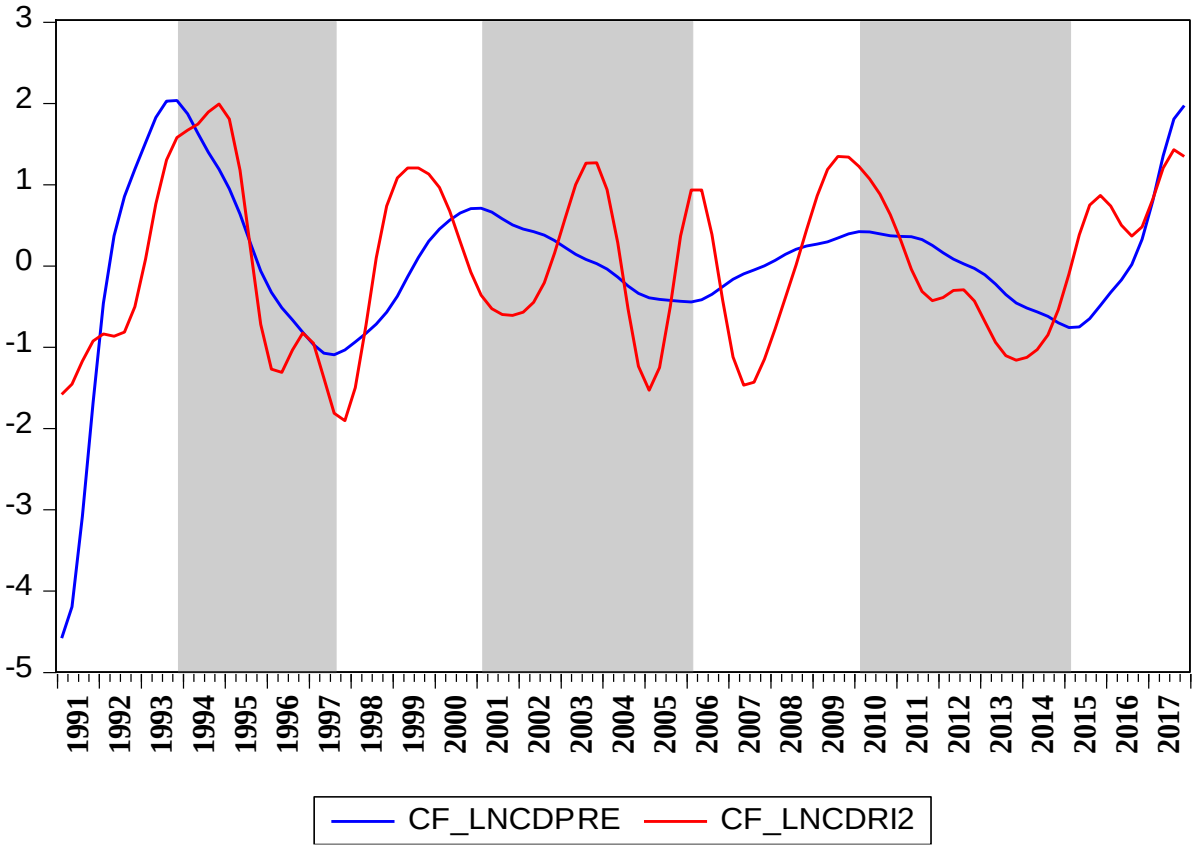

Figure 11: Cyclical Decomposition of LNCDPRE and LNCDRI2 by CF Filter

Furthermore, the PCA-weighted NCDRI3 for both sub-pillars and sub-components is clearly analysed through the visualisation of the graph shown in Figure 13. From the cyclical movements between LNCDPRE and LNCDRI3, we can see that the PCA-weighted NCDRI3 for both sub-pillars and sub-components is moving ahead of LNCDPRE most of the time, which means that the turning points of LNCDRI3 were leading by a few quarters ahead from the turning points of LNCDPRE. As the leading turning points are just an Illustration from the graph, hence, we needed to utilise the Bry and Boschan technique, proposed by Bry and Boschan (1971), to date the turning points.

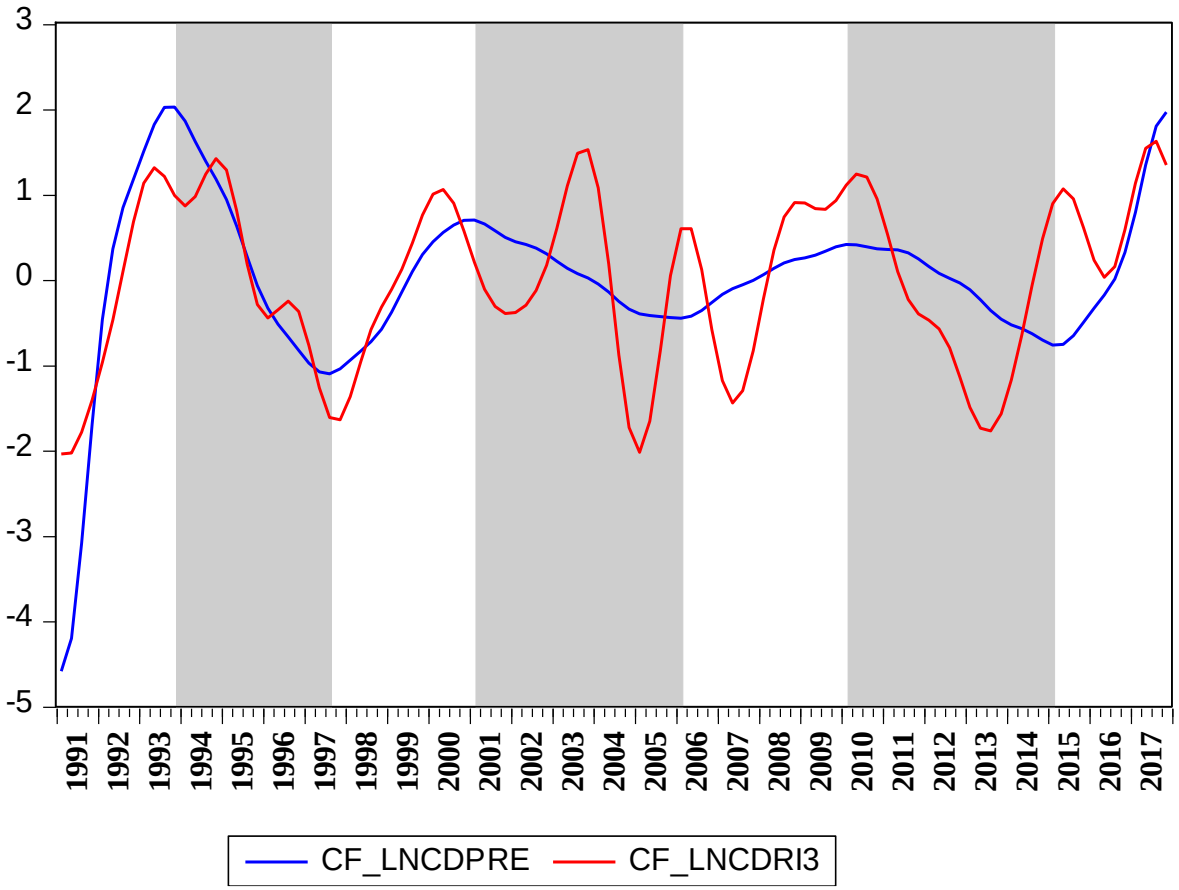

Figure 12: Cyclical Decomposition of LNCDPRE and LNCDRI3 by CF Filter

To further clarify the results, the equal-weighted, NCDRIE, the PCA-Weighted, NCDRI2 and the PCA-weighted, NCDRI3 are graphically represented in Figure 14. Meanwhile, it indicates the possibility that a weighted indicator may better reflect the relative contribution of the component series towards the reference series. More importantly, the PCA-weighted NCDRI can trace most of the important episodes in the prevalence of NCDs and the weights imposed on the sub-components do not deteriorate the signalling ability but on the other hand, ameliorate the capability. The cycle movements of each of the NCDRIs are clearly shown in the next section which dates the turning points using the Bry and Boschan technique, proposed by Bry and Boschan (1971).

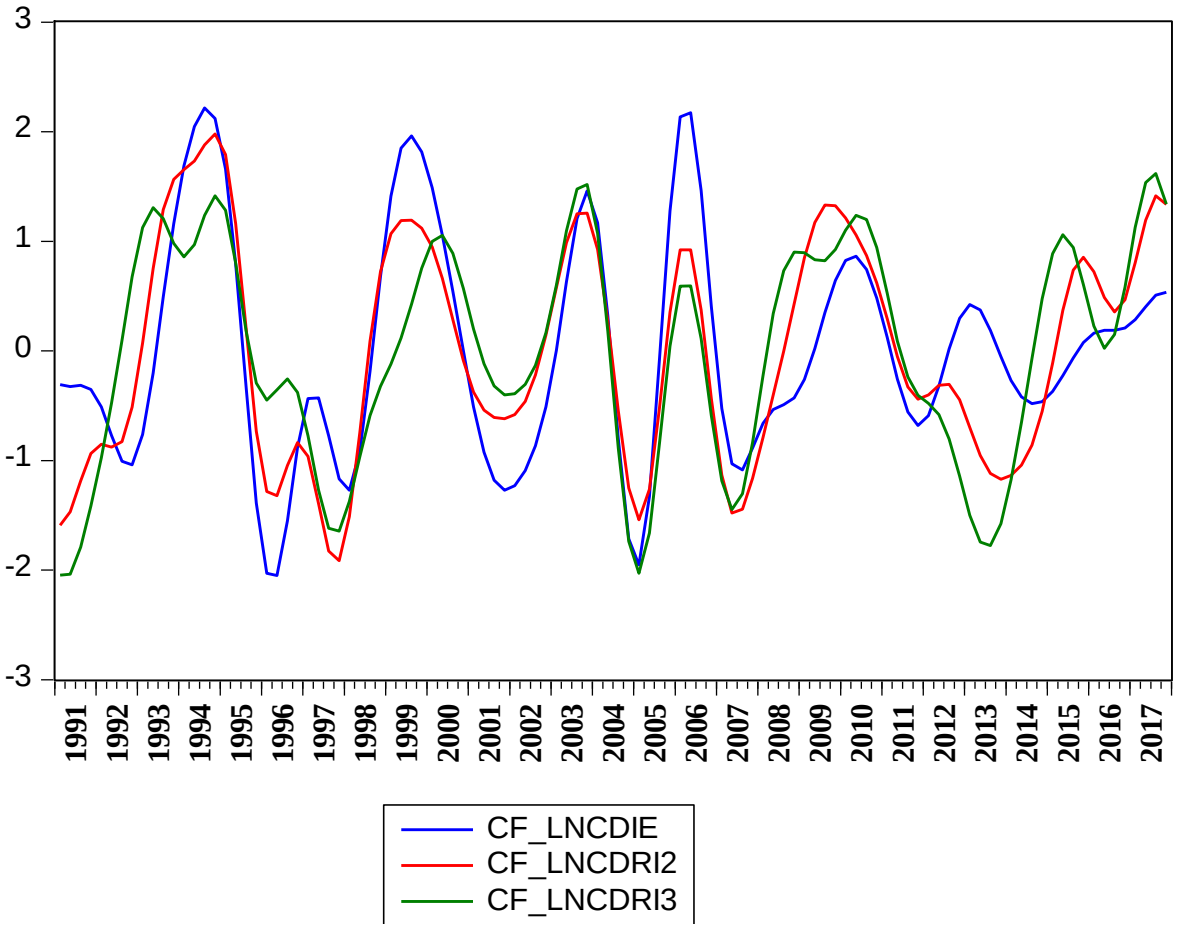

Figure 13: LNCDRIE, LNCDRI2 and LNCDRI3

4.5 Turning Point Analysis of Constructed Non-Communicable Diseases Risk Indicator (NCDRI)

Turning point determination is an important aspect of indicator construction. It is used to analyse the movements of the cyclical turns, particularly the peaks and troughs. Moreover, turning point analysis serves a critical role in forecasting the performance of the reference series and it also enables the determination of the number of early signals which are shown by the leading indicators. In this study, the quarterly basic data of the reference series and the NCDRIs for Malaysia was collected from the first quarter of 1991 to the last quarter of 2017. To date, the turning points, the Bry and Boschan (BB) procedure (1971), was employed on both the equal weighted NCDRI and the PCA-weighted NCDRI. As mentioned in the previous chapter, the PCA-weighted, NCDRI3 performed well compared to the equal-weighted, NCDRIE and the PCA-Weighted, NCDRI2 in terms of leading ability. Hence, in this subsection, the total prevalence of NCDs (NCDPRE) was selected as the reference series to reproduce the cyclical movement of NCDs in Malaysia which, thus, serves as the benchmark series to compare against the three constructed NCDRIs.

The results of the turning point analysis generated from the BB algorithm are shown in Tables 5, 6 and 7. With the former table presenting, findings from the three constructed NCDRIs it clearly shows the movement analysis of the cyclical turn. First and foremost, Table 5 presents the turning point analysis of the equal weighted, NCDRIE with the reference series. As presented in the table, the NCDRIE was found to lead on average by 2.2 quarters over the sample period from 1991 to 2017, where there were three peaks and three troughs indicated. In addition, based on the number of early signals submitted later by the

PCA-Weighted NCDRI2 in Table 6, it can be observed that the PCA-Weighted NCDRI2 had comparatively stable lead times compared to the equal weighted, NCDRIE, where there was an increase in leading the reference series from an average of 2.2 quarters to 3.7 quarters. Besides having a relatively higher average lead time, the PCA-Weighted NCDRI2 was also more consistent as most of the lead times fluctuated at around 4 to 6 quarters. Contrariwise, the early signals generated by the equal weighted NCDRIE were fairly large. In this context, the constructed NCDRI with higher lead times and consistency, in fact, performed well in tracing the significant events in advance.

Table 5: Turning Point Analysis of Equal weighted NCDRIE

	LNCDPRE	LNCDRIE	Amount of Lead/Lag (Quarters)	Reduction of NCDs risks due to:
Peak	1993Q4	1994Q3	-3	Control of Tobacco Products Regulations/
Trough	1997Q3	1996Q2	5	
Peak	2001Q1	1999Q3	6	Wellness Policy
Trough	2006Q1	2005Q1	4	
Peak	2010Q1	2010Q2	-1	National Plan of Action on Nutrition
Trough	2015Q1	2014Q3	2	
Average			2.2	

Table 6: Turning Point Analysis of PCA-Weighted, NCDRI2

	LNCDPRE	LNCDRI2	Amount of Lead/Lag (Quarters)	Reduction of NCDs risks due to:
Peak	1993Q4	1994Q4	-4	Control of Tobacco Products Regulations/
Trough	1997Q3	1996Q2	5	
Peak	2001Q1	1999Q3	6	Wellness Policy
Trough	2006Q1	2005Q1	4	
Peak	2010Q1	2009Q3	6	National Plan of Action on Nutrition
Trough	2015Q1	2013Q4	5	
Average			3.7	

Table 7: Turning Point Analysis of PCA-weighted, NCDRI3

	LNCDPRE	LNCDRI3	Amount of Lead/Lag (Quarters)	Reduction of NCDs risks due to:
Peak	1993Q4	1993Q2	2	Control of Tobacco Products Regulations/
Trough	1997Q3	1997Q4	-1	
Peak	2001Q1	2000Q2	3	Wellness Policy
Trough	2006Q1	2005Q1	4	
Peak	2010Q1	2008Q4	9	National Plan of Action on Nutrition
Trough	2015Q1	2013Q3	6	
Average			3.8	

As presented in the Table 7, NCDRI3 showed the most leading power of the three constructed indicators with a lead of on average 3.8 quarters in which with a lag of one quarter against the reference series. NCDRI3 was found to trace most of the historical turning points across the sample period with the correct timing. Moreover, this finding suggests that the constructed PCA-weighted NCDRI3 in which a weighting scheme was applied on both the sub-pillars and the subcomponents, had an intrinsic leading ability that enabled the indicator to predict the significant turning points in the prevalence of NCDs in Malaysia with more advanced timing. Therefore, the primary aim of constructing a composite NCDs surveillance indicator with leading characteristics was deemed to have been achieved.

4.6 Results of the Directional Accuracy Test

Subsequently, after the construction of the equal-weighted and PCA-weighted approach NCDRIs and the reference series, this section proceeds to the construction of chronologies for the series and the acquisition of average leading quarters, directional accuracy and

binomial testing. After computing the results of these tests, we are able to evaluate the accuracy of the computed equal weighted and PCA-weighted approach NCDRIs in forecasting the direction of the inflationary fluctuations. To serve as a comparison, Table 8 below shows the differences in the predictive power between the equal-weighted and the PCA-weighted NCDRIs.

In this case, the rate of directional accuracy presents important interpretations regarding the predictive power of the constructed NCDRIs. First and foremost, in this study, the constructed PCA-Weighted NCDRI2 and NCDRI3 were found to be more leading and consistent in predicting the direction of change in the fluctuations that cause the prevalence of NCDs.

Table 8: Comparative Analysis of Indicators' Directional Accuracy

	Directional Accuracy			P (Binomial)		
	NCDRIE	NCDRI2	NCDRI3	NCDRIE	NCDRI2	NCDRI3
Lag 1	57.84%	65.69%	73.53%	0.023**	0.001*	0.000*
Lag 2	57.43%	65.35%	73.27%	0.026**	0.001*	0.000*
Lag 3	57.00%	65.00%	73.00%	0.030**	0.001*	0.000*
Lag 4	56.57%	64.65%	72.73%	0.034**	0.001*	0.000*

Note: Asterisks (*) denotes 1% significance level and Asterisks (**) denotes 5% significance level

In particular, as shown in Table 8, the rate of directional accuracy improved from 57 % to 65% and even improved to 73%. In general, the three constructed NCDRIs depicted decent directional accuracy, where all of the lags were greater than 50% and this result

showed that the three constructed NCDRIs were able to predict the direction of change in prevalence is more than 50%. However, when comparing across the directional accuracy rate for the equal weighted and the PCA-Weighted NCDRI, there is a major improvement in predicting the direction of the movement of NCDPRE. The weighting scheme for the sub-pillars and the sub-components help in enhancing the directional accuracy of the constructed NCDRI.

4.7 Linkage between Non-communicable Diseases Risk Indicator (NCDRI) and Economic Activity

Economic recession shows contradictory effects on the mortality trends of the population of a nation. There is a vital relationship between a nation's economic status and the health of its population. Financial crises and economic recession are closely linked to the social features and condition that people and households face in their daily life, for example, the condition of their working status, living places, food and beverage consumption as well as the healthcare services. A contracting economy intensifies the likelihood of experiencing a burden and stress from different financial aspects, where, the consequences of unemployment, job insecurity, decreasing household revenues, consumption restrictions and heavy debts may lead to meagre living conditions. An individual who has a limited budget will reduce their investment in a healthy diet and expensive medical care and, thus, will increase their risk of illness.

Moreover, during periods of recession government spending or budget allocations may be challenged and new allocations may be time-consuming and difficult to arrange.

National income has a direct effect on the development of health systems, though, for instance; insurance coverage and public spending. In 1997 the WHO Commission on Macroeconomics and Health examined a panel of 167 countries and noted that; while health expenditures are determined mainly by national income, they increase faster than income. Government budgets come under pressure which may lead to drops in household income which may cause unhealthy national development. Countries with poorer health conditions and high unemployment rates find it harder to achieve sustained growth.

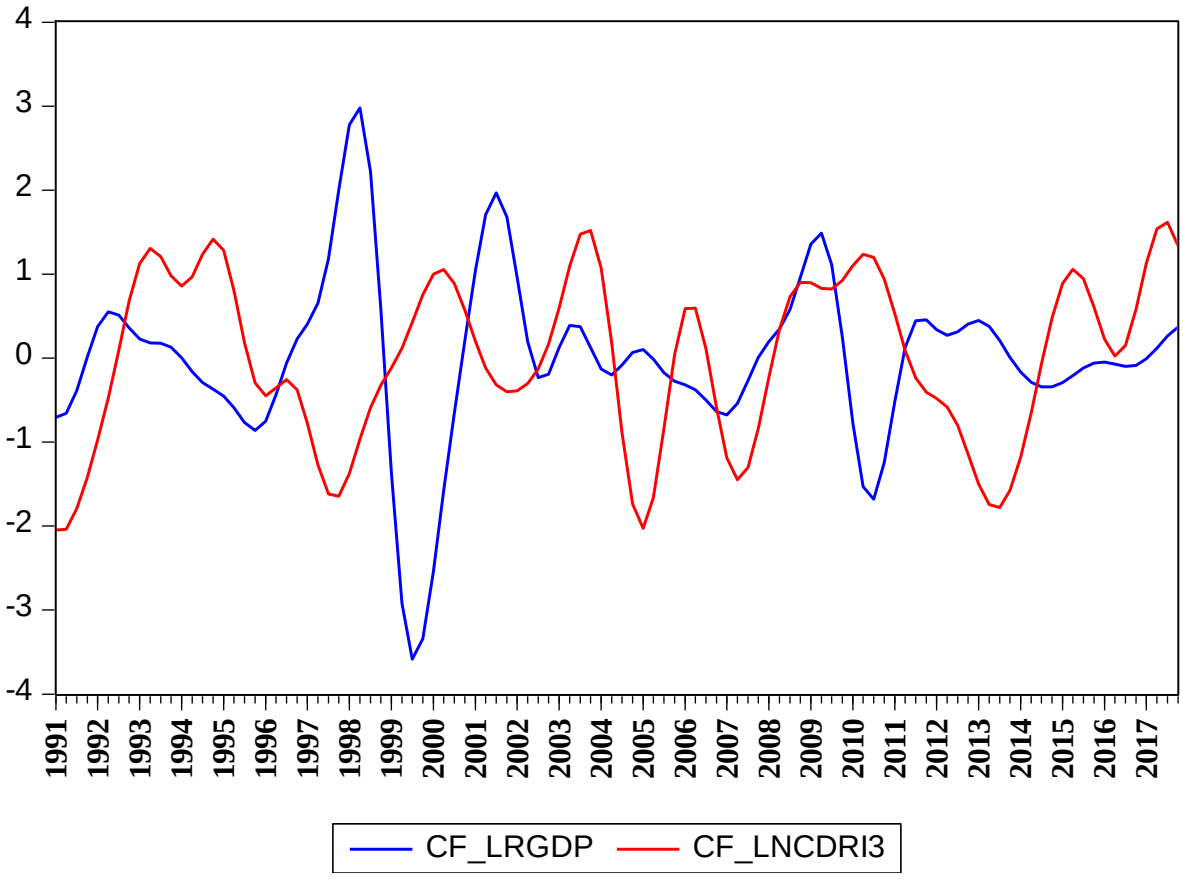

Figure 14: Cyclical Decomposition of LRGDP and LNCDRI3 by CF Filter

Figure above shows the countercyclical movement between the non-communicable diseases risks and the business cycle. It is clearly shown that the non-communicable diseases risks show an upsurge when the economy starting to slump, which means that more people

are exposed to the risk factors of NCDs and this may lead to the rise of the prevalence of NCDs. Based on the results shown, non-communicable disease risks showed continuous growth from 1997: Q4 to 2000: Q2 while at the same time, the economy indicated a downturn from 1998: Q2 to 1999: Q3.

The impacts from the Asian Financial Crisis led to a decline in the growth of national income but also triggered increases in the unemployment rate and poverty which later worsened education and ultimately health outcomes. The effects of the crisis were aggravated by increases in consumer prices, especially the prices of food. Referencing the statistical database of the Asian Development Bank, food prices in Malaysia were increasing by 9% in 1998, albeit with a smaller increase in the following year. Consequently, societies suffered from devastating increases in the unemployment rate and poverty, particularly for those who needed to devote a disproportionate segment of their income to food and beverage consumption. Vulnerable and socially disadvantaged people are more easily exposed to the risk factors of NCDs and when such consequences move from individuals to households, it clearly reflects that unhealthy behaviour, poor health status and unaffordable healthcare costs will affect the level of productivity and country development.

Coming to the year 2008, this vital relationship was evidenced once again. Based on Figure 15, the non-communicable disease risks present grew from 2007: Q2 to 2010: Q2 whereas, at the same time, the economy showed a depression from 2009: Q2 to 2010: Q3 and these movements once again substantiated a countercyclical movement between the non-communicable diseases risks and the business cycle. Malaysia suffered from the global financial crisis and the deep slump in global trade and recession in the year 2008. As an open

and export-dependent country, the negative impact of the global financial crisis deteriorated the country's exports and investment was affected. For instance, the global financial crisis of 2008 was deemed to have caused significant impacts on the population's health which had an adverse relationship on healthcare issues. The global financial crisis has been found to be the reason for the linkage of increases in unhealthy behaviour, negative mindsets, work absenteeism and declining healthcare utilisation (Boen, 2016). Meanwhile, at that time the prevalence of NCDs showed an upward rise bringing it into line the with financial crisis.

Table 9: Turning Point Analysis of LNCDRI and Fluctuation in Economic Activity

	LRGDP	LNCDRI3	Amount of Lead/Lag (Quarters)	Rises of NCDs risks due to:
Peak	1992Q2	1993Q2	-4	Asian Financial Crisis
Trough	1999Q3	1997Q4	7	
Peak	2009Q2	2008Q4	2	Global Financial Crisis
Trough	2010Q3	2009Q3	4	
Average			2.3	

The turning point analysis of the non-communicable diseases risks and the business cycle is presented in Table 9. From the table, it indicates that the constructed LNCDRI led the business cycle by on average 2.3 quarters, which demonstrated its alternative predicting ability in forecasting the movement of the business cycle in Malaysia. In this context, the constructed LNCDRI with greater lead time and consistency, in fact, performed well in tracing the significant events in advance.

4.8 Empirical Results of the Characteristics of the Relationships Between LNCDRI and Selected Macroeconomic Variables

4.8.1 Results of Correlation Analysis

The findings of the cross-correlation analysis between the LNCDRI and selected macroeconomic variable reference series using Harding and Pagan's (2002) concordance index approach is presented in Table 10.

Table 10: Degree of Correlation between LNCDRI and Selected Macroeconomic Variables

Degree of Correlation between LNCDRI and Selected Macroeconomic Variables: Harding and Pagan's (2002) Concordance Index Approach								
	LNCDI3	LURBUN	LHDI	LHEPC	LGLOBI	LUR	LEG	LOOP
LNCDRI	1.00							
LURBAN	0.99	1.00						
LHDI	0.99	0.99	1.00					
LHEPC	0.99	0.99	0.99	1.00				
LGLOBI	0.95	0.98	0.96	0.97	1.00			
LUR	0.03	0.04	-0.02	-0.02	0.02	1.00		
LEG	0.99	0.99	0.99	1.00	0.96	-0.02	1.00	
LOOP	0.40	0.39	0.36	0.38	0.39	-0.05	0.42	1.00

Findings indicated that the consistency on most of the selected component series were well correlated with the reference series with correlation values of up to 0.99 and this implies that most of the selected component series have a high possibility in having a significant relationship with the constructed LNCDRI. Nevertheless, LUR and LOOP showed relatively low correlation values of 0.03 and 0.40 respectively. Yet, in this study,

both of the variables were included as work and health are interrelated in many ways. According to studies carried out by other researchers, the ageing of the working population when combined with low employment rates will promote exposure to unhealthy lifestyles (Sommer et al., 2015; Leonardi & Scaratti, 2018). An unemployed individual will tend to reduce their daily expenses and prioritise their spending on their essential needs inversely exposing themselves to a unhealthier lifestyle. According to the WHO, out of pocket expenses on health can be defined as the direct payments that are incurred to any healthcare providers which are excluded from any prepayment of health services (WHO, 2019). When the burden of non-communicable diseases is mounting, individuals will tend to spend more on healthcare services, either on healthcare screening or supplements to ensure that they are healthy. Above and beyond this, there are advantages for people to have a sufficient intake of vitamins and supplements. Calcium, multivitamins and omega are effective in reducing the risk of strokes, cancers and diabetes mellitus (Grant, 2005). Hence, in line with the short-run causality, out of pocket expenses will influence human development and indirectly affect the growth of the risks of non-communicable diseases.

4.7.2 Results of Concordance Analysis

The degree of synchronisation between the selected macroeconomic variables and the constructed LNCDRI was scrutinised using the concordance index which was developed by Harding and Pagan (2002). The concordance index is a measure of the cyclical synchronisation between the LNCDRI and the selected macroeconomic variables. It implies an important inference regarding the co-movement or correspondence of the series over time. There is a perfect concordance between the series, which is the perfect juxtaposition of a

downturn and an upturn, if the CI is equal to 1 and a perfect disconcordance if the index is equal to 0. From the concordance index, a value of 0.5 indicates the lack of any systemic relationship in the dynamics of the two variables. From Table 11. Most of the macroeconomic variables were synchronised well with LNCDRI, except for the out-of-pocket expenditure on health (LOOP) and economic growth (LEG). Both of the concordance indexes were below the value of 0.5 and indicated a less systematic relationship. Interestingly, even though LUR and LOOP showed a very low correlation with the constructed LNCDRI, however, the concordance indexes were positioned at the borderline.

Table 11: Degree of Synchronization between LNCDRI and Selected Macroeconomic

	Concordance Index		
	LNCDRE	LNCDRI2	LNCDRI3
Urbanization Rate (LURBAN)	0.61	0.61	0.76
Human Development Index (LHDI)	0.48	0.57	0.65
Healthcare Expenditure per capita (LHEPC)	0.62	0.56	0.60
Globalization Index (LGLOBI)	0.37	0.48	0.56
Unemployment Rate (LUR)	0.58	0.58	0.55
Out-of-Pocket Spending on Health (LOOP)	0.52	0.48	0.48
Economic Growth (LEG)	0.42	0.40	0.45

4.9 Empirical Results of the LNCDRI and Selected Macroeconomic Variables

4.9.1 Results of Augmented Dickey-Fuller (ADF) Unit Root Test

This sub-section proceeds with unit root tests to observe the stationary properties of each of the selected macroeconomic variables. The table below summarises the results of the

Augmented Dickey-Fuller (ADF) unit root test that described the stationary properties of each of the variables that were used in this study, including the natural logarithm of economic growth (LEG), the natural logarithm of the unemployment rate (LUR), the natural logarithm of the urbanisation rate (LURBAN), the natural logarithm of the globalisation index (LGI), the natural logarithm of the non-communicable diseases risk indicator (LNCDRI), the natural logarithm of the human development index (LHDI), the natural logarithm of the out-of-pocket expenditure on health (LOOP) and the natural logarithm of the healthcare expenditure per capita (LHEPC) in Malaysia. The rejection rules for the ADF test occur when the t-statistic is larger than the critical value.

Table 12: Augmented Dickey Fuller (ADF) Unit Root Test Result

Variables	Test Statistic	
	ADF	
	Constant No Trend	Constant Trend
A: Level		
LEG	-1.351	-2.357
LUR	-2.135	-2.214
LURBUN	2.437	-2.883
LGLOBI	-2.373	-1.559
LNCDRI	-0.556	-2.320
LHDI	-1.884	-2.422
LOOP	-1.777	-2.175
LHEPC	-1.826	-0.356
B: First Difference		
Δ LEG	-3.050**	-3.257**
Δ LUR	5.206**	-5.163**
Δ LURBUN	-2.753**	-3.944**
Δ LGLOBI	-5.197**	-8.165**
Δ LNCDRI	-6.423**	-6.402**
Δ LHDI	-4.417**	-4.692**
Δ LOOP	-6.017**	-5.988**
Δ LHEPC	-2.951**	-3.821**

Notes: Asterisks (**) indicate statistically significant at 5 percent level. The term of (Δ) denotes the first different operator.

Referring to the ADF test results presented in Table 12, they indicate that all of the variables were not stationary in level form for both intercept and trend and intercept. There was not enough statistical evidence to reject the null hypothesis at level form and, hence, we proceeded to the first difference. In taking the first difference of the Augmented Dickey-Fuller (ADF) test, the results indicated that all of the variables were stationary in intercept and trend and intercept. In other words, the null hypothesis was rejected, and it was concluded that the variables were stationary at the first difference. In accordance with this, it can be concluded that all of the variables; LEG, LUR, LURBUN, LGI, LNCDRI, LHDI, LOOP and LHEPC were in fact integrated of order, I (1). Since all of the variables had the same order of integration, this allowed us to proceed with the Johansen-Juselius cointegration analysis.

4.9.2 Cointegration Test Result between NCDRI with selected Macroeconomics Variables based on VECM

The Johansen-Juselius cointegration analysis was performed to test for the long run equilibrium between the non-communicable diseases risk indicator (LNCDRI), economic growth (LEG), the unemployment rate (LUR), the globalisation index (LGLOBI) and urbanisation (LURBAN) in Malaysia. The empirical findings indicated that the null hypothesis of zero cointegration (r=0) was rejected in both the trace and the maximum eigenvalue tests at the 5% significance level as the t-statistic (84.27) was greater than the critical value (69.82) at the 5% significance level.

Table 13: Johansen and Juselius Cointegration Test Result

Johansen Juselius Cointegration Test, Y= LNCDRI					
Null	Alternative	Max-Eigen		Trace	
		Unadjusted	95 percent C. V	Unadjusted	95 percent C. V
r=0	r=1	37.419*	33.876	84.274*	69.818
r≤1	r=2	23.998	27.584	46.854	47.856
r≤2	r=3	13.287	21.131	22.856	29.797
r≤3	r=4	7.936	14.264	9.569	15.494
r≤4	r=5	1.632	3.841	1.632	3.841

Notes: Asterisk (*) denotes significant at 5% level, k is the number of lag and r is the number of cointegration vector(s)

Similarly, the maximum eigenvalue test produced similar results, the t-statistic was 37.42 which was greater than the critical value of 33.88 at the 5% significant level. Therefore, we can conclude that both the trace and maximum eigenvalue tests were statistically significant at the 5% level to reject the null hypothesis of the cointegrating vector being equal to zero. On top of this, there was one cointegration vector that existed between the variables and there was long run co-movement between the variables.

4.9.3 Cointegration Test between HDI, NCDRI and Selected Macroeconomics Variables based on VECM

Furthermore, the cointegration test between LHDI, LNCDRI and selected macroeconomic variables namely; the human development index (LHDI), economic growth (LEG), the non-communicable diseases risk indicator (LNCDRI), healthcare expenditure per capita (LHEPC) and out-of-pocket expenditure on Health (LOOP) were tested using the Johansen-Juselius

cointegration test. In the maximum eigenvalue test, the t-statistic was 32.42 which was smaller than the critical value (33.88) and, therefore, there was not enough evidence to reject the null hypothesis. On the contrary, the t-statistic (79.65) was larger than the critical value, which was 69.82 in the trace test, indicating that we should reject the null hypothesis. The maximum eigenvalue test indicated that there was no cointegration vector, whereas the trace test suggested that there was one cointegrating vector.

Table 14: Johansen and Juselius Cointegration Test Result

Johansen Juselius Cointegration Test, Y= LHDI					
Null	Alternative	Max-Eigen		Trace	
		Unadjusted	95 percent C. V	Unadjusted	95 percent C. V
r=0	r=1	32.424	33.876	79.648*	69.818
r≤1	r=2	25.403	27.584	47.223	47.856
r≤2	r=3	13.228	21.131	21.820	29.797
r≤3	r=4	7.417	14.264	8.591	15.494
r≤4	r=5	1.174	3.841	1.174	3.841

Notes: Asterisk (*) denotes significant at 5% level, k is the number of lag and r is the number of cointegration vector(s)

According to Lutkepohl, Saikkonen and Trenkler (2001), trace tests tend to have more distorted sizes, whereas their power is in some situations greater than that of the maximum eigenvalue tests. Therefore, one cointegrating vector based on the trace test will be applied in this study. Since the long run relationship occurs, vector error-correction modelling (VECM) will be discussed in the next section.

4.9.4 Multivariate Analysis of NCDRI with selected Macroeconomics Variables based on VECM

The long-run cointegration equation indicates an overview of the long-run associations between the variables. The summary of the long run cointegrating equations for analysing the non-communicable diseases risk indicator (LNCDRI), economic growth (LEG), the unemployment rate (LUR), the globalisation index (LGLOBI) and urbanisation (LURBAN) is presented in Table 15. The empirical findings show the estimated coefficients obtained by normalizing the variables. Based on the coefficient of LGLOBI of -0.921, this implies that there was a negative relationship existing between LNCDRI and LGLOBI. Where, if the LNCDRI increased by 1%, LGLOBI would decrease by 0.92%. In contrast, a 1% increase in LNCDRI, would lead to increases of 0.388%, 0.099% and 0.638% in LEG, LUR and LURBAN respectively. Besides, the results suggested that LURBAN was not significant in this test.

Table 15: Long-run Cointegrating Equation

LNCDRI = 2.381 + 0.388 LEG* + 0.099 LUR - 0.921 LGLOBI* + 0.638 LURBAN**

Notes: * denotes significant at 5% level, ** denotes significant at 10% level

Subsequently, the causality relationship between LEG, LUR, LGLOBI and LURBAN is presented, based on the VECM. In the short run, it was found that there was unidirectional Granger causality from LEG to LURBAN and from LURBAN to LNCDRI. There was a causal relationship between urbanisation and economic growth. Urbanisation has the potential to accelerate economic growth by favourable investments in conductive public infrastructure (Nguyen, 2018). Besides, the rapid growth of globalisation will

contribute to improving the living standards of a nation. However, there is some argument between the impact of urbanisation on the exposure to non-communicable diseases (NCDs). According to Angkurawaranon, Jiraporncharoen, Chenthanakij, Doyle and Nitsch in 2014, one of the major socio-environmental factors that are considered to be associated with such a rise in NCDs is urbanisation. Rapid and unplanned urbanisation is associated with behavioural changes, such as eating an unhealthy diet, and a decrease in physical activities, which may result in associated obesity. Besides, higher urban exposure was determined to be positively associated with diabetes mellitus, respiratory diseases, mental health issues and coronary heart diseases as the behavioural and working atmosphere changes. People tend to have instant eating habits, less exercise and high exposure to tension and the majority of the sufferers are expected to be relatively young. On the other hand, it is interesting to note that some studies have found that the urbanisation trend in developing countries can essentially reduce the risks of exposure to NCDs. When comparing between rural areas and urban areas, the behavioural risk factors tend to be higher in rural than urban areas which showed significantly higher results for alcohol drinking and low fruit consumption. (Htet et al., 2016 & Allender et al., 2010).

Table 16: Granger Causality Results Based on VECM

Dependent Variables	**Chi-square statistic [p-value]**					**ECT [t-statistics]**
	Δ LNCDRI	**Δ LEG**	**Δ LUR**	**Δ LGLOBI**	**Δ LURBAN**	
Δ LNCDRI	-	1.683007 [0.7938]	2.515712 [0.6418]	2.711293 [0.6072]]	7.855132 [0.0970]*	-0.036842** [-2.16147]
Δ LEG	3.248078 [0.5172]	-	16.35535 [0.0026]**	3.126801 [0.5368]	1.079962 [0.8974]	0.377073 [4.47812]
Δ LUR	1.820112 [0.7688]	49.32889 [0.0000]**	-	5.144693 [0.2728]	8.767802 [0.0672]*	0.021841 [1.48386]
Δ LGLOBI	1.360445 [0.8510]	3.627468 [0.4588]	1.440573 [0.8371]	-	7.952813 [0.0933]*	-0.000857 [-0.92184]
Δ LURBAN	2.060382 [0.7247]	36.15492 [0.0000]**	13.18841 [0.0104]**	9.589144 [0.0479]**	-	-0.00016 [-1.55625]

Notes: Asterisk (**) denotes significant at 5% level while (*) denotes significant at 10% level.

Meanwhile, there was a bidirectional causality running between LURBAN and LGLOBI, LURBAN and LUR and LUR to LEG and vice-versa. Globalisation is important for urbanisation and urban economic growth due to the proper allocation of resources, such as human capital and infrastructure. However, risks occur from globalisation towards urbanisation. The risks of globalisation are associated with the loss of local income and job opportunities, as a result of external competition from imports and rising urban inequality within the local expertise and labour markets. As part of economic progress, people tend to migrate from rural areas to urban areas to obtain advantages, such as job opportunities and secure living conditions as a result of industrialisation. Employment opportunities in all of the developmental sectors, such as public health, education, industries, business enterprises and public infrastructure have been generated and lead to additional employment opportunities. Furthermore, the gross domestic product (GDP) will be reduced if the unemployment rate rises. Increased unemployment leads to lower economic performance and fewer opportunities to achieve high economic growth (Al-Habees & Rumman,2012). Conversely, it is conspicuous that a significant correlation exists between economic growth and the changing rate of unemployment. According to Al-Habees and Rumman (2012), when an economy starts to grow, it requires .an additional labour force to be employed in the market and it inversely reduces in human society. In addition, the coefficient of the lagged error terms (ECT) represents the statistical significance of long-run causal effects.

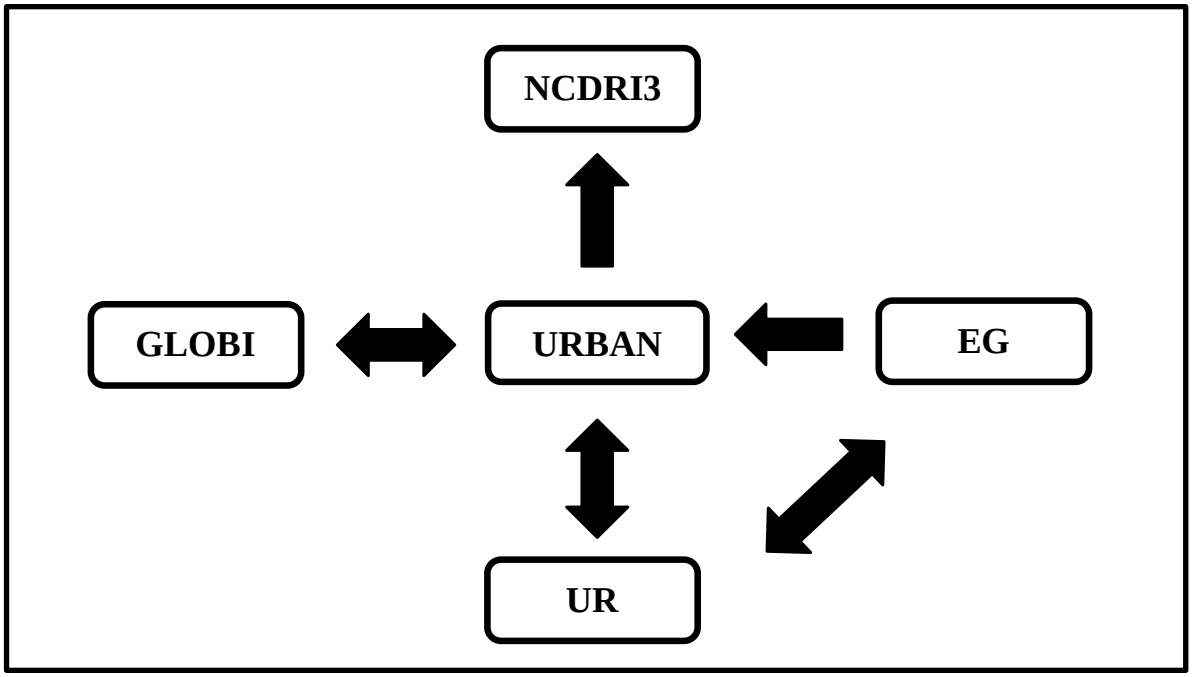

Figure 15: Diagram Short-run Causality NCDRI with Selected Macroeconomics Variables

Notes: Globalization Index proxied by GLOBI, Unemployment Rate proxied by UR, Economic Growth proxied by EG, Urbanization proxied by URBAN and Non-Communicable Diseases Risk Indicator proxied by NCDRI . ⟶ implies the unidirectional causality. ⟷ implies the bidirectional causality

According to the result, the coefficient of the lagged ECT is significant in the LNCDRI at the 5 % level with a negative sign. This implies that the change in non-communicable diseases risk indicator is the function of disequilibrium in the cointegrating relationship. The significant value indicates that LNCDRI solely bears the brunt of short-run adjustments to bring about the long run equilibrium in Malaysia. ECT coefficients measure the speed of adjustment toward long-run equilibrium. The estimated coefficient of the ECT for LNCDRI had a speed of adjustment of 3.68%, which in other words, means that it will require approximately 27.14 quarters or 6.8 years for it to return to equilibrium.

4.9.5 Multivariate Analysis of HDI, NCDRI and Selected Macroeconomics Variables based on VECM

The summary of the long run cointegrating equations for analyzing the human development index (LHDI), economic growth (LEG), the non-communicable diseases risk indicator (LNCDRI), healthcare expenditure per capita (LHEPC) and out-of-pocket expenditure on health (LOOP) is presented in Table 17. The empirical results suggest that all of the variables were significant in this test, whereas the results suggest that LEG, LGHEC and LOOP did have a statistically significant positive effect on LHDI. However, LNCDRI showed a negative effect on LHDI were a 1% increase in LHDI would lead to a corresponding increase of 0.325% in LNCDRI.

Table 17: Long-run Cointegrating Equation

LHDI = -2.090 + 0.156 LEG* – 0.325 LNCDRI* + 0.133 LGHEC* + 0.247 LOOP*

Note: * denotes significant at 5% level

The Granger causality results between the human development index (LHDI), economic growth (LEG), the non-communicable diseases risk indicator (LNCDRI), healthcare expenditure per capita (LHEPC) and out-of-pocket expenditure on health (LOOP) are summarised in Table 18. As can be seen from the table, the p-values of the dependent variables indicate a significant causal effect in the short-run, hence there is a relationship between the selected macroeconomic series, LHDI and LNCDRI.

Table 18: Granger Causality Results Based on VECM

Dependent Variables	Chi-square statistic [p-value]					ECT [t-statistics]
	Δ LHDI	Δ LEG	Δ LNCDRI	Δ LHEPC	Δ LOOP	
Δ LHDI	-	6.548391 [0.0105]**	0.1034 [0.7478]	0.095914 [0.7568]	10.64536 [0.0011]**	-0.011618 [-1.57176]
Δ LEG	0.027139 [0.8691]	-	0.288994 [0.5909]	0.048947 [0.8249]	1.034013 [0.3092]	0.031477 [0.34178]
Δ LNCDRI	6.584584 [0.0103]**	0.12393 [0.7248]	-	2.324826 [0.1273]	0.556833 [0.4555]	-0.050098** [-2.42663]
Δ LHEPC	7.473628 [0.0063]**	4.932362 [0.0264]**	1.512454 [0.2188]	-	0.424674 [0.5146]	0.930216 [4.79094]
Δ LOOP	1.555844 [0.2123]	0.256075 [0.6128]	3.680414 [0.0551]**	0.086353 [0.7689]	-	0.073400 [0.70942]

Notes: Asterisk (**) denotes significant at 5% level while (*) denotes significant at 10% level.

In particular, there is only a unidirectional granger causality between LGHEX, LHDI, LNCDRI, LOOP and LEG. Government expenditure, in the field of health and education, is the driving force of human development as humans are one of the factors of production in determining a nation's welfare. A healthy individual will improve his or her performance and this is characterised by decreasing absenteeism and increased productivity (Sulistyowati, 2017). In addition, there are similarities with the study carried out by Lubis (2015). She investigated the relationship between government spending and human development in Indonesia. Her findings showed that health, agriculture, and household expenditure showed a positive impact on human development.

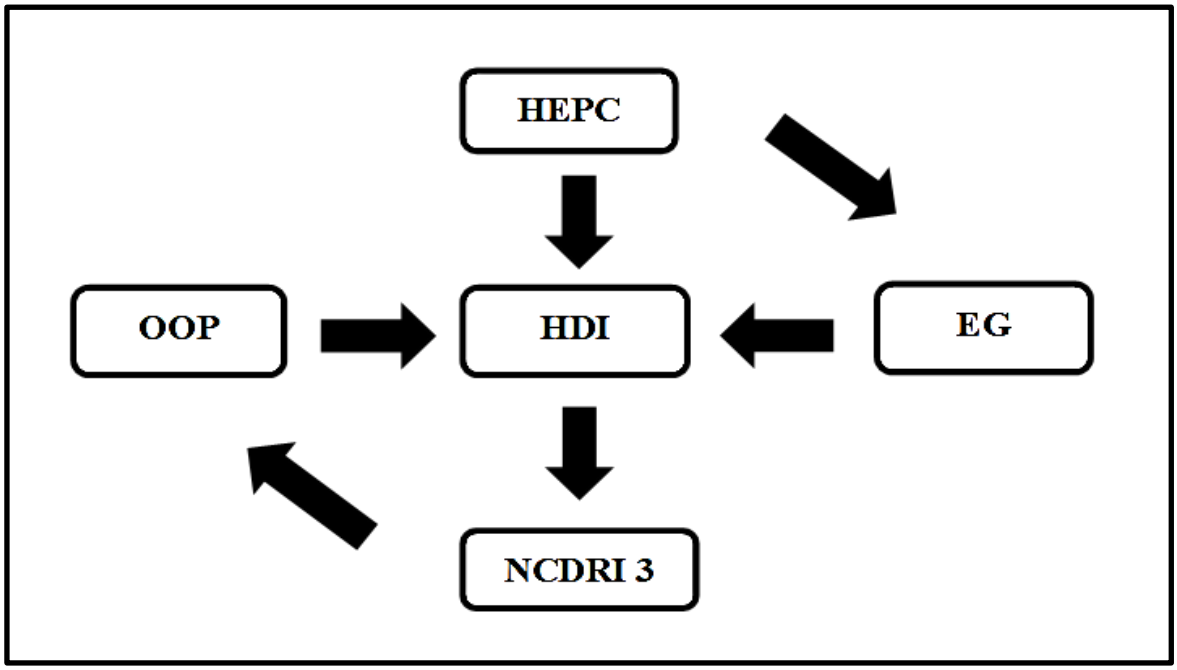

Figure 16: Diagram Short-run Causality HDI, NCDRI and Selected Macroeconomics Variables

Notes: Human Development Index proxied by HDI, Economic Growth proxied by EG, Non-Communicable Diseases Risk Indicator proxied by NCDRI, Government Healthcare Expenditure proxied by HEPC and Out-of-Pocket Spending on Health proxied by OOP. ⟶ implies the direct causality.

Interestingly, as shown in the table above, the coefficient of the lagged ECT is significant in the LNCDRI at the 5 % level. This finding seems to be consistent with the coefficient of the ECT shown in the Granger causality results. The significant ECT for LNCDRI indicates it to be strongly endogenous and it acts as the initial receptor of any exogenous shocks that disturb the equilibrium system. The estimated coefficient of the ECT for LNCDRI has a speed of adjustment of 5%. In other words, it will require approximately 20 quarters or 5 years for it to return to equilibrium.

4.10 A Remark

To concisely summarise this study, six sub-pillars and 29 sub-components were constructed as a composite leading indicator to target the risks prevalent to NCDs. It produced a remarkable early lead time of on average 3.8 quarters against the reference series. This finding implies that the PCA-weighted NCDRI has the ability to trace the movement of the NCDPRE in Malaysia with a greater lead time and most importantly, the PCA-weighted NCDRI could trace most of the important and significant events in the case of the prevalence of NCDs and the weights imposed on the sub-components can ameliorate the capability in signalling the prevalence by NCDs in advance. Further, the NCDRI is protracted in the econometric analysis which models the relationship between the NCDs risks and macroeconomic variables. Economic recession indicated contradictory effects where it showed a countercyclical movement between the non-communicable diseases risks and the business cycle. Most of the selected component series were correlated well with LNCDRI. Even though LUR and LOOP showed a relatively low correlation, they were, however, synchronised with NCDRI3. Additionally, all of the variables were stationary in intercept and trend and intercept in the first difference of the Augmented Dickey-Fuller (ADF) test. The multivariate analysis of LNCDRI with selected macroeconomic variables found that there was unidirectional Granger causality and bidirectional causality running in the short run and that the ECT was significant in the LNCDRI which required approximately 6.8 years to return to equilibrium. Subsequent multivariate analysis of LHDI, LNCDRI and selected macroeconomic variables indicated that there was only unidirectional Granger causality in the short-run and that the lagged ECT was significant in the LNCDRI which required 5 years for it to return to equilibrium.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter concludes this study by discussing some of the important inferences behind the empirical findings on indicator construction and turning point analyses. The general objective of this study was to develop an alternative non–communicable diseases (NCDs) surveillance indicator for targeting risks prevalence and for monitoring public health interventions in Malaysia. Unquestionably, in this study, a non–communicable disease risk indicator (NCDRI) was constructed. The leading characteristic obtained from this indicator successfully enabled the prediction of out-of-sample NCDs risks prevalence in Malaysia in the future. The most parsimonious variant of NCDRI was subsequently subjected to an econometric analysis to model the relationship between NCDs risks and selected macroeconomic variables. From the empirical discussion, the study indicated the interactions between NCDs risk, human capital development, and economic growth. This chapter highlights the relevant implications and recommendations of this study, as well as its limitations. This chapter ends with some concluding remarks.

5.2 Summary of Empirical Findings and Discussion

The objective of this study was to develop an alternative non–communicable diseases (NCDs) surveillance indicator for targeting risks prevalence; with this in mind, this study executed several analytical procedures to serve as empirical guidance for the component series selection. The component series consisting of leading characteristics derived from the Conference Board (2000) was chosen to construct the NCDRI. After the data was compiled, a cross-correlation analysis was carried out to examine the degree of association between the reference series and the selected component series. The results, with 29 component series used in total, showed a strong correlation with the reference series to ensure the accuracy and persistence of the empirical evidence.

Subsequently, study has constructed a number of non-parametric NCDRIs that accounted for the issues of weighting the pillars and components, equal weighted and PCA-weighted NCDRI indicator. The absence of a weighting or an equal-weighting scheme ruled out their possibility that certain pillars and components may influence the prevalence of NCDs. This variation would pose substantial bias in the collective information content of the composite NCDRI. Hence, it was meaningful to establish a set of weighting schemes by means of principal component analysis (PCA) by assigning an appropriate weight for each of the pillars and components. It is important to carry out the comparison between equal weighted and PCA-weighted indicator because by doing this, we can evidence that which model is more crucial and convincing in constructing NCDRI indicator with high leading power.

Furthermore, study able to be more convincing when we it can divvy into both practical aspect and theoretical aspect. As the findings demonstrated that the PCA-weighted indicator could trace the significant events in the case of the prevalence of NCDs in Malaysia with better predictive power than the equal weighted indicator which PCA-Weighted scheme, NCDRI3, had a remarkable lead time compared to the reference series, NCDPRE. Furthermore, with the deep-down weighting scheme of the sub-components, the finding can demonstrate that the sub-pillars and sub-components role to be the most crucial aspects in defining the NCDs risk prevalence in Malaysia. When comes to practical aspect, policy maker has sufficient number of budgets and proper budget allocation to the prevalence of NCDs with the contribution of weighting scheme. Precise budget on particular aspect will help to concentrate resources on improving clarity and focus on the essential aspects.

From another point of view, it could be more persuasive while numbers of the studies were used to measure the economic activity in which shift may predict onset of a business cycle, yet, from this study, it indicates that it would be well enough when come across to healthcare study. It is notable that numbers of indicators study were carried out by in the healthcare study. For example, in the study of Almost et al., (2018), leading indicators were constructed and findings were successfully used as a guideline for healthcare organizations in prioritise the occupational Health and Safety Management Systems. With the aid of the indicators, health and safety outcomes able to improve and strengthen. Further, there is some studies supported that PCA-weighted cable to perform better than equal weighted. For example, in the study of Chao and Wu in 2017, it revealed that equal weighted scheme in most of the indices is not the best method when compared across to the loadings obtained from PCA. Indices that using equal weighted scheme for each of the variables will not be

best possible in term of variance maximization and yet, it performs well for the PCA-weighted scheme.

Besides that, as per indicator approach is a short-term forecasting tools in tracking the direction of fluctuations, hence, with the high leading power, it is sufficient enough to fulfil as a short-term forecasting tool. Components and pillars with high leading power serve as a good predictor to foretell the NCDs prevalence in Malaysia in order to enable action executed before the incidence happen. Apart from that, implemented policies require time to show the effectiveness, ergo, 3.8 quarters which 11.4 months should therefore be good enough to reflect the consequences of policies.

In contrast, the weighting scheme for sub-pillars and sub-components helped in enhancing the directional accuracy of the constructed NCDRI. The rate of directional accuracy indicates important interpretations of the constructed NCDRI's predictive power. Across the three constructed NCDRIs, the rate of directional accuracy was improved and was accurate in predicting the movement of NCDs prevalence. In general, the three constructed NCDRIs depicted decent directional accuracy, where all of the lags were greater than 50% which means the three constructed NCDRIs were able to predict the direction of change in prevalence is more than 50%. Thus, at this point, it can be concluded that the constructed NCDRI with PCA weighted scheme can provide an early signal of the prevalence of NCDs with high directional accuracy rate when we tarry up to 4 quarters.

Furthermore, the economic recession shows contradictory effects on the mortality trends of populations in a nation which when economics turn down, the risk factor increased.

That is, it is consistent with the previous expectation. Economic downturns will lead to a reduction in a country's health spending on people in need, in particular among the poor and vulnerable groups. Unemployment and low-income causing patients to face constraints to cure their disease whereas, long-term medical treatments will relatively increase direct and indirect medical costs and lengthen the duration of treatment for the patient. This gave rise to people exposed to the risk factors of NCDs and this may lead to the surge of the prevalence of NCDs. Furthermore, the movement of the economic downturn was in line with the Asian Financial Crisis and the Global Financial Crisis. As a result, this finding suggests that the constructed NCDRI was able to predict the movement of economic recessions in Malaysia. Yet, it is worth noting that, further research can be conducted by scrutinizing the prolonged period of time.

Moreover, the contribution of NCDRI was extended in modelling the relationship between NCDs risks and macroeconomic variables via an econometric analysis. In spite of the fact that economic recession shows countercyclical effects with NCD risk factors, however, GDP sum up by many components of macroeconomic variables, so it is required to examine the other macroeconomic components that affect NCDRI. Primarily, correlation analysis was conducted to scrutinize the positive or negative relatives with reference series. Next, even though it shows the degree of correlation between selected macroeconomic components and NCDRI, yet, findings unable to indicate the synchronization of selected macroeconomic components and NCDRI. Therefore, concordance analysis was conducted. It deciphers a systematic relationship when the concordance indexes were more the value of 0.5 and with the high degree of synchronization with reference series, macroeconomic variables are able to shift simultaneously in the long run. From the findings, most of the

macroeconomic variables were synchronised well with LNCDRI. Subsequently, there are two forms of multivariate analysis conducted after the concordance analysis, in which the macroeconomic determinants towards NCDRI and the analysis of HDI, NCDRI and macroeconomic determinants.

First, multivariate analysis of macroeconomic determinants towards NCDRI was discussed. In the view of the fact that most of the macroeconomic variables were synchronised well with LNCDRI, thus, Augmented Dickey-Fuller (ADF) test was conducted to observe the stationary properties of each of the selected macroeconomic variables. Findings was then indicated all the variables had the same order of integration, therefore, this allowed us to proceed with the Johansen-Juselius cointegration analysis to test the long run equilibrium between NCDRI and selected macroeconomic variables. In this section, findings show that there was one cointegration vector that existed between the variables and there was long run co-movement between the variables.

Later, in the short run, it was found that there is unidirectional Granger causality from LEG to LURBAN and from LURBAN to LNCDRI. There was a causal relationship between urbanisation and economic growth which urbanisation has the potential to accelerate economic growth Besides, there is some argument between the impact of urbanisation on the exposure to non-communicable diseases (NCDs). Some of the researches construed that higher urban exposure was determined to be positively associated with diseases, though, some of the studies have found that the urbanization trend in developing countries can essentially reduce the risks of exposure to NCDs. Therefore, it is noteworthy that, further

study needed on this aspect., Meanwhile there was also bidirectional causality running between LURBAN and LGLOBI, LURBAN and LUR, and LUR to LEG in the short run.

Globalisation is important for urbanisation and urban economic growth due to the proper allocation of resources, such as human capital and infrastructure. However, risks might occur from globalization towards urbanization which focus on of local income and job opportunities, as a result of external competition from imports and rising urban inequality. Consequently, employment opportunities increased whilst it enables gross domestic product (GDP) reduced. Conversely, it is conspicuous that a significant correlation exists between economic growth and the changing rate of unemployment as when an economy starts to grow, it requires an additional labour force to be employed in the market and it inversely reduces in human society. In addition, the statistical significance of long-run causal effects that presented by ECT was carried out to measure the speed of adjustment toward long-run equilibrium. It can be noted that the ECT for LNCDRI require approximately 27.14 quarters or 6.8 years for it to return to equilibrium.

Secondly, multivariate analysis for LHDI, LNCDRI, and selected macroeconomic variables show the granger causality between LGHEX, LHDI, LNCDRI, LOOP, and LEG in the short run. It seems the government expenditure, in the field of health and education, is the driving force of human development as humans are one of the factors of production in determining a nation's welfare. In fact, a healthy individual will improve his or her performance and this is characterized by decreasing absenteeism and increased productivity.

Interestingly, it is noteworthy that the finding is consistent with the coefficient of the ECT which indicates that it is strongly endogenous and 20 quarters or 5 years is required to return to equilibrium.

5.3 Policy Implications

An appropriate regime for policymaking and implementation is required, followed by monitoring time-to-time, and acting fast, to reduce this deadly disease. From the findings of this study, the cost indicator was the most significant risk factor to indicate the prevalence of NCDs; therefore, policymakers should focus on this particular indicator. The Consumer Price Index (CPI) for Healthcare is a measure of medical expenses in households and includes medical products, healthcare appliances, and equipment. Based on statistics from the World Bank, the CPI of Healthcare showed a tremendous increase from 1990 up to the present. Medical costs bore by the patients are still high from year to year. At present, Malaysia's healthcare system is supported by the government-run sector and the private sector. While the government is urged to improve healthcare facilities and infrastructure, the private sector's role as a supporter in delivering high-professional healthcare services must also be emphasised. The unprecedented growth of private healthcare services has posed serious challenges to consumers and policymakers. To obtain prompt and efficient healthcare services, patients tend to shift to the private sector, but this action increases the patients' expenses a few times more than if they had chosen government services. Although the Malaysian government has enforced the Private Healthcare Facilities and Services Act 1998 (Act 586) in 2006 to restrict the growth of inequality between the sectors, problems like these still exist.

Moreover, although Malaysia is currently working towards upgrading and improving its healthcare services and facilities, there is still a need to speed up this progress to catch up with the rapid growth of this deadly disease. As Malaysia strives to become a high-income developed nation, the government is urged to ensure that each patient has secure financial protection when they fall ill and subsequently seek treatment. Patients who require treatments have increased financial burden. The situation can worsen if they are unable to work and lose the ability to maintain their productivity at work. Indirectly, this scenario will affect the economics of a society, as the sustained economic growth of a nation is a direct result of an increase in worker productivity. Therefore, expansions in public health insurance or social welfare program for low-income household is one of the key policy directions to alleviate poverty extended from rising healthcare cost as well as the financial catastrophe of treating NCDs.

The Fiscal Policy on Healthcare is one of the ways to intervene in identifying NCDs risk factors. Pattern of consumption and expenditure habits will be affected when the price increases and lead to finance disproportionately. Therefore, Fiscal policy approach can be the form of to promote healthy lifestyle in Malaysia. Moreover, tax revenue generates from taxation of health deteriorating items such as tobacco, cigarettes and sugary products could be channelled into the betterment of healthcare system as well as reinstatement of public subsidies that meet the medical needs of the poor population in Malaysia. Moreover, passive reporting in NCDs program should be improved to strengthen the capacity building in healthcare systems to support the NCDs risk monitoring initiative at national level. Whereas, the development of national NCDs risk indicator from this study that can use to predict the

trend of NCDs prevalence is crucial to support the future NCDs intervention and evidence-based decision making on public health.

5.4 Limitation of the Study

It is essential to note that any implications drawn from this present study must be interpreted cautiously, as several limitations have limited this study. In other words, the predictive power of the constructed indicator can only be achieved with available data. First and foremost, PCA-weighted NCDRI is a data-based generating tool, in which the outcome of the constructed NCDRFI relies on the predictive content of the selected component series. Risk could happen when there is a lack of systematised databases serving as elements for the analysis. In Malaysia, healthcare data is still lacking and incomplete. For example, the data on death caused by the diagnosis of cancer, the level of physical activity, and stroke cases are incomplete, and the consistency of each data still requires further validation. For instance, it was difficult for the researcher to find complete time-series data (monthly and quarterly data) for every healthcare component. Most of the data were not available and some skipped a certain time period. As a result, it was challenging to construct a reliable forecasting tool.

Moreover, the constructed PCA-weighted NCDRI was able to give 3.8 quarters of forecasting in predicting the cyclical movement of the prevalence of NCDs in Malaysia. This data serves as a long-term forecasting tool for predicting the case of NCDs in Malaysia. Undeniably, NCDs tend to have a long duration of diagnosis and are the result of a combination of a few risk factors. In particular, the risk factors that were accounted for will

not show the effect of NCDs prevalence immediately. A long duration is needed to observe each of the risk factors, and it could probably take years to identify the hidden risks. Besides, policy implications also take time to moderate the situation and the effectiveness of each implied policy can hardly be observed in such a limited time. Therefore, an innovative way for disseminating health messages to the masses is needed, so that, once armed with knowledge, the public can attain responsible self-care and recognise early signals of NCDs.

5.5 Recommendation for future research

Owing to the systematised database is the crucial element to the constructed NCDRFI, henceforth, a complete and reliable data with the predictive content remains a contested issue in research. For example, there are some of the impacts on demographic shift and environmental concerns were omitted in the development of the NCDs risk indicator due to incomplete dataset. As datasets been required at the first stage of the indicator construction to ensure the accuracy and persistence of the empirical evidence, hence, it would be helpful to retrieve a completed datasets from reliable sources to eliminate the potential bias. Further, intermediate risk factors were excluded as due to unavailability of intermediate risk data at national level. Consequently, additional and further application of the sophisticated statistical analysis techniques should only be performed after the maximal efforts have been employed to reduce missing data in the design and prevention techniques.

Particularly, the behavioural-related data in which the transformation of the behavioural risks could not be well-incorporated in the present study due to the unavailability of high quality behavioural-related data. Thus, researcher is advice to analysis each of the

behavioural-related data from different aspect to ensure the comprehensiveness and the quality of the datasets. Furthermore, NCDRI also extended its contribution to modelling the relationship between NCDs risks and the selected macroeconomic variables. It would be helpful to capture the interactions between NCDs risks and others economic variables in future study. Hence, the constructed NCDRI in this study can serve as a reference for the future development of NCDs in Malaysia. By using the findings of this study, other conceivable risk factors could be included to construct a more comprehensive and improved NCD indicator in the future.

REFERENCES

Abegunde, D. O., Mathers, C. D., Adam, T., Ortegon, M., & Strong, K. (2007). The burden and costs of chronic diseases in low-income and middle-income countries. *The Lancet, 370*(9603), 1929-1938.

Allender, S., Lacey, B., Webster, P., Rayner, M., Deepa, M., Scarborough, P., ... & Mohan, V. (2010). Level of urbanization and noncommunicable disease risk factors in Tamil Nadu, India. *Bulletin of the World Health Organization*, *88*, 297-304.

Almost, J. M., VanDenKerkhof, E. G., Strahlendorf, P., Tett, L. C., Noonan, J., Hayes, T., & Paré, G. C. (2018). A study of leading indicators for occupational health and safety management systems in healthcare. *BMC health services research*, *18*(1), 296.

Angkurawaranon, C., Jiraporncharoen, W., Chenthanakij, B., Doyle, P., & Nitsch, D. (2014). Urbanization and non-communicable disease in Southeast Asia: a review of current evidence. *Public Health*, *128*(10), 886-895.

Asteriou, D., & Hall, S. G. (2007). *Applied econometric: A modern approach* (Revised ed.). New York, NY: Palgrave Macmillan.

Atun, R., Jaffar, S., Nishtar, S., Knaul, F. M., Barreto, M. L., Nyirenda, M., ... & Piot, P. (2013). Improving responsiveness of health systems to non-communicable diseases. *The Lancet*, *381*(9867), 690-697.

Australian Women' s Health Network. (2014). Women and Non-Communicable Diseases (Chronic Conditions). Retrieved from http://www.parliament.tas.gov.au/ctee/Joint/ Submissions/No. 10 - AWHN Postion Paper 160215.pdf

Becker, W., Saisana, M., Paruolo, P., & Vandecasteele, I. (2017). Weights and importance in composite indicators: Closing the gap. *Ecological indicators*, *80*, 12-22.

Bio Differences. (2017). Difference between communicable and non-communicable disease. Retrieved from https://biodifferences.com/difference-between-communicable-and-non-communicable-disease.html.

Boden-Albala, B., Cammack, S., Chong, J., Wang, C., Wright, C., Rundek, T., ... & Sacco, R. L. (2008). Diabetes, fasting glucose levels, and risk of ischemic stroke and vascular events: Findings from the Northern Manhattan Study (NOMAS). *Diabetes Care*, *31*(6), 1132-1137.

Boen, C., & Yang, Y. C. (2016). The physiological impacts of wealth shocks in late life: Evidence from the Great Recession. *Social Science & Medicine*, 150, 221-230.

Boutayeb, A., & Boutayeb, S. (2005). The burden of non-communicable diseases in developing countries. *International Journal for Equity in Health*, *4*(1), 2.

Box, G. E. P. & Jenkins, G. M. (1970). *Time series analysis: Forecasting and Control.* San Francisco, Holden-Day.

Braveman, P. A., Cubbin, C., Egerter, S., Williams, D. R., & Pamuk, E. (2010). Socioeconomic disparities in health in the United States: what the patterns tell us. *American Journal of Public Health*, *100*(S1), S186-S196.

Bry, G., & Boschan, C. (1971). Programmed selection of cyclical turning points. In *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs* (pp. 7-63). NBER.

Burns, A. F., & Mitchell, W. C. (1946). Measuring Business Cycles, NBER, Studies in Business Cycle.

Butt, Z., & Haberman, S. (2009). llc: A collection of R functions for fitting a class of Lee-Carter mortality models using iterative fitting algorithms.

Castro, J. M. (2009). Healthcare in Malaysia. Retrieved from https://www.expatforum.com /articles/health/health-care-in-malaysia.html.

Centres of Disease Control and Prevention. (2006). Principles of Epidemiology, CDC, 2006. Definition of risk factor.

Chao, Y. S., & Wu, C. J. (2017). Principal component-based weighted indices and a framework to evaluate indices: Results from the Medical Expenditure Panel Survey 1996 to 2011. *PloS one*, *12*(9), e0183997.

Chee, H. L. 2007. Medical Tourism in Malaysia: International Movement of Healthcare Consumers and the Commodification of Healthcare. Working Paper Series No. 83. Singapore: Asia Research Institute.

Christiano, L. J., & Fitzgerald, T. J. (2003). The band pass filter. *International Economic Review*, *44*(2), 435-465.

Conference Board. (2000). *Business Cycle Indicators Handbook*. New York, NY: The Conference Board.

Cutler, D. M., & Lleras-Muney, A. (2006). Education and Health: Evaluating Theories and Evidence. *Edication and Health: Evaluating Theories and Evidence*. Retrieved from https://ideas.repec.org/p/nbr/nberwo/12352.html

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, *49*(4), 1057-1072.

Esteghamati, A., Meysamie, A., Khalilzadeh, O., Rashidi, A., Haghazali, M., Asgari, F., ... & Abbasi, M. (2009). Third national Surveillance of Risk Factors of Non-Communicable Diseases (SuRFNCD-2007) in Iran: Methods and results on prevalence of diabetes, hypertension, obesity, central obesity, and dyslipidemia. *BMC Public Health*, *9*(1), 167.

Feinstein, L., Sabates, R., Anderson, T. M., Sorhaindo, A., & Hammond, C. (2006). What are the Effects of Education on Health?, (December 2005), 171–354. Retrieved from http://discovery.ucl.ac.uk/1391842/

Filardo, A. J. (1994). Business Cycle Phases and Their Transitional Dynamics. *Journal of Business and Economic Statistics*, 12(3), 299-308.

Freudenberg, M. (2003). Composite indicators of country performance. Retrieved from https://ideas.repec.org/p/oec/stiaaa/2003-16-en.html

Ghandour, A. A. (2015). Out of Pocket Expenditure on Non-Communicable Diseases among Egyptian Patients. *Egyptian Journal of Hospital Medicine*, *58*.

Gil, Á., de Victoria, E. M., & Olza, J. (2015). Indicadores de evaluación de la calidad de la dieta. *Nutricion Hospitalaria*, *31*, 128–144.

Granger, C. W. (1986). Development in the study of co-integrated economic variables. *Oxford Bulletin of Economics and Statistics, 48*(3), 213-228.

Granger, C. W. (1988). Some recent development in a concept of causality. *Journal of Econometrics, 38*(1-2), 199-211.

Grant, W. B., & Holick, M. F. (2005). Benefits and requirements of vitamin D for optimal health: A review. *Altern Med Rev*, *10*(2), 94-111.

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics.* New York, NY: McGraw-Hill.

Habibov, N., Auchynnikava, A., Luo, R., & Fan, L. (2019). Effects of the 2008 global financial crisis on population health. *The International Journal of Health Planning and Management*, *34*(1), 327-353.

Hameed, M., Bibi, L. (2014). *An inquiry into privatisation's impact on healthcare services in Malaysia/Latifa Bibi Binti Musafar Hameed/*Doctoral dissertation, University Malaya. Retrieved from http://studentsrepo.um.edu.my/4626/14/Thesis_Title.pdf

Hameed, M., Bibi, L., Rasiah, R., & Mohd Shukor, N. (2018). Private Healthcare Expenditure: Absolute and Relative Changes. Retrieved from http://www.ums.edu.my/fpep/files/Latifah.pdf

Hamilton, J.D. (1989). A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle. *Econometrica*, 57, 357-384

Harding, D., & Pagan, A. (2002). Dissecting the cycle: a methodological investigation. *Journal of Monetary Economics*, *49*(2), 365-381.

Heng Leng, C., & Barraclough, S. (2007). *Healthcare in Malaysia: The dynamics or provision, financing and access*. *Routledge Malaysian Studies Series*.

Hodrick, R. J., & Prescott, E. C. (1980). Postwar U.S. Business Cycles: An Empirical Investigation. Carnegie Mellon University Discussion Paper, 451.

Hosseinpoor, A. R., Bergen, N., Kunst, A., Harper, S., Guthold, R., Rekve, D., ... & Chatterji, S. (2012). Socioeconomic inequalities in risk factors for non-communicable diseases in low-income and middle-income countries: results from the World Health Survey. *BMC Public Health*, *12*(1), 912.

Hjalmarsson, E., & Osterholm, P. (2007). *Testing for cointegration using the Johansen methodology when variables are near-integrated.* Board of Governors of the Federal Reserve System, International Finance Discussion Papers, No. 915.

International Agency for Research on Cancer; 2014. World cancer report. Retrieved from http://publications.iarc.fr/Non-Series-Publications/World-Cancer-Reports/World-Cancer-Report-2014

Jacobs, R., & Goddard, M. (2007). How do performance indicators add up? An examination of composite indicators in public services. *Public Money and Management*, *27*(2), 103-110.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with application to money demand. *Oxford Bulletin of Economics and Statistics, 52,* 169-210.

Kastor, A., & Mohanty, S. K. (2018). Disease-specific out-of-pocket and catastrophic health expenditure on hospitalization in India: Do Indian households face distress health financing? *PloS one*, *13*(5), e0196106.

Khademi, N., Babanejad, M., Asadmobini, A., & Karim, H. (2017). The association of age and gender with risk factors of non-communicable diseases among employees in West of Iran. *International Journal of Preventive Medicine*, *8*(1), 9.

Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T. Wells, J. C. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet*, *380*(9838), 219–229.

Leegwater, A., Wong, W., & Avila, C. (2015). A concise, health service coverage index for monitoring progress towards universal health coverage. *BMC Health Services Research*, *15*(1), 230.

Li, C., Ford, E. S., Zhao, G., & Mokdad, A. H. (2009). Prevalence of pre-diabetes and its association with clustering of cardiometabolic risk factors and hyperinsulinemia among US adolescents: National Health and Nutrition Examination Survey 2005–2006. *Diabetes Care*, *32*(2), 342-347.

Li, Y., Wang, L., Jiang, Y., Zhang, M., & Wang, L. (2013). Risk factors for non-communicable chronic diseases in women in China: Surveillance efforts. *Bulletin of the World Health Organization*, *91*, 650-660.

Lüutkepohl, H., Saikkonen, P., & Trenkler, C. (2001). Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process. *The Econometrics Journal*, *4*(2), 287-310.

Malaysian National Cancer Registry Report 2007-2011 . Moh/p/ikn/01.16 (ar), *16*, 94–95. Retrieved from https://www.crc.gov.my/wpcontent/uploads/documents/report/MNCRRreport2007-2011.pdf

Malaysia National Health Accounts. (2016). Health Expenditure Report 1997-2012. Retrieved from http://jknjohor.moh.gov.my/bmv/uploads/penerbitan/MNHA19972015.pdf.

Marins, V. M., Almeida, R. M., Pereira, R. A., & Sichieri, R. (2007). The association between socioeconomic indicators and cardiovascular disease risk factors in Rio de Janeiro, Brazil. *Journal of Biosocial Science*, *39*(2), 221-229.

Masih, M., Al-Elg, A., & Madani, H. (2009). Causality between financial development and economic growth: An application of vector error correction and variance decomposition method to Saudi Arabia. *Applied Economics*, *41*, 1691-1699.

McQuestion, M. J. (2006). Quality of care. Johns Hopkins Bloomberg School of Public Health. *Scandinavian Journal*, (3), 1–18.

Meeting, W. H. O. (2009). Surveillance of Non-communicable Diseases Report of a WHO Meeting, (August).

Merican, M. I., Rohaizat, Y., & Haniza, S. (2004). Developing the Malaysian health system to meet the challenges of the future. *The Medical Journal of Malaysia*, 59(1), 84-93.

Ministry of Finance Malaysia. (2018). Touchpoints 2018 Budget, 1–15. Retrieved from http://www.treasury.gov.my/pdf/budget/speech/bs18.pdf.

Ministry of Health Malaysia. (2011) Non-Communicable Disease Section. NCD Prevention and Control Annual Report 2011. Putrajaya: Ministry of Health Malaysia; 2011.

Ministry of Health Malaysia. (2012) Institute for Public Health (IPH). Report of the Global Adult Tobacco Survey (GATS) Malaysia, 2011.

Mpofu, J. J., de Moura, L., Farr, S. L., Malta, D. C., Iser, B. M., Bernal, R. T. I., ... & Lobelo, F. (2016). Associations between non-communicable disease risk factors, race, education, and health insurance status among women of reproductive age in Brazil—2011. *Preventive Medicine Reports*, *3*, 333-337.

Mustapha, F. I., Omar, Z. A., Mihat, O., Noh, K. M., Hassan, N., Bakar, R. A., ... & Rahman, L. A. (2014). Addressing non-communicable diseases in Malaysia: an integrative process of systems and community. *BMC Public Health*, *14*(2), S4.

National Coordinating Committee on Food and Nutrition. (2010). Key Message 3: Be physically active everyday. *Malaysian Dietary Guidelines*. Retrieved from http://dg.cnsoc.org/upload/affix/20140818104029708.pdf

National Diabetes Institute (2009). Type 1 Diabetes. Retrieved from http://www.diabetes Malaysia.com.my/article.php?aid=5

National Health & Morbidity Survey (2015). Retrieved from http;//iku.moh.gov.my/index. php research-eng/list-of-research-eng/iku-eng/nhms-eng/nhms-2015

Nguyen, H. M., & Nguyen, L. D. (2018). The relationship between urbanization and economic growth: An empirical study on ASEAN countries. *International Journal of Social Economics*, *45*(2), 316-339.

OECD. (2015). Alcohol consumption among adults, 2000 and 2013 (or nearest years), in *Non-medical determinants of health*, OECD Publishing, Paris. Retrieved from https://doi.org/10.1787/health_glance-2015-graph39-en.

OECD. (2006). Education at a Glance 2006. Retrieved from https://www.oecd.org/ education.

Pescetto, C. (2011). Economic Dimensions of the Impact of Chronic Diseases in the Region of the Americas: A Research Agenda. In Technical note prepared for the Workshop on Economics of Prevention of Noncommunicable Diseases and Risk Factors, Panamerican Health Organization, November (Vol. 14).

Protocol, K. (2009). Joint Research Centre, (August), 2009–2011. Retrieved from https://doi.org/10.1038/296283c0

Prinja, S., Gupta, R., Bahuguna, P., Sharma, A., Kumar Aggarwal, A., Phogat, A., & Kumar, R. (2016). A composite indicator to measure universal healthcare coverage in India: way forward for post-2015 health system performance monitoring framework. *Health Policy and Planning*, *32*(1), 43-56

Pulvermacher, K. (2017). The next pandemic? Non-communicable diseases in developing countries. *The Economist*. Retrieved from https:// accessaccelerated.economist.com/ wpcontent/uploads/sites/37/2016/12/The_next_pandemic.pdf.

Riley, L., Guthold, R., Cowan, M., Savin, S., Bhatti, L., Armstrong, T., & Bonita, R. (2016). The World Health Organization STEPwise approach to noncommunicable disease risk-factor surveillance: Methods, challenges, and opportunities. *American Journal of Public Health*, *106*(1), 74-78.

Ross, H., & Al-Sadat, N. A. (2007). Demand analysis of tobacco consumption in Malaysia. Nicotine & Tobacco Research, 9(11), 1163-1169.

Roush, S. W., & Wharton, M. (2011). Surveillance indicators. *Manual for the Surveillance of Vaccine-Preventable Diseases*. Retrieved from: https://www.cdc.gov /VACCINEs/ pubs/surv-manual/chpt18-surv-indicators.html

Rozanim, K. (2012). Alcohol consumption in Malaysia,. *15th National Institutes of Health (NIH) Scientific Meeting 2012*.

Russolillo, M. (2016). Tackling non-communicable diseases by a forecasting model for critical illness cover. *Problems and Perspectives in Management*, *14*(2), 8.

Sharma, A., Prinja, S., & Aggarwal, A. K. (2017). Measurement of health system performance at district level: A study protocol. *Journal of Public Health Research*, *6*(3), 917.

Singh, A., Bassi, S., Nazar, G. P., Saluja, K., Park, M., Kinra, S., & Arora, M. (2017). Impact of school policies on non-communicable disease risk factors – a systematic review. *BMC Public Health*, *17*(1), 292.

Sommer, I., Griebler, U., Mahlknecht, P., Thaler, K., Bouskill, K., Gartlehner, G., & Mendis, S. (2015). Socioeconomic inequalities in non-communicable diseases and their risk factors: an overview of systematic reviews. *BMC Public Health*, *15*(1), 914.

Stockwell, T., Chikritzhs, T., Holder, H., Single, E., Elena, M., & Jernigan, D. (2000). International guide for monitoring alcohol consumption and related harm. *Geneva, Switzerland: World Health Organization*, 1-193.

Sulistyowati, N., Sinaga, B. M., & Novindra, N. (2017). Impacts of Government and Household Expenditure on Human Development Index. *JEJAK: Jurnal Ekonomi dan Kebijakan*, *10*(2), 412-428.

System Hussein, RH, Asia Pacific Region Country Health Financing Profiles: Malaysia, Institute for Health Systems Research, Schematic overview of the Malaysian health. Retrieved from http://www.mpc.gov.my/wp-content/uploads/2016/10/C2-2.pdf

Thakur, J. S., Jeet, G., Pal, A., Singh, S., Singh, A., Deepti, S. S., ... & Saran, R. (2016). Profile of risk factors for non-communicable diseases in Punjab, Northern India: Results of a state-wide STEPS survey. *PloS One*, *11*(7), e0157705.

Tharakan, J. (2012). Stroke Registry - Relevance and Contributions, *Medical Journal Malaysia 67*(3), 251–252.

Tsioufis, K. P., Dimitriadis, K., Koutra, E., Kasiakogias, A., Kordalis, A., Tsiachris, D., Mattson, M. P. (2015). The metabolic syndrome: Requiescat in Pace. *Clinical Chemistry*, *51*(6), 931–938.

Van Minh, H., & Xuan Tran, B. (2012). Assessing the household financial burden associated with the chronic non-communicable diseases in a rural district of Vietnam. *Global Health Action*, *5*(1), 18892.

Vlachou, A., Stavroussi, P., Roka, O., Vasilou, E., Papadimitriou, D., Scaratti, C., ... & Tobiasz-Adamczyk, B. (2018). Policy Guidelines for Effective Inclusion and Reintegration of People with Chronic Diseases in the Workplace: National and European Perspectives. *International Journal of Environmental Research and Public Health*, *15*(3), 493.

Wang, F. (2015). More health expenditure, better economic performance? Empirical evidence from OECD countries. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*, *52*, 0046958015602666.

Wesonga, R., Guwatudde, D., Bahendeka, S. K., Mutungi, G., Nabugoomu, F., & Muwonge, J. (2016). Burden of cumulative risk factors associated with non-communicable diseases among adults in Uganda: Evidence from a national baseline survey. *International Journal for Equity in Health*, *15*(1), 195. Retrieved from https://doi.org/10.1186/s12939-016-0486-6

World Health Organizationj . (2010). Background Paper : Non-communicable diseases in low- and middle-income, (October), 1–14.

Wipfli, H. (2012). The Tobacco Atlas, Fourth Edition. *American Journal of Epidemiology*, *176*(12), 1193–1193.

World Bank. (2015). Prevalence of Insufficient Physical Activity among Adults by Income Groups. Retrieved from https://apps.who.int/gho/data/view.main.2487?lang=en

World Health Organization. (2003). The world health report 2003: Shaping the future. *Geneva: Wold Health Organization*, 204. Retrieved from https://www.annualreviews.org/doi/10.1146/ annurev.ecolsys.35.021103.105711

World Health Organization. (2010). *Health Financing Strategy for the Asia Pacific Region Health Financing Strategy For tHe Asia Pacific region (2010-2015). World Health Organization*.

World Health Organization. (2012). Asia Pacific Observatory on Health Systems and Policies. Malaysia Health System Review. Retrieved from http://iris.wpro.who.int/bitstream/handle/10665.1/5283/9789290615842_eng.pdf

World Health Organziation (2013). NCD targets and indicators, 2013.

World Health Organization (2013). Human Resource for Health Country Profiles : Malaysia, 60.

World Health Organization. (2013). Women and Non-Communicable Diseases (Chronic Conditions). Retrieved from http://www.parliament.tas.gov.au/ctee/Joint/ Submissions/No. 10 - AWHN Postion Paper 160215.pdf.

World Health Organization. (2014a). Non-communicable Diseases Global Monitoring Framework: Indicator Definitions and Specifications, 2–4.

World Health Organization. (2014b). World Health Organization – Non-communicable Disease (NCD) Country Profile, 2014. *World Health Organisation*, 1.

World Health Organization. (2014). World Health Organization – Non-communicable Disease (NCD) Country Profile, 2014. Retrieved from https://doi.org/10.1057/9781137275967.0010

World Health Organization. (2015). Prevalence of Insufficient Physical Activity among Adults in Malaysia. Retrieved from https://apps.who.int/gho/data/view.main.2463

World Health Organization. (2016). Non-communicable diseases: a global perspective. Retrieved from http://oldcmos.iub.edu.bd/sph/pluginfile.php/4055/mod_resource/content/4/GH_Lec3.pdf

World Health Organization (2017) Non-communicable diseases. Retrieved from http://www.who.int/mediacentre/factsheets/fs355/en/

World Health Organization. (2018). Cancer. *World Health Organization.* Retrieved from http://www.who.int/en/news-room/fact-sheets/detail/cancer

World Health Organization (2018) Non-communicable diseases and mental health (Global Action Plan for the Prevention and Control of NCDs 2013-2020). Retrieved from http://www.who.int/nmh/events/ncd_action_plan/en/