PSYCHOSOCIAL AND BEHAVIORAL FACTORS AFFECTING DIETARY INTAKE IN RELATION TO FEDERAL DIETARY GUIDANCE

by

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DEDICATION

To my parents, for making a refrigerator door of participation ribbons feel like a trophy case, and for teaching me that smart girls are cool girls. Because of you, I still don’t know what it means to “can’t.” Thank you.

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ABSTRACT

The purpose of this research is to identify psychosocial and cognitive correlates of dietary intake patterns and weight status, and to evaluate the effectiveness of nutrition guides and federal dietary guidance from an historical approach, identifying their long-term role in health attitudes and behaviors. Forty-seven college students completed a 24-hour dietary recall and Dietary Awareness Survey measuring demographic characteristics of participants, knowledge of the Food Guide Pyramid (FGP), support for federal dietary guidance, and self-efficacy for eating healthy. Adherence to FGP recommendations was low among participants, as were knowledge, support, and self-efficacy scores. No significant correlation was found between knowledge and intake. While there was no evidence of association between support, self-efficacy, and adherence, support was significantly correlated with increased fruit intake, and self-efficacy was associated with decreased intake of soft drinks. Lastly, those adhering to overall and dairy FGP recommendations had higher BMI scores than those not adhering. These results suggest limited retention of nutrition guide recommendations, as well as psychosocial determinants of adherence beyond intrapersonal factors. Limitations included, self-reported weight and dietary intake data, which may have introduced response bias, as well as a small, homogenous sample, limiting external validity. Future research should examine the role of interpersonal and environmental constructs in affecting dietary intake, as well as the association between dairy intake and weight status.

CHAPTER 1

INTRODUCTION

History and Purpose of Federal Dietary Guidance and Nutrition Guides

Since the passage of the 1990 National Nutrition Monitoring and Related Research (NNMRR) Act, the U.S. Departments of Agriculture (USDA) and Health and Human Services (DHHS) have been charged with publishing the Dietary Guidelines for Americans (DGA) once every five years to improve the health status of the nation. The DGA provides the population with nutrition information that reflects current research and public health needs, as well as driving public policy.[1] DGA recommendations dictate nutrition standards and food allotments for a wide range of federal programs, including the National School Lunch Program (NSLP) and Supplemental Nutrition Assistance Program (SNAP),[2] affecting the food choices of millions of people.[3,4] Additionally, DGA guides the development of nutrition guides, visual tools designed to provide health promotion and nutrition education materials for the public.[5]

Prevalence and Consequences of Obesity

When the Food Guide Pyramid (FGP), the first nutrition guide created after the 1990 NNMRR Act and mandated DGA, was released in 1992, 25% of adults in the US were obese.[6] In 2010, 35.1% of adults were considered obese.[7] As the population grows heavier, obesity has cost the U.S. greatly, and obesity-related chronic diseases accounted

for $147 million in medical costs in 2008.[8] The rising rate of obesity also poses a national security threat. A fourth of Americans ages 17-24 are now ineligible for military service due to weight status,[9] and in 2012, the Army dismissed 1,600 soldiers for being above the maximum body weight limit.[10]

Determinants of Health Behaviors

Theory has guided the understanding of health behaviors and related outcomes, and has helped shape program planning, policies, and interventions.[11] Theoretical frameworks and their constructs and models are not universally applicable, and change with each context and population. College students present a unique population in terms of examining dietary intake, and have been defined by a transitional status from youth to adulthood that results in a lack of self-efficacy in performing positive health behaviors.[12] Self-efficacy has been primarily used to describe and assess food choices and health outcomes of this population, with perceived confidence to manage time, stress, and emotions associated with improved dietary intake and health outcomes moreso than perceived confidence to make healthy choices.[12,13] Evidence of knowledge as a determinant of behavior remains inconclusive,[11] and dietary intake has been associated only weakly with cognition.[14]

Statement of Purpose

The purpose of this research is to identify psychosocial and cognitive correlates of dietary intake patterns and weight status, and to evaluate the effectiveness of nutrition

guides and federal dietary guidance from a historical approach, identifying their long-term role in health attitudes and behaviors.

Inclusion Criteria

The systematic review of literature presented in Chapter 2 was limited to U.S. studies, and only participants living in the U.S. during time of study (1992-2013) were included. For the research presented in Chapter 3, only data of participants born between 1987 and 1995 and having attended elementary school exclusively in the U.S. were included in the results. Participation in the study presented in Chapter 4 was limited to adult college students.

Limitations

These studies were limited by the demographic profile of the university from which participants were recruited. Generalizability of results may be limited to this mainly Caucasian, college-aged population. Use of self-reported weight and dietary intake may also introduce response bias and limit the accuracy of the results, although the 24 hour dietary recall used in this thesis has been validated.[15,16] Additionally, non-parametric data limited the use of regression analysis and identifying causality of variables.

Assumptions

It is assumed that participants responded to the 24-hour dietary recall accurately and honestly, with participants fully understanding and following dietary recall instructions and providing truthful information regarding dietary intake. It is also assumed that participants completing study instruments measuring knowledge online did not receive assistance in responding to these items and interpreted the questions as intended and responded as accurately as possible.

Operational Definitions

Adherence: Meeting recommendations as defined in federal dietary guidance or nutrition guide. For this study, meeting without exceeding recommendations.

Dairy: Unifying term for to FGP milk, yogurt, and cheese group and MyPyramid and MyPlate milk groups.

Federal dietary guidance: Documents and programs outlining nutrition recommendations as established by USDA and DHHS.

Food group: Category containing nutritionally similar items as defined by nutrition guide of interest.

Fruits: Unifying term for FGP, MyPyramid, and MyPlate fruit groups.

Grains: Unifying term for FGP bread, cereal, rice, and pasta group and MyPyramid and MyPlate grains groups.

Intake: Consumption of foods or food group servings in absolute terms (e.g., not in relation to nutrition guide recommendations).

Nutrition guide: Visual extension of federal dietary guidance used for consumer education and health promotion (e.g., FGP, MyPyramid, MyPlate).

Proteins: Unifying term for FGP meat, poultry, fish, dry beans, eggs, and nuts group, MyPyramid meat and beans group, and MyPlate protein group.

Serving: Quantifiable amount for measuring food intake. For this study, amounts as defined by DGA1990 and FGP.

Vegetables: Unifying term for FGP, MyPyramid, and MyPlate vegetable groups.

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CHAPTER TWO

RECENT POPULATION ADHERENCE TO AND KNOWLEDGE OF UNITED STATES FEDERAL NUTRITION GUIDES 1992-2013: A SYSTEMATIC REVIEW

Contribution of Authors and Co-Authors

Manuscript in Chapter 2

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Contributions: Conceived and implemented study design. Collected and analyzed data. Wrote first draft of manuscript. Edited additional drafts for final submission.

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Contributions: Helped conceive and implement study design. Provided field expertise and statistical advice. Edited drafts for final submission.

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ABSTRACT

The Dietary Guidelines for Americans dictate federal nutrition programs and policies. Corresponding nutrition guides have been established to guide the public in dietary intake patterns, as well as to ameliorate the US obesity epidemic and its health-related outcomes. The purpose of this systematic review is to summarize population adherence to and knowledge of United States nutrition guides since 1992, including Food Guide Pyramid, MyPyramid, and MyPlate. Of the 31 studies included for review, 22 examined adherence, six examined knowledge, and three examined both adherence and knowledge. Across studies, adherence to nutrition guides is low, with participants consuming inadequate levels of fruits, vegetables, and dairy in particular. Knowledge of nutrition guides increases over time since publication and decreases with age of participants. Association between knowledge of and adherence to nutrition guides was not found. Disparities in knowledge and adherence existed across demographic groups. Based on these findings, federal dietary guidance can be strengthened by increasing dissemination of nutrition guides to the public and tailoring promotional activities for demographic and socioeconomic groups.

INTRODUCTION

As of 2010, 35.1% of US adults and 16.7% of US children were considered obese,[1,2] a reflection of a national diet high in empty calories, refined grains, and saturated fat.[3] Since the passage of the 1990 National Nutrition Monitoring and Related Research Act, the United States Department of Agriculture and Department of Health and Human Services have been charged with publishing Dietary Guidelines for Americans

(DGA) once every five years in order to provide the public with nutrition information and guide federal nutrition programs.[4] These guidelines have evolved to meet population needs in line with current research. DGA 2010, for example, addresses overweight, obesity, and chronic disease concerns, and emphasizes both individual and environmental factors as determinants of health outcomes.[5]

DGA have served as the inspiration and scientific basis for the development of nutrition guides, visually-based population tools for communicating nutrition information to the public.[6] Also reflecting the current national health status, nutrition research, and consumer needs, the Food Guide Pyramid (1990),[7] MyPyramid (2005),[8] and MyPlate (2010)[9] have provided iconic representation of health promotion and education materials.

Nutrition guides are designed to influence public health.[10] Establishing the impact of these guides will assist nutrition educators, researchers, and policy makers in the development of evidence-based health promotion strategies. The purpose of this systematic review was to assess population adherence to and knowledge of United States (US) nutrition guides since 1992. Given the current dietary patterns of the US population and related health outcomes, poor adherence to and knowledge of nutrition guides for all nutrition guides is hypothesized.

METHODS

Knowledge of and adherence to nutrition guide recommendations were examined. In this review, knowledge refers to information known about nutrition guides or reported application of nutrition guides without measuring intake. Adherence refers to dietary intake of participants in terms of nutrition guide recommendations. Food group

terminology has changed as nutrition guides have evolved, and for the purpose of this review, "grains" refers to FGP bread, cereal, rice, and pasta group as well as MyPyramid and MyPlate grains groups; "proteins" refers to FGP meat, poultry, fish, dry beans, eggs, and nuts group, MyPyramid meat and beans group, and MyPlate protein foods group; and "dairy" refers to FGP milk, yogurt, and cheese group. Fruit and vegetable groups were nominally the same.

Articles included in the review were gleaned through a systematic literature search of three electronic databases (PubMed, ScienceDirect, and Web of Knowledge). Terms used in this search included: *Food Guide Pyramid*, *MyPyramid, or MyPlate* and *adherence*, *follow*, *knowledge*, *compliance,* or *behavior*. Articles retrieved from initial search were screened using the following criteria: English language, conducted in the US, and published after 1992 until October 2013. The year 1992 was chosen as it marks the year the FGP was published.[9]

Articles fitting inclusion criteria were considered for full review if the title, abstract, or keywords indicated that the study examined adherence or consumption in relation to or knowledge of FGP, MyPyramid, MyPlate, or a combination of those terms. A list of non-duplicative relevant articles that met the inclusion criteria was compiled. The full texts of potentially relevant articles were reviewed for inclusion if they focused on knowledge of or adherence to nutrition guides. For example, studies describing intake patterns of macronutrients and micronutrients without mention of food groups or studies with categorizations of food groups not matching nutrition guides were excluded.[11,12] Studies focusing on one or two food groups relative to a nutrition guide, such as just fruit

and vegetable (FV) consumption, were included. Studies were excluded if they occurred outside of the US or presented dietary data not compared to US nutrition guidance. Studies reviewing additional federal dietary guidance (DGA, etc.) were included in the review as supplementary insight only if they met the inclusion criteria and relevance to nutrition guides. No studies were excluded or reviewed based on study design, sample, or study quality to allow for a variety of participant characteristics, methods, and variables.

A final list of relevant studies was compiled for full review, and a data matrix of these studies was generated by study authors using the following headings: first author, year; nutrition guide; purpose; measures; sample size, demographics; results.

RESULTS

The initial database search retrieved 2,514 articles, and 2,461 abstracts were screened after initial exclusion of 53 non-English articles and articles published before 1992 (See Figure 2.1). After elimination of those that did not pertain to adherence to or knowledge of FGP, MyPlate, or MyPyramid, 37 non-duplicative articles remained. A full review of these articles eliminated one article not occurring in the United States and five articles presenting adherence or intake values other than food groups dictated by USDA nutrition guides, yielding 31 articles for the final sample. This review included 22 studies that examined adherence to federal dietary guidance (Table 2.1),[13-34] six that examined knowledge of federal dietary guidance (Table 2.2),[35-40] and three that examined adherence and knowledge (Table 2.3).[41-43]

A majority of studies were descriptive, with one experimental study included.[18] Of these descriptive studies, two were self-identified as longitudinal,[13,20] and four were

self-identified as cross-sectional.[14,16,17,34] Studies in the review involved children, both children and adults, and five studies targeted a specific population or population characteristics (n=5).[15,27,30,38,42] These targeted populations were NCAA Division I athletes,[15] Native American Oklahoma women not currently living on a reservation,[27] elderly Kansans participating in a congregate meal program,[30] women with two children or more under the age of 18,[38] and Latinas with or without type 2 diabetes who are neither breastfeeding nor pregnant.[42]

For studies examining adherence to nutrition guides, most used a 24-hour dietary recall (n=8)[13,14,23,26,30,32-34] or validated food frequency questionnaire (FFQ) (n=10).[16-18,24,25,28,29,41-43] All studies examining knowledge (n=9) of nutrition guides used a questionnaire or survey regarding knowledge, behaviors, or attitudes.[35-43] Two studies sampled questions from the NHANES 2005-6 questionnaire,[39,40] and seven studies used unique surveys,[35-41] two of which were tested for validity and reliability.[42,43] Three studies examining knowledge also used a FFQ to test dietary intake.[41-43]

All (n=31) studies reported descriptive statistics, including the mean number of servings of each food group consumed among participants,[13-15,17,19-26,29,33,41,42] percentage of participants meeting minimum food group serving recommendations,[13,16,18,20,23,26-28,30-32] and/or percentage of participants with knowledge of nutrition guides.[35-42] In addition, some studies made comparisons between participant groups based on age,[19] sex,[13,17,19,24,25,26,28,30,34,40,43] and ethnicity/race.[13,14,25,33,39,40,43]

Adherence Studies

Adherence Study Design and Methodology.

Twenty-one adherence studies examined the degree to which participant's dietary intake aligned with recommendations detailed in FGP,[13-27] MyPyramid,[28-30] or a combination of FGP, MyPyramid, DGA 2005, and/or the 5-a-Day program.[31-34] Adherence studies included self-identified longitudinal design,[13,20] cross-sectional design,[14,16,17,34] and all but one[28] were descriptive. Studies ranged from 28[15] to 215,000[24,25] participants, with many of the larger studies using secondary analysis of national survey data or data from cohort studies.[14,18-21,24,25,31-34] Adults (over the age of 18),[14,15,17,23-27,30-34] children,[13,14,16,19,20,22,28,29,32,33] or both children and adults,[14,32] were identified as participants.

All adherence studies used a dietary recall or FFQ to measure participants' consumption patterns. Eight studies[13,14,23,26,30,32-34] used 24-hour dietary recalls,[44] five studies[3,14,30,32,34] used the Automated Multiple-Pass Method (AMPM) 24-hour dietary recalls,[45] and seven studies[16-18,24,25,28,29] used FFQs.[46,47,48] Two-,[19-22,31] three-,[15,29] and four-day[27] recalls were also used to collect dietary intake.

Adherence Study Results.

Total intake of food groups was reported in two ways: mean intakes of a sample,[13-15,17,19,20,22-26,29,33] or percentage of a sample meeting certain recommendations.[13,16,18,20,23,26-32] Participants across studies tended to consume an inadequate mean amount of fruits.[13-15,17,20,21,29,33] vegetables,[13-15,17,19,20,22,29,33] and dairy,[13,14,20,21,24,25] and exceeded recommendations for proteins.[14,15,21,24,25] Four studies

using children as participants found inadequate consumption of grains[22,33] and proteins.[13,20] Two studies, sampling college students,[23,26] found mean intake to meet recommendations for all food groups.

Results reported as percentages described the proportion of a sample meeting a nutrition guide recommendation,[3,16,23,26,30-32] not meeting a recommendation,[18,28] meeting all recommendations,[23,27] and meeting no recommendations.[20,30] The percentage meeting recommendations ranged from 17.7%[30] to 61%[26] for grain, 8.4%[16] to 70%[23] for vegetables, 5%[13] to 62%[26] for fruit, 3.5%[30] to 60%[26] for dairy, and 26%[13] to 54.1%[31] for protein, with children and the elderly at the lower range,[13,16,30] and adults, particularly college students, at the higher range.[23,26,31] Low adherence to all FGP recommendations was common, with 100% of participants in one study inadequately consuming all food groups,[30] and 0.6%[23] to 6%[27] of participants meeting all recommendations in other studies.

Some studies included comparisons between demographic groups. Eight studies made comparisons between males and females.[13,17,24,[26,28,30,34] Females met FV recommendations servings more frequently than males in several studies,[24,25,30] although one study showed males as more likely to meet vegetable recommendations than females despite no significant difference in mean intake between the sexes.[13] Males consumed more proteins than females,[17,26,28] and were more likely to adhere to protein and grain recommendations.[25]

Four studies compared consumption with ethnicity/race,[13,14,25,33] three of which sampled children.[13,14,33] African-Americans consumed more fruits than whites, and

whites consumed more dairy and were more likely to meet dairy recommendations than African-Americans.[13,14] While non-Hispanic blacks scored highest on the FGP Index, a nutrition guide adherence index,[33] the same demographic group was most likely to consume inadequate servings of all food groups.[25]

Ha, Bae, Urrutia-Rojas, and Singh examined the relation between FV consumption and weight status, although no association was found.[16] Those preferring Extraversion, Intuition, and Judgment on the Myers-Briggs Type Indicator were more likely to adhere to FGP recommendations.[17] Children receiving WIC foods consumed more FV than those not receiving WIC foods.[22] Lastly, while children from low socioeconomic status (SES) households scored higher on the FGP Index than those from higher SES households,[33] adults at higher income levels were more likely to meet or exceed recommendations than those at lower income levels.[32]

Two studies utilized the Healthy Eating Index-2005 (HEI), to measure nutrition guide adherence compared to dietary intake reports.[27,34] Both studies featured disadvantaged adult populations from regions of lower SES, and scores for overall adherence ranged from 54.5[27] to 59.3 out of 100.[34] For studies in which component scores of recommendations were given, inadequate consumption of fruits, vegetables, and dairy contributed to low overall adherence score.[34]

Knowledge Studies

Knowledge Study Design and Methodology.

Six studies examined knowledge of FGP,[35,39,40] MyPyramid,[36,37,38] MyPlate,[36-38] 5-a-Day Program,[39,40] DGA 2005,[40] or a combination of the above.[36-40] Adult participants

were sampled, with the exception of one study (=17.5).[39] Studies ranged from 51 participants[37] to 5,499 participants,[40] with larger studies using secondary analysis of national health surveys such as the 2005-2006 NHANES.[39,40] Two studies used one-on-one interviews,[35,39] and five studies used surveys.[36-40]

Knowledge Study Results.

All knowledge studies reported results as the percentage of sample with knowledge of the targeted nutrition guides program. Knowledge ranged greatly among and between nutrition guides. Fifteen percent[35] to 92.4%[39] were familiar with FGP. Participants were more knowledgeable of MyPyramid versus MyPlate,[36-38] and participants were more likely to be familiar with MyPlate if they were familiar with MyPyramid.[38]

Some studies compared knowledge between demographic groups or other characteristics. Knowledge of nutrition guides was positively associated with education,[40] income,[40] perception of the guidelines as relevant and easy to use,[38] perception of the guidelines as accurate and helpful,[38] belief that obesity is not a predetermined state,[40] and preference for FV.[38] Whites were more likely to have heard of DGA 2005 and FGP than African-Americans and non-white Hispanics.[39,40] In one study, women had greater knowledge of nutrition guides than males,[40] and two studies showed knowledge of nutrition guides to decrease with age.[35,40]

Two studies included analysis of participants' acceptance, or belief in effectiveness or accuracy, of nutrition guides.[35,38] Eighty-seven percent of participants trusted FGP to help them achieve a healthy diet,[35] and a significant correlation was found

between acceptance of nutrition guides, perception of nutrition guides as relevant and easy to use, and preference for FV.[38]

Adherence and Knowledge Studies

Adherence and Knowledge Study Design and Methodology.

Three studies examined both adherence to and knowledge of FGP.[41-43] Adult participants were used in all studies,[41-43] with children also sampled in one study.[43] Surveys and/or questionnaires and FFQs or food intake records were used in combination in all studies.

Adherence and Knowledge Study Results.

Like in other adherence studies, intake and adherence were reported as percentage of sample meeting, missing, or exceeding FGP recommendations, or mean intake of a food group. Vegetable intake was lower than recommended in two studies,[41,42] although inadequate consumption of grains,[41] proteins,[41] fruits,[43] and dairy[43] was also reported, with 10.3%-16% of participants in one study meeting no FGP serving recommendations.[43]

Knowledge of nutrition guides was measured mostly as percentage aware of FGP or ability to accurately identify recommendations.[41,42] Between 44%[41] and 64.2%[42] had heard of FGP, although 30.6% recalled seeing it before.[41] Grain recommendations were least likely to be accurately identified,[41,42] contrasting the relatively high intake of this food group among participants. One study found a positive correlation between knowledge of FGP, use of food labels, and consumption of FV.[42]

Comparisons were made between knowledge of nutrition guides, intake, and

demographic and behavioral factors. Females in 11th grade were less likely than 11th grade males to consume adequate proteins and dairy, although females had higher nutrition knowledge scores than males.[43] Intake and knowledge also varied by race/ethnicity, with whites more likely than African-Americans to meet recommendations for vegetables, dairy, and protein; and white adolescents more likely than African-American adolescents to meet recommendations for all food groups.[43]

DISCUSSION

This review identified studies to date examining adherence to and knowledge of nutrition guides. The data supported the hypothesis of poor adherence and knowledge across all nutrition guides. The studies in this review also showed evidence of differences in dietary intake between age, sex, and race/ethnicity. From these trends in literature, recommendations can be made to increase knowledge of and adherence to nutrition guides, and to best leverage public health education and federal nutrition programs to close gaps between demographic groups.

Adherence

Studies showed no conclusive evidence that any nutrition guide affected dietary intake more than others, and adherence to nutrition guides was low throughout the studies. Similarly, adherence did not increase over time within a particular nutrition guide. The literature demonstrated trends in consumption of certain food groups.

For studies examining intake in relation to FGP, participants demonstrated low consumption of dairy,[13,14,20-25,27,42] fruits,[13-15,17,20,21,33,42] and vegetables, [13-15,19,20,22,33,41,42] regardless of demographics or aim of study. In three separate studies, less than 50% of

participants met minimum FV recommendations.[16,18,31] While FV intake was often inadequate, protein consumption was often found to exceed FGP recommendations.[14,15,21,24,25] Grains were the food group most likely to be consumed adequately, with low consumption cited in three studies.[22,33,41] Results from a longitudinal study indicated that adherence to the FGP did not change over time.[20]

Participants in studies examining adherence to MyPyramid also demonstrated poor adherence to recommendations. MyPyramid studies were fewer in number than FGP studies, making conclusions more difficult to accurately draw. Participants in these studies consumed inadequate amounts of FV, [29,31] with no participants[28] to 33.6%[30] adhering to all recommendations. No food groups were adhered to by more than 50% of participants, and in one study, no participants met any food group requirements.[30] No studies cited mean inadequate dairy consumption. While no studies were available on adherence to MyPlate recommendations during the data collection period, recent studies show mean intake of fruits, vegetables, and dairy in 2011 to be at 38%, 59%, and 50% of recommendations, respectively.[49] These developments show a continued trend of low adherence to serving recommendations for all nutrition guides,[13-15,17,19-30,33,41,42] and follow-up studies could help identify whether increased emphasis on nutrition education and outreach with MyPlate affects adherence over time.

Studies showed evidence of intake patterns varying between children and adults, with different age groups exhibiting a preference for certain food groups. Children had distinct intake patterns, consuming fewer grains and vegetables than adults.[13,14,19,20,22,23] Notably, several studies showed that children had greater adherence to dairy

recommendations than adults,[28,30,32] and federal programs and policies such as the National School Lunch Program and Child and Adult Care Food Program that mandate milk be served during meals could affect dairy consumption among children.[50-52]

Knowledge

Like the adherence studies, there was no conclusive evidence regarding differences in knowledge of nutrition guides. Both FGP and MyPyramid had high rates of knowledge among participants, with as many as 92.4% aware of the FGP[39] and 92% aware of MyPyramid.[36] Progression of knowledge of nutrition guides was examined in two ways: how age of nutrition guides and how age of participants affects knowledge. Evidence supported increased knowledge of nutrition guides over time, as well as decreasing knowledge of nutrition guides with increasing age.

Participants' knowledge of nutrition guides increased over time, suggesting a need for public health education to be given time to circulate before evaluating outcomes. This trend was supported by studies examining FGP in which knowledge increased over 12 years,[35,39,40-43] even as a new nutrition guide was introduced.[39,40] Knowledge of MyPyramid also increased over time, and 80.4% were aware of MyPyramid in 2011,[37] compared to 92% in 2012.[36] Additionally, multiple studies showed that participants were more aware of MyPyramid, released in 2005, than MyPlate, released in 2010,[36-38] with knowledge of MyPyramid as much as tripling that of MyPlate in one study.[36]

Lastly, studies in this review showed evidence for decreased knowledge of nutrition guides with increasing age of participants, demonstrating the influence of school systems and education in promoting nutrition guides.[35,39,40,43]

Association Between Knowledge and Consumption

This review also examined whether knowledge of nutrition guides correlates with adherence, and no positive relationship between these two variables was found. This confirms health behavior theory stating that knowledge does not equal behavior.[53] Studies that included analysis of both knowledge and adherence demonstrated inverse relationships. In one study, adults had lower nutrition knowledge scores than children, but a larger percentage of children met none of the FGP recommendations,[43] showing evidence of decreasing adherence with increasing knowledge. Similarly, in one study, 66% could identify FGP dairy recommendations, which was one of only two food groups adequately consumed by the group.[41] Comparing knowledge and adherence between studies, no positive relationship emerged. Despite high rates of knowledge of FGP and MyPyramid, especially over time, overall rates of adherence were low, and did not improve over time.

Comparing Demographic Variables

Studies in this review showed strong evidence of differences in consumption[13,17,24-26,30,34] and moderate evidence of differences in knowledge[40,43] between males and females. In general, females consumed more FV,[24,25,40] had higher overall HEI scores[34], and had a greater knowledge of nutrition and nutrition guides than males.[43] Females had low protein consumption, particularly in comparison to males.[17,25,26,28,43] Future dietary guidance should address these disparities in consumption patterns between males and females, potentially caused by sociological factors (e.g., gender norms) that dictate different body ideals and consumption patterns for the sexes

(e.g., promote minimal intake in females).[54-58]

Studies made distinct comparisons between racial/ethnic groups regarding adherence,[14,25,33] and knowledge,[39,40,43] and disparities existed between whites[13,14,43] and African-Americans,[13,14] as well as between different age groups within racial/ethnic groups.[27,28,31] The disparities between racial/ethnic groups may be related to higher rates of chronic diseases in certain demographic groups, particularly those of lower SES,[59] presenting an opportunity to close this gap in intake, knowledge, and health outcomes.

Gaps and Limitations

While the studies in this review cover a span of 28 years and three nutrition guides, a plethora of opportunities remain in determining knowledge of and adherence to nutrition guides over time and identifying ways of improving public health programs and the US population's health status.[1-3] The studies in this review failed to examine long-term adherence to nutrition guides, and viewing current dietary intake through the lens of past nutrition guides could offer an interesting perspective on the state of public health outreach in the US. Many studies utilized small sample sizes, which allowed for nuanced examination of specific populations, but limited applicability to the general population. While thorough in its scope, the breadth of the studies used in this review, covering many nutrition guides, target populations, methods, purposes, and analyses, limited the ability to use one standardized statistic to convey adherence and knowledge of nutrition guides. Future research would benefit from identifying standards for quality and sample size of studies, as well as including adherence evaluation tools such as HEI in the search criteria. The Healthy Eating Index is used for evaluating population adherence to federal dietary

guidance, specifically DGA.[60] This tool provides detailed, valuable insight regarding the population-wide dietary intake, and should not be discounted as an asset in analyzing national intake trends and effect of federal dietary guidance. Healthy Eating Index, however, does not report the absolute number of servings consumed by the sample, calculates overall adherence using factors not shown in nutrition guides such as nutrients (e.g. concrete sodium recommendations) or food group subcategories (e.g., dark leafy greens), and does not examine knowledge of nutrition guides or federal dietary guidance. While not exclusively suited for this review, future studies might incorporate more adherence factors and utilize Healthy Eating Index as a tool in evaluating dietary quality. Additionally, adherence to and knowledge of MyPlate should be assessed as this nutrition guide, now in its relative nascence, continues to be promoted through outreach and education efforts.

Recommendations

Federal agencies, policymakers, and other key stakeholders should establish effective dietary guidance and policy strategies that will maximize knowledge and adherence to nutrition standards. The trends in adherence and knowledge of populations found in this review point to shortcomings in public health education and implementation of otherwise scientifically sound nutrition guidelines. As MyPlate continues to be institutionalized and DGA 2015 begin to be formulated, particular attention should be paid to aligning recommendations with policy. MyPlate recommendations state, for example, that FV constitute half of one's diet, but receive less than 2% of funding from the 2008 Farm Bill. [61]

Additionally, those responsible for marketing and rollout of nutrition guides could strengthen public health initiatives by ensuring a strong aesthetic and visual aspect in their design of nutrition guides. In one example, two years after its rollout, FGP was familiar in name to 44% of participants, but only 70% of those participants could actually recall seeing it, potentially resulting in inadequate consumption of three of five food groups.[41] Studies examining other nutrition guides found even poorer results.[39,40] Nutrition guides, are highly tested for usability, relevance, and preference through focus groups, interviews, media analysis, and environmental scans.[62,63] MyPlate was designed to meet consumers' expressed needs for a nutrition guide that is simple yet different enough from FGP or MyPyramid to be recognizable as containing new nutrition information.[62] Future studies might examine whether this emphasis on *sustained visibility* affects knowledge of or adherence to nutrition guides.

To achieve desired health outcomes associated with adherence to dietary guidelines, nutrition programs must accommodate population nutrient needs. In this review, for example, dairy consumption was very low among adult populations, particularly among racially and ethnically diverse samples.[14,11,24,25,27,42] Lactose intolerance is most common among African Americans, Hispanic Americans, American Indians, and Asian Americans.[64] DGA 2010 only suggests that lactose intolerant populations eat smaller amounts of dairy products or lactose-free dairy products instead of finding alternatives for dairy products.[62] DGA 2015, as well as other future nutrition guides, should provide accommodating guidance that assists all populations in meeting their nutrient needs.

In addition to the mandated DGA and complementary nutrition guides, the US government also develops federal nutrition programs targeting specific foods or food plans for either advancement of public health, such as 5-a-Day[65] or market expansion through efforts such as commodity checkoffs.[66] Tailored development of dietary guidance that is effective in achieving better health outcomes should be a priority for federal agencies and key stakeholders. Despite its launch in 1991, only 43.5-51.2% of participants could identify the 5-a-Day program in 2005-2006.[27,28] Of the 25 studies examining dietary intake in this review,[13-34] 17 cited mean inadequate intake of FV by participants[14,15,17,19-22,33,41,42] or fewer than 50% of participants meeting recommendations for these food groups.[16,18,30-32] Similarly, the Fluid Milk Promotion Act of 1990 established the National Fluid Milk Processor Promotion Board in 1994 to promote milk consumption and provide funding for education and outreach programs[66], but dairy consumption has been shown to be inadequate among participants in many of the studies included in this review.[13,14,20,21,24,25,27,42]

In one study, 85% of participants had heard of or seen FGP, and 87% believed in and trusted the nutrition guide for accurate nutrition information, but only 25%, actually used FGP in meal planning.[23] Knowledge of a nutrition guide or nutrition campaign is ineffective if individuals cannot apply the guidelines to their daily lives, making behavioral strategies key in designing effective nutrition guides,[23,58] and knowledge has been shown to be an inconclusive determinant of actual dietary intake or health behavior patterns.[29,31,67-70]

CONCLUSION

Policymakers, practitioners, and researchers should apply these study findings to developing future nutrition guides. Given the lack of evidence that knowledge leads to behavior, future nutrition programs and policies should emphasize alternative motivating variables in promoting adherence to nutrition guides. It is in the best interest of federal agencies to develop nutrition guides that clearly expresses nutrition standards and principles for a public with a wide range of skills and attitudes about nutrition. MyPlate embodies this strategy well, presenting servings as straightforward proportions in the most applicable of settings – a plate. Future research, development, and implementation of nutrition guides should focus on public messaging that resonates with a diversity of demographics and is utilized in a number of settings (e.g., schools, computers, supplemental food programs). In addition, policymakers should focus on passing policies that promote behavioral and environmental strategies that align with DGA. Creating nutrition guides that makes an impact on the dietary intake of the American population will assist nutrition educators, researchers, and policymakers in the development of evidence-based strategies that promote future population health.

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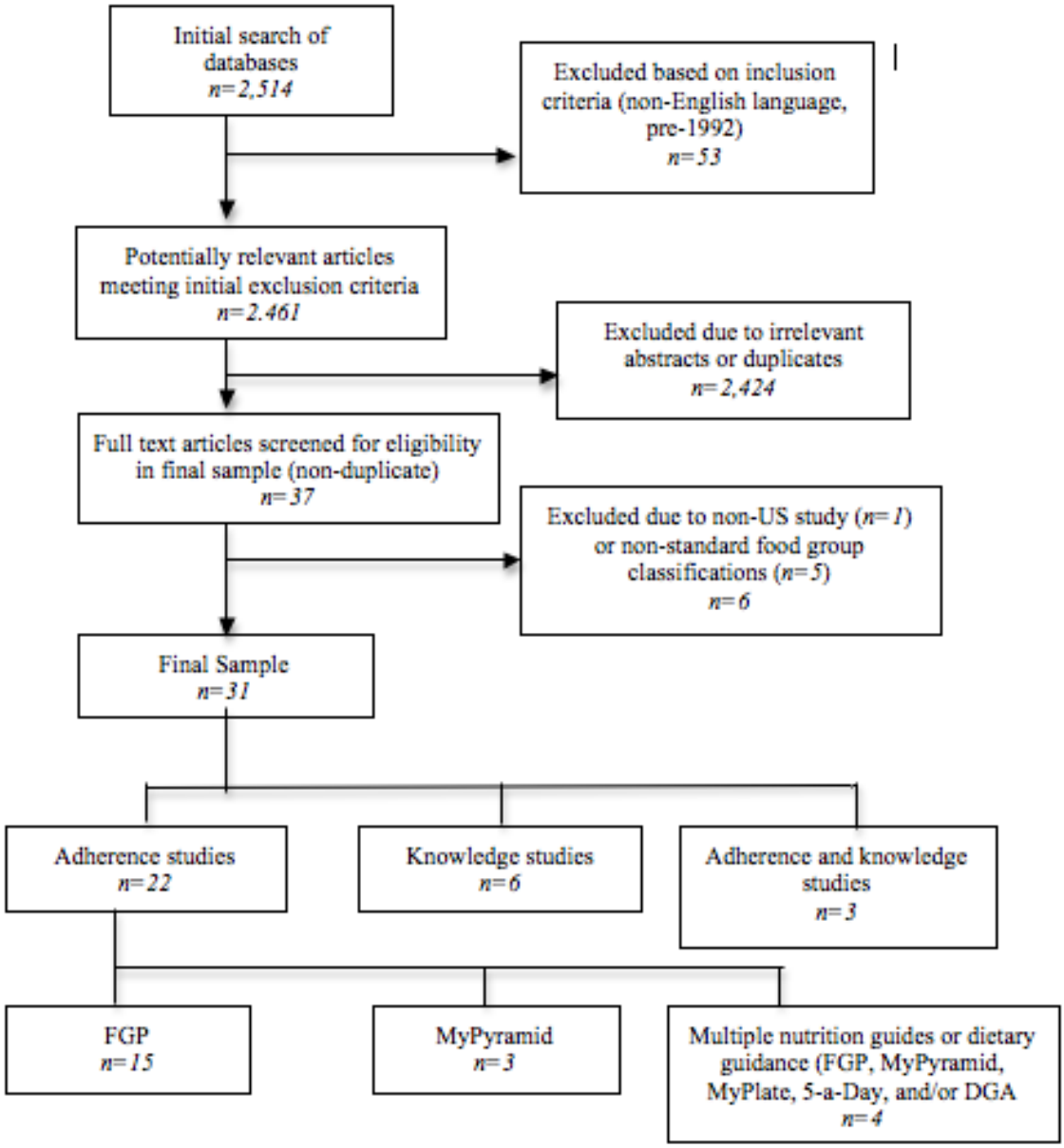
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Declaration of Interest

No competing interests were involved in the preparation of this manuscript.

FIGURES

Figure 2.1. Overview of review of literature regarding adherence to and knowledge of nutrition guides



TABLES

Table 2.1. Overview of United States federal dietary guidance adherence studies 1992-2013 (n=22)

First author (year)	Food guide	Purpose	Measures and methods	Sample size, demographics	Results[a]
FGP[b] (n=15)					
Brady et al. (2000)[13]	FGP	Compare children's dietary intake with FGP; determine whether sex or ethnic differences were evident	Longitudinal study; AMPM[b] 24-hour dietary recall	n=110, ages 7-14	Average daily intake below minimum servings for all food groups except grain; 5% met fruit servings, 9% met dairy servings, 20% met vegetable servings, 26% met proteins servings, and 46% met grain servings; more males (30%) met vegetable servings than females (13%); African-American children consumed significantly higher mean servings of fruit than whites (P<0.001); white children more likely to meet dairy requirements than African-Americans (P<0.001); African-American children more likely to meet proteins requirements (P<0.01)

Table 2.1 Continued

Champagne et al. (2004)[14]	FGP	Evaluate food intake data from a culturally diverse population	FOODS 2000[c]; AMPM 24-hour dietary recall	n=1,727, ages 3 and older	Servings of fruits (1.0, 1.3) and dairy (1.3, 0.8) lower than recommended for both white and African-American groups; servings of proteins (5.8) higher than recommended for both groups (adults); significantly higher consumption of fruits by African-Americans than whites (P=0.0005); significantly higher consumption of vegetables and dairy by whites than African-Americans (P=<0.0001) (adults); servings of fruit (1.1, 1.6), vegetables (2.2, 2.7), and dairy (2.0, 1.6) lower than recommended for both African-Americans and whites; servings of proteins (4.1) higher than recommended for both groups (children); significantly higher consumption of fruit by African-Americans than whites (P=0.004); significantly higher consumption of dairy by whites than African-Americans (P=0.0077) (children)
Cole et al. (2005)[15]	FGP	Evaluate the diet of NCAA Division I athletes	Two sets of 3-day dietary recalls	n=28, student athletes ages 19-23	Diets lacking in fruits and vegetable servings (1.6 and 1.3, respectively); participants consumed more protein than recommended by FGP (4.2)

Table 2.1 Continued

Ha et al. (2005)[16]	FGP	Identify eating patterns among overweight children compared to FGP	Cross-sectional study; self-reported FFQ[b]	n=1076, demographically representative 5th graders in Forth Worth, Texas	25% met FGP recommendations for fruit; 8.7% met serving recommendations for vegetables; no association between fruit/vegetable consumption and being overweight/at risk of overweight
Horacek et al. (1998)[17]	FGP	Evaluate differences in college students' dietary intake in relation to their Myers Briggs personality type	Adapted version of NCI[b] Health Habits and History Questionnaire; Myerrs Briggs Type Indicator Test	n=302, 67% female, 33% male	Low vegetable consumption among all personality types (1.68-1.93); low fruit consumption among groups (.95-1.28); low proteins consumption among all women (1.71-1.84)
Kant et al. (1997)[18]	FGP	Construct dietary variety measurements using FFQ	Data sourced from 1992 National Health Interview Survey Cancer Epidemiology Supplement Household interviews featuring 68-item FFQ	n=10,799, ages 18 or older	Over 70% reported consuming fewer than two servings of fruits a day; over 80% reported consuming fewer than two servings of vegetables a day

Table 2.1 Continued

Knol et al. (2006)[19]	FGP	Assess the diet of children in relation to FGP	Secondary analysis of data through CSFII[b] surveys from 1994-1996 and 1998	n=2,8152, ages 3-8; n=3,789, ages 4-8	Fruit servings and food group adherence scores (P<0.01) decreased by age; all age groups and genders consumed fewer servings than recommended for total vegetables
Lee SK et al. (2007)[20]	FGP	Describe changes in dietary patterns of adolescent girls in Hawaii from 2001 to 2003	Part of Female Adolescent Maturation cohort; two exams two years apart; three-day dietary recalls	n=151, ages 9-14 at onset	Participants consumed fewer servings than recommended for dairy (1.5), fruit (1.3), vegetable (2.1, 2.0), and proteins (3.6, 3.5) groups at both exams; more than half of participants did not meet any FGP recommendations for any food group at either exam; no significant difference in adherence to food groups between exams
McNamara PE et al. (1999)[21]	FGP	Measure gap between dietary guidelines and estimated food intakes	Secondary analysis of CSFII and Food Supply data surveys (1994); two-day average dietary recall	n= 4,953, demographically diverse sample	For all age groups, genders, and ethnicities, lower than recommended consumption of fruits (1.5), dairy (1.5); higher than recommended consumption of proteins (4.8)
Partington et al. (2000)[22]	FGP	Determine if diet quality of WIC[b] participants is affected by foods provided by WIC	24-hour dietary recall; comparison data sourced from CSFII	n=179, ages 2 and older, Wisconsin residents, children of WIC recipients	Children receiving WIC foods consumed more fruits and vegetables than those not receiving WIC benefits (P<0.05); inadequate vegetable (1.51-2.14) and grain (4.15-5.35) consumption for WIC and non-WIC recipients

Table 2.1 Continued

Schuette et al. (1996)[23]	FGP	Evaluate usefulness of FGP as a quantitative tool for assessing nutritional adequacy and quality	24-hour dietary recall	n=2,489, college students	Daily mean intakes for all food groups were at or above minimum serving recommendations; percentage of students meeting minimum recommended number of servings ranged from 45% for proteins to 70% for vegetables; 33% consumed no fruit; only 0.6 % met all minimum food group requirements
Sharma et al. (2003)[24]	FGP	Examine food group intake of Japanese Americans, Native Hawaiians, and whites	Part of Multiethnic Cohort study; FFQ	n=215,000, ages 45-75	Inadequate consumption of dairy (0.8-1.6) and excessive consumption of proteins (4.0-7.3) across all ethnicities and genders; greater adherence by women to fruit and vegetable servings
Sharma et al. (2004)[25]	FGP	Determine degree of adherence to FGP for African Americans, Latinos born in US, and Latinos born in Mexico	Part of Multiethnic Cohort study; FFQ	n=215,000, ages 45-75	Inadequate consumption of dairy (1.1-1.9) and excessive consumption of proteins (5.5-8.8) across all ethnicities and genders; women adhered more to fruit and vegetable groups; men adhered more to proteins and grain groups; African-Americans had greater percentage of people not adhering to recommendations for all food group

Table 2.1 Continued

Song et al. (1996)[26]	FGP	Determine food group intake in relation to FGP	24-hour dietary recall	n=2,489, college students	Adequate consumption of all food groups by both men and women except proteins consumption by women; participants consuming at least the minimum servings grain, vegetable, fruit, dairy, and proteins: 61%, 69%, 62%, 60%, and 45%, respectively; participants consuming no servings of grain, vegetable, fruit, dairy, and proteins: 1%, 8%, 33%, 10%, and 9%, respectively
Taylor et al. (2003)[27]	FGP	Assess dietary intake of Native American women who do not reside in reservation settings in relation to FGP	Four-day weighted food record	n=71, Native Americans female participants ages 18-65, residents of Oklahoma	Overall HEI[b] score of 59.3, signifying low nutritional intake; very low consumption of fruit and dairy (2.7 and 3.0); four of 71 participants (6%) met minimum FGP requirements
MyPyramid (n=3)					

Table 2.1 Continued

Hovland et al. (2010)[28]	MyPyramid	Determine whether Food, Math, and Science Teaching Enhancement Resource Initiative (FoodMASTER) curriculum in rural Ohio elementary schools improved dietary intake	Two groups: control and intervention; intervention received a 45-lesson FoodMASTER curriculum, control received normal lesson plans; pretest posttest of dietary intake using Block Kids FFQ 2004	n=138, 3rd grade students living in Ohio	High rates of noncompliance of food guide recommendations of food group serving ranging from 100% noncompliance (grain consumption among males) to 71.1% (dairy consumption among females); male children had higher intake of proteins group than females ($P<0.05$)
Vadivelloo et al (2009)[29]	MyPyramid	Describe eating patterns and physical activity habits of elementary school children	152-item FFQ; three-day food record	n=35, ages 8-10	Fruit (0.83, 1.01) and vegetable (1.3, 0.98) consumption very low among both males and females; overall adequate dairy consumption (2.42)

Table 2.1 Continued

Weeden et al (2010)[30]	MyPyramid	Describe and predict food group intake of elderly Kansans (80+ years old) participating in congregate meal program	AMPM 24-hour dietary recall	n=113, ages 80 or older, attending senior centers in rural Kansas	No participant met recommendations for all food groups; females more likely to meet fruit recommendation than males (P=0.039); participants consuming adequate servings of grain, vegetables, fruits, dairy, and proteins: 17.7%, 20.4%, 33.6%, 3.5%, and 29.2%, respectively
Multiple (FGP, MyPyramid, MyPlate, 5-a-Day, and/or DGA[a]) (n=4)					
Guenther et al. (2006)[31]	FGP; MyPyramid	Estimate proportion of population eating recommended servings of fruits and vegetables	Secondary evaluation of 1999-2000 NHANES[b] and 1994-1996 CSFII; one- or two-day 24-hour dietary recalls	n=23,033, demographically diverse sample	Only 40% of people met FGP recommendations for fruit and vegetable servings; less than 11% adhered to fruit and vegetable serving recommendations among those 18 years or older
Kirkpatrick et al. (2012)[32]	MyPyramid; DGA	Align food group and nutrient intake by family income and race/ethnicity	Data sourced from 2001-2004 NHANES survey; AMPM 24-hour dietary recall	n=16,338, demographically diverse sample	Adults with higher incomes more likely to meet/exceed food group recommendations (P<0.05); participants meeting or exceeding food group recommendations for fruits, vegetables, grains, proteins, and dairy: 17.5%, 12.9%, 58.9%, 54.1%, and 7.7%, respectively (adults); participants meeting or exceeding food group recommendations for fruits, vegetables, grains, proteins, and dairy: 28.7%, 6.6%, 80.7%, 43.8%, 37.1%, respectively (children)

Table 2.1 Continued

Melnik et al. (1998)[33]	FGP; 5-a-Day	Examine food consumption patterns of children	Part of dental study cohort; household questionnaire and non-quantitative 24-hour dietary recall	n=693, 2nd grade students; n=704, 5th grade students	Participants only met recommendations for dairy (2.5) and (2.2) proteins and consumed fewer servings than recommended of grains (3.1), vegetables (1.3, and fruit (1.9); mean FGP Index score of 29.2 for 2nd graders and 30.4 for 5th graders; 5th graders from low SES[b] households scored higher on FGP index (P<0.02); black non-Hispanic 5th graders scored higher on FGP index (P<0.02)
Thomson JL, (2011)[34]	MyPyramid; DGA	Evaluate diet of Lower Mississippi Delta residents	FOODS 2000; AMPM 24-hour dietary recall	n=1,689, demographically representative	Mean HEI scores higher for women than men; average HEI score of 54.5 pointing to lack of nutrients

[a]Values denote servings unless otherwise specified

[b]Abbreviations: FGP, Food Guide Pyramid; AMPM, Automated Multiple Pass Method; FFQ, Food Frequency Questionnaire; NCI, National Cancer Institute; CSFII, Continuing Survey of Food Intakes by Individuals; WIC, Women, Infants, and Children; HEI, Health Eating Index; DGA, Dietary Guidelines for Americans; NHANES, National Health and Nutrition Examination Survey

[c]Random-digit dialing telephone survey in 36 Delta, Mississippi counties

Table 2.2. Overview of United States federal dietary knowledge studies 1992-2013 (n=6)

First author (year)	Food guide	Purpose	Measures and methods	Sample size, demographics	Results
Gillham et al. (1999)[35]	FGP[a]	Examine cultural variations in use, knowledge, and adherence to FGP	Guided interview	n=115, primary purchasers for household	85% had heard of or seen FGP; 87% believed and trusted FGP; 75% did not use FGP in meal planning; participants over 50 less likely to be familiar with FGP than those under 50
McKinley et al. (2012)[36]	MyPyramid; MyPlate	Assess college students' familiarity with MyPlate, MyPyramid icons, and serving recommendations	Survey administered featuring both food guides and questions as to their constituent food groups and serving recommendations	n=61, ages 18-23 and enrolled at a university	Eleven of 61 participants (18%) familiar with MyPlate and MyPyramid, but 56 of 61 (92%) familiar with MyPyramid; participants significantly more likely to accurately predict food group servings from looking at MyPlate than at MyPyramid

Table 2.2 Continued

Uruakpa et al. (2013)[37]	MyPyramid; MyPlate	Assess consumer awareness of MyPlate's replacement of MyPyramid; determine MyPlate's influence on population's diet four months after MyPlate's release	11-question survey	n=51, ages 18-34	Forty-one of 51 participants were (80.4%) familiar with MyPyramid; 23 of 51 (45.1%) were familiar with MyPlate; 22 of 51 (43.1%) knew that MyPlate had replaced MyPyramid; 35 of 51 (68.6%) had noticed replacement of "protein" to "proteins and beans;" twenty-two of 51 (43.1%) indicated MyPlate might influence their diet, 22 of 51 (43.%) indicated they were unsure of how MyPlate would influence their diet
Wansink et al. (2013)[38]	MyPyramid; MyPlate	Understand characteristics of mothers who were early adopters of MyPlate	Survey including demographic and behavioral questions	n=497, women ages 18-65 with at least two children ages 18 or younger	30% familiar or somewhat familiar with MyPlate; 62% familiar or somewhat familiar with MyPyramid; significant correlation between familiarity with MyPlate and belief MyPlate would help them (P=0.002) and their children (P=0.009) eat better, finding MyPlate easy to understand (P=0.001), preference for fruits and vegetables, and familiarity with MyPyramid (P<0.01); significant correlation between belief MyPlate would help them eat better and finding MyPlate relevant and easy to understand (P<0.01) and preference for vegetables (P<0.01)

Table 2.2 Continued

Wojcicki et al. (2012)[39]	FGP; 5-a-Day; DGA[a]	Assess awareness of federal nutrition programs and relation between nutrition programs, food label use, and obesity	Data sourced from 2005-6 NHANES[a] survey Health-related at-home interviews	n=1160, mean age 17.5 +/- 1.1 years	92.4% aware of FGP, 29.3% aware of DGA, and 43.5% aware of 5-a-Day Program; whites were more significantly more likely to have heard of DGA and FGP than African-Americans, other Hispanics, and Mexican-Americans (P<0.05); no significant correlation between being overweight/obese and awareness of nutritional programs or use of food labels
Wright et al. (2011)[40]	FGP; 5-a-Day; DGA	Relate awareness of federal dietary guidelines with diet-related behaviors and attitudes	2005-6 NHANES survey regarding health behaviors	n=5,499, ages 16 and older	83.8% had heard of at least one set federal nutrition program; 49.2% had heard of DGA, 80.6% had heard of FGP; 51.2% had heard of 5-A-Day program; significantly significant (P<0.01) linear trend of increasing awareness of nutrition programs with decreasing age, increasing education and increasing awareness with increasing income levels; women had significantly (P<0.01) greater chance of having heard of at least one program; whites significantly more likely to have heard of at least one program than non-Hispanic blacks or Mexican-Americans (P<0.01); non-Hispanic blacks significantly more likely to have heard of at least one program than Mexican-Americans (P<0.01); no significant correlation between awareness of

					any federal dietary guidance and diet-related behaviors; significant (P<0.01) linear trend of decreasing awareness of federal dietary guidance with increasing agreement that people are born to be fat or thin
[a]Abbreviations: FGP, Food Guide Pyramid; DGA, Dietary Guidelines for Americans; NHANES, National Health and Nutrition Examination Survey					

Table 2.3. Overview of food guide adherence and knowledge/awareness studies (n=3)

First author (year)	**Food guide**	**Purpose**	**Measures and methods**	**Sample size, demographics**	**Results**
Cotugna et al. (1994)[41]	FGP[a]	Determine awareness of FGP, food group servings, and how intake compares to FGP	Questionnaire regarding awareness of FGP and knowledge of food group servings; FFQ[a]	n= 85, ages 17 to 44	Thirty-seven of 85 participants (44%) had heard of FGP, 26 of whom (70%) had actually seen it; four of 85 (5%) could correctly identify grain group servings and 56 of 85 (66%) could identify fruit; average consumption met minimum serving requirements for only dairy and fruit group

Table 2.3 Continued

Fitzgerald et al. (2008)[42]	FGP	Examine food knowledge and intake patterns among Latinas with and without diagnosed type 2 diabetes	25-item nutrition knowledge questionnaire; 18-item FFQ; food labeling use questionnaire; Transtheoretical Model and Social Cognitive Theory questionnaire	n=201, Latinas with or without type 2 diabetes ages 35-60 living in Hartford, Connecticut who are neither pregnant nor breastfeeding	Participants consumed inadequate dairy (1.84) and fruit and vegetable (3.60) servings; 35.8% had not heard of FGP; most could not identify FGP serving recommendations (from 44.2% for dairy to 93.8% for grains); participants with greater nutrition knowledge more likely to use food labels to select more healthful foods (P=0.007) after controlling for variables; women with more nutrition knowledge more likely to consume more fruits and vegetables (P<0.05); no significant difference in nutrition knowledge between those with and without diabetes

Table 2.3 Continued

Rafiroiu et al. (2002)[43]	FGP	Assess and identify correlates of adolescents' and parents' compliance with FGP	Survey of demographic, nutrition behaviors and attitudes, and food intake questions	n=2,021, 1,261 8th graders and 760 11th graders; n=1,231, parents of participants	Mean nutrition knowledge score[b] of 8.4 for 8th graders and 8.6 for 11th graders, 5.9 for parents; significantly higher knowledge scores among white 8th graders than African-American 8th graders (P<0.01) and females in 11th grade than males in 11th grade (P<0.01); 15% of 8th graders and 16% of 11th graders met none of the FGP recommendation; 10.3% of parents did not meet any recommendations; females in 11th grade less likely than males in 11th grade to meet recommendations for dairy and meat (p<0.05); white adolescents more likely than African-American adolescents to meet recommendations for all food groups (P<0.05); white parents more likely than African-American parents to meet recommendations for vegetables, dairy, and meat (P<0.01)

[a]Abbreviations: FGP, Food Guide Pyramid; FFQ, Food Frequency Questionnaire
[b]Number of correct responses to 16 general nutrition knowledge questions, max values=16

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CHAPTER THREE

THE ROLE OF PAST US NUTRITION GUIDES AND RELATED PSYCHOSOCIAL FACTORS ON CURRENT CONSUMPTION PATTERNS AND SELF-REPORTED BMI

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ABSTRACT

Objective

The purpose of this study is to identify how past nutrition guides, specifically the Food Guide Pyramid, and related psychosocial factors affect long-term consumption patterns.

Methods

University students born 1987-1995 and having attended elementary school in the U.S. were recruited to complete an ASA24 dietary recall and survey testing for support of federal dietary guidance and self-efficacy. ASA24 results were reported in terms of adherence to Food Guide Pyramid recommendations.

Results

The study included 47 participants. Overall adherence was positively correlated with BMI (r=.31), and BMI was significantly higher among those adhering to dairy recommendations (P=.04). Non-adherence was more likely than adherence for vegetable and protein recommendations (P<.001).

Conclusions and Implications

Low adherence to FGP recommendations suggests a short "shelf life" for nutrition information. With low retention of nutrition recommendations by the public, there is greater flexibility in applying research and implementing programs related to nutrition, an emerging field that is constantly evolving. Further research is needed to determine how low versus high energy dense dairy products affect BMI for a more nuanced examination of policy's role in health outcomes.

INTRODUCTION

Dietary Guidelines for Americans (DGA) direct federal nutrition programs and serve as the basis for developing nutrition guides, visual tools for communicating nutrition information to the public to influence health behaviors and outcomes.[1] Reflecting relevant public health issues, nutrition research, and consumer needs, the Food Guide Pyramid (FGP) (1990),[2] MyPyramid (2005),[3] and MyPlate (2010)[4] have provided iconic health promotion materials for consumer education. Adherence to nutrition guides has been low since the implementation of FGP over 20 years ago,[5-7] despite evidence that adherence may decrease risk of chronic disease and obesity.[8,9]

Although adherence to nutrition guides has been examined extensively, these studies have focused on adherence to current nutrition guides, failing to consider how present food choices might be influenced by past nutrition guides. Additionally, application of theory and psychosocial determinants of dietary behaviors can help guide research and improve the understanding of the impact of the DGA.[10] Despite research supporting individual psychosocial factors influences on dietary behaviors,[11,12] no studies to date have assessed how psychosocial factors affect long-term retention and application of dietary guidance. The purpose of this study is to identify how past nutrition guides, specifically FGP, and related psychosocial factors affect long-term consumption patterns and self-reported BMI.

METHODS

Study Participants

Students were recruited from introductory nutrition and coaching courses at a northwestern university during fall 2013. This study was approved by the Institutional Review Board at [blinded university]. Students in the nutrition and coaching classes consented to participate in the study. Inclusion criteria for study analysis included being born between 1987 and 1995 and attending elementary school in the U.S (while FGP was the USDA's primary guidance tool (1992-2004)).[2] Adherence to FGP was also chosen due to its longevity (13 years as primary nutrition guide) and age (eight years since replaced). Students recruited completed the study instruments, detailed below.

Demographic Information

To characterize the study population, demographic information was collected, including age, race, ethnicity, self-reported height and weight (converted to body mass index (BMI)),[13] years attending elementary school, and country in which elementary school was attended.

Dietary Intake Instrument – ASA24 Dietary Recall

The ASA24 dietary recall assessed dietary intake data and adherence to nutrition guidance.[14] Based on the validated Automated Multiple-Pass Method, ASA24 compiles nutritional information on individual foods consumed by participants, as well as each participant's overall intake. Food group servings are reported based on the USDA Food and Nutrient Database for Dietary Studies, and these standardized serving units were

used to calculate adherence. Adherence was defined as consuming within the given food group's recommended range of servings (Figure 3.1). Participants were given login information to complete the recall online. Detailed instructions were administered by researchers in-person, online, and with instruction sheets. No instruction was given about recommended dietary intake.

Dietary Awareness Survey

The Dietary Awareness Survey (Figure 3.2) included questions based upon psychosocial variables of support for federal dietary guidance and self-efficacy in applying federal dietary guidance. "Support" items were based on Diffusion of Innovation Theory (i.e., early adoption tendencies) and Health Belief Model (i.e., perceived benefits of adhering to federal dietary guidance, perceived susceptibility to nutrition-related health outcomes), and "Self-efficacy" items were based on Health Belief Model.[16]

Statistical Analysis

Statistical analysis was conducted using SPSS versions 20 (SPSS, Chicago, Illinois). Descriptive statistics were utilized to characterize participant demographics. For ASA24 results, frequencies were calculated for adherence to each FGP recommendation food group (grains, vegetables, fruits, dairy, proteins). Overall adherence was calculated by summing the number of FGP recommendation food groups to which each participant adhered (possible scores of 0 to 5). Medians and interquartile ranges were calculated for adherence to each and overall FGP recommendation food group.

The Dietary Awareness Survey was analyzed using Chronbach's alpha to determine internal consistency, yielding 0.86 for Support and 0.93 for Self-efficacy,

respectively. Values greater than 0.7 were considered sufficient for analysis.[17] Item responses (Figure 2) were averaged to calculate overall Support and Self-efficacy scores. Medians and interquartile ranges were calculated for Support and Self-efficacy scores.

Normality plots were created to test for normality. Adherence to FGP recommendations was compared with Support, Self-efficacy, and BMI using a Mann Whitney non-parametric test. Overall adherence was compared to Support, Self-efficacy, and self-reported BMI using a Spearman correlation test. Differences between those adhering and not adhering to FGP recommendations were calculated using a non-parametric chi-square test. Nonparametric data limited use of regression analysis.

RESULTS

Of the 62 participants recruited for the study, 76% (n=47) were included. Reasons for exclusion are as follows: age outside of inclusion criteria, 13% (n=8); non-U.S. country of elementary school attendance, 5% (n=3); and incomplete dietary recall and/or survey, 6% (n=4). Median age of participants was 20.0 (2.0), and 94% (n=44) were white, 2% (n=1) were black, 2% (n=1) were American Indian or Alaskan Native, and 2% (n=1) identified as "other." Complete demographic characteristics of included participants are shown in Table 3.1.

According to ASA24 dietary recall results, participants consumed an average of 5.4 (6.0), 1.3 (1.7), 1.0 (2.1), 1.8 (2.3), and 6.4 (8.5) servings of grains, vegetables, fruits, dairy, and proteins, respectively (Table 3.1), with consumed servings ranging from 0.0-13.8 for grains, 0.0-5.7 for vegetables, 0.0-5.2 for fruits, 0.0-8.4 for dairy, and 0.0-31.0

for proteins. Approximately 40% (n=19), 21% (n=10), 36% (n=17), 38% (n=18), and 15% (n=7) of participants adhered to grains, vegetables, fruits, dairy, and proteins servings, respectively. Non-adherence to vegetables ($P<.001$) and proteins ($P<.001$) was significantly more likely than adherence to these food groups. No participants adhered to all food groups, and 19% (n=9) adhered to no food groups.

Participants scored, on average, 3.2 (0.7) and 3.4 (1.0) for support and self-efficacy, respectively (Table 3.1). BMI was positively associated with overall adherence ($r=.31$), and those adhering to dairy had significantly higher BMI scores than those not adhering ($P=.04$), as shown in Table 2. Across all food groups, those adhering to FGP recommendations did not differ significantly in support and self-efficacy than those not adhering.

DISCUSSION

The purpose of this study was to identify how past nutrition guides, specifically FGP, and related psychosocial factors affect long-term consumption patterns and self-reported BMI. Overall adherence to FGP was significantly correlated with higher BMI. Those adhering to FGP dairy recommendations had higher BMI scores than those not adhering. Correlations between adherence, self-efficacy, and support were not significant, and the data failed to show evidence of any significance of FGP on current dietary intake of participants.

Adherence and BMI

Surprisingly, overall adherence to FGP recommendations was significantly correlated with BMI, with participants' BMI scores increasing as they adhered to more FGP recommendations, and those adhering to FGP dairy recommendations had higher BMI scores than those not adhering. Participants failed to meet most FGP recommendations, and meeting recommendations would increase overall intake, increased BMI, from higher overall caloric consumption. High fat, energy dense dairy products (e.g., pizza) were not differentiated from nonfat or low-fat dairy products, and these energy dense products have been associated with weight gain.[20] Future studies should further examine how BMI differs based on the nutritional content of dairy products consumed and total calories consumed. Additionally, non-adherence was more likely than adherence for FGP protein and vegetable recommendations. Median intake for vegetables, however, was less than the FGP recommendation, while median intake for proteins was greater than the FGP recommendation. This finding supports evidence of inadequate vegetable consumption.[21]

Psychosocial Support for FGP

No significant correlation was found between Support, Self-efficacy, and adherence to FGP recommendations. Previous studies where such significance was found also examined interpersonal and environmental determinants of dietary intake (e.g., social support, availability of healthy food),[10-12] and further research should include a broader array of theoretical frameworks and measures of associated constructs.

Limitations

Limitations to this study included a small, homogenous sample population. While efforts were made to recruit a diverse selection of students, the university's demographic profile limited the ability to recruit an ethnically and racially diverse sample. Although many participants had academic backgrounds outside of health-related majors, self-selection bias in the recruitment process may have skewed the sample towards those who already value nutrition. Participants reported BMI without verification, which is subject to underestimation.[22] Weight status may also signal a confounding factor, with normal weight status associated with factors beyond consumption, such as psychosocial or socioeconomic variables and physical activity. Further, while not a limitation exactly, food availability in a college setting may have affected intake and thus skewed results. Analysis of dietary recalls revealed many participants consumed the majority of their meals at a campus dining hall. The food environment may be a confounding factor to study findings as a determinant of health and behavior, and not necessarily an association with federal dietary guidance.

IMPLICATIONS FOR RESEARCH AND PRACTICE

The findings of this study showed a positive relationship between self-reported BMI and adherence to FGP recommendations, with a significant correlation between overall adherence and BMI, and higher BMI scores among those adhering to FGP dairy recommendations than those not adhering. Overweight and obesity have been associated with increased risk of chronic disease,[23] and it is imperative that researchers further

assess the relationship between dairy and dietary fats intake, obesity, and chronic disease to best guide nutrition programs and policies. Nutrition guides may not have a permanent place in the nation's collective memory, but these results highlight the importance of maintaining current, scientifically sound nutrition research and guidelines. Additionally, while nutrition guides serve as a means of educating the public on federal dietary guidance, the lack of association between support, self-efficacy, and adherence to FGP recommendations suggest an alternative determinant of eating behaviors, and future studies should examine environmental factors of health behaviors.

TABLES

Table 3.1. Demographic, Anthropometric, Dietary Intake, and Psychosocial Characteristics of College Students Ages 18-25 Participating in Dietary Recall and Dietary Awareness Survey (n=47)

Characteristic	**n (%)**	
Age, years[b]	20.0 (2.0)	
Race		
White	44 (94)	
Black	1 (2)	
Asian	0 (0)	
American Indian or Alaskan Native	1 (2)	
Native Hawaiian or other Pacific Islander	0 (0)	
Other	1 (2)	
Ethnicity		
Of Hispanic or Latino origin	0 (0)	
Not of Hispanic or Latino origin	47 (100)	
BMI[ab]	23.1 (3.9)	
Intake, servings/day[b]		
Grains	5.4 (6.0)	
Vegetables	1.3 (1.7)	
Fruits	1.0 (2.1)	
Dairy	1.8 (2.3)	
Proteins	6.4 (8.5)	
Adherence to FGP[ac]	**Adhering**	**Not Adhering**
Grains	19 (40)	28 (60)
Vegetables	10 (21)	37 (79)***
Fruits	17 (36)	30 (64)
Dairy	18 (38)	29 (62)
Proteins	7 (15)	40 (85)***
Adherence to all FGP food groups	0 (100)	
Adherence to no FGP food groups	9 (19)	
Support, score[bd]	3.2 (0.7)	
Self-efficacy, score[bd]	3.4 (1.0)	

***Denotes significance of $P<.001$

[a]Abbreviations: BMI, Body Mass Index; FGP, Food Guide Pyramid

[b]Median (IQR)

[c]Differences determined using non-parametric chi-square test

[d]Likert scale of 1-5

Table 3.2. Adherence to FGP[a] vs. Support, Self-efficacy, and BMI[a] of Participants (n=47)[b]

	Psychosocial Variables and BMI		
Adherence and Alignment Variables	**Support**	**Self-efficacy**	**BMI**
Grain adherence	3.2 (.7)	3.5 (1.1)	23.0 (6.7)
Vegetables adherence	2.8 (1.2)	3.3 (1.6)	23.3 (6.40)
Fruits adherence	3.5 (.8)	3.6 (.7)	23.6 (3.9)
Dairy adherence	3.2 (.78)	3.6 (1.2)	24.3 (3.8)*
Proteins adherence	3.1 (1.0)	3.9 (1.0)	22.3 (4.3)
Overall adherence[c]	.07	.06	.03*

*Denotes significance of $P<.05$
[a]Abbreviations: FGP, Food Guide Pyramid; BMI, Body mass Index
[b]Median (IQR) derived from Mann Whitney non-parametric test unless otherwise noted
[c]Correlation coefficients derived from Spearman non-parametric test

FIGURES

Figure 3.1. Food groups as defined in study by correlating FGP food groups and serving recommendations.[15]

Food Group Label	FGP Items	Serving Recommendation
Grains	Bread, cereal, rice, pasta	6-11 servings
Vegetables	Vegetables	3-5 servings
Fruits	Fruits	2-4 servings
Dairy	Milk, yogurt, cheese	2-3 servings
Proteins	Meat, poultry, fish, dry beans, eggs, nuts	2-3 servings

Figure 3.2. Dietary Awareness Survey items and response options examining psychosocial constructs related to dietary intake as utilized in study. Items developed from similar validated surveys.[18,19]

Psychosocial Construct	Item	Number of Items	Response Options	Alpha	Median Score	Inter-quartile Range
Support for Federal Dietary Guidance	Following government recommendations for healthy eating will help me: feel better, look better, live longer, weigh less, prevent disease.	5	5-point Likert scale of 1-5 (1=strongly disagree to 5=strongly agree)	.86	3.2	.7
	By not adhering to nutrition recommendations, I will: gain weight, increase chance of disease, have less energy, not live as long.	4				
	I make food choices in order to avoid health risks.	1				
	I base my diet on my taste preferences, not on what I read	1				
	In the past six months, I have made changes to my diet based on new information	1				
	I am usually the first among my friends to try new food/nutrition products.	1				
	I am hesitant to try new food or eating habits. (reverse coded)	1				
	I follow government recommendations for healthy eating.	1				
	I find it easy to incorporate fruits	1				

and vegetables in my diet.

Figure 3.2 Continued

Self-Efficacy to Follow Federal Dietary Guidance	I find it easy to incorporate fruits and vegetables in my diet.	1	5-point Likert scale of 1-5 (1=strongly disagree to 5=strongly agree **)**	.93	3.4	1.0
	Government recommendations for healthy eating are confusing. (reverse coded)	1				
	I understand government recommendations for healthy eating.	1				
	I am confident I can eat healthy foods when I am: stressed, bored, frustrated, anxious.	4				
	I am confident I can eat healthy foods when: unhealthy foods are available, I have to prepare the meal myself, eating a healthy meal is too much trouble, eating unhealthy food is more convenient.	4				
	I am confident I can purchase and select foods that are: low in fat, low in cholesterol, low in sodium, high in fiber.	4				

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CHAPTER FOUR

PSYCHOSOCIAL FACTORS AND DIETARY HABITS AFFECTING FOOD AND BEVERAGE CHOICES OF COLLEGE STUDENTS: A THEORY-BASED APPROACH

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Abstract

Introduction

Low fruit and vegetable intake and high soft drink consumption have been linked to obesity and chronic disease. The Health Belief Model and Diffusion of Innovations have been applied to health behavior, although not as a framework for understanding dietary habits in terms of Dietary Guidelines for Americans. The purpose of this study was to identify dietary and psychosocial factors associated with college students' eating habits.

Methods

Fifty-eight college students were recruited and completed a 24-hour dietary recall and accompanying survey to assess dietary intake, knowledge and support of Dietary Guidelines for Americans, and self-efficacy. These scores were compared between those who consumed soft drinks and those who did not using a Mann Whitney non-parametric test. Associations between variables were tested using Spearman's non-parametric test.

Results

Those consuming soft drinks had lower fruit intake, lower self-efficacy, and higher added sugar intake than those not consuming soft drinks. Fruit intake was positively correlated with support for Dietary Guidelines for Americans.

Conclusion

This study described psychosocial factors associated with dietary behaviors among college students. Self-efficacy was significantly associated with avoiding soft drinks, while barriers to change, benefits of change, and early or late adoption of Dietary

Guidelines for Americans were associated with increased fruit consumption. Those consuming soft drinks, both full-calorie and no-calorie, consumed more added sugar that those who did not, suggesting alternative dietary sources of added sugars. Further studies are needed using a larger, more representative sample. Future interventions should emphasize social support and self-efficacy for healthy eating.

Keywords: public health; health promotion; health behavior; diet; carbonated beverages; self-efficacy

1.1 Introduction

Since 1990, the United States Department of Agriculture (USDA) and Department of Health and Human Services have issued Dietary Guidelines for Americans (DGA) once every five years to guide the population in healthy eating habits aligned with public health goals and health-related outcomes (1). However, adherence to these guidelines is very low, particularly for fruit and vegetable (FV) intake (2-4), despite evidence linking FV consumption with reduced risk of cardiovascular disease, stroke, cancer, and obesity (5-8). Meanwhile, soft drink consumption has increased in the U.S. (9) and has been associated with higher rates of obesity (10), type 2 diabetes (11), and cardiovascular disease. (12,13).

While the link between intake and health outcomes is well documented, the psychosocial factors associated with dietary consumption are an area for further evaluation. Many studies have examined the connection between knowledge of and adherence to dietary guidelines, with mixed results (14-17). One study, utilizing a

weighted sample to approximate the U.S. population, found participants were more likely to consume 5 or more servings of FV per day if they were aware of the 5 A Day/Fruits and Veggies—More Matters campaign and recommended FV servings (14). Others found little correlation between knowledge and behavior (15-17) No studies, however, have examined the relationship between familiarity with past DGA and current dietary intake, support for DGA, and other psychosocial variables that affect nutrition-related health behaviors.

The Health Belief Model (HBM), which examines perceived barriers to and benefits of adopting a health behavior (18), has been applied to dietary intake with evidence of moderate correlation (19), including predicting eating behaviors of college students (20). This model is applicable to understanding dietary behaviors as much dietary guidance, particularly DGA, focuses on reducing perceived barriers and increasing perceived benefits of a consuming a healthy diet (e.g., providing tips on eating healthy snacks or promoting the link between maintaining a healthy weight and reducing chronic disease) (21). Diffusion of Innovations (DOI), which examines the factors that allow an individual or population to adopt a new paradigm or behavior (18), has been used to study changes in dietary intake patterns in populations and communities (22,23). However, DOI has not been used to assess whether individual beliefs and attitudes are indicators of nutrition behaviors related to DGA over time.

The purpose of this study was to identify factors associated with healthy or unhealthy eating habits in college students by exploring the relationship between soft drink consumption, dietary intake, and psychosocial indicators of support for DGA based on a previous food guide. We expect to observe increased FV intake with increased

knowledge of DGA and psychosocial support of healthy eating. We also expect to observe lower FV and increased knowledge and psychosocial support among those who consumed soft drinks than those who did not.

1.2 Materials and Methods

1.2.1 Study Participants

In total, 62 students were recruited to participate in this study from introductory nutrition and coaching courses at a northwestern land grant university during the fall 2013 semester. Students enrolled in the courses consented to participate in the study and were given the ASA24, a 24-hour dietary recall and an additional survey (24). Both groups completed the study instruments without any instruction about food, nutrition, or dietary intake. Students were recruited for the nutrition class through posters, promotional materials, and announcements in larger, general education classes and received extra credit for consenting to participate in the study. Students enrolled in the introductory coaching course were recruited through a class announcement and received extra credit upon completion of the ASA24 dietary recall and survey with permission of the course instructor. Both the ASA24 dietary recall and survey were completed online.

1.2.2 Instruments

The ASA24 dietary recall assessed dietary intake data. Participants were given individual usernames and passwords to complete the recall, and detailed instructions were administered in-person, online, and with instruction sheets. Based on the validated Automated Multiple-Pass Method, ASA24 compiles nutritional information on the individual foods consumed by participants, as well as each participants overall intake

(24). Food group servings are also reported based on the USDA Food and Nutrient Database for Dietary Studies.

The 24-question survey included three sections: demographics, knowledge of the Food Guide Pyramid, and psychosocial variables based on Diffusion of Innovation theory (e.g., early or late adoption) and the Health Belief Model (e.g., perceived benefit, perceived barrier, self-efficacy). Demographic variables contained five survey items, including age, race, ethnicity, and height and weight (converted to BMI as defined by the National Health Institute (25)). The knowledge portion included eight items inquiring about participants' ability to recall the name of the Food Guide Pyramid, ability to identify the correct number of recommended servings of food groups, and ability to correctly classify a given food item into a food group (26). Psychosocial questions (11 items) were based on validated items from the National Cancer Institute's Food and Attitude Behaviors survey and surveys developed for similar studies (27). Psychosocial items testing for support DGA measured participants' propensity of being early or late adopters. For example, "I am usually the first among my friends to try new food/diet nutrition products" and "In the past six months I have changed my diet based on new information." Aligning with HBM, perceived benefits of and barriers to adhering to DGA were also tested, with participants agreeing or disagreeing with items such as "Following government recommendations for healthy eating will help me feel better," "Following government recommendations for healthy eating will help me prevent disease," and "I understand government recommendations for healthy eating." Items testing for self-efficacy aligned with HBM measured participants' self-efficacy for eating healthy in a

range of situations, including times of boredom, frustration, or unavailability of health foods.

Items measuring early or late adoption tendencies, perceived benefits of adhering to DGA, and perceived barriers to DGA were categorized as "support," or willingness to act, while those items testing for self-efficacy- ability to act- were grouped together. Both support and self-efficacy variables were measured using a five-point Likert scale (1-5), with 1 being "strongly disagree" and 5 being "strongly agree." This study was approved by the Institutional Review Board at [blinded university].

1.2.3 Statistical Analysis

Statistical analysis was conducted using SPSS versions 20 (SPSS, Chicago, Illinois). Frequency reports were generated for weight status, race, ethnicity, and soft drink consumption. Means and standard deviations were calculated and reported for age, BMI, food group intake (grains, vegetables, fruits, dairy, proteins), added sugar intake, knowledge, support, and self-efficacy. Total knowledge was calculated as the sum of the correct responses to the corresponding items on the survey, given on a scale from 0-17. Self-efficacy and support were calculated as the mean of participants' corresponding survey responses. Normality plots were created to test for non-parametric data. Food group intake, added sugar intake, knowledge, support, and self-efficacy of those who had consumed soft drinks and those who had not were compared using a Mann Whitney non-parametric test, and the means of these two groups and corresponding *p* values were reported. Analysis also included a Spearman correlation test for food group intake and added sugar intake against knowledge, support, and self-efficacy. Nonparametric data limited use of regression analysis.

1.3 Results

Of the 62 participants recruited for the study, 58 (93.5% response rate) completed both the dietary recall and the survey, and were included in the study. Table 4.1 shows the demographic characteristics of the sample. The mean age was 22.9 (8.2), and participants' ages ranged from 18-58, and 86.2% were under the age of 25. The average body mass index (BMI) of participants was in the "normal weight" range at 23.7 (3.3), with BMI values ranging from 18.8 to 31.8. While demographic information was collected, the characteristics of the sample did not vary enough to compare groups, particularly between racial and ethnic groups, with 93.1% (n=54) of participants being white, and 3.4% (n=3) of total participants being of Hispanic or Latin origin (see Table 4.1).

Participants consumed an average of 6.1 (3.7), 1.7 (1.3), 1.4 (1.4), 1.9 (1.5), and 8.4 (7.5) servings of grains, vegetables, fruits, dairy, and proteins, respectively (Table 4.1), with food group intake ranging from 0.0-16.7 servings of grains, 0.0-5.74 servings of vegetables, 0.0-5.2 servings of fruits, 0.0-8.4 servings of dairy, 0.0-31.0 servings of proteins, and 0.0-44.9 grams of added sugars.

Participants scored an average of 10.6 (2.5) on the knowledge test, with scores ranging from 2-15. For support and self-efficacy, participants averaged a score of 3.3 (.65) and 3.4 (.78), respectively, with scores ranging from 1.7-4.7 and 1.2-4.7 (Table 4.1).

Fruit intake, added sugar intake, and self-efficacy varied significantly between those who consumed soft drinks and those who did not (Table 4.2). Fruit intake and self-efficacy were lower among those who consumed soft drinks by 89.6% (p=.008), 15.4%

(p=.02), and 9.2% (p=.02), respectively. Added sugar intake was higher among those who consumed soft drinks by 54.7% (p=.008). Fruit intake was significantly correlated with support (.01), with fruit intake increasing with increased support (Table 4.3).

1.4 Discussion

The purpose of the study was to identify factors associated with eating behaviors in college students by exploring the relationship between soft drink consumption, dietary intake, knowledge, and psychosocial indicators of support for DGA. We expected to observe increased FV intake with increased knowledge of DGA and psychosocial support for healthy eating. We also expected to observe lower FV intake and decreased knowledge and psychosocial support among those who consumed soft drinks than those who did not. Our data failed to show evidence of a correlation between vegetable intake and psychosocial variables or differences in vegetable intake between those who did or did not consume soft drinks. Participants who did not consume soft drinks, however, had higher fruit intake and self-efficacy scores than those who did not consume soft drinks, as well as lower intake of added sugar. Our data also supported the hypothesis that fruit intake is related with psychosocial variables, with a significantly positive correlation between fruit intake and support.

1.4.1 Soft Drink Consumption and Intake

Of all food groups examined, fruits were the only group consumed in significantly different quantities between participants who had consumed soft drinks and those who had not. Fruit intake, a “healthy” behavior, was lower among those who had consumed soft drinks, an “unhealthy” behavior. This finding demonstrates clustering of health

behaviors, or adherence to multiple healthy lifestyle factors, which has been reported elsewhere in regards to dietary behaviors (28). Future research should examine whether fruit intake contributes to individual engagement in health-promoting behaviors.

Added sugar intake was higher among those who consumed soft drinks, with mean intake almost doubling between the groups. Interestingly, both full-calorie soft drinks and no-calorie soft drinks were included in the soft drink group, potentially pointing to an alternative source of added sugar among some participants. This finding echoes studies citing increased appetite, cravings for sweetness, and weight gain among those consuming more no-calorie, artificially sweetened beverages (29). While not significant, grain intake was higher among those who had consumed soft drinks than those who had not, possibly due to an increase in grain-based desserts and sweets due to the referenced sugar cravings.

1.4.2 Psychosocial Influences on Consumption

Both psychosocial support and self-efficacy were found to be associated with consumption of FV and soft drinks, respectively. Those who consumed soft drinks had lower self-efficacy than those who did not consumed soft drinks. This suggests self-efficacy may be a major factor in guiding positive diet-related choices. Support of DGA did not differ between groups, demonstrating that factors such as perceived barriers to change, perceived benefits of change, and early adoption of DGA matter less than self-efficacy in implementing healthy eating behaviors.

Conversely, fruit intake was positively correlated with support of DGA. This suggests that the DGA can be influential in guiding healthy dietary patterns related to fruit consumption. Future studies may want to explore the messaging and education

associated with the DGA and the potential mediating effect on future dietary behaviors. Self-efficacy was also positively correlated with fruit intake, although not significant.

One explanation for this difference in contributing psychosocial factors (i.e., self-efficacy and support for DGA) could be that choosing not to consume soft drinks involves *giving up* a behavior. Aligned with HBM, forgoing pleasure could be viewed as a perceived barrier to not consuming soft drinks. Both soft drink-consuming and non-soft drink-consuming groups had equal knowledge and support of DGA scores, meaning that the perceived benefits of diet change were equal as well, but not enough to overcome the barriers. Changing the behavior involves eschewing soft drink consumption, and the perceived ability to give up harmful behaviors, or "resistance self-efficacy," has been applied to addiction studies (30). Similarly, increased self-efficacy scores among those not consuming soft drinks, in conditions of equal variables of other HBM and DOI constructs, translate to greater sense of resistance self-efficacy, with those individuals able to change that behavior.

Consuming FV, however, is a behavior not mutually exclusive with other unhealthy food choices, and involves actively engaging in a behavior rather than giving up a harmful one. One can, that is, have an orange in one hand and an orange soda in the other. The correlation between fruit intake and support of DGA suggests that adopting active health-related behaviors is driven by decreased perceived barriers to change, increased perceived benefits of change, and early adoption of DGA, factors that results suggest are not as influential in determining soft drink consumption.

1.4.3 Limitations

Limitations to this study included a small and homogenous sample population. While efforts were made to recruit students from a variety of backgrounds, including academic backgrounds, the demographic makeup of the university's population as a whole made finding a racially and ethnically representative sample difficult. Further, although many participants studied fields outside of nutrition, exercise science, and other health-related majors, self-selection bias may have skewed the sample towards those who already value nutrition. The distribution of BMI and weight status of participants does not reflect the average BMI in the US, pointing to a unifying factor that may have influenced participants' weight status as well other responses.

1.4.4 Recommendations

To further investigate associations between intake patterns, psychosocial factors, and healthy eating behaviors, studies with a more demographically representative and larger sample should be continued, perhaps using data from national surveys to ensure randomized participant selection. Additionally, the relationship between support for DGA and FV intake should be examined more in-depth, with intake compared to psychosocial constructs over time. Evaluating the relationship between adherence to DGA food group serving recommendations- not just total servings- and knowledge, support, self-efficacy would also illuminate the motivations behind a healthy diet. For example, increased protein intake is healthy only to a point, and adherence studies would better assess this distinction. We evaluated college student's current attitudes and behaviors and compared to their awareness and knowledge of DGA from several years earlier. Future studies may want to follow students over time to monitor their knowledge and awareness and

potential future attitudes and behaviors to determine the guiding factor in encouraging healthy dietary behaviors. Lastly, studies should be developed which explore not just associations between these variables, but causality, with determinants of health behaviors identified.

1.4.5 Conclusion

Low FV intake and high soft drink consumption in the US has been linked to chronic disease, most markedly obesity and its corresponding health outcomes, and by identifying the factors associated with these eating patterns, we may be able to change harmful health behaviors. Given the increased self-efficacy of those not consuming soft drinks, emphasis should be placed on increasing individuals' perceived ability to avoid unhealthy food and beverage choices rather than providing information about the risks of the undesirable behavior. While further research is needed on the most influential factor dictating positively associated fruit intake and support for dietary guidelines, efforts promoting active health behaviors should include reducing perceived barriers and strengthening perceived benefits of a health behavior as well as encouraging early adoption of new nutrition information and dietary guidance rather than focusing on an individuals' perceived abilities to change their own behaviors. Future interventions with college-aged students may want to emphasize social support for healthy eating and promote self-efficacy.

Tables

Table 4.1. Demographic, Dietary, and Psychosocial Characteristics of Sample Population (n=58), 2013[a]

Characteristic	**n (%)**
Age, years	22.9 (8.2)[b]
Race	
White	54 (93.1)
Black	1 (1.7)
Asian	1 (1.7)
American Indian or Alaskan Native	1 (1.7)
Native Hawaiian or other Pacific Islander	0 (0)
Other	2 (3.4)
Ethnicity	
Of Hispanic or Latino origin	2 (3.4)
Not of Hispanic or Latino origin	56 (96.6)
BMI	23.7 (3.3)[b]
Weight Status[c]	
Normal weight	39 (67.2)
Overweight	16 (27.6)
Obese	3 (5.2)
Intake, servings/day	
Grains	6.1 (3.7)[b]
Vegetables	1.7 (1.3)[b]
Fruits	1.4 (1.4)[b]
Dairy	1.9 (1.5)[b]
Proteins	8.4 (7.5)[b]
Soft drink consumption	
Yes	13 (22.4)
No	45 (77.6)
Added sugar intake, g	13.6 (10.5)[b]
Knowledge, score[d]	10.6 (2.5)[b]
Support, score[e]	3.3 (.65)[b]
Self-efficacy, score[e]	3.4 (.78)[b]

Abbreviations: BMI, Body Mass Index; g, grams
[a]Values are numbers (percentages) unless otherwise noted
[b]Mean (SD)
[c]Normal weight= 18.5-24.9, overweight=25-29.9, obese= ≥30
[d]Questionnaire scored from 0-17
[e]Likert scale of 1-5

Table 4.2. Relationship Between Soft Drink Consumption and Dietary Intake and Psychosocial Variables in College Students (n=58), 2013[a]

	Soft Drink Consumption Status		
Variable	**Soft Drink Consumption**	**No Soft Drink Consumption**	***P* Value**
Intake			
Grains	6.7 (4.1)	6.0 (3.6)	.53
Vegetables	1.2 (.89)	1.8 (1.4)	.17
Fruits	.61 (.92)	1.6 (1.4)	.008
Dairy	1.6 (1.0)	2.0 (1.7)	.47
Proteins	6.1 (4.3)	9.2 (8.1)	.28
Added sugar intake	20.5 (11.6)	11.7 (9.4)	.008
Knowledge	9.6 (3.3)	10.9 (2.1)	.21
Support	3.2 (.68)	3.3 (.65)	.68
Self-efficacy	3.0 (.61)	3.5 (.79)	.02

[a]Values for soft drink consumption and no soft drink consumption given as mean (standard deviation) and differences were assessed using Mann Whitney non-parametric test unless otherwise noted

Table 4.3. Relationship Between Psychosocial Variables and Dietary Intake in College Students (n=58), 2013[ab]

	Psychosocial Variables					
Intake Variables	**Knowledge**		**Support**		**Self-efficacy**	
	r	***P* value**	**r**	***P* value**	**r**	***P* value**
Intake						
Grains	.10	.44	.16	.24	.07	.59
Vegetables	-.09	.50	.01	.94	.13	.35
Fruits	-.06	.64	.39	.01	.20	.13
Dairy	-.10	.48	.17	.22	.05	.70
Proteins	-.03	.81	-.10	.45	.15	.27
Added sugar intake	.05	.72	-.02	.89	-.17	.20

[a]All r values denote correlation coefficient as determined by Spearman's rho
[b]All *P* values determined from Spearman's test

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CHAPTER 5

CONCLUSION

Adherence to FGP recommendations was found to be low for individual food groups as well as for overall adherence, and participants consumed inadequate servings of most food groups, with the exception of grains and proteins. Additionally, support and self-efficacy scores hovered just above an average neutral response on the Likert Scale in both studies, and participants answered, on average, only 62% of knowledge items correctly. This lack of behavioral, cognitive, and affective support for federal dietary guidance signals a need for improvement in nutrition-related attitudes and behaviors. While other psychosocial factors not reflected in results may affect dietary intake, a population with low awareness of or ability to implement federal dietary guidance is very unlikely to intentionally follow recommendations.

While there is ample evidence of today's nutritionally inadequate consumption patterns consequent negative health outcomes, dietary intake in relation to past nutrition guides has not yet been explored. The low adherence to FGP recommendations demonstrated in these studies suggests poor retention of federal dietary guidance, and that nutrition lessons learned during childhood are not carried over into late adolescence and early adulthood. Low adherence to FGP recommendations was found before it was replaced by MyPyramid, however, and these results suggest either diminishing cultural relevance of nutrition guides or non-adherence to federal dietary guidance in general, two alarming possibilities for policy makers, nutrition professionals, and those invested in the

success of federal dietary guidance. Alternatively, adoption of current federal dietary guidance and nutrition guide recommendations could affect the impact of past nutrition guides, if new eating patterns are emerging as a result of current, updated nutrition research and information. Non-adherence to FGP recommendations, should it reflect adoption of newer nutrition standards, may not necessarily be a negative finding, and may reflect the evolving nature of nutrition research.

Relationships between psychosocial constructs and intake were inconclusive, with no evidence of an association between knowledge and intake. While there were no significant findings regarding psychosocial factors and adherence to FGP recommendations, support was significantly correlated with fruit intake, and self-efficacy was significantly associated with lower soft drink and added sugar consumption. Federal dietary guidance and nutrition guides are primarily cognitive materials, and it is difficult to assess their effectiveness and use without evaluating knowledge. It is apparent from these findings, though, that health promotion programs must move beyond cognition-based approaches, tailoring strategies to the health behavior change objective at hand.

As government agencies move forward with the development of future dietary guidance and accompanying nutrition guides, effectively promoting dietary recommendations will be of little help if the recommendations achieve the opposite what was intended. Overall adherence to FGP recommendations was significantly correlated with BMI, although this could be due to higher overall caloric intake rather than faulty guidelines. Those adhering to FGP dairy recommendations, however, had higher BMI scores than those not adhering. Dairy serving recommendations have remained relatively static since FGP, and the large role of the dairy industry in nutrition and agricultural

policy should be examined given the potential effect of dairy products on weight gain and obesity. Additionally, this study did not delineate sources of dairy intake, and did not differentiate high-fat items from low-fat or nonfat items. An extension of this study should identify these sources, and assess BMI in relation to nutritional quality of dairy sources as well as overall caloric intake.

Limitations in recruitment of participants may have affected results of the studies, with the demographic, socioeconomic, and anthropometric profile of participants and the host university as a whole not representative of the population. Similarly, while efforts were made to recruit participants from a variety of academic backgrounds, self-selection bias may have confounded results by attracting participants already interested in health and nutrition. Future research should include a more representative sample, and should more closely investigate intake, adherence, and psychosocial variations between demographic groups, and explore the relationship between overweight and obesity and these variables.. Further, while not a limitation exactly, food availability in a college setting may have affected intake and thus skewed results. Analysis of dietary recalls revealed many participants consumed the majority of their meals at a campus dining hall. The food environment may be a confounding factor to study findings as a determinant of health and behavior, and not necessarily an association with federal dietary guidance.

These studies support previous evidence of low adherence to and knowledge of nutrition guides, building on these findings to demonstrate that federal dietary guidance does not have a significant long-term role in affecting health behavior change. Nutrition is a young science, and low retention and application of past federal dietary guidance allows for continued research and experimentation in the field without fear of lifelong

habits based on new, developing information. Conversely, efforts should be made to increase the lifespan of food guides to promote efficiency of government nutrition operations, programs, and policies.

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