THE CURRENT STATE OF NUTRITION AND NUTRITIONAL SUPPLEMENT TRAINING IN MEDICAL SCHOOLS

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To a great degree the successful completion of this dissertation represents a lifelong pursuit being fulfilled. It's not necessarily within the topic itself or even within the degree itself, so much as it is having the opportunity to tie multiple aspects of lifelong personal interests, elements of my career in health care and prior education together.

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Title of Study: THE CURRENT STATE OF NUTRITION AND NUTRITIONAL SUPPLEMENT TRAINING IN MEDICAL SCHOOLS

Major Field: HEALTH, LEISURE & HUMAN PERFORMANCE

Abstract: The purpose of this study was to examine the current state of nutrition and nutritional supplement training in US Medical Schools. For the purposes of this study, nutrition training was defined as training within the categories of basic nutrition topics such as healthy eating, essential vitamins and minerals. Nutritional supplement training is reflective of training over nutritional supplements that fall outside of the essential vitamin or essential mineral realms.

Objectives: The objective of this study was to compare the percentage of medical schools (allopathic & osteopathic) that had nutritional training as part of their core curriculum to medical board performance. This includes a review of Basic Nutrition (Vitamins & Minerals), as well as Advanced Nutrition coursework that includes training on nutraceuticals (Advanced Nutritional Compounds).

Methodology: The methodology utilized in this research was qualitative. This was deemed as a much more appropriate method, due to the aim was to review and affirm the existence of nutritional education within specific medical school curricula. It was deemed additionally appropriate in the aim to describe and stratify the levels of training within individual medical school curricula. Evidence of explicit and implicit education tied to Basic Nutrition was derived by a review of each Medical School Program's published curriculum.

Due to the limited population, the choice to review all programs was more desirable than simply taking a statistical sample. This also allowed for a review of variance between Allopathic and Osteopathic programs, as well as more recently established programs (Post-Y2K programs) versus earlier established programs (Pre-Y2K programs).

Research: Conducted research concluded that basic nutrition training within medical school programs was absent in 62.5% of programs. 9.5% of programs imply the inclusion of such training within their curriculum. 3.5% of programs offered it as an elective course. 24.5% of all programs explicitly required basic nutrition training within their curriculum. 0% of medical school programs examined were found to have nutraceuticals or advanced topics in nutrition within their curricula.

Conclusions: Physicians being the most trusted and reliable source of nutritional guidance are limited by the lack of education received during their medical school training. The drivers behind this need to be further explored.

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CHAPTER I

INTRODUCTION

1.10 Background

Dietary supplement usage continues to rise among Americans, both in the number of users, as well as the array of nutritional products being used (CRN Consumer Survey, 2019). In 2018, sales in the US were $42.6 billion (Watson, 2019), and a recent GAO report estimated approximately 80,000 nutritional supplements on the market with ongoing growth anticipated annually (GAO, 2017). This entails not only basic vitamins, minerals and meal replacement products, but also the consumption of herbal and other advanced nutritional compounds (CRN Consumer Survey, 2019).

One of the most commonly displayed guidance noted on nutritional products and supplements is the recommendation that the consumer consult with their physician prior to taking their product. While this would seem to be wise guidance and a prudent recommendation, it begs the question as to how well physicians are trained in the form of basic nutrition (basic vitamins and minerals), but also within nutraceuticals (nutritional products) and their potential interactions and benefits for patients.

There is ample evidence to support a generalization that there is a deficit of basic nutrition education within medical schools as a whole (Aggarwal, et al., 2018) (Vetter, Herring, Sood, Shah, & Kalet, 2008). This is primarily focused on a lack of general nutrition education addressing basic diet (calorie sources and dietary guidelines), vitamins, minerals and metabolic matters. The rise in obesity related diseases, especially cardiovascular disease, have been attributed to a deficit in basic

nutrition knowledge among physicians, including cardiovascular disease providers. It has been suggested that the lack of knowledge in basic nutrition results in less patient education and counseling from physicians (Aggarwal, et al., 2018).

Anecdotally several leading physicians have become very outspoken on both the lack of and very limited training on topics relating to basic nutrition received during medical school. One such individual is Dr. Steven Devries, a preventive cardiologist who serves as the Executive Director of the Gaples Institute for Integrative Cardiology. Dr. Devries is also Associate Professor of Medicine at Northwestern University in Chicago. When asked about the nutrition training he received in medical school, his answer was that he received "essentially zero" training in medical school (Abassi, 2018). This left him with a knowledge deficit with patients he sought to guide to better health. As both a professor and practicing physician, he notes that the "incredible deficiency in nutritional education" still exists today among practicing physicians (Abassi, 2018).

The majority of noted deficiencies in nutritional education are associated with fundamental training in basic nutrition. This includes education associated with basic dietary requirements and sources of nutrients, as well as the function of basic energy sources (proteins, fats and carbohydrates). It also includes topics on major vitamins, minerals, and the role of diet in chronic diseases, such as cardiovascular disease, cancer, diabetes, etc.

1.20 Objective

The primary objective of this study is to evaluate the existence and associated method of training, of both basic and advanced nutrition within medical schools located within the territorial United States. This objective is based on a review of published curricula of accredited medical schools, including both Allopathic (MD) and Osteopathic (DO) programs. The outcome of this

research assesses the level of training in contrast to the rising use of nutritional supplements and nutraceuticals by the general public.

1.30 Statement of the Problem

The backbone of American healthcare is inextricably linked to the program quality and curricula in which physicians are trained. This is true of both Allopathic (MD) and Osteopathic (DO) programs across the nation, which are the two approved pathways for training to become a licensed physician in the United States.

Both Allopathic (MD) and Osteopathic (DO) programs must be accredited before they can accept students. Allopathic (MD) programs are subject to the requirements of the Association of American Medical Colleges (AAMC). They are required to follow the prescribed elements of training in order to achieve and maintain accreditation for their program. Osteopathic (DO) programs are subject to the requirements of the Commission on Osteopathic College Accreditation (COCA). Neither of these programs require a basic nutrition course as either a prerequisite or a core requirement for curricula. From an accrediting stance, nutritional training is optional and is left to the discretion of each university (COCA COM Continuing Accreditation Standards Revision 2019, 2019) (Henien, Jackson, Mortenson, & McKean, 2010).

Contrasting the optionality of nutritional training for medical school accreditation to the rising consumption and utilization of over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds, this leads to the question of how well-trained and prepared physicians are when it comes to giving guidance on their utilization to their patients. This includes not only the actions, dosage, efficacy and side effects, but also potential interactions with existing prescription medications being taken by their patients.

The lack or limited nutritional training within medical schools is at odds with the needs of patients who are increasingly more likely to face the impact of diet related diseases (Broad-Leib, et al., 2019). In fact, dietary factors are the single leading cause of death and exceed the impact on health tied to smoking (Afshin, et al., 2019). From a public health perspective, this has been deemed to be "low hanging fruit" (Devries, 2019) within the practice of medicine and one that unfortunately continues to remain unresolved. A global study conducted over 27 years within 195 countries, including the United States, concluded that the current state of nutritional education within medical schools is inadequate (Devries, 2019).

When it comes to guidance on diet and nutritional topics, patients put the most confidence in their physicians (2018 Food & Health Survey, 2018). This is troubling in that training in medical school on even basic nutrition is limited (Vetter, Herring, Sood, Shah, & Kalet, 2008). Training tied to advanced topics beyond a basic diet, vitamins and minerals would no doubt suffer an even greater deficit.

One method to garner details on basic nutritional training comes from asking residents themselves. A study published in the Journal of the American College of Nutrition determined that while there is a rising need for nutritional counseling for patients, only 14% of residents surveyed felt they were adequately trained to provide nutritional counseling (Vetter, Herring, Sood, Shah, & Kalet, 2008). Despite the scarcity of nutritional education within most medical schools, a recent study found that interest among medical students in nutritional training is uniformly high (Devries, 2019).

The essence of the overall problem is that while the consumption and usage of over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds continues to rise among the average American, training opportunities remain limited. This appears to be certainly the case for general nutrition and would translate to even less available training within

advanced nutrition. Ironically, despite the higher confidence in advice from a physician, there's very little difference in opinion and guidance on diet and nutrition from that of the general public (Leeman, Fischler, & Rozin, 2011).

1.40 Purpose of the Study

The purpose of this study is to gauge the level of basic and advanced nutritional training within current medical schools. Basic nutrition is also referred to as general nutrition and encompasses education tied to diet, metabolism, energy sources and includes topics linked to basic vitamins and minerals. Advanced nutrition encompasses topics which go beyond the basics and include herbs, amino acids, dietary supplements and advanced nutraceutical compounds.

While neither basic nor advanced nutritional training is required by credentialing bodies of medical school curricula, the ongoing rise in consumption of over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds by patients is quite evident. It also remains quite evident that resident physicians do feel as though they did not receive adequate education on the use of herbal and dietary supplements (Foster, Corbin, Kwan, & LeClair, 2018).

This study will also be an evaluation of how well current medical schools are equipping new physicians, via training and/or tools, to reconcile over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds taken by their patients. This also relates to the ability to offer well-informed guidance towards the actions, dosage, efficacy, side effects and potential interactions with existing prescription medications being taken by their patients.

1.50 Significance of the Study

The objective of this study is to assess the readiness of current physicians in offering effective guidance to their patients on topics tied to the ongoing rise in consumption of over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds by patients.

1.60 Primary Research Question

The aim of this investigation was to find support for the research hypothesis, which states that nutritional training within medical school is curricula adequate when it comes to physician's ability to address nutritional topics with patients. Adequacy is defined as the existence of a course of a basic nutrition course that is required within the core curriculum. The core aim was to determine the current state of basic nutrition training within medical schools across the United States.

Null ($H_0 1$): All medical school programs in the United States require a course in basic nutrition as part of their curricula.

Alternate ($H_a 1$): Not all US medical schools require coursework in basic nutrition in their program.

1.65 Secondary Research Questions

1) Do Allopathic (MD) and Osteopathic (DO) programs both have the same focus on basic nutrition education?

Null ($H_0 2$): There is no difference between Allopathic (MD) and Osteopathic (DO) programs in their focus on basic nutrition education

Alternate (H_a2): Allopathic (MD) and Osteopathic (DO) programs do have a difference in focus on basic nutrition education as part of their curriculum.

2) Are there any regional variances between programs and their requirements for basic nutritional education within US medical schools?

Null ($H_0 3$): There are no regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.

Alternate ($H_a 3$): There are regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.

3) How do older more established programs (programs established prior to year 2000) compare to newer programs (programs established in year 2000 and later) when it comes to the inclusion of nutritional training?

Null ($H_0 4$): No disparity exists between newer programs versus older more established ones in the focus on basic nutrition training within their programs.

Alternate ($H_a 4$): A disparity exists between newer programs and older more established ones in the focus on basic nutrition training within their programs.

4) How many programs offer training in nutraceuticals that includes advanced nutritional topics tied to herbs and other advanced nutritional compounds?

5) Do any programs require a course of nutrition be taken as a prerequisite to admission into their medical school program?

1.70 Disclaimer

The research was conducted following the proper acceptance and approval of the Chair, Advisor and other PhD Committee members. The information covered throughout this dissertation

has been used with the assurance that copyright and plagiarism matters have been fully covered. The research report was produced with intention not to be exhaustive. Any distribution of the research report is subject to the condition that it shall not, in any way of trade or otherwise, be resold, lent, or circulated on a commercial basis without the prior approval of both the Chair of the Advising Committee and researcher.

1.80 Structure of the Report

The structure of this report has been designed to follow the chapter structure noted below:

Chapter 1: Introduction

This is the introduction to the dissertation which contains the pertinent background, scope and overall objectives of the research.

Chapter 2: Literature Review

This chapter is a discussion of prior research studies relating to topics associated with trends in basic and advanced nutritional training in medical schools. An exploration and review tied to the history of physician training in the United States is included for context. This includes a survey of the differences and commonalities between Osteopathic (DO) and Allopathic (MD) training programs.

The literature review examines current trends in the use of consumption of commonly utilized over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds by the average American. It also offers an illustration of examples of research tied to the impact of over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical

compounds and their impact on health. This includes research on efficacy, indications and contraindications, as well as interactions with commonly prescribed medications.

A select review of a few common medical conditions noted by primary care physicians and use of prescription medication is also included. In addition, relevant topics relating to medical licensure exams, pharmacology and prescription medication statistics is also encompassed within this literature review.

Chapter 3: Research Methodology

This chapter focuses on an elaboration of the research methodology adopted for this particular research study. This is inclusive of the aspects of the research that the research methodology will encompass.

Chapter 4: Findings and Analysis

This chapter is an illustration of the findings from the adopted research methodology and literature review.

Chapter 5: Conclusion

The conclusions and recommendations are drawn from the findings and literature review associated in this research. They outline the conclusions noted in the critical analysis tools used in the current research.

1.90 Operational Definitions

Osteopathic Medicine: Osteopathic medicine is one of two approved distinct branches of medicine in the United States. Doctors of Osteopathic Medicine are referred to as DOs. Osteopathic

medicine's practice philosophy is tied to the whole person and interrelation of systems within the body. While their philosophy differs from MDs, their training and scope of practice are similar (Osteopathic.org, 2020).

Allopathic Medicine: Allopathic Medicine is one of two approved distinct branches of medicine taught in the United States. Allopathic medical school program graduates become MDs. While their training and scope of practice are similar to that of Osteopathic Physicians (DOs), their training philosophy is more traditional and less holistic than that of Osteopathic Medicine (Kowarski I. , 2019).

Basic Nutrition: This is sometimes referred to as general nutrition. For the purpose of this research, basic nutrition will refer to basic vitamins and minerals, as well as training on diet and metabolism.

Nutraceutical: This refers to food and nutritional supplement products that are akin to medicinally or nutritionally functional foods. Functional foods, nutritional supplements and herbal remedies fall into this category. The phrase nutraceutical was brought into existence in 1989 by Stephen De Felice, MD. Dr. Felice is the founder and chairman of the Foundation for Innovation in Medicine. The term has been subject to inconsistencies as a definition. For the purpose of this research, nutraceuticals are defined as nutritional and herbal compounds that are not consumed for basic nutritional purposes but are more aimed at addressing a health concern or dysfunction. They essentially are products and compound which are neither nutritionally nor pharmaceutically focused (Aronson, 2017).

USMLE: Refers to the United States Medical Licensing Examination. USMLE is a three-step medical examination for medical licensure in the United States. USMLE passage is currently required for MDs (USMLE.org, 2020).

COMLEX: Refers to the Comprehensive Osteopathic Medical Licensing Examination and is a series of three medical licensing exams that are administered by the National Board of Osteopathic Medical Examiners (NBOME). COMLEX passage is required for DOs (NBOME, 2020).

LCME: Refers to the Liaison Committee of Medical Education. This is the accrediting body for medical education for allopathic medicine training programs in the United States (LCME, 2020).

COCA: Refers to the Commission on Osteopathic College Accreditation. This is the accrediting body for medical education for osteopathic medicine training programs in the United States (Osteopathic.org, 2020).

1.91 Limitations

As noted within section 1.92, this study represents a snapshot in time of a defined population of 200. Sources of materials are publicly available, with program details such as curricula, curriculum maps and catalogs. The accuracy of the materials themselves, at the time of this study, should be noted as a limitation.

An additional limitation ties to the rating method developed for the purposes of examination of findings. This ties to the construct that a medical program that offers an explicit course encompassing basic nutrition would be deemed adequate. The rating method employed has not been validated to what level of training would truly be adequate for medical school programs.

1.92 Delimitations

This study was delimited to all allopathic (MD) and osteopathic medical school programs that were fully accredited and had an active class on or before 2019. Medical school programs were all delimited to being located in one of the 50 states, with the inclusion of Washington DC and Puerto Rico. This resulted in 200 out of the 208 accredited programs being included in this study, with the population being 200 medical school programs.

1.93 Assumptions

Throughout this study, the following assumptions were made:

1. Every medical school program curriculum posted on their website was accurate.
2. Every curriculum map reviewed within their materials posted accurately reflected their most current curriculum.
3. Class descriptions for core and elective classes accurately reflected content within the actual courses noted in each medical school's catalog reviewed.

CHAPTER II

REVIEW OF LITERATURE

2.10 Introduction

As noted within chapter 1, section 1.8, this chapter is focused on a literature review of prior research studies relating to topics associated with trends in basic and advanced nutritional training in medical schools. Relevant details tied to historic and current physician training in the United States are also included, as are other relevant details that can offer clarity to the topics at hand.

The literature review also includes an examination of current trends in the consumption of commonly utilized over-the-counter dietary aids, vitamins, minerals, herbs and advanced nutraceutical compounds in the US. A review of pharmaceutical consumption trends was also conducted.

This review also offers an illustration of examples of research tied to the impact of vitamins, minerals, herbs and nutraceutical compound utilization, with a focus on their impact on health. This includes research on efficacy, indications and contraindications, as well as interactions with commonly prescribed medications. A review of a select number of common medical conditions noted by primary care physicians and use of prescription medication is also included.

2.15 Brief History & Overview of Physician Training in the United States

Early medical education curriculum at most schools included botany (Slawson, 2012). The study of botany within early medical schools was tied to the identification and uses of medicinal herbs for the treatment of patient maladies (Zunic, Skrbo, & Dobraca, 2017). In fact, botany was required at most medical schools until a shift in trends which started in 1860's. Botany taught during the early years at medical schools was sometimes synonymously referred to as "Homeopathy". While there are differences between the two fields, both served as precursors to modern day pharmacology (Slawson, 2012).

By the 1890's medical schools shifted their curriculum away from botany and towards with a focus on pharmacology. This was primarily due to advances in legitimizing the science behind it and the development of more predictable and safer drugs. Prior to this time, medicines were concocted most often with a mixture of "empiricism and prayer" (Lesney, 2000). Botany and homeopathy were the early predecessors to pharmacology. The focus and inclusion of botany within early medical training included the identification of plants and their medicinal uses. Homeopathy encompassed realms similar to botany, but also extended into none plant realms. While pharmacology was a discipline and profession for decades, governance over the approval, use and overall business of selling medicines was unregulated. Pharmacists at that time were in steep competition from an array of others who were making their fortune selling medications to a growingly willing and trusting public (Rutkow, 2010).

Briefly examining pharmacy as a discipline, the first college of pharmacy in the United States was established in 1821 as the Philadelphia College of Pharmacy (USciences, 2020). Despite the rise over the years in the number of programs that later developed across the nation over the years, it was still possible to train to be a pharmacist by correspondence even in the early 20th century (The Practical Druggist Institute, 1917).

During the 19th and early 20th century, there was not a great deal of regulation or oversight tied to medications that were sold to the public as regulations on most items were either marginal or nonexistent. Drugs such as heroin, cocaine and opium were marketed directly to the public. Examples of historic pharmaceutical advertisements have been included as part of this dissertation (See Appendix A through E). In the United States, it wasn't until 1914 that the Harrison Act was passed in the United States that banned the consumption of opiates and cocaine (Harrison, 1914). Beyond that, it wasn't until after the inception of the FDA in 1938 that medications began to be designated as safe for use only under the supervision of a medical professional (FDA, 2018).

One of the more common medical textbooks of its day was "A Text-Book of Physiology" by Dr. Michael Foster, M.A, M.D., LL.D, F.R.S. He served as the first Chair of Physiology at Trinity College in Cambridge, G.B. (People, 2020). His textbook became a standard work for medical training in not only Great Britain, but also with the United States (Hawgood, 2008).

In the 6th American Edition of Dr. Foster's book, published in 1895, the absence of botany, homeopathy and other related topics are rather telling. This also affirms the shift from botany as one notable chapter within the textbook was the chapter on Nutrition. This chapter included subchapters on the Statistics of Nutrition, Energy of the Body, General Nutrition and Diet. While the information within the text is certainly dated, there's a great deal of focus on the importance of nutrition and diet in achieving and maintaining good health (Foster M. , 1895).

Medical education in the United States, follows two pathways. One pathway is to train within an Allopathic (MD) program and the other is to train as an Osteopathic (DO) program. While there are distinctions between the two in their practice and training philosophy, each program leads to the same destination of becoming a licensed physician. In order to become a licensed physician in the United States, one must have graduated from a US or internationally accredited medical school. They must have a certificate of completion of a medical residency from an approved

graduate medical education program (AMA, 2018). Currently there are no other pathways for becoming a licensed physician in the United States. While licensure alone does not assure quality of care, evidence supports that it is a factor (Boulet & Zanten, 2014).

Allopathic (MD) physician programs find their genesis much earlier than Osteopathic (DO) programs. The first MD school began in 1765 at the College of Philadelphia in Pennsylvania (Fee, 2015). Given that the United States did not exist as a nation until after the Declaration of Independence in 1776, this program did not become an actual US medical school until after America's independence was achieved. Currently there are far more Allopathic physicians (MD) programs in the United States and as a result there are far more MDs in practice (AAMC, 2016).

Osteopathic (DO) physician programs started in the late 1800s by an MD who saw the need for a more patient-focused approach to medicine. Osteopathic medicine's practice philosophy is tied to the whole person and interrelation of systems within the body. While their philosophy differs from MDs, their training and scope of practice are similar (Osteopathic.org, 2020).

Osteopathic physicians are licensed to practice the full scope of medicine in all 50 states (What is Osteopathic Medicine?, 2020). In 2017, practicing DOs made up 8.4% of all practicing physicians in the United Stated (AAMC, 2017). This percentage has risen over the years with the rise in both the number of DO programs and the expansion of class size within existing DO programs (AACOM.org, 2018).

2.20 The State of Basic Nutrition Training Today

A Global Burden of Disease Study of 195 countries, published in 2019, reported dietary factors as the leading cause of death (Afshin, et al., 2019). The study included the United States and was focused on an evaluation of the consumption of major foods and nutrients within each

country. This and other well documented research on the exacerbation of dietary related diseases seem to more than hint that dietary training, as it currently exists, is either insufficient or ineffective. Diet related diseases pertain to diseases that are mostly driven by the diet of the individual and often can either be prevented or well managed with medical guidance with a focus on diet. It's worth also noting that related diseases include cardiovascular disease, diabetes, obesity osteoporosis and many types of cancers (WHO, 2006).

As mentioned in previous commentary, literature suggests that a deficit in nutritional training within medical schools exists. In contrast, this certainly seems to be at odds with the needs and health of the American public. While the United States is by far not alone, more and more individuals are either facing or feeling the impacted of diet related diseases (Broad-Leib, et al., 2019). In fact, dietary factors are the single leading cause of death and exceed the impact on health tied to smoking (Afshin, et al., 2019). From a public health perspective, this has been deemed to be more readily addressable within the practice of medicine and yet remains a going concern. A global study conducted over 27 years within 195 countries, which included the United States, concluded that the current state of nutritional education within medical schools is inadequate (Devries, 2019).

Literature supports that the lack of nutrition education is not a new development. In 1985 the National Research Council (US) Committee on Nutrition in Medical Education concluded that nutrition education within US medical schools was inadequate. The research conducted at the time included a review 45 medical schools. At the time, this represented nearly a third of all medical schools (National Research Council (US) Committee on Nutrition in Medical Education, 1985).

Several renowned physicians have also noted a greater need for nutrition education in medical school programs. Dr. Frank Lipman MD, a widely recognized leader in functional and integrative medicine, suggests that his training in medicine included less than 2 contact hours of actual education (Lawrence, 2019). This is not to be confused with credit hours. Dr. Bindiya

Gandhi, MD agrees and contends that in her estimation, nutritional training is closer to being an hour of training at best (Lawrence, 2019). Dr. Gandhi is board certified by the American Board of Family Medicine, as well as the American Board of Integrative and Holistic Physicians (Healthgrades, 2020).

2.25 How Do Medical Schools Rate Themselves?

Many see the lack of nutritional education within medical schools is an 800lb gorilla. That being stated, there is limited evidence to support that medical schools view themselves as lacking within this area of training. Such evidence only seems to be garnered by research tied to recently graduated residents (Vetter, Herring, Sood, Shah, & Kalet, 2008).

The LCME Medical School Questionnaire (Health.gov, 2020) is an annual questionnaire that includes a survey, for data collection purposes, of allopathic medical school programs (MD programs) in the US. Such data collected ties to financial data, student aid, student indebtedness and program characteristics. Within this particular questionnaire, schools also report on required and elective course topics (Health.gov, 2020). The results of these surveys are made available to the public on the AAMC website.

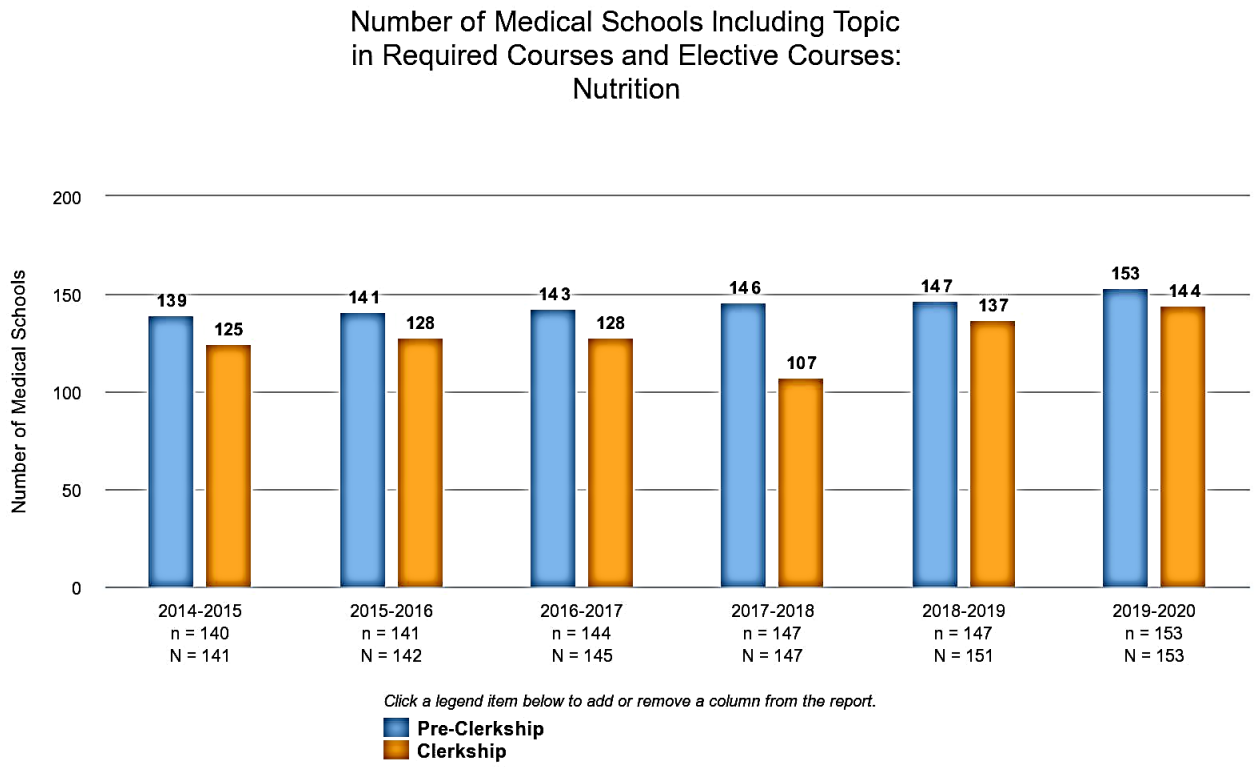

Figure 1 **(AAMC, 2020)**

An examination of the 2019-2020 survey found that 153 allopathic (MD) programs reported having either required or elective nutrition training within their program during pre-clerkship (AAMC, 2020). This is out of a total of 156 MD programs and equates mathematically to 98.1% of active MD programs. Allopathic programs also reported having the same training, either required or elective, within 144 Allopathic (MD) programs during their clerkships (AAMC, 2020). These results are also out of 156 Allopathic (MD) programs and represent 92.3% reported having elective or required nutrition training during clerkship. While no individual program data is available, it would appear that MD programs self-report as having a much greater level of emphasis than what's noted in an array of peer reviewed research and reporting. Given that the focus of this dissertation is aimed at defining the current state of nutrition and nutritional supplement training in medical schools, it will be interesting to see how this survey compares to results from the research.

Lastly, it's worth noting that no such survey was publicly available for Osteopathic (DO) programs. Efforts were made to garner such a summation, but the effort did not yield results as their reporting elements are different and not readily made available to the public.

2.30 A Review of Potential Influences on Nutrition Training in US Medical Schools

The reality that nutrition training, as either a prerequisite for entry nor as a required course, does not exist for either allopathic or osteopathic accreditation (Henien, Jackson, Mortenson, & McKean, 2010) (COCA COM Continuing Accreditation Standards Revision 2019, 2019). This in essence, makes any nutritional focus outside of a strategic aim for a particular medical school program to be almost solely just an added expense to their program. Such an expense would likely be tied to the need for additional faculty, staff and an allocation of resources which may be scarce at some universities. To expound further, from an accreditation stance, a failure to offer a required course, such as nutrition, could cost the program its accreditation. Inversely, the failure to offer non-required course would not result in the loss of accreditation.

2.31 The Influence of Medical Licensing Exams

Regardless of the training followed (Allopathic or Osteopathic), a physician cannot legally practice without a medical license in the United States which is typical for most countries. Noting such realities, it is a given that the need to assure that students are trained not only to be good clinicians, but also in the aim to assure readiness in order to pass the licensure examinations. A medical student could be at the top of his or her class and also excel clinically, but the ability to pass board exams is a determining factor as to whether or not they will at become a practicing physician. This is true of both MD and DO programs.

While there are a host of other factors that influence students making choices as to where to attend medical school, board pass rates do have some level of influence on choices students make. When it comes to medical schools, higher pass rates do reflect positively and tend to attract more applicants. Pragmatically, medical students are often drawn a bit more towards programs where graduates have a tendency to do well, or at least pass exams with greater frequency (Kowarski I. , 2019).

It has been suggested that the lack of nutritional training is linked to the lack of meaningful questions on board exams (Broad-Leib, et al., 2019). In an aim to better understand the influence licensure examinations have on nutritional education, it is worth looking perhaps at what type of basic nutrition questions are included on exams. While actual exam questions are not readily available for obvious reasons, test prep questions and illustrations are available. Looking at USMLE exam guidance, the National Board of Medical Examiners (NBME) note that questions tied to nutrition are merged into questions related to Multisystem Processes and Disorders. This includes substance abuse. Questions on the nutrition side within this realm are somewhat limited to basic vitamin and mineral deficiencies. The percentage of questions tied to Multisystem Processes and Disorders overall generally make up between 1-5% of all exam questions (NBME, 2020). Below is an illustration sourced from MEDBULLETS, which offers test prep for USMLE and COMLEX examinations.

Vitamin Algorithm

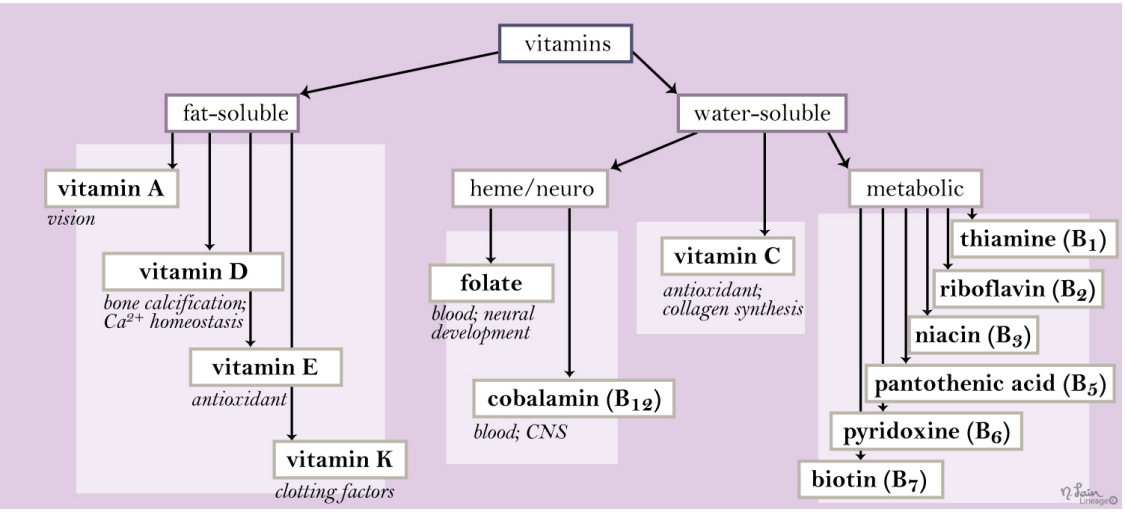

Figure 2 **(MedBullets, 2020)**

A review of prep questions bound closely to basic vitamins and their deficiencies as related to diseases, and most were posed in patient symptom scenarios, with the potential options for a resolution noted as possible responses. Below is an illustration of one of multiple examples of typical questions.

Example Question with Optional Responses:

> *A 21-year-old woman comes to the physician for counseling prior to conception. She delivered a female newborn with anencephaly 1 year ago. The newborn died at the age of 4 days. She asks the physician if she can take any vitamins to decrease her risk for conceiving a fetus with anencephaly. It is most appropriate for the physician to recommend which of the following vitamins?*
>
> *(A) Biotin*
>
> *(B) Folic acid*
>
> *(C) Vitamin B1 (thiamine)*
>
> *(D) Vitamin B2 (riboflavin)*
>
> *(E) Vitamin B6 (pyridoxine)*

(F) Vitamin B12 (cyanocobalamin)

(NBME, 2020)

In reviewing available questions posted with the National Board of Medical Examiners (NBME), the National Board of Osteopathic Medical Examiners and other available examples, questions addressing topics beyond a basic and limited smattering related to vitamins and minerals, were nonexistent. Due to the limits of access to question bank materials, this conclusion is far from scientific, but it does support the assertions made by other researchers (Abassi, 2018).

2.35 Pharmacology

Pharmacology is a core course within all medical school curricula. It is generally taught in the second year in most medical schools (Candler, Ihnat, & Huang, 2007). Pharmacy education covers both basic aspects and useful drugs for the treatment of diseases. Even for programs outside of the United States, pharmacology is considered a core course for nearly every medical school in the world (Candler, Ihnat, & Huang, 2007).

Pharmacology entails studying topics such as receptor mechanisms, pharmacokinetics and pharmacodynamics. The topic of pharmacokinetics explores how drugs are absorbed, their bioavailability, how they are distributed, their metabolism and excretion. It is sometimes referred to simply as "what the body does to the drugs" (Merck Manual, 2020). Conversely, the topic of pharmacodynamics is often described simply as "what the drugs do to the body." It encompasses the biochemical, physiological and molecular effects medications have on the body (Merck, 2019).

Pharmacology is a key part of the medical training programs as physicians need to not only know how and when to prescribe medications, but also how to ensure appropriate dosing. This is a

giant task considering that there are over 20,000 prescription drug products approved for marketing in the United States (FDA, 2020).

It is worth noting that there remains a huge need to focus on pharmacology. This is due to the reality that medication errors remain an issue, despite the heavy focus on pharmacology. In 2014, research concluded that medication errors resulted in one out of every 131 (0.7%) of all outpatient deaths in the United States and one out of every 854 (0.1%) inpatient deaths in the United States (Wittich, Burkle, & Lanier, 2014).

Data supports that the percentages of deaths tied to outpatient medication errors versus inpatient medication errors, outpatient medication errors are much more common (Wittich, Burkle, & Lanier, 2014). The rationale for this is beyond the scope of this research, but certainly worth noting. In the aggregate, inpatient medication error rates have been noted to run between 4.8% and 5.3% for medications prescribed by outpatient providers (Wittich, Burkle, & Lanier, 2014). That means for roughly 20 medications prescribed there is a likelihood for an error. Despite such findings, the likelihood of harm from medication errors remains low, at an estimated 0.9% of all medication errors.

Besides the consequences and impact on patients, errors that do cause harm to the patient leave open higher risk of potential for civil litigation, criminal charges and the suspension or loss of a medical license. Any litigation, no matter the verdict, often leads to an increase in cost to physicians and medical groups in the form of their malpractice premiums (Pozgar & Santucci, 2016).

2.36 FDA Oversight

The Food and Drug Administration (FDA) is the federal agency responsible for protecting and promoting public health. It also holds oversight over the regulation of food safety, tobacco products, nutritional supplements, prescription medications, over the counter pharmaceuticals, vaccines, biopharmaceuticals, medical devices, cosmetics, veterinary and other related realms (FDA, 2020). The FDA has the overall responsibility for the oversight of more than $2.8 trillion in consumption of food medical products and tobacco products annually (FDA, 2020).

Prescription medications, non-prescription medications (over-the-counter (OTC) medications) and nutritional supplements, each are handled differently in the form of oversight. Prescription medications having the most oversight and nutritional supplements having the least. This is due to prescription medications having a much higher risk to an individual if not monitored by a physician (Hilmas, 2018).

Prescription Medication Oversight

Prescription medications are by definition FDA approved substances that are intended to be used in the treatment of prevention of a disease. They require a prescription from a physician and are intended for use only by the specific individual (patient) noted on the prescription. Prescription medications must be purchased at a licensed pharmacy (US FDA, 2017). Currently the number of approved prescription medications is overwhelming. The FDA currently has approved over 20,000 prescription drugs since their inception. Over the past five years, the FDA has approved an average of 44 new medications per year (Statistica, 2020).

Non-Prescription Medication Oversight

Non-prescription medications (Over-The-Counter medications (OTC)) are drugs that are regulated by the FDA to assure ingredients, dosage, formulation and adherence to quality and

manufacturing standards. These medications do not require a prescription and can be used by more than one individual (US FDA, 2017). Examples of OTC medications are both exhaustive and numerous, but include such things as Ibuprofen, Benadryl and TUMS, just to name a few.

Many of today's OTC medications were at one time prescription medications and were subsequently approved by the FDA to be sold as OTC medications, as they have been deemed safe to consume without a prescription. There are a host of examples of such changes. A few examples of this from the last decade include Allegra, Nexium, Nasocort and Flonase. Each of these had been previously available by prescription (Saleh, 2020).

Nutritional Supplement Oversight

Nutritional supplements (AKA nutraceuticals) fall into the Dietary Supplements category within the FDA. They are more specifically defined by FDA regulations under the Dietary Health Safety and Education Act of 1994 (DSHEA) (Dickinson, History and overview of DSHEA, 2011). Products that fall within this category are deemed safe for consumption and do not require FDA review or approval for safety before being marketed to the public. Products within this group are also not allowed to make disease claims or they risk being examined and regulated as a drug by the FDA (Dickinson, History and overview of DSHEA, 2011).

2.37 A Deeper Look at Prescription Medications

Prescription medications are medications that require a prescription by a physician or physician extender (Physician Assistant (PA) or Nurse Practitioner (NP)). Prescription medications are purchased from a pharmacy and are prescribed and intended for one person. Prescription medications are also approved and regulated by the FDA (FDA, 2017).

The most recent report from the National Center for Health Statistics reported that between the years 2013 and 2016, 48.4% of Americans made use of at least one prescription medication within the past 30 days. They also reported that 24% of Americans used three or more prescription medications within the past 30 days and that 12.6% used five or more prescription medications in the past 30 days. Among those 65 and over, this was even higher with 40.9% of Americans used five or more prescription drugs in the past 30 days (Prescription Drug Use in Past 30 Days, 2018).

2.38 Examples of Common Prescriptions and Interactions with Nutraceuticals

As noted in Chapter 1, a review of some prescription medications and their research-backed medical considerations with regards to dietary and nutritional supplements would be included in this dissertation. In that effort, what follows below are a few of what certainly could be an exhaustive number of examples, were they the focus of this research.

Lisinopril: Black Cohosh taken in conjunction with Lisinopril can lead to elevated potassium levels in the blood. Black Cohosh is a nutraceutical that consumers often use to address menopausal symptoms and dysmenorrhea. Patients taking lisinopril are also cautioned to avoid diets high in potassium. Foods that are high in potassium include bananas, lima beans, broccoli, French fries, clams (canned), milk, orange juice, potato chips, baked potatoes, sweet potatoes, fish and a host of other common foods that are often not thought of as being high in potassium (Healthwise Staff, 2019).

Levothyroxine: Supplements containing iron, such as multivitamins containing iron and foods rich in iron can decrease the effectiveness of levothyroxine (Campbell, Hasinoff, Stalts, Rao, & Wong, 1992). Calcium citrate should also be avoided as well (Csako, McGriff, Rotman-Pikielny, Sarlis, & Pucino, 2001). Both supplements can decrease the efficacy of levothyroxine.

The absorption of levothyroxine may also be decreased by diet as well. Foods containing soybean flour, cotton seed meal, walnuts, dietary fiber, calcium, and calcium fortified juices can also decrease the effectiveness of levothyroxine (Csako, McGriff, Rotman-Pikielny, Sarlis, & Pucino, 2001).

Metformin: Metformin together with turmeric may have additive effects on blood sugar and increase the risk of hypoglycemia. Studies have shown that turmeric has a positive impact in the effective management and prevention of type II diabetes mellitus (Chuengsamarn, Rattanamongkolgul, Luechapudiporn, Phisalaphong, & Jirawatnotai, 2012). Taking this in tandem with metformin can result in a risk of an additive effect which could result in hypoglycemia.

Simvastatin: Research supports there is a risk of increased serum concentrations of Simvastatin for patients taking echinacea in tandem with Simvastatin. This relates to the effect of intestinal CYP3A inhibition (Gorski, et al., 2004). Even the consumption of grapefruit was noted as having the potential to increase plasma concentrations of Simvastatin (Bailey, Malcolm, Arnold, & Spence, 1998) (Drugsite Trust, 2020).

2.39 Government Support for Pharmaceutical R&D

A number of circumstances speak to the high level of involvement the government has within the pharmaceutical sector, including the most recent pandemic and historical government spending data on pharmaceutical research and development (OECD, 2017). The interest in the government doing so has been under the auspices for the public good.

In 2014, US government funding for supporting research and development of pharmaceuticals was $33.5 billion (OECD, 2017). If you were to compare it to the average drug approvals per year, which was noted earlier at 44 drugs, the on average investment in research and development equates to just over $761 million per drug (Statistica, 2020).

2.40 *Vitamins & Nutraceuticals*

Vitamins are organic molecules that are essential micronutrients necessary to assure our metabolism functions properly. Vitamins had been only theorized until their actual discovery. While the consumption of vitamins has become commonplace, the discovery of vitamins is somewhat recent with the first vitamin to be discovered being Vitamin A in 1914 (Carpenter, 2004).

Additionally, basic nutrition is inclusive of essential nutrients. Such topics include the identification and education on the necessity of essential minerals, essential fatty acids and essential amino acids. The designation of being essential is best described as being essential for the body's ability to function and maintain good health. Essential nutrients are required by the body to assure a variety of cellular metabolic processes and repair and function of tissues and organs to occur (Chipponi, Santi, & Rudman, 1982).

While one can find vitamins in nearly every grocery store or pharmacy, most of our nutrients come from the foods we eat (WHO, 2004). Despite that, the use and inclusion of vitamin supplements remains popular.

2.41 What Are Nutraceuticals?

The term nutraceutical was initially coined in 1989 by Stephen De Felice, MD. Dr. Felice is the founder and chairman of the Foundation for Innovation in Medicine. The term has been subject to inconsistencies as a definition. For the purpose of this research, nutraceuticals are defined as nutritional and herbal compounds that are not consumed for basic nutritional purposes but are more aimed at addressing a health concern or dysfunction. They essentially are products and compound which are neither nutritionally nor pharmaceutically focused (Aronson, 2017).

In the broadest sense, nutraceuticals refer to foods and nutritional supplement products that are akin to medicinally or nutritionally functional foods. Functional foods, nutritional supplements and herbal remedies fall into this category, as do basic vitamins and minerals (Aronson, 2017).

2.42 Nutraceutical Consumption

According to the Center for Responsible Nutrition, the top five best-selling supplement categories fall into the categories below:

1) Vitamins and Minerals
2) Specialty Supplements
3) Herbals and Botanicals
4) Sports Nutrition
5) Weight Management

According to a 2017 CRN report, the most popular items consumed within the Vitamins and Minerals category were Multivitamins, Vitamin D, Vitamin C, Calcium, Vitamin B and Vitamin B-Complex. Among specialty supplements, the most popular were Fatty Acids (Omega-3 and others), Probiotics, Fiber, Melatonin and Glucosamine/Chondroitin. Within the Herbals and

Botanicals category, Green Tea, Cranberry, Turmeric, Garlic, Ginseng, Ginkgo Biloba, Milk Thistle and Echinacea were the most popular. Looking at Sports Nutrition, Protein (powders/drinks/bars), Energy Drinks, Hydration Drinks, Creatine, Amino Acids and Recovery Drinks lead the way. Within the Weight Management realm, Protein (powders/drinks/bars), Garcinia Cambogia, Green Coffee, Medium Chain Triglyceride Oil, White Kidney Bean, Bitter Orange (Synephrine), Glucomannan and CLA were the most widely consumed products (CRN, 2017).

Information on consumption trends is of critical importance to both the manufacturers and marketers of nutritional supplements (dietary supplements) who seek to track and produce what consumers are more likely to purchase. Such information is tracked and statistically analyzed by such organizations as the Council for Responsible Nutrition (CRN). Accurate data on the commercial front equates to greater financial success for manufactures, ingredient suppliers and marketers. While this information is of perhaps equal importance to physicians and other healthcare providers, it is less likely to be deemed relevant to them.

The typical supplement user in the United States is more likely to have a college degree and is more health conscious than their peers. They tend to have higher income and exercise with some regularity. Other characteristics of dietary supplement users include being more likely to maintain a healthy weight, follow a healthier diet and more apt to avoid tobacco products (Dickinson & MacKay, Health habits and other characteristics of dietary supplement users: a review, 2014). Dietary supplement users are also slightly more likely to visit their doctor with regularity (Who Takes Dietary Supplements?, 2017).

A National Health and Nutrition Examination Survey, conducted from 2011 through 2012, provided a more granular view of those who take nutritional supplements. Regardless of age, sex,

race, education and self-reported health status, 52% of respondents reported using supplements with regularity within the past 30 days (Kantor, Rehm, Du, White, & Giovannucci, 2016).

A review of age groups, revealed that respondents 65 and older reported the highest use with 72% of respondents taking at least one nutritional supplement. Conversely, usage likelihood declined steadily among younger groups. Those aged 20 to 39 years of age had the lowest likelihood, with only 40% of respondents that reported taking at least one nutritional supplement (Kantor, Rehm, Du, White, & Giovannucci, 2016).

Other items of note from the study conclude that women were far more likely to make use of dietary supplements. Participants with a four-year degree or higher made for the most prevalent group of users. Subjects who reported their health status on the survey were the most likely to be actively using supplements. With regards to race/ethnicity, non-hispanic white participants represented the highest percentage of users of supplements, with 58% of participants reporting using supplements (Kantor, Rehm, Du, White, & Giovannucci, 2016).

Research addressing age and consumption of prescription, OTC medication and dietary supplements indicated 2,351 participants with a median age of 70.9. Results found that both the number of prescription medications and dietary supplements increased significantly with older adults (Qato, Wilder, Schumm, Gillet, & Alexander, 2016). Additional findings noted that 15.1% of participants were at risk for a potential major drug interaction with either other drugs and/or dietary supplements. The interactions highlighted in the study were typically interactions between prescription medications and those between prescription and non-prescription medications (Qato, Wilder, Schumm, Gillet, & Alexander, 2016).

2.43 Government Support for Nutritional Research

In 2014, research and development support for dietary supplements was $26.8 million (Betz, 2019). In 2019, the budget was $25.3 million, which was $1.5 million lower than what was noted for 2014 (NIH ODS, 2019). It's worth noting that the peak budget for the Office of Dietary Supplements was $29 million in 2010. Noting that the budget for 2004 was $26 million (Betz, 2019), it appears that, from a Federal government stance, their mission has not been one of a rising priority. Taking 2004's budget of $26 million and applying the Bureau of Labor and Statistics CPI Inflation Calculator, 2004's budget of $26 million equates to $35 million in 2019 dollars. This means that the purchasing power of $26 million represented in the 2004 budget equates to $35 million today. From that vantage point, the ODS budget, which has been somewhat flat since 2004, has actually been on a decline due to inflation.

2.44 Use of Dietary Supplements in the United States

According to a National Health and Nutrition Examination Survey conducted from 2007-2010, more than half of US adults are taking one or more dietary supplements daily. The most commonly reported reasons for using supplements were to "improve" and "maintain" health. While these were the primary reasons stated, participants were able to choose more than one reason as to their rationale for using dietary supplements (Bailey, Gahche, Miller, Thomas, & Dwyer, 2013). See Appendix J for additional details.

More recent data from the Council for Responsible Nutrition (CRN) indicates that 77% of adults in the United States take dietary supplements. The Council for Responsible Nutrition (CRN) is the leading trade organization in the U.S. Their organization represents dietary supplement

manufacturers and ingredient suppliers. For their members, they are a source of not only advocacy, but also provide consumer data and economic reporting as well (CRN Fact Sheet, 2020).

A 2019 survey data from CRN concluded that supplement users were more likely than non-users to practice healthy habits. In fact, 54% of supplement users consulted their primary care physicians about supplement use (CRN Consumer Survey, 2019). See Table 1 below for additional details.

Table 1: CRN Survey Data

Statement	% of Supplement Users Who Agree	% of Supplement Non-Users Who Agree
"I exercise regularly"	71%	53%
"I regularly get a good night's sleep"	71%	61%
"I try to eat a balanced diet"	86%	75%
"I maintain a healthy weight"	69%	66%
"I visit the doctor regularly"	80%	65%

(CRN Consumer Survey, 2019)

This would indicate that, from a nutritional supplement consumer perspective, the desire for professional guidance seems highly desirable. This becomes somewhat problematic when 14% of residents report feeling they were adequately trained well enough during medical school to provide meaningful nutritional counseling (Vetter, Herring, Sood, Shah, & Kalet, 2008).

As for the array of nutritional supplements consumed, it's worth noting that while the use of multivitamin and mineral compounds has been on the decline, amino acid, herbal and other advanced nutritional compound have been on the rise. In addition to this, the number of products taken by a typical user has and continues to grow. A fourteen-year study, concluded in 2012, found that roughly 10% of nutritional supplement users took four or more supplements daily (Kantor, Rehm, Du, White, & Giovannucci, 2016).

2.45 Dietary Supplement Market

Sales of nutritional supplements has been increasing year over year. In examining how large the nutritional supplement market is in the United States, sales in the US in 2018 were $42.6 billion (Watson, 2019). A recent GAO report estimated that were approximately 80,000 nutritional supplements on the market with ongoing growth anticipated annually (GAO, 2017). The market identification for dietary supplements is products that contain one or more of the types of nutritional ingredients: vitamins, minerals, amino acids, herbs or other botanical ingredients. This in combination with the form (pills, capsules, tablets, powder or liquid form) define the market for the category (Watson, 2019).

While many of the products identified in the GAO study were identical with variations only in name and branding, a host of others were unique based on types of ingredients and concentrations. A report in 2000 had estimated at the time that there were approximately 29,000 products on the market with an anticipated growth of 1,000 new products being added per year (NASEM, 2002). Extrapolating from the 2000 report, it is apparent that estimations from where the market stood in the year 2000 have well eclipsed earlier estimations.

2.46 Examples of Common Nutraceuticals and Interactions with Medications

As noted in Chapter 1, the need to review some common dietary supplements and their research-backed medical considerations would be included in this dissertation. In that effort, what follows are a few of what could be an exhaustive number of examples were they to be the focus of this research.

Milk Thistle: Milk thistle (AKA Silymarin) is a commonly consumed product that can come in an array of forms from health food stores. This includes such things as capsules, liquid extracts, tablets

and tea bags, just to name a few. It is known for its antioxidant properties and the claim that it helps detoxify the liver. Unfortunately, this popular product and staple of most health food stores may increase the blood levels of deferiprone, which increases the risk of side effects. These can include a decline in white blood cells resulting in neutropenia, agranulocytosis, nausea and vomiting (NIH, 2020).

Deferiprone (Feriprox) is an iron chelating agent used to treat chronic iron overload (hematochromatosis), which is often associated with patients who undergo regular transfusions (NIH, 2020). It is prescribed to help patients suffering from iron overload which can, if left unresolved damage organs (MedlinePlus, 2020).

Zinc: Zinc has been known to induce significant resistance to antibiotics. Microbial growth experiments illustrated that Ciprofloxacin, Oxytetracycline and Tylosin were all showed decreases in effectiveness in the presence of zinc (Peltier, Vincent, Finn, & Graham, 2010). It has also been noted that Ciprofloxacin and zinc sulfate should not be taken orally at the same time as zinc can reduce the absorption of ciprofloxacin in the bloodstream and reduce its effectiveness. This is also true of products that contain magnesium, calcium and iron. Additional antibiotics that are also impacted by zinc include, but are not limited to Cinoxacin, Delafloxacin, Demeclocycline, Enoxacin, Gatifloxacin, Gemifloxacin, Levofloxacin, Lomefloxacin, Minocycline, Moxifloxacin, Norfloxacin, Ofloxacin, Oxytetracycline, Penicillamine, Sarecycline, Tetracycline and Trovafloxacine (Drugsite Trust, 2020).

5-HTP: Also known as L-5-Hydroxytryptophan, 5-HTP is an amino acid produced naturally in the body that supports the brain's ability to produce serotonin. It is also a popular supplement that is often taken for its reported properties as a mood booster and even sometimes by those suffering from fibromyalgia. Some have also sought the product in an effort to aid in weight loss (Van De Wall, 2018).

No matter the desired aim in taking 5-HTP, those taking 5-HTP who are also taking SSRI medications should be instructed to avoid taking 5-HTP. It has been noted in research that taking an SSRI in tandem with 5-HTP increases the risk of serotonin syndrome (Buckley, Dawson, & Isbister, 2014). There are a number of drugs that fall into the SSRI category. Probably the most notable one would be Prozac (AKA fluoxetine), but there are a host of others. As for the interaction severity, while serotonin syndrome is rare, it is a serious condition that is potentially fatal (Buckley, Dawson, & Isbister, 2014).

Grapefruit Juice: As an example of a common food item, consider the grapefruit. Grapefruit juice has shown to increase the bioavailability of an array of medications (Drugsite Trust, 2020). A single glass of grapefruit juice has the potential to enhance the oral bioavailability and to enhance the positive or adverse effects of a broad range of medications. This is even true if the juice was consumed hours prior to taking many medications. Grapefruit juice acts by inhibiting pre-systemic drug metabolism mediated by CYP3A isoforms in the small intestine. A conclusion drawn from grapefruit consumption is that physicians, pharmacists and other health professionals should educate patients about consumption of grapefruit juice with medications. (Bailey, Malcolm, Arnold, & Spence, 1998).

Echinacea: Echinacea is a dietary supplement that is usually promoted as supplement for helping ward off common colds and other infections. It is a commonly consumed product that can come in an array of forms from health food stores. This includes such things as capsules, liquid extracts, tablets and tea bags, just to name a few.

Atorvastatin is a synthetic cholesterol lowering agent (NIH, 2020). Patients taking atorvastatin, who also take echinacea, risk an increase in the blood levels and of atorvastatin, which ups the risk of major side effects. Patients may need a dose adjustment or more frequent monitoring by their doctor to safely use both medications (Drugsite Trust, 2020).

2.50 Consumer Knowledge and Decision-making

There are a host of ways that consumers of nutritional supplements tend to make the decision to take a particular supplement. Regarding nutritional knowledge, research has actually shown that a typical physician's attitudes, knowledge and personal use of vitamins are more like that of the general public (Leeman, Fischler, & Rozin, 2011). This is perhaps not a surprise given the previously noted deficit in basic nutrition training reported for medical schools in the United States.

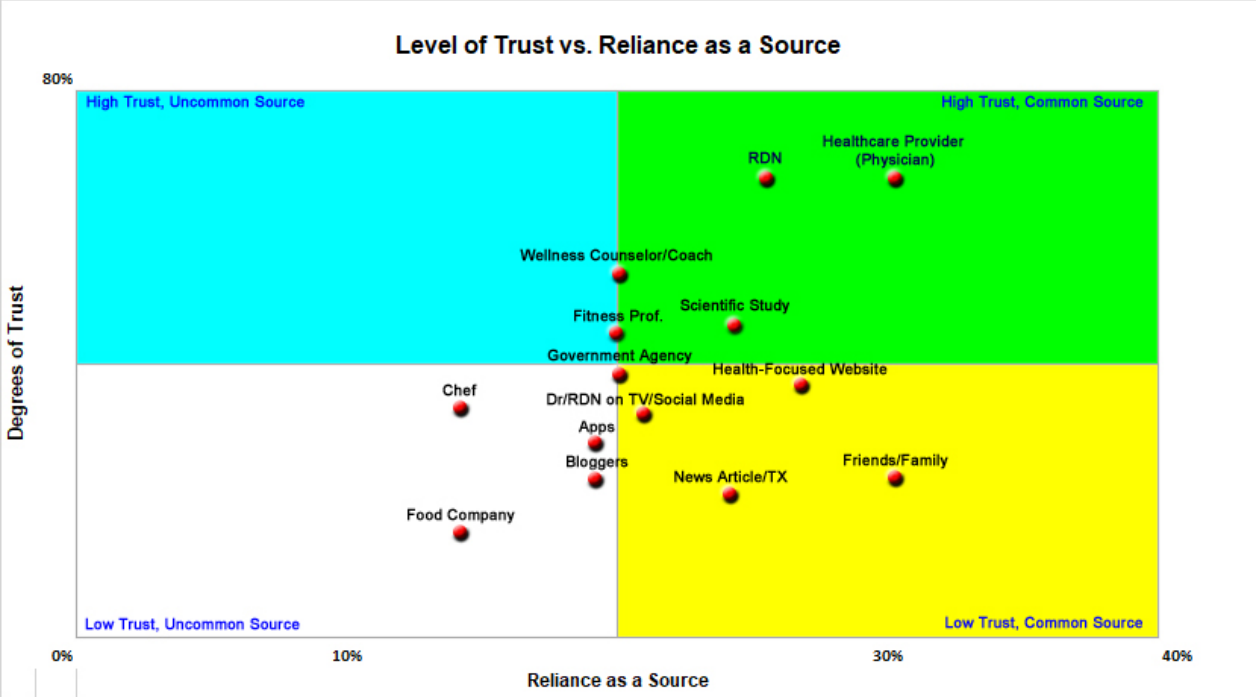

Figure 3

A 2018 FHS report examined sources influencing decisions related to health, nutritional supplement usage and diet advice. The report examined the level of trust worthiness of the source, as well as the perceived reliability, as reported by respondents. Food companies and manufacturers were seen as the least reliable and also had the lowest degree of trust. While respondents rated

healthcare professionals the highest in trust, they were tied with advice from friends and family when it came to reliance as a source for decision making (2018 Food & Health Survey, 2018).

2.60 Summary

Research indicates that nutritional training is not only currently lacking within medical school programs in the US, but that this is not a recent phenomenon. Research seems to illustrate quite well that kicking the proverbial can down the road has been rather a consistent modus operandi (National Research Council (US) Committee on Nutrition in Medical Education, 1985).

A summation of the literature review does infer considerable doubt and concern when it comes to the adequacy of knowledge physicians possess in basic nutrition. There appears to be an adequate amount of support suggesting that nutritional training is limited to nonexistent within medical school programs. This is in spite of substantial evidence that notes that dietary factors, which are preventable, are the leading cause of death globally. As the focus of this dissertation is on the United States, it's worth also pointing out that the United States was not immune from this reality (Afshin, et al., 2019).

One notable point is the reported lack of confidence that medical residents have when discussing or offering guidance to patients on basic nutrition and diet (Vetter, Herring, Sood, Shah, & Kalet, 2008). Putting this in contrast to the reality that it is common for nutritional products to have stated on their label the recommendation that users reach out to their physician or healthcare provider before taking them. It's also worth noting that the FDA recommends that consumers of dietary supplements consult with their doctor or health care provider before taking them (FDA.gov, 2018).

The reality that a host of supplement labels and the FDA recommend users consult with their physician before taking a dietary supplement is concerning. This point would seemingly put

physicians in a vulnerable position given that physicians are rated as the most trusted source for supplement guidance (2018 Food & Health Survey, 2018), however their nutritional knowledge differs little from that of the general public (Leeman, Fischler, & Rozin, 2011). While they have received little formal training in this area, typically the onus is on them to offer nutritional guidance to their patients.

It has also been suggested that medical school curriculums have a tendency to mirror the expectations for what subjects are key to passing medical board exams. This is also supported by the fact that more and more medical schools are tying in board preparation program offerings within their programs. Given that the marginal point value assigned to the limited questions related to anything, beyond perhaps a few basic vitamin deficiency questions has perhaps made, as suggested by the literature, nutrition knowledge a low priority. The lack of any requirement for the purposes of accreditation was also a noted point.

The need to focus on medications patients are taking and their potential interactions seems to also be a factor. As noted earlier within the literature review, there are over 20,000 prescription medications approved and marketed in the US. This makes for an important driver as well (Statistica, 2020). Noting also that prescription medications are medicines that are not deemed safe for general public consumption, the need for physicians to focus on pharmaceuticals is indeed also a solid point that makes the emphasis on pharmaceuticals important (Hilmas, 2018).

In summarizing how the United States, as a whole, views the importance of nutritional research, it becomes rather clear when you compare federal spending on pharmaceutical research and development versus nutritional research. In 2014, US government funding for supporting research and development of pharmaceuticals was $33.5 billion (OECD, 2017). In contrast, research and development support for dietary supplements was $26.8 million (Betz, 2019). This is a rather significant disparity with the difference in spending between the two being $33.47 billion.

The spending on pharmaceutical research and development by the federal government is effectively 125000% higher than what is expended on nutritional research.

CHAPTER III

METHODOLOGY

3.10 Introduction

The purpose of this study was to examine the current level of inclusion of nutrition and nutritional supplement training in US Medical Schools. For the purposes of this study, nutrition training has been defined as training within the categories of basic nutrition topics such as healthy eating, essential vitamins and minerals. Nutritional supplement training is reflective of training related to nutritional supplements that fall outside of the essential vitamin or essential mineral realms.

3.20 Methodology

The methodology utilized in this research was qualitative. This was deemed as a much more appropriate method, due to the fact that the aim has been to review and affirm the existence of nutritional education within specific medical school curricula. It was deemed additionally appropriate to describe and stratify the levels of training within individual medical school curricula. Evidence of explicit and implicit education related to Basic Nutrition was derived through a review of each medical school program's published curriculum.

The benefit of a qualitative analysis allows for a thorough understanding of the research subject. Qualitative analysis is generally used in situations where the subject of research is one that

incorporates a significant degree of study of attributes or the study of trends that cannot be expressed using quantitative methods.

At the time of this study, 208 medical schools were noted to be in existence within the United States, including medical schools in Puerto Rico. Eight of these schools were excluded from this study due to their first entering class having a start date beyond 2019. This included two Allopathic (MD) programs and six Osteopathic programs. This resulted in a total of 200 active medical school programs identified as being the population.

Due to the size of the study population, the choice to review all 200 programs was more desirable than simply taking a statistical sample. Additionally, some analytical elements were utilized for the comparison of regional comparison, established versus newer programs, as well as program types. Any statistical forms of analysis noted serve solely as referential and anecdotal support to the qualitative methodology utilized within this study.

3.30 Data Gathering

Data collected for this report was gathered directly from each school via perusal of published curriculum schematics, university catalogs, and other published details tied to curriculum, as well as course requirements for entry into the program itself. In reviewing the details for each program, the following questions were considered:

What is the program type (DO of MD)?

What year was the program initiated?

Is basic nutrition training a prerequisite for acceptance into the program?

Is nutritional training required in the program's curriculum?

If required or optional, what type of nutrition training exists in the program?

If nutritional training exists in the program, is it an explicit course or considered topical as part of other subjects?

Is advanced nutritional training on dietary supplements, herbs and advanced nutritional compounds (nutraceuticals) part of the curriculum?

Using data gathered from the research, a review and comparison of the concentration of nutrition courses and education methodology was conducted to review variances between Allopathic and Osteopathic programs, as well as Newer programs (Post-Y2K programs) versus Older programs (Pre-Y2K programs).

Regional comparisons of curriculum were conducted within the study to identify any potential disparities within nutritional education. Region assignments, for the purposes of this study, were similar to assigned regions noted by the U.S. Department of Health & Human Services Regions (See *Appendix F and G*). Figure 4 was created for this report and includes an 11th region.

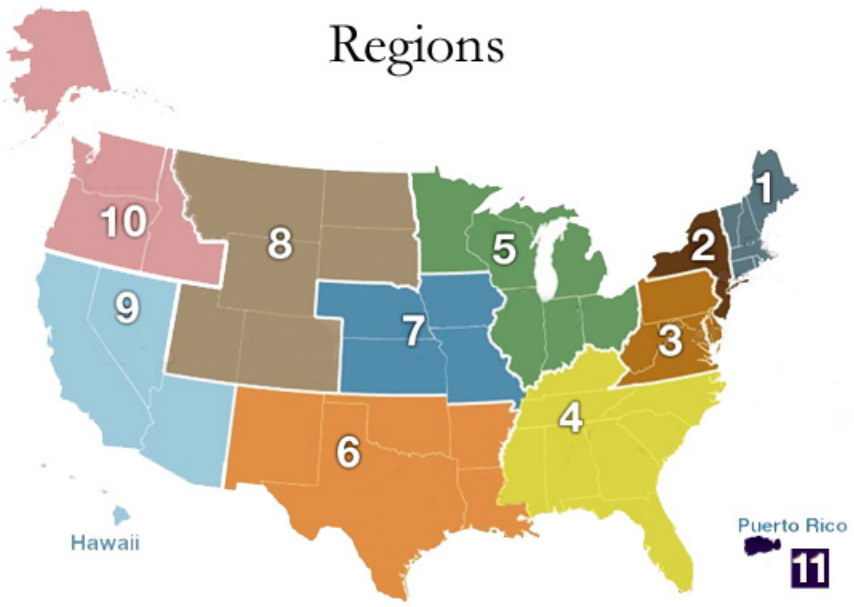

Figure 4

The study included an examination of programs within all 50 states, this included both Washington DC and Puerto Rico. Below is a table which more explicitly frames which states and territories are in each of the 11 identified regions noted in figure 4.

Table 2: Regions

Region	States
1	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
2	New Jersey and New York
3	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia
4	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
5	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
6	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
7	Iowa, Kansas, Missouri, and Nebraska
8	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
9	Arizona, California, Hawaii and Nevada
10	Alaska, Idaho, Oregon, and Washington
11	Puerto Rico

Data elements were gathered and recorded in a Microsoft Excel file. The file was then linked to SAS for analysis once the data for each school was fully collected. Analytical tools such as SAS and Microsoft Excel were utilized to aid in quantification of the data. Links to source materials were also included in the database to maintain links to the information for each of the 200 medical schools.

In order to assess the level of nutrition education within the curriculum of each medical school program, it was necessary to create and assign categories with an associated point value. Categories were formed on the basis of the existence, type and level of nutritional training found. Source materials for the categorization of each school included a thorough review of published

curriculum schematics, university catalogs, and other published details tied to each program. Table 3 below illustrates how each medical school curriculum was categorized.

ZOIED Score Assignment

Table 3

Classification	Description	Point Value
Z	Zero nutritional training noted.	**0**
O	Optional nutritional course available (elective course)	**1**
I	Implied nutritional training within other subject matter.	**2**
E	Explicit required nutritional training course (identifiable course).	**3**
D	Dietary and nutritional supplement training (advanced nutrition).	**4**

To expand upon what is noted within Table 3, what follows below are more details on each classification assignment.

Classification Z: Programs classified at "Z" had zero elements of nutritional training identified in the curriculum, meaning there was an absence of any evidence of any optional, implied or required emphasis on nutrition within the program curriculum. Assigned point value for programs with a "Z" classification was 0 points.

Classification O: Programs classified as "O" had at least one nutritional offering course as an elective option. The point value for programs with an "O" classification was 1 point.

Classification I: Programs classified as "I" did not have an explicit course within the curriculum focused on nutrition, but did infer said training as part of the longitudinal or integrated theme within other coursework. The point value for programs with an "I" classification was 2 points. An example of longitudinal (integrated theme) tied to nutrition topics within other courses is noted in the appendix (*See Appendices H and I*).

Classification E: Programs classified at E had an explicitly required course that is in the curriculum encompassing nutrition training. The point value for programs with an "E" classification was 3 points. For the purposes of research, "E" is the mark of adequacy.

Classification D: Programs classified at D had not only an explicitly required nutrition training course within the curriculum, but also had optional or elective coursework for advanced training. The point value for programs with an "D" classification was 4 points.

It is worth noting that program classification assignments were based on the highest-level element drawn from the analysis of their curriculum. As an example, if a program had an optional course noted as an elective (E), but also had nutritional training implied longitudinally (I), the classification assignment would be assigned to "E" versus the lower classification of "I".

In performing the analysis, a classification of "E" was set as the bar for a program being noted as having adequate nutrition education. It is also worth noting that a classification of "D", which was the highest point value on the ZOIED scale, indicated that a program was above and beyond basic. Such programs would offer advanced training on topics such as nutraceuticals, dietary supplements, nutritional care for the acute/chronic ill, sports nutrition or other related realms beyond basic/general nutrition.

Classification Scoring:

Table 4

ZOIED Score Assigned Point Value

Classification	Point Value
Z	0
O	1
I	2
E	3
D	4

ZOIED scores were used to address the primary research question (central hypothesis) which is noted below:

Null ($H_0$1): *All medical school programs in the United States require a course in basic nutrition as part of their curricula.*

Alternate (H_a1): *Not all US medical schools require coursework in basic nutrition in their program.*

The scores were also used to answer the secondary research questions which follow below:

1) Do both Allopathic (MD) and Osteopathic (DO) programs have the same focus on basic nutrition education?

Null ($H_0$2): *There is no difference between Allopathic (MD) and Osteopathic (DO) programs in their focus on basic nutrition education*

Alternate (H_a2): *Allopathic (MD) and Osteopathic (DO) programs have differences in their focus on basic nutrition education as part of their curriculum.*

2) Are there any regional variances among programs and their requirements for basic nutritional education within US medical schools?

Null ($H_0$3): *There are no regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.*

Alternate (H_a3): *There are regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.*

3) How do older more established programs (programs established prior to year 2000) compare to newer programs (programs established in year 2000 and later) when it comes to the inclusion of nutritional training?

Null ($H_0$4): *No disparity exists between newer programs versus older more established ones*

in the focus on basic nutrition training within their programs.

Alternate (H_a4): *A disparity exists between newer programs and older more established ones in the focus on basic nutrition training within their programs.*

4) How many programs offer training in nutraceuticals that includes advanced nutritional topics tied to herbs and other advanced nutritional compounds?

5) Do any programs require a course of nutrition be taken as a prerequisite to admission into their medical school program?

CHAPTER IV

RESEARCH FINDINGS

4.10 Introduction

The primary research question of this study was to test the hypothesis which stated that *All medical school programs in the United States require a course in basic nutrition as part of their curricula.* The data demonstrates this was not the case. Of the 200 medical school programs reviewed, only 49 of 200 were deemed adequate by receiving a ZOIED classification of "E". Those receiving "E" equated to 24.5% of all medical school programs (See *Figure 6*). Thus, the null hypothesis was therefore rejected and the alternate hypothesis which states, "*Not all US medical schools require coursework in basic nutrition in their program",* was consequently supported. The figures that follow, illustrate the distribution of scores by the count (See *Figure 5*) and by percentage (See *Figure 6*) of overall medical school programs at the time of this research.

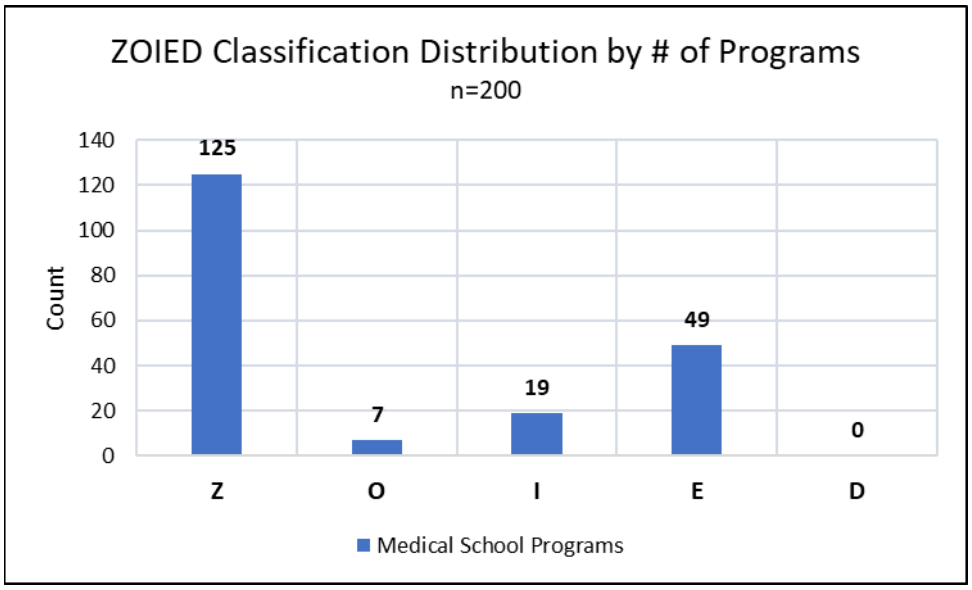

Figure 5

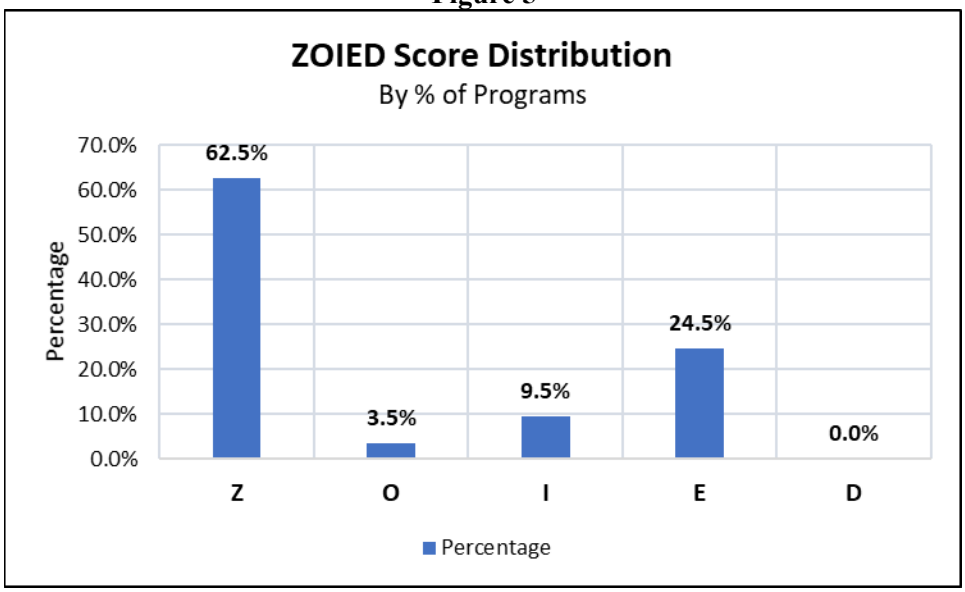

Figure 6

As illustrated in *Figure 6*, the majority of medical school programs fell into the "Z" classification. "Z" programs have no elements of nutritional training identified in their curriculum. Specifically, there was an absence of any evidence of any optional, implied or required emphasis on nutrition within their program curriculum. As a percentile basis, this equated to 62.5% of all medical school programs at the time of this study (See *Figure 6*).

In contrast to those with a "Z" classification, it is worth noting that zero percent (0%), of the medical school programs in the population, were rated as having a ZOIED classification of "D".

As noted previously in Chapter 3, programs classified as "D" had not only an explicitly required nutrition training course within their curriculum, but also had advanced coursework tied to nutritional topics. Examples include such topics as nutraceuticals, dietary supplements, nutritional care for the acute/chronic ill, sports nutrition or other related realms beyond basic/general nutrition. All classifications by percentage are illustrated in *Figure 6*.

Taking *Figure 5* and utilizing the point values assigned by the ZOIED score, as noted on Table 4 in Chapter 3, the total sum of all points would be 192 (*Figure 7*).

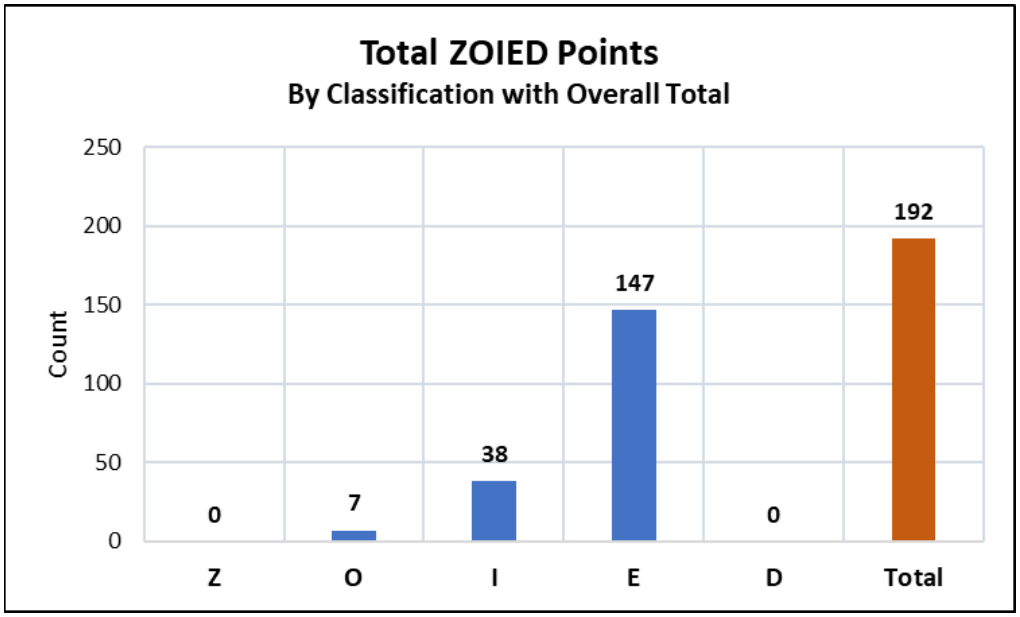

Figure 7

ZOIED Classification "E", in accordance with the constructed scale, was held as the standard for adequacy. On a macro level, the population needed to achieve a cumulative score at or above 600 in order to imply overall adequacy. This was due to classification "E" being worth 3 points and then multiplying stated point value for "E" by the population (n=200). Actual points (192) versus Total points to achieve an average classification of "E" are noted in *Figure 8*.

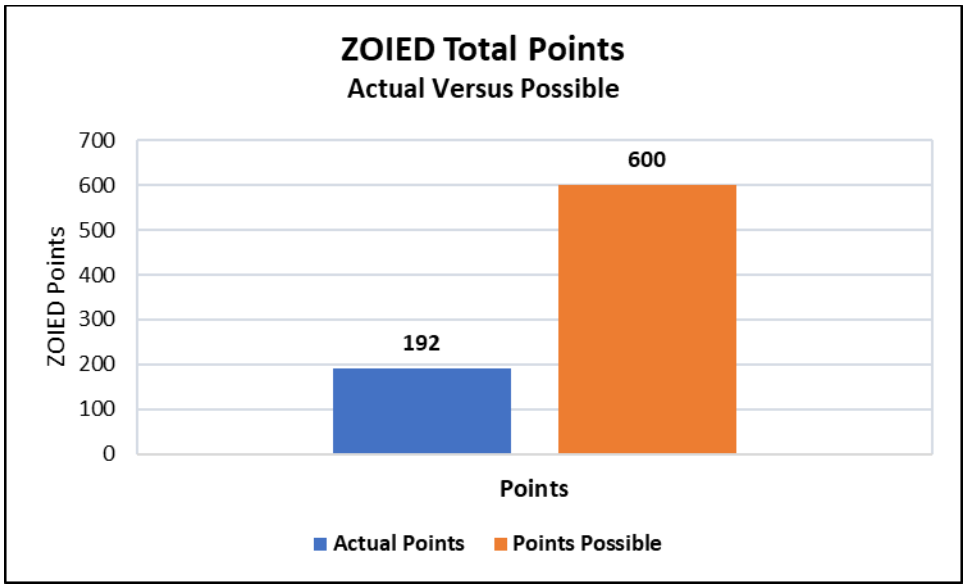

Figure 8

From a macro level, a cumulative value of 600 ZOIED points was set as the bar for overall adequacy, the score of 192 points, as noted in *Figure 8*, would indicate inadequacy. From the vantage point of generously equating 600 ZOIED points both as adequacy and the 100% mark, 192 points out of 600 possible would result in an average score of 32% for the overall population. Referring back to *Figure 5*, of all the scores attuned to individual programs, only 49 medical school programs out of the entire class (population), received a passing grade. The 19 medical school programs noted in *Figure 5* possessing a ZOIED classification of "I", would receive a D+ (assuming that a D would be assigned the range ≥60% and <70%).

4.20 Findings from Secondary Research

Within this section resulting data will be used to respond to the secondary research questions that were noted in chapter one (Section 1.65).

4.21 Secondary Research Question One

1) Do Allopathic (MD) and Osteopathic (DO) programs both have the same focus on basic nutrition education?

Null ($H_0$2): *There is no difference between Allopathic (MD) and Osteopathic (DO) programs in their focus on basic nutrition education.*

Alternate (H_a2): *Allopathic (MD) and Osteopathic (DO) programs have differences in their focus on basic nutrition education as part of their curriculum.*

Analyzing Allopathic (MD) and Osteopathic (DO) programs, the data suggested there were differences between the two groups. A review of the data revealed that while both MD and DO programs had a high percentage of programs with a ZOIED classification of "Z", DO programs were more likely to have a higher percentage of programs with zero identifiable focus on nutritional education within curricula. As noted in *Table 5* below, 68.2% of DO programs had a ZOIED classification of D, versus their MD counterparts which were 60.9% likely to be classified as "Z".

Table 5

	Programs		Percentages	
Classification	**DO**	**MD**	**DO**	**MD**
Z	30	95	68.2%	60.9%
O	7	0	15.9%	0%
I	2	17	4.5%	10.9%
E	5	44	11.4%	28.2%
D	0	0	0%	0%
Total	**44**	**156**	**100%**	**100%**

As noted in the data in *Table 5*, there were no MD programs found as having an elective option for coursework tied to basic/general nutrition. This was in contrast to 15.9% of DO programs having such offerings. Lastly, MD programs were far more likely to have topics associated with diet and nutrition imbedded within other courses (ZOIED Classification "I"). As for how programs fared when it came to having reached the adequacy mark (ZOIED Classification "E"), MD

programs were more than twice as likely to have achieved adequacy. Despite that point, both program types had low percentages when it came to nutritional training overall. This was emphasized in that neither DO nor MD programs had any schools with a ZOIED classification of "D".

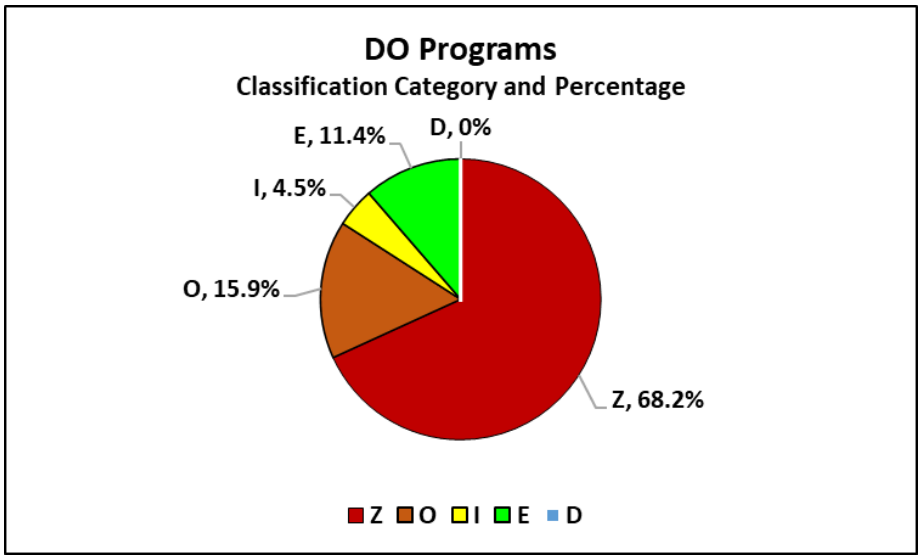

Figure 9

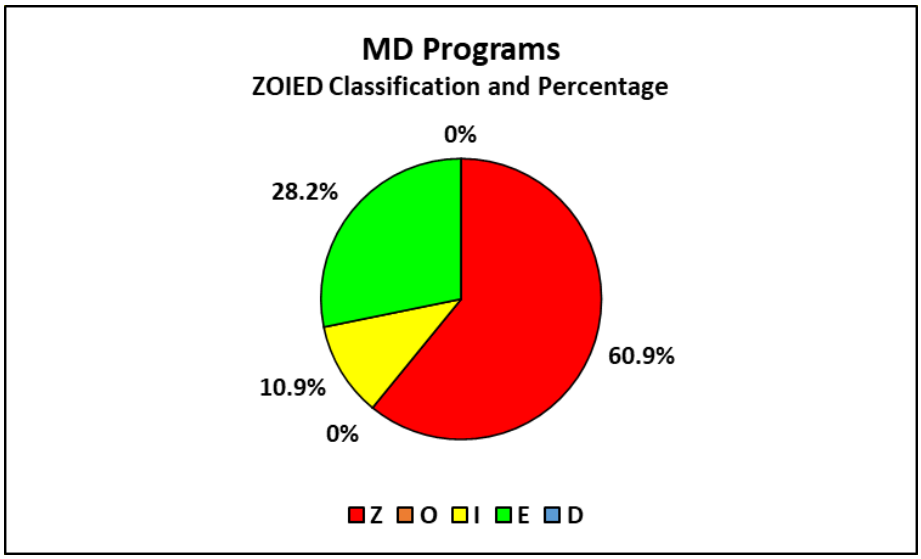

Figure 10

As evidenced in the data noted in Table 5, there did appear to be significant differences between Allopathic (MD) and Osteopathic (DO) programs in how they focus on basic nutrition education. Therefore, the null hypothesis was rejected indicating that the alternative hypothesis

which states, "Allopathic (MD) and Osteopathic (DO) programs have differences in their focus on basic nutrition education as part of their curriculum", was consequently supported.

4.22 Secondary Research Question Two

2) Are there any regional variances between programs and their requirements for basic nutritional education within US medical schools?

Null ($H_0$3): *There are no regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.*

Alternate (H_a3): *There are regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.*

In analyzing the data for regional variances, the data indicated there are differences between the 11 regions. This is illustrated within *Table 6*:

Table 6

Program Ranking by Region **MD & DO Programs Combined**			
Rank	**Region(s)**	**AVE Points**	**States & Territories Included**
1	9	1.42	Arizona, California, Hawaii and Nevada
2	5	1.23	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
3	3	1.12	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia
4	1	1.09	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
5	6	1.00	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
6	4	0.87	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
7	7	0.73	Iowa, Kansas, Missouri, and Nebraska
8	2	0.50	New Jersey and New York
9	8	0.50	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
10*	10 & 11	0	*Region 10*: Alaska, Idaho, Oregon, and Washington *Region 11*: Puerto Rico

* Regions 10 and 11 tied for last and as such were ranked 10th

Table 6 displays ranking results from the data for medical school programs residing within each identified region. The data included all programs (MD & DO) operating within each region. Ranking was based on the average points, based on their ZOIED classification score for all programs in each region.

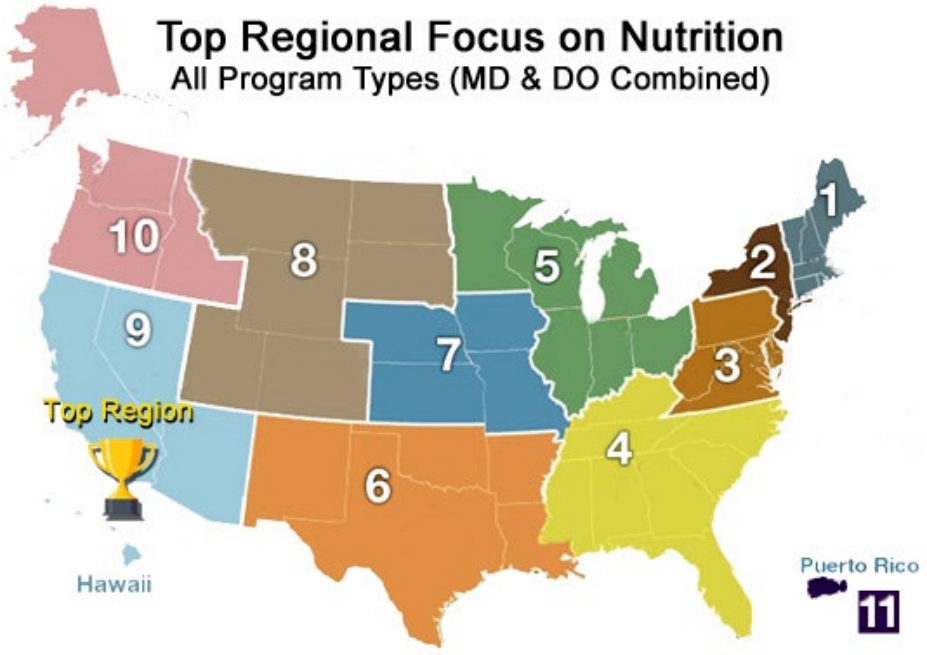

Figure 11

As noted within *Table 6* and in *Figure 11*, region 9 ranked highest. Region 9 included the states of Arizona, California, Hawaii and Nevada indicating that programs within region 9 had the most focus on nutrition education versus the other 10 regions.

Regions 10 and 11 were ranked equally at the bottom of all regions. Programs within both regions had an average of zero points. Region 10 included the states of Alaska, Idaho, Oregon and Washington. Region 11 was comprised solely of Puerto Rico.

MD Programs by Region

MD programs and how they ranked regionally is noted in *Table 7*. The separate visuals allow one to explore regional variances within MD programs without any potential influence from DO programs.

Table 7

Program Ranking by Region MD Programs Only			
Rank	**Region(s)**	**AVE Points**	**States & Territories Included**
1	9	1.72	Arizona, California, Hawaii and Nevada
2	5	1.37	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
3	3	1.33	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, & W. Virginia
4	1	1.20	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
5	6	1.00	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
6	4	0.85	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
7	7	0.63	Iowa, Kansas, Missouri, and Nebraska
8	2	0.61	New Jersey and New York
9	8	0.50	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
10*	10 & 11	0	*Region 10*: Alaska, Idaho, Oregon, and Washington Region 11: Puerto Rico

* Regions 10 and 11 tied for last and as such were ranked 10th

As noted in *Figure 12* below, region 9 was also the top region for MD programs.

Figure 12

Table 8

Program Ranking by Region DO Programs Only			
Rank	**Region(s)**	**AVE Points**	**States & Territories Included**
1	3	1.75	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia
2	7	1.00	Iowa, Kansas, Missouri, and Nebraska
3	4	0.92	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
4	8	0.50	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
5	9	0.50	Arizona, California, Hawaii and Nevada
6	5	0.25	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
7	6	0.17	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
8	1	0	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
8	2	0	New Jersey and New York
8	10	0	Alaska, Idaho, Oregon, and Washington

As noted within *Table 8* and as illustrated in *Figure 13*, region 3 ranked the highest with the overall best alignment with nutrition training in their curricula. Region 3 included the states of Delaware, Maryland, Pennsylvania, Virginia, West Virginia and also the District of Columbia. In contrast, regions 1, 2 and 10 tied in having the lowest ranking and accordingly the lowest score at 0%. It should be noted that region 11 was excluded as no Osteopathic medical school programs were found to exist in Puerto Rico.

Figure 13

As evidenced in the data noted in *Table 6,* regional variances did exist when examining MD & DO programs combined. This was true even when reviewing solely MD programs (*Table 7*) or DO programs (*Table 8*) by region. Thus, the null hypothesis was rejected at any level of examination. Therefore, the alternative hypothesis which states, "There are regional variances when it comes to programs and their requirements for basic nutritional education within US medical schools.", was correspondingly be supported.

4.23 Secondary Research Question Three

3) How do older more established programs (programs established prior to year 2000) compare to newer programs (programs established in year 2000 and later) when it comes to the inclusion of nutritional training?

Null ($H_0$4): *No disparity exists between newer programs versus older more established ones in the focus on basic nutrition training within their programs.*

Alternate (H_a4): *A disparity exists between newer programs and older more established ones in the focus on basic nutrition training within their programs.*

The combined total of new MD and DO programs started since the year 2000 was 52. Comparing this to older more established programs, which totaled 148, indicating that there has been a roughly 35% increase in the number of medical school programs nationwide since that time.

These data, inclusive of both MD and DO programs show that older and more established programs had a greater percentage of programs with adequate training as evidenced by the higher percentage noted with the "E" classification. Medical school programs with a "Z" classification, for both older and newer programs, were similar at 62% and 63% respectively. Newer programs

had a much higher percentage of implied program training as evidenced by the percentages of programs classified as "I". Details on this are illustrated in *Figure 14*.

Programs with a ZOIED classification of "D", neither the older more established programs (Older) nor the more recently established programs (Newer) had any programs rated in that category. Classification "D" was the class given to programs that not only had an explicitly required course in nutrition, but also had optional or elective coursework for advanced training. An illustration of this, along with previously noted changes in percentage for other classifications are depicted in *Figure 14* below:

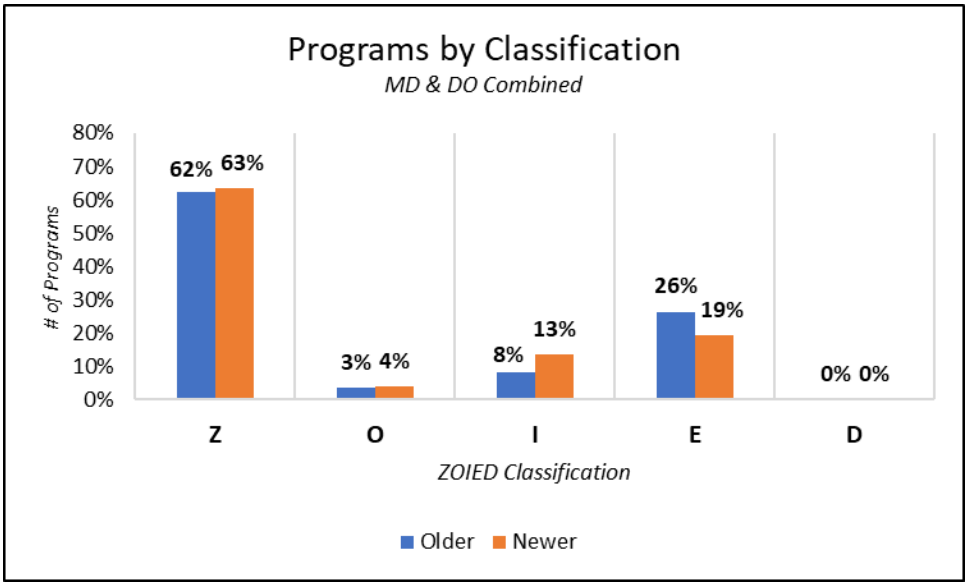

Figure 14

The next point within the findings ties more specifically to each of the two program types themselves (MD & DO). *Figure 15*, which follows, is a look at how older more established MD programs (Pre-2000 MD programs) compared to newer more recently established programs (≥2000 MD programs).

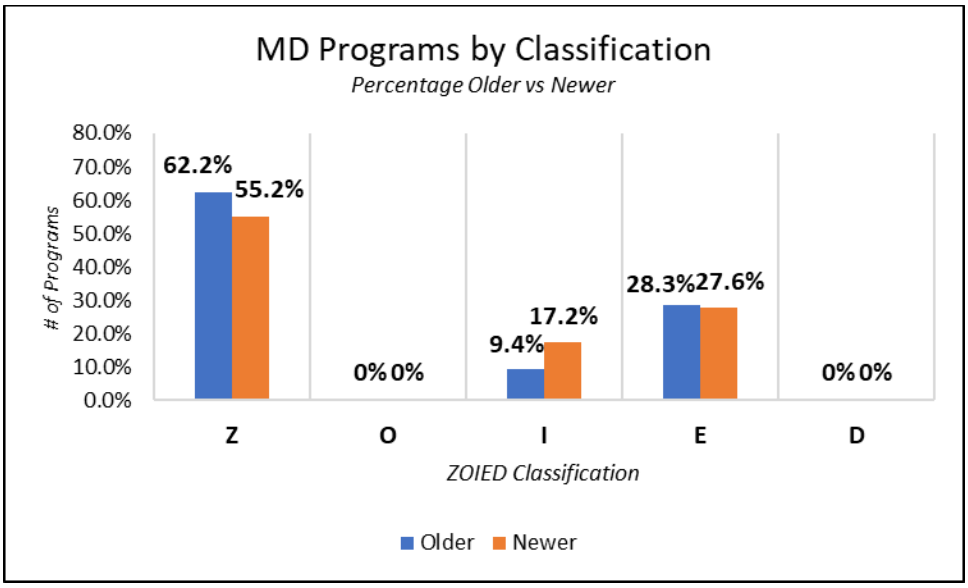

Figure 15

As exemplified in the results in *Figure 15*, among MD programs, newer MD programs were less likely to have zero focus (Class "Z") on nutrition within their newer programs. While they were slightly less likely to have explicit and adequate (Class "E") training, they were far more likely to have an implied or longitudinal inclusion of topics within their program (Class "I").

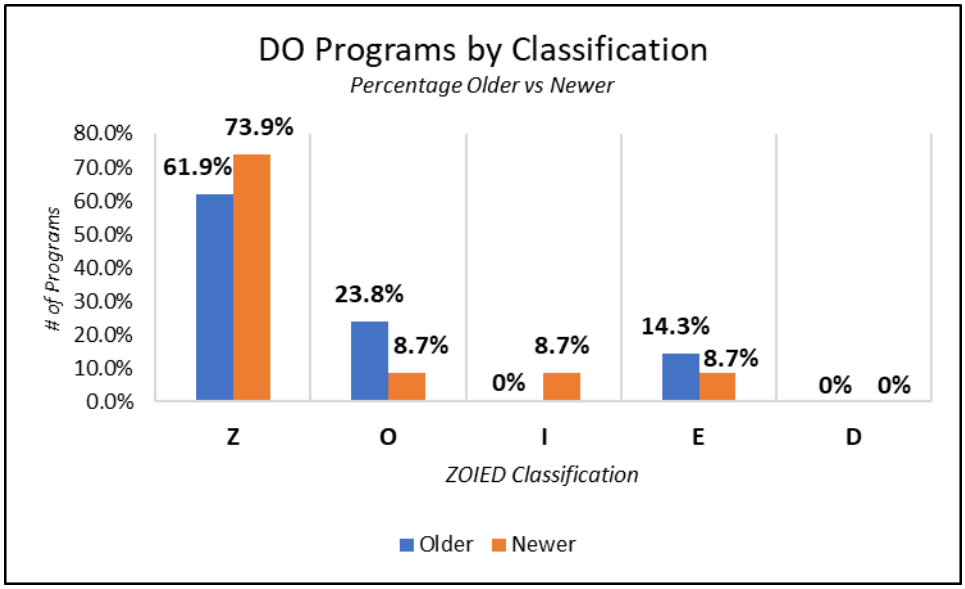

Figure 16

As illustrated by *Figure 16*, newer DO programs (≥2000 DO programs) were less adequate than earlier established programs. This was depicted by comparing the 8.7% of newer schools rated

as adequate (ZOIED classification “E”) to older programs that had 14.3% with an “E” classification.

4.24 Secondary Research Question Four

4) How many programs offer training in nutraceuticals that includes advanced nutritional topics tied to herbs and other advanced nutritional compounds?

Programs offering training on such topics were classified as “D” and at the time of this study, there were no programs with a “D” classification. This was further exemplified within *Figure 14* that was illustrated within section 4.23.

4.25 Secondary Research Question Five

5) Do any programs require a course of nutrition be taken as a prerequisite to admission into their medical school program?

Data gathered from each program found no requirements for a nutrition course as a prerequisite for acceptance. Therefore, the answer is to this research question was no.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions drawn from this research effort offer significant support to a host of prior research noting the need for better nutritional training for physicians. This study adds a unique contribution to the literature in that it encompassed every osteopathic and allopathic medical school program in the US during the 2019-2020 academic year. Geographically, this included all 50 states, as well as programs in Washington, DC and Puerto Rico. The inclusion of relevant history, curricula drivers and examples of pharmaceutical-nutraceutical influences, were aimed at orienting future readers to the nuances of healthcare, nutraceuticals and other associated realms.

As evidenced within the literature review, assertions of a deficit in nutritional training within US medical schools was indeed supported by this research effort. In creating and utilizing the ZOIED classification as a measure, it has been revealed that a mere 24.5% (nearly 1 out of 4) medical school programs have an adequate focus on nutrition within their curricula (Classification "E"). It's worth noting that just over 3 out of 5 programs were found to have zero focus on nutrition (Classification "Z"). Percentages are noted in figure 18.

.

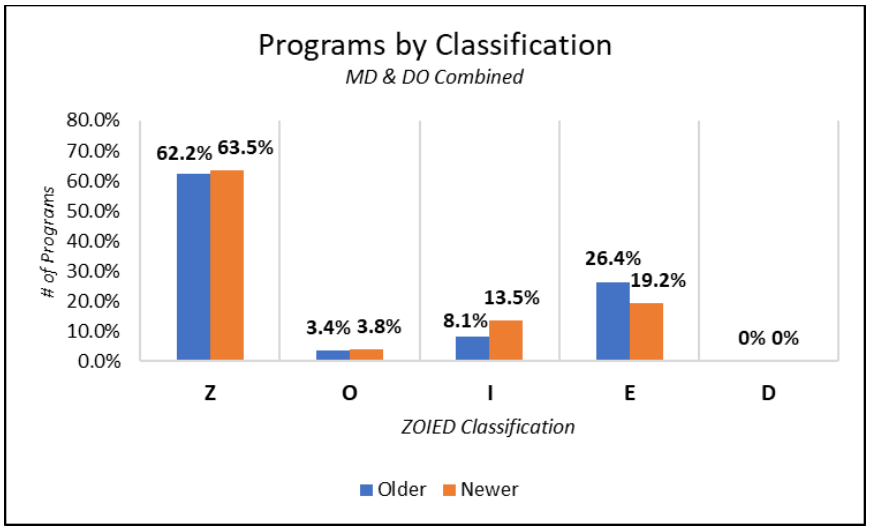

Figure 17

On a macro level, the slight rise noted within classification "Z" and decline with classification "E" as identified in *Figure 17* which is noted above leave room for concern. This should not take away from the roughly 1 in 4 programs that did hit the mark but would seem to infer that either the message for more focus on nutrition is either being unheralded or unheeded.

5.10 Discussion

The primary objective of this study was to evaluate the existence and associated method of training, of both basic and advanced nutrition training, within medical schools in the United States. The objective was based on a review of published curricula of accredited medical schools, which included published curricular required for admission to and completion of the degree at each institution. Additional materials reviewed included program catalogs, curriculum maps and other publicly available related materials (Curriculum map example noted in *Appendix I)*.

During the time of this study, there were 208 medical school programs total. This total included DO and MD programs combined and given that eight of those in existence were excluded

due to their first class having a start date beyond 2019. That resulted in a total of 200 active medical school programs identified as being the population.

While it would have perhaps been more convenient and less time consuming to sample from the population and run statistics over their details, that path was ultimately not chosen. This was chiefly due to the desire to ascertain, not only the overall picture, but also to be able to assess regional performance. It was also felt that the benefits of investigating all 200 programs, would offer greater details and less potential for ambiguity and a more reliable picture with a clearer view of subtler details that may be useful. It was ultimately determined that the benefits of the extra work and time involved would well outweigh the time invested.

5.20 Hypotheses Overview & Results

The major takeaways from this research are certainly tied purposefully to address the primary research question and the five additional secondary research questions. An overview of each is noted in the text that follows.

Primary Research Question

The major question or stance to be addressed was the adequacy of physician training within nutrition. This led to the need to test the hypothesis (Null ($H_0$1)) which states *"All medical school programs in the United States require a course in basic nutrition as part of their curricula."*. As noted in section 1.60, adequacy was defined as the existence of a course of a basic nutrition course that is required within the core curriculum. The resulting research led to a rather clear rejection of Null ($H_0$1) and acceptance of the alternate hypothesis (H_a1), which stated that "*Not all US medical schools require coursework in basic nutrition in their program.*". On that point, the results of the

research illustrated that less than 1 out of 4 (24.5%) medical school programs require a course that encompasses basic nutrition. Additional details on this are well illustrated in section 4.21.

Secondary Research Questions

The first of five secondary questions posed was, "*Do Allopathic (MD) and Osteopathic (DO) programs both have the same focus on nutrition?*". The null hypothesis stated that there is no difference between Allopathic (MD) and Osteopathic (DO) programs. As a result of the research, the null was rejected as variances were determined to exist as tied to the ZOIED scores that were tied to each category of program (MD and DO). Details on this are well illustrated in section 4.21.

The second question asked, "*Are there any regional variances between programs and their requirements for basic nutritional education within US medical schools*?". Research performed indicated that there were indeed regional variances. This was true of the 11 regions in question for the combination of MD & DO programs, but also true when looking solely at MD or DO programs on their own. Details on this are well illustrated in section 4.22.

The third question inquired, "*How do older more established programs (programs established prior to year 2000) compare to newer programs (programs established in year 2000 and later) when it comes to the inclusion of nutritional training?*". The null hypothesis stated, no disparity exists between newer programs versus older more established ones in the focus on basic nutrition training within their programs. It was subsequently rejected as variances in focus between the two groups were found and well-illustrated. Details on this are well illustrated in section 4.23.

The fourth question asked, "*How many programs offer training in nutraceuticals that includes advanced nutritional topics tied to herbs and other advanced nutritional compounds?*". Programs offering training on such topics would have a ZOIED classification of "D", which is the highest score available. At the time of this study, it was found that none of the 200 programs were classified at that level. Additional details on this are noted in section 4.24.

The fifth and final question asked was," *Do any programs require a course of nutrition be taken as a prerequisite to admission into their medical school program?*". The answer to this was a rather unambiguous no. This held true through a review of each of the 200 medical schools reviewed. Additional details on this are available within section 4.25.

While there is some satisfaction or silver lining from having completed the research that helps affirm some of what others have inferred in the past, the results tied to the status of nutritional education within medical schools remains troubling. Nutrition education has been marginal at best for a relative handful of medical schools across the country, yet the onus is on physicians to offer guidance. This is at a time when more and more people are taking supplements.

This is not to say that every person taking a nutraceutical connects with their physician prior to taking them. We should certainly expect that is not happening as the results of a 2019 CRN survey showed that only 54% of dietary supplement users consulted with their physician "about supplement use" (CRN Consumer Survey, 2019). This did not relate to whether or not they consulted with their physician about use prior to taking a specific supplement. It was open ended as to affirm that they had at one point had a conversation with their physician about "supplement use" (CRN Consumer Survey, 2019).

The reality that the onus has been on physicians, due to not only guidance from nutritional product manufacturers, but further reemphasized by the FDA as well (FDA.gov, 2018). This would seem to put them at a steep and unfortunate disadvantage, given their knowledge and opinions of nutraceuticals differs very little from that of the general public (Leeman, Fischler, & Rozin, 2011).

Why This Matters

It goes without saying that those attending medical schools across the country represent some of our best and the brightest minds. It is not at all due to a lack of aptitude that physicians enter their career lacking in competency and confidence tied to topics relating to nutrition. Despite

all of this, physicians are seen by the public generally as the most reliable and trustworthy source of nutritional guidance (2018 Food & Health Survey, 2018).

A peer reviewed study which included 114 resident physicians was published in the Journal of the American College of Nutrition (Vetter, Herring, Sood, Shah, & Kalet, 2008). Results from the study determined that 94% of resident physicians agreed it was their obligation to discuss nutrition with patients (Vetter, Herring, Sood, Shah, & Kalet, 2008). This was in contrast to only 14% of those surveyed feeling they were adequately trained to provide nutritional counseling (Vetter, Herring, Sood, Shah, & Kalet, 2008). This study and others have more than suggested the feeling of inadequacy that many physicians face when it comes to consulting with patients on topics tied to dietary supplements.

One may assume that competency and the need for conversations on dietary supplements are solely an outpatient or primary care matter. A peer reviewed study aimed at assessing the level of medicine reconciliation that included the reconciliation of dietary supplements was performed, and their results would definitely have most of us perhaps rethinking our position. The study found that overall, 72.4% of patients admitted to regularly taking at least one dietary supplement (Gardiner, Sadikova, Filippelli, White, & Jack, 2015). This same study found that 59.7% of admitted patients take at least one prescription medication and one dietary supplement regularly (Gardiner, Sadikova, Filippelli, White, & Jack, 2015). This runs contra to the reality where their research found that only 20% of patients were asked about dietary supplement use by their provider (Gardiner, Sadikova, Filippelli, White, & Jack, 2015).

The overwhelming lack of confidence reported among resident physicians, in feeling they were adequately trained well enough to provide nutritional counseling to their patients illustrates a genuine going concern (Vetter, Herring, Sood, Shah, & Kalet, 2008). 14% of the residents studied reported feeling adequately trained. (Vetter, Herring, Sood, Shah, & Kalet, 2008). This in tandem

with the research showing that only 20% of patients hospitalized (Gardiner, Sadikova, Filippelli, White, & Jack, 2015) are ever asked about nutritional supplements by their physician would seem to be related. It's certainly not a logical leap to conclude that physicians, who largely have a genuine lack basic nutrition training, may not actively seek to engage on such topics with patients.

A wealth of observations has resulted from this research effort that support the points below:

- Emphasis on the importance of nutritional education has and continues to languish in the United States. This is not simply an issue with allopathic (MD) or osteopathic (DO) programs. It exists to varying degrees within every program across the United States.

- Looking at the programs across the nation, the very best are merely adequate and have effectively zero training above that of a basic nutrition class.

- Government support of research within nutritional realms such as dietary supplements research at $25.3 million (Betz, 2019) pales fiercely with the FDA's support of pharmaceutical research, which topped $33.5 billion in 2017 (OECD, 2017).

- Physicians have been elected, whether they like it or not, to address this need. This comes both by way of FDA guidance and by public perception that they are highly trained experts on topics tied to nutrition and dietary supplements. This would obviously include topics spanning everything from basic nutritional, such as guidance on vitamins & minerals and diet, through more advanced topics tied to guidance on any of roughly 80,000 products (GAO, 2017) that their patients may be consuming.

5.30 Recommendations

Recommendation One

While there are no quick fixes to the current state, there are indeed a multitude of things that can be done to reverse the current trends. Probably the most significant and impactful changes, would be to seek changes at the federal level by seeking performance-based incentives for medical education tied to the inclusion of nutrition as a required course within their curriculum.

The need to illustrate the state of nutrition training and why changes are necessary, would be essential. An example of how this would not only benefit the public at large, but also how it makes fiscal sense would be useful. Along that note, using something similar to the impact type 2 diabetes on lifespan, productivity and healthcare spending may be useful. Below is a high-level overview of type 2 diabetes that offers some food for thought on the previously described points.

Type 2 Diabetes Consideration

According to the 2020 National Diabetes Statistics Report from the CDC, 34.2 million Americans had diabetes in 2018 and between 90-95% of the cases were Type 2 (CDC.gov, 2020). That translates to between 30.7 and 32.5 million Americans being treated for the disease. The loss of life, in comparison to individuals who are not type 2 diabetic are 5.4 years for men and 6.3 years for women (Wright, et al., 2017).

Despite our best efforts, the number of type 2 diabetes cases continues to rise annually (CDC.gov, 2020). The CDC noted new cases continue to rise annually and that in 2018 alone the rise in cases equated to roughly 1.5 new cases of diabetes (CDC.gov, 2020). This is despite the medical expertise and standards of care we have in place.

Benefits of Education

It is essential for physicians to be educated so they can more actively and effectively engage in counseling with patients (Hallberg, Gershuni, Hazbun, & Athinarayanan, 2019). As was noted earlier in chapter 2, physicians have the highest degree of trust as a source for guidance on nutrition and dietary supplements (2018 Food & Health Survey, 2018). Yet their level of knowledge and opinions differ little from those of the general public (Leeman, Fischler, & Rozin, 2011). This is the same public that is seeing a steady rise in type 2 cases (CDC.gov, 2020). Considering the importance of dietary and nutritional guidance in the prevention and management tied of type 2 diabetes (Sami, Ansari, Butt, & Hamid, 2017), this would seem to make a solid case for a change from the status quo.

Nutritional and Communication Factors

As discussed within the literature review, turmeric (curcumin) is one of the more common herbal supplements consumed today (See section 2.62). The product gained in popularity due to more and more people taking it for reported properties that can aid in the management of pain and inflammation. Users of turmeric most likely have zero knowledge about its potential impact with medications such as metformin. On the same note, since most physicians have no more understanding of turmeric than the general public, it may not dawn on them to intervene. Imagine how many of the 30+ million type 2 diabetics in the US may be taking metformin along with turmeric (curcumin)? In 2018 metformin was the 4th most prescribed medication in the United States. Revisiting the literature review in chapter 2 (Section 2.51), the potential is noted that the consumption of turmeric (curcumin) can impact metformin by creating an additive effect on blood sugar, thereby increasing the potential risk of hypoglycemia (Chuengsamarn, Rattanamongkolgul, Luechapudiporn, Phisalaphong, & Jirawatnotai, 2012). It is also worth noting that hypoglycemia is

in itself a potential side effect in taking metformin by itself (John P. Cunha, 2020), This is especially so if patients fail to heed the protocol prescribed by their physician.

Given the status quo where physician knowledge on nutraceuticals is similar to the general public (Leeman, Fischler, & Rozin, 2011), it is not optimal when neither the patient nor the physician is aware of the potential dynamic. Even if the physician did know, if the patient was not asked, it would be likely that the factor would remain unknown and any thoughts towards incidents on hypoglycemia would be chocked to either the patients' diet, compliance or even potentially the dosage prescribed. Knowledge of this would give the physician an opportunity to guide the patient appropriately and ultimately have better outcomes. The reality that turmeric has even been shown to have a positive impact in the effective management and prevention of type 2 diabetes (Chuengsamarn, Rattanamongkolgul, Luechapudiporn, Phisalaphong, & Jirawatnotai, 2012) may also expand their success.

Economic Factors

Direct medical costs tied to the treatment of type 2 diabetes totaled $237 billion in 2017 (American Diabetes Association, 2018). Most of the cost of type 2 diabetes care is covered by government insurance, which includes payors such as Medicare, Medicaid, etc., (American Diabetes Association, 2018). In 2017 it was noted that 67.3% (approximately $159 billion) of the costs were incurred and covered by government insurance, which includes coverage by Medicare, Medicaid and military insurance (American Diabetes Association, 2020).

The question that comes to mind now is how much would care potentially improve when it comes to the prevention, management and potentially even reversals of type 2 diabetes? If cases were to be better managed, would we see the upward trend of annual cases ease, flatten or eventually decline? These are certainly questions to consider. Using the $237 billion in medical costs associated with type 2 diabetes in 2017 as an example (American Diabetes Association,

2018), if aims for better nutritional training resulted in the prevention or reversal even 0.5% of direct costs, that would equate to a savings of nearly $1.2 billion dollars annually.

Recommendation Two

Potentially in tandem with seeking governmental changes that would support more effective nutritional education within medical school, there is a need to support research on nutraceuticals. The NIH Office of Dietary Supplements functions to some degree in that direction, but with an overall budget of $26.8 million (Betz, 2019), it seems well underfunded for any type of meaningful research initiative. Perhaps the potential savings tied to improved management of type 2 diabetes and cost savings would offer some encouragement.

Recommendation Three

State legislatures should consider the benefits of requiring physicians to complete CME courses in nutrition prior to licensure renewal. This might allow for physicians who are currently practicing medicine to build more knowledge in this realm and serve as a benefit to their patients.

Recommendation Four

Medical schools themselves could take the lead on their own as well. This would be by changing their own curriculums to include nutrition being part of their core curriculum and also include advanced training on nutraceuticals or other such topics as electives. Funding for this could potentially be covered by the pursuit of grants from granting agencies or from willing benefactors that see this as being a cause worth supporting.

Recommendation Five

Medical schools could effectively elect to make a course in nutrition mandatory for admission to their program. That would take the cost off their shoulders and also assure that their students had training in advance of being accepted into the program.

No doubt there are a host of other recommendations that could be made which would add to this list. The hope of this research is that it spurs action and perhaps offers support to those who seek to be able to illustrate the negative impact tied to the lack of emphasis on nutrition training has on our health system. The status quo has been to kick the can down the road and it has left our best and brightest at a great disadvantage. There are numerous opportunities to better manage our resources and also to gain from a greater synergy between having a well-developed educational basis within both the pharmaceutical and nutraceutical realms. The hope is that medical schools and physicians will recognize the need for change and act accordingly, so that they can truly serve as the experts they are trusted and expected to be for the general public.

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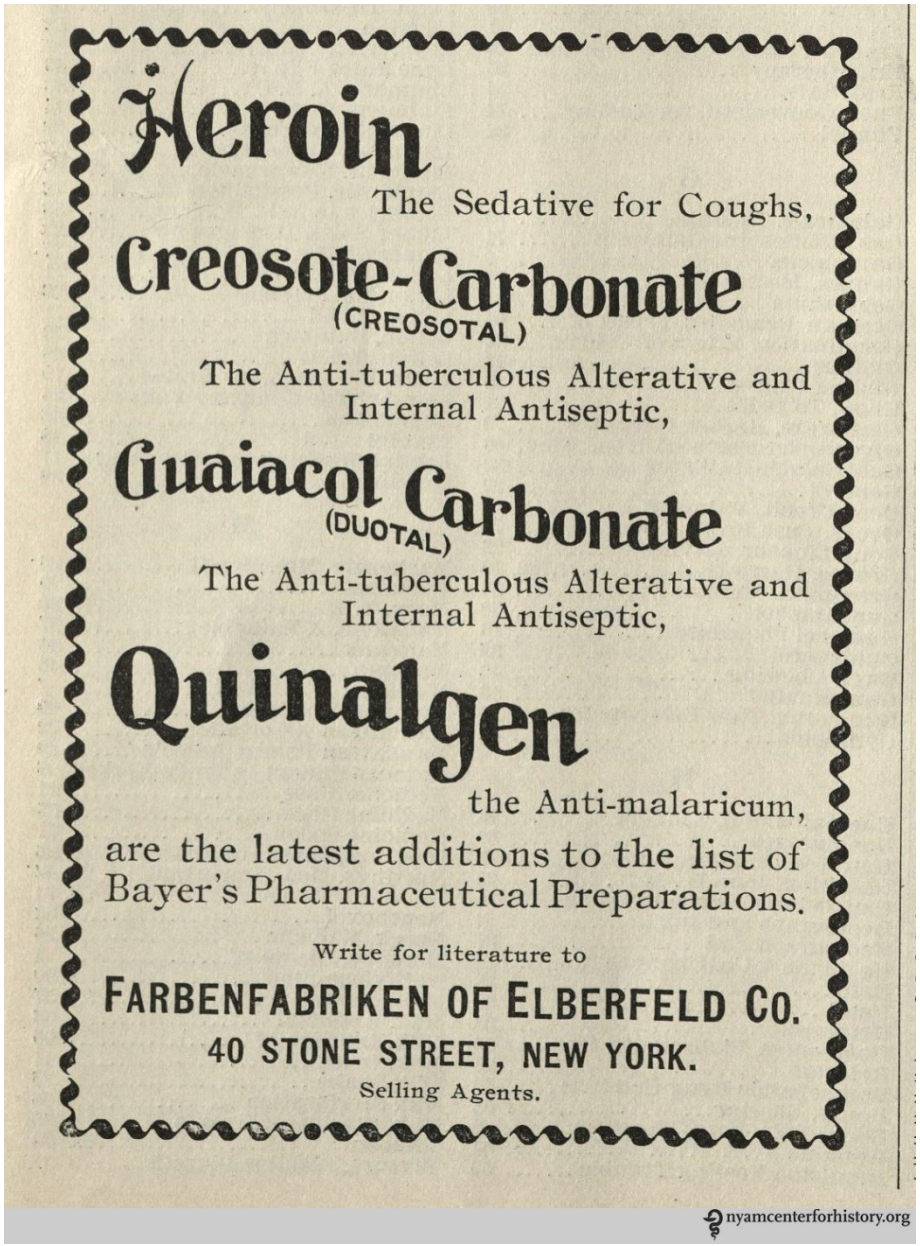
APPENDICES

APPENDIX A: Practical Druggist Advertisement 1907

(The Practical Druggist and Review of Reviews, 1907)

APPENDIX B

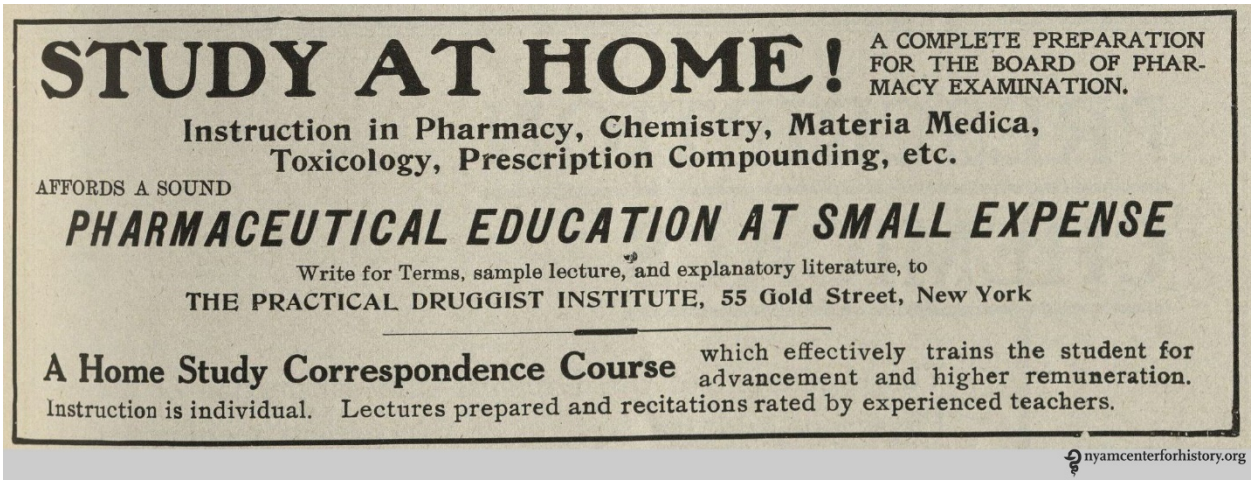


(The Practical Druggist and Review of Reviews, 1899)

APPENDIX C

(Ad, 1900)

APPENDIX D



(The Practical Druggist Institute, 1917)

APPENDIX E

THE PRIZE ADVERTISEMENT.

Prescription Filling

Is the one part of the drug business which I should imagine would be of interest to every customer of a drug store. Not because it is anything wonderful, this being able to compound a doctor's prescription without making an error, but the wonder of obtaining these delicate chemicals, where they came from, the change that takes place in compounding, and a thousand and one things of importance to health and life in the proper handling of what at first may appear a simple prescription. For instance, the mixing of Antipyrine with sweet spirits of nitre, as all pharmacists know, makes a compound which would probably cause death if given in doses as large as might be given of either one alone. For a druggist to attempt to mix turpentine, sweet oil and sulphuric acid in a bottle would result in an explosion and the ruining of his clothing if nothing worse happened.

Speaking of Antipyrine, it might be of interest to the customer to know that since the patent on Antipyrine has expired it can be bought at a very material reduction from their old price of $1.40 per ounce. But such new remedies as Heroin at $4 per ounce, Tetraethyammonium Hydroxide at $2, Propylamine at $5, and Eucaine at $2.50 have put in an appearance and consequently your breath may be taken away occasionally by the high price of a prescription.

However, it has always been my aim to compound prescriptions at a reasonable profit and not make the price of a cheap prescription high enough to pay the extra price of an expensive one.

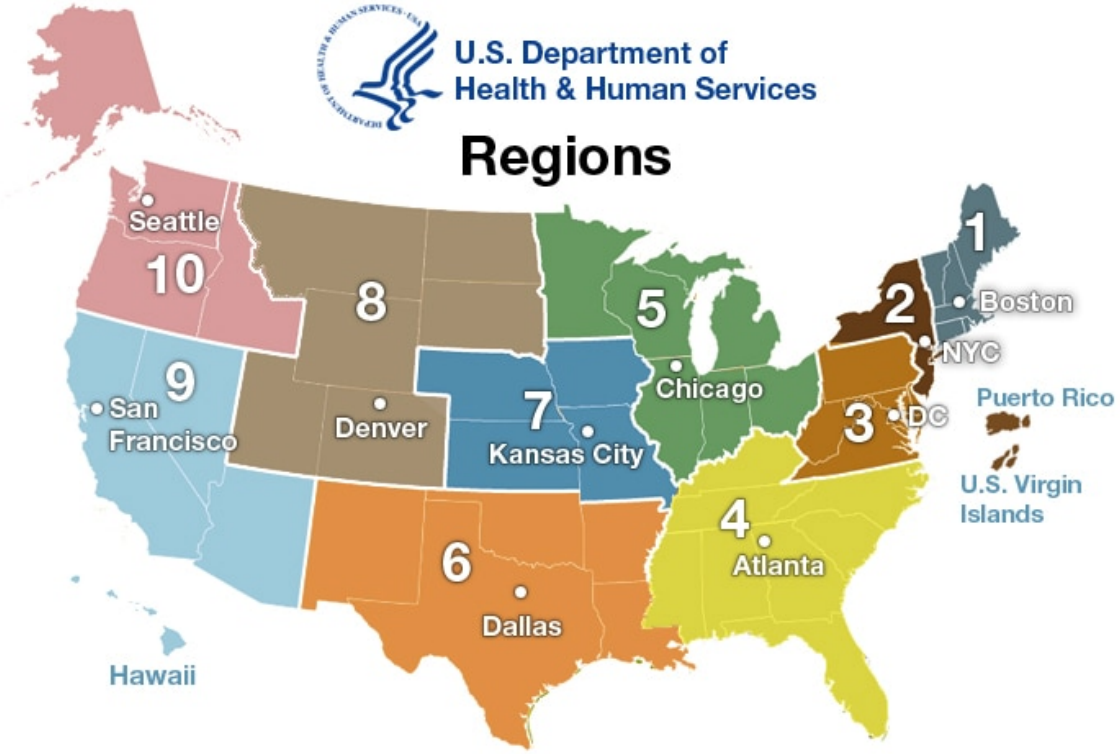
I have been in the prescription business pretty much all my life and each year am making an effort to serve my customers better than the year before.

C. G. HUNTLEY,

Prescription Druggist, OREGON CITY, ORE.

(American Druggist and Pharmaceutical Record, 1899)

APPENDIX F



(HHS.gov, 2020)

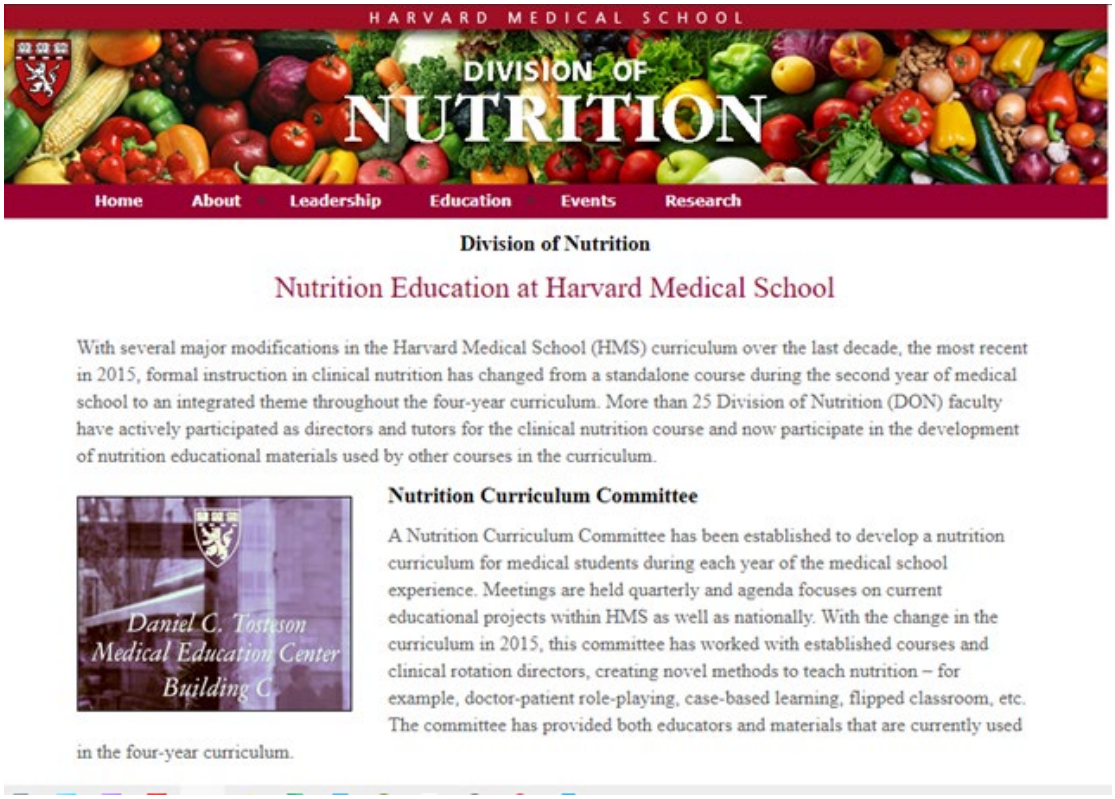
APPENDIX G

Region	States
1	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
2	New Jersey, New York, Puerto Rico and Virgin Islands
3	Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia
4	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee
5	Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin
6	Arkansas, Louisiana, New Mexico, Oklahoma, and Texas
7	Iowa, Kansas, Missouri, and Nebraska
8	Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming
9	Arizona, California, Hawaii and Nevada
10	Alaska, Idaho, Oregon, and Washington

(HHS.gov, 2020)

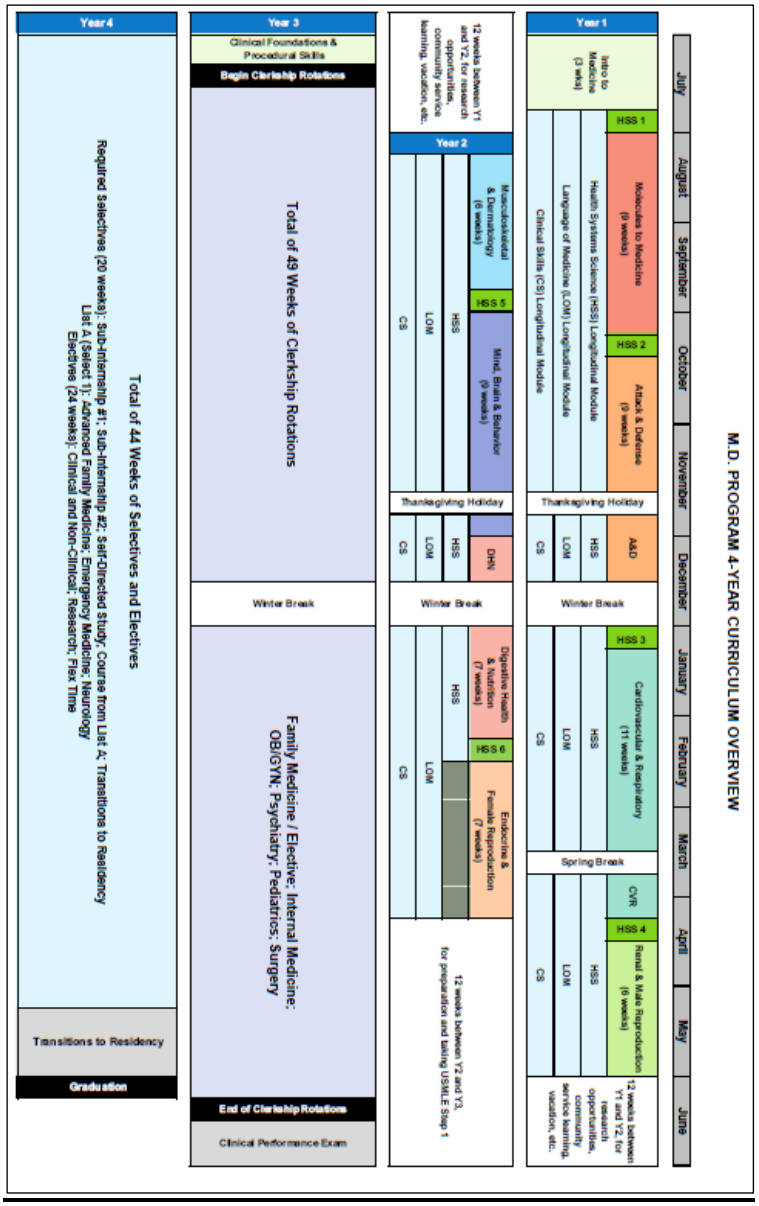
APPENDIX H

Harvard Medical School, Division of Nutrition Screenshot



(Harvard Medical School)

APPENDIX I



(UTRGV, 2020)

APPENDIX J

Table 2. Prevalence of Reported Motivations for Use of Dietary Supplements Among Adults (≥20 Years) by Sex in the United States, 2007-2010[a,b]

	% (SE)		
Reason	All Adults (n = 5514)	Men (n = 2450)	Women (n = 3064)
To improve overall health	45.0 (1.2)	46.4 (1.5)	43.9 (1.2)
To maintain health (stay healthy)	32.8 (1.1)	32.8 (1.4)	32.8 (1.4)
For bone health	25.2 (0.8)	11.3 (0.8)	35.8 (1.2)[c]
To supplement the diet	22.0 (1.1)	20.8 (1.2)	23.0 (1.4)
To prevent health problems	20.4 (0.8)	20.6 (1.0)	20.2 (1.0)
For heart health, lower cholesterol	15.1 (0.8)	17.6 (1.1)	13.2 (0.8)[c]
To boost immunity, prevent colds	14.5 (0.9)	15.8 (1.1)	13.4 (1.2)
For healthy joints, prevent arthritis	12.4 (0.6)	12.2 (0.9)	12.5 (0.8)
For enhanced energy	10.8 (0.5)	9.9 (0.8)	11.4 (0.6)
For skin health, dry skin	5.1 (0.5)	3.8 (0.7)	6.0 (0.7)
Other reason	4.5 (0.4)	3.4 (0.5)	5.4 (0.6)
For bowel or colon health	4.8 (0.4)	3.7 (0.4)	5.6 (0.6)[c]
For anemia, low iron	4.6 (0.3)	2.6 (0.4)	6.2 (0.5)[c]
For eye health	4.3 (0.3)	3.7 (0.4)	4.7 (0.4)
For mental health	3.7 (0.4)	3.9 (0.5)	3.5 (0.4)
For weight loss	2.6 (0.3)	2.0 (0.3)	3.1 (0.4)
For muscle-related issues	1.5 (0.2)	1.5 (0.3)	1.5 (0.2)
For healthy hair and nails	1.2 (0.2)	0.3 (0.1)[d]	1.8 (0.3)[c]
To improve sleep	1.1 (0.2)	0.9 (0.3)[d]	1.2 (0.2)[c]
For prostate health	NA	4.2 (0.4)	NA
For menopause	NA	NA	1.5 (0.3)
For pregnancy[b]	NA	NA	1.6 (0.3)

(Bailey, Gahche, Miller, Thomas, & Dwyer, 2013)

VITA

Donald P. Lowther

Candidate for the Degree of

Doctor of Philosophy

Dissertation: THE CURRENT STATE OF NUTRITION AND NUTRITIONAL SUPPLEMENT TRAINING IN MEDICAL SCHOOLS

Major Field: Health, Leisure & Human Performance

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Completed the requirements for the Bachelor of Science in Business Administration at University of Tulsa, Tulsa, Oklahoma in 2007.

Completed the requirements for the Associates of Applied Science in Physical Therapy at Tulsa Community College, Tulsa, Oklahoma in 1995.

Experience: A polymath entrepreneurial background with over 20 years of combined healthcare experience within the administrative, financial and clinical realms (physical therapy). Other realms include: Product launches, Leadership, Finance, Arbitrage, Healthcare Operations, Analytics, Strategy and Consulting. Veteran of the US Navy serving 4 years aboard a fast attack nuclear submarine. Meritorious Unit Commendation recipient (Naval equivalent of Bronze Star for valor). Humanitarian Service Medal and Naval Expeditionary Medal recipient. Two-time Battle Efficiency E recipient.

Professional Memberships: American Society for Nutrition