Posting point-of-purchase nutrition information in university canteens does not influence meal choice and nutrient intake[1–4]

Christine Hoefkens, Carl Lachat, Patrick Kolsteren, John Van Camp, and Wim Verbeke

ABSTRACT

Background: Growing concern over the relation between out-of-home eating and overweight has triggered the use of point-of-purchase (POP) nutrition information when eating out of the home. In canteens that offer various unhealthy choices, the posting of POP nutrition information has the potential to improve meal choices and dietary intakes.

Objective: The objective of this study was to increase the proportion of consumed meals that comply with recommendations for energy, saturated fat, sodium, and vegetable content by 5%.

Design: A one-group pretest-posttest design was used. A total of 224 customers of 2 university canteens completed a questionnaire used for consumer profiling and 3-d food records to assess their meal choices and nutrient intakes. The 12 best meal combinations received star ratings and descriptors for nutrients or food groups that did not comply.

Results: Reported meal choices in canteens and nutrient intakes did not improve after the intervention ($P > 0.05$). The nutritional profile of the meal choice, obtained from a qualitative and quantitative nutritional assessment of meals, mirrored the nutritional profile of all meals offered ($P > 0.05$) and not that of the recommended meals offered ($P < 0.001$). Meal choices were not compensated for later in the day ($P > 0.05$). The healthiest choices were made by participants with greater objective nutrition knowledge, stronger health and weight-control motives, and a greater openness to change meal choices at baseline ($P < 0.05$).

Conclusions: The posting of nutrition information in university canteens did not effectively change meal choices and nutrient intakes. Despite the intervention, meal choices were largely determined by meals offered. Therefore, nutrition-information interventions in canteens may be more effective with a healthier meal supply. This trial was registered at clinicaltrials.gov as NCT01249508. *Am J Clin Nutr* 2011;94:562–70.

INTRODUCTION

The increase in diet-related diseases worldwide is considered to be primarily caused by a changing environment [eg, accessibility of out-of-home (OH) food outlets] that encourages poor dietary patterns and a sedentary lifestyle (1). The increased importance of OH eating in the habitual diet is potentially worrisome and has been associated with higher intakes of energy, fat, and sodium and insufficient amounts of fruit and vegetables (2–5). Most consumers are unaware of the inferior nutritional quality of foods consumed OH compared with at home. The provision of simple and easily accessible nutrition information on OH foods could benefit public health by facilitating healthier food choices (6).

Nutrition-information interventions have shown mixed results depending on the information provided (7–12). Various studies have stressed the need for nutrition information that is comprehensive and easy to understand and use for consumers (ie, so-called simplified nutrition information or signposting information) (13–15). Simplified nutrition labeling on prepacked foods that display the nutritional profile of a food has become an attractive instrument because of its behavioral rather than environmental approach to healthy eating by providing information while retaining consumer freedom of choice or the so-called "libertarian paternalistic" approach (14, 16). A couple of recent studies have evaluated the effectiveness of such simplified nutrition labels on prepacked foods and showed promising results in terms of increased sales of targeted foods (17, 18). To our knowledge, it is not known whether and how such simplified nutrition information on OH meals (ie, not prepacked) can influence the individual meal choice and intake of nutrients of canteen customers during lunch and on a daily basis.

When entering university, young adults become more independent and explore and develop their identity in a different social environment that often leads to different food choices and poorer dietary habits (19). Many of these young adults rely regularly on the university canteen for their main meal (20). The improvement of the dietary pattern of young adults is important because better nutritional habits at this stage of life will likely have positive effects on their future health (21).

The primary objective of the study was to evaluate the effect of posting point-of-purchase (POP) nutrition information in canteens on the meals chosen and consumed by customers (or meal choice) in terms of an increase in the proportion of meals that complied

[1] From the Departments of Agricultural Economics (CH and WV) and Food Safety and Food Quality (CH, CL, PK, and JVC), Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium, and the Nutrition and Child Health Unit, Department of Public Health, Institute of Tropical Medicine, Antwerp, Belgium (CL and PK).

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[4] Address correspondence to C Hoefkens, Faculty of Bioscience Engineering, Ghent University, Coupure Links 653, B-9000 Ghent, Belgium. E-mail: christine.hoefkens@ugent.be.

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with all 4 meal recommendations (ie, 3-star meals). A secondary objective was to examine this intervention on the individual nutrient intake from the meal and the 24-h diet to check for compensatory behaviors during the remaining course of the day. Finally, the study attempted to profile consumer subgroups according to the individual effectiveness of the intervention.

SUBJECTS AND METHODS

Study area

The current study was conducted between October 2008 and May 2009 in 2 canteens of Ghent University (Ghent, Belgium). The canteen of the Faculty of Bioscience Engineering and the canteen of the Faculty of Psychology and Educational Sciences were selected because of logistic advantages, their similarities in size and number of customers, and their equal meal supply. Both canteens served ≈225 hot meals/d. Preparation methods and menus were standardized, and meals offered were largely the same in all canteens of the university. The menus composed by the canteen administration were not adapted for the purpose of this study. Besides a few fixed meal choices (eg, spaghetti), customers could choose daily from 4 protein sources (eg, meat), 1 or 2 warm sauces, 2 cooked vegetables, 1 salad, and 5 carbohydrate components (eg, French fries) to compose their meal, which meant that ≈180 meal combinations were possibly consumed each day. The meal consisting of these 4 components without any extra purchased food such as additional portions, dressings, fruit, other desserts, and drinks was defined as *canteen meal*. The same meal components were served throughout the year; only the fruit availability might have differed between seasons (eg, mandarins only available during the fall). Because fruit were not included in the meal, the seasonal effect was expected to be negligible.

Study population

Participants were regular customers of one of the 2 mentioned university canteens, between the ages of 17 and 35 y, and essentially BSc, MSc, or PhD students. An open-recruitment procedure was applied, and potential participants were invited by e-mail, flyers, and poster boards at both faculties or addressed in the classroom (*see* supplemental Figures 1 and 2 under "Supplemental data" in the online issue). A one-group pretest-posttest design was used in this study, which meant that each participant was exposed to the nutrition information and served as his or her own control as assessed at baseline (October and November 2008). The nutrition information was first posted 1 mo before the follow-up measurement in April and May 2009. Participation was entirely voluntary and rewarded with one cinema ticket after completion of the baseline study and 2 additional tickets at the end of the follow-up study. The overall research procedure was explained to participants. To avoid demand effects, participants were not informed about the posting of nutrition information in the university canteens and were told the study measured eating habits in general. All participants provided written informed consent before entering the study (*see* supplemental Figure 3 under "Supplemental data" in the online issue). Together with the informed consent, participants completed a short questionnaire about their sociodemographic characteristics, body mass index (BMI; in kg/m^2), dieting, and smoking status. The study protocol was granted ethics approval by the Belgian Ethics Committee of the Ghent University Hospital (ethics approval no. EC/2008/482). Initial recruitment started on 15 October 2008.

POP nutrition-information intervention

Possible meal combinations were evaluated daily for the energy content, saturated fat, sodium, and vegetable portion. If a meal complied with a recommendation, it received a score of 1. The maximum score was 4. These scores were translated into stars, whereby scores 2, 3, and 4 received, respectively, 1, 2, and 3 stars. We opted for a maximum of 3 stars to avoid the situation that a meal that complied with only 1 of the 4 recommendations would be considered as a healthier meal option worthy of one star. In addition, a 3-star rating is a widely used quality appraisal in restaurants (eg, Michelin stars). Besides the number of stars, noncomplying nutrients or food group were posted in a red font and followed by an exclamation mark or verbal descriptor (an example is shown in **Figure 1**). The following meal recommendations were used for the evaluation of the meal: *1*) meal supplied ≤500 kcal (otherwise posted as "Calorie!") (22), *2*) the energy from saturated fat was ≤13% of the total energy supply (otherwise posted as "Saturated fat!") (23, 24), *3*) the amount of sodium in the meal was <2.2 mg Na/kcal (otherwise posted as "Salt!"), *4*) the meal contained ≥150 g vegetables (otherwise posted as "Vegetable!") (23, 24). Of all possible meal combinations, the 12 best ones (ie, the 3 best meal options for each of the 4 protein components) were selected on the basis of the meal recommendations and posted on large poster boards at the entrance of the canteens and next to example dishes at the buffet counter. During the 3-wk follow-up period, it occurred only once that the 12 best meal options offered did not include any 3-star meals. Posters and brochures that explained the use of the nutrition information and the meal recommendations used to assign star ratings were available for consultation throughout the study canteens (*see* supplemental Figure 4 under "Supplemental data" in the online issue). Because consumers are less familiar with the terms *energy* and *sodium* than with the terms *calories* and *salt*, the latter terms were used in the nutrition information (13, 15). Each day before opening hours, the main researcher visited both canteens to post the nutrition information on the buffet counter and to check the availability of brochures. By having the nutrition information placed before opening hours and by formatting the supportive material according to the house style of all communications by the canteen administration, experimenter-

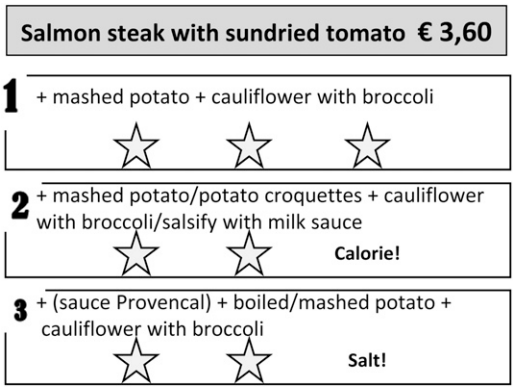

FIGURE 1. Example of a nutrition label.

demand effects were expected to be minimal. The canteen administration and staff were involved in the study from the outset to ascertain that no changes were made to their marketing and meals offered.

Food intake data

Food intake data were obtained from a self-administered 3-d food and drink record. The baseline study was conducted in a 2-wk period of regular activity in October and November 2008 (ie, not just before or after a holiday and not during an examination period). Participants were asked to record all foods and drinks consumed during 24-h on 3 d chosen freely in that period according to their habitual schedule of eating at the canteen, which meant that the days recorded were not necessarily consecutive. The only condition was that participants had lunch in the canteen during these days. Because both canteens were closed on weekends, only weekdays were included in the food record. Instructions on how to complete the form were provided by researchers at the registration desk and on the form itself. The measurement of food intake was repeated with the same procedure at the 6-mo follow-up (April and May 2009). The period of follow-up was 3 instead of 2 wk because many participants reported to have fewer classes (thus, a lower presence at the university and a lower chance to eat in the canteen) in the second term (spring term) of the academic year compared with the first term (fall term). Portion sizes of canteen meals were obtained from the canteen administration, whereas other foods were quantified by using a standardized reference manual for foods in Belgium if exact quantities were not available (25). For example, if participants reported to have consumed only 6 of 8 potatoes of their canteen meal, the standard portion size of potatoes was reduced with 2 times the amount of a single potato to estimate the nutrient intake. The composition of meals was obtained from the technical files provided by the producers. For foods not served in the canteen (ie, all foods eaten at home or during other occasions), nutritional composition data were taken from the Belgian food-composition table (26). If data were not available from these sources, the Dutch food-composition database (27) and food labels were used to complete the food-composition table. Collected data on food intakes were entered and processed with an online tool (Lucille, version 1; http://www.foodintake.ugent.be; Ghent University) developed to process 24-h dietary recall data. The average of the 3 recall days was used to assess the nutrient intake at lunch and on a daily basis.

Physical activity data

Together with their food intakes, participants were asked to record all physical activities for each 15-min period of a day. The time spent on each activity (in min) was multiplied with the corresponding metabolic equivalent coefficient (28) and summed to obtain an individual estimation of energy expenditure for the 3 d of recording at both baseline and follow-up. An average was taken from the 3 d to obtain a measure of the amount of physical activity per day and period. The 15-min diary of physical activities has been validated against the doubly labeled water technique (29). Physical activity data were entered in MS Excel 2007 software (Microsoft Corp, Redmond, WA) and processed in Stata 11.0 software (StataCorp, College Station, TX).

Individual characteristics for consumer profiling

The variables used for the profiling of consumer groups were assessed at baseline and estimated diet-health awareness, intention of dietary change, objective nutrition knowledge, meal-choice motives, and sociodemographic characteristics. The awareness of participants of the relation between diet and health was measured by using the 7-point scale described by Ragaert et al (30) and consisted of 3 items (Cronbach's $\alpha = 0.64$; eg, "My health is determined by the food I eat"). The intention to change diet in the next 6 mo was measured on a 7-point interval scale from "very unlikely" to "very likely" (5 items; Cronbach's $\alpha = 0.94$; eg, "In the next 6 months I plan to eat more healthy") (31). Objective nutrition knowledge was assessed by using the first part of the knowledge index (ie, knowledge on dietary recommendations) developed by Grunert et al (32). Motives underlying the selection of canteen meals were measured by 19 items adapted from Steptoe et al (33). This scale assessed the degree to which participants placed importance on motives in making canteen meal choices by using a 7-point scale that ranged from 'not at all important' to 'very important' (eg, "It is important to me that the meal I choose in a canteen is healthy"). An exploratory factor analysis that used the principal components extraction method with varimax rotation on these 19 items revealed 5 factors or motives as follows: health (3 items; Cronbach's $\alpha = 0.84$), weight control (2 items; Cronbach's $\alpha = 0.90$), sensory appeal (4 items; Cronbach's $\alpha = 0.64$), price (3 items; Cronbach's $\alpha = 0.81$), and familiarity (2 items; Cronbach's $\alpha = 0.87$). The factors explained almost 65% of the variance in the original data. The internal reliability coefficient or Cronbach's α for all of these individual characteristics was satisfactory, and constructs were computed as the average of corresponding items.

Statistical analysis

As many volunteers as possible were recruited, but only volunteers who provided complete dietary data at baseline and follow-up were retained for analysis. The aim was to show a 5% increase in the proportion of consumed meals that complied with all 4 meal recommendations. The 5% increase was chosen on the basis of on a previous study in the same setting (3) that showed that 5% of meal combinations chosen met all considered recommendations. A similar low percentage of compliance was expected at baseline. Doubling of the percentage was considered feasible and necessary for the intervention to be relevant for public health. In addition, doubling of the percentage was also considered as the minimum effect size by the canteen administration to upscale the information initiative to all university canteens. Power calculations were carried out with PASS v11 software (NCSS, Kaysville, UT) for an inequality test for 2 dependent proportions from one sample.

Data analyses of the food intake data were carried out with Stata 11.0 software (StataCorp). Pearson's chi-square tests were conducted to assess significant differences in proportions between categories. Paired-samples *t* tests were performed to detect significant differences in mean nutrient intakes between baseline and follow-up. If there were nonnormally distributed data and a lack of homogeneity of variance, a nonparametric Wilcoxon's signed-rank test was used. Differences in the nutritional profile between categories of meal choice or differences between consumer

groups were calculated by using independent-samples *t* tests and one-factor analysis of variance in case of normally distributed data, whereas Wilcoxon's rank-sum test was used for data that were not normally distributed. As an extension to the latter test, a simple test for the trend across ordered groups was performed to assess the presence of a trend in the nutritional profile across meal star-rating categories. Results are expressed as means ± SDs unless otherwise specified. *P* values were considered statistically significant at $P < 0.05$. All statistical tests were 2-sided.

RESULTS

Description of participants

A total of 380 persons participated in the baseline study, and 59% of participants completed the follow-up study, which gave us 224 persons who completed both study periods. There were no differences between participants who dropped out and participants who completed the study in terms of sociodemographic characteristics, BMI, dieting, and smoking status (chi-square test, all $P > 0.05$; results not shown). General characteristics of the final sample are shown in **Table 1**. The final valid sample of 224 participants mostly consisted of regular canteen customers, undergraduates, and students who lived away from home during the week. This student sample mostly included women of ≈21 y of age and in good health as indicated by their self-reported BMI, smoking status, and energy expenditure. There was no difference in the total reported energy expenditure before and after posting the POP nutrition information ($P = 0.275$). No differences were observed between the 2 canteens except for sex and age, and the latter difference was very small ($P < 0.05$). Data from both canteens were pooled because an evaluation of the effect of the intervention on the reported meal choice by canteen showed no difference in the proportion of chosen meals between star-rating categories for both canteens (chi-square test; Faculty of Bioscience Engineering: $P = 0.427$; Faculty of Psychology and Educational Sciences: $P = 0.607$). Moreover, age ($P = 0.074$) and sex ($P = 0.495$) did not influence compliance of the meal choice with the recommended meals offered. The final sample size had a power of 91% to show an increase of 5% in the proportion of meals that complied with all 4 meal recommendations at a significance level of 0.05.

Effect of posting POP nutrition information on canteen meal choices

The change in reported meal choice (ie, meals selected and consumed) and meals offered (ie, meals offered for sale) between baseline and follow-up is presented in **Table 2**. The proportion of meals chosen in the different star-rating categories remained relatively constant after posting the nutrition information ($P =$

TABLE 1
Study sample characteristics

	Total sample	Canteen 1	Canteen 2	P^1
n (%)	224 (100.0)	94 (42.0)	130 (58.0)	
Customer frequency [*n* (%)]				0.603
<1 time/wk	30	12 (40.0)	18 (60.0)	
1 time/wk	52	19 (36.5)	33 (63.5)	
≥2 times/wk	142	63 (44.4)	79 (55.6)	
Living away from home during week [*n* (%)]				0.519
Yes	146	59 (40.4)	87 (59.6)	
No	78	35 (44.9)	43 (55.1)	
Sex [*n* (%)]				<0.001
M	59	38 (64.4)	21 (35.6)	
F	165	56 (33.9)	109 (66.1)	
Age (y)	21 ± 3[2]	22 ± 4	21 ± 2	0.002[3]
BMI status [*n* (%)]				0.667
Underweight	15	7 (46.7)	8 (53.3)	
Normal weight	188	78 (41.5)	110 (58.5)	
Overweight	16	8 (50.0)	8 (50.0)	
Obese	5	1 (20.0)	4 (80.0)	
BMI (kg/m^2)	22 ± 3	22 ± 3	22 ± 3	0.930[3]
Dieting [*n* (%)]				0.347
Yes	39	19 (48.7)	20 (51.3)	
No	185	75 (40.5)	110 (59.5)	
Smoking status [*n* (%)]				0.483
Yes	15	5 (33.3)	10 (66.7)	
No	209	89 (42.6)	120 (57.4)	
Energy expenditure (kcal)				
Baseline	2558 ± 485	2575 ± 469	2552 ± 503	0.486[3]
Follow-up	2583 ± 508	2580 ± 506	2585 ± 511	0.934[3]
P^4	0.275	0.959	0.159	—

[1] *P* values are from the chi-square test for comparison of sample characteristics between canteens 1 and 2.
[2] Mean ± SD (all such values).
[3] Value corresponds to the nonparametric Wilcoxon's rank-sum test (Mann-Whitney *U* test).
[4] Values derived from the nonparametric Wilcoxon's signed-rank test.

TABLE 2
Change in reported meal choice and meals offered by star rating and label descriptor between baseline and follow-up[1]

	Meal choice			Meals offered		
	Baseline (n = 657)	Follow-up (n = 664)	P	Baseline (n = 1460)	Follow-up (n = 2198)	P
Star rating [n (%)]						
0 stars	245 (37.3)	243 (36.6)	—	410 (28.1)	599 (27.3)	—
1 star	230 (35.0)	235 (35.4)	—	646 (44.3)	947 (43.1)	—
2 stars	148 (22.5)	144 (21.7)	—	353 (24.2)	524 (23.8)	—
3 stars	34 (5.2)	42 (6.3)	0.820	51 (3.5)	128 (5.8)	0.016
Descriptor [n (%)][2]						
Calorie!	435 (66.2)	432 (65.0)	0.660	1007 (69.0)	1498 (68.2)	0.601
SFA!	279 (42.5)	252 (38.0)	0.094	470 (32.2)	552 (25.1)	<0.001
Salt!	355 (54.03)	409 (61.6)	0.005	883 (60.5)	1521 (69.2)	<0.001
Vegetable!	275 (41.9)	293 (44.1)	0.405	530 (36.3)	736 (33.5)	0.080

[1] SFA, saturated fatty acid. P values are from the chi-square test for comparison of the number of meals in each star-rating category between baseline and follow-up.
[2] Calorie!, SFA!, Salt!, and Vegetable! denote that the meal was not in compliance with meal recommendations for energy (>500 kcal), saturated fat (>13% of energy), sodium (>2.2 mg/kcal), and vegetables (<150 g), respectively.

0.820). An increase of only 1% was shown in the proportion of 3-star meals compared with the expected increase of 5%. Meals offered included 2% more 3-star meals (P = 0.016). About 70% of meal choices were meals without stars or with one star only, which was similar to the profile of the meals supplied. Posting nutrition information did not affect the number of meals chosen that complied with the meal recommendations for energy (P = 0.660) and vegetables (P = 0.405). Despite a decrease in the proportion of meals offered with too much saturated fat between baseline and follow-up, no significant change was observed in the reported meal choice for saturated fat (P = 0.094). After posting the nutrition information, an increase in the proportion of chosen meals with too much sodium was observed (P = 0.005). This finding was consistent with the meals offered, which also had more sodium-rich meal options after the introduction of the nutrition information ($P < 0.001$). In both periods, about two-thirds of meals chosen and offered contained too much energy and sodium, whereas about one-third supplied too much saturated fat and not enough vegetables.

From these findings, it appears that the meal choice simply mirrored the meals offered in terms of star ratings and noncomplying nutrients or food group. There were no significant differences in the contents of energy, saturated fat, sodium, and vegetable portions between the meal choice and meals offered at baseline ($P > 0.05$) and between the meal choice and the meals offered at follow-up ($P > 0.05$) (data not shown).

Effect of posting POP nutrition information on nutrient intake from canteen meals and daily diet

A similar meal choice before and after posting the nutrition information in terms of nutrients targeted by the intervention resulted in a nonsignificant difference in the nutrient intake from the canteen meal (**Table 3**). The intake of the targeted nutrients and the intake of nontargeted nutrients such as carbohydrates, protein, and total fat ($P > 0.05$) were not affected by the intervention. A significant increase in the consumed amount of vegetables from the meal was observed after posting the nutrition information ($P <$

TABLE 3
Change in consumer intake of targeted and nontargeted nutrients from the canteen meal and 24-h diet between baseline and follow-up (n = 224)[1]

	Canteen meal			24-h diet		
	Baseline	Follow-up	P[2]	Baseline	Follow-up	P[3]
Targeted nutrients and food group						
Energy (kcal)	597 ± 114	598 ± 98	0.967	2113 ± 566	2046 ± 533	0.110
Energy from SFA (%)	11.52 ± 4.00	11.81 ± 4.31	0.381	12.29 ± 2.79	11.97 ± 2.95	0.201
Sodium (mg)	1620 ± 499	1652 ± 429	0.392	3446 ± 901	3379 ± 924	0.263
Vegetables (g)	167 ± 52	189 ± 52	<0.001	238 ± 87	257 ± 90	0.008
Nontargeted nutrients (g)						
Carbohydrate	68 ± 15	66 ± 15	0.085	268 ± 75	259 ± 71	0.029
Protein	30 ± 6	30 ± 6	0.593	73 ± 16	73 ± 26	0.155
Fat	23 ± 8	24 ± 7	0.178	234 ± 150	221 ± 158	0.397

[1] All values are means ± SDs. SFA, saturated fatty acid.
[2] P values derived from a paired-samples t test for comparison of the mean nutrient intake between baseline and follow-up.
[3] P values derived from a nonparametric Wilcoxon's signed-rank test.

0.001). This improvement was also significant when the total daily diet was considered ($P = 0.008$), although the vegetable consumption during other eating occasions than lunch in the canteen did not change (baseline: 65.3 ± 59.4 g; follow-up: 62.7 ± 62.1 g; $P = 0.324$). The results of the 24-h intake (except for carbohydrates ($P = 0.029$) indicated that participants did not compensate for their canteen meal choice later during the day ($P > 0.05$).

Effectiveness of the POP nutrition information in categorizing meals on the basis of their nutritional profiles

Compared with meal recommendations, a large proportion of meals chosen after posting the nutrition information still contained too much of targeted nutrients. Sixty-five percent and 62% of the meal choice did not comply with the meal recommendations for energy and sodium, respectively. Noncompliance with the advised saturated fat content and vegetable portion occurred in 38% and 44% of the meals chosen, respectively. The meals chosen provided an average of 598 ± 159 kcal. The average saturated fat and sodium density of the meals were 11.82 ± 7.18% of energy from saturated fat and 2.77 ± 1.06 mg Na/kcal. On average, a portion of 190 ± 80 g of vegetables was included in the meals chosen by consumers.

To evaluate the effectiveness of the POP nutrition information, the nutritional profile of the reported meal choice was compared between star-rating categories as well as between categories by verbal descriptors (**Table 4**). A no-star meal supplied, on average, 667 ± 151 kcal, 16.92 ± 6.99% of energy from saturated fat, 3.28 ± 1.02 mg Na/kcal, and 173± 79 g of vegetables, whereas a meal that earned 3 stars contained, on average, 423 ± 56 kcal, 6.18 ± 3.90% of energy from saturated fat, 1.61 ± 0.53 mg Na/kcal, and 208 ± 21 g of vegetables. Consequently, the nutritional profile of meals with a higher star rating was significantly better (P for trend < 0.001). Meal profiles that were based on energy, saturated fat, sodium, and vegetables corresponded to actual differences in the composition of meals for the respective descriptor. When participants consumed a recommended meal, consumers had a significantly lower intake of energy, saturated fat, and sodium and a higher vegetable intake ($P < 0.05$).

Meals that exceeded the recommendation for energy contained significantly higher amounts of sodium ($P < 0.001$) and vegetables ($P = 0.026$). The average energy content of meals too rich in sodium was significantly higher ($P < 0.001$). Meals with too much energy from saturated fat also supplied significantly higher contents of energy and sodium ($P < 0.001$). A significantly higher vegetable portion was observed for meals that had contents of sodium above the meal recommendation ($P = 0.004$). The meals consumed and profiled as supplying an insufficient portion of vegetables contained significantly more saturated fat ($P < 0.001$) and sodium ($P = 0.038$).

Only 8% of participants chose a recommended meal on each of the 3 d they recorded their food intakes (**Table 5**). The majority of participants ($n = 164/224$, 73%) either did not follow the daily meal recommendation at all (31%) or in only 1 of 3 times made a meal choice (42%). Intakes of energy and sodium from the canteen meal showed a consistent downward trend with increasing compliance with the recommendations, whereas the vegetable intake was characterized by an increase ($P < 0.05$). Although not significant, the trend in the intake of energy from saturated fat lent further support to the observation that a higher compliance with the recommended meals offered was associated with an improved nutrient intake.

Consumer profiling

Participants who reported to have chosen recommended meals ≥2 of 3 times (27% of the sample) differed from the other subjects, with a significantly higher level of objective nutrition knowledge and a greater importance placed on health and weight-control motives in their canteen meal choices ($P < 0.05$) (**Table 6**). These participants were also more open to change and, thus, less restricted to familiar meal choices ($P = 0.001$). For the remaining variables (ie, sex, age, BMI, energy expenditure, diet-health awareness, intention of dietary change, and sensory and price motives that underlie meal choices), no significant differences were shown between the 3 consumer groups ($P > 0.05$).

DISCUSSION

Canteen meals are important in the diets of many students and a wide range of adults in the workplace. However, when eating

TABLE 4
Nutritional profile of the reported meal choice at follow-up by star rating and label descriptor ($n = 664$)[1]

	Star rating		Calorie!		SFA!		Salt!		Vegetable!		Recommended[2]	
	Δ[3]	P for trend[4]	Δ[5]	P	Δ[5]	P	Δ[5]	P	Δ[5]	P	Δ[5]	P
Energy (kcal)	81	<0.001	185	<0.001[6]	97	<0.001[6]	49	<0.001[7]	−16	0.219[7]	−66	<0.001[6]
Energy from SFA (%)	4	<0.001	1	0.055[7]	9	<0.001[6]	0	0.113[6]	3	<0.001[6]	−1	0.006[6]
Sodium (mg/kcal)	0.6	<0.001	0.5	<0.001[7]	0.5	<0.001[6]	0.7	<0.001[6]	0.3	0.038[6]	−0.3	<0.001[7]
Vegetables (g)	−12	<0.001	14	0.026[7]	19	0.269[6]	18	0.004[7]	−84	<0.001[6]	17	0.002[6]

[1] SFA, saturated fatty acid. Calorie!, SFA!, Salt!, and Vegetable! denote that the meal was not in compliance with meal recommendations for energy (>500 kcal), saturated fat (>13% of energy), sodium (>2.2 mg/kcal), and vegetables (<150 g), respectively.
[2] The 3 best meal options per day for each protein component (meat, fish, or vegetarian; $n = 10$ or 12) that were based on meal recommendations.
[3] Values are mean differences in nutritional profile between star-rating categories (from 0 to 3 stars).
[4] P values corresponding to the test for trend across ordered groups.
[5] Values are differences in nutritional profile between the category that did not comply with the meal recommendation and the category that was in compliance with the meal recommendation.
[6] Nonparametric Wilcoxon's rank-sum test (Mann-Whitney U test).
[7] Independent-samples t test.

TABLE 5
Nutrition profile of the reported meal choice at follow-up (n = 664) according to the compliance with the recommended meals offered[1]

Compliance of meal choice with recommended meals offered	0 of 3 meal choices	1 of 3 meal choices	2 of 3 meal choices	3 of 3 meal choices	P for trend
n (%)	70 (31)	94 (42)	42 (19)	18 (8)	—
Energy (kcal)	610 ± 92[2]	610 ± 93	573 ± 115	555 ± 88	0.008
Energy from SFA (%)	12.03 ± 4.31	12.35 ± 4.34	10.66 ± 4.16	10.68 ± 3.96	0.075
Sodium (mg/kcal)	2.93 ± 0.64	2.72 ± 0.59	2.68 ± 0.60	2.66 ± 0.62	0.009
Vegetables (g)	178 ± 56	192 ± 52	196 ± 48	208 ± 28	0.013

[1] The 3 best meal options per day for each protein component (meat, fish, or vegetarian; n = 10 or 12) were based on the following meal recommendations: ≤500 kcal of energy, ≤13% of energy from saturated fatty acid (SFA), ≤2.2 mg Na/kcal, and ≥150 g vegetables. P values correspond to the test for trend across ordered groups.
[2] Mean ± SD (all such values).

OH, customers might not be aware of the nutritional profile of their food choices and are consequently subjected to simply what is offered. Posting nutrition information on canteen menus has the potential to promote healthier choices when eating OH. However, our findings showed that nutrition information by using a star-rating system in combination with a descriptor of the noncomplying nutrients or food groups did not significantly affect meal choices during a canteen lunch or nutrient intakes at lunch or on a daily basis. Nevertheless, this star-rating system had the potential to positively influence the diet because it provided a good representation of the actual differences in meal compositions. Only 27% of participants followed the daily meal recommendations ≥2 of 3 times.

Despite the intervention, the nutritional profile of the reported meal choice reflected nutritional characteristics of all meals offered and not of recommended meals offered, with the exception of vegetables. Only a few meals met all 4 meal recommendations (ie, 3-star meals). Although the vegetable consumption significantly increased after posting the nutrition information, this could not be attributed to the intervention. The number of meals consumed and offered with adequate vegetables did not significantly differ between baseline and follow-up. However, meals offered at follow-up contained slightly more vegetables (baseline: 181 ± 48 g; follow-up: 187 ± 29 g). Another possible explanation for the increase in vegetable intake was the increase in sodium-rich meals offered and, therefore, chosen, which happened to contain a significant higher amount of vegetables.

The nature of our sample [ie, mostly women, who generally have greater weight-control involvement and a stronger interest in healthy eating than do men (34) and with a higher educational level (35, 36)] and the fixed moderate price of the canteen meals suggested that this nutrition-information intervention had the potential to alter meal choices and increase the proportion of 3-star meal choices by 5%. However, the ineffectiveness of the intervention in this particular sample and setting showed the enormous challenge of changing dietary habits of young adults for

TABLE 6
Profiling of consumer groups (n = 224) according to the compliance with the recommended meals offered at follow-up[1]

Compliance of meal choice with recommended meals offered	0 of 3 meal choices	1 of 3 meal choices	2–3 of 3 meal choices	P
n (%)	70 (31)	94 (42)	60 (27)	
Female sex [n (%)]	48 (29)	72 (44)	45 (27)	0.495[2]
Age (y)	20.5 ± 1.9[3]	21.5 ± 3.6	22.1 ± 3.5	0.074[4]
BMI (kg/m^2)	21.6 ± 2.4	21.5 ± 2.9	22.4 ± 3.0	0.114[5]
Energy expenditure (kcal)	2562 ± 484	2502 ± 433	2655 ± 562	0.171[5]
Diet-health awareness[6]	5.03 ± 0.90	5.12 ± 0.89	5.15 ± 0.73	0.827[5]
Intention of dietary change[6]	4.69 ± 1.00	4.63 ± 1.24	4.61 ± 1.28	0.551[5]
Objective nutrition knowledge[7]	8.44 ± 2.34[a]	8.88 ± 3.11[a]	10.03 ± 2.90[b]	0.010[5]
Health motive in meal choice[6]	5.38 ± 0.85[a,b]	5.11 ± 1.09[a]	5.53 ± 0.96[b]	0.028[5]
Weight control motive in meal choice[6]	4.59 ± 1.35[a,b]	4.12 ± 1.50[a]	4.75 ± 1.32[b]	0.016[5]
Sensory motive in meal choice[6]	5.85 ± 0.73	5.92 ± 0.69	5.70 ± 0.73	0.187[5]
Price motive in meal choice[6]	5.68 ± 0.94	5.70 ± 0.97	5.48 ± 1.24	0.410[5]
Familiarity motive in meal choice[6]	3.75 ± 1.52[b]	3.54 ± 1.29[b]	2.84 ± 1.35[a]	0.001[5]

[1] The 3 best meal options per day for each protein component (meat, fish, or vegetarian; n = 10 or 12) were based on the following meal recommendations: ≤500 kcal of energy, ≤13% of energy from saturated fatty acid, ≤2.2 mg Na/kcal, and ≥150 g of vegetables. Superscript letters indicate significant differences by one-factor ANOVA.
[2] Chi-square test.
[3] Mean ± SD (all such values).
[4] Kruskal-Wallis equality-of-populations rank test.
[5] One-factor ANOVA.
[6] Measured on a 7-point scale.
[7] Measured as a score on 19.

whom price, taste, and appearance are often more important than the healthfulness of foods (37, 38). For future information initiatives in the catering sector, it is important to know that the intervention was most effective in participants who, at baseline, had a higher objective nutrition knowledge, stronger health and weight-control motives, and a higher openness to change meal choices.

This study aimed to evaluate a practical and simple method to improve healthy meal choices. Compared with more persuasive communications such as advertisements or sales techniques, a nonpersuasive way to inform customers was used that did not actively try to influence them at the time of their meal choices. Posting POP nutrition information still requires an individual to make the healthy choice. Knowing that the meal choice reflects the meals offered, interventions in which the individual does not have to actively choose healthier foods because of a limited number of unhealthy choices may have a greater effect on healthy eating (10) but is contradictory with the idea of libertarian paternalism.

Because the study rationale was to reflect the real-life setting and to not interfere in the planning of menus, different proportions of star ratings could occur between days. The number of 3-, 2-, 1-, and 0-star meals per day (at follow-up) among the best meal options of the day varied between 0% and 45%, 11% and 74%, 2% and 80%, 0% and 58%, respectively. To test for the effect of the different proportions of star ratings on the meal choice, the binary outcome variable (ie, choosing a best meal option or not) was regressed on the percentage of 3-, 2-, 1-, and 0-star meals included in the 12 best meal options, respectively. The results indicated that the number of 3-star ($P = 0.006$) and 2-star ($P = 0.003$) meals were significant predictors for choosing a best or recommended meal, whereas the number of 1-star ($P = 0.935$) and 0-star ($P = 0.399$) meals were not significant. For a 1% increase of 3- and 2-star meals in the meals offered, the odds of choosing a recommended meal (compared with not choosing a recommended meal) increased by 2% and decreased by 1%, respectively. These results illustrated the need for a healthy meal supply for nutrition information to be potentially effective in improving meal choices.

Besides the real-life setting, the major strength of this study was the careful follow-up of the daily food consumption and physical activity of young adults in a free-living environment. Young adulthood is increasingly being recognized as an important period for health promotion and disease prevention because, for the majority of young people, it is the first time they have to make their own food choices (19). The collection of individual 24-h consumption data as opposed to aggregated sales data allowed for the investigation of the possible occurrence of compensatory behaviors. Interestingly, participants did not positively or negatively compensate for their food choices at the canteen later during the day. Another strength of the study pertained to the use of science-based comprehensive and easy-to-use nutrition information for canteen meals that targeted disqualifying nutrients (eg saturated fat and sodium) and a qualifying food group (eg, vegetable). In addition, to our knowledge, no nutrition-information intervention considered the individual taste preference next to healthfulness (10). The highlighting of nutritional shortcomings of a meal may appear unacceptable to many caterers (39) and may be less appealing for customers, which would form a barrier for its wider scale implementation.

Some limitations should be acknowledged when interpreting our findings. First, a one-group pretest-posttest design was used because randomization of canteens was impossible because of the insufficient number of canteens within Ghent University. Although susceptible to threats to validity associated with history, maturation, and testing, this quasiexperimental design without a control group was considered most appropriate because intact groups were required for this intervention (40). Because the time gap between the baseline and follow-up was relatively short, extraneous influences, rather than the intervention, were assumed not to substantially change responses of participants. Such a possible threat was addressed by the comparison of energy expenditures between the baseline and follow-up, which confirmed that the amount of energy expenditure did not change (Table 1). Second, to be inclusive, a convenience sampling approach was adopted, which is vulnerable to a sampling bias because of subject self-selection. However, this sampling would have favored a positive effect of the intervention. Therefore, this intervention, when used on a population basis, would have equally produced no improvement in the actual meal choice and nutrient intake. Third, meal components were occasionally out of stock by the end of lunchtime and replaced by food items that originally were not on the menu. This change in meals offered could not have been predicted and could, therefore, not have been covered by the intervention. To address this issue, the analysis was repeated without the meal choices that were not part of the menu. Similar results were obtained after the exclusion of these meals. Finally, the 1-mo implementation period of the nutrition information in the canteens before follow-up measurement may have been too short to allow some participants to acquire the necessary interest and skills to use the information. However, the lack of an effect of the intervention was not expected to be due to missing supportive material because the availability of posters and brochures was checked daily by the main researcher.

In conclusion, posting POP nutrition information in canteens as implemented in this study was not effective in improving meal choices and nutrient intakes from the canteen meal and the total diet of students. Regardless of the nutrition-information intervention, the nutritional profile of the meal choice was largely determined by the meals offered. Compliers had a higher objective nutrition knowledge, stronger health and weight-control motives, and a higher openness to change meal choices. The current findings highlight that posting nutrition information in canteens requires a healthy meal supply to be effective in a larger population.

The authors' responsibilities were as follows—CH: conducted data collection and processing, drafted and had primary responsibility for final content of the manuscript; CH and CL: performed statistical analyses; and all authors: contributed to the conceptualization and design of the study and the writing of the manuscript and critically reviewed and approved the final manuscript. None of the authors had a conflict of interest.

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