Cancer Causes Control (2009) 20:1271–1280
DOI 10.1007/s10552-009-9340-0

ORIGINAL PAPER

Multivitamin use among multi-ethnic, low-income adults

Rachel C. Shelton · Elaine Puleo · Sapna Syngal · Karen M. Emmons

Received: 28 November 2008 / Accepted: 1 April 2009 / Published online: 3 May 2009

Abstract There has been growing interest in the protective health benefits of multivitamin use (MVU). Relatively little research has investigated the factors associated with MVU among adults across a broad age range, particularly among lower-income, racially/ethnically diverse adults. In light of standing MVU recommendations and documented health benefits for certain groups, as well as ongoing studies evaluating the potential health benefits of multivitamins, vitamin D, and calcium, research among this understudied population is warranted. The aims of this paper were to assess the association between MVU and (1) sociodemographic, (2) preventive/health, and (3) patient/provider factors among a racially and ethnically diverse adult sample of over 1,500 low-income housing residents living in Boston, Massachusetts (USA). Bivariate and multivariable logistic regression models were the primary analytic strategy for investigating these associations. In multivariable analyses, sociodemographic factors (female gender, older age, and White or Other race/ethnicity) were significantly associated with regular MVU ($p \leq .05$). Preventive/health variables (health status, physical activity, and body mass index) and characteristics of patient/provider relationships (having a regular provider, last provider visit, decision-autonomy, and quality of relationship) were not significantly associated with MVU. While more evidence is needed to understand the benefits of MVU, future studies should address low use of MVU among lower-income, multi-ethnic populations, particularly in light of health disparities.

Keywords Health disparities · Multivitamins · Cancer prevention

R. C. Shelton (✉)
Department of Oncological Sciences, Mount Sinai School of Medicine, 1425 Madison Avenue, P.O. Box 1130, New York, NY 10029, USA
e-mail: rshelton@post.harvard.edu

E. Puleo
Department of Public Health, University of Massachusetts, Amherst, MA, USA

S. Syngal · K. M. Emmons
Department of Medical Oncology/Population Sciences, Dana-Farber Cancer Institute, Boston, MA, USA

S. Syngal
Department of Medicine, Harvard Medical School, Boston, MA, USA

K. M. Emmons
Department of Society, Human Development and Health, Harvard School of Public Health, Boston, MA, USA

Introduction

Daily multivitamins, typically comprised of at least 10 vitamins and 10 minerals and the US Recommended Daily Allowances of vitamins C, D, and E, represent an important source of essential nutrients [1]. There has been growing interest in the potential role of multivitamins in reducing the risk for chronic diseases, including cancer, cardiovascular disease (CVD), hypertension, cataracts, and age-related macular degeneration [1]. The US Preventive Services Task Force and authors of recent clinical reviews have concluded that there is insufficient evidence at this time to determine whether multivitamin use (MVU) reduces the risk for chronic diseases such as cancer and CVD. While the epidemiological evidence from recent trials also calls into question the protective effects of regular MVU for cancer and CVD, there continues to be work in this

area. For example, several recent studies indicate that there may be protective effects of vitamin D and calcium for breast and colorectal cancer (CRC), areas in which socioeconomic and racial/ethnic disparities are striking [2–7]. It has also been posited that other major chronic diseases (e.g., type-2 diabetes, end-stage renal disease, osteoarthritis) share common risk factors and pathologic mechanisms that may be modified by nutrients [8], though more research is needed to understand the role that MVU plays in this area.

Despite the inconclusive evidence with respect to multivitamins and chronic disease prevention, there are several recommendations and potential benefits for different subgroups of people regarding MVU, including women of childbearing age and populations where nutrient deficiencies might be more prevalent, such as elderly adults and low-income populations [1, 9, 10]. Unfortunately, little is known about MVU among lower-income, racially/ethnically diverse populations. Because of standing recommendations, continued epidemiological evaluations, the potential of vitamin D and calcium, and other documented benefits of multivitamins (e.g., in terms of improved nutritional status, immune response, reduced risk of birth defects) [10–14], it is important to understand the patterns and predictors of MVU among this understudied population. Furthermore, if clinical or public health recommendations are made that advocate multivitamin or supplement use in the future, this population will certainly be a priority for educational interventions.

While multivitamins and mineral supplements are the most common dietary supplements in the US [15], regular MVU is still not widespread in the general US population. The INTERMAP study (1997–1999) among adults aged 40–59 years in US found that 56% of women and 46% of men used a daily vitamin or other supplement [16]. The nationally representative National Health and Nutrition Examination Survey (1999–2000) found that 52% of adults reported taking any kind of dietary supplement in the past month (57% of women and 47% of men), while 35% reported regular use of a multivitamin in the previous month (38% of women and 32% of men) [15].

Much of the research on MVU has been conducted among women of childbearing age and has focused on understanding and increasing use of multivitamins (as a source of folic acid) to decrease the risk of birth-related defects [17–20]. Less research has focused on examining factors associated with MVU among male and female adults across a wide age range. The limited available evidence suggests that regular multivitamin users are more likely to be non-Hispanic White, female, older, more educated, more physically active, non-smokers, and have a lower body mass index (BMI) [15, 16, 21–28]. There are also a few studies that suggest that providers may play an important role in promoting MVU [17, 29], although these studies have focused on women of childbearing age. There have been mixed findings with respect to health status, medical conditions, and MVU [15, 26, 30, 31].

The aims of this article are to examine sociodemographic, preventive/health, and patient/provider-related factors associated with MVU in a multi-ethnic, low-income population. The sample for this article is a large multi-ethnic sample of over 1,500 residents living in lower-income housing in metropolitan Boston, Massachusetts (USA).

Methods

Sample

Excluded people who could not speak English or Spanish

The data for this study, which was funded by the National Cancer Institute, come from a cluster randomized controlled trial, the Open Doors to Health (ODH) study, that targeted physical activity, CRC screening, and multivitamin intake. The baseline data used for these analyses were collected in 2004–2005. The primary sampling units were 12 urban public housing sites in Boston, Massachusetts (USA), and the secondary sampling units were individuals within the housing sites. Housing sites varied in size and layout, ranging from high-rise apartments to townhouse-style units. To be eligible, participants had to (1) reside within the housing site (2) be at least 18 years old (3) be fluent in English or Spanish and (4) not currently undergoing cancer treatment. A random sample of potential participants was drawn in larger housing sites (>300 units), and a census sample was drawn in smaller housing sites (<300 units). Sampling aimed to obtain an approximate 35% sample of the full population of each individual housing site, with at least 250 individuals per each housing site. More detailed information about sampling and recruitment for the study are provided in previous publications [32, 33]. The Human Subjects Committee at the Harvard School of Public Health approved this study protocol.

During baseline data collection, 1,554 participants completed surveys, with an overall response rate of 53% (range: 34–92% across sites). For all analyses, based on the cluster design, data are weighted up to the population size within each housing site (with a total weighted size of 2,271). Of these, all participants had complete data for our primary outcome, regular MVU. We excluded from our sample residents missing physical activity data (weighted $n = 536$) (as a result of being non-ambulatory or having insufficient amount of observations to provide an accurate measure) and those with incomplete BMI data (weighted $n = 160$), since these were exposures of interest in the analyses for this article. In addition, due to factors such as

scheduling conflicts or limited time, some residents (weighted $n = 89$) were excluded because they were administered a shorter version of the baseline survey which did not include all exposures of interest for this article. Therefore, the primary sample for these analyses is a weighted sample size of 1,485. For sub-analyses that examined characteristics of provider/patient relationships among those with a regular provider, we also did not include residents who did not have a regular health care provider (weighted $n = 205$) or who were missing data for this variable (weighted $n = 10$), leaving us with a weighted sample size of 1,270 for those specific sub-analyses.

Survey and measures

Participants of the study completed an interview-administered survey in English or Spanish and provided informed consent. All participants who completed the baseline assessment received a $25 grocery store gift card.

Multivitamin Use: The primary outcome for these analyses was assessed by asking participants how many days a week they take multivitamins, with multivitamins defined as "one pill that contains several different vitamins and minerals, like One-A-Day or Centrum" [34]. Response options included: Never; Less than once a week; 1 day per week; 2 days per week; 3 days per week; 4 days per week; 5 days per week; 6 days per week; and 7 days per week. For the purposes of these analyses, this variable was dichotomized (yes/no), with regular MVU (yes) defined as taking multivitamins six or more days a week and non-regular MVU (no) defined as taking multivitamins less than 6 days a week. This categorical analytical approach is consistent with prior research [34].

Sociodemographic variables

Age, education, employment, gender, and language were measured using standard demographic questions. Participants reported their race or ethnicity as Black, White, Hispanic, Asian, American Indian, Native Hawaiian or Pacific Islander, or Other (which included those reporting multiple race/ethnicities). Due to small sample sizes, race/ethnicity was categorized into Black, Hispanic, and White/Other. Nativity was measured by asking people to report where they were born. This was categorized into 'Born in the US,' 'Born in Puerto Rico,' or 'Not born in the US or Puerto Rico' for the purposes of analyses, based on the distribution of responses. Based on the 2005 Federal Poverty Guidelines, we determined whether residents were at/below/above poverty level by combining yearly household income and the number of people supported by that income. Insurance status was assessed and categorized into the following four categories: no insurance; public insurance (Medicare/Medicaid/Free Care); private insurance only; and public and private insurance.

Preventive/health-related variables

Physical activity was measured by pedometers (Yamax SW200) that were worn by study participants. Keeping their daily routine, participants were asked to wear the pedometer for 5 days and keep a sampling log that recorded the information about when the pedometer was worn. Detailed information about the pedometer protocol is provided elsewhere [35]. The median number of steps/day for the sample was 4,700. For these analyses, physical activity was dichotomized into taking at least 4,700 steps/day or more or taking below the median of 4,700 steps/day. Body mass index (BMI; kg/m^2) was numerically calculated from height and weight. Current health status was measured by asking participants if they had "any health problems that make it hard for you to exercise" (yes;no).

Provider-related variables

Participants were asked whether they had a doctor or nurse practitioner DR/NP that they think of as their regular health care provider (yes;no). If participants had a regular DR/NP, they were asked how long ago they last saw their provider (response option range: within past month to 5 or more years ago). Almost 95% of the sample had a visit within the last 12 months, so this variable was categorized into three categories: within past month; 1–12 months ago; and more than 12 months ago. We assessed decision autonomy by asking, in reference to their regular DR or NP, whether they agreed or disagreed with the statement 'I leave all decisions about screening tests to my doctor' (response options: Strongly agree; Somewhat agree; Somewhat disagree; Strongly disagree). This was dichotomized into yes or no for the analyses presented here with Strongly or Somewhat agree categorized as 'yes' and Somewhat or Strongly disagree categorized as 'no'. Quality of relationship with provider was assessed by asking how well their regular DR or NP knows them related to three areas: (a) your responsibilities at work, home, or school; (b) your worries about your health; and (c) you as a person, and your values and beliefs (response options for each: Not at all; A little; Somewhat; Very well). A summary score (range: 0 to 3) was created to reflect the number of items for which respondents felt their provider knows them somewhat or very well.

Statistical analyses

All analyses were conducted with SUDAAN Version 9.01 and SAS Version 9.1 statistical software for clustered data,

with data weighted up to the population size within each housing site. Resident-level data were used for all analyses, accounting for the cluster design and the correlation between individuals within the same housing community. After examining the distributions of key exposure and outcome variables, we conducted bivariate, age-adjusted models predicting MVU. Multivariable logistic regression models were used for our primary analytic models. The choice of inclusion of variables in the final multivariable model was based on both statistical significance (significant in bivariate analyses at the .15 level) and consideration of factors that the literature would suggest are associated with preventive behaviors (e.g., having health care, better education).

Results

Sample characteristics

Table 1 provides detailed information about the study sample. Most participants in the study were racial and ethnic minorities, with 49.4% identifying as Black and 42.0% as Hispanic. The mean age of study participants was 48 years old. The sample was predominately female (73.1%), with 35.6% having less than a high school education. About 42% of residents were currently working full- or part-time. The majority of the sample had some form of public or private insurance, and only 4.6% of the sample was uninsured; 86% reported having a regular health care provider. Only 26% of the main sample reported regular MVU. In terms of physical activity, 48.8% of the sample was below the median of 4,700 steps/day; 43.4% had a BMI of 30 kg/m^2 or higher.

Predicting MVU with sociodemographic factors

In age-adjusted bivariate analyses, a number of statistically significant differences in MVU were found by sociodemographic factors (see Table 2). It was evident that all bivariate models control for age since it was significantly associated with MVU in bivariate analyses ($p < .0001$), with older age associated with regular MVU (OR: 1.04, 1.03–1.05). Females were 1.52 (1.10, 2.10) times more likely to regularly use multivitamins than males. Residents who spoke English as a 1st language were 1.49 (1.10, 2.02) times more likely to regularly take multivitamins than their counterparts. Residents who identified as White/Other race/ethnicity were 1.57 (0.94, 2.61) times more likely to regularly use multivitamins than Blacks, while Hispanics were .66 (0.48, 0.91) times less likely to use multivitamins than Blacks. Residents living above poverty were 1.34 (0.99, 1.81) times more likely to take multivitamins than those living below poverty, although this difference was borderline significant ($p = .06$). There were also differences by nativity which were marginally significant ($p = .06$). Compared to those born in Puerto Rico, residents born in the continental US were 1.61 (1.08, 2.40) times more likely to regularly take multivitamins, as were residents who were not born in the US or Puerto Rico (OR: 1.55, 0.97–2.47). There was no statistical difference in regular MVU by education ($p = .27$): compared to residents with less than a high school education, residents who had completed high school/vocational school and residents with some college education or more were not significantly more likely to take multivitamins regularly (OR: 1.15, 0.79–1.67 and OR: 1.32, 0.92–1.89, respectively). There was also no statistical difference in MVU by employment status ($p = 0.57$; OR: 1.09, 0.79–1.49) or by insurance status ($p = .19$) (latter data not shown). In multivariable analyses, the only sociodemographic factors that remained significant ($p \leq .05$) were gender, age, and race/ethnicity, while poverty status remained borderline significant ($p \leq .10$).

The relationship between MVU and preventive/health factors

In bivariate age-adjusted analyses, residents with current health problems were 1.28 (0.95, 1.72) times more likely to use multivitamins regularly than residents without current health problems ($p = .10$). We also examined whether residents with higher levels of physical activity and lower BMIs would be more likely to regularly use multivitamins than those who were less active and had higher BMIs (see Table 2). There was no association between either physical activity level or BMI (as exposures) and MVU in separate age-adjusted bivariate models. These associations remained non-significant in multivariable models, controlling for age, gender, poverty level and race/ethnicity (see Table 2).

The association between MVU and patient/provider relationship

No significant association was found between having a regular provider and MVU in bivariate ($p = .13$; OR: 1.45, 0.88–2.39) or multivariable analyses ($p = .17$), controlling for sociodemographics and current health problems (see Table 2). Among participants with a regular provider, no significant bivariate associations were found between MVU and (a) when the provider was last seen, (b) decision autonomy, and (c) how well your regular health provider knows you (see Table 3). We also ran an overall main effects model (see Table 3) that combined the significant sociodemographic and preventive variables, along with these three main provider variables of interest. We found

Table 1 Sociodemographic characteristics of the sample

	Main analytic sample (weighted $n = 1{,}485$)		Sub-sample (excluding residents without a regular health care provider) (weighted $n = 1{,}270$)	
	Regular MVU n (%)	Not regular MVU n (%)	Regular MVU n (%)	Not regular MVU n (%)
Total	392 (26%)	1,093 (74%)	358 (28%)	912 (72%)
Race/ethnicity				
Black	209 (29%)	524 (71%)	189 (30%)	430 (70%)
White	32 (43%)	43 (57%)	26 (45%)	32 (55%)
Hispanic	129 (21%)	495 (79%)	122 (22%)	429 (78%)
Other	20 (42%)	28 (58%)	19 (53%)	17 (47%)
Gender				
Male	92 (23%)	308 (77%)	78 (25%)	228 (75%)
Female	300 (28%)	785 (72%)	280 (29%)	684 (71%)
Age				
<35	50 (14%)	309 (86%)	38 (15%)	212 (85%)
35–49	72 (18%)	334 (82%)	69 (19%)	289 (81%)
50–64	169 (35%)	312 (65%)	160 (36%)	283 (64%)
65+	100 (42%)	138 (58%)	91 (42%)	128 (58%)
Employment				
Work full-time	72 (19%)	306 (81%)	67 (21%)	249 (79%)
Work part-time	58 (24%)	184 (76%)	53 (26%)	148 (74%)
Disabled	97 (35%)	181 (65%)	88 (34%)	174 (66%)
Not working	164 (28%)	421 (72%)	150 (30%)	341 (70%)
Poverty level				
Below poverty	182 (26%)	531 (74%)	171 (27%)	456 (73%)
Above poverty	187 (30%)	443 (70%)	167 (31%)	366 (69%)
Education				
Less than HS	154 (29%)	374 (71%)	146 (30%)	333 (70%)
Completed HS/Voc	107 (25%)	326 (75%)	97 (27%)	265 (73%)
Some college+	130 (25%)	393 (75%)	114 (27%)	314 (73%)
Nativity				
Born in US	227 (28%)	594 (72%)	204 (30%)	479 (70%)
Born in PR	77 (23%)	265 (77%)	75 (23%)	243 (77%)
Not born in US, PR	88 (27%)	235 (73%)	79 (29%)	189 (71%)
English 1st language				
No	148 (22%)	517 (78%)	138 (24%)	445 (76%)
Yes	244 (30%)	577 (70%)	220 (32%)	467 (68%)

Women take multis far more than men

that when the provider was last seen ($p = .35$), decision autonomy ($p = .81$), and how well your provider knows you ($p = .30$) all remained non-significant in this multivariable model, controlling for age, gender, and race/ethnicity. Age ($p < .001$), gender ($p = .02$), and race/ethnicity ($p = .01$) remained significant in this main effects model.

We also examined how MVU changes with age and whether age modifies the effects of other variables, using Baron and Kenny's tests for modification and mediation [36]. There was no moderating effect of age in any of the models, but there was a mediating effect of age for two of the provider variables of interest (for when the provider was last seen and how well your regular provider knows you). As a mediator, age is significantly associated with these provider-related variables, as well as the primary outcome (MVU). Furthermore, age changes the effect of these two provider variables, such that they are no longer significant when age is included in the model, and accounts for the relationship between these two provider variables and MVU (e.g., if your provider knows you well, you are more likely to be older, and older age is associated with greater MVU).

Table 2 Bivariate and multivariable models predicting multivitamin use-sociodemographic, preventive and health-related factors

Weighted (n = 1,485)	Age-adjusted bivariate OR (95% CI)	Multivariable-adjusted with PA as exposure OR (95% CI)	Multivariable-adjusted with BMI as exposure OR (95% CI)
Gender			
Male (n = 401)	REF	REF	REF
Female (n = 1,085)	1.52 (1.10, 2.10)**	1.54 (1.09, 2.18)**	1.57 (1.12, 2.22)**
Poverty level			
Below poverty (n = 713)	REF	REF	REF
Above poverty (n = 630)	1.34 (0.99, 1.81)*	1.29 (0.95, 1.75)*	1.29 (0.95, 1.75)*
Education			
Less than HS (n = 528)	REF		
Completed HS/Voc (n = 432)	1.15 (0.79,1.67)		
Some college+ (n = 523)	1.32 (0.92,1.89)		
Nativity			
Born in US (n = 821)	1.61 (1.08, 2.40)**		
Born in PR (n = 342)	REF		
Not born in US, PR (n = 323)	1.55 (0.97, 2.47)*		
English 1st language			
Yes (n = 821)	1.49 (1.10, 2.02)**		
No (n = 665)	REF		
Race/ethnicity			
Black (n = 733)	REF	REF	REF
Hispanic (n = 624)	0.66 (0.48, 0.91)**	0.70 (0.51, 0.97)**	0.70 (0.50, 0.97)**
White/Other (n = 122)	1.57 (0.94, 2.61)*	1.65 (0.96, 2.82)*	1.61 (0.94, 2.77)*
Employment status			
Work full/part time (n = 621)	REF		
Disabled/not working (n = 864)	1.09 (0.79, 1.49)		
Physical activity (steps/day)			
Meets median of 4,700 steps/day or above (n = 761)	REF	REF	
Below median of 4,700 steps/day (n = 724)	1.15 (0.86, 1.54)	1.12 (0.82, 1.53)	
Body mass index (BMI)			
<25 (n = 378)	1.15 (0.78, 1.71)		1.10 (0.73, 1.66)
25–29.9 (n = 463)	REF		REF
30+ (n = 644)	1.14 (0.81, 1.61)		0.99 (0.70, 1.42)
Age (in 1 year increments)		1.04 (1.03, 1.05)**	1.04 (1.03, 1.05)**
Current health problems			
Yes (n = 614)	1.28 (0.95, 1.72)*		
No (n = 871)	REF		
Have regular provider			
Yes (n = 1,270)	1.45 (0.88, 2.39)		
No (n = 205)	REF		

* $p \leq .10$; ** $p \leq .05$

Discussion

The goal of this article was to examine factors associated with regular MVU among a multi-ethnic sample of low-income housing residents representing a range of ages. Little research to date has investigated factors associated with MVU among lower-income or racially/ethnically diverse populations. In light of the potential benefits of multivitamins, particularly for groups at higher risk for nutritional deficiencies, and ongoing epidemiological evaluations of the protective effects of multivitamins and specific nutrients (e.g., vitamin D and calcium) for chronic

Table 3 Bivariate models and multivariable model predicting multivitamin use: factors related to patient/provider relationships among participants with a regular provider

Weighted (n = 1,270)	Age-adjusted bivariate OR (95% CI)	Multivariable OR (95% CI)
Leave screening test to DR		
Yes (n = 1,001)	0.87 (0.60, 1.27)	1.05 (0.70, 1.57)
No (n = 267)	REF	REF
How well DR/NP knows you		
0 (n = 198)	REF	REF
1 (n = 201)	0.94 (0.52, 1.70)	0.92 (0.50, 1.69)
2 (n = 212)	0.76 (0.43, 1.36)	0.77 (0.43, 1.36)
3 (n = 648)	1.19 (0.74, 1.91)	1.14 (0.70, 1.84)
Last see provider		
Within the past month (n = 608)	1.59 (0.51, 4.94)	1.38 (0.44, 4.31)
1–12 months ago (n = 621)	1.25 (0.41, 3.87)	1.12 (0.36, 3.48)
More than 12 months ago (n = 34)	REF	REF
Gender		
Male (n = 401)		REF
Female (n = 1,085)		1.54 (1.07, 2.21)**
Race/ethnicity		
Black (n = 733)		0.51 (0.28, 0.94)**
Hispanic (n = 624)		0.36 (0.19, 0.67)**
White/Other (n = 122)		REF
Age (in 1 year increments)		1.04 (1.03, 1.05)**

** $p \leq .05$

diseases, research is warranted to understand patterns of use among this population.

Sociodemographic factors found to be significantly associated with MVU were generally consistent with prior findings in the literature among the US population [15, 16, 21–28]. Specifically, females, older residents, and those who identified as White/Other had higher rates of regular MVU than their referents. While there were borderline significant findings for poverty level, with residents living above poverty marginally more likely to take multivitamins, there were not any differences by education, employment, or insurance status. This is in contrast to prior research on indicators of socioeconomic position and MVU. For example, among a national sample of US adults, 21.4% of people with less than a high school education used multivitamin/multimineral supplements in the previous month compared to 43.9% of people with more than a high school education [15]. Although we had some variability in education in our sample, our findings here may be explained by the fact that our sample is predominately very low income with little variability with respect to income.

It is interesting to note that Hispanics had the lowest rates of MVU compared to other racial/ethnic groups. Though research typically suggests that Whites are more likely to regularly use multivitamins than other racial/ethnic groups, most studies examining MVU to date have largely been conducted among predominately White samples, with a few exceptions [23, 37]. Recent data from the Multi-ethnic Cohort Study (1999–2001) found that regular multivitamin/mineral use (at least once a week over the past year) was reported by 50% participants, ranging from 38% among Native Hawaiians, 43% among African–Americans, 44% among Latinos, 52% among Japanese Americans, and 57% among Whites [37]. Data from the National Health and Nutritional Examination Survey found MVU in the past month to be nearly 40% among non-Hispanic Whites, compared to 23% and 20%, respectively among non-Hispanic Blacks and Mexican–Americans [15]. More research among diverse racial and ethnic samples is clearly needed.

With respect to health-related variables, we found a non-significant association between current health status and MVU. There have been mixed findings with respect to health status, medical conditions, and MVU in the literature. One study among a large cohort of men and women in western Washington from the VITAL study (ages 50–76) found that multivitamins were not more likely to be used by cancer survivors than by cancer-free controls, with the exception of women with a history of breast cancer having somewhat higher use [30]. Other research suggests that supplement and/or multivitamin users are more likely to have been diagnosed with a disease and be on a diet, but are also more likely to rate their health status as excellent or good [15, 26, 31]. Since health behaviors and patterns have been found to cluster together [38, 39], we hypothesized that residents with higher levels of physical activity

and lower BMIs would be more likely to regularly use multivitamins than those who were less active and had higher BMIs. Interestingly, among this population, we did not find that MVU clustered with other health behaviors or patterns. However, it is important to note that this population tended to have low levels of MVU, low levels of PA, and high rates of obesity; therefore, the limited variability may in part explain these findings.

In examining health care provider/patient relationships, we hypothesized that residents who have a regular health care provider, have seen their health care provider recently (in the last 12 months), perceive that their health care provider knows them well, or leave all screening tests to their provider would be more likely to regularly use multivitamins than their counterparts. Though little research has specifically looked at these provider-related characteristics in relation to MVU, research suggests that health care providers may play an influential role in determining whether women of childbearing age take multivitamins [17, 29, 40, 41]. In contrast to what we hypothesized, this research suggested that there was no difference in MVU by any of the provider-related characteristics. Unfortunately, from this data, we are not able to determine whether providers actually recommended taking multivitamins. However, we would speculate that in the context of strong provider/patient relationships, it is probably necessary for the provider to also specifically recommend MVU to ultimately increase intake among this population.

Importantly, while patterns of use are fairly consistent with the literature in terms of who is more likely to take multivitamins, the overall rates of MVU found in this study (26%) are much lower than the rate of MVU reported in the general US population. It is important to note that the overall evidence available related to the long-term protective effects of multi-vitamins is not conclusive with respect to CVD and cancer. While prior observational studies have suggested possible protective benefits for some cancers [42, 43], as well as CVD, osteoporosis, and birth defects [44, 45], the evidence has been deemed insufficient by the US Clinical Preventive Services Task Force at this time. There are several large randomized clinical trials underway that may provide more definitive evidence in the future. In the meantime, it is critical for future studies to address this issue, particularly from the perspective of disparities. Multivitamins are a relatively simple and low cost 'intervention', and if they do have preventive effects and certain population groups are not utilizing them, it could explain persistent disparities at least to some extent.

Study limitations and strengths should be addressed. We achieved a response rate of 53% which ranged from a low of 34% to a high of 92% across the housing sites. Nevertheless, we targeted, recruited, and enrolled 1,554 participants, which represents a large, ethnically diverse underserved population. Furthermore, the response rate reported here is consistent with other response rates that have been reported from community-based studies [46, 47]. However, the low response rates does introduce the possibility of bias in model estimates and associations. While we do not have any information on non-responders in this study, it is well documented that people who do not respond to surveys have poorer health behaviors than those who do respond, suggesting that if there is any bias, it is likely that we are overestimating the prevalence of MVU. Multivitamin intake was collected by self-report, which may have biased our estimates. However, such biases, which would likely have been due to socially desirable reporting, if anything would have biased our results in terms of over-estimating MVU. Given that the overall use rates were so low (26%), this is unlikely. There may also have been confounding variables that we did not assess. This study has limited generalizability to other populations other than low-income, urban, racial/ethnic minorities living in public housing.

A number of strengths should also be noted. Little research to date has explored MVU among low-income populations. The ODH sample is particularly interesting, because, despite its low-income status, over 95% of participants had health insurance and most had an ongoing relationship with a health care provider. Thus, we are better able to isolate the role of provider related characteristics from access-related issues. This is also a relatively large and diverse sample, in terms of race/ethnicity, gender, and age. Finally, this study had significant data related to other health behaviors and provider–patient relationship, which makes it possible to explore relationships not typically evaluated in the literature.

Findings from this study suggest that the prevalence of MVU is comparatively lower among lower-income, multiethnic housing residents than among national samples. This is troubling given that low-income populations likely have a higher prevalence of nutrient deficiencies and therefore may receive greater benefits from MVU. Furthermore, our findings indicate that sociodemographic factors primarily drive use among this population. These are valuable data for both the scientific and public health communities. First, it could help explain some of the differences in disease prevalence and morbidity seen in low-income and racially/ethnically diverse populations. Furthermore, if clinical or public health recommendations are made that encourage MVU, this population will be made a priority for educational interventions. Thus, the results presented here provide a basis for later research to build upon in understanding factors associated with MVU among underserved populations. Our findings may also have

important implications for research on other dietary supplements. For example, if research continues to suggest the roles of vitamin D and calcium in preventing cancer [2–7], we may soon see recommendations for daily supplements of these vitamins. Thus, our findings are useful in helping us think about how to effectively meet those recommendations. Future research may want to further explore some of the psychosocial, attitudinal, and cultural factors that may mediate the association between sociodemographic factors and MVU.

Acknowledgments We gratefully acknowledge the efforts of the Open Doors to Health Research Team: Elise Dietrich, Elizabeth Gonzalez Suarez, Terri Greene, Lucia Leone, Mike Massagli, Vanessa Melamede, Maribel Melendez, Tamara Parent, Lina Rincón, Claudia Viega, Monifa Watson, Caitlin Gutheil, Zoe Bendixen, Roona Ray, Aidana Baldassrre, David Wilson, Ruth Lederman. We would like to thank the resident helpers and resident service coordinators at collaborating housing sites.

Funding This research was supported by grants 5R01CA098864-02, 1K22CA126992-01, and K05 CA124415 from the National Cancer Institute and support to the Dana-Farber Cancer Institute by Liberty Mutual, National Grid, and the Patterson Fellowship. Funding support for the lead author (R.S.) was also provided through the National Cancer Institute by the Harvard Education Program in Cancer Prevention and Control (5 R25-CA057711-14) and the Mt. Sinai Program in Cancer Prevention and Control: Multidisciplinary Training (5R25-CA081137).

References

1. Huang HY, Caballero B, Chang S, Alberg AJ, Semba RD, Schneyer CR et al (2006) The efficacy and safety of multivitamin and mineral supplement use to prevent cancer and chronic disease in adults: a systematic review for a national institutes of health state-of-the-science conference. Ann Intern Med 145:372–385
2. Wei MY, Garland CF, Gorham ED, Mohr SB, Giovannucci E (2008) Vitamin D and prevention of colorectal adenoma: a meta-analysis. Cancer Epidemiol Biomarkers Prev 17(11):2958–2969. doi:10.1158/1055-9965.EPI-08-0402
3. Cui Y, Rohan TE (2006) Vitamin D, calcium, and breast cancer risk: a review. Cancer Epidemiol Biomarkers Prev 15(8):1427–1437. doi:10.1158/1055-9965.EPI-06-0075
4. Gorham ED, Garland CF, Garland FC, Grant WB, Mohr SB, Lipkin M et al (2007) Optimal vitamin D status for colorectal cancer prevention: a quantitative meta analysis. Am J Prev Med 32(3):210–216. doi:10.1016/j.amepre.2006.11.004
5. Garland CF, Gorham ED, Mohr SB, Grant WB, Giovannucci EL, Lipkin M (2007) Vitamin D and prevention of breast cancer: pooled analysis. J Steroid Biochem Mol Biol 103:708–711. doi:10.1016/j.jsbmb.2006.12.007
6. Gissel T, Rejnmark L, Mosekilde L, Vestergaard P (2008) Intake of vitamin D and risk of breast cancer—a meta-analysis. J Steroid Biochem Mol Biol 111(3–5):195–199. doi:10.1016/j.jsbmb.2008.06.002
7. McCullough ML, Robertson AS, Rodriguez C, Jacobs EJ, Chao A, Carolyn J et al (2003) Calcium, vitamin D, dairy products, and risk of colorectal cancer in the Cancer Prevention Study II Nutrition Cohort (United States). Cancer Causes Control 14:1–12. doi:10.1023/A:1022591007673
8. Huang H, Caballero B, Chang S, Alberg AJ, Semba RD, Schneyer C et al (2007) Multivitamin/mineral supplements and prevention of chronic disease: executive summary. Am J Clin Nutr 85(suppl):265S–268S
9. Stampfer M (2007) Toward optimal health: Meir Stampfer, MD, Dr. PH, discusses multivitamin and mineral supplementation for women. J Womens Health 16(7):959–962. doi:10.1089/jwh.2007.C077
10. Park S, Johnson MA, Fischer JG (2008) Vitamin and mineral supplements: barriers and challenges for older adults. J Nutr Elder 27(3/4):297–317. doi:10.1080/01639360802265855
11. McKay DL, Perrone G, Rasmussen H, Dallal G, Blumberg JB (2000) Multivitamin/mineral supplementation improves plasma B-vitamin status and homocysteine concentration in healthy older adults consuming a folate-fortified diet. J Nutr 130(12):3090–3096
12. Chandra RK (2004) Impact of nutritional status and nutrient supplements on immune responses and incidence of infection in older adults. Ageing Res Rev 3(1):91–104. doi:10.1016/j.arr.2003.08.004
13. Smithells RW, Sheppard S, Schorah CJ et al (1980) Possible prevention of neural tube defects by periconceptual vitamin supplementation. Lancet 1:339–340. doi:10.1016/S0140-6736(80)90886-7
14. Smithells RW, Sheppard S, Wild J, Schorah CJ (1989) Prevention of neural tube defect recurrences in Yorkshire: final report. Lancet 2:498–499. doi:10.1016/S0140-6736(89)92103-X
15. Radimer K, Bindewald B, Hughes J, Ervin B, Swanson C, Picciano MF (2004) Dietary supplement use by US adults: data from the National Health and Nutrition Examination Survey, 1999–2000. Am J Epidemiol 160:339–349. doi:10.1093/aje/kwh207
16. Archer SL, Stamler J, Moag-Stahlberg A et al (2005) Association of dietary supplement use with specific micronutrient intakes among middle-aged American men and women: the INTERMAP study. J Am Diet Assoc 105:1106–1114. doi:10.1016/j.jada.2005.04.010
17. Ahluwalia IB, Lawrence JM, Balluz J (2007) Psychosocial factors associated with use of multivitamins by women of childbearing age. J Commun Health 32(1):57–69. doi:10.1007/s10900-006-9029-1
18. Catov JM, Bodnar LM, Ness RB, Markovic N, Roberts JM (2007) Association of periconceptional multivitamin use and risk of preterm or small-for-gestational-age births. Am J Epidemiol 166(3):296–303. doi:10.1093/aje/kwm071
19. Pawlak R, Connell C, Brown D, Meyer MK, Yadrick K (2005) Predictors of multivitamin supplement use among African–American female students: a prospective study utilizing the theory of planned behavior. Ethn Dis 15(4):540–547
20. Vahratian A, Siega-Riz AM, Savitz DA, Thorp JM Jr (2004) Multivitamin use and the risk of preterm birth. Am J Epidemiol 160(9):886–892. doi:10.1093/aje/kwh305
21. Jacobs EJ, Connell CJ, Patel AV, Chao A, Rodriguez C, Seymour J, McCullough ML, Calle EE, Thun MF (2001) Multivitamin use and colon cancer mortality in the Cancer Prevention Study II Cohort (United States). Cancer Causes Control 12:927–934. doi:10.1023/A:1013716323466
22. Briefel RR, Johnson CL (2004) Secular trends in dietary intake in the United States. Annu Rev Nutr 24:401–431. doi:10.1146/annurev.nutr.23.011702.073349
23. Foote JA, Murphy SP, Wilkens LR, Hankin JH, Henderson BE, Kolonel LN (2003) Factors associated with dietary supplement use among healthy adults of five ethnicities: the Multiethnic Cohort Study. Am J Epidemiol 157:888–897. doi:10.1093/aje/kwg072
24. Gordon NP, Schaffer DM (2005) Use of dietary supplements by female seniors in a large Northern California health plan. BMC Geriatr 5:4. doi:10.1186/1471-2318-5-4

25. Kimmons JE, Blanck HM, Tohill BC, Zhang J, Khan LK (2006) Multivitamin use in relation to self-reported body mass index and weight loss attempts. Med Gen Med 8(3):3
26. Rock CL (2007) Multivitamin-multimineral supplements: who uses them? Am J Clin Nutr 85(suppl):277S–279S
27. Jasti S, Siega-Riz AM, Bentley ME (2003) Dietary supplement use in the context of health disparities: cultural, ethnic and demographic determinants of use. J Nutr 133(6):2010S–2013S
28. Langer RD, White E, Lewis CE, Kotchen JM, Hendrix SL, Trevisan M (2003) The women's health initiative observational study: baseline characteristics of participants and reliability of baseline measures. Ann Epidemiol 13:S107–S121. doi:10.1016/S1047-2797(03)00047-4
29. O'Rourke KM, Roddy ME, Williams D, Mena K (2006) Predictors of early postpartum vitamin use among women of Mexican origin: implications for healthcare provider recommendations. Ethn Dis 16(1):194–200
30. Greenlee H, White E, Patterson RE, Kristal AR (2004) Supplement use among cancer survivors in the Vitamins and Lifestyle (VITAL) study cohort. J Altern Complement Med 10(4):660–666
31. Satia-Abouta J, Kristal AR, Patterson RE, Littman AJ, Stratton KL, White E (2003) Dietary supplement use and medical conditions: the VITAL study. Am J Prev Med 24(1):43–51. doi:10.1016/S0749-3797(02)00571-8
32. Bennett GG, McNeill LH, Wolin KY, Duncan DT, Puleo E, Emmons KM (2007) Safe to walk? Neighborhood safety and physical activity among public housing residents. PLoS Med 4(10):1599–1606. doi:10.1371/journal.pmed.0040306
33. McNeill LH, Puleo E, Bennett GG, Emmons KM (2007) Exploring social contextual correlates of computer ownership and frequency of use among urban, low-income, public housing adult residents. J Med Internet Res 9(4):e35. doi:10.2196/jmir.9.4.e35
34. Emmons KM, Stoddard AM, Fletcher R, Gutheil C, Suarez EG, Lobb R, Weeks J, Bigby JA (2005) Cancer prevention among working class, multiethnic adults: results of the healthy directions-health centers study. Am J Public Health 95(7):1200–1205. doi:10.2105/AJPH.2004.038695
35. Bennett GG, Wolin KY, Puleo E, Emmons K (2006) Pedometer-determined physical activity among multiethnic low income housing residents. Med Sci Sports Exerc 38:768–773. doi:10.1249/01.mss.0000210200.87328.3f
36. Baron RM, Kenny DA (1986) The moderator-mediator variable distinction in social psychological research: conceptual, strategies, and statistical considerations. J Pers Soc Psychol 51(6):1173–1182. doi:10.1037/0022-3514.51.6.1173
37. Park SY, Murphy SP, Martin LC, Kolonel KN (2008) Nutrient intake from multivitamin/mineral supplements is similar among users from five ethnic groups: the Multiethnic Cohort Study. J Am Diet Assoc 108(3):529–533. doi:10.1016/j.jada.2007.12.011
38. Emmons KM, McBride CM, Puleo E, Pollak KI, Marcus BH, Napolitano M, Clipp E, Onken J, Farraye FA, Fletcher R (2005) Prevalence and predictors of multiple behavioral risk factors for colon cancer. Prev Med 40(5):527–534. doi:10.1016/j.ypmed.2004.10.001
39. Coups EJ, Manne SL, Meropol NJ, Weinberg DS (2007) Multiple behavioral risk factors for colorectal cancer and colorectal cancer screening status. Biomarkers Prev 16(3):510–516. doi:10.1158/1055-9965.EPI-06-0143
40. Cleves MA, Hobbs CA, Collins HB, Andrews N, Smith LN, Robbins JM (2004) Folic acid use by women receiving routine gynecologic care. Obstet Gynecol 103:746–753
41. March of Dimes (2000) Folic acid and the prevention of birth defects. A national survey of pre-pregnancy awareness and behavior among women of childbearing age 1995–2000. Conducted by the Gallup Organization. March of Dimes, White Plains (NY)
42. Giovannucci E, Stampfer MJ, Colditz GA et al (1998) Multivitamin use, folate, and colon cancer in women in the Nurses' Health Study. Ann Intern Med 129:517–524
43. Rohan TE, Jain MG, Howe GR et al (2000) Dietary folate consumption and breast cancer risk. J Natl Cancer Inst 92:266–269. doi:10.1093/jnci/92.3.266
44. Fairfield KM, Fletcher RH (2002) Vitamins for chronic disease prevention in adults: scientific review. JAMA 287:3116–3126. doi:10.1001/jama.287.23.3116
45. Fletcher RH, Fairfield KM (2002) Vitamins for chronic disease prevention in adults: clinical applications. JAMA 287:3127–3129. doi:10.1001/jama.287.23.3127
46. Ansong KS, Lewis C, Jenkins P, Bell J (2000) Epidemiology of erectile dysfunction: a community-based study in rural New York State. Ann Epidemiol 10(5):293–296. doi:10.1016/S1047-2797(00)00050-8
47. Ellison-Loschmann L, Sunyer J, Plana E, Pearce N, Zock JP, Jarvis D et al (2007) Socioeconomic status, asthma and chronic bronchitis in a large community-based study. Eur Respir J 29(5):897–905. doi:10.1183/09031936.00101606