



# Food cost and adherence to guidelines for healthy diets: evidence from Belgium

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## Abstract

**Background/Objectives** Evidence on whether healthy diets are more expensive than less healthy diets is mixed. The relative cost of meeting healthy diet guidelines in Belgium was estimated.

**Subjects/Methods** Data from the nationally representative food consumption survey (FCS) 2014–2015 ( $n = 3146$ ; 3–64 years) were used. Dietary data were collected through two non-consecutive 24-h recalls (records for children). Average prices for >2000 foods were retrieved from the 2014 GfK ConsumerScan panel and linked with foods consumed in the FCS. Daily costs of meeting nutritional guidelines were estimated across age and household education level groups.

**Results** Processed meat contributed most (9.8%–14.4% dependent on age group) to the daily cost of diets. Soft drinks contributed to the daily cost more while fruits and vegetables contributed less for lower versus higher educated households. Compared to individuals not meeting any nutrient recommendations (sodium, saturated fat, free sugar, fibre), the average cost/2000 kcal was significantly higher for individuals meeting one ( $0.36 \pm 0.11\text{€}$ ,  $p = 0.001$ ), two ( $0.87 \pm 0.14\text{€}$ ,  $p < 0.001$ ) or three or more ( $1.44 \pm 0.24\text{€}$ ,  $p < 0.001$ ) recommendations. Similarly, compared to individuals not meeting any of the food-based recommendations (fruit, vegetables, wholegrain, nuts and seeds, red meat, processed meat), the average cost/2000 kcal was significantly higher for individuals meeting three or more ( $1.04 \pm 0.27\text{€}$ ;  $p < 0.001$ ) recommendations. For adults, diets meeting guidelines for vegetables were 20% and for fruits 10% more expensive than diets not meeting those guidelines.

**Conclusions** The cost of diets of Belgian people meeting healthy diet guidelines is greater than of those not meeting guidelines. Policies that make healthy diets more affordable are recommended.

## Introduction

Globally, non-communicable diseases (NCDs) related to diet and nutrition are on the rise. In 2016, it was estimated that 71% of global deaths were caused by NCDs, of which 32.2 million (80%) deaths were due to cancers, cardiovascular diseases, chronic respiratory diseases and diabetes [1]. In Europe, in 2016, 59% of the adult population was found

to be overweight [2]. Although countries in Europe are diverse in terms of food culture and traditions, most challenges related to unhealthy diets are common. Diets in Europe are mainly characterized by excessive intakes of sugar and salt, attributed to the consumption of energy-dense and nutrient-poor foods and sugar-sweetened beverages (SSBs) [3], as well as insufficient consumption of vegetables, fruits and whole grains [4].

A recent study on policies for better nutrition in the European region conducted by the Regional World Health Organization (WHO) Office for Europe showed that while significant progress has been made by EU member states in some areas of public health nutrition, such as for school nutrition policies, product reformulation and implementation of trans fat regulations, more ambitious policies are needed to achieve global targets for the reduction of NCDs [5]. For example, to address the burden of unhealthy diets and improve the relative affordability of healthy foods, the WHO has called on member states to introduce health-related food taxes and subsidies [6]. To inform and evaluate

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these policies, knowing the cost of healthy/healthier and unhealthy/less healthy foods is essential [7]. Some countries have recently implemented health-related taxes or subsidies in an effort to improve population diets [8]. Taxes on SSBs are increasingly common internationally [9], and have actually shown to significantly reduce SSB purchases, especially among lower socio-economic population groups [10, 11]. Subsidies have been much less frequently implemented internationally. Australia has an exemption from the goods and services tax (GST) for fresh foods, such as fruits and vegetables, and it has been calculated that adding GST to fruits and vegetables could cost about 100,000 healthy life-years over the lifetime of the 2003 Australian adult population, due to an additional 90,000 cases of ischaemic heart disease, stroke and cancer [12].

When people purchase foods, a large set of determinants may affect their food choices: advertising, packaging and labelling; physical accessibility in stores and other settings; perception of health; individual taste; convenience or cultural norms. Among them, the cost of food is an important determinant, especially for those on the lowest incomes [13]. When the household budget is limited, fixed costs are prioritized so the money allocated for food may be reduced, which often results in food insecurity with potential health consequences [14, 15].

Socio-economic characteristics such as education, occupation and income (the most studied) have been revealed as sources of disparities in diet quality in Western countries [16, 17].

A systematic review by Rao et al. [18] concluded that healthier diets generally cost more than less healthy diets, though this depended on whether the daily cost of the total diet or the cost per 2000 kcal was used. This finding can be explained by the relatively lower cost of energy-dense foods while nutrient-dense foods are more expensive comparatively [19]. To date, studies have employed various methodologies to estimate the costs of healthier and less healthy diets, which makes it difficult to make comparisons between findings in various contexts [20]. Beyond the general conclusion that there is a correlation between diet cost and quality, estimations on the money amount necessary to reach guidelines have been shown to vary across studies. Contexts in which such estimations have been made may account for such differences.

In Belgium, dietary risks are ranked as the top third risk factor following tobacco and high fasting plasma glucose [21]. Based on the results from the nationally representative 2014–2015 food consumption survey (FCS), Belgians tended to fall short of most dietary recommendations. For example, less than 10% of Belgians meet minimum recommendations for fruit and vegetable intake [22, 23]. Belgians also get on average 30% of their energy intake from ultra-processed food products, and this percentage is

significantly higher among children than adolescents and adults [24]. Therefore, dietary behaviours in Belgium are likely to substantially contribute to the cost of health spending for both the public sector and the individual, like in other Western countries.

Up to now, research on the cost of healthy versus less healthy diets has been carried out in countries like the USA [25], the UK [26], New Zealand [27] and France [28]. A recent global analysis found that healthy diets meeting food-based dietary guidelines were unaffordable for more than 3 billion people in the world in 2017. Assuming that no more than 63% of their income can be spent on food, the percentage of the population in Western Europe whose household income was found below the cost of the most affordable locally available items to meet each standard of diet quality was 0.2% [29]. However, no recent European studies on the cost of healthy versus less healthy diets using representative nutrition survey data including different age groups have been conducted. The aim of this study was to assess the relative monetary cost of meeting nutritional guidelines for healthy diets for different age groups in Belgium, using dietary data from the most recent Belgian FCS.

## Materials and methods

### Food consumption survey

The Belgian 2014/2015 FCS was organized in line with the recommendations from the European Food Safety Authority [30]. The survey was accepted by the Human Ethics Committee of the University of Ghent and the Commission for the Protection of Privacy. Participants provided written informed consent. The survey design and methods have been published previously [23, 24, 31]. Briefly, a representative sample of the Belgian population ( $n = 3146$ ; residents 3–64 years) was randomly selected from the National Population Register using multistage stratified sampling. The sample comprised 992 children (3–9 years), 928 adolescents (10–17 years) and 1226 adults (18–64 years). Food intake in adolescents and adults (10–64 years) was assessed through two non-consecutive 24-h food recalls. GloboDiet<sup>®</sup> (formerly EPIC-SOFT), a computerised program designed for the standardized collection of 24-h dietary recall data within a pan-European survey, was used and adapted to the Belgian context [32]. GloboDiet<sup>®</sup> involves a structured methodology to collect detailed information and quantities of consumed foods, recipes and dietary supplements. Food portion sizes were quantified using household measures (e.g. glasses, cups, spoons, etc.), food portions (obtained from food industry) and a photo book including a selection of Belgian specific meals in

different portion sizes. Dietary assessment in children (3–9 years old) was performed using two self-administered non-consecutive 1-day open-ended food diaries followed by a GloboDiet<sup>®</sup> completion interview with the proxy respondent (parent or legal guardian). The collected food consumption data was thereafter linked with detailed information on the nutrient composition of each specific food item, using the NUBEL Belgian Food Composition Database and the Food Composition database from the Netherlands (NEVO) [23, 24, 31].

### Covariates

Height was measured to 0.5 cm using a stadiometer (type SECA 213) and weight to 0.1 kg using an electronic scale (type SECA 815 and 804) during the second home visit, and body mass index (BMI) was calculated. To identify overweight and obese children and adolescents, the thresholds recommended by the International Obesity Task Force, now the World Obesity Federation, were used [33]. Data on sex, region and household educational level (higher education long type = university (qualified as “high”), higher education short type = post-secondary non-university (“medium”), secondary education or lower (“low”)) were retrieved from a computer-assisted personal interview conducted during the first home visit. In children (3–9 years) a parent or legal guardian was used as a proxy respondent [24].

### GfK Consumer Panel

Average prices for >2000 different foods consumed in the FCS, including fresh foods (year 2014), were retrieved from GfK ConsumerScan panel data [34]. This panel includes a sample ( $n = 5000$ ) of private Belgian households, stratified based on the age of the reference person of the household and household size. The participants register household purchasing behaviour (and related shop-visiting behaviour) with respect to a broadly defined group of products regardless of the place of purchase. An electronic measuring instrument with an integrated scanner for barcode scanning, is used for purchase registration. The purchase and visit data recorded by the participants are sent to the GfK Research Centre via the GSM network.

A template was drafted based on the GloboDiet<sup>®</sup> food classification used in the FCS that took into account different food characteristics (i.e. fresh/frozen/canned, full/semi-skimmed/skimmed, dried/liquid, full sugar/light/no sugar). Average prices were linked to the foods and ingredients consumed in the FCS, after taking into account factors for edible parts and yield. The GfK ConsumerScan panel data provided the prices for 70% of the foods included in the FCS. For 15% of missing prices, we used the price of

the most similar food (in terms of nutritional composition) within the same food group (e.g. price of white beans was assigned to red beans). For the remaining 15%, a conversion was needed. For example, the price of eggs was given by piece, so a conversion was made to obtain the price per kilogram. For out-of-home meals, the costs of their ingredients were taken into account for the purposes of this study as no prices were available for those meals from GfK.

### Dietary guidelines

The specific food-based (fruit, vegetables, wholegrain, nuts and seeds, processed meat and red meat) and nutrient-based (sodium, saturated fat, free sugar, fibre) recommendations, as derived from the Superior Health Council in Belgium (HGR-CSS), that were used in this study, as well as the definitions of the food groups can be found in Annex Table 1. Most are consistent with the WHO recommendations when they exist at the international level [35]. While the nutrient recommendations (sodium, free sugar, saturated fat, fibre) are available for adults and children, the food-based dietary guidelines [36] have been developed mainly for healthy adults and include a focus on five key messages:

- (1) Eat a minimum of 125 g of wholegrain products daily.
- (2) Eat 250 g of fruit daily.
- (3) Eat 300 g of vegetables (fresh or prepared) daily.
- (4) Eat legumes at least once a week. Eat 15–25 g of nuts or seeds daily without salty or sweet shells.
- (5) Limit the intake of sodium to maximum 2000 mg/day.

### Data analysis

Analyses were conducted in SAS 9.3. All analyses took the FCS survey design and weights into account. The average (over 2 interview/record days) total daily cost (€/day) as well as the average cost per 2000 kcal (€/2000 kcal) was calculated for different age, sex and household education level groups. Contributions of food groups to the total daily cost were calculated using data from the first interview (or record) day of the FCS. Alcohol was included in the cost and food group contribution estimations.

The percentage of Belgians within different sex and age groups that met the nutrient and food-based recommendations, based on average intakes over 2 interview/record days, was calculated using the FCS 2014/15. The cost differential between meeting versus not meeting the guidelines was assessed using linear regressions adjusting for age group, sex, household education level, region and BMI category (and total energy intake when total daily cost was used instead of the cost per 2000 kcal). The cost differential was assessed for each nutrient- and food-based

recommendation separately, as well as for the combination of nutrient recommendations (number of recommendations met out of a total of 4 taking into account sodium, saturated fat, free sugar and fibre) and the combination of food-based recommendations (number of recommendations met out of a total of 6 taking into account fruits, vegetables, nuts and seeds, wholegrain, red meat and processed meat). A  $p$  value of  $<0.05$  was considered statistically significant for all analyses conducted.

To verify whether or not individuals meeting guidelines bought not just larger quantities of certain foods to meet the guidelines, but also bought more expensive varieties of those foods and/or chose more expensive items in other food categories, we compared differences in the average price of food items consumed within the groups of fruits, vegetables, red and processed meat and some other food groups (snacks, confectionery, cakes and sweet biscuits, cheeses, pasta and other grains) between individuals meeting and not meeting the guidelines for fruits, vegetables, red and processed meat.

## Results

The average costs of diets per day and per 2000 kcal are shown in Tables 1 and 2. For all age groups, the mean total cost per day was significantly higher for males than females, while the mean cost per 2000 kcal was significantly higher for females than males except for children and adolescents (Table 1). The mean cost per 2000 kcal significantly increased with the household education level and in all age groups except in young boys (Table 2).

**Table 1** Average total cost per day and average cost per 2000 kcal (including alcohol) for different age groups by sex in Belgium (Belgian national food consumption survey 2014/15).

Age group	Sex	Unit	Mean cost	SE	Range (max–min)
Children (3–9 years, $n = 992$ )	Males	€/day	4.24*	0.08	8.12
		€/2000 kcal	5.41	0.07	7.81
	Females	€/day	3.90	0.07	9.73
		€/2000 kcal	5.51	0.08	9.01
Adolescents (10–17 years, $n = 928$ )	Males	€/day	5.43*	0.10	13.63
		€/2000 kcal	5.35	0.06	6.94
	Females	€/day	4.57	0.08	13.03
		€/2000 kcal	5.53	0.07	14.49
Adults (18–64 years, $n = 1226$ )	Males	€/day	7.40*	0.14	21.16
		€/2000 kcal	6.58*	0.08	15.49
	Females	€/day	5.67	0.09	11.63
		€/2000 kcal	7.15	0.09	15.35

SE standard error.

\* $p < 0.05$  for comparing males and females.

The food groups which contributed most to the total daily cost of diets in Belgium are given in Figs. 1 and 2. Across sexes, age groups and household education level groups, processed meat products contributed most to the cost of the diet, ranging from 9.8% for adult females to 14.4% for adolescent males. In addition, meat and poultry were also among the top five contributors for adolescents and adults (7.2–8.6%). Fruits featured among the top five contributors for young boys (8.2%), young girls (9.1%) and women (6.6%), while vegetables only featured among the top five contributors for females (7.9% for adults, 6.3% for children and 5.5% for adolescents). Soft drinks and juices, as well as cakes, pies and biscuits featured as top contributors for all male age groups and for young girls and adolescents (6.8–10.5% for soft drinks and juices and 5.4–10.7% for cakes, pies and biscuits) (Fig. 1). The percentage contribution of soft drinks and juices to the daily cost of diets was higher while the percentage contribution of fruits and vegetables to the daily cost of diets was lower for individuals from lower household education level compared to those from higher household education level. Fruits did not feature among the top contributors for the population groups with the lowest household education level. For adolescents, soft drinks and juices and cakes, pies and biscuits were among the top three contributors, regardless of socio-economic status (Fig. 2). Alcohol contributed  $6.8 \pm 0.6\%$  on average for men and  $3.5 \pm 0.4\%$  on average for women to the cost of diets (data not shown).

The percentage of individuals within different population groups meeting the nutritional guidelines for healthy diets is given in Annex Table 1. The percentage of individuals meeting five or more out of the ten recommendations taken into account ranged between 2.7% in male adolescents and 9.5% in female adults. No individuals met all six food-based recommendations (Annex Table 1). Including all population, adjusted for age group, sex, household education level, region and BMI category, the average dietary cost per 2000 kcal was significantly higher when meeting versus not meeting the guidelines for fruit ( $0.65 \pm 0.16$  €/2000 kcal), vegetables ( $1.40 \pm 0.22$  €/2000 kcal), processed meat ( $0.66 \pm 0.17$  €/2000 kcal), sodium ( $0.25 \pm 0.10$  €/2000 kcal), free sugar ( $0.85 \pm 0.10$  €/2000 kcal) and saturated fat ( $0.81 \pm 0.14$  €/2000 kcal) (Table 3). In addition, the average dietary cost per 2000 kcal was significantly lower when meeting versus not meeting the guidelines for red meat ( $-0.34 \pm 0.12$  €/2000 kcal per day) and fibre ( $-0.34 \pm 0.13$  €/2000 kcal per day). There were no significant differences in the average dietary cost per 2000 kcal between meeting and not meeting the guidelines for wholegrain and nuts and seeds (Table 3).

Adjusted for covariates, including all population, and compared to individuals not meeting any of the nutrient recommendations (sodium, saturated fat, free sugar, fibre),

**Table 2** Average total cost per day and average cost per 2000 kcal (including alcohol) for different age groups and by household education level (EL) in Belgium (Belgian national food consumption survey 2014/15).

Sex	Age group	EL	n	Unit	Mean cost	SE	Range (max–min)
Males	Children (3–9 years; n = 509)	Low	180	€/day	4.09	0.16	7.58
				€/2000 kcal	5.31	0.14	6.04
		Medium	155	€/day	4.27	0.15	6.72
				€/2000 kcal	5.37	0.10	5.74
		High	162	€/day	4.34	0.12	7.22
				€/2000 kcal	5.50	0.12	5.69
	Adolescents* (10–17 years; n = 450)	Low	192	€/day	5.30	0.15	10.87
				€/2000 kcal	5.25	0.09	5.82
		Medium	114	€/day	5.43	0.22	11.93
				€/2000 kcal	5.31	0.09	4.89
		High	133	€/day	5.67	0.19	12.52
				€/2000 kcal	5.54	0.11	6.64
Adults* (18–64 years; n = 589)	Low	270	€/day	7.25	0.21	21.16	
			€/2000 kcal	6.35	0.12	15.21	
	Medium	167	€/day	7.60	0.26	16.81	
			€/2000 kcal	6.75	0.14	7.35	
	High	145	€/day	7.43	0.26	12.61	
			€/2000 kcal	6.75	0.18	9.86	
Females	Children** (3–9 years; n = 483)	Low	176	€/day	3.81	0.11	6.54
				€/2000 kcal	5.24	0.09	5.02
		Medium	146	€/day	3.96	0.12	5.03
				€/2000 kcal	5.66	0.20	8.20
		High	156	€/day	3.96	0.14	9.17
				€/2000 kcal	5.62	0.12	8.69
	Adolescents*** (10–17 years; n = 478)	Low	192	€/day	4.27	0.11	7.10
				€/2000 kcal	5.34	0.10	7.02
		Medium	132	€/day	4.77	0.16	7.81
				€/2000 kcal	5.52	0.11	6.61
		High	143	€/day	4.79	0.14	12.11
				€/2000 kcal	5.81	0.14	13.90
	Adults* (18–64 years; n = 637)	Low	280	€/day	5.25	0.13	9.68
				€/2000 kcal	6.95	0.14	13.59
		Medium	171	€/day	5.84	0.15	11.00
				€/2000 kcal	7.27	0.15	14.97
		High	177	€/day	6.17	0.17	10.33
				€/2000 kcal	7.32	0.19	13.31

EL education level, SE standard error.

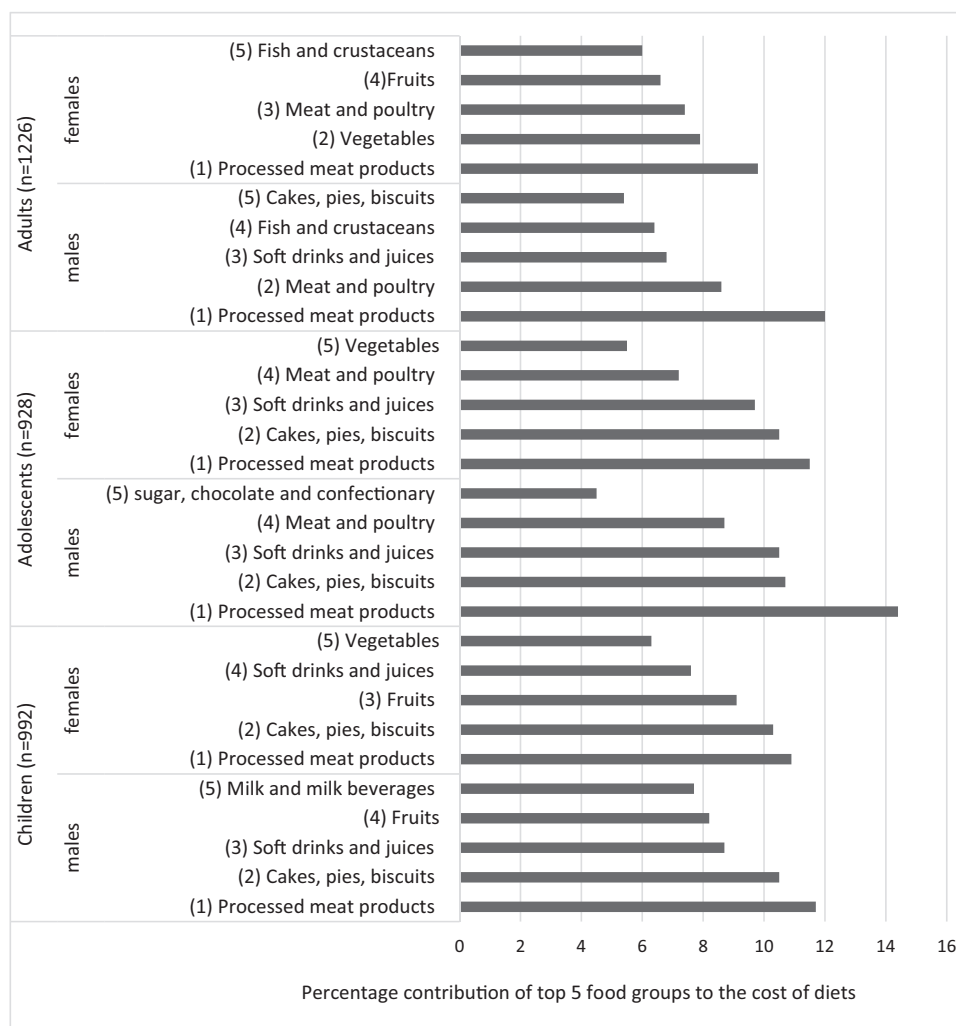
\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$  for comparing the education groups.

the average daily dietary cost per 2000 kcal was significantly more expensive for individuals meeting one ( $0.36 \pm 0.11$  €/2000 kcal per day), two ( $0.87 \pm 0.14$  €/2000 kcal per day) or three or more ( $1.44 \pm 0.25$  €/2000 kcal per day) of these nutrient-based recommendations. Similarly, adjusted for covariates, including all population, compared to individuals not meeting any of the food group recommendations (fruit, vegetables, wholegrain, nuts and seeds, red meat, processed meat), the average daily

dietary cost per 2000 kcal was significantly more expensive for individuals meeting three or more ( $1.04 \pm 0.27$  €/2000 kcal per day) of the food-based recommendations (Table 3).

There were no significant differences in the average price of food items consumed for different food groups between individuals meeting and not meeting the guidelines for fruits, vegetables, red and processed meat (Annex Table 2).

**Fig. 1** Top five contributions of different food groups to the costs of the diets (cost per day; using interview/record day 1) for different age groups by sex in Belgium (Belgian national food consumption survey 2014/15).



## Discussion

The cost of healthy diets is widely acknowledged as one of the key factors relating to the healthiness of population diets [37, 38] especially for those on lower incomes [39]. This study analyzed for the first time the relative cost of meeting nutritional guidelines for healthy diets for different age groups in Belgium using representative nutrition survey data. For all population groups, processed meat products contributed most to the cost of diets. Other important contributors were cakes, pies and biscuits and soft drinks and fruit and vegetables. Lower educated households spent more on soft drinks and less on fruits and vegetables compared to higher educated households. For adolescents, soft drinks and cakes, pies and biscuits were among the top three contributors to the cost of the diet, regardless of socioeconomic status.

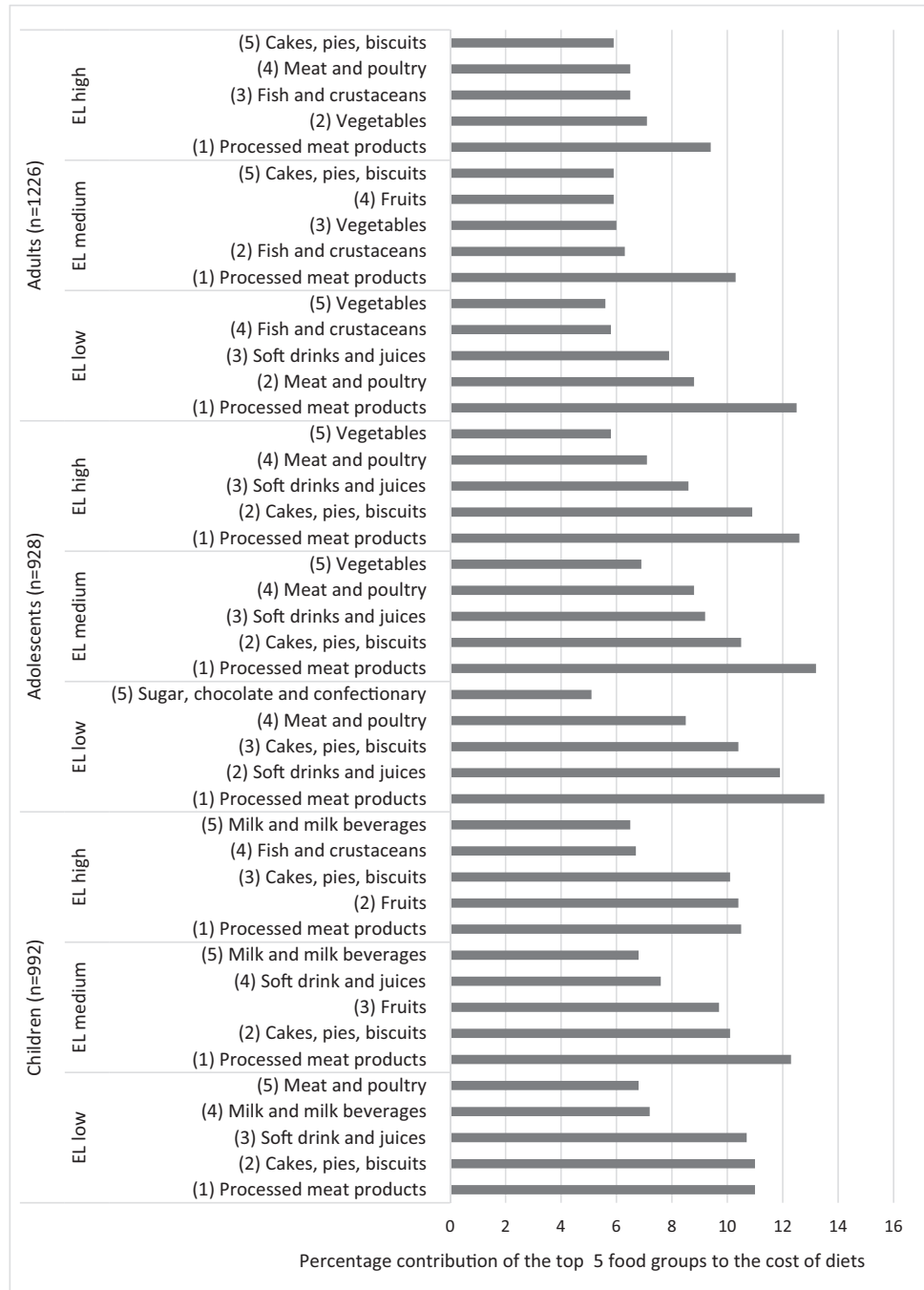
Generally, except for fibre, wholegrain, nuts and seeds and red meat, the cost of diets per 2000 kcal meeting nutritional guidelines was significantly higher compared to

those that do not meet guidelines; this is the case when considering recommendations separately or in combination. The cost differential between meeting and not meeting the guidelines was the highest for vegetables compared to other food groups or nutrients. Diets for adults meeting the guidelines for vegetables were about 20% more expensive compared to diets not meeting those guidelines. Diets for adults meeting the guidelines for fruits, saturated fat and free sugars were about 10%, 13%, and 14% more expensive than diets not meeting those guidelines, respectively.

Across population groups, diets meeting the maximum limits for red meat consumption were significantly cheaper than those exceeding those limits. The opposite was found for processed meat products.

A systematic review and meta-analysis found that healthy diets generally cost more than current less healthy diets [19]. The costs of commonly consumed less healthy items, such as alcohol and takeaway foods, were however not reported consistently in the included studies. A recent study in Australia, including alcohol and takeaway foods in

**Fig. 2** Top five contributions of different food groups to the costs of the diets (cost per day; using interview/record day 1) for different household education levels (EL) by age in Belgium (Belgian national food consumption survey 2014/15).



the less healthy diets, found that under the exemption from the GST for fresh foods, healthy diets were 15–17% less expensive than current less healthy diets in all locations [40]. In our study, the cost of current less healthy diets might have been higher if the cost of takeaway meals rather than the cost of their ingredients would have been taken into account. In 2006, families in France living below 2.5€ per person/day were unable to afford a nutritious diet, priced at 3.5€ per person/day [41]. A later study in France however showed it is possible in iso-cost models to design

nutritionally adequate diets whatever the initial observed cost [42].

Strengths of this study include the use of representative FCS data, and the use of a detailed set of prices data for Belgium over the same year as the nutrition survey was performed. The limitations include a lack of data on prices for out-of-home dishes, for which the costs of ingredients were taken into account. This may noticeably impact the costs of the diets. We calculated the mean consumption and cost over 2 interview/record days rather than the usual

**Table 3** Cost differential (€/day or €/2000 kcal) between diets meeting versus not meeting guidelines for healthy diets, adjusted for age group (only for “all population”), sex, household education level, region, BMI category and energy intake (the latter only for “cost per day”).

	All population (n = 3146)						Adults (n = 1226)						Adolescents (n = 928)						Children (n = 992)						
	Cost/day		Cost/2000 kcal		p		Cost/day		Cost/2000 kcal		p		Cost/day		Cost/2000 kcal		p		Cost/day		Cost/2000 kcal		p		
	Coeff	(CI)	Coeff	(CI)	p	Coeff	(CI)	Coeff	(CI)	p	Coeff	(CI)	Coeff	(CI)	p	Coeff	(CI)	Coeff	(CI)	p	Coeff	(CI)	Coeff	(CI)	p
Fruit ≥ 250 g/day	0.61	(0.16)	<0.001	0.65	(0.16)	<0.001	0.62	(0.19)	0.001	0.66	(0.20)	<0.001	0.56	(0.17)	0.001	0.48	(0.18)	0.006	0.52	(0.13)	<0.001	0.51	(0.16)	0.001	
Vegetables ≥ 300 g/day	1.11	(0.18)	<0.001	1.40	(0.22)	<0.001	1.13	(0.19)	<0.001	1.44	(0.24)	<0.001	NS	NS	NS	NS	NS	NS	1.06	(0.27)	0.001	0.90	(0.31)	0.004	
Wholegrain ≥ 125 g/day	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Nuts and seeds 15–25 g/day	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Red meat ≤ 300 g/week	-0.47	(0.11)	<0.001	-0.34	(0.12)	0.005	-0.42	(0.14)	0.003	-0.31	(0.14)	0.030	-0.83	(0.13)	<0.001	-0.68	(0.12)	<0.001	-0.41	(0.11)	<0.001	-0.38	(0.12)	0.002	
Processed meat ≤ 30 g/week	0.34	(0.16)	0.035	0.66	(0.17)	<0.001	0.43	(0.19)	0.026	0.79	(0.20)	<0.001	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Sodium ≤ 2000 mg/day	NS	NS	NS	0.25	(0.10)	0.014	NS	NS	NS	0.29	(0.13)	0.033	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Free sugar ≤ 10% of energy/day	0.67	(0.10)	<0.001	0.85	(0.10)	<0.001	0.77	(0.12)	<0.001	0.97	(0.12)	<0.001	0.21	(0.11)	0.06	0.32	(0.12)	0.007	NS	NS	NS	NS	NS	NS	
Saturated fat ≤ 10% of energy/day	0.54	(0.13)	<0.001	0.81	(0.14)	<0.001	0.62	(0.16)	<0.001	0.92	(0.17)	<0.001	NS	NS	NS	NS	NS	NS	0.34	(0.13)	0.008	0.48	(0.16)	0.003	
Fibre (age-specific recommendations —g/day)	NS	NS	NS	-0.34	(0.13)	0.013	NS	NS	NS	-0.49	(0.19)	0.011	NS	NS	NS	NS	NS	NS	0.34	(0.12)	0.006	NS	NS	NS	
Number of nutrient recommendations met																									
1	0.26	(0.13)	0.042	0.36	(0.11)	0.001	0.35	(0.16)	0.036	0.44	(0.15)	0.002	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
2	0.47	(0.15)	0.002	0.87	(0.14)	<0.001	0.59	(0.19)	0.002	1.02	(0.18)	<0.001	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.36	(0.14)	0.010	
≥3	0.93	(0.26)	<0.001	1.44	(0.24)	<0.001	1.08	(0.32)	<0.001	1.63	(0.30)	<0.001	NS	NS	NS	0.73	(0.35)	0.041	0.49	(0.18)	0.006	0.68	(0.21)	0.002	
Number of food-based recommendations met <sup>a</sup>																									
1	-0.57	(0.15)	<0.001	-0.38	(0.13)	0.004	-0.55	(0.18)	0.002	-0.35	(0.16)	0.033	-0.86	(0.15)	<0.001	-0.73	(0.14)	<0.001	-0.38	(0.12)	0.001	-0.43	(0.14)	0.003	
2	-0.36	(0.17)	0.039	NS	NS	NS	NS	NS	NS	NS	NS	-0.86	(0.17)	<0.001	-0.69	(0.17)	<0.001	NS	NS	NS	NS	NS	NS	NS	
≥3	0.59	(0.25)	0.021	1.04	(0.27)	<0.001	0.67	(0.29)	0.020	1.14	(0.31)	<0.001	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	

NS not significant.

<sup>a</sup>No individuals met all six food-based recommendations.



intakes and costs, as usual intakes for individuals cannot be calculated using the Statistical Program to Assess Dietary Exposure, which is generally used to calculate the proportion of the population meeting dietary guidelines [43]. While nutrient guidelines are available for children and adolescents and have been used, food-based dietary guidelines are not available for children and adolescents in Belgium. Therefore, the guidelines for adults have been used in this study. For all of the guidelines included in the study, more than 1% of children and adolescents met these guidelines but percentages were quite a bit lower than among adults for some of the guidelines. When food-based dietary guidelines for children and adolescents become available for Belgium, an adapted estimation will be carried out. As diets in Belgium are largely less healthy, the proportion of individuals meeting a combination of different dietary guidelines is generally limited. Therefore, modelling approaches have been developed and proposed to estimate the cost differential between a set of generated healthy and current diets of households in populations [27].

In this study, average food prices were used and so the variation in prices across different supermarkets, seasons, regions and lower and higher socio-economic areas was not taken into account and the respondents in the FCS all got assigned the same average food prices. Food prices are a complex concept and there are many factors of influence such as political, economic, socio-cultural and environmental factors at local, national and global levels [39]. In addition, price is only one barrier to healthy eating. Other key influences are taste, traditions, convenience, knowledge and cooking skills.

This study highlights that a sole focus on nutrition education and consumer awareness campaigns to stimulate healthy eating, although important, is insufficient to improve population diets as healthy foods, in particular vegetables and fruits, are less accessible due to the higher cost. The focus needs to shift towards creating an enabling food environment for consumers in order to better support them to make healthier food choices. The federal Minister of Health in Belgium recently introduced the Nutriscore front-of-pack label system to support consumers to make healthier choices, but this is a voluntary measure and it is not accompanied by more ambitious policies such as marketing restrictions or health-related food taxes and subsidies. Based on the results from this study, pricing policies would be recommended to correct the differential in cost between healthy and current diets in Belgium. In 2016, Belgium introduced for economic rather than health reasons a small excise duty (around \$0.07 per liter) on all soft drinks, including non-alcoholic drinks and water containing added sugar or other sweeteners or flavours. In other countries, higher taxes on sugary drinks or junk food, introduced for health reasons, have shown a significant

impact on purchases and greater impacts for lower income groups [44, 45].

## Conclusion

Processed meat products, cakes, pies and biscuits and soft drinks contributed most to the cost of diets in Belgium. The cost of diets of people meeting guidelines for healthy diets is greater than of those not meeting guidelines in Belgium. Policies that make healthy diets more affordable are recommended.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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