

Chapter 10

PRICE DISCOUNTS SIGNIFICANTLY ENHANCE FRUIT AND VEGETABLE PURCHASES WHEN COMBINED WITH NUTRITION EDUCATION: A RANDOMIZED CONTROLLED SUPERMARKET TRIAL

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Abstract

Background: Reducing the price of fruits and vegetables (F&V) is a promising but unproven intervention to improve dietary habits in the context of health promotion. The aim of this study is to examine the effects of discounting F&V and nutrition education on supermarket purchases in a randomized controlled trial.

Methods: A 6 month randomized controlled trial was conducted in 4 Dutch supermarkets. N=199 participants were randomized into one of four conditions: 1) price discounts (50%) on F&V; 2) nutrition education; 3) price discounts plus nutrition education; 4) no intervention. Outcomes were F&V purchases (gram), change in F&V consumption and monetary expenditures in other product categories. Data were collected using supermarket cash receipts supplemented with questionnaires.

Results: Adjusted multilevel models revealed significant higher F&V purchases (per household per two weeks) as a result of the price discount plus education intervention at six months compared to control: +4.7 kilogram fruits plus vegetables ($p=.002$), +3 kilogram fruit ($p=.005$) and +1.6 kilogram vegetables ($p=.05$). Moreover, the percentage of participants consuming recommended amounts of F&V (≥ 400 gram/day) increased from 42.5% at baseline to 61.3% at six months in both discount groups ($p=.03$). No significant effects of the education alone were found. There were no indications that participants spent the money they saved on other food categories.

Conclusion: Offering a 50% price discount on F&V lead to substantial higher purchases of these products when combined with education. The percentage of participants consuming recommended amounts of F&V increased considerably during the intervention in both groups who received discounts.

Introduction

Sufficient intake of fruits and vegetables (F&V) forms a principal component of dietary recommendations¹. Nevertheless, both in the USA² and Europe³ intakes of F&V are far below these recommended levels. Increasing the intake of F&V in line with dietary recommendations could reduce the burden of non-communicable diseases drastically⁴. Effective interventions to promote F&V intake are urgently needed to accomplish this goal⁵. Such interventions are particularly needed among people with a lower socio economic status (SES) since diet related problems are most urgent in these groups^{6,7}.

Food pricing strategies are frequently cited as a promising intervention opportunity to stimulate F&V purchases^{8,9}. Especially consumers with a lower SES perceive healthy foods to be expensive and indicate they would buy more of those products if they would become cheaper^{10,11}. Nevertheless, evidence on the effects of making healthy foods cheaper is small^{12,13}. Furthermore, there are also indications for negative side effects¹⁴ such as an increased number of total purchased energy^{15,16}.

In order to gain insight into the effects of making healthy foods cheaper it is important to study the effects in supermarkets^{17,18}. In many parts of the world, supermarkets are the dominant food environment^{19,20}, but evidence on effective interventions in retail settings is limited²¹. There are some examples of pricing trials which were conducted in a laboratory or computerized supermarket^{15,16,22}. For example, in an experimental study using a three-dimensional web-based supermarket we found that a 25% discount on F&V was effective in stimulating the purchases of these products²². Although these results are promising, they need to be replicated in real-life settings.

To our knowledge, the only randomized controlled trials studying the effects of pricing strategies in real supermarkets are the New Zealand SHOP study²³ and a French study on the effects of F&V vouchers²⁴. SHOP evaluated the effects of a 12.5% discount on healthier foods and nutrition education on supermarket purchases. The authors found that participants receiving price discounts purchased 11% more healthy food items at six months, but concluded that further work is needed to determine how to amplify the effect of pricing strategies²³. Similarly, the French study observed positive effects for price discounts on F&V consumption, but a major limitation of this study was a significant loss to follow-up²⁴.

In conclusion, the evidence on the effectiveness of pricing interventions to stimulate F&V purchases is limited. This study will therefore extend the findings from earlier work. The aim was to examine the effects of a 50% discount on F&V or nutrition education or a combination of both on supermarket purchases. F&V were chosen to be discounted because they form a key component of a healthy diet and consist of clearly defined products. The nutrition education component was added because previous authors emphasized that price alone will not improve dietary habits and that additional education interventions are needed^{25,26}. We included people with a relatively low SES since the burden of non-communicable disease is largest in this group and potential financial barriers in up taking a healthy diet mainly applies to these people^{10,11,27}.

Methods

Study Design

The present study was a nine month randomized controlled trial, with a six month intervention and three month follow-up period. The trial contained four research arms: 1) price discounts on F&V; 2) nutrition education; 3) price discounts on F&V plus nutrition education; 4) no intervention. The study was conducted between September 2010 and July 2011 in four Dutch supermarkets. The trial was registered in the ISRCTN Register (ISRCTN56596945) and the study protocol was approved by the Institutional Medical Ethical Committee on February 12th 2009. All participants provided written informed consent.

Selection and recruitment of supermarkets

This study was conducted in collaboration with individual store owners of C1000 and PLUS supermarket chains. These chains had the second and third largest market share in the Netherlands respectively. We recruited supermarkets in areas with no other supermarkets in the vicinity (using Google Maps). This approach was used to prevent interference, for example, from appealing promotions in nearby other supermarkets. This resulted in an initial list of seven PLUS and four C1000 stores. Owners of these eleven stores were sent a formal letter explaining the rationales of the study. After one week, all owners were phoned and were asked for participation. Four owners could not be reached in time due to holidays. Three owners were not willing or able to participate. Four store owners (2 PLUS and 2 C1000) agreed to participate in the study. The stores were spread through four different Dutch provinces and located in rural areas within villages with a population size ranging from 3,300 to 6,100.

Participants and recruitment

Participants were recruited in July and August 2010. For recruitment we used posters, flyers (handed out by the cashiers) and advertisements in local newspapers. A sample size was calculated using data on F&V intakes (mean and standard deviations (SD)) from the Dutch National Food Consumption Survey²⁸. It was calculated that in order to detect a significant difference of 65 grams of fruits and 50 grams of vegetables per person per day, a sample size of n=180 was required. In total, n=316 participants signed up (see Figure 10.1). Following, participants were checked for their eligibility. Because Dutch people are generally reluctant in providing details about their income; low SES consumers were selected based on their education level (no more than a completed medium secondary education). Second, participants had to be frequent shoppers in the participating stores. Finally, participants had to be 18 years onwards and speak the Dutch language. Based on these criteria n=234 participants were included and were sent the baseline questionnaire and informed consent.

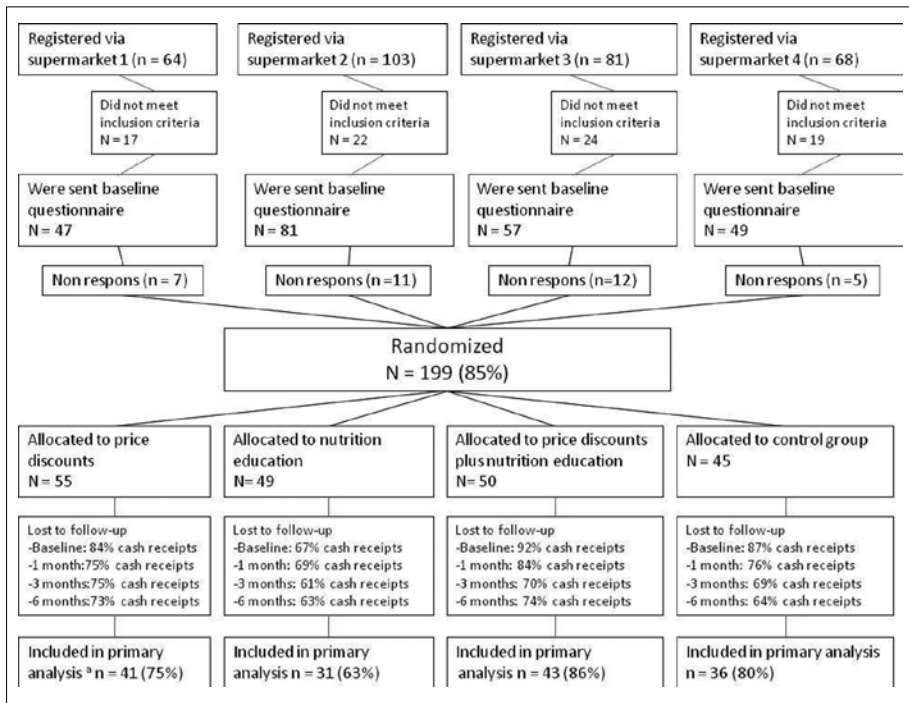


Figure 10.1 Consort flow diagram

Randomization

N=199 (85%) participants returned the baseline questionnaire (Figure 10.1) and were individually randomized by using the Random Number Generator in Excel into one of four study conditions. This allocation procedure was blinded. Participants were blinded to the research aims of this study, but not with regard to allocation of the intervention conditions.

Interventions

Nutrition education

Nutrition education consisted of two elements. Participants received recipe books and underwent telephone counseling. The recipe books were based on a Dutch municipal health service program and provided easy, tasty and cheap recipes containing large quantities of F&V. Participants received two recipe books: one containing autumn recipes (at the start of the intervention) and one containing winter recipes (halfway the intervention in January).

The telephone counseling consisted of four telephone calls that were conducted by a qualified dietitian ²⁹. Every round, at least three attempts were made to reach a participant, including one evening attempt. If a participant could not be reached, new attempts were made in the next counseling round. Each call lasted around 20 minutes. The counseling scheme was based on the principles of Motivational Interviewing (MI). The rounds were divided in two phases: 1) building motivation for change and 2) strengthening commitment to change ³⁰. MI uses several specific conversation techniques such as asking open questions and reflective listening, with the aim to create an open conversation without any counselor bias. The dietitian received two full days of certified training in MI in order to obtain these skills. Within this MI framework, different theoretical insights were combined in order to provide a firm education program. Psycho-social determinants of F&V intake were addressed based on the Theory of Planned Behavior (TPB) ³¹. Second, special attention was paid to the misperceptions of own behavior ³². Finally, the self-regulatory process action planning (e.g., specifying when and how to act) and coping planning (e.g., anticipating personal risk situations and planning coping responses beforehand) were incorporated ^{33,34}.

Price discounts

The pricing intervention consisted of a 50% price discount on F&V. Discount levels up to 50% seem to be feasible³⁵ and are frequently used by retailers. Furthermore, similar discount levels have been previously used in experimental studies in smaller settings and it is interesting to extrapolate these findings to a real supermarket environment^{13,16,36}. The discounts were provided by use of coupons. Coupons were used because this method was previously found to be effective³⁷ and because this system enabled offering discounts in all four supermarkets without interfering with the non-discount intervention groups. Participants were sent discount coupons (by post) for seven types of vegetables and five types of fruits every two weeks with two coupons for each item. Throughout the intervention period, participants received thirteen coupon series (26 weeks) with changing discount selections. In addition, apples were discounted throughout the entire intervention period, enabling to study the effects of a continuous price reduction too. Discounts were chosen in line with seasonal availability. To prevent sharing, each coupon had a maximum amount of produce that could be purchased. Overall, participants were able to buy a maximum of approximately 48 kilogram of F&V on discount per two weeks. Discounted products were mostly fresh produce, but every series also included some canned and frozen products. Discounts were given on F&V as a whole product only and not on products such as meal salads or ready to eat meals. Fruit and vegetable juices, apple sauce, tomato sauce and potatoes were also excluded from discount.

Data collection and outcome measures

Data collection took place in five rounds: baseline, 1 month after start of the intervention; at 3 months, at 6 months (end intervention period) and 9 months (3 month follow-up). This paper is restricted to the results obtained in the six months of intervention.

Outcome Measures

The main outcome measures were household F&V purchases (combined and separately, measured in grams) and household expenditures on other supermarket items (€). These measures were derived from supermarket cash receipts (from the participating supermarkets) that were collected each measurement round during a two-week period. This method has been previously validated and found to be a sufficient measure for household food purchases³⁸. In order to capture purchases outside the participating supermarkets, participants were additionally asked to fill out questionnaires asking what part of their F&V they purchased at the participating supermarket. Second,

the supermarket owners provided information on how much discount coupons were handed in each period. Finally, F&V consumption was measured by a shortened Food Frequency Questionnaire (FFQ) which was specifically developed to measure F&V consumption in the Dutch population. The FFQ was found a valid and reproducible instrument to measure F&V intake ³⁹. Data from this questionnaire were used to detect participants consuming sufficient (≥ 400 gram/day) or insufficient F&V.

Covariates

Participants were asked to report some basic personal characteristics (see Table 10.1), their use of the discount coupons, their evaluation of the nutrition education, and frequency of shopping at the participating supermarket. Body Mass Index (BMI) was measured by self reported height and weight at baseline and after nine months. Next, the index of habit strength ⁴⁰ was used to measure habit strength with regard to F&V purchases (measured separately). The habit score was determined by calculating the average score of the individual twelve items which were measured on a 5 point Likert scale.

Incentives

Participants received several small gifts in order to prevent drop out. First, participants in the discount group received a substantial discount on F&V. Second, small gifts were sent to the whole sample, including fridge magnets, coins for supermarket trolleys, shopping bags, ballpoints, and flower seeds. Also, participants received a St Nicholas gift and a Christmas card. At the end of the study, a special meeting was arranged at all four supermarkets where participants received a box filled with groceries (value around €40) and a gift coupon (€5) (non discount groups) or a discount coupon (€5) only (discount groups).

Statistical Analyses

Intervention reach

The discount coupon reach was examined using supermarket data showing the number of coupons that were handed in at each time period. Also, these data were used to examine differences in general coupon use and the specific use of apple coupons (consistently provided during the entire intervention). One supermarket did not provide reliable data and was thus excluded for analysis on apple coupons. Supermarket data were supplemented with descriptive questionnaires to obtain coupon use at

consumer level. The nutrition education reach was examined by keeping track of the individual phone calls and was supplemented with descriptive questionnaires.

Main analyses

All randomly assigned participants with at least cash receipt measures at baseline and one follow-up measure were included in an intention to treat analyses (See Figure 10.1)⁴¹. Differences in fruit- (gram), vegetable- (gram), fruit+ vegetable purchases (gram) and total expenditures (€) between the intervention conditions and the control group at all follow-up measurements were analyzed using multilevel analyses with a random intercept at the subject level and including supermarket as fixed effect to adjust for clustering of individuals within supermarkets. All models included an interaction term between intervention and measurement time in order to calculate the time-specific intervention effects. In addition, we computed crude and adjusted models for all the outcomes. Besides the abovementioned factors and interaction, the crude models included baseline fruit and/or vegetables purchases or total expenditures. The adjusted models were extended by also including demographics on age, gender, ethnicity, education, income, household size, and BMI at baseline and finally by adding 'part of fresh F&V at participating supermarket', 'part of tinned/canned F&V at participating supermarket', and baseline habit for fruit and/or vegetable purchases to the model. Furthermore, it was examined whether habit specific for F&V purchases modified the effects. We found only one significant dummy interaction term and therefore it was decided to remove the interaction terms from the models. Next, sensitivity analyses were conducted on participants of whom the cash receipt measures were considered valid. Participants in the lowest 2.5 percentile for total expenditures were excluded here³¹ (total n=9 equally spread among the study conditions). Next, it was examined whether the percentage of participants consuming recommended amounts of F&V increased through the intervention period (using McNemar related samples-tests) and finally cross-price elasticity effects⁴² were tested (using paired samples *t*-tests). The latter effects were tested by comparing expenditures in other (non)food categories at baseline and at one month for both discount groups. We used an alpha of 0.05 for all tests of intervention effects. For the multilevel analyses we used MLWin2.24 and for the analyses on F&V consumption and cross-price elasticity we used SPSS version 17.0.

- 1 Cut-off points were <€18.36 total expenditures in two weeks at baseline <€15.62 at one month; <€24.91 at three months and <€32.29 at six months
- 2 Cross price elasticity is defined as the percentage change in the quantity demanded of a certain good in response to a given percentage change in the price of another good ⁴².

Results

Participant characteristics

Baseline characteristics are shown in Table 10.1. Some participants did not provide correct baseline data, leading to a sample of n=173 that could be used in analysis. Most participants were female (96%) and around 80% purchased at least half of their F&V in the participating supermarket.

Table 10.1 Baseline participant characteristics

	Price discount (n = 55)		Nutrition education (n = 49)		Price discount + nutrition education (n = 50)		Control (n = 45)		Total sample (n = 199)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Age ^a	52.6	12.8	48.3	11.4	52.7	12.6	52.6	12.5	51.7	12.4
Household size ^b	2.8	1.4	3.3	1.2	3.2	1.3	3.2	1.4	3.1	1.3
Purchased fruit (gram per 2 weeks) ^c	3,356	3,679	4,342	3,041	4,556	4,449	4,631	3,877	4,194	3,848
Purchased vegetables (gram per 2 weeks) ^d	3,277	2,539	3,840	2,406	3,396	2,406	3,169	2,482	3,398	2,451
Total expenditures (€ per 2 weeks) ^e	137.3	87.1	133.8	47.1	138.8	82.8	131.8	82.9	135.7	77.7
Habit score fruit Purchases ^f	3.7	0.8	3.8	0.7	3.6	0.8	3.6	0.9	3.7	0.8
Habit score vegetable Purchases ^f	3.6	0.9	4.0	0.8	3.7	0.7	3.6	0.8	3.7	0.8
	n	%	n	%	n	%	n	%	n	%
Sex										
<i>Male</i>	3	6.1	2	5.1	1	2.2	1	2.5	7	4.0
<i>Female</i>	46	93.9	37	94.9	44	97.8	39	97.5	166	96.0
Education level										
<i>Primary education</i>	2	4.2	-	-	2	4.8	1	2.5	5	3.0
<i>Lower secondary</i>	19	39.6	9	23.7	22	52.4	18	45.0	68	40.5
<i>Higher secondary</i>	5	10.4	4	10.5	3	7.1	1	2.5	13	7.7
<i>Intermediate vocational</i>	22	45.8	25	65.8	15	35.7	20	50.0	82	48.8
Income, gross monthly (€) ^f										
<i>Low (≤ 2000)</i>	21	43.8	10	26.3	12	27.3	12	30.8	55	32.5
<i>Medium (2000 – 3000)</i>	3	6.2	6	15.8	7	15.9	4	10.3	20	11.9
<i>High (3000 +)</i>	11	22.9	13	34.2	12	27.3	13	33.3	49	29.0
<i>Not answered</i>	13	27.1	9	23.7	13	29.5	10	25.6	45	26.6

Body Mass Index										
(BMI) ^g										
<i>≤ 25</i>	26	53.1	17	43.6	16	37.2	22	55.0	81	47.4
<i>25 – 30</i>	17	34.7	18	46.2	19	44.2	12	30.0	66	38.6
<i>30 +</i>	6	12.2	4	10.3	8	18.6	6	15.0	24	14.0
Ethnicity ^h										
<i>Dutch</i>	48	98.0	38	97.4	43	95.6	38	95	167	96.5
<i>Other</i>	1	2.0	1	2.6	2	4.4	2	5	6	3.5
Fresh F&V in studied supermarket										
<i>All</i>	15	30.6	7	18.4	6	14.6	16	40.0	44	26.2
<i>Most</i>	16	32.7	13	34.2	17	41.5	11	27.5	57	33.9
<i>Half</i>	5	10.2	11	28.9	11	26.8	6	15.0	33	19.6
<i>Some</i>	11	22.4	5	13.2	6	14.6	6	15.0	28	16.7
<i>None</i>	2	4.1	2	5.3	1	2.4	1	2.5	6	3.6
Other F&V in studied supermarket										
<i>All</i>	19	39.6	17	43.6	12	30.0	16	40.0	64	38.3
<i>Most</i>	10	20.8	6	15.4	14	35.0	8	20.0	38	22.8
<i>Half</i>	1	2.1	4	10.3	3	7.5	3	7.5	11	6.6
<i>Some</i>	8	26.7	7	17.9	6	15.0	3	7.5	24	14.4
<i>None</i>	10	20.8	5	12.8	5	12.5	18	25.0	30	18.0
Grows own vegetables										
<i>Yes (partially)</i>	11	22.4	12	33.3	9	20.0	15	37.5	47	27.7
<i>No</i>	38	77.6	26	66.7	36	80.0	25	62.5	125	72.3
Grows own fruit										
<i>Yes (partially)</i>	10	20.4	7	20.5	6	15.6	12	30.0	35	21.4
<i>No</i>	39	79.6	31	79.5	38	84.4	28	70.0	136	78.6

a. The average age in the Netherlands in 2011 was 40.3 years ⁵⁹

b. The average household size in the Netherlands in 2011 was 2.20 persons ⁵⁹

c. The amount (gram) that is purchased for the household in two weeks in the participating supermarkets measured by cash receipts. Range for overall sample = min 0 – max 22,172 gram

d. The amount (gram) that is purchased for the household in two weeks in the participating supermarkets measured by cash receipts. Range for overall sample = min 0 – max 11,650 gram

e. Total expenditures on groceries in the participating supermarket (2 wks) measured by cash receipts

f. Measured by the index of Habit strength⁴⁰: minimum = 1 (low habit); maximum = 5 (strong habit)
The standard gross monthly income in the Netherlands (2011) was € 2,546 ⁶⁰

g. In 2009, 35% of the Dutch adult population was overweight (BMI 25 – 30) and 11.8% obese ⁶¹

h. In 2011, the Dutch population consisted for 20.6% of migrants ⁵⁹

One-hundred eleven (56%) participants provided shopping data for all four measurement rounds and n=151 (76%) participants had sufficient shopping data for the intervention phase and were included in multilevel analyses (See Figure

10.1). Forty-eight participants were excluded from analyses, of which n=24 provided valid baseline data. When comparing these participants with the remaining sample (n=151) on baseline characteristics, it was found that drop outs differed slightly by supermarket (p=.04), that relatively more men dropped out (p=.00); and that relatively less participants with a high income dropped out (p=.004). For the remaining characteristics no significant differences were found.

Intervention reach

Participants in the price discount groups received all discount coupons in line with the intervention protocol. Supermarket data revealed that the percentage of coupons that was handed in throughout the intervention period ranged from 15% to 100% (Figure 10.2a). The percentage of apple coupons handed in was similar to the other coupons (Figure 10.2b). On average around 41% of the coupons were handed in. Data in the questionnaires indicated a maximum of three participants that did not use the coupons. Furthermore, 73%, 60% and 71% of the participants indicated to have used at least half of the coupons, at one month, three months and six months respectively.

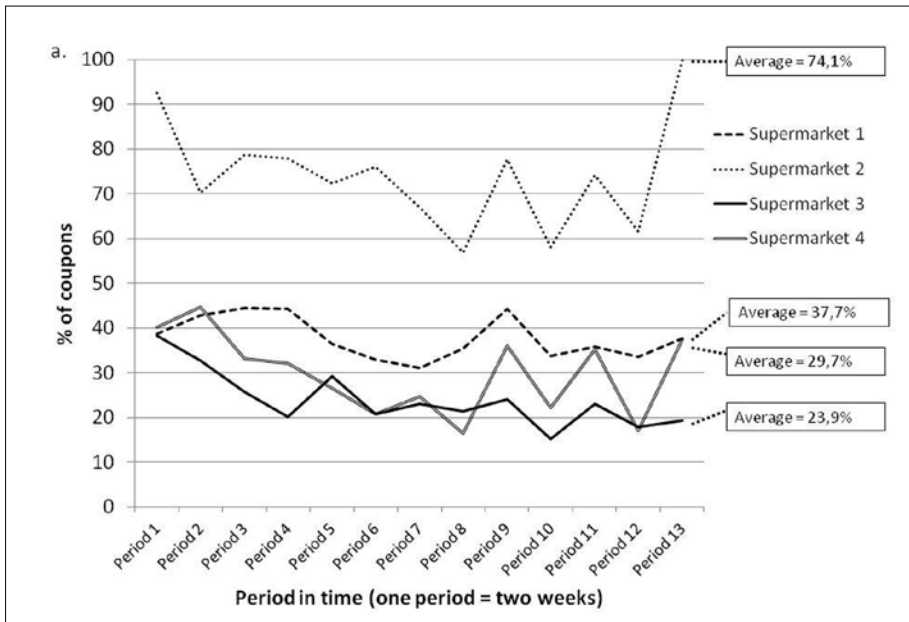


Figure 10.2a Percentage of coupons handed in per supermarket through time

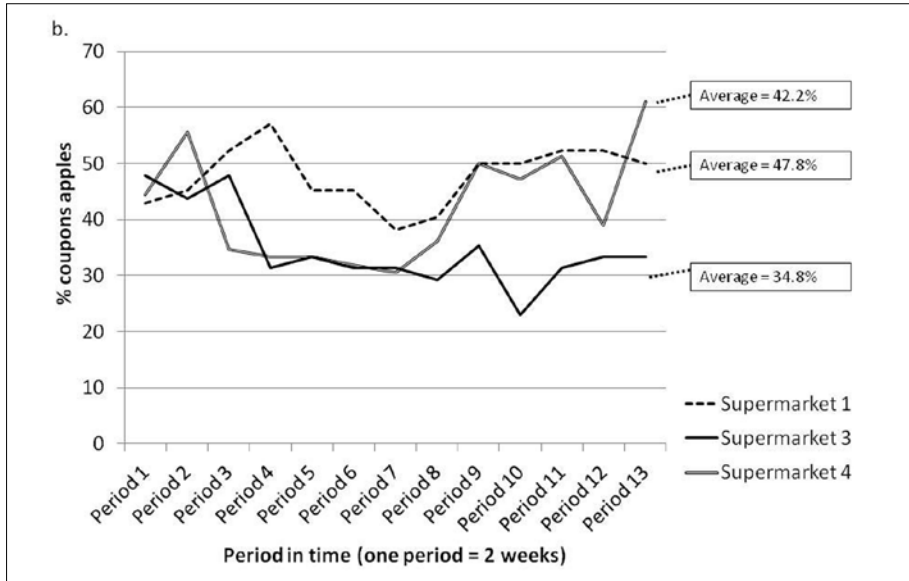


Figure 10.2b Percentage of coupons for apples handed in per supermarket through time

In the education groups all participants received the two recipe books as planned. Furthermore, 54.5% received all four counselling calls; 16.2% received three calls; 9.1% received two calls; 6.1% received one call and 14.1% was not reached at all. At 6 months participants were asked whether they had changed their nutrition behaviour due to the calls: 23% answered 'a little'; 15% answered 'a lot'; and 7% answered 'very much'. Overall, participants reviewed the counselling calls positively.

Differences in fruit and vegetable purchases and total expenditures

Crude multilevel model

Table 10.2 shows that participants in the discount and discount plus education group purchased more F&V compared to the control group. These differences were largest at the 6 month measurement, where the discount group purchased over 3 kilogram more fruit ($p < .001$), 1.9 kilogram more vegetables ($p = .003$) and 5.3 kilogram more fruits plus vegetables ($p < .001$) for their household for two weeks compared to the control group. Similar differences were found in the price discount plus education group. No statistically significant effects of the education alone were observed, except for a negative effect for vegetable purchases at one month (-1.3 kilogram, $p = .046$).

Table 10.2 Crude effects of the price discounts, nutrition education and price discounts + nutrition education at all time points ^a

Time	Outcome measure ^b	Price discounts (n=41)			Nutrition Education (n=31)			Price discounts+ nutrition education (n=43)		
		B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI
One month	Fruit (gram)	2,274*	552	3,996	-233	-2,077	1,611	1,244	-449	2,937
	Vegetables (gram)	120	-1,066	1,306	-1,297*	-2,572	-22.5	610	-561	1,781
	Fruit + vegetables (gram)	2,415‡	-47.5	4,878	-1,547	-4,190	1,096	1,885	-545	4,314
	Total expenditures (€)	-19.3	-48.5	9.93	-12.3	-43.7	19.0	-22.9	-51.8	5.95
Three months	Fruit (gram)	621	-1,125	2,366	-319	-2,224	1,586	729	-1,039	2,498
	Vegetables (gram)	515	-687	1,716	-611	-1,928	705	101	-1,121	1,324
	Fruit + vegetables (gram)	1,148	-1,347	3,643	-990	-3,720	1,739	838	-1,696	3,372
	Total expenditures (€)	-24.3	-55.0	5.37	-19.0	-51.2	13.3	-12.9	-42.8	17.1
Six months	Fruit (gram)	3,367***	1,553	5,181	-1,203	-3,445	1,040	3,656***	1,839	5,473
	Vegetables (gram)	1,869**	622	3,116	709	-640	2,057	1,678**	423	2,934
	Fruit + vegetables (gram)	5,264***	2,674	7,854	64.0	-2,730	2,858	5,308***	2,709	7,908
	Total expenditures (€)	-1.31	-32.0	29.4	1.50	-31.4	34.4	6.99	-23.7	37.7

^a Results of crude multilevel analyses. Models included a random intercept at the subject level, supermarket as fixed effect, an interaction term between intervention and measurement time and baseline value of the outcome measure.

^b Outcomes were measured by cash receipts from the participating supermarkets collected during a two-week period

‡ Borderline significant at p=.05

* significant at p<.05

** significant at p<.01

*** significant at p<.001

Adjusted multilevel model

Table 10.3 shows the results for the fully adjusted multilevel models. Here only statistically significant effects were observed in the price discount plus education group at six months. The effects of the discounts only at one and six months remain

large and positive in the adjusted models, but cease to be statistically significant. The largest part of the difference in effects found between the crude and adjusted models was explained by ‘the amount of purchases that was done in the participating supermarkets’ (Table Appendix 10.1).

Table 10.3 Adjusted effects of the price discounts, nutrition education and price discounts + nutrition education at all time points ^a

Time	Outcome measure ^b	Price discounts (n=41)			Nutrition Education (n=31)			Price discounts + nutrition education (n=43)		
		B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI
One month	Fruit (gram)	1,948	-160	4,056	979	-1,153	3,111	1,279	-761	3,319
	Vegetables (gram)	-688	-2,248	873	-581	-2,187	1,025	893	-662	2,448
	Fruit + vegetables (gram)	1,168	-1,851	4,188	640	-2,455	3,736	2,125	-875	5,125
	Total expenditures (€)	8.73	-65.5	82.9	18.8	-54.7	92.3	8.95	-65.2	83.1
Three months	Fruit (gram)	-130	-2,160	1,901	-303	-2,545	1,938	499	-1,499	2,497
	Vegetables (gram)	616	-861	2,094	355	-1,307	2,017	740	-741	2,221
	Fruit + vegetables (gram)	481	-2,376	3,338	253	-2,949	3,454	1,336	-1,529	4,202
	Total expenditures (€)	-38.5	-109	32.5	-8.41	-86.8	70.0	0.78	-71.1	72.6
Six months	Fruit (gram)	1,915	-243	4,074	-542	-2,827	1,743	3,053*	939	5,168
	Vegetables (gram)	900	-658	2,458	1,269	-421	2,959	1,567‡	-.80	3,135
	Fruit + vegetables (gram)	2,673	-359	5,706	924	-2,325	4,172	4,738*	1,715	7,761
	Total expenditures (€)	45.6	-28.3	119.5	-11.5	-90.0	67.1	1.65	-73.3	76.6

^a Results of adjusted multilevel analyses. Models included a random intercept at the subject level, supermarket as fixed effect, an interaction term between intervention and measurement time and baseline value of the outcome measure *plus* age, gender, ethnicity, education level, income, household size, part of fresh fruits and vegetables at participating supermarket, part of tinned/canned fruits and vegetables at participating supermarket, BMI at baseline and baseline habit for fruit and/or vegetable purchases

^b Outcome measures were measured by cash receipts from the participating supermarkets collected during a two-week period

‡ Borderline significant at p=.05

* significant at p<.05

** significant at p<.01

Sensitivity analyses

Some participants returned incomplete numbers of cash receipts. Therefore, we conducted sensitivity analyses on a subsample of participants who purchased at minimum of around € 20 at the participating supermarkets. These analyses yielded similar results as the analyses on the total sample (results not shown).

Changes in fruit and vegetable consumption

Looking at the percentage of participants consuming sufficient amounts of F&V at baseline and six months, it was found that this percentage increased significantly from 42.5% at baseline to 61.3% at six months in the discount groups ($p=.03$). For the non-discount groups these percentages were 52.7% and 52.5% respectively ($p=.80$).

Other purchases/ Cross price elasticity

Table 10.4 shows mean differences between baseline and one month supermarket purchases for both discount groups. No significant differences in total expenditures, expenditures on other items than F&V, other *food* items than F&V or non-food items were observed. This indicates that participants did not use the extra money from the discounts to purchase other supermarket items.

Table 10.4 Mean differences in expenditures at baseline and one month for participants in the discount groups (n = 81)^a

	Mean difference	Lower 95% CI	Upper 95% CI
Total expenditures (€)	-8.44	-25.45	8.55
Expenditures on vegetables (€) ^b	2.49	0.88	4.09
Expenditures on fruit (€) ^b	3.25	1.56	4.94
Fruit (gram)	1,816 ^{***}	858	2,774
Vegetables (gram)	1,327 ^{***}	654	2,001
Total other expenditures (€)	-7.67	-21.19	5.84
Expenditures on other food items (€)	-8.34	-20.91	4.22
Expenditures on non-food (€)	2.09	-2.66	6.84

^a Reports the value at one month minus the value at baseline using paired samples t-tests. Outcome measures were measured by cash receipts from the participating supermarkets collected during a two-week period.

^b These are the expenditures when not incorporating the discounts.

^{***} Significant at $p<.001$

Discussion

This randomized controlled supermarket trial studying the effects of F&V price discounts and nutrition education on supermarket purchases shows significant positive effects of the price plus education intervention on F&V purchases in both the crude and adjusted models. Moreover, the percentage of participants consuming recommended amounts of F&V increased substantially in the discount groups from baseline to six months while no difference was observed in the non-discount groups. The largest intervention effects were observed at 6 months (at the end of the intervention period) and were generally stronger for fruit than for vegetable purchases. Comparing expenditures on other (food) items at baseline and one month for the discount groups revealed no significant differences, indicating that participants did not use the saved money from the discounts to purchase other supermarket items. No effects of the education alone were found.

Despite the growing consensus that food pricing strategies are a promising intervention to stimulate healthy food purchases, supermarket trials examining such interventions are scarce^{12, 18, 43}. To our knowledge, this is the first randomized controlled trial specifically studying the effects of F&V price discounts and nutrition education in a real supermarket setting during a 6 month time period. Results showed that, at 6 months, the price discount plus education group purchased 4.7 kilogram more F&V for their household for two weeks than the control group. Calculating this number into grams per person per day would result in 113 grams extra purchases. As the latest Dutch Food Consumption Survey showed that on average people consumed 198 grams of F&V per day⁴⁴, this would implicate a major increase which is very relevant for public health⁴⁵.

An important notion on our results is however that the fully adjusted models only showed statistically significant effects of the price discount *plus* nutrition education and only at 6 months. This means that accompanying strategies, such as education, may be needed to amplify the effects of pricing strategies, which was also concluded in the SHOP study²³. Nevertheless, also the effect of pricing alone seems relevant. The discount only group purchased at 6 months 2.7 kilogram more F&V for their household for two weeks than the control group, which relates to a difference of 68 gram per person per day. Our relatively small sample and thus low power may form an important explanation for the non significant effects in the adjusted models. The standard deviations found in the present study were much larger than the ones used in our initial sample size calculation. An important indication for the relevance of

the pricing effect alone comes from the finding that the percentage of participants consuming recommended amounts of F&V increased substantially from baseline to six months in both groups who received discounts. Supermarket data revealed that the discount coupons were heavily used, which provides extra confidence in the successfulness of this intervention strategy. These findings are in line with earlier work showing that study participants made frequent use of the provided discount coupons and increased their servings of F&V^{37,46}. Moreover, the SHOP study found that study participants purchased 11% more healthy food items due to a 12.5% price discount on these items²³.

An explanation for the relatively stronger effects at one and six months compared to three months may be that these two periods profited from 'good start' and 'good end' effects. In other words, people react mostly stronger to an intervention in the beginning. Also, participants were aware of the fact that the discounts would end at 6 months, for which they may have wanted to profit extra from the final coupons. In addition, the 3 month measurement was in middle of a strong winter, which may have influenced the intervention effects because people had worse access to the supermarkets. Nevertheless, the supermarket data revealed that participants handed in similar numbers of coupons through time. It is therefore important that future studies examine time-effects of food pricing strategies (more) closely⁴⁷.

An important strength of this study was that supermarket cash receipts were used to measure F&V purchases. An advantage of this method over traditional surveys is that the data are objective, unaffected by recall bias and largely also unaffected by overrepresentation of occasional purchases, or social desirability of answers^{48,49}. In addition, the use of cash receipts has been validated and found to be a sufficient measure for household food purchases³⁸ and to have strong associations with household nutrient intake⁵⁰. For these reasons, cash receipts were considered a more valuable instrument than food consumption surveys, although they do not reveal actual food consumption^{48,51}. We did however also measure F&V consumption by a shortened FFQ, which was used to determine the change in percentage of participants that consumed recommended amounts of F&V from baseline to six months. FFQ's are found to be valid for making such classifications³⁹, and the results form an additional support for the positive price intervention effects found by the cash receipts. Moreover, these results show that not just people who already consumed much F&V increased the purchases, but also those at lower intakes did so.

Another merit of this study is that we were able to get a proper indication of the intervention effects on total food purchases. This is very important because it can be expected that the discount coupons may have driven participants in these particular groups to visit the participating supermarkets more frequently than the non-discount groups. This potential bias was minimized by several elements of the design of the study ^{23,24}. First, supermarkets were located in areas with no other supermarkets or F&V stores in the vicinity; meaning that it can be expected that most purchases were captured by the cash receipts. In addition, only participants who indicated that they purchased at least half of their F&V in the participating supermarkets were included in this study. Furthermore, we asked how much F&V were purchased at the participating supermarkets and this was included in the adjusted models as a covariate. Adding this covariate to the model attenuated the intervention effects of discount with education considerably. This implies that, especially, participants in the non-discount groups may have travelled to other stores to find good F&V offers there. It is therefore interesting to know how people react upon discounts that apply to all possible points of purchase and, more importantly, what the exact total F&V purchases will be. A related point is that the present study used coupons to provide the price discounts. This strategy can be expected to have different effects than in store price discounts. A merit of using coupons is that they can be specifically targeted at low SES consumers who are most in need for such financial incentives, for example by incorporating them into existing schemes such as the Food Stamp Program ⁵², the Special Supplemental Nutrition Program for Women (WIC) ^{37,46} or Food Assistance Programs. A focus at specific target groups is also relevant with regard to the distributional effects of food pricing strategies. A population wide fiscal policy could worsen economic inequality wherefore strategies that target specific vulnerable populations are more appropriate ⁵³

In addition to the intervention effects on F&V purchases, also cross-price elasticity effects are important to consider. The importance of measuring these effects is shown by results from studies in non-real supermarket settings which found that people used the money saved from discounts on healthier products to buy other (less healthy) food products ^{15,16}. The two present real supermarket trials did not examine cross-price elasticity in detail (SHOP)²³ or did not include such effects at all ²⁴. Our study is thus the first real supermarket trial that brings more detailed cross-price elasticity effects. Results revealed that participants did not use the money saved from the discounts in other (food) categories in the supermarkets. Although our analyses were restricted

to one month follow-up data, we do not expect the 3 and 6 month data to indicate otherwise. Likewise, in the virtual supermarket no major cross-price elasticity effects were observed when only F&V were discounted ²², as apposed to a general healthy food subsidy. Total expenses were, however, not significantly affected, which is important for supermarkets who offer the discounts. Next, food price changes, especially when they are large, can also be expected to have effects in domains outside the supermarket (e.g., eating out, cigarettes). Therefore, further research is needed to capture the effects on overall household expenditures ^{54,55}.

In contrast with a meta-analysis showing moderate effects of MI on dietary changes ⁵⁶ our study did not find statistically significant effects of the nutrition education intervention alone. Three potential reasons for the lack of effects may have been the experience of the counsellor, the use of telephone calls to deliver the intervention and the relative low number of calls²⁹. The effectiveness of MI could probably be increased by a more intensive, professional and long-term intervention. Nevertheless the sustainability and affordability of such education programmes may be a barrier to implementation, especially when it is aimed to reach whole populations ⁵⁷. In line with the SHOP study, we therefore put forward that structural interventions in the food environment are more powerful to change dietary behaviour than programs that rely on individual behaviour change ²³. Still, the results of the present study revealed that educational programs can be helpful in enlarging the effects of food pricing strategies. Alongside the sustainability and affordability of education programs, also the feasibility of pricing interventions is important to consider. The 50% price discount used in the present study was relatively high. Nevertheless, a recently published paper illustrated that an expert panel was uniformly in favor of stimulating healthy food purchases by a F&V subsidy ⁵⁸, and also in our earlier Delphi Study we found that experts favored subsidizing strategies to stimulate healthy eating ³⁵. Nevertheless, implementation and administrative costs need to be examined ¹² and also the long term effects of food pricing strategies and long-term effects on health should be carefully monitored ⁴⁷.

Our study shows that discount coupons offering a 50% price discount on F&V were heavily used and lead to a substantial increase in F&V purchases. The effects added up to an average extra purchase of 113 gram per person per day when combined with nutrition education. While the effects of price changes alone were substantial, they were not statistically significant in the adjusted models, indicating that accompanying

education interventions are needed to enlarge and continue the pricing effects. Nevertheless, we propose that discounting F&V is a promising intervention strategy, especially because we found a substantial increase in the percentage of consumers consuming sufficient amounts of F&V in the discount groups and no effects of education alone. Future research should focus on how lower F&V prices affect overall household expenditures and examine what the definite health effects of such measures will be.

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Table Appendix 10.1 Partly adjusted effects of the price discounts, nutrition education and price discounts + nutrition education at all time points ^a

Time	Outcome measure ^b	Price discounts (n=41)			Nutrition Education (n=31)			Price discounts+ nutrition education (n=43)		
		B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI	B	Lower 95%CI	Upper 95%CI
One month	Fruit (gram)	2,922^{**}	845	4,999	735	-1,400	2,870	1,984[‡]	-26.0	3,994
	Vegetables (gram)	139	-1,402	1,681	-624	-2,236	988	1,433	-88.9	2,954
	Fruit + vegetables (gram)	3,271[*]	202	6,340	421	-2,802	3,644	3,584[*]	543	6,626
Three months	Fruit (gram)	498	-1,586	2,582	-239	-2,478	2,000	850	-1,204	2,906
	Vegetables (gram)	779	-749	2,307	-124	-1,788	1,539	835	-700	2,369
	Fruit + vegetables (gram)	1,442	-1,605	4,489	-191	-3,509	3,128	1,845	-1,221	4,910
Six months	Fruit (gram)	2,509[*]	340	4,678	-1,244	-3,544	1,055	3,133^{**}	970	5,296
	Vegetables (gram)	1,036	-550	2,621	416	-1,288	2,120	1,400	-214	3,014
	Fruit + vegetables (gram)	3,694[*]	528	6,859	-609	-4,008	2,789	4,700^{**}	1,488	7,912

^a Results of adjusted multilevel analyses. Models included a random intercept at the subject level, supermarket as fixed effect, an interaction term between intervention and measurement time and baseline value of the outcome measure *plus* age, gender, ethnicity, education level, income, household size, BMI at baseline and baseline habit for fruit and/or vegetable purchases

^b Outcome measures were measured by cash receipts from the participating supermarkets collected during a two-week period

[‡] Borderline significant at p=.05

^{*} significant at p<.05

^{**} significant at p<.01