

# Is there an association between the home food environment, the local food shopping environment and children's fruit and vegetable intake? Results from the Dutch INPACT study

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## Abstract

**Objective:** To examine: (i) the association between home availability of fruit and vegetables and children's fruit and vegetable intake; (ii) the association between parental perception of the local food shopping environment and the home availability of fruit and vegetables; and (iii) whether the home availability of fruit and vegetables mediates the association between parental perception of the local food environment and children's fruit and vegetable consumption.

**Design:** Cross-sectional study.

**Setting:** A total of ninety-one primary schools in the Netherlands.

**Subjects:** In total 1501 primary caregivers completed a questionnaire to measure children's fruit and vegetable consumption, home availability of fruit and vegetables, parental perceptions of the local food shopping environment (price, quality and availability), the child's socio-economic status, the child's ethnicity and maternal height and weight.

**Results:** The home availability of fruit and vegetables was positively associated with children's fruit and vegetable intake ( $P < 0.01$  and  $P < 0.001$ , respectively). Negative parental perceptions of the local food shopping environment were associated with less fruit available at home ( $P < 0.05$ ,  $P < 0.01$  and  $P < 0.05$  for price, quality and availability of fruit, respectively). No significant associations were found between parental perception of the local food shopping environment and children's fruit and vegetable consumption. We found no evidence that home availability of fruit and vegetables mediates the association between parental perception of the local food environment and children's fruit and vegetable intake.

**Conclusions:** Interventions focusing on improving the home availability of fruit and vegetables may help to increase children's fruit and vegetable consumption. However, more data are required on factors influencing the home availability of fruit and vegetables.

## Keywords

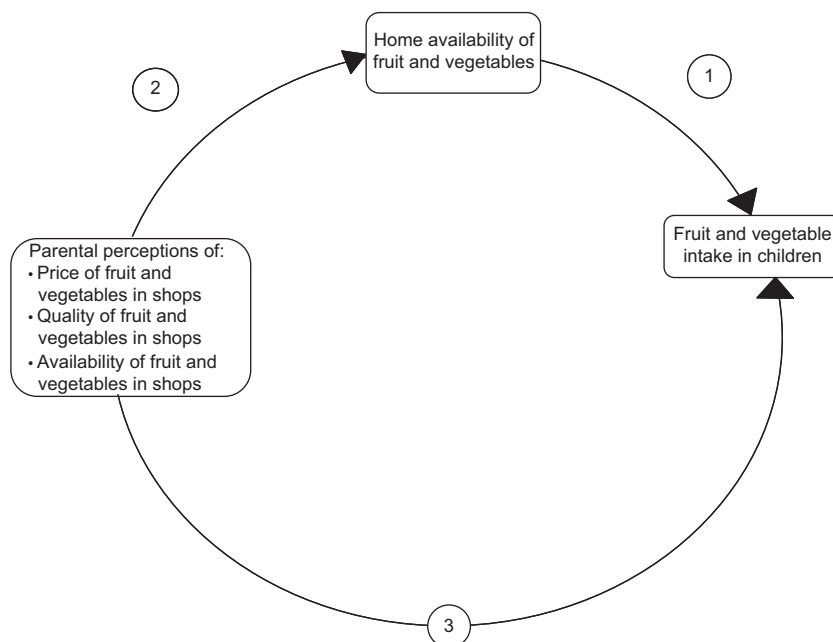
Home food environment  
Food shopping environment  
Fruit and vegetable intake  
Children

The beneficial effects on health of fruit and vegetables are well documented. Fruit and vegetables are rich in vitamins and fibre and can protect against CVD, some types of cancer and obesity<sup>(1–3)</sup>. There is also evidence that fruit and vegetable consumption in childhood protects against respiratory diseases<sup>(4–6)</sup>. It is also reported that fruit consumption in childhood reduces the risk of cancer in adulthood<sup>(7)</sup>. Because of the beneficial effects of fruit and vegetables, many countries (including the Netherlands) have dietary recommendation guidelines for fruit and vegetable intake for adults and children. For example, the US Department of Agriculture recommends a daily intake of 1½ cups of fruit and 2 cups of vegetables for children aged 9–13 years<sup>(8)</sup>. The WHO and FAO

recommend daily intake of 400 g of both fruit and vegetables<sup>(9)</sup>. The Dutch dietary guidelines for children aged 9–13 years recommend to consume at least two pieces of fruit and 150 g of vegetables daily<sup>(10)</sup>. However, the majority of children in the Netherlands, as in many other countries, do not consume these recommended amounts<sup>(11–14)</sup>. This stresses the need to develop interventions aimed at promoting increased intake of fruit and vegetables among children. In order to develop such interventions, more knowledge on the determinants of their fruit and vegetable intake is required.

Several studies have examined the correlates of children's nutritional behaviour. Traditionally, these focused on individual-level correlates such as knowledge,

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**Fig. 1** Conceptual research model used in the present study

attitudes, beliefs and taste preference. In recent years, ecological models and frameworks have highlighted the need to consider environmental factors in relation to nutritional behaviour<sup>(15–18)</sup>. For children, the home food environment, the local food shopping environment and the school food environment are important settings in which their nutritional behaviour takes place. Most research on environmental correlates of children's fruit and vegetable consumption have included the home food environment<sup>(19–23)</sup> and the local food shopping environment<sup>(24–26)</sup>.

The home food environment is a broad concept and includes home availability and accessibility of food, parental role modelling, parenting feeding styles and family food rules. Several literature reviews have concluded that elements of the home food environment are associated with children's fruit and vegetable intake. One of the elements of the home food environment that has been strongly associated with children's fruit and vegetable consumption is food availability at home. Children eat more fruit and vegetables when fruit and vegetables are available in their homes<sup>(21–23)</sup>.

The local food shopping environment includes measures of proximity and density of food outlets and availability, quality and price of food in shops. Research on the association between aspects of the local food shopping environment and children's fruit and vegetable intake is limited<sup>(24–26)</sup>; most studies in this field were performed among adults. Some studies among children and adolescents have been performed, but with inconsistent findings. For example, one study found that children with more fast-food restaurants and convenience

stores close to home consumed lower amounts of fruit and vegetables; it was also found that children who lived further away from a supermarket or a fast-food store consumed more vegetables<sup>(24)</sup>. Another study found that children who lived further away from supermarkets consumed more fruit and vegetables; however, that study found that a higher density of supermarkets in a neighbourhood was related to increased vegetable consumption<sup>(25)</sup>. In a more recent study, no association was found between the proximity of food outlets and children's fruit and vegetable consumption<sup>(26)</sup>.

As stated before, most research on environmental determinants of children's fruit and vegetable intake focuses mainly on either the home food environment or the local food shopping environment. Few studies have focused on both the home food environment and the local food shopping environment. It is likely that the local food shopping environment influences the home food environment, especially the home availability of fruit and vegetables. Therefore, the main aim of the present study was to examine both direct and indirect pathways between the local food shopping environment and children's fruit and vegetable intake (Fig. 1; conceptual research model).

The local food shopping environment can be measured objectively (e.g. objective assessment via geographic information systems) or subjectively (e.g. perceptions about characteristics of the local food shopping environment). Objectively measured environmental determinants neglect the perception of respondents about their environments. This perception is likely to be more important for behavioural choices, such as fruit and vegetable consumption,

than objectively measured aspects of the local food shopping environment<sup>(27)</sup>. The present study is, as far as we know, the first one which examines subjectively measured factors of the local food shopping environment in relation to children's fruit and vegetable consumption.

In the current paper we examine: (i) the association between home availability of fruit and vegetables and children's fruit and vegetables intake; (ii) the association between parental perception of the local food shopping environment and the home availability of fruit and vegetables; and (iii) whether the home availability of fruit and vegetables mediates the association between parental perception of the local food shopping environment and children's fruit and vegetable intake.

## Methods

### *Population and design*

INPACT is the acronym for IVO Nutrition Physical Activity Child cohort. INPACT is a longitudinal Dutch study among 8–12-year-old children and their parents. The aim of the study is to examine environmental determinants of children's dietary behaviour and physical activity. In 2008 the INPACT study started among grade 3 children (age 8 years); the subsequent waves of data collection took place in 2009 (second wave) and 2010 (third wave). Participants were recruited through primary schools in the southern part of the Netherlands (Eindhoven and surroundings). All general primary schools ( $n$  265) in this area were invited to participate in the study by the municipal health services; finally, ninety-one schools (34.3%) took part.

The response rate from rural and urban schools was equal. A sample of 1844 primary caregivers and their children (62.5%) gave informed consent.

The INPACT study was approved by the Ethical Committee of Erasmus Medical Centre, Rotterdam.

The present study was based on the data collection of the third wave (2010) of the INPACT study, which is the only wave that collected data on the local food shopping environment. All data presented herein were measured by means of a questionnaire. The primary caregiver filled in a questionnaire at home; 1501 (81.4%) primary caregivers, of whom 91.8% ( $n$  1378) were the biological mother, completed the questionnaire in 2010.

### *Measures*

#### *Fruit and vegetable intake*

Usual fruit and vegetable intake was measured with a questionnaire that was based on validated FFQ<sup>(28,29)</sup>. The primary caregiver of the child was asked how often his/her child usually eats: (i) fruit (fresh or canned fruit); (ii) cooked, fried, steamed or otherwise heated vegetables; and (iii) salad or other raw vegetables. Answering categories ranged from 'none or less than one day a week' to

'7 days a week'. The primary caregiver was also asked how many servings of fruit and vegetables his/her child usually eats. For fruit, answer categories ranged from '0 pieces a day' to 'more than three pieces a day' in increments of half a piece of fruit. Reported fruit consumption of 'more than three pieces a day' ( $n$  12) was recoded as 'four pieces a day'. For vegetables, answer categories ranged from '0 serving spoons' to 'more than four serving spoons a day' in increments of half a serving spoon. Reported vegetable consumption of 'more than four serving spoons a day' ( $n$  22) was recoded as 'five serving spoons'. One serving spoon was equivalent to 50 g of vegetables, which is a standard serving of vegetables in the Netherlands. Total fruit and vegetable intake was calculated for each child by multiplying consumption frequency and serving portions. Total fruit and vegetable intake was dichotomized to be consistent with the current Dutch guidelines for fruit (<2 pieces/d,  $\geq$ 2 pieces/d) and vegetables (<150 g/d,  $\geq$ 150 g/d) for children in this age group.

#### *Home availability fruit and vegetables*

The availability of fruit and vegetables at home was measured with a questionnaire based on the validated Home Environment Survey<sup>(30)</sup>. The primary caregiver was asked about the availability of fruit and vegetables in their home, separately. Response categories were 'yes, always', 'yes, usually', 'sometimes', 'no, usually not' and 'no, never'. Due to limited variability of these variables, we dichotomized both variables into 'always' ('yes, always') and 'not always' ('yes, usually'; 'sometimes'; 'no, usually not'; 'no, never').

#### *Local food shopping environment*

We measured perceptions of the local food shopping environment with regard to: (i) price of fruit and vegetables; (ii) quality of fruit and vegetables; and (iii) availability of fruit and vegetables in the shops. Parental perceptions of these features were measured with three statements ('Fruit is expensive'; 'Quality of fruit is bad'; 'Availability of fruit in the shops is limited'). For vegetables the same statements were used. Answering categories for these statements were dichotomous: 'agree' or 'disagree'. The statements about the local food shopping environment have been used in another Dutch study<sup>(31)</sup> and were based on the results from a focus group of Dutch adults<sup>(32)</sup> and a literature review, to identify salient environmental determinants of fruit and vegetable consumption.

To avoid misunderstanding about the meaning of 'the local food shopping environment', we described in the questionnaire that the above-mentioned statements refer explicitly to food shopping outlets where participants usually go to purchase their fruit or vegetables.

#### *Potential confounders*

Child's age, child's ethnicity, child's socio-economic status (SES), child's BMI and maternal BMI were assessed as potential confounders.

Child's age was calculated from the date of birth and the date of measurement. Child's ethnicity was categorized into: 'native Dutch' (both parents were born in the Netherlands), 'Western immigrant' (at least one of the parents was not born in the Netherlands, but inside Europe (including former Yugoslavia and Soviet Union), North America, Oceania, Indonesia or Japan) and 'non-Western immigrant' (at least one of the parents was born in Turkey, Africa, Latin America or Asia).

Maternal educational level was used to measure child's SES. Maternal educational level was categorized into three groups: 'low' (primary school and lower secondary education), 'intermediate' (intermediate vocational education, higher secondary school and pre-university education) and 'high' (higher vocational education and university).

### BMI

Children's weight and height were measured in underwear without shoes to the nearest 0.1 cm and 0.1 kg; the measurements were made by trained research assistants. Weight and height were used to calculate the children's BMI; subsequently, children's BMI was categorized as 'underweight', 'normal weight' and 'overweight/obese'<sup>(33)</sup>. Overweight and obesity were pooled into one category due to the small number of obese children. Maternal BMI was calculated from self-reported data of weight and height. Maternal BMI was categorized into underweight (BMI < 18.50 kg/m<sup>2</sup>), normal weight (BMI = 18.50–24.99 kg/m<sup>2</sup>) and overweight/obese (BMI ≥ 25.00 kg/m<sup>2</sup>).

### Statistical analyses

Descriptive analyses were performed to describe the distribution of child age, child gender, child ethnicity, child BMI, maternal BMI and maternal educational level, children's consumption of fruit and vegetables, home availability of fruit and vegetables and parental perceptions of the local food environment.

The Pearson  $\chi^2$  test was used to explore possible confounders (child age, child gender, child ethnicity, child BMI, maternal BMI, child SES). Based on the results of the Pearson  $\chi^2$  test, all analyses were controlled for ethnicity, child BMI and child SES.

We used the four-step approach of Baron and Kenny to test whether home availability of fruit and vegetables mediated the association between the local food shopping environment and children's fruit and vegetable consumption<sup>(34)</sup>. According to Baron and Kenny, a mediator has to be associated with the predicted variable and with the outcome variable, and the predicted variable has to be associated with the outcome variable (steps 1–3 of the approach). When the associations in steps 1–3 are all significant, the criteria for mediation are met. Subsequently, step 4 assesses whether it is full mediation or partial mediation. To test if the criteria for mediation were met, several multivariate logistic regression

**Table 1** Characteristics of the study population: 8–12-year-old children and their parents, Dutch INPACT study, 2010

Characteristic	<i>n</i>	%
Child's age (years)		
9	45	3.0
10	1172	78.4
11	268	17.9
>12	9	0.6
Child's gender		
Boy	757	50.5
Girl	742	49.5
Child's ethnicity		
Native Dutch	1288	86.0
Western immigrant	121	8.1
Non-Western immigrant	89	5.9
Child's BMI		
Underweight	116	7.0
Normal weight	1281	77.7
Overweight/obese	251	15.2
Maternal BMI		
Underweight	19	1.3
Normal weight	953	65.7
Overweight/obese	479	33.0
Maternal educational level		
Low	380	22.1
Intermediate	791	46.1
High	545	31.8

models were computed to assess the associations between (Fig. 1):

1. home availability of fruit and vegetables (possible mediator) and children's fruit and vegetable consumption (outcome variable);
2. parental perception of the local food shopping environment (predicted variable) and home availability of fruit and vegetables (possible mediator); and
3. parental perception of the local food shopping environment (predicted variable) and children's fruit and vegetable consumption (outcome variable).

All analyses were performed with the statistical software package IBM SPSS statistics 19. Due to missing values, the numbers of participants included in the analyses differ for each model that was computed.

## Results

### Participant's characteristics

Table 1 presents some characteristics of the study population. Mean age of the children was 10.2 years, most were native Dutch (86.0%) and 15.2% were overweight/obese. The majority of the mothers had an intermediate level of education and 33.0% of them were overweight/obese.

### Associations between home availability of fruit and vegetables and children's fruit and vegetable consumption

Most children did not consume the recommended amount of fruit and vegetables: 87.4% of the children consumed

**Table 2** Associations between home availability of fruit and vegetables and children's fruit and vegetable consumption, Dutch INPACT study, 2010

	% of children not consuming recommended amount of fruit or vegetables	OR	95 % CI
Home availability of fruit† (n 1323)‡			
Always available	86.3	1.00	Ref.
Not always available	96.4	4.08**	1.75, 9.48
Home availability of vegetable† (n 1314)‡			
Always available	81.9	1.00	Ref.
Not always available	92.3	2.62***	1.61, 4.26

Ref., referent category.

\*\* $P < 0.01$ , \*\*\* $P < 0.001$ .

†Home availability of fruit and vegetables was measured on a 5-point scale which was dichotomized into 'always available' ('yes, always') and 'not always available' ('yes, usually'; 'sometimes'; 'no, usually not'; 'no, never').

‡Analyses adjusted for child's ethnicity, child's BMI and child's socio-economic status.

**Table 3** Negative parental perceptions of price, quality and availability of fruit and vegetables in shops, Dutch INPACT study, 2010

Negative parental perceptions of the local food shopping environment		n	%
Price (n 1465)	Fruit is expensive	234	16.0
Quality (n 1469)	Quality of fruit is bad	65	4.4
Availability (n 1466)	Availability of fruit in shops is bad	58	4.0
Price (n 1465)	Vegetables are expensive	168	11.5
Quality (n 1465)	Quality of vegetables is bad	44	3.0
Availability (n 1468)	Availability of vegetables in shops is bad	63	4.3

<2 pieces fruit/d and 83.8% consumed <150 g vegetables/d. The majority of the children had fruit (88.8%) or vegetables (80.8%) always available in their homes. Table 2 shows the association between the home availability of fruit and vegetables and children's fruit and vegetable consumption. Children who lived in a household where fruit was not always available were less likely to consume the recommended amount of fruit (OR = 4.08, 95 % CI 1.75, 9.48,  $P < 0.01$ ). For vegetables, a similar association was found between home availability and children's consumption (OR = 2.62, 95 % CI 1.61, 4.26,  $P < 0.001$ ).

#### **Associations between parental perception of the local food shopping environment and home availability of fruit and vegetables**

Table 3 provides data on parental perceptions of the local food environment. A minority of parents had a negative perception about the price of fruit or vegetables (fruit: 16.0%, vegetables: 11.5%), quality of fruit or vegetables (fruit: 4.4%, vegetables: 3.0%) and the availability of fruit or vegetables in shops (fruit: 4.0%, vegetables: 4.3%). Table 4 presents data on the association between parental perceptions about the price, quality and availability of fruit and vegetables in shops and the home availability of fruit and vegetables. Children of parents with negative perceptions of price, quality and availability were more likely to not always have fruit available in their homes (price: OR = 1.56, 95 % CI 1.02, 2.40,  $P < 0.05$ ; quality: OR = 3.03, 95 % CI 1.59, 5.77,  $P < 0.01$ ; availability: OR = 2.79; 95 % CI 1.38, 5.64,  $P < 0.05$ ).

For vegetables, no significant association was found between parental perceptions concerning the price, quality and availability in shops and the availability of vegetables at home.

#### **Associations between parental perception of the local food shopping environment and children's fruit and vegetable consumption**

Table 5 presents data on the association between parental perceptions of the price, quality and availability of fruit and vegetables in shops and children's fruit and vegetable consumption. No aspect of the local food shopping environment was associated with children's fruit and vegetable consumption.

#### **Mediation of the home food environment on the association between parental perception of the local food shopping environment and children's fruit and vegetable consumption**

We found no association between parental perception of the local food shopping environment and children's fruit and vegetable consumption, and no association between parental perception of the local food shopping environment and the home availability of vegetables. Therefore, the criteria for mediation were not met for both the association between parental perception of the local food shopping environment and children's fruit consumption and the association between parental perception of the local food shopping environment and children's vegetable consumption.

**Table 4** Associations between parental perceptions of price, quality and availability of fruit and vegetables and the availability of fruit and vegetables at home, Dutch INPACT study, 2010

	% of children who do not always have fruit or vegetables available at home†	OR	95 % CI
<b>Fruit‡</b>			
Price (n 1303)			
Fruit is expensive	15.0	1.56*	1.02, 2.40
Fruit is not expensive	10.5	1.00	Ref.
Quality (n 1309)			
Quality of fruit in shops is bad	23.4	3.03**	1.59, 5.77
Quality of fruit in shops is not bad	10.5	1.00	Ref.
Availability (n 1306)			
Availability of fruit in shops is limited	20.7	2.79*	1.38, 5.64
Availability of fruit in shops is not limited	10.9	1.00	Ref.
<b>Vegetables‡</b>			
Price (n 1294)			
Vegetables are expensive	17.4	0.93	0.60, 1.44
Vegetables are not expensive	19.8	1.00	Ref.
Quality (n 1295)			
Quality of vegetables in shops is bad	22.7	1.34	0.65, 2.79
Quality of vegetables in shops is not bad	19.3	1.00	Ref.
Availability (n 1298)			
Availability of vegetables in shops is limited	23.0	1.63	0.89, 3.09
Availability of vegetables in shops is not limited	19.2	1.00	Ref.

Ref., referent category.

\* $P < 0.05$ , \*\* $P < 0.01$ .

†Home availability of fruit and vegetables was measured on a 5-point scale which was dichotomized into 'always available' ('yes, always') and 'not always available' ('yes, usually'; 'sometimes'; 'no, usually not'; 'no, never').

‡Analyses adjusted for child's ethnicity, child's BMI and child's socio-economic status.

**Table 5** Associations between parental perceptions of price, quality and availability of fruit and vegetables and children's fruit and vegetable consumption, Dutch INPACT study, 2010

	% of children not consuming the recommended amount of fruit or vegetables	OR	95 % CI
<b>Fruit</b>			
Price (n 1300)			
Fruit is expensive	87.1	0.89	0.57, 1.40
Fruit is not expensive	87.7	1.00	Ref.
Quality (n 1306)			
Quality of fruit in shops is bad	89.2	0.67	0.26, 1.72
Quality of fruit in shops is not bad	87.5	1.00	Ref.
Availability (n 1303)			
Availability of fruit in shops is limited	89.7	0.36	0.11, 1.20
Availability of fruit in shops is not limited	87.4	1.00	Ref.
<b>Vegetables</b>			
Price (n 1299)			
Vegetables are expensive	83.3	1.01	0.64, 1.59
Vegetables are not expensive	83.8	1.00	Ref.
Quality (n 1301)			
Quality of vegetables in shops is bad	90.9	0.54	0.19, 1.56
Quality of vegetables in shops is not bad	83.5	1.00	Ref.
Availability (n 1304)			
Availability of vegetables in shops is limited	82.5	0.77	0.79, 1.67
Availability of vegetables in shops is not limited	83.7	1.00	Ref.

Ref., referent category.

†Analyses adjusted for child's ethnicity, child's BMI and child's socio-economic status.

## Discussion

The present study is one of the first to examine associations between parental perception of the local food shopping environment, the home food environment and children's fruit and vegetable intake. It was found that children who

lived in a household where fruit and/or vegetables were not always available were less likely to consume the recommended daily amount of fruit or vegetables. Furthermore, negative parental perceptions of the local food shopping environment were associated with a reduced availability of fruit at home. No associations were found

between parental perception of the local food shopping environment and children's fruit and vegetable intake. Finally, home availability of fruit and vegetables did not mediate the association between parental perception of the local food shopping environment and children's fruit and vegetable consumption.

The finding that home availability of fruit and vegetables is positively associated with children's fruit and vegetable consumption is in line with earlier studies<sup>(35-37)</sup>. Several reviews have concluded that home availability of fruit and vegetables is an important aspect of the home environment in relation to children's fruit and vegetable intake<sup>(21-23)</sup>.

However, before developing interventions targeting home availability of fruit and vegetables, more knowledge on factors influencing the availability of fruit and vegetables is needed. Few studies have examined determinants of the home availability of fruit and vegetables. The present study investigates the relationship between parental perception of the local food shopping environment and home availability of fruit and vegetables. Our results show that negative perceptions of price, quality and availability of fruit in shops are associated with less fruit being available at home, albeit the associations are weak. Contrary to our expectations, we found no associations between parental perceptions of price, quality and availability of vegetables in shops and the home availability of vegetables. However, because only a very small number of people agreed with the statements about the local food shopping environments, there was insufficient variation of the independent variables. This might explain why we found only a weak association between parental perception of the local food shopping environment and the home availability of fruit and no association between parental perception of the local food shopping environment and the home food environment of vegetables. Another explanation for the different findings between parental perception of the local food shopping environment and fruit and vegetable availability at home may be Dutch dietary habits. Traditionally, Dutch people consume three main meals per day and a snack between the main meals. Vegetables are a part of the dinner (as is fish or meat and rice or pasta), whereas fruit is not generally a part of the main meals. In the Netherlands, fruit is mainly consumed as a kind of snack and is generally seen as 'something extra'. Therefore the purchase of vegetables may not be influenced by perceptions about price, quality and availability, whereas this may be the case for fruit.

The present study examined associations between parental perception about the local food shopping environment and children's fruit and vegetable consumption. For both fruit and vegetables no such association was found. This is unexpected because an association was found between parental perception and the home availability of fruit (Fig. 1; association 2) and a strong association was found between the home availability of fruit and children's

fruit consumption (Fig. 1; association 1). This unexpected finding may be due to insufficient variation in either the dependent or the independent variable to detect any association. To get more variation in the data we performed the analyses with fruit and vegetable consumption as a continuous variable; however, these analyses yielded comparable results (data not shown). Unfortunately, it was not possible to increase the variability of the measures of the local food shopping environment because the perceptions were measured on a dichotomous scale.

Besides possible methodological shortcomings of the present study another explanation may be that parental perceptions of the local food shopping environment are too distal to directly influence child behaviour. Other determinants such as preference of food taste, food habits or parental attitude regarding fruit and vegetables may be in the indirect pathway and could be more important in relation to children's fruit and vegetable consumption. Also, other factors acting like mediators (which we did not measure) may have an effect opposite to the direct effect of parental perception of the local food shopping environment and children's fruit and vegetable consumption. The opposite effect of the direct pathway and the indirect pathway can cancel each other out, resulting in a non-significant overall relationship between parental perception of the local food shopping environment and children's fruit and vegetable consumption.

To our knowledge, no other studies have examined the relationship between children's fruit and vegetable intake and subjectively measured environmental determinants. However, studies among adults have examined the perceived local food shopping environment and fruit and vegetable consumption. One Dutch study found that some of the subjectively measured factors of the local food shopping neighbourhood were associated with fruit and vegetable consumption; its finding that the quality and availability of fruit and vegetables in shops was not significantly associated with participants' fruit and vegetable consumption is in line with our results<sup>(31)</sup>. Another study found that perceived greater access to fruit and vegetables was significantly associated with increased fruit and vegetable intake<sup>(38)</sup>, while two other American studies found no significant association between subjectively measured determinants of the local food shopping environment and participants' fruit and vegetable consumption<sup>(39,40)</sup>. However, their results are difficult to compare with ours due to different measures of the local food shopping environment. Furthermore, the urban landscape in the Netherlands differs from that in the USA. The population density in the Netherlands is high and shops are generally close to participants' homes. Due to these differences in landscaping the results of the US studies may be not generalizable to the Netherlands.

The present study has some limitations which may have influenced the results. First, our study has a cross-sectional design, which hampers drawing conclusions

about any causal relationships. Second, only one-third of the schools and 62.5% of the parents participated in the study. However, the school response rate among urban and rural areas was equal. Furthermore, the consumption of fruit and vegetables and the overweight and obesity prevalence were comparable to national prevalence rates among children<sup>(41)</sup>. Therefore, we think that the results in our study are not biased through selective participation.

A third limitation is the use of parent reports on children's fruit and vegetable consumption instead of child reports. It is still unclear, however, whether child reports or parents report of child fruit consumption are more valid. Two Dutch studies reported low agreement between parent and child report on child fruit and vegetable intake<sup>(42,43)</sup>. However, Tak *et al.* stated that parents' report could be considered a valid method to measure children's fruit and vegetable intake<sup>(42)</sup>. Nevertheless, parents may respond in a socially desirable way, i.e. they may overestimate home availability of fruit and vegetables and overestimate their children's fruit and vegetable consumption. However, we do not expect that this has significantly influenced our results.

Finally, we used maternal educational level as a measure of SES of the household, instead of household income, due to the high number of missing values on this variable (31.2%). Several studies emphasize that cost is one of the most important determinants of consumer food choice<sup>(44,45)</sup>. Therefore, household income may be a more appropriate measure of the SES of the household. However, after performing all analyses again with household income as the measure for SES (data not shown), the direction and magnitude of the results were similar to those reported based on maternal educational level.

## Conclusions

In the present study, only 12.6% of the children met the recommendation for fruit consumption and only 16.2% met the recommendation for vegetable consumption. The home availability of fruit and vegetables was strongly associated with children's fruit and vegetable intake. Weaker associations were found for subjectively measured factors of the local food shopping environment and the availability of fruit at home. Interventions focusing on improving the home availability of fruit and vegetables may contribute to an increase of children's fruit and vegetable consumption. However, more knowledge on the factors influencing the home availability of fruit and vegetables is required.

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