Cardiovascular Disease in the United States

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Abstract: Cardiovascular disease (CVD) refers to the symptoms caused by narrowing or closed blood vessels; these symptoms include heart attacks, strokes, and chest pain. Cardiovascular disease is generally associated with the term heart disease. CVDs are the leading cause of death in the United States for both men and women of most ethnic and racial groups. In 2016, CVDs were responsible for 840,767 deaths in the country [13]. There are many risk factors ranging from age, ethnicity, lifestyle choices, etc. that can cause a person to develop a CVD. Even though cardiovascular disease causes many deaths throughout the America, it is still preventable. It is our goal to decrease the rate at which people in the United States contract and suffer from CVDs by targeting the risk factors.

1 Introduction

Death is a part of life and is the result of many factors, and most of them, in today's society, are due to medical issues and diseases. One such disease is cardiovascular disease (CVD), which is medical terminology for heart disease or diseases associated with the cardiovascular system.

The purpose of the cardiovascular system is to circulate blood throughout the body within a closed circuit, and it is comprised of vessels called arteries and veins. Arteries circulate oxygen-enriched blood from the heart to the rest of the body while veins return the blood back to the heart so that the process can be repeated on a continuous loop. The ends of arteries and veins become very small and are connected through a system of tiny vessels, which are called capillaries, that supply blood to directly to organs and tissues. The continuous flow of blood within the body is ensured by one of the most important organs, the heart. "The mechanical activity of the heart is a regular and timely succession … responsible for the heart pumping ... about 7000 litres over 24 hours" [4]. In cardiovascular disease, these vessels are narrowed or blocked, causing heart attacks and other symptoms.

CVD greatly affects the population of the United States and the rest of the world. In an article submitted to the U.S. Department of Human and Health Services in 2012, it was reported that heart disease is the leading cause of death in the United States [8].   This

trend has continued, for in 2016 cardiovascular disease was again reported as the leading cause of death in the United States, responsible for 840,678 deaths that year [13].

2   Symptoms of Cardiovascular Disease

The symptoms of CVD vary with each individual from mild chest pain to the most severe, death. The same disease may be present in two different individuals, but it can also be experienced in two different ways. Some symptoms are present and persist more than some others. Adrian Chenzbraun [4] says, "Chest pain, palpitations, shortness of breath, fainting, and leg swelling are associated with heart disease". These symptoms are not precursors for the each other, and each comes with its own level of awareness and caution.

"Chest pain is a very frequent complaint encountered in many conditions from a tense chest muscle to heart disease" [4]. It is a "defining symptom of angina and heart attack" [4] and as such brings about concern. This symptom is branded with the idea of heart disease and raises caution in individuals.

Palpitations can be described as a disturbance in the rhythm of the heart. Individuals can confuse the normal changes in heart rhythm with this symptom, causing it to be a common complaint. "As a rule of thumb, the occurrence of rare, well-tolerated, and isolated palpitations in a young person without any evidence of heart disease is a benign symptom that does not warrant treatment or investigation" [4].

Another symptom encountered with heart disease is shortness of breath, "where it can be related to heart failure" [4]. Shortness of breath is not specific to heart conditions and is more associated with lung disease and obesity.

A loss of consciousness or fainting is yet another "frequent reason for a cardiology consultation" [4]. This symptom may indicate a serious disorder in a person, but some instances are just trivial. For example, a loss of consciousness can be caused by witnessing a stressful event, suddenly changing position under certain circumstances, or giving blood, and these actions can be replicated or reproduced causing the same risk for fainting.

Lastly, swelling of the legs is a symptom frequently used as a reason to refer a patient for cardiac evaluation because of suspected heart failure. "Leg swelling is a common feature of advanced heart failure because of water retention and a rise in the venous pressure, resulting in passage of blood plasma out of the vessels. … Leg swelling, however, can be a symptom of other known non-cardiac conditions" [4].

3   Risk Factors

The epidemic of cardiovascular disease is not a supernatural phenomenon because it is caused by the way we eat and live day to day. The personal characteristics for each individual that are responsible for developing a CVD are called risk factors. They range from factors that can be controlled, such as what you eat, how much you exercise, and how you interact with others, to factors that are unalienable, such as ethnic group, familial genes or traits, sex, age, etc.

Individuals can control certain risk factors, yet they may still practice bad habits causing them to develop cardiovascular diseases. For example, the way someone eats directly correlates with risk factors such as hypertension, high blood pressure, and high cholesterol. These can be maintained through efficient dieting. Dieting helps a person manage what they ingest daily, and this process allows them to keep their health, which in turn limits the possibility of them developing cardiovascular disease. "High blood pressure is a major modifiable risk factor for heart attacks ... and premature cardiovascular death" [13].   Obesity is another risk factor that can lead to cardiovascular disease. Obesity can be stalled or halted through regular exercise or physical activity. Obesity can cause shortness of breath, and is a condition that worsens other factors such as hypertension, cholesterol, and diabetes. Hypertension is an easily influenced factor because the causality of high blood pressure and heart disease is closely connected, and heart disease has many risk factors. "Uncontrolled high blood pressure can result in hardening and thickening of your arteries, narrowing the vessels through which blood flows" [8]. The choices people make every day from purposely putting themselves in stressful situations to addicting habits like smoking affect hypertension and their chances of developing heart disease. These factors can be regulated in everyone's daily life if they are willing to take steps and are physically able to do it.

There are risk factors that you can't control because you are born with them and cannot change them. Factors like age and sex or gender play a part in calculating the chance of cardiovascular disease diagnosis. "Heart disease is the leading cause of death in the United States, accounting for 261 deaths per 100,000 men and 273 deaths per 100,000 women" [12].   It can be inferred that women have a slightly higher death rate from cardiovascular disease than men in the United States. Age plays a significant role in determining the probability that a person can develop a CVD. The older a person becomes, the more susceptible to cardiovascular disease they become. Older people are also more likely to be diagnosed with other illnesses like hypertension or diabetes, which in turn increases their probability for contracting heart disease. The ethnic group a person is born into is also a risk factor that cannot be changed or monitored because their genes determine that they may have elevated blood pressure, cholesterol, or slower than average metabolic rates. Whether a person is Black, Mexican, or Caucasian, their ethnic group is equally affected by CVDs in their respective communities. "Among Hispanics, heart disease is the leading cause of death, representing 29% of all mortality and accounting for 192.4 deaths per 100,000 men and 129.1 deaths per 100,000 women in 2007" [12]. From the data, it can be deduced that Hispanic men suffer from CVDs more than Hispanic women. These traits characterize an individual from birth and are present with them throughout life and they pass them on to the next generation.

4 Data and Mathematical Modeling

Cardiovascular disease is the leading cause of death in the United States, and a major issue around the world. From an internet search we found some annual data for CVD deaths in the United States [5], as shown in Figure 1.

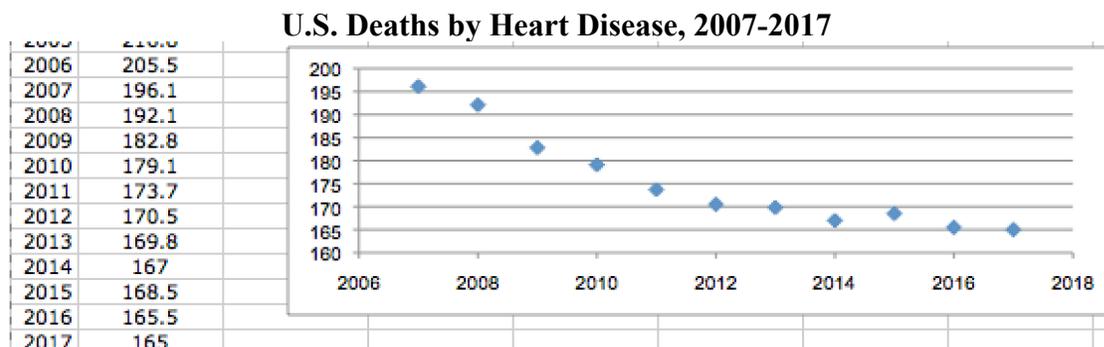|		U.S. Deaths by Heart Disease, 2007-2017
2005	210.0	
2006	205.5	
2007	196.1	
2008	192.1	
2009	182.8	
2010	179.1	
2011	173.7	
2012	170.5	
2013	169.8	
2014	167	
2015	168.5	
2016	165.5	
2017	165	

Figure 1. Spreadsheet graph for heart diseases death data 2005-2017 [5].

Because the decreasing curve of Figure 1 is vaguely exponential, a reasonable model can be made using the differential equation $y' = k\,y$, which assumes that the rate y' of deaths is proportional to the population y. The solution is an exponential function,

$$y = Ce^{kt},$$

which has two parameters, C and k.

We found a reasonable fit to the data curve by setting $t = 0$ in 2011, when $y_0 = 173{,}700$, and $t = 1$ in 2012, when $y_1 = 170{,}500$. The following calculations determine C and k.

$$173{,}700 = Ce^{k(0)} = C,$$

and

$$173{,}700 = 170{,}500e^{k(1)},$$

$$e^k = 173{,}700/170{,}500$$

$$k = \ln(173{,}700/170{,}500) = -0.01859.$$

Therefore

$$y = 173{,}700\ e^{-0.01859t}.$$

The results are shown in Table 1 and Figure 2.

year	deaths per 100,000 population	t	predicted value
2007	196.1	-4	187.1
2008	192.1	-3	183.7
2009	182.8	-2	180.3
2010	179.1	-1	177.0
2011	173.7	0	173.7
2012	170.5	1	170.5
2013	169.8	2	167.4
2014	167.0	3	164.3
2015	168.5	4	161.3
2016	165.5	5	158.3
2017	165.0	6	155.4

Table 1. Annual data for CVD [5], and predicted values from model.
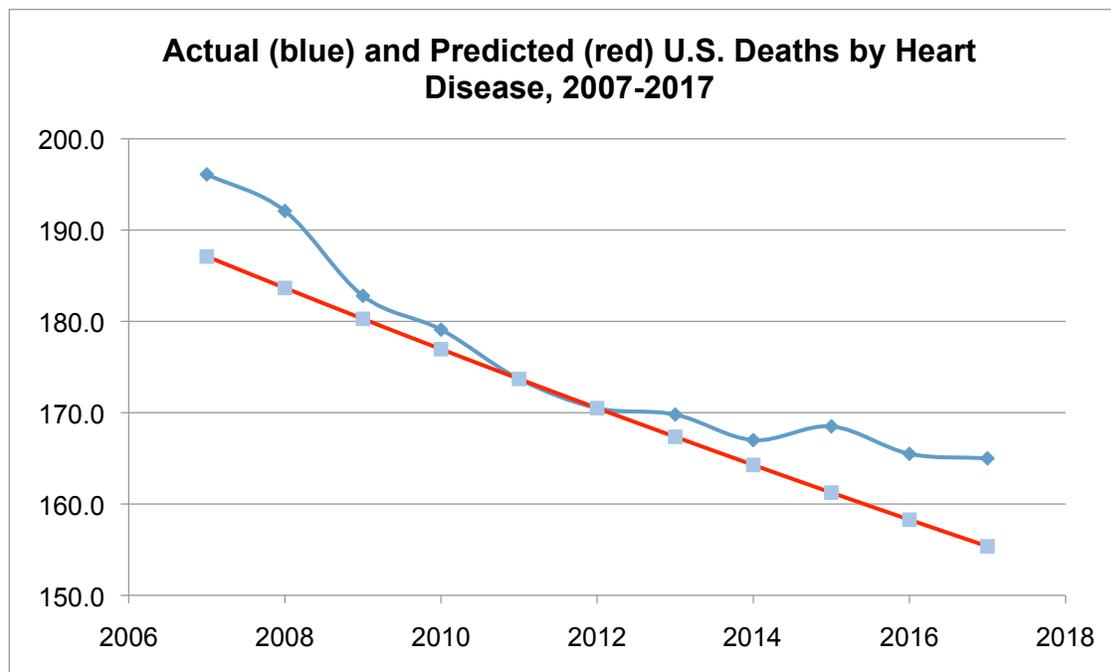
Figure 2. Graphs from spreadsheet for actual and predicted
heart diseases U.S. death data 2007-2017 [5].

We note in Figure 2 that the annual death totals do *not* continue the downward exponential trend. While the data still is decreasing overall, it is at a slower rate. We will offer suggestions that could bring the decreasing rate down faster again.

5   To Continue Bringing Down the Numbers

A solution to continue and even improve the downward trend of the graph in Figure 2 would be to adjust the accessibility of healthy foods from places like farmers' markets and neighborhood gardens in the country. This is a subtle solution that requires the commitment of all people concerned about their own health and the health of others. Gardens and farmers' market create places where individuals would learn how to use their resources appropriately and make healthier food choices, instead of buying fast food because cooking costs too much. This solution decreases risk of hypertension and high cholesterol, which are some the main reasons for cardiovascular disease. The upkeep of the gardens creates more jobs and a sense of community within neighborhoods, which is much needed in the state of harsh, brutal societal tension that exists today.

Another solution is to mandate that children in schools be in at least one active club and that businesses create exercise regimes for their employees. This solution can be seen as radical, but the extra exercise and effort needed to completely participate in these activities decrease the chance of high cholesterol in individuals. The curve of the graph would decrease by getting the large and growing number of obese people in the country to

become more active; it would be a means to be a better participant in society and to operate successfully in their lives.

There is a continuing epidemic of heart disease cases in the United States and steps need to be taken to save the lives of people now and be proactive for others in the future. Without any effort taken, the number of people dying from this disease will continue to be too high because of the neglect of a simple issue. The health of all individuals is important, and we need stay healthy and make wise decisions to continue living prosperous lives.

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