Assessing the Use and Perception of Dietary Supplements Among Obese Patients with National Health and Nutrition Examination Survey

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Abstract

Complementary alternative medicine, especially dietary supplements (DS), has gained increasing popularity for weight loss due to its availability without prescription, price, and ease of use. Besides weight loss, there are various perceived, potential benefits linked to DS use. However, health consumers with limited health literacy may not adequately know the benefits and risk of overdose for DS. In this project, we aim to gain a better understanding of the use of DS products among obese people as well as the perceived benefits of these products. We identified obese adults after combining the National Health and Nutrition Examination Survey data collected from 2003 to 2014. We found that there is a knowledge gap between the reported benefits of major DS by obese adults and the existing DS knowledge base and label database. This gap may inform the design of patient education material on DS usage in the future.

Introduction

Obesity, a complex chronic medical condition having multifactorial etiology, is on the rise not only in the US but also around the globe.[1] In the US, the prevalence of obesity among population 18 years or older has increased from 33.7% in 2007-2008 to 39.6% in 2015-2016, whereas prevalence of severe obesity in adults has increased from 5.7% in 2007-2008 to 7.7% in 2015-2016.[2] The resultant, global epidemic is considered to be a consequence of an imbalance between reduced energy expenditure and increased energy intake.[3] Low socioeconomic status such as lower income and lower level of education is associated with a greater risk of obesity.[4] It was estimated that an obese person in the US incurs an average of over $1,400 more in annual medical expenses, accumulating to approximately $147 billion in medical expenses spent per year in the US.[5] Moreover, obesity has been reported to contribute to about 100,000 – 400,000 deaths per year in the US.[6]

Obesity in adults is defined as a body mass index (BMI, i.e., weight in kilograms divided by height in meters squared) of ≥ 30 kg/m^{2}or more. Obesity is often represented in terms of three categories based on BMI values, i.e., Class 1 (BMI=30 to 35 kg/m^2), Class 2 (BMI= 35 to 40 kg/m^2), and Class 3 (BMI ≥ 40 kg/m^2). Class 3 obesity is sometimes categorized as "extreme" or "severe" obesity. Obesity is often a predecessor of chronic, more serious medical issues (e.g., Type 2 diabetes mellitus, hyperlipidemia, ischemic heart disease, stroke),[7] and/or mental health conditions (e.g., depression, anxiety, eating disorders),[8] in addition to functional limitations ensuing in poor quality of life and high mortality rates.[9] Apart from public health concerns, the high prevalence of adult obesity also poses a substantial financial and economic burden resulting from extravagant medical care costs.[10]

Currently, there are a number of available options out there to simply maintain a healthy weight, or to actually treat people with obesity or those who are at a high risk of weight-related comorbidities. This ranges from lifestyle changes (e.g., exercise, diet modifications) to more aggressive treatments, i.e., pharmacological (e.g., Phentermine, Orlistat, Lorcaserin, Naltrexone/Bupropion) and/or invasive bariatric surgeries (e.g., gastric banding, gastric bypass, Roux-en-Y gastric bypass).[9] However, the vast majority of treatment around lifestyle changes often fail due to noncompliance resulting from various factors, e.g., poor motivation, lack of time, gaps in knowledge/awareness, lack of strong commitment to seeing actual results.[11] On the other hand, most of the pharmacological and surgical procedures are associated with a substantial amount of health risk and at the cost of large dollar amounts.[9] Hence, people often are looking for alternative therapies (e.g., supplements, acupuncture, non-invasive body-contouring) which are effective, quick-acting with minimal side effects, easily available, and relatively cheap. Many patients who are overweight and obese consider using dietary supplements for weight loss.

The popularity of complementary alternative medicine (CAM), especially the use of dietary supplements (DSs) for weight management, has gained much popularity. Aside from the health benefits resulting from weight loss, there are various other reasons for people to turn to DSs for losing weight and/or maintaining a healthy weight, e.g., resulting frustration from failures in previous weight loss attempts following strict diet and exercise regimens, DSs being falsely considered as "magic bullets" that are "natural and safe", easy availability without a prescription, easy to take, less expensive, bypassing the physician's office visit fee, inflated advertising claims.[12] Some of the commonly used DSs classified according to their proposed mechanism of actions are DSs: stimulating energy expenditure (e.g., Ephedra, Bitter orange), modulating carbohydrate metabolism (e.g., Chromium, Ginseng), increasing satiety (e.g., Guar gum, Psyllium), increasing fat oxidation or decreasing fat synthesis (e.g., Green tea, Licorice), blocking absorption of fat (e.g., Chitosan), eliminating excessive body water (e.g., Dandelion, Cascara), enhancing mood (e.g., St. John's wart), and others (e.g., Laminaria, Apple cider vinegar).[12]

Interestingly, earlier studies have revealed that the use of DSs is more commonly preventive with an aim to maintain and improve overall health, rather than being therapeutic in order to treat obesity.[13] According to the National Health and Nutrition Examination Survey (NHANES) 2003–2006, a nationally representative, cross-sectional survey, obese respondents reported relatively less DS use (48%) than those categorized as overweight (57%) or normal weight (56%).[13] Hence, DS users, as compared to non-users, are significantly more likely to have better dietary patterns, exercise regularly, maintain a healthy weight, and avoid tobacco products.[13] It is also known that DS consumers with limited health literacy may not adequately know the benefits and risk of overdose for DSs.[14] Thus, it is critical to create a DS profile for general health consumers to inform the design of patient education material for DSs.

In this project, we aim to gain a better understanding of the use of DS products among obese people as well as their perceived benefits of these products. We used the combined NHANES data from 2003-2014 to answer three research questions (RQ):

RQ1: What are the perceived benefits of DS use for patients with obesity?

RQ2: Are there associations between patients' socioeconomic status and demographic information with DS use?

RQ3: Is there a knowledge gap between the benefits for DS for patients with obesity and existing DS knowledge bases?

Methods

Data Source

NHANES is a continuous cross-sectional health survey conducted by the National Center for Health Statistics of CDC.[15] It evaluates a stratified multistage probability sample of the non-institutionalized population of the United States. The survey samples are first interviewed at home, followed by a physical and laboratory test in a mobile examination center. Its rigorous quality control standards ensure national representativeness and high-quality data collection. NHANES data have facilitated various public health[16] and biomedical informatics research.[17-19]

Data Preparation

We first extracted the demographic, examination, and dietary data from NHANES for survey years 2003 – 2014 (6 survey cycles). To strengthen the analytical power of the study, survey data from multiple survey cycles were combined for the following analyses. Inclusion criteria included: (1) DS use information, and (2) age ≥ 18. We split this cohort into a control and obese group based on BMI, with the obese group including all participants having BMI ≥ 30 kg/m^2. From NHANES data, we removed 1937 participants (5.4%) with no BMI values. We also removed 27 participants with no values for taking DS or not. The "wtint2yr" variable (2-year sample weight for interviewed participants) is a sample weight assigned to each sample person by NHANES to match U.S. census population totals. It represents the number of non-institutional people in the US that a survey participant can represent. According to NHANES analytical guideline[1], when appropriately combining all 6 survey cycles, we divided "wtint2yr" by 6 to construct new sample weights before the analyses. Note that the one person only appeared in one survey cycle. After applying sample weights, the control group includes the remaining 21,997 respondents with a total sample weight of 140,431,403 and the obese group includes 11,954 respondents with a sample weight of 73,697,181.

[1] https://wwwn.cdc.gov/nchs/data/nhanes/2011-2012/analyticguidelines/analytic_guidelines_11_16.pdf

DS use was pulled for this cohort. Total and individual DS use was available for all survey cycles although detailed data was inconsistent for years 2003-2004 and 2007-2008. These inconsistencies caused minor issues with data processing but not with the data validity. DSs used were grouped into types based on product information. Detailed information on reasons for DS use was available for survey cycles from 2007-2014.

Data Analysis

Basic Characteristics: We first created a profile of the cohort with respect to gender, age, race, and household income. On the more detailed data from 2007-2014, we assessed the major perceived benefits of the DSs used by the cohort, stratified by specific DS type.

Comparing the Reported DS Use with Existing Knowledge Bases: We analyzed the individual reasons given by survey participants for years 2007-2014 related to DS use. In addition, we also investigated if the information provided in the existing knowledge base aligns with the reported use of a particular DS. In our previous study, a qualitative evaluation was performed (RR- a coauthor, physician and health informaticist) and compared across five selected databases for presences of essential data elements after cross-checking them against a preliminary, standardized set of data elements.[20] It was learned that Natural Medicine Comprehensive Database (NMCD)[21] was found to be the most comprehensive of all the resources, providing DS information that is reliable, clinically relevant data and evidence-based, monitored and updated regularly. Hence, in this study, we compared the reported benefits of obese adults in NHANES with NMCD aiming at identifying the knowledge gap.

Correlation Analysis: We used Pearson correlation coefficient to assess the correlation between numeric variables (e.g., age and the number of DSs taken). We also used multivariate logistic regression to evaluate the impact of basic characteristics on DS use between control and obese groups. In addition, we attempted to use analysis of covariance (ANCOVA) for the correlation analysis between a numeric and categorical variable (e.g., household income and DS use). ANCOVA is a method that is subject to a number of assumptions including: 1) linear relationship between dependent and independent variables, 2) independent homogeneous normally distributed error, 3) homogeneity of regression slopes between groups. Unfortunately, these assumptions were not met in our case, thus ANCOVA results are not reportable in this study.

Results

The average BMI for males in the obese group was 35 kg/m^2. The average BMI for females in the obese group was 36.53 kg/m^2. Table 1 shows the basic characteristics of the study population. Out of the 33,951 survey participants, 51.26% (weighted frequency, WF, is 109,766,046) self-report taking at least one DS. The control group accounts for 74,458,068 of this and the obese group accounts for 35,307,978. The participants in survey cycles 2007-2014, they were asked if '*they took the product on their own*' (Self) or '*doctor or health provider told me to*' (HCP). For this group of survey participants (taking WF 170,115,087 DSs in total), 74.12% were taken due to their personal will and the remaining 25.88% were taken due to the advice of a health care practitioner. When looking at the control the WF are as follows "Self" – 88,231,094 (76.44%) and "HCP" – 27,200,815 (23.56%). The obese group is 37,855,117 (69.23%) and 16,828,061 (30.77%) respectively. Wald Chi-square tests showed statistically significant differences between the control and obese groups with respect to gender, age group, race, and household income (P<.0001).

Table 1. Basic characteristics of the study population

Variable	**Overall**		**0 DS**		**1 or more DS**	
	Control	**Obese**	**Control**	**Obese**	**Control**	**Obese**
Gender	**WF (%)**	**WF (%)**	**WF (%)**	**WF (%)**	**WF (%)**	**WF (%)**
Male	69,398,631 (49.42%)	33,945,341 (46.06%)	37,481,223 (54.01%)	19,739,505 (58.15%)	31,917,408 (45.99%)	14,205,836 (41.85%)
Female	71,032,772 (50.58%)	39,751,841 (53.94%)	28,492,112 (40.11%)	18,649,699 (46.92%)	42,540,660 (59.89%)	21,102,142 (53.08%)
Age						
18-24	21,130,392 (15.05%)	6,556,637 (8.90%)	14,144,116 (66.94%)	4,676,915 (71.33%)	6,986,276 (33.06%)	1,879,722 (28.67%)

25-34	25,791,429 (18.37%)	11,813,620 (16.03%)	14,561,110 (56.46%)	7,778,604 (65.84%)	11,230,319 (43.54%)	4,035,016 (34.16%)
35-44	25,153,315 (17.91%)	14,941,874 (20.27%)	12,795,306 (50.87%)	9,218,501 (61.70%)	12,358,010 (49.13%)	5,723,372 (38.3%)
45-54	26,139,764 (18.61%)	15,787,763 (21.42%)	11,529,146 (44.11%)	8,009,651 (50.73%)	14,610,617 (55.89%)	7,778,111 (49.27%)
55-64	18,781,403 (13.37%)	12,794,888 (17.36%)	6,469,237 (34.44%)	4,844,214 (37.86%)	12,312,166 (65.56%)	7,950,674 (62.14%)
65-74	12,680,140 (9.03%)	7,809,087 (10.60%)	3,670,919 (28.95%)	2,598,196 (33.27%)	9,009,221 (71.05%)	5,210,891 (66.73%)
75 and over	10,754,960 (7.66%)	3,993,312 (5.42%)	2,803,501 (26.07%)	1,263,121 (31.63%)	7,951,459 (73.93%)	2,730,191 (68.37%)
Race						
Mexican American	10,937,873 (7.79%)	7,093,000 (9.62%)	7,503,518 (68.60%)	4,865,723 (68.60%)	3,434,356 (31.40%)	2,227,277 (31.40%)
Other Hispanic	6,838,482 (4.87%)	3,634,863 (4.93%)	4,059,906 (59.37%)	2,222,149 (61.13%)	2,778,576 (40.63%)	1,412,714 (38.87%)
Non-Hispanic White	98,016,824 (69.80%)	48,756,475 (66.16%)	40,424,225 (41.24%)	22,858,918 (46.88%)	57,592,599 (58.76%)	25,897,557 (53.12%)
Non-Hispanic Black	13,389,691 (9.53%)	11,304,379 (15.34%)	8,518,257 (63.62%)	6,931,321 (61.32%)	4,871,434 (36.38%)	4,373,057 (38.68%)
Other Race or Multi-Racial	11,248,533 (8.01%)	2,908,465 (3.95%)	5,467,429 (48.61%)	1,511,093 (51.96%)	5,781,104 (51.39%)	1,397,372 (48.04%)
Household Income						
$0 to $4,999	2,185,115 (1.56%)	1,040,625 (1.41%)	1,334,103 (61.05%)	703,261 (67.58%)	851,012 (38.95%)	337,364 (32.42%)
$5,000 to $9,999	3,642,234 (2.59%)	2,363,568 (3.21%)	21,68,371 (59.53%)	1,433,092 (60.63%)	1,473,863 (40.47%)	930,476 (39.37%)
$10,000 to $14,999	7,013,669 (4.99%)	4,088,184 (5.55%)	3,977,111 (56.71%)	2,358,676 (57.70%)	3,036,558 (43.29%)	1,729,508 (42.30%)
$15,000 to $19,999	6,979,855 (4.97%)	3,925,689 (5.33%)	3,988,366 (57.14%)	2,296,441 (58.50%)	2,991,489 (42.86%)	1,629,248 (41.50%)
$20,000 to $24,999	8,526,874 (6.07%)	4,840,260 (6.57%)	4,577,403 (53.68%)	2,797,069 (57.79%)	3,949,471 (46.32%)	2,043,190 (42.21%)
$25,000 to $34,999	13,829,794 (9.85%)	8,092,533 (10.98%)	7,328,211 (52.99%)	4,536,612 (56.06%)	6,501,583 (47.01%)	3,555,920 (43.94%)
$35,000 to $44,999	12,077,157 (8.60%)	7,681,006 (10.42%)	5,822,324 (48.21%)	3,810,995 (49.62%)	6,254,834 (51.79%)	3,870,010 (50.38%)
$45,000 to $54,999	11,950,643 (8.51%)	6,404,692 (8.69%)	6,509,041 (45.53%)	3,325,334 (51.92%)	5,441,602 (54.47%)	3,079,358 (48.08%)
$55,000 to $64,999	9,129,822 (6.50%)	5,057,820 (6.86%)	4,297,419 (47.07%)	2,479,668 (49.03%)	4,832,404 (52.93%)	2,578,153 (50.97%)
$65,000 to $74,999	7,942,767 (5.66%)	5,039,288 (6.84%)	3,494,125 (43.99%)	2,541,089 (50.43%)	4,448,642 (56.01%)	2,498,199 (49.57%)
$75,000 and over	46,857,423 (33.37%)	20,313,403 (27.56%)	17,870,026 (38.14%)	9,451,482 (46.53%)	28,987,397 (61.86%)	10,861,921 (53.47%)
No answer	10,296,050 (7.33%)	4,850,113 (6.58%)	341,156 (55.11%)	2,655,484 (54.75%)	276,400 (44.89%)	2,194,629 (45.25%)

We looked at the individual reasons given by survey participants for years 2007-2014 related to DS use. Participants were given a list of options to choose from for each DS. They could choose one or more options from the given list. Table 2 shows the top five reasons. In addition, we also looked at DS use for two additional reasons that were believed to be applicable to the population we are studying. These included '*For Weight Loss*' and '*To Maintain Blood Sugar/Diabetes*'. Reasons for DS use were matched to specific DS type. Table 2 shows the type of DS with the highest weighted frequency and percent of total response for each reason. The most frequent DS types for the obese group and the control group are the same across all the reasons.

Table 2. Reason for DS use matched to type of DS

Reason	Group	Most frequent DS type	Weighted Frequency of responses for this DS type	% of total responses for this reason
General Overall Health[a]	Control	MVMM[c]	26,453,115	42.38%
	Obese	MVMM[c]	12,189,835	42.58%
Bone and Joint Health[b]	Control	Calcium / Bone/ Joint	12,815,331	63.61%
	Obese	Calcium / Bone/ Joint	5,192,835	57.23%
To Supplement Diet/Food Not Enough	Control	MVMM[c]	7,851,917	54.41%
	Obese	MVMM[c]	3,335,217	50.64%
Heart Health/Cholesterol	Control	Omega-3	4,770,226	48.84%
	Obese	Omega-3	2,814,685	53.79%
To Get More Energy	Control	MVMM[c]	3,613,966	42.51%
	Obese	MVMM[c]	1,999,447	44.60%
For Weight Loss	Control	MVMM[c]	356,359	32.36%
	Obese	MVMM[c]	402,195	30.57%
To Maintain Blood Sugar/Diabetes	Control	MVMM[c]	283,031	36.00%
	Obese	MVMM[c]	251,621	29.10%

a: Includes: To prevent health problems, to improve my overall health, to maintain health/to stay healthy, and to prevent colds/boost immune system.
b: Includes: For healthy joints/arthritis and for bone health/build strong bones/osteoporosis.
c: Multivitamins/multiminerals

The top five types based on the weighted frequency of DS are shown in Table 3.

Table 3. Top five types of DS

Dietary Supplement	Control (Weighted Frequency) / (%)	Obese (Weighted Frequency) / (%)
MVMM	57,398,221 / 32.25%	25,997,389 / 32.03%
Calcium / Bone / Joint	25,353,315 / 14.25%	10,730,464 / 13.22%
Vitamin B / B-Complex	15,114,941 / 8.49%	7,646,862 / 9.42%
Omega-3	13,742,677 / 7.72%	6,678,531 / 8.23%
Botanical[a]	13,059,133 / 7.34%	6,009,226 / 7.40%

a: DS classified as a botanical if it is part of a plant, tree, shrub, herb, etc.

Table 4 shows the top five DS types compared to the seven reasons we focused on. In addition, we also investigated if the information provided in the existing knowledge base aligns with the reported use of a particular DS. We found consistency between the reported use of a particular DS (as extracted from NHANES data) for conditions like general

overall health, bone and joint health, supplementing food and diets, and heart health/cholesterol, and its use/effectiveness provided in the existing knowledge base (i.e., NMCD). In fact, we found additional useful information about the primary use of a particular DS in addition to its other uses, e.g., use of calcium mainly for bone and joint health other than to improve general health.

For rest of the three conditions (i.e., getting energy, losing weight and maintaining blood sugar), we found that often consumers are taking DS indiscriminately without sufficient, current and scientific knowledge on how a particular DS actually impacts human body, e.g., the use of MVMM and Vitamin B-complexes for losing weight and/or maintaining blood sugars among diabetic patients rather than their actual role of simply supplementing diet in people who are on restricted diets.

Table 4. DS types and comparison of reported benefits for DS use compared to known knowledge bases

		MVMM		**Calcium / Bone / Joint**		**Vitamin B / B-Complex**		**Omega-3**		**Botanical**	
Reason	**Group**	Weighted Frequency (%)	Supported by the KB?	Weighted Frequency (%)	Supported by the KB?	Weighted Frequency (%)	Supported by the KB?	Weighted Frequency (%)	Supported by the KB?	Weighted Frequency (%)	Supported by the KB?
General Overall Health[a]	Control	26,453,115 (42.4%)	Primarily	4,013,511 (6.4%)	Yes	4,436,521 (7.1%)	Primarily	5,613,467 (9.0%)	Yes	3,319,571 (5.3%)	Yes
	Obese	12,189,835 (42.6%)		1,661,002 (5.8%)		2,174,237 (7.6%)		2,412,219 (8.4%)		1,653,574 (5.8%)	
Bone and Joint Health[b]	Control	1,631,498 (8.1%)	Yes	12,815,331 (63.6%)	Primarily	221,802 (1.1%)	Yes	1,041,431 (5.2%)	Yes	446,372 (2.2%)	Yes
	Obese	853,981 (9.4%)		5,192,835 (57.2%)		165,819 (1.8%)		554,147 (6.1%)		156,958 (1.7%)	
To Supplement Diet / Food Not Enough	Control	7,851,917 (54.4%)	Primarily	946,322 (6.6%)	Yes	1,203,612 (8.3%)	Primarily	725,957 (5.0%)	Yes	432,633 (3.0%)	Yes
	Obese	3,335,217 (50.6%)		482,093 (7.3%)		384,737 (5.8%)		482,233 (7.3%)		106,195 (1.6%)	
Heart Health / Cholesterol	Control	784,580 (8.0%)	Yes	179,802 (1.8%)	Conflicting	734,043 (7.5%)	Yes	4,770,226 (48.8%)	Primarily	759,119 (7.8%)	Yes
	Obese	453,180 (8.7%)		61,349 (1.2%)		500,191 (9.6%)		2,814,685 (53.8%)		300,371 (5.7%)	
To Get More Energy	Control	3,613,966 (42.5%)	Yes	183,743 (2.2%)	No	2,406,102 (28.3%)	Yes	236,695 (2.8%)	No	546,402 (6.4%)	Yes
	Obese	1,999,447 (44.6%)		68,179 (1.5%)		1,246,553 (27.8%)		93,423 (2.1%)		295,225 (6.6%)	
For Weight Loss	Control	356,359 (32.4%)	No[c]	4,170 (0.4%)	No[c]	62,440 (5.7%)	No[c]	48,707 (4.4%)	Yes	205,332 (18.6%)	Yes
	Obese	402,195 (30.6%)		53,291 (4.1%)		87,574 (6.7%)		74,769 (5.7%)		278,418 (21.2%)	
To Maintain Blood Sugar	Control	283,031 (36.0%)	No[c]	29,274 (3.7%)	Insufficient	54,507 (6.9%)	No[c]	39,871 (5.1%)	Yes	137,073 (17.4%)	Yes
	Obese	251,621 (29.1%)		27,005 (3.1%)		98,499 (11.4%)		3,777 (0.4%)		295,622 (34.2%)	

a: Includes: To prevent health problems, to improve my overall health, to maintain health/to stay healthy, and to prevent colds/boost immune system.
b: Includes: For healthy joints/arthritis and for bone health/build strong bones/osteoporosis.
c: DS can be used to supplement diets for people on restricted diets such as those actively participating in weight loss or those with DM

Correlation Analysis

We were interested in testing the correlations between the number of DS taken (DS Count) and age, BMI. Table 5 reports the results of Pearson correlation coefficients. Both age and BMI have significant correlations with the number

of DS taken. However, the correlation between DS count and BMI are negative, which means a person having lower BMI value are likely to take more DSs. These findings are consistent with the results in the published study.[22]

We further used a multivariate logistic regression model to assess the impact of basic characteristics (gender, age group, race, and household income) on DS use between control and obese groups. We found that the obese group is less likely to take DS than control group. In addition, male respondents are less likely to take DS compared to female (odds ratio=0.560, CI: 0.530-0.592, p<0.001). When setting the 45-54 years old age group as the reference, younger respondents who are under 45 are less likely to take DS. On the other hand, older respondents who are over 54 are more likely to take DS. Regarding race, Mexican American, other Hispanic, non-Hispanic Black, and other race or multi-racial are all less likely to take DS compared to the reference group Non-Hispanic White. Moreover, respondents who reported the household income is $75,000 and over are more likely to take DS compared to other lower levels of household income.

Table 5. Correlation analysis with the DS data with Pearson correlation coefficients

Variable Pairs	Coefficient	P-value
DS Count – Age	0.28234	< 0.001
DS Count – BMI	-0.03596	< 0.001

Table 6. Multivariate logistic regression results

	Odds Ratio	95% Confidence Interval		P-values
Obese or Not (reference = Control Group)				
Obese Group	0.783	0.742	0.827	<.0001
Gender (reference = Female)				
Male	0.560	0.530	0.592	<.0001
Age Group (reference = 45-54)				
18-24	0.462	0.407	0.526	<.0001
25-34	0.637	0.567	0.715	<.0001
35-44	0.737	0.642	0.846	<.0001
55-64	1.613	1.440	1.806	<.0001
65-74	2.172	1.889	2.497	<.0001
75 over	2.535	2.219	2.897	<.0001
Race (reference = Non-Hispanic White)				
Mexican American	0.510	0.460	0.565	<.0001
Other Hispanic	0.665	0.593	0.747	<.0001
Non-Hispanic Black	0.564	0.511	0.623	<.0001
Other Race or Multi-Racial	0.875	0.769	0.997	0.0449
Household Income (reference = $75,000 and over)				
$0 to $4,999	0.520	0.407	0.663	<.0001
$10,000 to $14,999	0.463	0.395	0.541	<.0001
$15,000 to $19,999	0.473	0.408	0.547	<.0001
$20,000 to $24,999	0.542	0.465	0.633	<.0001

$25,000 to $34,999	0.576	0.515	0.645	<.0001
$35,000 to $44,999	0.708	0.609	0.823	<.0001
$45,000 to $54,999	0.745	0.641	0.867	0.0002
$5,000 to $9,999	0.452	0.383	0.533	<.0001
$55,000 to $64,999	0.747	0.641	0.869	0.0002
$65,000 to $74,999	0.809	0.697	0.938	0.0054
NA	0.573	0.496	0.663	<.0001

Discussion

In this study, we used the NHANES data to assess the use and perceived benefits of dietary supplements among obese adults. Demographics clearly play a role in DS use. Based on the information in Table 1, female is more likely than male to use DS. With respect to age, the older the respondent was, the more likely he/she used at least one DS. The 45-54 year-old age group was the only age group in which there was no statistically significant difference in DS use between obese and control groups. Race also plays a role in DS use, with non-Hispanic Whites showing the highest percentage of DS use. Other Race or Multi-Race respondents were the only category in which there was no significance in terms of DS use. Household income is also shown to play a role in DS use. Those that have an income over $35,000 have a percentage of use of 48.08-53.47% versus those under $35,000 have a percentage of use of 32.42-43.94%.

With respect to the correlation between age and BMI information and the number of DS taken, we found that both age (coefficient = 0.28, p-value < 0.001) and BMI (coefficient = -0.04, p-value <0.001) have significant correlation with the number of DS taken, indicating that older adults and those with lower BMI are likely to take more DSs. It is consistent with the results from a previous study that obese respondents reported relatively less DS use (48%) than those categorized as overweight (57%) or normal weight (56%).[13] Hence, DS users, as compared to non-users, are significantly more likely to have better dietary patterns and exercises.

The overall impression from the results of this study is that obese population does not show increased usage of DS to facilitate weight loss. The results between the obese group and the control group are quite similar.

Another clear opportunity shown in the results was that most respondents took DSs on their own, as opposed to be told by the healthcare professionals. They could have learned about the DS from word of mouth, advertisement, or some sources other than a health practitioner. There is clearly an opportunity for knowledge about DSs to be passed to this population via healthcare providers. The actual benefit of each DS may be clearer if the information was from providers instead of another source.

We also investigated if the information provided in the existing knowledge base aligns with the reported use of a particular DS. We found that often consumers are taking DSs indiscriminately without sufficient, current and scientific knowledge on how a particular DS actually impacts the human body. This includes use of calcium for heart health, despite a considerable number of existing controversies (validated by various research studies) regarding the association between dietary calcium intake and risk of mortality from cardiovascular disease and its causes.[23] Similarly, the use of MVMM and Vitamin B complexes for losing weight and/or maintaining blood sugar among diabetic patients rather than their actual role of simply supplementing diet in people who are on restricted diets. Similarly, use of herbs for conditions like weight loss, diabetes, heart health etc., with a false perception that they have minimal or no side effects since being natural products. Overall, we found NMCD to be reasonable in finding the relevant information for most of the ingredients/products despite a few challenges. Since NMCD has DS related information as monographs with detailed information at “ingredient” level, DS products corresponding to more than one ingredients, e.g., MVMM, Vitamin B / B-Complex need to be searched individually for each comprising ingredients for any specific information. In contrary, although Dietary Supplements Label Database (DSLD) is primarily a product level resource with plenty of multi ingredients products, the information provided is not helpful since it is (1) not specific (providing only LanguaL™ related dietary claims or uses), and (2) fragmented/distributed under various sections.

We also noted the lack of consistency of information in the DS knowledge bases. The information available to researchers/professionals is not always accurate and is not always up to date. We also acknowledge that there is no one, comprehensive DS knowledge base available to consumers. It is clear that from a consumer perspective, the DS knowledge affects the actual use of DS. In our preliminary comparison between the reported benefits for each of the major DSs and the knowledge base, there is a knowledge gap between the perceived and documented benefits of the DSs.

Limitation

A few limitations should be noted when interpreting the study results. First, the most recent data was not available at the time of the study. Second, specific usage information was not available for the entire time frame. Third, in the correlation analysis, some variables (e.g., BMI, number of DSs taken) are skewed, which may affect the correlation analysis. We attempted a few transformations (e.g., square root transformation) but have not fully resolved the data skewness problem.

Future Work

Additional studies comparing DS use in adult in the obese versus non-obese populations would provide additional information regarding DS use in the adult population as a whole and potentially provide more information regarding the use of knowledge bases. In addition, we would also like to look at medication use in the obese population using NHANES data to see what knowledge can be gained from this diverse database. We would like to also perform a study looking at specific questionnaire data related to certain health conditions and related medication use in the adult population to see what information can be gathered regarding specific diseases and how they relate to obesity. As clinical trials generate gold-standard medical evidence, we are also interested in assessing the population representativeness of DS trials and identifying the systematic biases in the eligibility criteria in the trial design using informatics methods such as Generalizability Index for Study Traits[24] and its variants.[18,25]

Conclusions

Complementary alternative medicine, especially dietary supplements, has gained increasing popularity for many reasons including availability without prescription, price, and ease of use. Besides weight loss, there are various potential benefits for DS. Nevertheless, health consumers with limited health literacy may not adequately understand the benefits and risk of overdose for DS. In this project, we aim to gain a better understanding of the use of DS products among obese people as well as their perceived benefits of these products. We identified obese adults after combining the National Health and Nutrition Examination Survey data collected during 2003-2014. We found that there is a knowledge gap between the reported benefits of major DS by obese adults and the existing DS knowledge base and label database. This gap may inform the design of patient education material on DS usage in the future.

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