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Comparison of a Medication Inventory and a Dietary Supplement Interview in Assessing Dietary Supplement Use in the Hispanic Community Health Study/Study of Latinos

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ABSTRACT: Although dietary supplement use is common, its assessment is challenging, especially among ethnic minority populations such as Hispanics/Latinos. Using the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) (n = 16,415), this report compares two strategies for capturing dietary supplement use over a 30-day period: a medication-based inventory and a nutrition-based dietary supplement interview. Age-standardized prevalence was calculated across multiple dietary supplement definitions, adjusted with survey/nonresponse weights. The prevalence of dietary supplement use was substantially higher as measured in the dietary supplement interview, compared to the medication inventory: for total dietary supplements (39% vs 26%, respectively), for nonvitamin, nonmineral supplements (24% vs 12%), and for botanicals (9.2% vs 4.5%). Concordance between the two assessments was fair to moderate (Cohen's kappa: 0.31–0.52). Among women, inclusion of botanical teas increased the prevalence of botanical supplement use from 7% to 15%. Supplement assessment that includes queries about botanical teas yields more information about patient supplement use.

KEYWORDS: dietary supplements, epidemiology, Hispanics/Latinos, measurement methodology

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Introduction

Growth in the number of marketed dietary supplements has been marked, increasing from 4,000 products in 1994 to 55,000 in 2009.¹ Dietary supplements result in >\$20 billion in sales each year with growth of about 6% per year² and prevalence of dietary supplement use is common in the United States (US) general public.^{3,4} In national studies, among Hispanics/Latinos, the reported prevalence of any dietary supplement use

(34%) in the past 30 days was lower as compared with non-Hispanic whites (59%).³ National studies of botanical and nonvitamin, nonmineral (NVNM) supplement use in the prior year also report lower prevalence among Hispanics/Latinos, 12% compared with 23%,⁴ but other studies conducted within Hispanic/Latino populations have resulted in much higher estimates: >60% in the past 12 months,^{5,6} leading to questions about the comparability of these study designs.



Assessment of supplement use is challenging in any population, but is particularly difficult among ethnic minorities and with regard to botanical and other NVNM supplements. Most observational studies rely on self-completed questionnaires⁷⁻¹⁰ or telephone surveys¹¹ to collect dietary supplement data, asking participants to choose from a list of supplements that may or may not be consistent with cultural traditions. Product examination is considered a criterion standard for supplement assessment,¹² but, if not assessed in the home, could miss supplements individuals forget to bring in to the study visit. Moreover, disclosure of supplement use to healthcare providers has been suboptimal, potentially leaving patients open to adverse effects.¹³ A more systematic approach to supplement assessment is clearly indicated.

The current study utilizes the baseline data of the Hispanic Community Health Study/Study of Latinos (HCHS/SOL). HCHS/SOL is unique in its supplement assessments in two ways. The study collected supplement data in a sample of US Hispanics/Latinos using both a dietary interview method and a medication-based (product examination inventory) method to assess supplement use over 30 days. In addition, supplement use was also captured in the 24-hour dietary recall data, reflecting immediate use. This analysis categorized dietary supplement types and measured their prevalence among Hispanics/Latinos of diverse Hispanic backgrounds by a medication inventory (MV) and a dietary supplement interview (DI). The analysis also addresses the prevalence of common supplement ingredients.

Methods

Data source. The HCHS/SOL is a prospective cohort study designed to identify risk factors and disease prevalence among Hispanic/Latino residents of four communities in the US (Miami, Bronx, Chicago, and San Diego). To achieve a representative sample of the target population, a two-stage area household probability design was employed.^{14,15} HCHS/SOL investigators chose communities to achieve a balanced recruitment of Hispanics/Latinos from across countries of origin and geographic areas of the US.¹⁴ Within communities, census tracts were selected based on their proximity to the field center clinics and demographics; study plans called for cross-stratifying by high vs low concentration of Hispanic/Latino residents and high vs low SES.¹⁵ The recruitment plan focused on advertising and face-to-face recruitment within neighborhoods and housing blocks, including communities with high concentrations of Hispanics/Latinos.^{14,15} Hispanic/Latino community involvement was key to the highly successful recruitment strategy.¹⁵ This report is based on cross-sectional data from the baseline data collection, 2008–2011.

Study population. The study enrolled 16,415 noninstitutionalized adults who self-identified their background as Cuban, Dominican, Puerto Rican, Mexican, Central American, South American, or other Hispanic/Latino. Of the enrolled, 16,279 had data for the outcomes and were

included in the analyses. Individuals within sampled households were screened for eligibility (living in the household, age 18–74, able to attend a clinic visit, and not planning to move within six months).¹⁵ Enrolled individuals attended a comprehensive examination visit at the study field center where they reviewed/signed consent documents and participated in study assessments, including demographic, medical, nutrition, and physical activity assessments. Study procedures were approved by human research ethics boards at participating institutions. Human research ethics approval for the current study was waived by the University of North Carolina Institutional Review Board, because the analysis was based solely on secondary, de-identified data.

Categorization of the dietary supplement data. The medication inventory, the dietary supplement interview, and the two 24-hour dietary recalls all contained product name files for a variety of dietary supplements. Dietary supplement products were categorized using an adapted form of the Languag categorization system proposed by Saldanha et al.¹⁶ The Languag system involves coding multiple facets of a product, from the general, to the specific. For this study, coded facets included product type (Facet A), physical form (Facet E, with collapsed categories), and ingredients (Facet H).

Although the Languag system nicely organizes dietary supplement ingredients, definitions of dietary supplement product types have not yet been standardized. In this study, based on the available product information, combination products that contained $\geq 50\%$ of the recommended daily allowance (RDA) of a vitamin or mineral, and also contained a botanical or other NVNM ingredient were classified as a dietary supplement with NVNM. Those that contained $< 50\%$ RDA of a vitamin or mineral were classified as a primarily NVNM product. Botanicals were similarly classified. NVNM products included botanicals, but botanical products excluded other NVNM (eg, glucosamine, coenzyme Q10, omega-3 and omega-6 fatty acids, fiber products, enzymes, probiotics, amino acids, and protein supplements) (Fig. 1). Based on these classifications, supplement users were defined as: (1) users of any dietary supplements; (2) users of supplements containing any NVNM (including botanicals); (3) users of supplements consisting of primarily NVNM ingredients (including botanicals); (4) users of supplements containing any botanical ingredients; (5) users of primarily botanical supplements.

Measurement variables. *Medication inventory.* Participants in the HCHS/SOL were asked to bring all medications, dietary supplements, and herbal remedies taken in the four weeks prior to their baseline visit. The medication inventory was designed to therapeutically classify all prescription and over-the-counter medications and supplements, including vitamins, minerals, botanicals, and supplements used by participants during the four weeks preceding examination. The inventory involved scanning any Universal Product Code bar code symbols on medication packaging, pill imprint searches

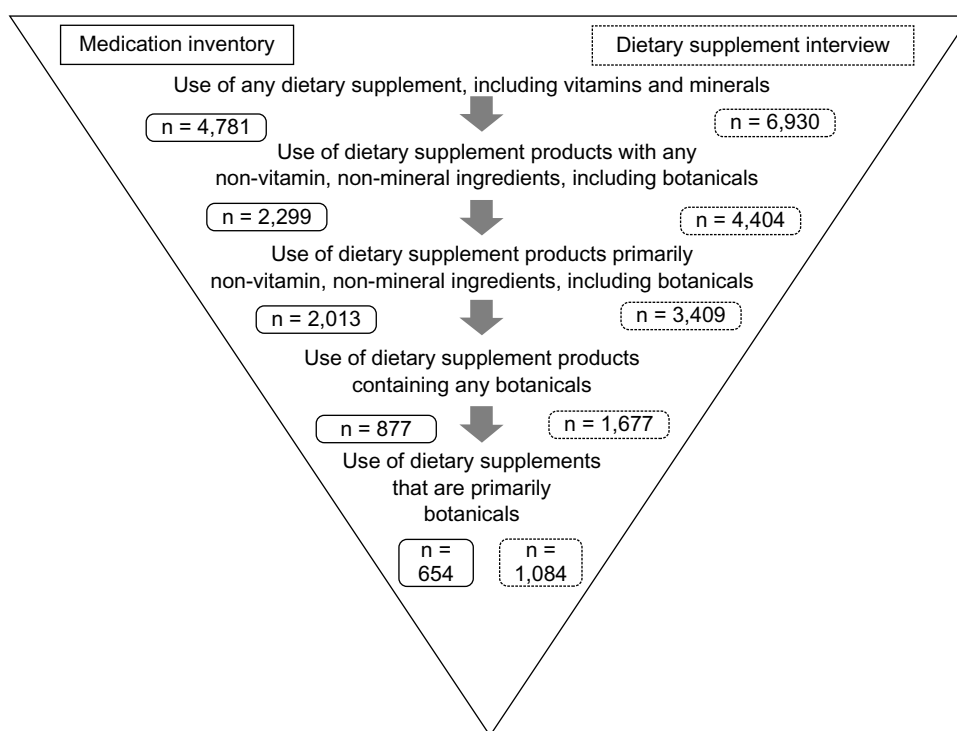


Figure 1. Dietary supplement assessment protocol.

Notes: Sample is restricted to participants with data for both the medication inventory and the dietary supplement interview. For the medication inventory, participants were asked to bring in all dietary supplements and home remedies taken in the past four weeks. Supplements were recorded in the medications database. For the dietary supplement interview, after providing information about food intakes in the past 24 hours, participants responded to a series of questions about their supplement use in the past 30 days. The dietary supplement interview utilized the dietary supplements assessment module of the Nutrition Data System for Research. Additional botanicals, captured with the 24-hour food recalls, are not reflected in the figure because of a differing time frame.

using Facts & Comparisons® Drug Identifier and Ident-A-Drug Reference © when necessary, and automated therapeutic classification of >99% of products based on their generic/brand name using a Master Drug Data Base (Medspan MDDB®) supplemented with Spanish-language brand and generic name equivalents from Lexi-Comp Online™ and OVID © Martindale. For the remaining 1% of products, manual coding was performed by healthcare professionals with expertise in medication and supplement identification. Approximately 10,000 products were identified as dietary supplements. Over 1,600 products could not be coded beyond identification as a dietary supplement because of insufficient information, resulting in missing NVNM data for 630 individuals (4%).

Dietary supplement interview. At the time of the field center clinic visit, immediately following the 24-hour dietary recall, technicians interviewed participants (in Spanish or English, according to their preference) about their recalled dietary supplement use in the 30 days prior to the study visit. The dietary supplements from the 30-day supplement interview were recorded in the Dietary Supplement Assessment Module (DSAM) of the Nutrition Data System for Research database (NDSR). Information for supplements that did not match in the DSAM were updated from the product label (obtained from the manufacturer when possible) and validated against outside resources. DSAM-based product name files

were recorded with greater detail than the medication inventory files, enabling refined product coding. The dietary supplement interview data consisted of ~2,700 different products representing ~15,000 entries. Calculations of the prevalence of individual botanicals within dietary supplement products depended on the DSAM ingredient-level dataset. Botanical supplement reports were limited to those with a prevalence of at least 0.2%.

Twenty-four-hour dietary recall. The 30-day dietary supplement interview files recorded a few botanical teas. However, botanical teas, other liquid dietary supplement products, and culturally specific botanicals appeared in the two 24-hour dietary recalls enabling the calculation of: (1) estimates of supplement use including botanical teas and (2) estimates also including green tea (*Camellia sinensis*) and nopal (whole fruit).

Statistical analysis. The distribution of key variables was examined across dietary supplement users, NVNM supplement users, and botanical supplement users, including demographics (age, gender, education, percent of poverty for family size, and year), healthcare access (percent of poverty, insurance status, self-reported lack of access to care), health behaviors (cigarette smoking, diet quality, physical activity), and acculturation measures (language preference, years of residence in the US, born in US). All variables were examined



for missing data; analyses were based on 16,060 individuals who had data for both the medication inventory and dietary supplement interview.

Because neither the dietary supplement interview nor the medication inventory could be considered a gold standard measure, comparison of the two was limited to calculation of Cohen's kappa statistics with positive and negative agreements¹⁷ and prevalence and bias-corrected kappa (PABAK).¹⁸ Kappa statistics were interpreted following established criteria.¹⁹ In addition, to look at the sensitivity of dietary supplement prevalence estimates to various assumptions, estimates were calculated based on: (1) the dietary supplement interview updated with botanical teas from the 24-hour dietary recall; (2) the dietary supplement interview with 24-hour recall data, including nopal and green tea; and (3) the combined dietary supplement interview, medication inventory, and dietary recall.

Results

Characteristics of the study population. Distributions of key characteristics of the study population are presented, classifying participants as users of any dietary supplement ($n = 7,658$), users of NVNM supplements (including botanicals) ($n = 3,916$), users of botanical supplements ($n = 1,433$), and users of no supplements ($n = 8,402$) based on their reported use in either the dietary supplement interview or the medication inventory (Table 1). Supplement use categories are nested (Fig. 1). Users of supplements that included NVNM ingredients were older (mean age of 46 vs 38 years among nonusers), more likely to be female (55 vs 48%), and more likely to be nonsmokers (65 vs 58%).

Users of botanical supplements only had a higher education and greater adherence to a higher quality diet as measured by the 2010 Alternative Healthy Eating Index. They

Table 1. Distribution of sample population characteristics by the use of supplement types^a in HCHS/SOL.

	N ^b	USERS OF ANY SUPPLEMENTS ^a N = 7,658	USERS OF ANY NVNM SUPPLEMENTS N = 3,916	USERS OF ANY BOTANICAL SUPPLEMENTS N = 1,433	NONUSERS OF DIETARY SUPPLEMENTS N = 8,402
		MEAN OR% (95% CI) ^c	MEAN OR% (95% CI) ^c	MEAN OR% (95% CI) ^c	MEAN OR% (95% CI) ^c
Mean age	16, 279	45.5 (44.8, 46.2)	46.4 (45.6, 47.1)	43.8 (42.8, 44.8)	37.7 (37.2, 38.2)
% Female	9,764	56.5 (54.7, 58.3)	54.8 (52.5, 57.1)	58.4 (55.0, 61.7)	48.3 (46.7, 49.8)
Mean% poverty threshold	14,669	169 (160, 178)	182 (170, 193)	183 (169, 197)	142 (137, 147)
Hispanic/Latino Background (%)					
Dominican	1,466	9.8 (8.3, 11.6)	7.6 (6.3, 9.3)	6.6 (5.2, 8.4)	9.8 (8.4, 11.3)
Central American	1,718	7.7 (6.5, 9.0)	8.3 (7.0, 10.0)	8.6 (6.9, 10.6)	7.0 (6.0, 8.2)
Cuban	2,338	18.7 (16.0, 21.7)	19.4 (16.6, 22.5)	16.1 (13.4, 19.3)	22.8 (19.1, 26.8)
Mexican	6,455	40.0 (36.5, 43.6)	41.6 (37.8, 45.6)	46.9 (42.7, 51.2)	34.7 (31.5, 38.1)
Puerto Rican	2,708	14.6 (13.0, 16.3)	13.3 (11.5, 15.4)	12.6 (10.4, 15.2)	17.0 (15.2, 19.0)
South American	1,071	5.6 (4.8, 6.5)	6.0 (5.0, 7.3)	5.6 (4.4, 7.2)	4.6 (4.0, 5.3)
Other	523	3.7 (3.0, 4.6)	3.7 (2.8, 4.8)	3.6 (2.5, 5.1)	4.1 (3.5, 4.8)
Preference for Spanish	13,009	74.8 (72.6, 76.8)	74.7 (72.2, 77.0)	75.5 (72.5, 78.1)	76.6 (74.4, 78.7)
Born in US (%)	2,855	21.5 (19.6, 23.5)	20.7 (18.7, 22.8)	20.7 (18.1, 23.4)	21.5 (20.0, 23.1)
Mean years in US	16,211	21.2 (20.5, 21.9)	21.1 (20.3, 21.9)	21.1 (20.2, 21.9)	20.0 (19.1, 20.8)
Education (%)					
<HS	6,091	28.5 (26.5, 30.6)	25.8 (23.5, 28.3)	25.5 (22.5, 28.7)	36.2 (34.5, 38.1)
HS graduate	4,116	26.3 (24.6, 28.0)	24.9 (22.8, 27.1)	23.7 (21.1, 26.5)	29.2 (27.8, 30.6)
At least some college	5,741	45.2 (42.8, 47.7)	49.3 (46.3, 52.2)	50.8 (47.1, 54.5)	34.6 (32.9, 36.3)
% with no insurance	7,893	47.2 (44.8, 49.7)	50.0 (47.0, 53.0)	53.2 (49.4, 57.1)	50.6 (48.6, 52.7)
% unable to get needed healthcare	2,695	15.1 (13.7, 16.6)	15.6 (14.0, 17.4)	17.0 (14.8, 19.4)	15.6 (14.4, 16.8)
% meeting physical activity guidelines ^d	10,335	68.7 (66.9, 70.5)	70.4 (68.3, 72.5)	71.3 (68.2, 74.2)	64.5 (63.1, 66.0)
Mean AHEI ^e	16,126	48.3 (47.9, 48.7)	48.9 (48.4, 49.4)	49.5 (49.0, 50.1)	47.1 (46.7, 47.5)
Cigarette use (%)					
Never smoked	9,884	64.6 (62.8, 66.4)	64.8 (62.4, 67.0)	63.0 (59.5, 66.3)	57.8 (56.0, 59.5)
Former smoker	3,216	18.6 (17.3, 20.1)	19.8 (18.1, 21.6)	21.3 (18.9, 24.1)	17.6 (16.5, 18.7)
Current smoker	3,148	16.7 (15.1, 18.5)	15.5 (13.7, 17.4)	15.7 (13.2, 18.5)	24.7 (23.3, 26.1)

(Continued)



Table 1. (Continued)

	USERS OF ANY SUPPLEMENTS ^a N = 7,658	USERS OF ANY NVNM SUPPLEMENTS N = 3,916	USERS OF ANY BOTANICAL SUPPLEMENTS N = 1,433	NONUSERS OF DIETARY SUPPLEMENTS N = 8,402
	N ^b	MEAN OR% (95% CI) ^c	MEAN OR% (95% CI) ^c	MEAN OR% (95% CI) ^c
Self-reported health (%)				
Fair-poor	4,834	25.5 (23.7, 27.4)	24.3 (22.2, 26.5)	23.7 (21.2, 26.5)
Good	7,492	45.1 (43.1, 47.0)	44.1 (41.7, 46.5)	46.1 (43.0, 49.3)
Very good–excellent	3,898	29.4 (27.5, 31.4)	31.6 (29.0, 34.3)	30.2 (27.0, 33.5)
Geographic area (US) (%)				
Bronx	4,051	25.8 (22.9, 28.9)	21.2 (18.5, 24.2)	18.1 (15.3, 21.3)
Chicago	4,108	14.2 (12.3, 16.3)	14.6 (12.4, 17.1)	15.2 (12.5, 18.4)
Miami	4,054	28.8 (25.0, 33.0)	30.8 (26.8, 35.2)	28.8 (24.8, 33.3)
San Diego	4,066	31.2 (27.1, 35.6)	33.3 (28.6, 38.4)	37.8 (32.5, 43.5)

Notes: ^aSupplement users were defined as users by either the medication inventory or the dietary supplement interview. Categories presented for comparison of distributions include only users of any dietary supplement, users of primarily NVNM products (including botanicals), and users of botanical supplements (including fiber). ^bN, number of participants in sample, rather than the representative population. ^cMeans and percentages reflect sample weights and are age standardized to the US population. ^dPhysical activity data were summarized as meeting or not meeting CDC 2008 guidelines for physical activity. ^eNutritional data were summarized with the Alternative Healthy Eating Index-2010 (AHEI-2010). The AHEI was developed to update prior healthy eating indices based on US Dietary Guidelines with recommendations derived from scientific studies of diet and health outcomes.^{33,34} The AHEI assigns values for consumption of vegetables, fruit, whole grains, sugar-sweetened beverages, nuts/legumes, red/processed meats, trans fat, long-chain n-3 fatty acids, total polyunsaturated fatty acids, sodium, and alcohol intake with a maximum value of 110.³⁴ Healthy individuals aged 55–80 in the Nurses' Health Study had a mean AHEI-2010 of 53.2.³³

Abbreviation: AHEI, alternative healthy eating index.

were more likely to be of Mexican background and living in San Diego; they were less likely to have insurance or to have access to needed healthcare.

Concordance of the medication inventory and dietary supplement interview. Prevalence of supplement use as measured by the dietary supplement interview was higher than that for the medication inventory, even for overall dietary supplement use (39.3% vs 25.9%) (Table 2). The absolute differences were smaller, but the proportional difference was greater for NVNM and botanical products: prevalence estimates of products with any NVNM or botanical components in the dietary supplement interview were about twice that of the medication inventory. Positive agreement and overall kappa statistics were consistent with moderate agreement for most comparisons (κ : 0.44–0.52). Kappa for botanical products was only fair (κ : 0.31–0.36), but negative agreement was high, as was prevalence and bias-adjusted kappa (PABAK: 0.81–0.88). Kappa statistics for liquid or powdered products (κ : 0.11–0.13) were low, but negative agreement for these products were high at 0.96–0.99 (PABAK: 0.85–0.95). In fact, negative agreement was high across all categories of supplements (κ : 0.82–0.99). In sensitivity analyses, assigning uncategorized products from the medication inventory to NVNM or botanical supplements, based on their similarity to products that were definitely classified as such, reduced the disparity between the two assessments (Table 2).

Sensitivity of the prevalence estimates to the measurement strategy. NVNM and botanical prevalence estimates were sensitive to inclusion of botanical teas and other

liquid supplements captured in the dietary recalls (Fig. 2). The use of botanical teas (excluding green tea) was relatively common: A total of 6.5% (95% CI: 5.8–7.3) reported a botanical tea or other botanical liquid product on either of the recall visits. The prevalence of use of any nopal was 3.2% (95% CI: 2.7–3.6), and the prevalence of the use of dietary green tea was 3.6% (95% CI: 3.1–4.1). If teas, liquid nopal, and other liquid supplements were included in the estimates as primarily botanical supplements, prevalence increased by 131% in women and 105% in men. Additionally, counting brewed green tea and nopal as botanical supplements increased the prevalence of botanical supplements substantially, by 32% in women and 34% in men. Additionally, counting all fiber products as botanicals increased the prevalence of botanical use by another 9% in women and 11% in men to 22.5% and 14.7%, respectively. The combined dietary and medication information resulted in a prevalence of 43.6% (95% CI: 42.2–45.0) for any dietary supplement, 27.8% (95% CI: 26.5–29.1) for supplements with NVNM, and 11.9% (95% CI: 11.0–12.7) for supplements with any botanical components.

Prevalence of individual supplement ingredients. NVNM ingredients included fish oil, glucosamine or related products, lutein-containing products; prevalence of these substances and individual botanical ingredients were calculated from the ingredient files (Table 3). Among the NVNM supplements, omega-3 fatty acids, lutein, and lycopene were the most common, occurring with a prevalence of about 10%. Omega-3 fatty acids were most often consumed as single



Table 2. Comparison of the 30-day dietary supplement use assessed through the medication inventory and dietary supplement interview in HCHS/SOL^a.

VARIABLE	MEDICATION INVENTORY (MV)		DIETARY SUPPLEMENT INTERVIEW (DI)		MV+		MV-		MV- DI-	n	POSITIVE AGREEMENT (95% CI)	NEGATIVE AGREEMENT (95% CI)	COHEN'S KAPPA (95% CI)	PREVALENCE - AND BIAS- ADJUSTED KAPPA ^c
	% (95% CI) ^b	n	DI+	DI-	n	n								
Any dietary supplement (DS)	25.9 (24.6, 27.1)	4053	759	2910	8557	0.69 (0.68, 0.70)	0.82 (0.82, 0.83)	0.52 (0.51, 0.53)	0.55					
DS with any NVNM component	12.4 (11.6, 13.2)	1733	577	2,306	11,033	0.55 (0.53, 0.56)	0.88 (0.88, 0.89)	0.44 (0.42, 0.46)	0.63					
DS primarily NVNM	10.8 (10.1, 11.5)	1465	544	1612	12,028	0.58 (0.56, 0.59)	0.92 (0.91, 0.92)	0.50 (0.48, 0.52)	0.72					
DS with any botanical	4.5 (4.1, 4.9)	417	466	1009	13,737	0.36 (0.34, 0.39)	0.95 (0.95, 0.95)	0.31 (0.29, 0.34)	0.81					
Primarily botanical products	3.3 (3.0, 3.7)	305	354	589	14,401	0.39 (0.36, 0.42)	0.97 (0.97, 0.97)	0.36 (0.33, 0.39)	0.88					
Sensitivity Analysis														
DS with NVNM ^d	15.3 (14.3, 16.4)	2125	804	2263	11,008	0.58 (0.57, 0.59)	0.88 (0.87, 0.88)	0.46 (0.45, 0.48)	0.62					
DS with botanical ^d	5.1 (4.6, 5.5)	485	534	986	13,739	0.39 (0.37, 0.41)	0.95 (0.94, 0.95)	0.34 (0.31, 0.36)	0.81					

Notes: Agreement statistics were calculated with DAG_Stat, an Excel-based program for the calculation of agreement statistics.³⁵ ^aAnalysis is restricted to subjects with data for both the medication inventory and the dietary supplement interview (n = 16,279). An additional 630 (4%) of participants took supplements for which insufficient detail was available for coding. ^bProportions are adjusted by sample and nonresponse weights and are age standardized to the 2010 Census distribution for Hispanics/Latinos. ^cThe PABAK adjusts not only for the prevalence effect (the difference between the positive and negative agreements) but also for differences in the marginal probability of supplement use between the assessments. ^dSensitivity analysis reflects coding supplements with insufficient information, but likely to be NVNM and botanical (based on similar products and those with the same medication inventory codes).

Abbreviations: DS, dietary supplements; NVNM, nonvitamin, nonmineral products, including botanicals; MV, medication inventory; DS, dietary supplement interview.

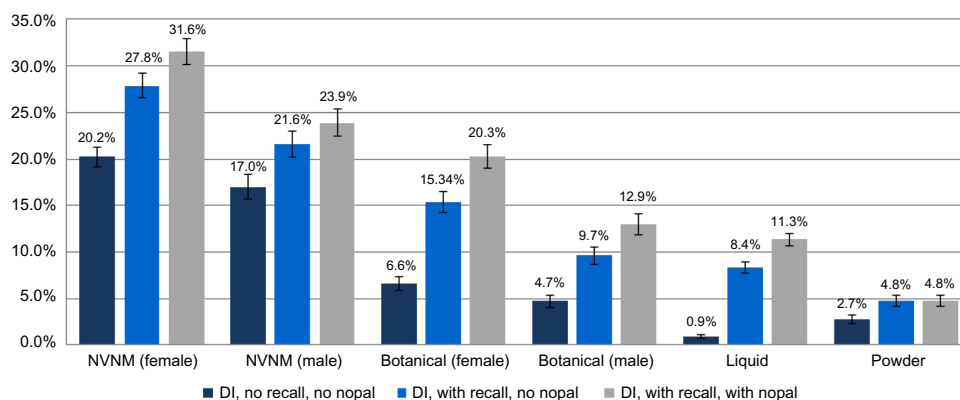


Figure 2. Prevalence of NVNM supplements considering the addition of supplements captured in the dietary recalls. Prevalence estimates are standardized to the 2010 US Census and weighted with sample and nonresponse weights and stratified by gender: “DI no recall no nopal” references the dietary supplement interview data without dietary recall data. “DI with recall no nopal” references the dietary supplement interview data with the addition of dietary recall data, but excluding raw nopal and green tea. “DI with recall with nopal” references the dietary supplement interview data with dietary recall data, including raw/cooked nopal and green tea.

Note: Only nopal ingested outside recipes were included in these estimates.

supplements, while lutein and lycopene were often added to multivitamin products. Other common combination products included those containing glucosamine (3.4%) and lipotropic agents (primarily lecithin and inositol –3.4%).

Many combination products containing vegetable or fruit extracts were counted as botanicals. Over 2% of study participants consumed a supplement with at least one vegetable extract and over 4% consumed a product containing a fruit extract. Culinary herbs, such as parsley, sage, and oregano were occasional constituents of combination products.

Ginkgo and ginseng were the most commonly reported botanicals (2.6%), followed by green tea extracts and garlic (1.7%). Licorice was also a component of botanical products among about 1% of participants. Chamomile at 0.23% and nopal at 0.13% were less common constituents of dietary supplement products – almost 2% of participants reported consuming chamomile tea in the dietary recall (1.9%; 95% CI: 1.6–2.3).

Discussion

Depending on the assessment (medication inventory and/or dietary supplement interview ± dietary recall data), HCHS/SOL estimated that 4.5%–19% of participants reported taking botanical supplements and 12%–32% reported use of NVNM supplements, including botanicals. Results of this study demonstrate the challenges of accurate dietary supplement assessments, particularly with regard to the botanical and other NVNM products. Estimates based on the medication inventory alone differed substantially from those based on the dietary supplement interview and neither assessment appears to have captured the use completely. Some products were reported only with the medication inventory and the others only with the dietary supplement interview. Botanical estimates in particular were markedly sensitive to varying assumptions about what constitutes a botanical product

– including all fiber products as botanicals, a reasonable, but not universal assumption, markedly increased estimates, as did the inclusion of botanical teas and other liquid dietary supplements ascertained in the 24-hour dietary recall files.

Comparability of assessment comparisons. The most accurate self-report measure of dietary supplement use is considered to be a detailed interview with label capture and transcriptions, conducted in the home.¹² Other studies have used a label capture system conducted in the clinic for supplement assessment, similar to the medication inventory in HCHS/SOL.^{20,21} In these studies, participants completed a dietary supplement questionnaire at home prior to the in-person interview, perhaps prompting improved supplement recall.

Kappa statistics in studies comparing questionnaires with label capture have been variable, ranging from 0.46 to 0.92.^{12,21} Agreement of supplement use as measured by a telephone interview compared to a label capture was somewhat lower—with a kappa as low as 0.14.²⁰ A fourth study compared vitamin and mineral supplement assessment via a self-completed health questionnaire and two types of dietary assessments, a food frequency questionnaire and a 7-day food diary.²² Agreement in these studies comparing the three instruments was substantial (κ : 0.72–0.81).

In contrast, our agreement statistics are somewhat lower, especially for botanical products. Although every effort was made to classify dietary supplement products similarly in the two datasets, some misclassification was likely, given the amount of missing information in the medication inventory. In addition, a kappa statistic is less reliable in a setting of low prevalence, as seen with botanical supplements²³ and with imbalances in the marginal totals as was seen in both the botanical and NVNM data.²⁴ However, moderate agreement was seen with the comparisons of overall dietary supplement use and with the comparisons of NVNM supplements and negative agreement statistics were uniformly high.



Table 3. Prevalence of selected supplement ingredients in the 30-day dietary supplement interview in HCHS/SOL.

SUPPLEMENT INGREDIENT	N	PREVALENCE	SUPPLEMENT INGREDIENT	N	PREVALENCE
Vitamins	5,674	32.7 (31.5, 33.9)			
Minerals	5,484	31.7 (30.4, 33.0)	Garlic	333	1.7 (1.4, 2.1)
NVNM			Ginger	111	0.65 (0.49, 0.87)
Amino acids	562	3.1 (2.8, 3.6)	Ginkgo	454	2.6 (2.2, 3.0)
Chondroitin	351	1.9 (1.6, 2.3)	Ginseng	435	2.6 (2.3, 3.0)
Coenzyme Q10	158	1.0 (0.7, 1.3)	Grain ^e	271	1.5 (1.3, 1.8)
Collagen	179	0.9 (0.7, 1.1)	Grape seed	176	0.90 (0.72, 1.1)
Enzyme	55	0.25 (0.18, 0.36)	Green tea	277	1.7 (1.4, 2.0)
Fiber	246	1.3 (1.1, 1.5)	Guarana	54	0.29 (0.20, 0.41)
Glucosamine	664	3.4 (3.0, 4.0)	Hawthorn	42	0.21 (0.13, 0.34)
Lipotropic ^a	666	3.4 (3.1, 3.8)	Holy basil (Tulsi)	29	0.21 (0.11, 0.38)
Lutein	1,574	9.5 (8.8, 10.3)	Horseradish	53	0.37 (0.24, 0.58)
Lycopene	1,654	10.5 (9.7, 11.4)	Horsetail	160	0.70 (0.54, 0.90)
MSM	271	1.4 (1.1, 1.7)	Licorice	232	0.93 (0.77, 1.1)
Omega-3 ^b	1,765	9.6 (9.0, 10.4)	Milk thistle	71	0.50 (0.30, 0.84)
Omega-6 ^c	190	1.1 (0.83, 1.4)	Mint	54	0.27 (0.19, 0.38)
Omega-9 ^d	143	0.87 (0.62, 1.2)	Mushroom	102	0.43 (0.30, 0.63)
Probiotics	120	0.55(0.42, 0.72)	Nettle	45	0.37 (0.21, 0.65)
Protein	359	2.2 (1.8, 2.6)	Olive leaf	40	0.20 (0.13, 0.32)
Botanicals			Parsley	153	0.88 (0.69, 1.1)
Aloe	127	0.60 (0.45, 0.79)	Pepper (black)	43	0.23 (0.11, 0.40)
Astragalus	48	0.29 (0.18, 0.48)	Pine bark	93	0.39 (0.29, 0.53)
Bioflavonoids	36	0.28 (0.17, 0.46)	Pumpkin seed	59	0.48 (0.31, 0.73)
Black cohosh	80	0.30 (0.22, 0.40)	Rhodiola	88	0.40 (0.29, 0.56)
Boswellia	81	0.27 (0.19, 0.37)	Rose hips	75	0.29 (0.21, 0.40)
Cascara/Senna	61	0.30 (0.22, 0.42)	Rosemary	94	0.57 (0.42, 0.77)
Cayenne	96	0.41 (0.31, 0.54)	Sage	37	0.21 (0.12, 0.36)
Cinnamon	101	0.48 (0.36, 0.64)	Saw palmetto	106	0.88 (0.66, 1.2)
Chamomile	54	0.23 (0.16, 0.33)	Schisandra	59	0.35 (0.24, 0.50)
Dandelion	75	0.38 (0.27, 0.53)	Seaweed	213	1.0 (0.82, 1.3)
Dong quai	52	0.22 (0.15, 0.33)	Soy	100	0.49 (0.37, 0.64)
Echinacea	101	0.69 (0.52, 0.92)	Spirulina	157	0.86 (0.67, 1.1)
Elderberry	52	0.33 (0.21, 0.52)	Turmeric	79	0.37 (0.26, 0.53)
Eleuthero	103	0.55 (0.38, 0.81)	Valerian	44	0.22 (0.15, 0.31)
Fennel	54	0.28 (0.20, 0.40)	Vegetable extract	432	2.3 (2.0, 2.7)
Fo-ti	58	0.21 (0.15, 0.30)	Yerba Mate	40	0.25 (0.17, 0.37)
Fruit extracts	796	4.1 (3.7, 4.5)			

Notes: Chamomile, green tea, and nopal are also commonly consumed as foods – not included in these estimates. Prevalence estimates are based on the entire sample rather than within dietary supplement users and are adjusted for age and the complex survey weights. ^aLipotropic: lecithin, inositol. ^bOmega-3: fish oils, flaxseed oil; ^cOmega-6: linoleic acid, borage, evening primrose oils; ^dOmega-9: olive oil, oleic acid; ^eGrain: oats, wheat, corn, quinoa, alfalfa.

Low agreement was not surprising, given the very different supplement ascertainment by the two systems. A review of medications is more likely to underestimate dietary supplement use. In clinical situations, accurate capture of dietary supplement use is uncommon: 33% of individuals with chronic disease reported that they had informed their healthcare

provider of their supplement use and disclosure rates were lower among Hispanics (22%).¹³ When asked why they did not disclose their supplement use, patients reported that they did not think that it was important for their providers to know.²⁵ A similar mechanism may be driving the lower prevalence in the medication inventory data in this study.



On the other hand, the dietary supplement interview benefited from both a systematic inquiry and the use of DSAM, a detailed database designed specifically for the capture of dietary supplement data. In addition, the dietary supplement interview followed a detailed interview about food intakes in the past 24 hours. Individuals may have been more likely to recall supplements they regarded as enhancements to their diet after a 24-hour dietary recall.

The value of the medication inventory and the dietary supplement interview independently could be called into question. However, together, and when combined with data from the 24-hour dietary recalls, a more complete picture of supplement use emerges. Comparisons of supplement assessments by these different techniques furnish important information about the impact of study design on reports of supplement prevalence in the Hispanic/Latino literature. Wide variations in botanical supplement prevalence may result from differences in assessment strategies as well as supplement definitions (including vs excluding botanical teas). In addition, because of the high probability of under-reporting, asking about supplement use multiple times is more likely to yield accurate estimates. In a study of home remedies for childhood diarrhea, researchers only learned of the botanical remedies after establishing a trusted relationship with participants.²⁶

Comparing HCHS/SOL dietary supplement prevalence estimates to other studies. Depending on the instrument (inventory vs interview), HCHS/SOL prevalence estimates of botanical dietary supplement use in the last 30 days ranged from 4.5% to 9%, increasing to 15% with the addition of data from the dietary recall (botanical teas and other liquid supplements also consumed as foods). Commonly reported supplements were consistent with patterns in the general US public, rather than those reportedly common among Hispanics/Latinos such as aloe, mint, chamomile, flax, and linden.²⁷ Interestingly, botanicals traditional among Hispanics/Latinos were more often reported with the 24-hour dietary recalls than with either the dietary supplement interview or the medication inventory.

Comparable studies were limited to four; most of them targeted an older population. In a home-based interview of dietary supplement use in the past two weeks with label capture among individuals aged ≥ 77 years in Texas, about 38% of Hispanics reported using vitamin or mineral supplements and 5% reported using botanicals, most commonly garlic, ginkgo, and saw palmetto.²⁸ Another study employed a similar strategy (home-based interviews, use in the past two weeks) among Mexican Americans aged ≥ 65 years across the US–Mexican Border States and reported botanical medicine use was about 10%.²⁹ In this latter study, investigators specifically inquired about the use of herbal teas and the most common botanical supplements were consistent with the previously reported favorites among Hispanics/Latinos: chamomile, mint, and aloe.²⁹ In another study, using a telephone interview of supplement and medication use in the past seven days³⁰ in the general US public, the prevalence of NVNM use was 12%

among Hispanics; the most common supplements were lutein, ginkgo, garlic, and glucosamine,³⁰ similar to those reported in HCHS/SOL. Another telephone interview (subjects ≥ 52) reported Hispanic/Latino use of any supplement at 45% and botanicals at 12%.

Limitations and strengths. All HCHS/SOL participants were recruited from urban centers; the dietary supplement habits of Hispanics/Latinos in rural areas may be very different. However, although the target population is limited to the four cities, HCHS/SOL's design, using probability sampling within diverse regions, is superior to the convenience samples typical of many dietary supplement studies in these populations.

Dietary supplement assessment suffers from the same limitations as other data largely dependent on self-report or inventory methods conducted outside the home. It is unlikely that the medication inventory or the dietary supplement interview alone adequately captured supplement use. In the medication inventory, because supplements were spread across the files, instead of receiving a designation as a supplement, some supplements could have been missed, artificially reducing the prevalence estimates resulting from these data. On the other hand, the dietary supplement interview could have been improved by the use of prompts for supplements common among Hispanics/Latinos (eg, chamomile, mint, and aloe) rather than those common in the general population (Echinacea, ginseng, ginkgo, St. John's wort). However, the dietary supplement interview data, using the DSAM, achieved much greater detail than has been reported in prior studies. The ability to add botanical teas from the 24-hour dietary recall data filled in some of the missing information from the dietary supplement interview alone. Moreover, the combination of instruments enriched the picture of dietary supplement use in the population.

An additional limitation of self-reported data is that consistency of use is impossible to determine. This limitation also applies to administrative data: even with prescription fill data, it is unclear whether or not individuals are taking the medications they purchase.

Public health significance. The importance of accurate measurement of dietary supplement use cannot be overstated. Although dietary supplements have biologic activity with the potential for adverse reactions and interactions with drugs,^{31,32} dietary supplements are not regulated with the same level of scrutiny as drugs.^{31,33} The limited regulation also precludes adequate surveillance of use – estimates of interactions and harmful reactions rely on adverse events reporting from individual users and their healthcare providers, many of which will go unrecognized.^{1,34} Unlike prescription drugs, tracking use via pharmacy charges is not possible, and supplement recording via medical records is poor,³⁵ particularly among ethnic minorities.³⁶ In an era of electronic health records, an updated, user-friendly dietary supplement database could greatly enhance the ability of clinicians to capture supplement use among patients, perhaps even by enabling patients to input their own supplement and over-the-counter products.



Areas for future research. The reported prevalence of types of dietary supplements (botanical, NVNM) has been variable among Hispanics/Latinos. Some of this variability is related to sampling design (probability vs convenience), but, based on the findings in this report, it is likely that some of the variability reflects the nonstandardized definitions of what constitutes a botanical or even a dietary supplement. Studies that include only purchased dietary supplement products are not counting home remedies such as botanical teas. Because unprocessed botanicals and teas are part of the health practices of many ethnic minority populations, including Hispanics/Latinos, excluding them from estimates may seriously underestimate use. In addition, failing to inquire about the use of a wide range of dietary supplements, including botanical teas, compromises clinical assessments. Development of dietary supplement assessment strategies that are rapid, patient- and provider-friendly, and comprehensive are likely to both enhance patient empowerment and increase patient safety.

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Author Contributions

Conceived and designed the study: AMSR, KRF, EAW, HMG, GAT, SFC, MLD, JB, REG, LVH. Analyzed the data: KRF. Wrote the first draft of the manuscript: KRF, AMSR. Contributed to the writing of the manuscript: KRF, AMSR, PG, JOR, LAY, EAW, CP. Agreed with manuscript results and conclusions: KRF, AMSR, PG, JOR, LAY, CP, EAW, HMG, DACM, GAT, SFC, MLD, JB, REG, LVH. Jointly developed the structure and arguments for the paper: KRF, AMSR, PG, JOR, LAY, EAW, CP. Made critical revisions and approved the final version: KRF, AMSR, PG, JOR, LAY, CP, EAW, HMG, DACM, GAT, SFC, MLD, JB, REG, LVH. All the authors reviewed and approved the final manuscript.

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