

This article was downloaded by: [Vienna University Library]

On: 12 March 2011

Access details: Access Details: [subscription number 931547329]

Publisher Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Ergonomics

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713701117>

Cross-sectional analysis of BMI and some lifestyle variables in Flemish vegetarians compared with non-vegetarians

K. Alewaeters^a; P. Clarys^b; M. Hebbelinck^b; P. Deriemaeker^b; J. P. Clarys^a

^a Department of Experimental Anatomy, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Brussels, Belgium ^b Laboratory of Human Biometry, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Brussels, Belgium

To cite this Article Alewaeters, K. , Clarys, P. , Hebbelinck, M. , Deriemaeker, P. and Clarys, J. P.(2005) 'Cross-sectional analysis of BMI and some lifestyle variables in Flemish vegetarians compared with non-vegetarians', *Ergonomics*, 48: 11, 1433 – 1444

To link to this Article: DOI: 10.1080/00140130500101031

URL: <http://dx.doi.org/10.1080/00140130500101031>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

Cross-sectional analysis of BMI and some lifestyle variables in Flemish vegetarians compared with non-vegetarians

K. ALEWAETERS^{†*}, P. CLARYS[‡], M. HEBBELINCK[‡],
P. DERIEMAERKER[‡] and J.P. CLARYS[†]

[†]Department of Experimental Anatomy, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Laarbeeklaan 103, B-1090 Brussels, Belgium
[‡]Laboratory of Human Biometry, Faculty of Physical Education and Physiotherapy, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

Epidemiological studies on vegetarians indicate that appropriately planned vegetarian diets are associated with certain health benefits, which may lower mortality and morbidity. A healthy lifestyle, such as regular physical activity and avoidance of harmful practices, such as smoking and heavy drinking, could also influence these positive health-related outcomes in vegetarians. This study reports BMI, smoking and drinking habits, engagement in physical activity, medication use and subjective health perception in a vegetarian population (women: $n = 206$, mean age 37.0 ± 12.3 years; men: $n = 120$, mean age 42.3 ± 15.9 years) as compared with a reference Belgian population (women: $n = 4993$, mean age 49.8 ± 18.0 years; men: $n = 4666$, mean age 48.0 ± 17.1 years).

When considering the vegetarian group as a whole, the vegetarians had a lower mean BMI compared with the reference population (respectively 22.1 ± 3.1 kg/m² compared with 24.6 ± 4.8 kg/m² for women ($p < 0.001$) and respectively 22.6 ± 3.6 kg/m² compared with 25.7 ± 4.0 kg/m² for men ($p < 0.001$)). Vegetarians smoked less than subjects of the reference group (13.5% compared with 28.5% respectively; $p < 0.001$). During weekdays the percentage of subjects consuming alcoholic drinks in the two populations was comparable (32.8 in the vegetarian and 35.8 in the reference population; $p = 0.159$). During the weekend, more subjects of the reference population drank alcohol compared with the vegetarian subjects (70.2% vs. 58.6% respectively; $p = 0.026$). More vegetarians were involved in intensive physical activity (over 4 h per week) compared with the reference population (36.8% vs. 17.3% respectively; $p < 0.001$), while fewer vegetarians were involved in moderate physical activity (up to 4 h per week) compared with subjects of the reference group (28.2% and 51.0% respectively; $p < 0.001$). Percentages of subjects involved in no physical activity were comparable in both groups (vegetarians 34.9 vs. reference subjects 31.8; $p = 0.625$). Use of prescribed medication was lower among the vegetarians (25.5% compared with 47.3%

*Corresponding author. Email: Katrien.Alewaeters@vub.ac.be

in the reference population; $p < 0.001$), while use of non-prescribed drugs was comparable between both groups (34.1% in the vegetarian group and 28.2% in the reference group; $p = 0.580$). More vegetarian subjects perceived their health to be good to very good compared with the subjects of the reference population (90.4% vs. 77.2% respectively; $p < 0.001$).

The significant difference for the BMI values when comparing the vegetarian males and females with the reference population cannot be completely explained by the evaluated lifestyle characteristics. However, the lower BMI values in vegetarians are in agreement with the literature.

Keywords: Vegetarianism; Healthy lifestyle; Smoking; Alcohol consumption; Physical activity

1. Introduction

Vegetarians do not eat meat, fish or fowl and base their diet mainly on vegetables and fruit, cereals, pulses, nuts and seeds. A classification is made based on whether dairy products and eggs are included or excluded from the diet. Lacto-ovo-vegetarians include both, while lacto-vegetarians exclude eggs and ovo-vegetarians exclude dairy products. Vegans exclude all animal products from their diet, so in addition to the exclusion of meat, fish and fowl, they exclude both dairy products and eggs (Sabaté *et al.* 2001). Epidemiological studies on vegetarians indicate that appropriately planned vegetarian diets are healthful, nutritionally adequate and can provide certain health benefits in the prevention and treatment of certain diseases and, hence, could lower morbidity and mortality (Key *et al.* 1999, American Dietetic Association 2003). Nevertheless, several authors have pointed to vitamin B₁₂ deficiencies for strict vegetarians (vegans) (American Dietetic Association 2003). Vegetarians are shown to have lower BMI and a lower risk of death from ischaemic heart disease when compared with non-vegetarians (Key *et al.* 1998). Other reported advantages of vegetarianism are lower blood pressure, lower blood cholesterol levels and a reduced risk of hypertension, type 2 diabetes, obesity, prostate and colon cancer (Fraser 1999, 2003, Rajaram and Sabaté 2000). These positive health-related outcomes in vegetarians could be influenced by factors other than dietary practices. A healthy lifestyle, including regular physical activity and the avoidance of harmful practices such as smoking and drinking, may also play a role (Whitten 2001). It is also possible that certain health benefits associated with a vegetarian diet only become apparent after a certain (perhaps long) period of adherence. A longer duration of vegetarianism (at least 20 years) has been shown to lead to a lower risk of early death (Chang-Claude and Frentzel-Beyme 1993).

The aim of this study on vegetarians is to report BMI, smoking and drinking habits, engagement in physical activity, medication use and subjective health perception in a vegetarian population as compared with a reference Belgian population (Demarest *et al.* 2002).

2. Participants and methods

2.1. Subjects

Subjects were recruited in the Flemish region of Belgium through advertising in health food shops, in publications and on the web site of vegetarian and animal rights

associations, and through word of mouth. Criteria for inclusion were being a vegetarian (for at least 1 year) and being at least 20 years of age. A total of 650 people responded, of whom 405 actually completed a health and fitness-related questionnaire. Of these 405 volunteers, 375 met the inclusion criteria, corresponding to a completion rate of 58%. This rather low completion rate could have been due to subjects being discouraged when seeing the length of the questionnaire, to not having sent a reminder to the non-responding subjects, or to the fact that no deadline for returning the questionnaires was specified. Volunteers were able to choose between completing an online questionnaire or a regular questionnaire, which was then sent to them by post.

The self-administered questionnaire consisted of general questions on socio-economic characteristics, medical history, current smoking and drinking habits, physical activity and nutrition. Most of the items were taken from the National Health Survey (Demarest *et al.* 2002), which is a validated instrument used to estimate health-related issues in the Belgian population every 5 years. Information on physical activity was collected using the questionnaire of Baecke *et al.* (1982) since questions related to physical activity were sparse in the National Health Survey. A test-retest reliability study of the used questionnaire was conducted over a 1-month interval ($n = 13$). Test-retest reliability results indicated that 57% of the questions correlated perfectly ($r = 1.000$), 22% of the questions had a correlation coefficient between 0.800 and 0.999 and the remaining 21% of the questions had a correlation coefficient between 0.799 and 0.598. Of these correlations, 81% were significant on a 0.01 level, while the remaining 19% was significant on a 0.05 level. Only two questions on time dependent items did not correlate significantly ($p = 0.388$ and $p = 0.059$).

The 133 responding men and 242 responding women all considered themselves 'vegetarians', but after closer analysis of their nutritional habits, 9.8% of the men ($n = 13$) and 14.9% of the women ($n = 36$) were excluded from the test group for being fish-eaters (i.e. people who do not eat meat but do include fish in their diet). The majority of the remaining 120 male and 206 female subjects were lacto-ovo-vegetarians (79.8%). Because of the small number of ovo-vegetarians (1.8%), lacto-vegetarians (2.1%) and vegans (15.0%), all the subjects were handled as one group, referred to as 'vegetarians' in the rest of the article. The male subjects ranged between 23 and 98 years old with a mean (\pm SD) age of 42.3 ± 15.9 years and a median age of 38, while the female subjects ranged between 20 and 78 years old with a mean (\pm SD) age of 37.0 ± 12.3 years and a median age of 34. More women participated than men, respectively 63.2% and 36.8%.

2.2. Data analysis

All calculations were performed using Microsoft Excel. All values were calculated separately for men and women. Since most of the parameters were age related, comparisons between vegetarians and non-vegetarians were made by age group (Malina 1996). The results of the vegetarians were compared with the results of a recent health survey of a representative sample of the Belgian population ($n = 9000$), held by the Belgian government (Demarest *et al.* 2002). Statistical comparisons were performed using SPSS (version 11.0). BMI were compared using an independent samples *t*-test, and a nonparametric two-independent samples test was used to compare tobacco and alcohol consumption, perception of health status, physical activity level and medication use. Significance level was set at 0.05.

3. Results

3.1. BMI

BMI was calculated from the body mass and the body height data given by the vegetarian subjects. When compared with the mean BMI of the female Belgian population ($24.6 \pm 4.8 \text{ kg/m}^2$), the BMI of the female vegetarian subjects was significantly lower with a mean value of $22.1 \pm 3.1 \text{ kg/m}^2$ ($p < 0.001$). The same observation was made for the men; vegetarian subjects had a mean BMI of $22.6 \pm 3.6 \text{ kg/m}^2$ compared with a BMI of $25.7 \pm 4.0 \text{ kg/m}^2$ ($p < 0.001$) for the subjects of the reference population (table 1). Only 11.9% of the men and 7.3% of the women had a BMI over the reference value of 27. Although a BMI cut-off of 25 is more usual to indicate overweight, a cut-off of 27 was used in order to compare these data with the results of the reference group, where a cut-off of 27 was used. For both the vegetarian group and the reference population, mean

Table 1. Lifestyle characteristics by gender and by group.

	Men		Women	
	Vegetarian group (n = 120)	Reference group (n = 4666)	Vegetarian group (n = 206)	Reference group (n = 4993)
Age at recruitment (years)				
20–24	4.2%	7.4%	11.7%	6.9%
25–34	39.2%	18.6%	41.3%	18.0%
35–44	21.7%	21.2%	21.8%	19.3%
45–54	11.7%	17.8%	15.0%	17.6%
55–64	12.5%	14.6%	7.3%	13.9%
65–74	6.7%	12.1%	1.9%	13.5%
75+	4.2%	8.2%	1.0%	10.7%
Mean \pm SD (median)	42.3 \pm 15.9 (38)	48.0 \pm 17.1 (46)	37.0 \pm 12.3 (34)	49.8 \pm 18.0 (47)
BMI \pm SD (kg/m^2)	22.6 \pm 3.6	25.7 \pm 4.0	22.1 \pm 3.1	24.6 \pm 4.8
Alcohol consumers				
Week	33.3%	41.9%	32.5%	28.9%
Weekend	58.3%	75.4%	58.7%	64.1%
Tobacco use				
Current smokers	15.8%	33.7%	12.1%	23.6%
Physical activity				
> 4h/week	42.5%	18.6%	33.5%	9.0%
< 4h/week	24.2%	42.8%	30.6%	45.9%
Sedentary	33.3%	29.0%	35.9%	38.3%
Drug use (last 2 weeks)				
Prescribed	20.8%	39.4%	28.2%	54.9%
Non-prescribed	26.7%	23.7%	38.3%	32.5%
Subjective perception of health				
Good–very good	94.8%	79.6%	87.9%	74.9%
Fair–very bad	5.2%	20.4%	12.1%	25.1%
Evolution of health				
Better–a lot better	27.7%	11.7%	29.8%	14.2%
About the same	57.1%	67.3%	65.4%	70.5%
Worse–a lot worse	12.6%	11.0%	4.8%	14.6%

BMI values increased with age, except for the upper age group (75 years and above) where BMI values decreased. This was true for both men and women. Some age groups were excluded from statistical analysis because of the small number of vegetarian subjects. The excluded groups were for the men: 20–24 years ($n = 5$), 65–74 years ($n = 8$), 75 years and above ($n = 5$); and for the women: 65–74 years ($n = 4$), 75 years and above ($n = 1$). For the remaining groups, the BMI value of the male vegetarian subjects aged between 55–64 years was significantly lower than the BMI value of the reference subjects of the same age ($p = 0.038$) (figure 1a). The BMI values of the

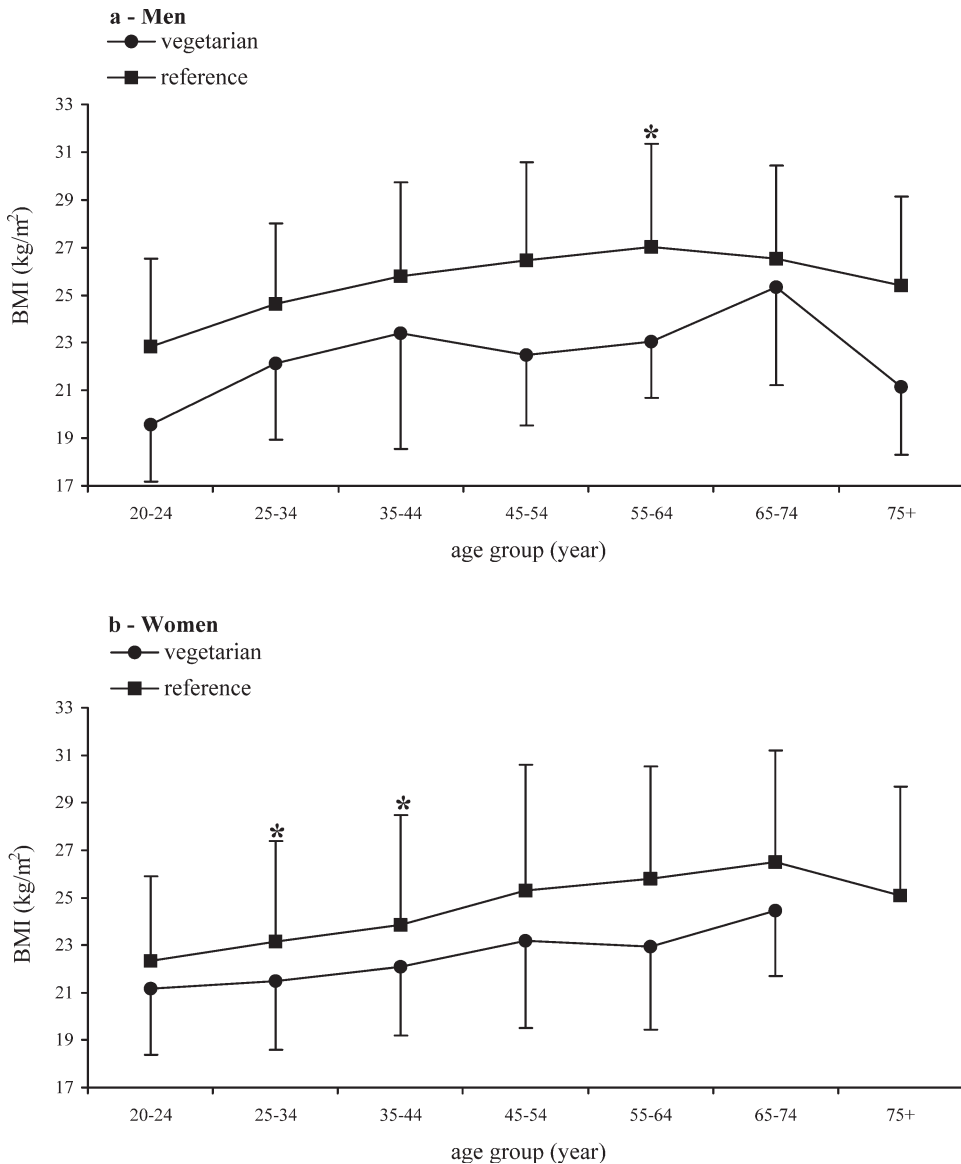


Figure 1. Mean BMI (kg/m²) by gender for the vegetarian group and the reference population. Values were significantly different: * $p < 0.05$.

vegetarian women aged between 25–34 years and 35–44 years were significantly lower compared with the BMI values of the women of the same age groups from the reference group ($p = 0.001$ and $p = 0.003$ respectively) (figure 1b).

3.2. Smoking

Results showed that fewer vegetarians smoked compared with the subjects of the reference population (13.5% compared with 28.5%; $p < 0.001$) (table 1). Among the vegetarians, the number of male smokers was comparable to the number of female smokers (15.8% compared with 12.1% respectively; $p = 0.332$), whilst in the reference group more men smoked compared with women (33.7% compared with 23.6%; $p < 0.001$). In some age groups, the number of vegetarian subjects was very small; hence, it was decided not to subject these age groups to statistical comparison with the matching age groups of the reference population. Because of the small number of subjects, percentages of smokers could be somewhat misleading. For the sake of completeness, the results of these age groups are mentioned (men: 20–34 years: $n = 5$, one smoker: 20.0%; 65–74 years: $n = 8$, one smoker: 12.5%; 75 years and above: $n = 5$, one smoker: 20.0%; women: 65–74 years: $n = 4$, one smoker: 25.0%; 75 years and above: $n = 2$, no smokers, 0.0%). In the remaining age groups, for both men (figure 2a) and women (figure 2b), fewer vegetarian subjects smoked compared with the reference group, reaching significance for the following age groups: men: 25–34 years ($p = 0.002$), 35–44 years ($p = 0.008$), 45–54 years ($p = 0.015$); women: 20–24 years ($p = 0.010$), 25–34 years ($p = 0.012$), 35–44 years ($p < 0.001$), 45–54 years ($p = 0.044$).

3.3. Alcohol consumption

In Belgium, 35.8% of the subjects of the reference group reported consuming alcohol during the week (Monday–Thursday) (table 1). The percentage of vegetarians drinking alcohol during the week was comparable (32.8; $p = 0.159$). During the weekend (Friday–Sunday) more of the Belgian population seemed to consume alcohol than the vegetarian population (70.2% compared with 58.6% respectively; $p = 0.026$). No differences were found when comparing male and female vegetarians concerning alcohol consumption during the week (33.3% and 32.5% respectively; $p = 0.864$). This was not the case for the reference group, where more male subjects drank during the week than female subjects (41.9% and 28.9% respectively; $p < 0.001$). During the weekend, fewer Belgian women consumed alcohol than the men (64.1% and 75.4% respectively; $p < 0.001$), whereas no difference between the vegetarian men and women was noticed (58.3% men vs. 58.7% women; $p = 0.967$). No difference was found between the alcohol consumption throughout the entire week (Monday–Sunday) of the Belgian population and the vegetarian subjects when compared by age group, except for the female age group 25–34 years, where significantly more vegetarian women consumed alcoholic beverages (28.2% vegetarian subjects compared with 14.4% reference subjects; $p = 0.028$). Among the men, in the upper age group (75 years and above), significantly fewer vegetarian subjects drank compared with the Belgian men in the same age group (20.0% and 39.1% respectively; $p = 0.018$). Once again, in this latter case results must be interpreted with care because of the small number of vegetarian subjects ($n = 5$), and the lack of information about the amount of alcoholic beverages consumed.

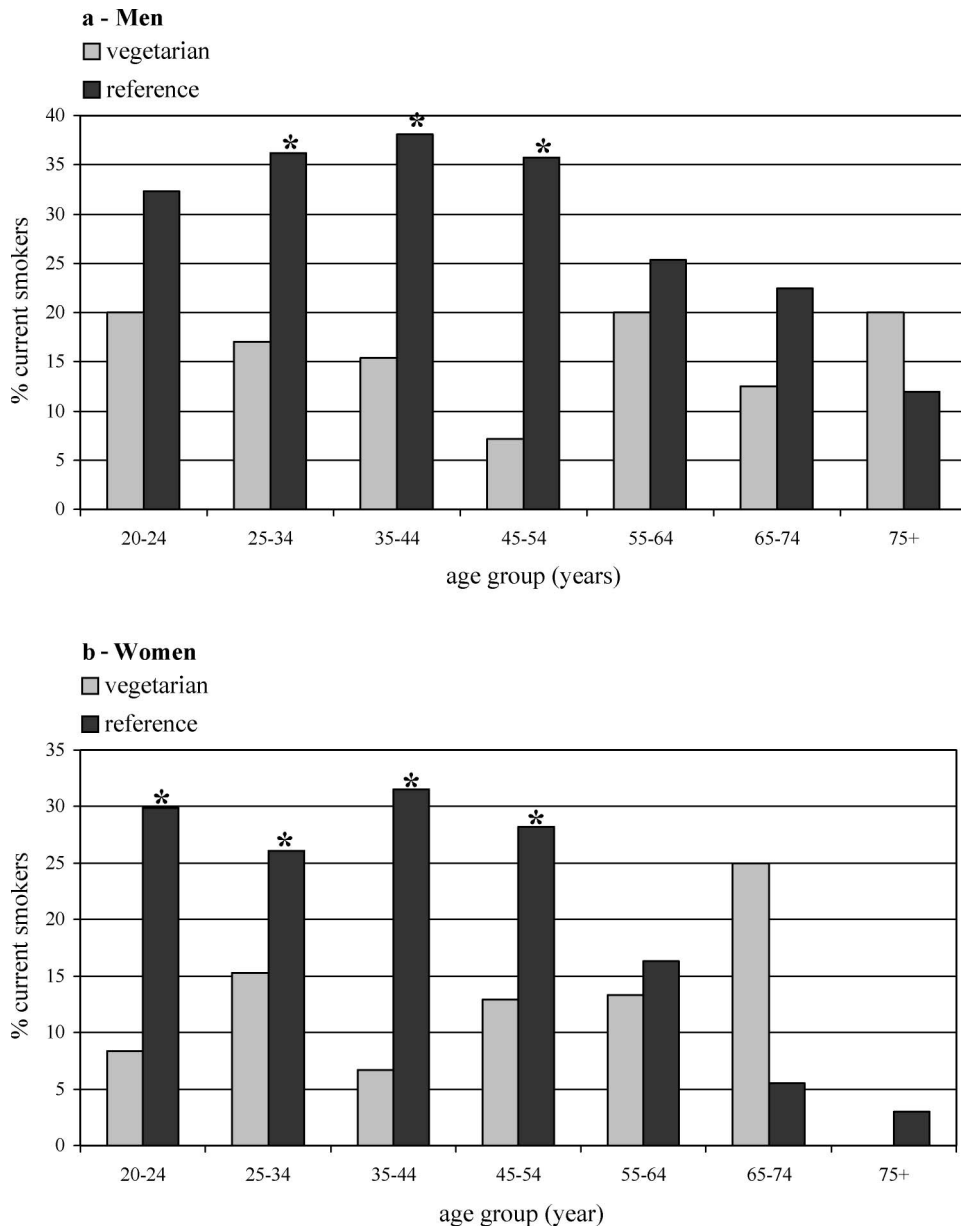


Figure 2. Number of current smokers among vegetarian group and reference population by gender. Values were significantly different: * $p < 0.05$.

3.4. Physical activity

The number of subjects not involved in any physical activity as leisure was comparable between the reference group and the vegetarian group (34.9% vegetarians compared with 31.8% of the reference group; $p = 0.625$) (table 1). The percentage of vegetarians participating in physical activities up to 4 h a week was smaller compared with the Belgian population (28.2 and 51.0 respectively; $p < 0.001$). In contrast, the involvement

in physical activity for more than 4 h per week was remarkably higher among vegetarians than among the subjects of the reference group (36.8% compared with 17.3% respectively; $p < 0.001$). Both for men and women, when comparing vegetarian with reference subjects within age groups, differences were not significant, except for the women between the ages of 35 and 44 years ($p = 0.023$). Within this age group, there were a lot more vegetarian women involved in sporting activities over 4 h per week compared with the Belgian women of this age (35.6% compared with 9.9% respectively). Of the vegetarian females aged 35–44 years, 37.8% were involved in physical activities less than 4 h per week, whilst 26.7% did no physical activity, compared with 50.4% and 34.0% for the reference female subjects in this age group respectively.

3.5. Medication use

3.5.1. Prescribed drugs. In the reference group, almost half of the subjects (47.3%) declared using a prescribed drug in the last 2 weeks, whilst this was the case for only a quarter (25.5%; $p < 0.001$) of the vegetarian subjects (table 1). For both men and women, in most age groups, significantly fewer vegetarian subjects took prescribed drugs compared with the Belgian subjects of the same age group (men: 25–34 years ($p = 0.032$), 45–54 years ($p = 0.002$), 55–64 years ($p = 0.005$), 75 years and above ($p = 0.001$); women: 20–24 years ($p = 0.040$), 25–34 years ($p = 0.005$), 35–44 years ($p = 0.002$), 45–54 years ($p = 0.002$), 55–64 years ($p < 0.001$)). Once again, because of the low number of male subjects in the upper age group ($n = 5$), interpretation should be done cautiously. More female subjects in the reference group used drugs than the male subjects (54.9% and 39.4% respectively; $p < 0.001$). This was not the case in the vegetarian group (28.2% and 20.8% of the women and men respectively; $p = 0.183$). Whilst drug use increased with age in the reference population, this was not noticeable among the vegetarian subjects.

3.5.2. Non-prescribed drugs. The use of non-prescribed drugs (homeopathic medication, vitamin and mineral supplements, non-steroidal anti-inflammatories) was comparable between the vegetarian group and the reference population (34.1% compared with 28.2% respectively; $p = 0.580$) (table 1). Among the vegetarians, female subjects took more non-prescribed drugs compared with the male subjects (38.3% vs. 26.7% respectively; $p = 0.044$). This was also the case among the reference subjects (32.5% women compared with 23.7% men; $p < 0.001$). After statistical analysis none of the differences between the age groups of the vegetarian group and the matching age groups of the reference population was significant. Comparison of percentages of men and women indicated that the women used more non-prescribed drugs than the men, both in the vegetarian as in the reference group.

3.6. Subjective health perception

Approximately four times more people of Belgium described their health to be 'good' to 'very good' (77.2%), while the rest (22.8%) did not find their health very satisfying ('reasonable', 'bad', 'very bad') (table 1). Significantly more vegetarians (90.4%; $p < 0.001$) described their health 'good' to 'very good', whilst only 9.6% found it 'reasonable', 'bad' or 'very bad'. In both the vegetarian group and the reference population, more men seemed satisfied about their health compared with the women. Of the vegetarian men 94.8% compared with 87.9% of the vegetarian women ($p = 0.018$).

answered 'good' or 'very good', while 79.6% of the male compared with 74.9% of the female reference subjects ($p < 0.001$) found their health to be 'good' to 'very good'. When comparing age groups, a significantly higher number of vegetarian men in the age group 55–64 years ($n = 15$; $p = 0.010$) answered 'good' or 'very good'. The difference was also significant in the two following age groups (65–74 years and 75 years and above), but because of the low number of subjects in those groups ($n = 8$ and $n = 4$ respectively), no definite pronouncement about those findings can be made. Among the vegetarian women, a significantly higher number found their health to be 'good' or 'very good' in the age groups 20–24 years ($n = 22$; $p < 0.001$), 25–34 years ($n = 83$; $p < 0.001$), 35–44 years ($n = 45$; $p < 0.001$) and 45–54 years ($n = 30$; $p = 0.001$).

When asked about how their health evolved over the last 12 months, 13.0% of the reference population answered their health to be 'somewhat to a lot better' compared with 1 year ago, whereas more than double the percentage of vegetarian subjects (29.3; $p < 0.001$) did so. Of the reference group, 74.3% of the subjects found their health to be 'about the same' compared with 62.8% ($p = 0.004$) of the vegetarian subjects. Respectively 12.8% and 7.9% ($p = 0.008$) found their health to be 'somewhat to a lot worse' when compared with 1 year ago. When comparing matching age groups, differences between the vegetarian group and the reference population were significant for the men in age group 45–54 years ($p = 0.011$) and for the women in age groups 20–24 years ($p = 0.002$), 35–44 years ($p = 0.000$) 45–54 years ($p = 0.004$) and 55–64 years ($p = 0.010$).

4. Discussion

As in most studies on vegetarians, it was not possible to work with subjects from a random sample, since no register of vegetarians exists. Recruited vegetarian volunteers were used in this study. Hence, conclusions about health practices of vegetarians should be handled cautiously, due to a possible 'healthy volunteer effect'. Vegetarians are often also more health conscious compared with the general population and hence motivated to participate in health-related research projects concerning their chosen diet.

Although the term vegetarianism is well defined in literature (American Dietetic Association 2003), society is not fully familiarized with these definitions. Among the volunteers of this study 13.1% called themselves vegetarians, while in fact they ate fish.

Values of the mean BMI in this analysis were lower than the mean of $25.7 \pm 4.8 \text{ kg/m}^2$ for men and $24.6 \pm 4.8 \text{ kg/m}^2$ for women in a representative sample of the Belgian population. Although underestimation of the BMI is possible, because of the tendency to overestimate body height and underestimate body weight when self-administered (Appleby *et al.* 1998), it is not likely that this can account for a large difference in BMI values. Furthermore, since height and weight data from the reference population were also self-reported, a possible error may have occurred in both groups. The low BMI value found in the vegetarian group was not surprising as this is in full agreement with the literature (Appleby *et al.* 1998, Sabaté and Blix 2001, Fraser 2003). A high BMI is considered a risk factor for mortality and numerous conditions including diabetes and heart disease (Spencer *et al.* 2003), whilst values at the lower side of the BMI scale are generally related with a good health status (Troiano *et al.* 1996).

The prevalence of smoking was less than half among the vegetarian subjects compared with the reference population. Furthermore, this difference was significant for the men between the ages of 20–24, 25–34 and 35–44 years, whilst a significant lower amount of female smokers occurred in the age groups 20–24, 25–34, 35–44 and 45–54 years.

Other studies on vegetarians have also found lower smoking rates among vegetarians compared with the general population as well as to comparable non-vegetarians (Key *et al.* 1998, Davey *et al.* 2002). Smoking is considered one of the major causes of coronary heart diseases (Key and Appleby 2001).

Alcohol consumption was comparable for the vegetarian subjects and the reference group, with only less vegetarians consuming alcohol during the weekend. Yet, other studies reported a relatively low alcohol use among Western vegetarians (Appleby *et al.* 1998, Clarys *et al.* 2004). Recently, some analyses suggest that moderate intake of alcohol has a protective effect against coronary heart disease, yet there is no evidence that alcohol intake actually decreases the risk of coronary heart disease among vegetarians (Key and Appleby 2001). Willett (2002) also suggested that a daily moderate intake of alcohol could have a positive effect on coronary heart disease.

No more vegetarians in this analysis were involved in moderate physical activity (less than 4 h per week) compared with the reference population and about one-third of both groups was not involved in any sports whatsoever. In contrast, a higher percentage of vegetarian subjects were involved in physical activity for over 4 h per week compared with the reference group. Other authors also found a higher percentage of high exercisers among the vegetarian subjects compared with the general population (Key *et al.* 1998). Low physical activity in vegetarians was associated with an increase in the risk of dying from cardiovascular diseases (Chang-Claude and Frentzel-Beyme 1993).

Both the fact that the vegetarian group consumed significantly less alcohol (during the weekend) and was significantly more involved in (intensive) physical activity could be attributed to the fact that the reasons for following a vegetarian diet among the volunteers in this study were health-oriented. A vegetarian diet is not *per se* a healthy diet. This may be more the case in people choosing a vegetarian diet for ethical reasons (Clarys *et al.* 2004).

In most age groups, significantly fewer male and female vegetarians took prescribed medication compared with the reference subjects. The number of vegetarian and reference subjects taking non-prescribed drugs was comparable. This may be attributed to the fact that vegetarians are more likely to choose alternative medicine such as homeopathy, although no literature on this subject was found. Further research will also evaluate morbidity and co-morbidity in the vegetarian group, because a possible lower occurrence of illness may also be the basis of a reduced intake of prescribed medication.

Most of the vegetarian subjects in the current study were satisfied with their health and one-third of the group claimed their health to have improved over the last year. The latter was not the case in the reference group, where only 13% reported an improvement over the same time period.

Vegetarians generally enjoy better health, exemplified by low rates of obesity (Key and Davey 1996, Appleby *et al.* 1998, Singh and Lindsted 1998), coronary heart disease (Snowdon *et al.* 1984, Thorogood *et al.* 1994, Fraser *et al.* 1995), diabetes (Snowdon and Phillips 1985) and some cancers (Thorogood *et al.* 1994). This may be due to the absence of meat and a greater amount and variety of plant foods in the vegetarian diet (Willett 1999). Beneficial non-dietary lifestyle factors, such as absence of smoking, of heavy drinking and participation in physical activities, generally more prevalent among vegetarians, explain only part of the health benefits of vegetarians (Phillips *et al.* 1980, Mills *et al.* 1994, Key *et al.* 1996). However, in the present study, significantly more female vegetarians aged between 25–34 years consumed alcoholic beverages compared with the reference subjects of the same age group.

The lower BMI values in the vegetarian population studied may be a result of a healthier diet. Vegetarian diets are known to be high in fibre content and low in animal fat (Messina and Messina 1996). Appleby *et al.* (1998) found a significantly inverse association between dietary fibre and BMI, and a significant positive association between animal fat intake and BMI. Further research on the test group in the present study, including food questionnaire analysis, is required in order to corroborate these findings.

Acknowledgements

The authors wish to thank all the volunteers for their willingness to complete the questionnaire. They also wish to acknowledge the organizations EVA, GAIA & NVB for their support, and the Unit of Epidemiology of the Scientific Institute of Public Health, Brussels, Belgium, for providing the data of the reference population.

References

- AMERICAN DIETETIC ASSOCIATION, 2003, Position of the American Dietetic Association and Dietitians of Canada: vegetarian diets. *Journal of the American Dietetic Association*, **103**, 748–765.
- APPLEBY, P.N., THOROGOOD, M., MANN, J.I. and KEY, T.J., 1998, Low body mass index in non-meat eaters: the possible roles of animal fat, dietary fibre and alcohol. *International Journal of Obesity*, **22**, 454–460.
- BAECKE, J.A., BUREMA, H.J. and FRITERS, J.E.R., 1982, A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *American Journal of Clinical Nutrition*, **36**, 936–942.
- CHANG-CLAUDE, J. and FRENTZEL-BEYME, R., 1993, Dietary and lifestyle determinants of mortality among German vegetarians. *International Journal of Epidemiology*, **22**, 228–236.
- CLARYS, P., DERIEMAER, P., HEBBELINCK, M., BOSMANS, D. and BERTIER, B., 2004, Physical fitness and health related parameters in Flemish life-long vegetarians: a pilot study. *Nutrition and Food Science*, **34**, 29–42.
- DAVEY, G., ALLEN, N., SPENCER, E., VERKASALO, P., KNOX, K., POSTANS, J., TIPPER, S., HOBSON, C. and KEY, T., 2002, Dietary and lifestyle characteristics of meat-eaters, fish-eaters, vegetarians and vegans. *IARC Scientific Publications*, **156**, 113–114.
- DEMAREST, S., VAN DER HEYDEN, J., GISLE, L., BUZIARISIT, J., MIERMANS, P.J., SARTOR, F., VAN OYEN, H. and TAFFOREAU, J., 2002, *Health Survey by Means of Interview, Belgium, 2001*. IPH/EPI Reports no. 2002–25. (Brussels: Epidemiology Unit, Scientific Institute of Public Health).
- FRASER, G.E., 1999, Associations between diet and cancer, ischaemic heart disease, and all-cause mortality in non-Hispanic white California Seventh-day Adventists. *American Journal of Clinical Nutrition*, **70**, 532S–538S.
- FRASER, G.E., 2003, *Diet, Life Expectancy and Chronic Disease* (Oxford: Oxford University Press).
- FRASER, G.E., LINDSTED, K.D. and BEESON, W.L., 1995, Effect of risk factor values on lifetime risk of and age at first coronary event. The Adventist Health Study. *American Journal of Epidemiology*, **142**, 746–758.
- KEY, T.J. and APPLEBY, P.N., 2001, Vegetarianism, coronary risk factors and coronary heart disease. In *Vegetarian Nutrition*, J. Sabate (Ed.), 33–54 (Boca Raton, CRC Press).
- KEY, T.J. and DAVEY, G., 1996, Prevalence of obesity is low in people who do not eat meat. *British Medical Journal*, **313**, 816–817.
- KEY, T.J., DAVEY, G.K. and APPLEBY, P.N., 1999, Health benefits of a vegetarian diet. *Proceedings of the Nutrition Society*, **58**, 271–275.
- KEY, T.J., FRASER, G.E., THOROGOOD, M., APPLEBY, P.N., BERAL, V., REEVES, G., BURR, M.L., CHANG-CLAUDE, J., FRENTZEL-BEYME, R., KUZMA, J.W., MANN, J. and McPHERSON, K., 1998, Mortality in vegetarians and non-vegetarians: a collaborative analysis of 8300 deaths among 76000 men and women in five prospective studies. *Public Health Nutrition*, **1**, 33–41.
- KEY, T.J., THOROGOOD, M., APPLEBY, P.N. and BURR, M.L., 1996, Dietary habits and mortality in 11,000 vegetarians and health conscious people: results of a 17-year follow-up. *British Medical Journal*, **13**, 775–779.
- MALINA, R.M., 1996, Tracking of physical activity and physical fitness across the lifespan. *Research Quarterly for Exercise and Sport*, **67**, S48–S57.
- MESSINA, M. and MESSINA, V., 1996, *The Dietician's Guide to Vegetarian Diets* (Gaithersburg, MD: Aspen Publishers, Inc.).

- MILLS, P.K., BEESON, W.L., PHILLIPS, R.L. and FRASER, G.E., 1994, Cancer incidence among California Seventh-day Adventists, 1976–1982. *American Journal of Clinical Nutrition*, **59**, 1136S–1142S.
- PHILLIPS, R.L., GARFINKEL, L., KUZMA, J.W., BEESON, W.L., LOTZ, T. and BRIN, B., 1980, Mortality among California Seventh-day Adventists for selected cancer sites. *Journal of the National Cancer Institute*, **65**, 1097–1107.
- RAJARAM, S. and SABATÉ, J., 2000, Health benefits of a vegetarian diet. *Nutrition*, **16**, 531–533.
- SABATÉ, J. and BLIX, G., 2001, Vegetarian diets and obesity prevention. In *Vegetarian Nutrition*, J. Sabaté (Ed.), 91–107 (Boca Raton, FL: CRC Press).
- SABATÉ, J., RATZIN-TURNER, R.A. and BROWN, J.E., 2001, Vegetarian diets: descriptions and trends. In *Vegetarian Nutrition*, J. Sabaté (Ed.), 3–17 (Boca Raton, FL: CRC Press).
- SINGH, P.N. and LINDSTED, K.D., 1998, Body mass and 26-year risk of mortality from specific diseases among women who never smoked. *Epidemiology*, **9**, 246–254.
- SNOWDON, D.A. and PHILLIPS, R.L., 1985, Does a vegetarian diet reduce the occurrence of diabetes? *American Journal of Public Health*, **75**, 507–512.
- SNOWDON, D.A., PHILLIPS, R.L. and FRASER, G.E., 1984, Meat consumption and fatal ischemic heart disease. *Preventive Medicine*, **13**, 490–500.
- SPENCER, E.A., APPLEBY, P.N., DAVEY, G.K. and KEY, T.J., 2003, Diet and body mass index in 38000 EPIC-Oxford meat-eaters, fish-eaters, vegetarians and vegans. *International Journal of Obesity*, **27**, 728–734.
- THOROGOOD, M., MANN, J., APPLEBY, P. and MCPHERSON, K., 1994, Risk of death from cancer and ischemic heart disease in meat and non-meat eaters. *British Journal of Medicine*, **308**, 1667–1670.
- TROIANO, R.P., FRONGILLO, E.A., SOBAL, J. and LEVITSKY, D.A., 1996, The relationship between body weight and mortality: a quantitative analysis of combined information from existing studies. *International Journal of Obesity and Related Metabolic Disorders*, **20**, 63–75.
- WHITTEN, C., 2001, Developing a vegetarian food guide. In *Vegetarian Nutrition*, J. Sabaté (Ed.), 411–437 (Boca Raton, FL: CRC Press).
- WILLETT, W.C., 1999, Convergence of philosophy and science: the Third International Congress on Vegetarian Nutrition. *American Journal of Clinical Nutrition*, **70**, 434S–438S.
- WILLETT, W.C., 2002, *Eat, Drink and Be Healthy: the Harvard Medical School Guide to Healthy Eating* (London: Simon & Schuster Books).