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ORIGINAL ARTICLE

Socioeconomic, health, and dietary determinants of multivitamin supplements use in Belgium

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Abstract
Objective This study aimed at investigating the use of multivitamin supplements in relationship to dietary pattern, socio-economic conditions and some health indicators.
Methods A cross-sectional design was used. Mailed questionnaires were sent to 5,000 Belgian military men. Use of multivitamins, frequency and food consumption were recorded during the past year, together with health (BMI, smoking, physical activity) and socioeconomic indicators (education, income). Dietary patterns were determined using the Mediterranean Diet Score (MDS).
Results Use of multivitamin supplements was associated with healthy lifestyle characteristics, such as a higher physical activity level and non smoking. Moreover, it was found that on average more participants with a Flemish cultural background (19.8%) used supplements compared with participants with a French cultural background (9.3%). The MDS was related to multivitamin supplement use, with 34.9% of users having the highest score range. The socioeconomic indicators 'education' and 'income' were not related to vitamin supplement use.
Conclusion A low BMI, healthy diet, regular physical activity, non-smoking status and cultural background were associated with a higher intake of multivitamin supplements.

Keywords Multivitamin supplements · Dietary pattern · Nutritional assessment · Health behavior · Nutritional epidemiology · Public health

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Introduction

The daily use of multivitamin supplements by healthy men and women increased over the past two decennia, despite a lack of consensus concerning possible health benefits and a possible increased mortality associated with some vitamins (Bjelakovic et al. 2007). Increase in mortality was associated with a daily intake of high doses of vitamin E and beta-carotene.

However, previous studies suggest that the intake of multivitamin supplements is predominantly associated with a healthy lifestyle (diet, physical activity and non-smoking) (Radimer et al. 2000, 2004; Touvier et al. 2009; Kerver et al. 2003; Messerer et al. 2001; McNaughton et al. 2005; de Jong et al. 2003; Beitz et al. 2004; Kirk et al. 1999). Hence, it is probable that those taking multivitamin supplements may be the least likely to need them. For instance, multivitamin supplement intake has been associated with a higher intake

of fruits and vegetables, with a lower Body Mass Index (BMI), with higher levels of physical activity and with non smoking behavior.

Yet, few studies have been conducted concerning the use of multivitamin supplements in function of a general dietary pattern. Dietary pattern analysis, based on the concept that foods eaten combined are as important as a reductive methodology characterized by a single food or nutrient analysis, has emerged more than a decennium ago as an alternative approach to study the relation between nutrition and disease (Slattery 2008). As reviewed by Hu (2002), dietary pattern analysis is a better method to examine the effect of overall diet: food and nutrients are not eaten in isolation, and the "single food or nutrient" approach will not take into account the complex interactions between food and nutrients. The Mediterranean Diet Score (MDS), associated with the Mediterranean dietary pattern, has received a lot of attention since its higher scores have been associated with reduction in mortality (Sofi et al. 2008). This reduction has been reported in different populations and by different research teams.

The aim of the present work was to investigate the use of multivitamin supplements in relationship to dietary pattern, socio-economic conditions and some health indicators. As socioeconomic indicators, education and income were used and as health indicators physical activity, smoking and BMI. MDS was selected for dietary pattern analysis because of the strong associated reduction in mortality.

Methods

In February 2007, air and terrestrial components of the Belgian army totaled 33,053 men. After stratification for military rank and age, 5,000 men were selected representative for the total army structure. Stratification in Belgian army consists in officers (from lieutenant to general), non-commissioned officers (from sergeant to warrant officer) and soldiers (corporal and other personnel with no command authority). The selection consisted of 598 officers, 2,103 non-commissioned officers and 2,299 soldiers.

A French and a Flemish semi-quantitative food frequency questionnaire, including 150 food items, was mailed to the subjects. For each food item, the following categories of consumption frequency during the past year were used: never, one to three times a month, once a week, two to four times a week, five to six times a week, once a day, and more than once a day. Portion sizes were predefined using household measures (teaspoon, glass, cup…). An open question was added concerning the use or non-use of multivitamin supplements over the past year and the type of vitamins used. The validity of the food frequency questionnaire was tested on a sample of 100 men representative for the participants to the present study. They were asked to complete two semi-quantitative food frequency questionnaires (SFFQ1 and QFFQ2) with 2 weeks' interval together with 4 days' food record (4DFR). The correlation coefficients for energy-adjusted nutrients between SFFQ1 and SFFQ2 ranged between 0.42 (vitamin A) and 0.79 (total energy intake). The correlation coefficients between SFFQ1 and 4DFR ranged between 0.05 (vitamin A) and 0.50 (total energy intake). The correlation coefficients between SFFQ2 and 4DFR ranged between 0.01 (vitamin A) and 0.52 (total energy intake). The percentage individuals classified in the same tertile comparing SFFQ1 and 4DFR ranged between 33.7 (vitamin A) and 52.6% (total alcohol intake) (Mullie et al. 2009).

A second questionnaire, more general in nature, was used to register health-related and lifestyle characteristics such as smoking, marital status, main occupation, age, weight, height, number of children and knowledge of cardiovascular risk factors. This questionnaire was used in previous research (Autier et al. 2003). Yearly gross salary was obtained from administrative services, taking into account the rank and years of active duty.

For descriptive statistics, two groups were created: user and non-users of multivitamin supplements. Users were defined as participants who took multivitamin supplements for an undefined period during the past year, as prescribed by their general practitioner, advised by their health worker, and/or as self prescribed.

Age (20–29 years, 30–39 years, 40–49 years, 50–59 years), BMI classified according to the World Health Organization (normal weight, $18.5 \leq \text{BMI} < 25.0$ kg/m^2, overweight, $25.0 \leq \text{BMI} < 30.0$ kg/m^2 and obesity, BMI ≥ 30.0 kg/m^2 (World Health Organisation 2006)), physical activity level (stratified as low, moderate and high according to the International Physical Activity Questionnaire) (Hallal and Victora 2004), actual smoking (yes or no), educational level (low for vocational education, moderate for secondary level and high for high school level or university, i.e. bachelor or master's level), income (low for lowest tertile of yearly gross income of the group, moderate for intermediate tertile of income and high for highest tertile of yearly income) and cultural background (identified by French or Flemish speaking as native language) are presented in Table 1.

The MDS was computed as described previously (Sofi et al. 2008). Briefly, a value of 0 or 1 was assigned to each of nine indicated components with the use of the median as the cutoff. For beneficial components (vegetables, legumes, fruits and nuts, cereal and fish), persons whose consumption was below the median were assigned a value of 0, and persons whose consumption was at or above the median were assigned a value of 1. For components presumed to be

Table 1 Characteristics of the 1,852 Belgian army men (February 2007)

Characteristics	Categorisation	Responders *n* (%)	Non-responders *n* (%)
Total		1,852 (100.0)	3,148 (100.0)
Age (in years)	20–29	119 (6.4)*	461 (14.6)*
	30–39	358 (19.3)	753 (23.9)*
	40–49	1,064 (57.5)*	1,439 (45.7)*
	50–59	311 (16.8)*	495 (15.7)*
Military rank	Officers	217 (11.7)*	381 (12.1)*
	Non-commissioned officers	936 (50.5)*	1,167 (37.1)*
	Soldiers	699 (37.7)*	1,600 (50.8)*
Body Mass Index	Normal (<25.0)	744 (40.2)	
	Overweight (≥25.0 to <30.0)	836 (45.1)	
	Obesity (≥30.0)	244 (13.2)	
	Missing	28 (1.5)	
Physical activity	Low	365 (20.7)	
	Moderate	383 (21.7)	
	High	1,016 (57.6)	
	Missing	88 (4.8)	
Regularly use of vitamin supplementation		283 (15.3)	
Actual smoking		447 (24.1)	
Educational level	Low	789 (42.6)	
	Moderate	811 (43.8)	
	High	252 (13.6)	
Income	Low	618 (33.4)	
	Moderate	616 (33.3)	
	High	618 (33.4)	
Cultural background	French	804 (43.4)	
	Flemish	1,048 (56.6)	
Mediterranean Diet Score	Low (0–3)	694 (38.3)	
	Moderate (4–6)	803 (52.5)	
	High (7–9)	108 (9.2)	

* $P < 0.001$

detrimental (meat, poultry and dairy products), persons whose consumption was below the median were assigned a value of 1, and persons whose consumption was at or above the median were assigned a value of 0. For ethanol, a value of 1 was assigned to men who consumed between 10 and 50 g/day. Finally, for fat intake, the ratio of monounsaturated lipids to saturated lipids was used. Thus, the total Mediterranean-diet score ranged from 0 (minimal adherence to the traditional Mediterranean diet) to 9 (maximal adherence).

A binary logistic regression was executed to estimate the effect of age, BMI, physical activity, smoking, education, income categories, cultural background and MDS on use or non-use of vitamin supplements. All variables were introduced at the same time in the model. Plots of the residuals versus the predicted values were examined to ascertain that basic model assumptions were met. A two-sided level of significance of 0.05 was defined. SPSS 16.0 (SPSS Inc. Chicago, IL, USA) statistics software was used. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Bioethical Committee of the University of Leuven. Written informed consent was obtained from all subjects.

Results

Table 1 presents the demographic and lifestyle characteristics of the subjects. In total, 1,852 subjects were included in the study, which represents 37% of the 5,000 preselected men. The most prevalent age-category was 40–49 years; 76% were non-smokers. About 58% had a BMI $\geq$ 25.0 kg/m^2, while 42.6% had a low level of education. Responders to the mailing tended to be older than non-responders (74.3% were older than 40 years compared with 61.4% for the non-responders) ($p < 0.001$). Moreover, soldiers were less inclined to participate in the study ($p < 0.001$).

Table 2 Determinants of multivitamin supplement intake by 1,852 Belgian army men (February 2007)

Characteristics	Categorisation	OR	95% CI
Age	in years	1.01	0.98–1.03
Body Mass Index	in kg/m^2	0.90*	0.86–0.94
Physical activity	Low, moderate, high	1.39*	1.15–1.67
Smoking	Yes versus no	0.52*	0.36–0.77
Educational level	Low, moderate, high	1.03	0.82–1.28
Income level	Low, moderate, high	0.90	0.73–1.10
Cultural background	Dutch versus French	2.10*	1.55–2.84
Mediterranean Diet Score	Score from 0 to 9	1.22*	1.13–1.33

* $p < 0.001$

Fifteen percent ($n = 283$) of the participants had used a multivitamin supplement in the year before completing the questionnaire (Table 1).

Table 2 presents the odds ratios (OR) of the multivariable analysis with 95% confidence intervals (95% CI). Use of multivitamin supplements was negatively associated with BMI and smoking. A BMI increase of 1 kg/m^2 was associated with an OR of 0.90 (95% CI: 0.86–0.94). Smokers had an OR of 0.52 (95% CI: 0.36–0.77) compared with non smokers. A higher level of physical activity level, Flemish cultural background and an increasing score for the MDS were positively associated with the use of multivitamin supplements, which confirms the results of the bivariate analysis. A Flemish cultural background was associated with an OR of 2.10 (95% CI: 1.55–2.84) compared with a French cultural background.

Both socioeconomic indicators, i.e. education and income, were not significantly related to use of multivitamin supplements.

Discussion

The main findings of this study are the strong cultural influence on the use of multivitamin supplements and the association with a higher score for the MDS and consequently with a healthier eating pattern.

A polarization in dietary pattern between the Flemish and French part of the country has been confirmed by a recent Belgian Food Consumption Survey, with a healthier lifestyle for the Flemish cultural background (Devriese et al. 2006). The association between a healthy lifestyle and the use of multivitamin supplements is well known; this can probably partly explain the polarization in consumption of multivitamin (Radimer et al. 2000, 2004; Messerer et al. 2001; McNaughton et al. 2005; de Jong et al. 2003; Beitz et al. 2004; Kirk et al. 1999).

Previous studies could associate the use of multivitamin supplements with a higher intake of fruits and vegetables, with a lower BMI, with higher levels of physical activity and with non smoking (Radimer et al. 2000, 2004; Messerer et al. 2001; McNaughton et al. 2005; de Jong et al. 2003; Beitz et al. 2004; Kirk et al. 1999); i.e. a more healthy lifestyle, so it is highly probable that those taking multivitamin supplements may be the least likely to need them. To our knowledge, this was the first study carried out that found an association of the use of multivitamin supplements with a more general dietary pattern. In this study we used the MDS, because of the strong negative association of this score with total mortality, as reported in different populations by different research teams (Sofi et al. 2008).

A high MDS was associated with a higher consumption of multivitamin supplements. This implies that undernutrition is probably not the motivation and/or explanation for the increased consumption of multivitamin supplements. The benefit of using multivitamin supplements associated with a cluster of healthy lifestyle is not supported by existing scientific evidence. On the contrary, in a systematic review, Bjelakovic et al. (2007) recently reported an increase in mortality associated with the use of some vitamins. The relative risk (RR) and 95% confidence intervals in the low-biased studies were 1.07 (95% CI: 1.02–1.11) for beta-carotene, for vitamin A 1.16 (95% CI: 1.10–1.24) and for vitamin E 1.04 (95% CI: 1.01–1.07). This indicates that a more prudent approach in the use of those supplements could be necessary in the future.

Comparison of results of this study with other studies remains difficult since inter-studies variations exist in defining dietary supplements in general and in the definition of users in particularly. The definition in this study of users can be seen as large, i.e. having taken a multivitamin supplements for an undefined period during the past year. Some studies include as supplements not only vitamins, but also fish oil, garlic supplements and minerals (Beitz et al. 2004). In this study the definition of supplements was limited to multivitamins. Other studies only register consumption during previous week or month, whereas in the present study consumption was evaluated over the previous year. Beitz et al. (2004) found in a German male population 14.4–22.1% vitamin and mineral users according to age-categories, which is comparable with the results of this study (14.1–18.2% users of multivitamin supplements). de Jong et al. (2003) found an overall use of 20% of multivitamin and mineral supplements in a Dutch population. In a British Birth Cohort, 13% of the men were using regularly multivitamin supplements (McNaughton et al. 2005). Those three European studies, together with the present study, indicate that the prevalence of multivitamin users varies between 13 and 22% depending on age-category. This is a much lower prevalence compared with the United States. For instance, in the NHANES 1999–2000, Radimer

et al. (2004) found a prevalence of 30.4–39.8% multivitamins and minerals users depending of the age-category.

Despite the possible differences in definitions of supplements and in recorded duration of consumption, in a large number of studies, vitamin supplements consumption was found to be associated with a healthier lifestyle.

In this study, the socioeconomic determinants 'education' and 'income' were no predictors for using multivitamin supplements. In a multivariate analysis, there was a non-significant increase in consumption with increasing income and education. Other researchers found that education was a predicting variable of consumption of dietary supplements including minerals and fish oil (Messerer et al. 2001; de Jong et al. 2003; Radimer et al. 2004). The weak association in this study could be due to the low prevalence of users, limiting the statistical power to detect associations and the limitation to multivitamin supplements.

A limitation of this study is the low response of 37%, but information could be gathered concerning non-responders. The responders to this study were older than non-responders. Socioeconomic position, as measured by military rank, was comparable between responders and non-responders. However, the main purpose of this study was not to provide exact estimations of prevalence, but to detect differences in socioeconomic position, health behavior factors and dietary pattern between users and non users.

In their publication, Lorant et al. (2007) found that lower educated subjects were less likely to participate in a survey when they had a poor health status compared with better-off groups. This may lead to an underestimation of the relation between socioeconomic position and dietary pattern or healthy lifestyle.

The nutritional intake registered by the used semi-quantitative food frequency questionnaire was compared with the nutritional intake as registered by the 4-day food records (Mullie et al. 2009). The validity of the semi-quantitative food frequency questionnaire was low, with energy-adjusted correlation coefficients between food frequency questionnaire and 4-day food record ranging from 0.01 to 0.52. Studies trying to validate food frequency questionnaires are often hampered by the lack of a general accepted "gold standard" for nutritional monitoring (Masson et al. 2003). This means that validation studies are not true validation studies because the standard assessment methods are themselves of unknown validity (Kushi 1994). According to Willett, when comparing food frequency questionnaires with records of diets, the correlation coefficient could reach 0.6–0.7, which is much higher than in our validation study (Willett 1994).

This low correlation could be due to a limited number of days studied with the 4-day food record, to a rather limited study group and to possible seasonal effects. In our study, 4 days were chosen instead of seven in order to reduce non-participation due to a time-consuming procedure. The possible consequence of this decision could be that the 4-day record is not representative for long-term nutritional and seasonal habits as reported by food frequency questionnaire. This may result in low agreement between the two methods. A second reason could be that our study group consisted only of men. Masson et al. (2003) found in their validation study lower measure of agreements for men compared with women. A possible reason is the lower awareness of habitual diet in male populations and the higher ability of women to estimate portion size.

In conclusion, a low body mass index, higher physical activity level, non smoking, a Flemish cultural background and a healthy diet are associated with a higher intake of multivitamin supplements. From a public health point of view, the health-related advantages of multivitamin supplement intake by a healthier fraction of the population are questionable. Precise guidelines concerning use of multivitamin supplements should be developed, with the aim to inform correctly general practitioners and pharmacists. Marketing and accessibility of those supplements should be restricted.

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Conflict of interest The authors declare that they have no competing interests.

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