Complementary and Alternative Medicine and Influenza Vaccine Uptake in US Children

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abstract

BACKGROUND: Complementary and alternative medicine (CAM) is increasingly used in the United States. Although CAM is mostly used in conjunction with conventional medicine, some CAM practitioners recommend against vaccination, and children who saw naturopathic physicians or chiropractors were less likely to receive vaccines and more likely to get vaccine-preventable diseases. Nothing is known about how child CAM usage affects influenza vaccination.

METHODS: This nationally representative study analyzed ~9000 children from the Child Complementary and Alternative Medicine File of the 2012 National Health Interview Survey. Adjusting for health services use factors, it examined influenza vaccination odds by ever using major CAM domains: (1) alternative medical systems (AMS; eg, acupuncture); (2) biologically-based therapies, excluding multivitamins/multiminerals (eg, herbal supplements); (3) multivitamins/multiminerals; (4) manipulative and body-based therapies (MBBT; eg, chiropractic manipulation); and (5) mind–body therapies (eg, yoga).

RESULTS: Influenza vaccination uptake was lower among children ever (versus never) using AMS (33% vs 43%; $P = .008$) or MBBT (35% vs 43%; $P = .002$) but higher by using multivitamins/multiminerals (45% vs 39%; $P < .001$). In multivariate analyses, multivitamin/multimineral use lost significance, but children ever (versus never) using any AMS or MBBT had lower uptake (respective odds ratios: 0.61 [95% confidence interval: 0.44–0.85]; and 0.74 [0.58–0.94]).

CONCLUSIONS: Children who have ever used certain CAM domains that may require contact with vaccine-hesitant CAM practitioners are vulnerable to lower annual uptake of influenza vaccination. Opportunity exists for US public health, policy, and medical professionals to improve child health by better engaging parents of children using particular domains of CAM and CAM practitioners advising them.

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Dr Bleser conceptualized the study, conducted data analyses, and led the writing and revision of the manuscript; Ms Elewonibi helped to conceptualize the analysis, helped to write the manuscript, and critically reviewed and revised the manuscript; Drs BeLue and Miranda supervised the research project, helped to conceptualize the analysis, and critically reviewed and revised the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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WHAT'S KNOWN ON THIS SUBJECT: Complementary and alternative medicine (CAM) is increasingly popular and is implicated in supporting antivaccine viewpoints. Some CAM practitioners advise alternative vaccination schedules or against vaccination. No previous studies about the association of child CAM usage and influenza vaccination were identified.

WHAT THIS STUDY ADDS: US children who have ever used domains of CAM often requiring contact with CAM practitioners (eg, chiropractors, naturopathic physicians) have lower odds of influenza vaccination. Opportunity exists to improve child health by engaging their parents and their CAM practitioners.

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Adverse effects of routinely recommended vaccines are markedly outweighed by their benefits, but the public is not trained to carefully weigh such risks and benefits.[1] Coupled with the success of vaccines at preventing disease, this scenario has created a public health challenge: the current low incidence of most vaccine-preventable diseases often misleads the public to the misperception that the risks of these diseases are low and the costs/risks of the vaccines are comparatively high, resulting in relatively low vaccination program participation.[2] Recently, there has been a rise in "antivaccine" and "vaccine-hesitant" sentiment in the United States.[3] Vaccine hesitancy, which recognizes a spectrum of beliefs ranging from total vaccine acceptance to total vaccine refusal, is a complex and contextual issue and requires approaches at multiple levels, including addressing individuals, providers, health systems, and the nation.[3,4] Vaccine hesitancy is heavily grounded in myths about vaccine-preventable diseases and their corresponding vaccines that are not supported by scientific evidence.[5–7] However, vaccine hesitancy is also entwined with broader factors such as institutional trust, socioeconomic context, the media, social norms, and health beliefs, among others.[3,4] Although vaccine hesitancy has received increasing empirical attention lately,[4] it is an extremely important issue that requires more investigation.[3]

Complementary and alternative medicine (CAM), approaches to health that are not considered part of conventional medicine (eg, homeopathy, chiropractic manipulation, chelation therapy),[8] have also recently risen in popularity as a form of health care. Estimates from the previous decade (pooled data from 2002, 2007, and 2012) show that one-third of the US population had used at least 1 type of CAM in the previous 12 months.[9] The prevalence of CAM is highest among middle-aged, non-Hispanic white women of high socioeconomic status, as well as those with multiple health conditions and who frequently visit medical facilities.[8,9] CAM is mostly used in conjunction with conventional medicine[10] for prevention of diseases and to improve health and well-being[11] and thus should not, in theory, interfere with vaccination uptake. However, CAM has been implicated as lending support to antivaccine/vaccine-hesitant viewpoints via criticism of vaccination, public health, and conventional medicine from adults using CAM,[12–14] as well as from CAM practitioners and practitioners-in-training.[12,15,16] Even among CAM practitioners who generally support the concept of vaccination, a majority report they recommend a vaccine schedule different from the standard schedule put forth by the Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices.[17]

Influenza is a vaccine-preventable disease of particular importance in the United States, causing up to 200 000 hospitalizations,[18] 49 000 deaths,[19] and an estimated $87 billion of economic burden annually.[20] The association of CAM use and influenza vaccination in adults has been examined, although nationally representative findings are limited and conflicting: adults who use CAM may have significantly lower uptake,[21] no difference in uptake,[22] or higher uptake[23] compared with non-CAM users. To the best of our knowledge, there has been no examination of the association of CAM use and influenza vaccination in US children.

This limitation of the literature is important for 2 primary reasons. First, US children are an extremely important population pertaining to influenza. They experience the highest rates of infection and serve as a major source of transmission in the family and community.[24–28] Children aged <5 years are a high-risk group because they are at increased danger of influenza-related complications and comprise a substantial portion of influenza-related morbidity and care visits.[18,24,29,30] Influenza vaccination is recommended for all persons aged ≥6 months annually.[25] In children, the vaccine is safe,[31] widely available, and increasingly affordable,[32,33] and although the effectiveness varies each year,[34] influenza vaccines are immunologically efficacious and effective at preventing numerous outcomes.[35] However, influenza vaccination uptake among US children is suboptimal[36] and substantially lower than uptake of other recommended childhood vaccines.[37] Second, CAM use in children is not uncommon, and the sparse literature available suggests that children using CAM are less likely to be vaccinated. National estimates from 2007 to 2012 show that nearly 12% of US children had used 1 type of CAM in the last 12 months.[8,38] Child CAM use was more common among adolescents, non-Hispanic white children, and children whose parents had high levels of education, were not poor, and had private health insurance. Furthermore, a study of vaccine uptake (not including influenza) in Washington from 2000 to 2003 found that children who saw a naturopathic physician or chiropractor were less likely to receive recommended vaccines and more likely to be diagnosed with vaccine-preventable diseases,[39] suggesting children who use CAM may be less likely to be vaccinated against influenza. The present study examines the association of CAM use with influenza vaccination in a nationally representative sample of US children.

METHODS

Data Source and Study Population

This study uses data from 2012 National Health Interview Survey

(NHIS), the most recent NHIS to include the Child Complementary and Alternative Medicine File (CAL). The NHIS annually collects information on the health of the US noninstitutionalized civilian population through household interviews of household adults.[40] Houses were sampled by using multistage area probability design, and the total household response rate was 77.6%.[41] The 2012 CAL collected information about all NHIS sample children aged 4 to 17 years (N = 10 218) on use of nonconventional health care practices (children aged <4 years are excluded from the CAL). Approximately 1.9% (n = 195) of the CAL respondents did not provide any responses to the CAL questions but are retained in the file as the missing values.[41] All questions are reported by household adult respondents.

Dependent Variable

The dependent variable is parent-reported child receipt of an influenza vaccination within the previous 12 months from the NHIS Child Sample file.

Independent Variables

The CAL asks household adults if the child has used 37 types of CAM for health reasons both ever and within the previous 12 months. The prevalence of ever using CAM varied from 0.01% to 6.4% across all types of CAM except the use of multivitamins/multiminerals (62.3%). We used the "ever" questions because although the prevalences are still small, they are larger than the "previous 12 months" questions. Using CAM literature as a guide, we grouped these 37 therapies across 4 domains developed by the National Center for Complementary and Alternative Medicine in 2012[42–45]: (1) alternative medical systems (AMS; eg, acupuncture); (2) biologically based therapies (BBTs; eg, herbal supplements); (3) manipulative and body-based therapies (MBBT; eg, chiropractic manipulation); and (4) mind–body therapies (MBT; eg, yoga) (Table 1). Variables were constructed representing having ever used at least 1 type of CAM separately for each domain (eg, ever using any type of AMS), as done in previous literature.[44] Because the prevalence of ever using multivitamins/multiminerals was much higher than any other single CAM type, we hypothesized it to be different and separated it from other BBT types. Thus, the 5 independent variables in this study are ever using, for health reasons, the following: (1) any AMS type; (2) any BBT type, excluding multivitamins/multiminerals; (3) multivitamins/multiminerals; (4) any MBBT type; and (5) any MBT type.

TABLE 1 Prevalence of Ever Using CAM, US Children Aged 4 to 17 Years, 2012 NHIS

CAM Categories and Subtypes	Prevalence (%)	*N*
AMS for health reasons		
Acupuncture	0.22	25
Naturopathy	0.70	62
Homeopathy	3.09	281
Ayurveda	0.11	9
Traditional healer (includes Curandero or Parchero; Native-American health or medicine man; medicine shaman; Sobrador; Yerbero or Hierbista; or Huesero)	0.32	51
Any AMS subtype[a]	3.80	359
BBT for health reasons		
Chelation therapy	0.10	7
Herbal or other nonvitamin supplement	6.38	615
Biofeedback	0.17	17
Vegetarian (including vegan) diet for ≥2 wk	1.43	126
Macrobiotic diet for ≥2 wk	0.08	11
Atkins diet for ≥2 wk	0.03	4
Pritikin diet for ≥2 wk	0.01	2
Ornish diet for ≥2 wk	0.05	3
Multivitamins or multiminerals[a]	62.33	6122
Any BBT subtype (excluding multivitamins or multiminerals)[a]	7.55	718
Any BBT subtype	63.49	6221
MBBT for health reasons		
Chiropractic or osteopathic manipulation	5.49	503
Craniosacral therapy	0.32	28
Massage	1.47	162
Feldenkrais Method	0.10	6
Pilates	0.11	105
Trager psychophysical integration	0.04	3
Alexander technique	0.06	5
Any MBBT subtype[a]	7.32	686
MBT for health reasons		
Yoga	4.22	421
Qigong	0.11	13
Tai Chi	0.42	46
Energy healing therapy	0.26	30
Hypnosis	0.12	10
Meditation, guided imagery, or progressive relaxation (includes progressive relaxation, guided imagery, mantra meditation, spiritual meditation, and mindfulness meditation)	1.38	137
Any MBT subtype[a]	5.29	532
Summary measures		
Ever used any type of CAM (excluding multivitamins or multiminerals)	17.06	1648
Ever used any type of CAM	65.89	6445

Percentages weighted to be nationally representative. *N* unweighted to show actual number of observations in each cell (may not add up to total *N* total due to missing values).

[a] Used as independent variables in this study.

TABLE 2 Descriptive Statistics of Study Population, US Children Aged 4 to 17 Years, 2012 NHIS

Variable	% or Mean ± SD	*N*
Outcome variable		
Received influenza vaccination, previous 12 mo	42.72	4246
Did not receive influenza vaccination, previous 12 mo	57.28	5633
Independent variables		
Ever used any AMS CAM subtype for health reasons	3.80	359
Ever used any BBT CAM subtype for health reasons (excluding multivitamins or multiminerals)	7.55	718
Ever taken multivitamins or multiminerals for health reasons	62.33	6122
Ever used any MBBT CAM subtype for health reasons	7.32	686
Ever used any MBT CAM subtype for health reasons	5.29	532
Covariates		
Sex		
Female	48.87	5012
Male	51.13	5206
Age, y	10.52 ± 4.03	10218
Race/ethnicity		
Non-Hispanic white	53.69	4559
Non-Hispanic black or African American	13.40	1570
Non-Hispanic Asian	4.39	586
Non-Hispanic other or multiple race	5.05	557
Any Hispanic	23.47	2946
Child has a usual source of care they go to when sick		
Yes	95.80	9696
No	4.20	508
Had a well-child checkup, previous 12 mo		
Yes	77.37	7747
No	22.63	2377
Child born in the United States		
Yes	95.30	9620
No	4.70	595
Total no. of physician office visits, previous 12 mo		
None	9.96	1118
1	25.43	2548
2–3	38.13	3869
4–5	13.44	1307
≥6	13.05	1264
Child has ≥1 serious chronic condition/limitation[a]		
No	96.56	9860
Yes	3.44	351
Ever been told child has asthma		
No	83.75	8466
Yes	16.25	1743
Insurance type		
Any private	53.95	5131
Only public	39.03	4208
No coverage	7.03	829
Highest family education		
Less than high school	10.56	1161
Completed high school or GED	18.88	2107
Associate's degree or some college (no degree)	34.44	3587
Bachelor's degree or higher	36.13	3354
Family income as a percentage of the federal poverty level		
<100%	20.73	2060
100% to 199%	22.90	2238
≥200%	56.38	5207
Language of interview		
English only	90.34	8873
Other	9.66	1260

Percentages weighted to be nationally representative. *N* unweighted to show actual observations (may not add up to total *N* total due to missing values). GED, General Educational Development test.

[a] Down syndrome, cerebral palsy, muscular dystrophy, cystic fibrosis, sickle cell anemia, autism or autism spectrum disorder, type 1 diabetes mellitus, arthritis, congenital heart disease, or other heart condition.

Covariates

The selection of covariates was conceptually grounded in Andersen's Behavioral Model of Health Services Use.[46] This model has been used in varying health settings to study different health outcomes,[47] and it provides conceptual factors influencing health service use (influenza vaccination) at more distal levels (predisposing, enabling, and creating need), as well as the more intermediary health behavior level. Using this model, 13 covariates were selected. At the child level, these covariates were: sex (female/male); age (years); race/ethnicity (non-Hispanic white; non-Hispanic black or African American; non-Hispanic Asian; non-Hispanic other or multiple race; and Hispanic); usual source of care they go to when the child is sick or the parent needs advice about the child's health (yes/no); well-child checkup in the previous 12 months (yes/no); number of physician visits in the previous 12 months; US-born status (yes/no); presence of at least 1 serious chronic condition or limitation (yes/no [defined as having 1 of the following: Down syndrome, cerebral palsy, muscular dystrophy, cystic fibrosis, sickle cell anemia, autism or autism spectrum disorder, type 1 diabetes mellitus, arthritis, congenital heart disease, or other heart condition]); asthma status (yes/no); and insurance type (private, public, or no coverage). At the family level, these covariates were: highest family education (less than high school, completed high school or the General Educational Development test, associate's degree or some college [no degree], or bachelor's degree or higher); family income as a percentage of the federal poverty level (<100%, 100%–199%, or ≥200%); and language of interview (English only or other). These variables come from the NHIS Sample Child, Family, and Person files.

Analysis

Bivariate associations were used to show unadjusted associations between ever use of CAM domains and influenza vaccination uptake. Multivariate logistic regression was then used to examine these associations, adjusting for factors of health services use (n = 8981–8989 across CAM domains), as well as in 1 model including all CAM domain variables to adjust for ever using other types of CAM (n = 8947). Analyses were conducted by using Stata/MP 14.1 with preconstructed NHIS weights[41] and Stata's *svy* commands to obtain nationally representative results and SEs accounting for complex survey design.[48] We obtained exempt status from the institutional review board of Pennsylvania State University.

RESULTS

The percentage of sample children who had ever used multivitamins or multiminerals was 62%; otherwise, the percentages ever using any subtype of AMS, BBT, MBBT, and MBT CAM domains were 3.8%, 7.6%, 7.3%, and 5.3%, respectively. Overall, 43% of sample children received an influenza vaccine in the previous 12 months. Sample children were predominantly native-born, non-Hispanic white, and privately insured, did not have asthma or serious chronic condition/limitations, and had a usual source of care, annual well-child evaluations, and physician visits. They lived with English-speaking families with at least some college education and income above the poverty line (Table 2).

In unadjusted analyses, uptake was lower among children who had ever (versus never) used AMS (33% vs 43%; P = .008) and MBBT (35% vs 43%; P = .002). Conversely, uptake was higher among children who ever (versus never) used multivitamins/multiminerals (45% vs 39%;

TABLE 3 Bivariate Correlates of Influenza Vaccination, US Children Aged 4 to 17 Years, 2012 NHIS

Categorical Variables	Unvaccinated		Vaccinated		*P*
	N	% or Mean ± SE	*N*	% or Mean ± SE	
Ever used any AMS CAM subtype for health reasons					.008
No	5359	57.03	4095	42.97	
Yes	243	66.73	115	33.27	
Ever used any BBT CAM subtype for health reasons (excluding multivitamins or multiminerals)					.150
No	5157	57.18	3930	42.82	
Yes	441	60.68	271	39.32	
Ever taken multivitamins or multiminerals for health reasons					<.001
No	2274	60.64	1499	39.36	
Yes	3328	55.49	2702	44.51	
Ever used any MBBT CAM subtype for health reasons					.002
No	5165	56.76	3958	43.24	
Yes	435	65.47	246	34.53	
Ever used any MBT CAM subtype for health reasons					.957
No	5296	57.44	3982	42.56	
Yes	306	57.29	221	42.71	
Sex					.803
Female	2748	57.46	2096	42.54	
Male	2885	57.12	2150	42.88	
Age, y	5633	10.99 ± 0.071	4246	9.84 ± 0.080	<.001
Race/ethnicity					<.001
Non-Hispanic white	2660	60.16	1748	39.84	
Non-Hispanic black or African American	868	57.86	635	42.14	
Non-Hispanic Asian	278	46.68	292	53.32	
Non-Hispanic Other or multiple race	260	49.26	273	50.74	
Any Hispanic	1567	54.08	1298	45.92	
Child has a usual source of care they go to when sick					<.001
Yes	5255	56.38	4128	43.62	
No	374	78.03	116	21.97	
Had a well-child checkup, previous 12 mo					<.001
Yes	3899	51.85	3621	48.15	
No	1708	75.53	614	24.47	
Child born in the United States					.485
Yes	5320	57.37	3980	42.63	
No	312	55.53	265	44.47	
No. of physician visits, previous 12 mo					<.001
None	841	77.56	255	22.44	
1	1582	64.35	907	35.65	
2–3	1976	53.48	1774	46.52	
4–5	637	48.69	641	51.31	
≥6	578	47.92	650	52.08	
Child has ≥1 serious chronic condition/limitation[a]					.038
No	5466	57.53	4070	42.47	
Yes	163	50.44	173	49.56	
Ever been told child has asthma					<.001
No	4787	58.78	3402	41.22	
Yes	843	49.61	840	50.39	
Insurance type					<.001
Any private	2867	58.46	2091	41.54	
Only public	2157	52.54	1918	47.46	
No coverage	580	74.23	223	25.77	
Highest family education					<.001

TABLE 3 Continued

Categorical Variables	Unvaccinated		Vaccinated		*P*
	N	% or Mean ± SE	*N*	% or Mean ± SE	
Less than high school	571	51.36	544	48.64	
High school or GED	1166	57.68	859	42.32	
Associate's degree, or some college (no degree)	2086	61.06	1387	38.94	
Bachelor's degree or higher	1804	55.18	1453	44.82	
Family incomes, % of federal poverty level					.672
<100%	1113	56.22	882	43.78	
100%–199%	1237	58.04	927	41.96	
≥200%	2902	57.37	2153	42.63	
Language of interview					.165
English only	4919	57.47	3651	42.53	
Other	671	55.05	560	44.95	

Percentages and means weighted to be nationally representative; SEs adjusted for complex survey design. GED, General Educational Development test.

[a] Down syndrome, cerebral palsy, muscular dystrophy, cystic fibrosis, sickle cell anemia, autism or autism spectrum disorder, type 1 diabetes mellitus, arthritis, congenital heart disease, or other heart condition.

$P < .001$). There was no significant association in children by ever using any BBT or MBT. Across covariates, significantly lower uptake was seen in children according to race/ethnicity (lowest: non-Hispanic white children) and with each increasing year of age. Lower uptake was also noted in children: without a usual source of care; without a recent well-child checkup; without serious chronic conditions/limitations; without asthma; with no insurance coverage; with decreasing recent physician visits; and in families with some college but no degree (Table 3).

Results from multivariate analyses adjusting for all health services use covariates had similar significant results (Table 4). Children ever using any type of AMS, or any type of MBBT, had lower odds of influenza vaccination in the previous 12 months compared with those never using those types of CAM (adjusted odds ratios of 0.61 [95% confidence interval: 0.44–0.85] and 0.74 [95% confidence interval: 0.58–0.94], respectively). There were still no significant differences in odds of uptake among children ever using BBT or MBT, and having ever used multivitamins or multiminerals was no longer significant. Adding all CAM domains variables together in one model, the MBBT outcome moved just outside of significance (odds ratio: 0.78 [95% confidence interval: 0.61–1.00]).

Looking at covariates across the columns in Table 4, there were several patterns of significant results. Compared with non-Hispanic white children, higher odds of influenza vaccination were seen in non-Hispanic Asian, non-Hispanic other or multiple race, and Hispanic children; there was no significant difference between black and white children. Compared with children with private insurance, children with no coverage during the year had lower odds of vaccination; there was no significant public–private difference. Higher odds of vaccination were recorded in children with a well-child visit in the previous year, with increasing number of physician visits, with each decreasing year of age, with asthma, and not born in the United States. There was a U-shaped pattern of vaccination odds according to family education, whereby the lowest and highest categories of education had the highest uptake.

DISCUSSION

Although CAM is mostly used in conjunction with conventional medicine, the present study provides evidence that US children who have ever used any subtype of AMS or MBBT had lower odds of influenza vaccination. In our sample, the second most prevalent type of AMS was naturopathy, and the most prevalent type of MBBT was chiropractic or osteopathic manipulation. These specific types of CAM may require contact with CAM practitioners shown to have vaccine-critical viewpoints, advise against vaccination, or advise vaccine schedules different from those recommended by the federal government.[12,15–17,39] Because chiropractic manipulation is grouped in the survey question with osteopathic manipulation, it is possible that the association of MBBT use with lower vaccination odds is diluted if osteopathic physicians hold viewpoints closer to medical physicians and further from chiropractors. The MBBT finding moved just outside of significance when all CAM variables were included in 1 model; other CAM use may confound the relationship between MBBT use and influenza vaccination. In terms of the lack of a significant difference in uptake observed among children ever using BBT or MBT, we do not know if CAM practitioners are involved in the study children's CAM use; it is plausible, however, that these types of CAM may involve less contact with CAM practitioners (eg, herbal supplements, alternative diets, and yoga are easily available for home use). More research is needed investigating these patterns.

Several covariates were also significantly associated with influenza vaccination uptake and warrant further investigation in a future, longitudinal study as potential mediators and/or moderators of influenza vaccine disparities in children. Consistent with other studies, we found higher uptake among the following groups of children: those with a higher number

TABLE 4 ORs of Influenza Vaccination From Logistic Regression Models, US Children Aged 4 to 17 Years, 2012

Variable	Any AMS	Any BBT (Except Multivitamins/ Multiminerals) (*n* = 9799)	Multivitamins or Multiminerals (*n* = 9803)	Any MBBT (*n* = 9804)	Any MBT (*n* = 9805)	Any CAM (*n* = 9759)
	(*n* = 9812)	(*n* = 9799)	(*n* = 9803)	(*n* = 9804)	(*n* = 9805)	(*n* = 9759)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Unadjusted logistic regression						
Ever used any AMS type for health reasons (ref: no)	0.66 (0.49–0.90)**	—	—	—	—	0.70 (0.50– 0.96)*
Ever used any BBT type (except multivitamins/multiminerals) for health reasons (ref: no)	—	0.87 (0.71–1.05)	—	—	—	0.93 (0.75 to 1.17)
Ever used multivitamins/multiminerals for health reasons (ref: no)	—	—	1.24 (1.10–1.39)***	—	—	1.26 (1.13–1.42)***
Ever used any MBBT type for health reasons (ref: no)	—	—	—	0.69 0.55–0.87)**	—	0.71 (0.56–0.90)**
Ever used any MBT type for health reasons (ref: no)	—	—	—	—	1.01 (0.80–1.27)	1.12 (0.88–1.43)
	(*n* = 8989) aOR (95% CI)	(*n* = 8982) aOR (95% CI)	(*n* = 8984) aOR (95% CI)	(*n* = 8981) aOR (95% CI)	(*n* = 8983) aOR (95% CI)	(*n* = 8947) aOR (95% CI)
Multivariate logistic regression						
Ever used any AMS type for health reasons (ref: no)	0.61 (0.44–0.85)**	—	—	—	—	0.64 (0.45–0.91)*
Ever used any BBT type (except multivitamins/multiminerals) for health reasons (ref: no)	—	0.83 (0.68–1.02)	—	—	—	0.91 (0.73–1.14)
Ever used multivitamins/multiminerals for health reasons (ref: no)	—	—	1.12 (0.98–1.28)	—	—	1.13 (0.99–1.29)
Ever used any MBBT type for health reasons (ref: no)	—	—	—	0.74 (0.58–0.94)*	—	0.78 (0.61–1.00)
Ever used any MBT type for health reasons (ref: no)	—	—	—	—	1.01 (0.78–1.32)	1.14 (0.86–1.50)
Female (versus male)	1.00 (0.89–1.13)	1.00 (0.88–1.13)	1.01 (0.89–1.14)	1.00 (0.89–1.14)	1.00 (0.88–1.13)	1.01 (0.89–1.14)
Age (years, decreasing)	1.06 (1.05–1.08)***	1.06 (1.05–1.08)***	1.06 (1.05–1.08)***	1.06 (1.04–1.07)***	1.06 (1.05–1.08)***	1.06 (1.04–1.07)***
Race/ethnicity (ref: non-Hispanic white)						
Non-Hispanic black or African American	1.02 (0.87–1.21)	1.04 (0.88–1.23)	1.05 (0.88–1.23)	1.02 (0.86–1.20)	1.04 (0.88–1.22)	1.01 (0.86–1.20)
Non-Hispanic Asian	1.90 (1.45–2.47)***	1.92 (1.47–2.50)***	1.91 (1.46–2.49)***	1.87 (1.44–2.44)***	1.91 (1.47–2.49)***	1.87 (1.44–2.44)***
Non-Hispanic other or multiple race	1.42 (1.05–1.90)*	1.43 (1.06–1.92)*	1.40 (1.04–1.88)*	1.42 (1.05–1.92)*	1.41 (1.05–1.90)*	1.42 (1.06–1.91)*
Any Hispanic	1.34 (1.13–1.58)**	1.35 (1.14–1.59)***	1.35 (1.14–1.59)***	1.34 (1.13–1.58)**	1.35 (1.15–1.60)***	1.34 (1.13–1.58)**
Has a usual source of care to go to (versus does not)	1.38 (0.99–1.93)	1.39 (0.99–1.93)	1.41 (1.01–1.97)*	1.40 (1.00–1.95)*	1.40 (1.00–1.95)	1.39 (0.99–1.95)
Well-child visit, previous 12 mo (versus had none)	2.22 (1.92–2.55)***	2.22 (1.92–2.55)***	2.22 (1.93–2.56)***	2.20 (1.91–2.53)***	2.22 (1.92–2.55)***	2.20 (1.91–2.53)***
No. of physician visits, previous 12 mo (ref: none)						
1	1.16 (0.92–1.47)	1.17 (0.92–1.48)	1.15 (0.90–1.45)	1.15 (0.91–1.46)	1.16 (0.91–1.47)	1.16 (0.91–1.47)
2–3	1.74 (1.38–2.19)***	1.76 (1.40–2.21)***	1.70 (1.35–2.14)***	1.75 (1.38–2.20)***	1.73 (1.38–2.18)***	1.73 (1.37–2.19)***
4–5	1.99 (1.55–2.56)***	2.00 (1.56–2.57)***	1.93 (1.51–2.47)***	1.98 (1.54–2.54)***	1.97 (1.53–2.52)***	1.98 (1.54–2.55)***
≥6	2.17 (1.67–2.83)***	2.18 (1.68–2.83)***	2.08 (1.60–2.70)***	2.17 (1.66–2.82)***	2.13 (1.64–2.78)***	2.19 (1.68–2.86)***
Child has ≥1 serious chronic condition/ limitation[a] (versus not)	1.17 (0.88–1.55)	1.17 (0.88–1.55)	1.15 (0.87–1.53)	1.20 (0.91–1.60)	1.17 (0.87–1.55)	1.22 (0.92–1.62)

TABLE 4 Continued

Variable	Any AMS	Any BBT (Except Multivitamins/ Multiminerals) (*n* = 9799)	Multivitamins or Multiminerals (*n* = 9803)	Any MBBT (*n* = 9804)	Any MBT (*n* = 9805)	Any CAM (*n* = 9759)
	(*n* = 9812)	(*n* = 9799)	(*n* = 9803)	(*n* = 9804)	(*n* = 9805)	(*n* = 9759)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Child has ever been told they have asthma (versus not)	1.33 (1.14–1.55)***	1.32 (1.14–1.54)***	1.33 (1.14–1.55)***	1.33 (1.14–1.55)***	1.32 (1.13–1.54)***	1.32 (1.13–1.54)***
Child is foreign-born (versus born in the United States)	1.29 (1.01–1.66)*	1.29 (1.00–1.65)*	1.27 (<1.00–1.63)	1.29 (1.01–1.65)*	1.27 (1.00–1.65)*	1.29 (1.00–1.65)*
Insurance type (ref: any private)						
Public only	1.19 (0.99, 1.42)	1.19 (<1.00–1.42)	1.19 (<1.00–1.43)	1.19 (<1.00–1.43)	1.19 (<1.00–1.43)	1.19 (0.99–1.42)
No coverage	0.69 (0.52–0.91)*	0.69 (0.52–0.92)*	0.69 (0.52–0.92)*	0.69 (0.52–0.91)**	0.69 (0.52–0.91)*	0.68 (0.51–0.90)**
Highest family education (ref: bachelor's degree or higher)						
Less than high school	1.24 (0.98–1.57)	1.24 (0.98–1.58)	1.27 (1.00–1.62)*	1.26 (0.99–1.60)	1.26 (0.99–1.60)	1.27 (<1.00–1.63)
High school or GED	0.97 (0.82–1.15)	0.98 (0.83–1.16)	1.00 (0.85–1.18)	0.97 (0.83–1.15)	0.99 (0.84–1.17)	0.98 (0.82–1.15)
Associate's degree or some college (no degree)	0.83 (0.72–0.96)*	0.83 (0.72–0.96)*	0.83 (0.72–0.96)*	0.83 (0.71–0.96)*	0.84 (0.72–0.97)*	0.83 (0.71–0.96)*
Family income, % of federal poverty level (ref: <100%)						
100%–199%	1.10 (0.91–1.33)	1.09 (0.91–1.32)	1.08 (0.90–1.31)	1.09 (0.91–1.32)	1.09 (0.91–1.32)	1.08 (0.90–1.31)
≥200%	1.23 (<1.00–1.51)	1.24 (1.00–1.52)*	1.22 (0.99–1.50)	1.23 (1.00–1.52)*	1.23(<1.00–1.52)	1.21 (0.99–1.50)
Interview only in English language (versus other language)	1.03 (0.84–1.27)	1.03 (0.83–1.27)	1.02 (0.83–1.26)	1.05 (0.85–1.29)	1.03 (0.84–1.28)	1.03 (0.83–1.27)

Odds ratios (ORs) weighted to be nationally representative; SEs adjusted for complex survey design. aOR, adjusted odds ratios.

[a] Down syndrome, cerebral palsy, muscular dystrophy, cystic fibrosis, sickle cell anemia, autism or autism spectrum disorder, type 1 diabetes mellitus, arthritis, congenital heart disease, or other heart condition.

* $P < .05$.

** $P < .01$.

*** $P < .001$.

of recent provider visits[49–53] (which is conceptually related to having a well-child visit and a usual source of care, all of which are important given that physician recommendation of the vaccine is one of most commonly cited correlates of higher influenza vaccine uptake[51,54–65]); those without health insurance[66]; those with asthma or parental worry about asthma[51,67]; and those of a younger age.[50–52,58,68–70] Although we found no disparities between black and white children, we did observe higher uptake in Asian, Hispanic, and other/multiracial children. There were no significant racial/ethnic disparities nationally among children in most recent influenza seasons,[69] although higher uptake among Asian children has been observed.[70] Generally, higher parental education is associated with higher influenza vaccine uptake in children.[56,68,70] However, this scenario is not always the case, and in this study we found the inverse association. Studies (not including influenza vaccination) have documented that parents who delay or refuse vaccinating their children in general tend to be college educated, higher income, white populations, and also tend to have lifestyles that include CAM use and alternative diets.[14,71–73] Perhaps not coincidentally, CAM is associated with higher income and higher education,[74] which may partially explain the inverse education relationship we observed. Lastly, we found that foreign-born children had higher odds of vaccination compared with US-born children. Although we are unaware of studies examining the relationship of nativity/citizenship and influenza vaccination in US children, a recent study of Mexican adults in California found that higher influenza vaccine uptake diminishes after the first generation postmigration.[75] Furthermore, a study of other vaccines found that having a foreign-born or noncitizen mother was associated with reduced odds or vaccination.[76] More research is needed in these areas.

The findings of this study should be interpreted within its limitations.

First, aggregating CAM therapies into domains masks the effects of individual therapies. Because the prevalence of ever using most individual CAM therapies in children in the NHIS was very small, we were not afforded the statistical opportunity to conduct such individual analyses. Furthermore, the use of the "ever" CAM questions instead of the "within the previous 12 months" questions, although necessary for power reasons, prevented us from discerning if these are children whose parents were having them "try out" CAM versus consistent CAM users. Second, the CAL excludes children aged <4 years, although children aged <5 years are at high risk for influenza complications.[18,24,29,30] These are survey limitations; future studies should capture larger samples of children's CAM use and include those aged 0 to 3 years. Related, both the CAM variables and the influenza vaccine question are parent-reported, creating potential recall bias, although for the latter, the influenza vaccine is recommended annually, lessening the time period that the parent needs to recall and thus also the chance of recall bias. Last, this study was cross-sectional, and therefore the findings are associative and not causal. We believe the possibility of bidirectionality in our findings, however, to be less likely. The reasons many use CAM include cultural and philosophical beliefs about health and health services, and CAM often aims to treat illness beyond the physical and biomedical contexts.[43] Andersen's model posits that such health beliefs, values, and knowledge are individual predisposing characteristics that temporally precede the decision to use a health service such as vaccination.[46] However, although we feel it is less likely, the reverse relationship is possible: that parents who have already chosen not to vaccinate their child feel pressured by conventional medicine and thus choose to pursue CAM.

CONCLUSIONS

From 2001 to 2010, significant progress was made in reducing disparities across many domains in many vaccinations among US children, largely in part due to the Vaccines For Children program.[77] Furthermore, in 2010, the Patient Protection and Affordable Care Act began requiring all new health plans to cover routinely recommended vaccinations (including influenza vaccination) without cost-sharing.[33] Significant disparities remain, however.[77] The findings from this study suggest that children who have ever used any type of AMS or MBBT (ie, CAM types more likely to result in contact with CAM practitioners documented as advising alternative vaccine schedules or against vaccination) should be considered as a group vulnerable to low annual uptake of influenza vaccination. Although more and more patients are using CAM and may be expecting health professionals to guide them in making decisions about whether CAM and/or conventional approaches work better for disease treatment or prevention, most CAM users do not disclose to their physicians that they use CAM.[74] At the same time, there is increasing vaccine hesitancy in the United States. However, there is very limited research on how vaccination perspectives develop among CAM practitioners- and medical practitioners-in-training.[78] There is opportunity for US public health, policy, and conventional medical professionals and educators to improve vaccine uptake and child health by better engaging both CAM and conventional medicine practitioners-in-training, parents of children using particular domains of CAM, and the CAM practitioners advising them.

ABBREVIATIONS

AMS: alternative medical systems
BBT: biologically based therapy
CAL: Child Complementary and Alternative Medicine File of the National Health Interview Survey
CAM: complementary and alternative medicine
MBBT: manipulative and body-based therapy
MBT: mind–body therapy
NHIS: National Health Interview Survey

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