

Machine learning and Natural Language Processing Applications in Health

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Abstract—One profound statement in the sciences read, **When you stop doing things that make people sick, they get well. History provides evidence about the diet for humans. It is proven that the bulk amount of calorie intake came from starch. Geographically the people of Aztecs and Mayans are known as the people of the corn, further South at the Incas lived on potatoes except when they went to battle made a switch to quinoa. Middle East people are known as the breadbasket of the world. In Asia, it is a predominantly rice-based diet. A reflection on the characteristics of these people – trim, hearty, healthy, strong. It behooves us to consider the question what food habits do great civilizations have in common? As people became more effective in gathering calories and with the industrial revolution and discovery of fossil fuels, people became wealthy and no longer depended on starches – plant-based diets. Instead, they ate the animals that fed on a plant-based diet (grass, legumes, or silage), and the plant-based diet became a side dish. An examination of their bodies later showed heart-related diseases, cancer, chronic kidney diseases, high blood pressure, high cholesterol, and more. Conventional medicine has failed in addressing some of the diseases most of which have resulted in chronic ailments.**

Index Terms—Health, Machine Learning, Medicine, Data

I. MOTIVATION

Conventional medicine needs to integrate with Functional Medicine and fill the gap that conventional medicine does not address. Conventional medicine has high medical costs; CAM is becoming more popular with patients. The lack of integration from the health care provider (physician, hospitals, insurance companies) level resulted in inadequate access and poor quality care. To create less costly and holistic health care, emphasis should be put on effective training. Functional medicine can build the bridge that connects the conventional and CAM into a new health care system. This new approach requires the highest level of support from healthcare providers. Modern health care progresses from a disease-based treatment to a more patient. centric approach that addresses biochemical individuality to improve the overall health. We are analyzing the challenges of functional medicine’s clinical decision-making practice compare to human decision-making and identifying solutions to improve them. Evaluation of Successful Functional Medicine practice can be achievable from a real solution to the chronic disease crisis we are facing today. The functional medicine practice demands identifying root cause of the diseases.

II. INTRODUCTION

Our analysis will delve into the need for more functional medicine practitioners and analyze the reasoning behind why

it should be more accessible. A rise in chronic and debilitating diseases over the past few decades have led to growing public interest in non-conventional approaches to healthcare. Functional Medicine is a growing movement because it keeps us healthy rather than keeping us alive. Essentially, it treats the root cause of the symptoms rather than the disease. Functional Medicine teaches us how to listen to our body and how to live our life well. Currently, it is not accessible to most people because there are far and few functional medicine practitioners and even fewer that accept insurance.

Our society is seeing a sharp rise in the number of people suffering from complicated chronic diseases. Presently, 6 in 10 Adults in the United States have a chronic disease. This is the leading causes of death and leading drivers of the Nation’s \$3.8 Trillion in Annual Health Care Costs. With that figure predicted to grow, clearly something is lacking from the one-size. fits-all paradigm of traditional medicine. Caring for this new population requires an entirely different mindset; this is where functional medicine steps in. Functional medication can help prevent disease thus potentially proving to be more cost-effective for the insured and insurer overall in the long term. However, there are approximately 1400 functional medicine practitioners across the U.S., and a little under 350 that accept insurance. Additionally, there is an even smaller number of functional medicine practitioners outside the United States. The number of functional medicine practitioners are limited because there is not enough research, development, or data to support the need for additional practitioners. As a result, insurance companies do not cover the medical costs accumulated from visits to functional medicine practitioners. Thus, most Americans has to pay the entire out-of-pockets costs for seeking out functional healthcare, which makes it more expensive and out of reach to the average person. For context, among U.S. adults 43.4% were inadequately insured and 12.5% uninsured. Functional medicine will not only benefit those who need care the most (those suffering from chronic, debilitating diseases) but also anyone at risk of developing these diseases.

III. LITERATURE REVIEW

Statistics show that both adult and children are suffering from rich Western Civilization dietary habits – 30% of kids are overweight with arthritis, atherosclerosis. With a fast forward life span, most of these kids experience precocious puberty between ages 8-9. We have a healthcare system where diseases

and for that matter patients are seen by insurance companies as goldmines and 20% of the gross national product is expected to be spent on illness. “As an insurance company we take a Piece of the pie and the bigger the pie the more we get”. Today, obesity and diabetes are twice what it was in the 70s. By focusing on mortality and the health status of a population, we highlight the concepts of child mortality and life expectancy rates, which are based on mortality estimates. At a global level, the largest burden of diseases stem from heart related issues and it accounts for 15% of the total. Health data in social media can show the society opinion about homeopathy [1]–[18] [?]. If the hypothesis proves to be true in being efficient in driving the stock market on specific stocks on the specific stocks, it could be then be used for helping on predicting the market for investors, or the other way around, to prevent people from buying such mentioned ones [19]–[22]. Fake online medical information affect the drug industry and customer satisfaction [23]–[25].

Natural language processing models in Bioinformatics can show the bias view of conventional medicine [26]–[28] [29]–[36].

Several aspects of medicine are in practice Integrative Medicine, Standard Medical Care 3 (Conventional Medicine), Complementary Medicine and Alternative Medicine. Functional medicine is one of many different areas in Complementary Alternative Medicine CAM. CAM is a term for medical products and practices that are not part of standard medical care. It is an aspect of integrative medicine, which includes - Traditional alternative medicine that have been practiced for centuries with proven results e.g. acupuncture, homeopathy, naturopathy, and Chinese or oriental medicine. Diet and Herbs, for that matter plant-based diet attempts to balance the body’s nutritional well being.

Conventional medicine uses a specific approach to identify specific areas within different segments of medicine. It identifies the causes of diseases without a wholesome, systematic, and fundamental law of biology than governs the functionality of the body. Functional medicine uses concepts of science to understand the cause of diseases; therefore, it treats the whole system and not just the symptoms.

Unfortunately, conventional medicine lacks the right approach and methodology to cure and prevent chronic diseases that are on the rise in our modern Western Society because of modern lifestyle. According to Dr. John McDougall, modern medicine is not a solution to the 80% of diseases afflicting people in North America and the rest of the Western World. Functional Medicine is an evolution in the practice of medicine addresses the healthcare needs of the 21st Century.

A. Examining the correlation between nutrition and the burden of diseases

Most people are confused today about their health as they are burdened with all kinds of diseases. Truth be told heart diseases, diabetes, and obesity could be reversed by a healthy diet, what a sigh of relief would people experience! Instead, research shows that various cancers, autoimmune diseases,

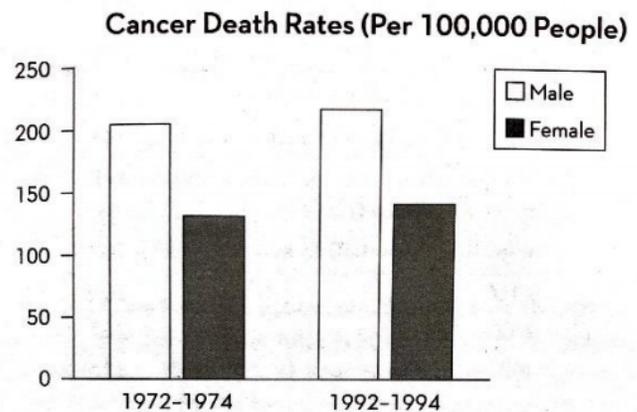


Fig. 1. Cancer Death Rates(Per 100,1000 people)

bone health, kidney health, vision and brain disorders in old age (like cognitive dysfunction and Alzheimer’s) are increasingly influenced by diet. Most importantly, the bulk amount of calorie intake for human diet – starch, whole foods, plant based diet (WFPB) has stood the test of time and proven to reverse and/or prevent these diseases. The findings are consistent among certain Functional Medicine Practitioners like Dr. Mcdougall, Dr, Sprouts, and Dr. Esselstyn. Meanwhile, regardless of the powerful influence of this information, and the rising hope it generates, the urgent need for the basic understanding of health and nutrition most people remain confused. The story of how food can change and enhance our lives and livelihood has been the fate and fight of functional medicine. Health care system is too pricey and eliminates too many people and neither promotes health nor prevents diseases. There are volumes of publications on how the problem might be solved; however, progress is painstaking slow. According to the American Cancer Society, males in the United States have 47% chance of getting cancer, and females stand 38% lifetime chance of getting cancer.

Despite four decades of the fight on cancer, very little progress is recorded beyond the control, exposure or finding better cancer treatments.

Contrary to popular believe, cancer is not a natural event. However, cancer is only a part of the big picture of adverse diseases and deaths rate in America. On the broad scheme of things and following the overall pattern of poor health, there is a growing number of morbidly overweight individuals. According to National Center for Health and Statistics, one third of adults, 20 years and over are morbidly obese and with growing trends among children of 2 years of age.

Cancer and obesity are not the only pandemics; there is a trending high-rise in the rate of diabetes. If we ignore to heed the importance of Functional Medicine and Practitioners, and the need for the importance of proper dietary needs, millions will suffer effects of these diseases – blindness, limb amputation, cardiovascular diseases, kidney diseases, and ultimately premature death. The most dramatic recent findings are that almost close to 100% of heart diseases can be prevented and

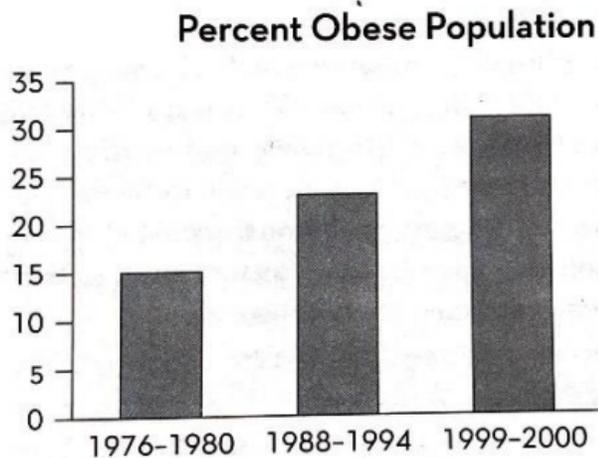


Fig. 2. Percent Obese population

Number of Americans Per Year Who Die From:	
Medication Errors ¹⁵	7,400
Unnecessary Surgery ¹⁶	12,000
Other Preventable Errors in Hospitals ¹³	20,000
Hospital Borne Infections ¹³	80,000
Averse Drug Effects ¹⁷	106,000

Fig. 3. Death by Health Care

even reversed by healthy diet.

By embracing the evolution of functional medicine, we will by all mean experience this revolutionary information and collectively defeat and over this pandemic plaguing our lives and livelihood. A publication by Barbara Starfield, MD states that physician error, medication error, and adverse effects from drugs or surgery were killing 225,400 people per year.

Indeed, there is no doubt that conventional medicine is continuously failing our society, and these charts calls for a war cry for long haul of functional medicine and increased vigilance in medical care. One thing is certain, if nutrition were better understood, and prevention and natural treatment were more accepted in the medical community, the outpour of toxic and potentially lethal drugs into our bodies would be the last resort at the stage of disease. We would not be searching for new medicine that alleviates the symptoms and does nothing to address the fundamental causes of illness.

We would not be spending more money on developing, patenting, and commercializing “magic bullet” drugs that often cause additional health problems. As observed and well known, the current medical system has not lived up to its Hippocratic Oath to do no harm, but rather fervently failed the community at large. It is time for a paradigm shift toward a broader perspective on health, one that eliminates conventional medicine and promotes an accurate comprehension that the

same nutrition that prevents disease in its early 5 stages can halt and reverse disease in its latter stages. Thus, good nutrition propels health in all areas of our existence. All parts are interconnected – the mantra for functional medicine practitioners.

B. analyzing the limitations to the conventional approach of medicine (the role of politics and the lack of training)

The irresponsible acts of leaders in the healthcare community is a major setback for years. It is arguable that the amount of funds available to drugs, genes, devices, and technology research will not cure chronic diseases invading our communities. In addition, isolated chemical in drug form can be very dangerous. “What is clear is that most of our current treatments will produce some measure of adversity”, stated by the National Cancer Institute. The dangers to conventional medicine is far left from the benefits of eating healthy diet, and massive cost savings on either the treatment or prevention of diseases. It is mind bugging to understand why the government ignores the abundant scientific research in supporting a dietary approach in favor of largely ineffective, potentially dangerous drug and device interventions.

The medical status quo relies heavily on medication and surgery to the exclusion of nutrition and lifestyle. Doctors have virtually no training in nutrition and how it and how it related to health. Nutrition training of doctors is not merely inadequate; it is practically nonexistent. The 1985 National Research Council report found that physicians receive, on average, twenty-one classroom hours (about two credits) of nutrition training during the four years of medical school. In other words, nutrition is often not taught in relation to public health problems, like obesity, cancer, diabetes etc. In conjunction with the 1985 government report, the president of the American Medical Students Association, William Kassler writes: “Most nutrition in the formal curriculum is incorporated into other courses. Biochemistry, physiology, and pharmacology are the courses most often alleged to contain some nutrition instruction. Too often in such courses, nutrition is touched on briefly with primary emphasis on the major discipline”. One survey found “a shortage in nutrition-oriented physician role models is probably the major constraint in teaching nutrition to residents. According to John Mcdougall, the medical profession has lost its credibility: its ties to the drug industry. Medical education and drug companies have been in bed for quite some time.

C. The agony of functional medicine practitioners

There is growing resistance and fight from the practice of “Big Medicine” to Functional Medicine Practitioners and nobody has a better experience than Dr. John Mcdougall. His experience confirms every study that has found nutrition training among physicians to be sorely inadequate. Dr. John had great success in his early practice as a physician. He taught nutrition and used nutrition to treat his patients. Later in his practice, he had clashes with other doctors in the hospital where he practiced. One significant moment of friction

between John and the hospital where he practiced involved Dr. Roy Swank's multiple sclerosis program. According to the story, John contacted Dr. Roy on merging his MS program with the hospital where he, John practiced, upon learning that Dr. Roy was retiring. To much of John's excitement, he took the proposal to the head of his department. John was dumbfounded about the many unreasonably answered questions he received. In a tense moment, Dr. McDougall expressed his agony saying, "Wait a minute! I am a doctor. This a hospital. As far as I know, our job is to relieve the suffering of the sick. These are sick people. Just because other doctors cannot help them does not mean we cannot. Moreover, here's proven evidence that we can". John demanded an explanation why the hospital did not want to take care of MS patients.

It is just so gripingly unbelievable to think that we are being led around by people who refuse to believe the obvious! "Of all the forms of inequality, injustice in health care is the most shocking and inhumane" – Dr. Martin Luther King Jr. (Speaking before the National Convention of the Medical Committee for Human Rights in Chicago, IL on March 25, 1966). For certainty, those who need functional medicine the most are not receiving this care.

IV. PROPOSED APPROACH

In this project, we will evaluate the correlation of between nutrition and burden of diseases. We expect to find that a nutritional intake that aligns with a plant-based diet will correlate to lower communicable, maternal, neonatal, nutritional, and non-communicable burden of diseases. We expect to see this pattern continue across the demographic and geographic variables over the span of the 25 years of data available.

We have gathered our dataset from the Global Dietary Database (GDD), The GDD 2015 Beta Version. The GDD is an initiative of Tufts University's Friedman School of Nutrition Science and Policy. The GDD compiles data across multiple surveys to identify and model nutritional intake around the world. The data we will explore in our project is current through 2015 and is the most up-to-date version of the dataset available. The dataset dates as far back to 1990 and was collected in increments of five years, providing data over a span of 25 years. In addition, the dataset provides data on the nutritional intake across demographic, dietary, and geographic variables.

The data was provided in a ZIP file, containing various excel spreadsheets grouped by country, region, and global estimates. Within the file, we can find there is data for 187 countries across seven regions. Notably, the dataset includes the former Soviet Union and western high-income countries as their own regions. As there are approximately 195 countries, apart from disputed territories, we can see that there is no data available for some countries. For example, we can see that Western Sahara is not included in the dataset.

As we are evaluating plant-based diets specifically, we must note that nutritional intake is presented through the following variables: fruits, non-starchy vegetables, beans and legumes,

nuts and seeds, unprocessed red meats, sugar-sweetened beverages, fruit juice, total milk, total protein, calcium, and potassium. We will evaluate plant-based diets with a focus on plant foods that will include the fruits, non-starchy vegetables, beans and legumes, nuts and seeds variables. In addition to geographic and dietary variables, the dataset includes other demographic variables. Age is grouped into incremental sets of 4-5 years, as well as some files including a view of all ages and a comparison view of children versus adults. Other demographic variables include education level, urbanization (rural, urban), and sex. We will also reference data that gathers the burden of diseases. Burden of diseases is a way to assess the quality of health due to diseases. The data from Our World in Data provides distribution of the burden of diseases across the globe and breaks down into the cause and type of diseases as well. We will use the visualizations provided from our analysis to compare to the visualizations that represent the Burden of Diseases to draw our conclusions.

A. Proposed method for evaluation

After initial perusing of the GDD dataset, we have determined there are no null values in any of the files provided. This will allow us to spend less time cleaning the dataset and dive right into our statistical analysis. We will begin this process by using R for gathering descriptive statistics of our categorical and numerical values. We will use both a categorical and quantifiable approach to evaluating the data. We will iterate this process for each dataset, using a top-down approach beginning with the global data followed by the region-specific data, and finally down to our country specific data. Since we are specifically evaluating the data available for the United States, we will focus our analysis on the relevant data but we will use the data for other countries to compare to our rates of diseases and nutritional intake. We will supplement the top-down approach to each file by the year the data was collected and then evaluate over the 25 years of available data. This will deliver the data points for each variable, each year the data was collected and the trend of data points. We will also use python to pull some of our trending visualizations.

We will follow up with outlier analysis to determine which values across the dataset remain well outside the normal range of values. Followed by using heat maps to identify correlations of different variables. We will also use Tableau to create the visualizations that project the data across the explored regions and countries.

B. Preliminary results

We began analyzing the GDD data by using python for gathering descriptive statistics of our categorical and numerical values. As we are working with several workbooks from GDD, we applied a top-down approach to analyze the datasets. We started analyzing the global datasets that encompass data across all nutritional and demographic fields.

Our initial exploratory analysis found correlations with related nutritional fields over the 25 years of data collection. For example, we can see that consumption of fruits

has a positive correlation with the consumption of beans and legumes. However, fruits also have a stronger positive correlation with the consumption of unprocessed red meats. Another observation is that nuts and seeds show as having the lowest correlation among all the other nutritional fields. Since these fields are evaluated very broadly without exploring the demographic attributes and how they play in tandem with consumption, the analysis does not give too much away.

However, when we evaluate the data across all demographics and over 25 years, we can see clear trends in the consumption of certain nutritional fields. Most notably, we can see a drastic decline in the consumption of non starchy vegetables. There is a difference of nearly 40 grams per day less consumed than in 1990 than in 2015. The consumption of fruits and unprocessed red meats have been steadily declining over the years. Other nutritional fields, such as beans and legumes, nuts and seeds, and fruit juices show a steady pattern in consumption. The only nutritional field that shows a steady increase in consumption at a global scale over the past 25 years is sugar sweetened beverages.

Going forward, we will iterate this process for each dataset using a top-down approach. The next datasets we will analyze are the region specific data, and then country specific data. We will also evaluate the data against the demographics captured too. We will then move into analyzing the correlation between the GDD datasets and the Burden of Diseases to draw our conclusions. We will also use Tableau to create the visualizations that project the data across the explored fields.

V. MY CITES

cites [37]–[44], [44]–[51]

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