

The Model of Chronic Cardiovascular Diseases Growth and Effective Control Costs Management: A qualitative System Dynamics Approach

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Abstract

Chronic diseases are the main cause of global mortality in recent decades and due to the lack of absolute treatment and need to permanent control, Imposes high costs to the health system of the country. One of the most important chronic diseases is cardiovascular diseases which are the first cause of death in Iran, according to the World Health Organization's report. Analyzing the process of catching these diseases and its feedback consequence on the health economy, are the main problem of this study. Therefore, in this research, in addition to the representation of cardiovascular chronic diseases generator and growth system structure, based limit to growth archetype in system thinking theory, Balancing and adjusting solution and strategies for insurance cost effective management will present. The results show that obesity, lack of physical activity and unsuitable nutrition style are the most important reinforcing loop in the system and they impose high costs to the health economy system. Also, by replacing part of the insurance covering cost with development costs of preventive factors such as physical activity infrastructures development, insurance costs effective management can be achieved.

Keywords:

System Dynamics, System Approach, Chronic Diseases, Cardiovascular Diseases, Limit to Growth

Introduction

The growing costs of health systems become one of the main concerns the health system managers and decision makers around the world. Continued expansion of new and expensive health technologies, growing expectations of communities of health systems and chronic diseases among

the people, has been intense important reasons for the development of this costs[1]. The increasing burden of chronic diseases costs is one of the main challenges of health systems. Today, in the area of common illnesses and deaths of their contribution, a paradigm shift occurred in an environment that reflects the increasing share of non-communicable diseases and cost of chronic diseases. Unlike in the past, chronic diseases had not a significant impact on the per capita mortality from and not in arbitrarily imposed costs, today, are nearly 80 percent of mortality and morbidity in the country. Since there is no deterministic cure for this type of diseases and usually the course of this diseases is long-term, high costs for the health system will be imposed to control the diseases.

According to reports, very countries also experienced huge cost for these diseases. For example, 44 percent of the US population had been suffering at least one from various chronic diseases in 2005. Even 13 percent of people in this country suffer from three or more than three chronic diseases. It is estimated that by 2020, 157 million people in the United States will be one or more than one chronic disease[2]. At the global level, assessment of the prospects report on global risks of the market economy have indicated that chronic non-communicable diseases are one of the major threats that the nation's economy will be faced with. In 2005, heart disease, stroke and diabetes cause loss of \$ 18 billion in China, 9 billion in India and \$ 3 billion in Brazil, and these losses will increase over time[3].

Based on the literature of health economics chronic diseases and followed by health programs to cover some of the several costs that impose on individuals and households. The first cost, direct and tangible costs caused by the disease, such as capital costs and ongoing health intervention. The second type of costs, are direct costs, but not tangible, such as program support costs or other payments, the third cost are indirect costs such as the cost of time and opportunity to show patients and their relatives



and the fourth type cost are, non-financial costs such as the cost of pain, anxiety, stress, etc.[4]. It should be noted the economic burden of chronic diseases in poor communities is greater to comparison with rich societies and poor people are more vulnerable due to rising risks and reduce access to health care. Chronic diseases led to the fall in the abyss of poverty and the status of individuals and families complex and worse than the disease, and poverty [5].

The health system in Iran is faced with the challenge of sharp increases in costs like other health systems. While the overall cost index has been 30 times in the country in the last 20 years; this growth has been 71 times in health care costs. This has caused the health system faced many problems in different parts. Iran's current health care system is facing the challenge of service continuity. Patients share to pay of health care costs are so high that annually 3.5 million people are below the poverty line only because of health care costs[6]. According to the preventable chronic diseases in order to maintain and improve public health and reduce the costs imposed on them, it seems very important the policies that avoidable costs of treatment and cure of the disease to develop ways to prevent them spend and will create more effective management of health and its economy. In other words reaching a decision support framework will be a necessity to review alternative policy costs of chronic diseases with an alternative preventative mechanism in the health system that this is the main issue of present study.

Literature and Background

As defined by the World Health Organization, non-communicable diseases are to reduce the body's structure or operation of the necessity of changing the normal life of their patients and continued over a period of time longer and stable [7]. Overweight and obesity, blood pressure, lack of physical activity, hypercholesterolemia and addiction, including are five primary risk factors that have the highest share of disease burden. One of the most important events of chronic diseases will be noted lifestyle changes, eating pattern, physical activity, tobacco and mental tension. Lifestyle is ordinary daily activities that people have accepted them in their lives are acceptable so that these activities affect the individual's health. Recent studies show which amounts to about 53 percent of deaths of people connected with their lifestyle. Industrial development increased the tendency to urbanization and mechanization of life, has created a major impact on lifestyle and inactive lifestyle has brought to communities. Among the ten risk factors related to mortality in the world, six factors are associated with diet and physical activity. In fact, the amount of physical activity as an independent factor affecting the incidence of some chronic diseases such as diabetes, high blood pressure, cardiovascular disease and osteoporosis involved. It is estimated approximately 70 to 80 percent of the Iranian population has an inactive lifestyle. Inappropriate and unhealthy lifestyle is responsible for many types of chronic diseases [8]. In the field of tobacco also can say that the effect of smoking on cardiovascular disease, similar to the two main risk factor for the disease is

high blood pressure and high cholesterol. Tobacco consumption and exposure to tobacco smoke exposure is the first and third cause of preventable death progress in the world. On the other hand, mental stress plays an important role in the development of mental and physical diseases special in non-communicable diseases. Modifiable nature of some of the main causes of cardiovascular disease such as poor nutrition, low physical activity, obesity, smoking and other tobacco products, stress, hypertension, abnormal glucose tolerance and dis- Lipoprotein caused different countries and the World Health Organization, intervention programs to reduce the incidence of cardiovascular disease risk factors in order to reduce their design and implementation.

According to the World Health Organization report, could be having more healthy diets, keep fit and not smoking as much as 80 percent of the occurrence of heart disease and be prevented type II diabetes. A Canadian study showed that 10 percent reduction in the prevalence of physical inactivity could reduce direct health costs in the amount of 150 million Canadian dollars (about 124 million dollars in America) at one year [9]. Several studies have been conducted in the field of this research. Koelling et al.[10] classified the healthcare system and considered the best way to architecture healthcare system through the use of causal loop diagrams that powerful way to represent complex systems. Grossman et al.[11] reviewed the positive effects on the demand for health education and salary as well as demonstrated the positive impact of aging on health demand a negative effect health care.

Mehrjerdi [12] examined among to human weight, eating habits, exercise, body fat, medicines, drugs and general health problem and addressed a systems thinking approach to the relationship between factors discussed using system dynamics simulation concept and suggests the system's behavior and thus concludes that how weight can be a factor in heart attacks, blood pressure and blood sugar affect, and relation of the expense is general that an insurance company have to pay in the past.

Methodology

We will use the system dynamics methodology for modeling and analysis. This method is one of the Appropriate methods to simulate complex systems is based on causal relationships that enabling the system to provide appropriate learning by providing an environment for testing various scenarios. This method can be also used to analyze the problems with the qualitative approach (causal analysis) and quantitative approach (stock and flow). There are some applications of this methodology in social and economic complex problem modeling such as Mobile banking adoption simulation [13], Banking Risk Management [14], Banking Paradox [15], Sustainable development [16], Organizational demographics [17], Brain drain [18], Dust emission [19], Waste management [20], Crisis Management [21], Inflation Rate [22], Housing Cost [23], User satisfaction in Healthcare services [24], Public health [25].



Model

According to the World Health Organization report, obesity and Immobility, poor nutrition and lack of physical activity and sport are the most important causes of cardiovascular disease. As shown in Figure 1 the first development link of this system is loop of obesity and inactivity that loop factors has an impact on the both and are increasing. The second loop is insufficient loop that impact of mobility and increased risk of cardiovascular disease. The third loop is impacted loop of the new lifestyle that is occurring which typical due to the impact of the previous looping the loop inactivity.

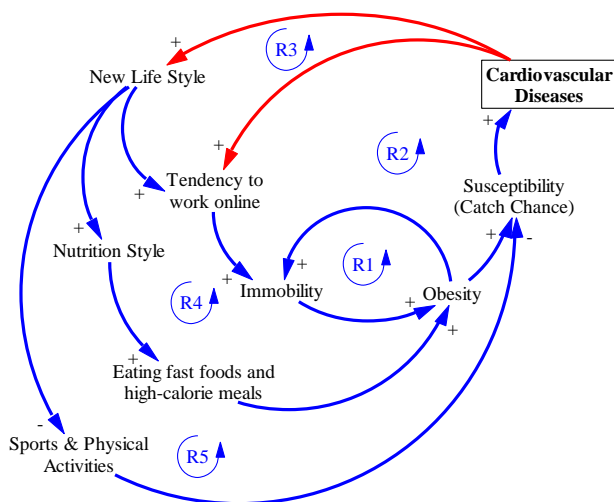


Figure 1-The growth Loops of cardiovascular disease

Increasingly loops fourth and fifth are effects loops of inadequate nutrition and physical activity show the increased risk of disease. According to the positive circular structure, if the state variables are placed on this type of loop; will be exponential growth due to the progressive nature of the loop. In fact, we can say increase the risk of cardiovascular disease, is the result of growing loop system. On the other hand, according to the limit to growth archetype which provided by D. Meadows [26], no growth can't continue indefinitely to infinity and certainly adjust by the negative control reactions or loop structure regulator. We can consider two types of limited growth that exist in cardiovascular health and chronic disease management issue. The first group is structured to form loops by their positive outcomes arising and in fact, its papillae system behavior and have the role of natural brake in growth. The second category structures that can be applied the management of health systems and interventions create a system that is the purpose of this study.

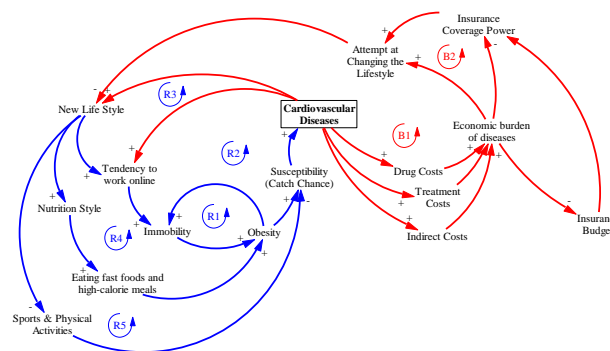


Figure 2-Balancing Loops of Economic burden of diseases and its effects on changing the lifestyle disease

As can be seen in Figure 2, with the enormous growth of cardiovascular disease and therefore increase the cost of direct and indirect control of the disease, begun efforts by the government and households to change its lifestyle that includes a lot of factors to disease and this is the first negative feedback loop and system settings. Then, with the continuing increase in the financial burden of disease management, health organizations and insurance companies will face the challenge of continuing to provide services and to cover costs and it will be a limiting factor for growth for this system.

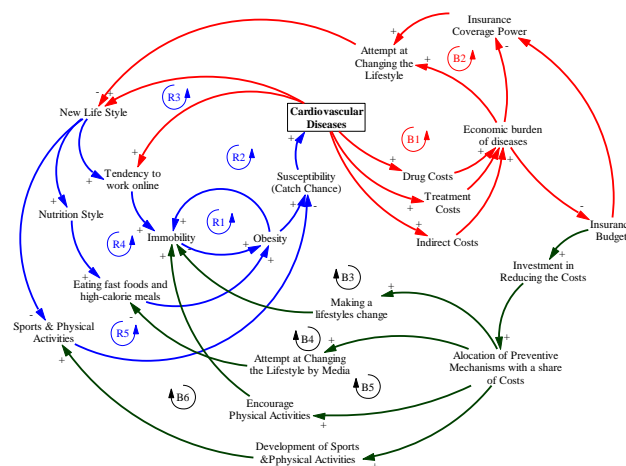


Figure 3-Balancing loops of insurance cost effectiveness Management

As can be seen in Figure 3, the insurance system can consume your budget in two ways. According to the classical structure, insurance can spend own funds only to towards the cost of medication and treatment of cardiovascular disease. Although this structure is a limiting mechanism to the growth of diseases, but the dominance of positive polarity loops, this solution can't prevent the proper growth of chronic diseases and increasing the cost of medication and treatment to it. From another perspective the change in strategy in the insurance system so that part of the budget in order to reduce costs through investments to develop mechanisms for limiting consumption, and instead of solving the problem provide to solve the root of the problem. As can be seen in the above Figure, can be

created five limiting growth mechanism for chronic cardiovascular disease.

Insurance can invest in the development of sports infrastructure and require the insured to the use of these spaces are legally insured positive effect on increasing physical activity levels apply and in this way reduce the risk of disease for them. It also spent part of the cost in the media and trying to introduce proper nutrition pattern can be moved in order to change the pattern.

Conclusion

Today, the health of people around the world is facing the dramatic changes. Non-communicable diseases are cause two-thirds of global mortality allocation and this is very disturbing. Iran as a country with low and middle income, spend large sums of money and the healthcare budget in the area of non-communicable diseases and in the diagnosis and treatment of cardiovascular disease is one of the most important of which is the cost every year. Increasing the cost of medication and treatment of chronic diseases to the extent that has been faced public health system with the challenge of continuous services and insurance sectors and the challenges faced with a lack of long-term obligations.

with representation generating system structure and adjusting mechanisms of disease, it can be said that Immobility abd lack of physical activity; a new nutrition stlye and lifestyle most important feedback structures are increasingly at risk of cardiovascular disease.

In this study, using causal loop diagrams in system dynamics methodology and take advantage of limit to archetype , some structure of regulatory intervention was introduced for insurance companies. According to the proposed model, insurance companies by investing a portion of their budgets instead of spending commitments drug coverage and treatment of disease, with the construction of sports infrastructure and requiring the use of their insured, efforts to introduce lifestyle changes and proper nutrition pattern through paid media can be an effective control on costs, while in the long run will reduce the cost of paying them, will be also a society with a healthy workforce and higher productivity. The decision should be presented in order to do future research is suggested by stock and flow model to simulate scenarios.

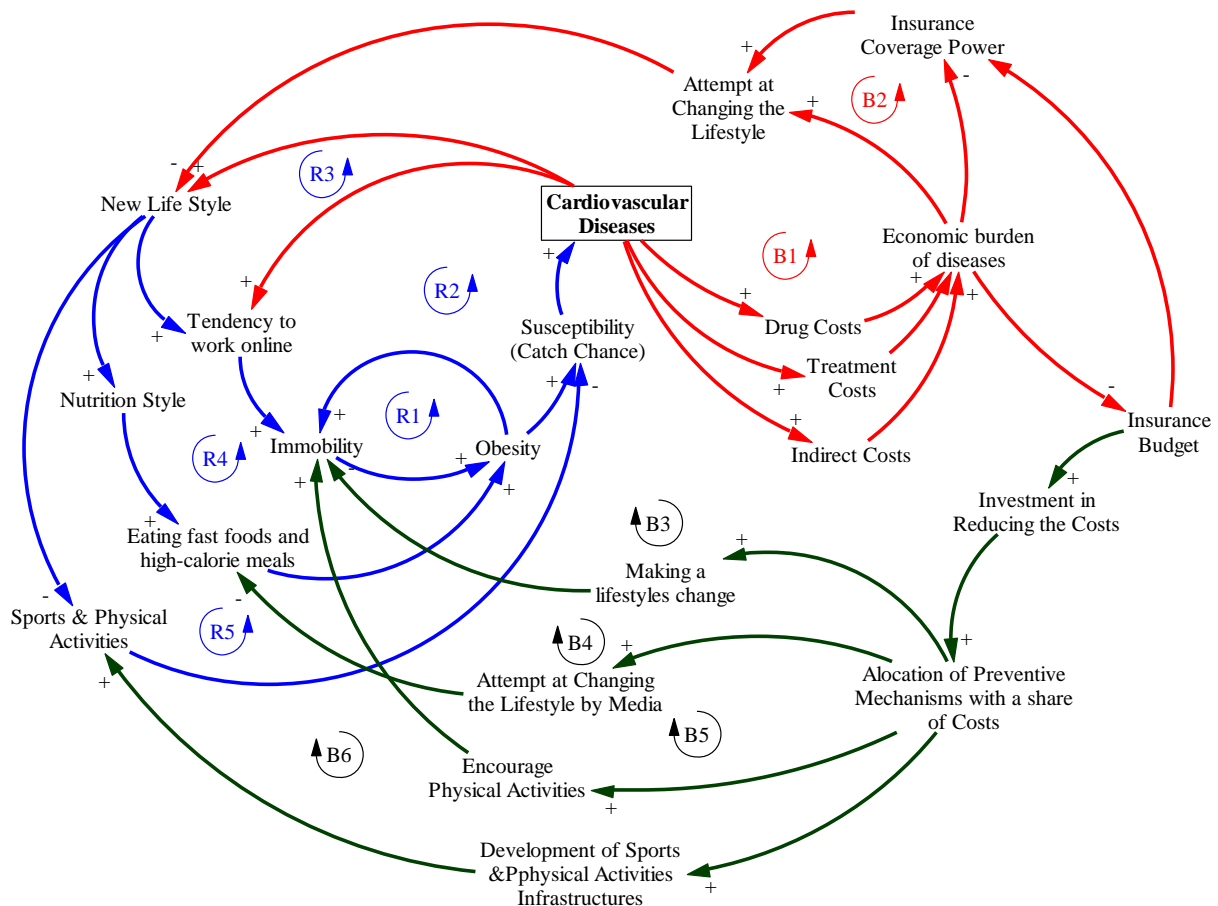


Figure 4-Total Causal loop Diagram of Cardiovascular Diseases



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