What determines fruit and vegetables intake of primary school children?

- An analysis of personal and social determinants -

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Introduction

High prevalence of childhood obesity is a major concern in developed as well as in developing countries (Ng et al., 2014). An increase of fruit and vegetable (F&V) intake is seen as one of numerous strategies to prevent and reduce the risk for adiposity (He et al., 2004; Oliveira, Sichieri, & Venturim Mozzer, 2008; Vioque, Weinbrenner, Castelló, Asensio, & Garcia de la Hera, 2008).[1] However, children's average consumption of these food items is – in Germany as well as in many other countries – still below the recommended consumption level (Borrmann & Mensink, 2015; Yngve et al., 2005) while at the same time prevalence of childhood obesity is high (Brettschneidera et al., 2015; Dehghan, Akhtar-Danesh, & Merchant, 2005). As eating habit acquired in childhood track to some extend into adulthood (Fletcher, Wright, Jones, Parkinson, & Adamson, 2016; Lien, Lytle, & Klepp, 2001) programs to induce dietary behavior change, such as an increase in F&V intake of children, are needed. Understanding the determinants of children's dietary behavior, however, is necessary to design interventions, which are successful in achieving the desired behavioral change.

According to the reciprocal determinism model from social cognitive theory there exist a dynamic reciprocal interaction among a person's behavior, the surrounding environment of a person, and personal characteristics. This implies that a child's dietary behavior, including its F&V consumption, is influenced by environmental and personal factors while the behavior itself has an effect on those other factors. In the context of families, family members are parts of each other's social environment and can be both agent for change and responder to change. With regard to dietary behavior, this implies that parents influence their children as role models with respect to e.g. the consumption of specific food items as well as by rewarding, reinforcement or punishment strategies (Baranowski & Hearn, 1997). Empirical research

[1] Even through F&V consumption has not always been directly linked to obesity prevalence of children (Ledoux, Hingle, & Baranowski, 2011), there is some evidence that eating more F&V leads to reduced consumption of energy-dense foods in families (Epstein et al., 2001).

confirms the major role social environment plays in the development of healthy eating habits of children. Dave et al. (2012) as well as Trost et al. (2003) show that parental social support has a significant impact on children's health and measurable effects on behavioral change. Along the same lines Patrick and Nicklas (2005) highlight the importance of meal times structure within the family context. In addition, Gross et al. (2010) found an association of family and home environmental factors with F&V consumption of school aged children. In the context of social environment, also peers are known to have a significant impact on a child's dietary behavior (Cullen et al., 2001). Lowe et al. (2004) successfully used the influence of peers to increase F&V intake of pupils in an intervention study targeting primary school children. The same holds for a more recent study of Staiano et al. (2016) who used video based peers modeling to increase young children's F&V consumption.

Personal characteristics are the second core element of the reciprocal determinism model and include e.g. 'regulatory skills', 'self-efficacy', 'taste' and 'knowledge'. Especially, self-efficacy, a motivation related construct, has gained considerable attention in academic research. It has been found to be associated with dietary behavior and even successful in influencing F&V consumption of children (Fitzgerald, Heary, Kelly, Nixon, & Shevlin, 2013; Luszczynska et al., 2016; Rasmussen et al., 2006; Santiago Rivera et al., 2013). Despite this more theoretical based construct, empirical evidence suggest that taste preferences are promising determinants that should be improved by intervention. Preferences in general as well as the liking of a high number of different types of F&V have been shown to be positively associated with actual F&V intake of children (Rasmussen et al., 2006). Furthermore, Fletcher et al. (2016) demonstrate that the number of vegetables toddlers liked, predict vegetable consumption of the respective children at age seven. Research on the association of 'nutritional knowledge', e.g. knowing the recommended F&V intake and actual consumption level of these food items, has been examined in several studies. Brug et al. (2008) found that knowledge of recommended F&V intake levels was significantly associated with F&V consumption of school-aged children in nine European

countries. In addition, Erinosho et al. (2012) showed that adults who were aware of the '5 A Day/Fruits and Veggies - More Matters campaign' were likely to eat more than five servings F&V per day. However, a current review carried out by Spronk et al. (2014) comes to the conclusion that the majority of studies considered in the review reported significant, but weak positive associations between higher nutrition knowledge and dietary intake, whereby in terms of desirable nutrition behavior a higher F&V intake was most often observed.

Overall, it can be stated that factors influencing dietary behavior are complex and not yet sufficiently investigated. This hold especially for children's F&V intake. Given this background, the present study aims to identify social and personal determinants with relevance for primary school children's F&V intake and thus, to provide insights into those factors most promising to be considered in intervention programs.

Methodology

Data collection and survey instruments

The study had a cross-sectional design using data from the baseline survey of the evaluation of the European School Fruit Scheme in North-Rhine-Westphalia one federal state of Germany. Data were collected from children of 48 primary school classes (3^{th} and 4^{th} graders) at 12 schools during August and September 2012. To assess parents F&V consumption as well as family related factors, children received a parent questionnaire in a closed envelop to take home for completion.

Children's F&V intake was recorded in three repeated 24 hours (24 h) dietary recalls. The 24 h dietary recall applied in the survey is based on the Day in a Life Questionnaire (DILQ), which was originally developed and validated by Edmunds and Ziebland (2002) and adapted to the German school system in the first evaluation period of the European School Fruit Scheme in North-Rhine-Westphalia (Methner, 2015). Using words and pictures, children are encouraged to recall the previous day and to describe the foods and drinks they consumed. For the analysis,

F&V frequencies were added up for the day, using a clearly defined coding strategy. Each participating child was asked to fill in three of those dietary recalls on predefined days during one school week. The questionnaire was done as a collective class task, whereby only children who returned informed consent forms from their parents were included in the study sample. On the first day of the survey, members of the research team were present to explain children the task and train class teachers. On this specific day children additionally filled in a questionnaire asking for personal and social determinants.

The parent questionnaire covered a Food Frequency Questionnaire (Haftenberger et al., 2010) for measuring F&V consumption of parents as well as questions focusing on social determinants of F&V intake. Parents completed the questionnaire at home on a voluntary basis. An overview of all assessed personal and social determinants, as well as information on their mean and standard deviation is given in Table 1.

Sample and procedure

Eight of the participating schools were recruited from those that had applied for participation in the School Fruit Scheme for the upcoming school year. The remaining four schools had not applied for the scheme and served as control in a subsequent phase program evaluation. To participate in the study schools had to have a minimum of two 3^{th} and two 4^{th} grade classes in which the class teacher had agreed to take part in the study.

Only children fulfilling the following three criteria were considered in the further analysis: first, it was expected that they filled in the 24 h dietary recall and the survey providing information on personal and social determinants of F&V intake at the first day of the survey. Second, at least one additional 24 h recall needs to be present, and third, a corresponding parent questionnaire had to be available. After data processing, a sample size of 702 parent-child pairs remained for analysis.

Table 1: Description of measures, mean values and standard deviations

Measures	Respondent	Scale	Source	Mean	SD
PERSONAL DETERMINANTS					
Attitudes towards F&V	child	12 dichotomous items (1) yes, (0) no	(Prelip, Slusser, Thai, Kinsler, & Erausquin, 2011)	0.80	0.20
Preferences for F&V	child	2 items, 5-point emoticon scale	Self-administrates scale	4.26	0.77
Self-efficacy to eat F&V	child	2 items, 4-point scale from (1) very much to (4) very little	(Bourdeaudhuij et al., 2005)	3.31	0.64
Knowing different types of F&V	child	24 dichotomous items (1) I do know, (0) I don't know	Self-administrated index	0.76	0.16
Liking different types of F&V	child	24 Items on a 3-point emoticon scale from (3) I like, (1) I don't like	Self-administrated index	2.51	0.31
Trying different types of F&V	child	24 dichotomous items (1) tried, (0) never tried	Self-administrated index	0.88	0.16
Nutritional knowledge	child	9 dichotomous items (1) right, (0) wrong	(Meier, 2012), self-administrated	0.74	0.16
Knowing 5 a day recommendation	child	Open question	Self-administrated	0.13	0.34
SOCIAL DETERMINANTS					
Parents F&V consumption	parent	Food frequency questionnaire	(Haftenberger et al., 2010; Truthmann, Mensink, & Richter, 2011)	3.40	2.00
Parental modeling (subjective norm)	child	4 Items on a 4-point scale from (1) fully agree to (4) fully disagree	(Bourdeaudhuij et al., 2005)	2.87	0.68
Peer influence	child	8 dichotomous items (1) yes, (0) no	(Prelip et al., 2011)	0.31	0.22
Priority of family meals	parent	5 Items on a 5-point scale from (1) strongly disagree to (5) strongly agree	(Neumark-Sztainer, Wall, Perry, & Story, 2003)	4.18	0.69
Parental practice to promote F&V	parent	5 Items on a 5-point scale from (1) strongly disagree to (5) strongly agree	(Dave, Evans, Pfeiffer, Watkins, & Saunders, 2010)	4.26	0.66
Positive encouragement to eat F&V	parent	5 Items on a 5-point scale from (1) not at all to (5) about every day	(Dave, Evans, Condrasky, & Williams, 2012)	2.93	0.88
Negative role modeling	parent	3 Items on a 5-point scale from (1) not at all to (5) about every day	(Dave et al., 2012)	2.09	0.70

Statistical analysis

To group subscale items of social determinants in the parent questionnaire, a principal component analysis was conducted using the statistical package SPSS (Version 22.0). Factors were defined based on eigenvalues. Varimax rotation was used for the initial extraction of the factors. To assess consistencies of the dimensions Cronbach's Alpha were calculated for each subscale.

In a next step bivariate correlation were estimated for analyzing the relationship of assessed personal and social determinants with F&V intake of children. Finally, to account for the clustered data structure (children nested in classes) hierarchical linear modelling (HLM) according to Raudenbush and Bryk (2002) was implemented to examine the effects of the significant correlated predictor variables on the dependent variable (estimation method: FML). The hierarchical linear regression analyses was done in five stages.

In the first stage, the empty model with no independent variables was estimated, providing a measure of the variance within and between classes for the dependent variable. The model is described in equation 1.1 and 1.2.

Level 1: $Y_{ij} = \beta_{0j} + r_{ij}$ (1.1)

Level 2: $\beta_{0j} = \gamma_{00} + u_{0j}$ (1.2)

In this equations Y is representing the outcome (F&V consumption frequency of children), whereby the subscript j is for the classes (j = 1…J) and the subscript i is for individual pupils (i = 1…n). According to the first equation Y is equal to the average outcome in the class β_{0j} and an individual-level error r_{ij}. Because there may also be an effect that is common to all children within the same class, a second equation for the intercept is specified, where γ_{00} is representing the grand mean of the sample (population) and u_{0j} is representing the class-specific error term.

Combining these two equations yields:

$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \quad (1.3)$$

At the second stage, significant correlated control variables (gender, school lunch, SES) were added to the empty model. As all of these variables were children variables, they were included at level 1:

Level 1: $$Y_{ij} = \beta_{0j} + \beta_{1j}*X_{1ij} + \beta_{2j}* X_{2ij} + \beta_{3j}* X_{3ij} + r_{ij} \quad (2.1)$$

Level 2: $$\beta_{0j} = \gamma_{00} + u_{0j} \quad (2.2)$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$

Combining these equations yields:

$$Y_{ij} = \gamma_{00} + \gamma_{10}*X_{1ij} + \gamma_{20}* X_{2ij} + \gamma_{30}* X_{3ij} + u_{0j} + r_{ij} \quad (2.3)$$

Predictor variables were centered around the group mean, taking into account that the level 1 relationship is desired (Enders & Tofighi, 2007). Dummy variables were not centered.

In the third stage, equation 2.3 was extended by adding one personal or social determinant (X_{4ij}) and the corresponding parameter γ_{40} to the model to determine whether the respective variable has a significant absolute effect on children's F&V intake. Taking the penultimate step, personal and social determinants that proofed to be significant in the third stage, where combined in one model for personal and social determinants, respectively (fourth stage). Stepwise backward elimination was used to evaluate which of the predictor variables had a significant relative effect on children's F&V intake in the presence of other variables belonging to the same group (personal/social). Due to the fact that HLM does not have an automatic elimination option, elimination of variables was done by estimating a model with all considered predictor variables in the first instance. In the following steps the predictor variable with the highest p-value was removed from the model and it was refitted again until all p-values were lower than $\alpha = 10\%$.

In the fifth stage, a comprehensive model, including personal and social determinants simultaneously was estimated. Again, backward elimination was used to remove redundant predictor variables. In each step the improvement of model fit was evaluated using the deviance statistic. As HLM does not provide a traditional R^2 value, the percentage of variance accounted for was estimated by comparing the level 1 residual variance components from the empty model to the particular full model. In order to compare regression coefficients, standardized estimates were calculated according to Hox (2010).

Results

Demographic characteristics of pupils participating in the study are shown in Table 2. Respondents are characterized by an even distribution with respect to grade (51.4 % 3rd grade and 48.6 % 4th grade) and gender (49.7 % girls and 50.3 % boys). The share of children usually eating lunch outside the school is higher (57.5 %) compared to those having lunch in the school canteen (42.5 %). 50.6 % of participating pupils come from homes with high socioeconomic-status, 26.6 % from homes with medium socioeconomic-status and 19.5 % from homes with low socioeconomic-status.

Table 2: Sample description

		n	%
Grade	3rd grade	361	51.4
	4th grade	341	48.6
Gender	girl	349	49.7
	boy	353	50.3
Lunch outside	yes	404	57,5
	no	298	42.5
Social status (SES)[1,2]	low	137	19.5
	medium	187	26.6
	high	355	50.6

Note: [1]*Brandenburger Social Index according to Böhm et al. (2007).*
[2] *Due to missing values, variables do not sum up to the N=702.*

Principal component analysis was used to group the 17-item of social determinants from the parent questionnaire (Table 3). The analysis yielded five factors with an eigenvalue exceeding 1 confirming the literature based items of the two constructs 'parental practice to promote F&V' as well as 'negative role modeling'.

Table 3: Summary of principal component analysis with varimax rotation of social determinant items from the parents' questionnaire

Priority of family meals (14.6%)[a)]	**Load**	**Parental practice to promote F&V (13.5%) [a)]**	**Load**
In my family it is often difficult to find a time when family members can sit down to a meal together	.842	I include fruits and vegetables in meals for my child at home	.804
In my family, different schedules make it hard to eat meal together on a regular basis	.786	I make sure my child eats vegetables before he/she can eat dessert	.693
I am often just too busy to eat dinner with my family	.743	I fix vegetable dishes on most days of the week	.678
In my family it is important that the family eat at least one meal a day together	.575	I include fruits and vegetables in snacks for my child at home	.631
Cronbach's Alpha	.73	Cronbach's Alpha	.67
Negative role modelling (13.7%) [a)]		**Positive encouragement to eat F&V (11.9%) [a)]**	
Bought home junk food	.847	Asked your child on ideas on how you could eat more fruits and vegetables	.794
Ate junk food in front of your child	.847	Discussed your child's eating habits with him/her	.762
Offered your child junk food	.820	Compliment your child on his/her eating habits ("keep it up", "we are proud of you")	.708
Cronbach's Alpha	.81	Cronbach's Alpha	.70
Reminding encouragement (9.4%) [a)]			
Encouraged your child to eat fruits and vegetables when he or she is tempted not to	.832		
Reminded your child to eat fruits and vegetables	.812	**Excluded Item**	
Cronbach's Alpha	.65	In my family we are expected to be home for dinner	

Note: a) % explained variance

As in the initial solution one item of the scale 'priority of family meals' loaded on the factor 'parental practice' with only a small factor loading of .309, it was removed and the analysis was conducted again with all remaining items. Based on the results of the principal component

analysis the construct ‘positive encouragement to eat F&V’ was splitted into two factors, with two items loading on the new factor labeled as ‘reminding encouragement’ and three items loading on the factor ‘positive encouragement to eat F&V’. Factor loadings for the identified five factors ranged from .631 to .847. Cronbach’s Alpha for ‘priority of family meals’ was .73, for ‘negative role modelling’ .81, for ‘reminding encouragement’ .65, for ‘parental practice to promote F&V’ .67, and for ‘positive encouragement to eat F&V’ .70. The Kaiser-Meyer-Olkin values of .75 as well as the significant Bartlett test of sphericity confirmed the overall suitability of the data for factor analysis.

Bivariate correlation analyses provided first insights regarding the relationship between children’s F&V intake, personal as well as social determinants and control variables. Constructs derived from the parents’ questionnaire entered the analysis based on the factors identified in the previous step, those obtained from the children’s questionnaire were defined as unweighted scale or index values as defined in Table 1. All control variables but age were significant correlated with F&V intake of children, with gender (girls = 1), SES showing a significant positive association, and eating lunch outside the school (yes = 1) a significant negative association. Regarding personal determinants all variables except ‘knowing the 5 a day recommendation’ proved to be significantly positive correlated with F&V consumption frequency of children. Moving towards social determinants reveals that ‘positive encouragement’ and ‘priority of family meals’ showed no significant correlation with F&V intake of children while the remaining social determinants were significantly correlated in the expected direction (Table 4).

Hierarchical linear regression were performed according to the stepwise procedure discussed above. To prevent any bias in the stepwise analysis only participates without missing values (n = 661) were considered in this step of analysis. The results of the HLMs are summarized in Tables 5-8. In the unconditional two level model (empty model) 16 % of the variance in children

F&V consumption frequency can be attributed to the class level, illustrating the need for hierarchical linear modeling. The intercept of 1.03 presents the average F&V intake of children measured in F&V frequencies per day (Table 5). According to the deviance statistic, the inclusion of the control variables lead to a highly significant improvement of model fit (p-value < 0.001). Overall control variables account for 9.15 % of level 1 variance.

Table 4: Bivariate correlation of control variables, personal and social determinants with children's F&V intake

	n	r
CONTROL VARIABLES		
Gender (girl=1)	702	.166***
SES	679	.133***
Lunch outside the school (yes=1)	702	-.026***
Age		.044
PERSONAL DETERMINANTS		
Attitudes	701	.174***
Preferences	697	.153***
Self-efficacy	699	.150***
Knowing	701	.285***
Liking	701	.121***
Trying	697	.209***
Nutritional knowledge	695	.193***
Recommendation 5 a day	683	.027
SOCIAL DETERMINANTS		
Parents F&V cons.	702	.063*
Parental modeling [a)]	699	.172***
Peer Influence	701	.164***
Parental practice	702	.079*
Neg. role modeling [a)]	702	-.079**
Reminding encouragement [a)]	702	-.120***
Positive encouragement [a)]	702	-.012
Priority of family meals [a)]	702	.017

Note: *Data were presented as Pearson correlation (p-value, two-tailed)*
**p ≤ .10, **p ≤ .05, ***p ≤ .001.*
a) Construct based on factor analysis

Table 6-7 present the results of the HLMs each including besides the control variable one personal or social determinant, respectively. All predictor variables proved to have a significant absolute effect on children's F&V consumption but the social determinant, 'negative role modeling'. In case of this determinant also the deviance statistic was insignificant

(p-value = 0.186). Standardized regression coefficients were in general slightly higher for personal compared to social variables. In the former group those coefficients were highest for the determinant 'knowing different types of F&V', in the latter for 'parental modeling' and 'influence of peers'.

Table 5: Estimates of HLMs without covariates and with control variables

	Fixed						Random		
	Coef.	Est.	Std. Est.	SE	t	df	Var.	Est.	SD
EMPTY MODEL									
Intercept	γ_{00}	1.03		0.06	17.49***	47	u_{0j}	0.12	0.34
							r_{ij}	0.63	0.79
CONTROL VARIABLES									
Intercept	γ_{00}	1.05		0.08	13.83***	47	u_{0j}	0.11	0.34
Gender	γ_{10}	0.35	0.20	0.06	5.80***	610	r_{ij}	0.57	0.76
SES	γ_{20}	0.04	0.08	0.02	1.96*	610			
School lunch	γ_{30}	-0.32	-0.18	0.06	-5.01***	610			

*Note: n=661; Coef= Coefficient; Est. = Estimate, Std. Est. = standardized Estimate, SE = Standard Error, df = Degrees of Freedom; Var. = Variance Components, SD = Standard Deviation; *p ≤ .10, **p ≤ .05, ***p ≤ .001*

Table 8 summarizes the result of the three HLM estimations considering simultaneously all personal and social determinants, respectively, that had an absolute effect on children's F&V intake as well as one model combining the significant predictor variables of the latter models. All models were adjusted for the control variables gender, SES and school lunch. The model focusing on personal determinants ('Personal') simultaneously yields only significant results for the variables 'knowing different types of F&V', 'preferences towards F&V' and 'liking of different F&V', with the highest standardized regression coefficients for the first, and the lowest for the last predictor variable. Compared to the model including only control variables the model fit was significantly higher (p-value < 0.001). In total predictor variables account for 14 % of level 1 variance (R^2 = .140).

Combining social determinants in one model simultaneously ('Social'), revealed that the factors 'reminding encouragement', 'parental modeling' and 'peer influence' were significant, with the

former two being of equal relevance measured by the standardized regression coefficient but of opposite sign (Table 8).

Table 6: Estimates of HLMs adjusting for control variables, each considering one personal determinant as predictor variable

	Fixed						Random		
	Coef.	Est.	Std. Est.	SE	t	df	Var.	Est.	SD
Intercept	γ_{00}	1.06		0.08	14.06***	47	u_{0j}	0.12	0.34
Attitudes	γ_{40}	0.60	0.14	0.15	3.93***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.06		0.08	14.13***	47	u_{0j}	0.12	0.34
Preferences	γ_{40}	0.17	0.15	0.04	4.30***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.07		0.08	14.14***	47	u_{0j}	0.11	0.34
Self-efficacy	γ_{40}	0.16	0.12	0.05	3.29**	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.08		0.08	13.89***	47	u_{0j}	0.11	0.34
Knowing	γ_{40}	0.88	0.16	0.20	4.46***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.06		0.08	14.13***	47	u_{0j}	0.12	0.34
Liking	γ_{40}	0.39	0.14	0.10	3.98***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.05		0.08	13.87***	47	u_{0j}	0.12	0.34
Trying	γ_{40}	0.79	0.14	0.20	3.98***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.05		0.08	13.97***	47	u_{0j}	0.11	0.34
Nutritional knowledge	γ_{40}	0.53	0.10	0.21	2.52**	609	r_{ij}	0.57	0.76

*Note: n=661; Coef. = Coefficient; Est. = Estimate, Std. Est. = standardized Estimate, SE = Standard Error, df = Degrees of Freedom; Var. = Variance Components, SD = Standard Deviation; *p < .10, **p < .05, ***p < .001. All models adjusted for gender, school lunch (yes/no) and SES.*

Table 7: Estimates of HLMs adjusting for control variables, each considering one social determinant as predictor variable

	Fixed						Random		
	Coef.	Est.	Std. Est.	SE	t	df	Var.	Est.	SD
Intercept	γ_{00}	1.05		0.08	13.90***	47	u_{0j}	0.12	0.34
Parents F&V cons.	γ_{40}	0.03	0.08	0.02	2.09**	609	r_{ij}	0.57	0.75
Intercept	γ_{00}	1.05		0.08	14.01***	47	u_{0j}	0.12	0.34
Parental modeling	γ_{40}	0.17	0.13	0.05	3.65***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.06		0.08	14.07***	47	u_{0j}	0.12	0.34
Peer Influence	γ_{40}	0.50	0.13	0.15	3.42***	609	r_{ij}	0.56	0.75
Intercept	γ_{00}	1.05		0.08	13.93***	47	u_{0j}	0.11	0.34
Parental practice	γ_{40}	0.06	0.07	0.03	1.89*	609	r_{ij}	0.57	0.75
Intercept	γ_{00}	1.05		0.08	13.87***	47	u_{0j}	0.11	0.34
Neg. role modeling	γ_{40}	-0.04	-0.05	0.03	-1.31	609	r_{ij}	0.57	0.76
Intercept	γ_{00}	1.04		0.08	13.74***	47	u_{0j}	0.12	0.34
Reminding encouragement	γ_{40}	-0.10	-0.09	0.03	-3.37***	609	r_{ij}	0.56	0.75

*Note: n=661; Coef. = Coefficient; Est. = Estimate, Std. Est. = standardized Estimate, SE = Standard Error, df = Degrees of Freedom; Var. = Variance Components, SD = Standard Deviation; *p < .10, **p < .05, ***p < .001. All models adjusted for gender, school lunch (yes/no) and SES.*

Table 8: Estimates of HLMs adjusting for control variables, based on a stepwise consideration of personal and/or social determinants

	Fixed						Random		
	Coef.	Est.	Std. Est.	SE	t	df	Var.	Est.	SD
PERSONAL									
Intercept	γ_{00}	1.09		0.08	14.53***	47	u_{0j}	0.12	0.34
Knowing	γ_{40}	0.70	0.13	0.22	3.16**	607	r_{ij}	0.54	0.74
Preferences	γ_{50}	0.10	0.09	0.05	2.08**	607			
Liking	γ_{60}	0.20	0.07	0.12	1.68*	607			
SOCIAL									
Intercept	γ_{00}	1.05		0.08	14.04***	47	u_{0j}	0.12	0.34
Reminding encouragement	γ_{40}	-0.10	-0.11	0.03	-3.28**	607	r_{ij}	0.55	0.74
Parental modeling	γ_{50}	0.15	0.11	0.05	3.07**	607			
Peer influence	γ_{60}	0.31	0.08	0.15	2.06**	607			
PERSONAL & SOCIAL									
Intercept	γ_{00}	1.08		0.07	14.42***	47	u_{0j}	0.12	0.35
Knowing	γ_{40}	0.67	0.12	0.22	3.05**	606	r_{ij}	0.54	0.74
Reminding encouragement	γ_{50}	-0.09	-0.10	0.03	-2.92**	606			
Parental modeling	γ_{60}	0.13	0.10	0.05	2.78**	606			
Preferences	γ_{70}	0.10	0.09	0.04	2.41**	606			

*Note: n=661; Coef. = Coefficient; Est. = Estimate, Std. Est. = standardized Estimate, SE = Standard Error, df = Degrees of Freedom; Var. = Variance Components, SD = Standard Deviation; *p < .10, **p < .05, ***p < .001. All models adjusted for gender, school lunch (yes/no) and SES.*

According to the deviance statistic, the model fit compared to the model only including control variables improved significantly (p-value < 0.001). With an R2 of .136, the three social determinants explain together with the control variables roughly 14 % of level 1 variance.

Combining personal and social determinants significant in the models 'Personal' and 'Social', in one model ('Personal & Social') resulted in four significant predictor variables, two personal ones 'knowing different types of F&V' and 'preferences for F&V' and two social ones 'reminding encouragement' and 'parental modeling'. Highest standardized coefficients were observed for 'knowing different types of F&V' followed by 'reminding encouragement' and 'parental modeling'. The four predictor variables together with the control variables account for roughly 15 % of level 1 variance (R^2 of .153). According to the deviance statistic the final

model yielded a significant improvement in model fit compared to the model considering only control, personal and control or social and control variables, respectively (p-value < 0001).

Discussion

The analysis provides insights regarding the relevance of different social and personal determinants for primary school children's F&V intake. At a general level, the results support the relevance of both social and personal determinants for children's F&V intake.

Based on a principal component analysis it was found that the construct 'positive encouragement' used in the literature (Dave et al., 2012) needs further differentiation, into a factor 'reminding encouragement' and a factor 'positive encouragement to eat F&V'. In fact, this differentiation reveals interesting insights in the further analysis. 'Reminding encouragement' proved to be significant in all estimated regression models having a negative influence on children's F&V intake. Previous studies found that parenting practices providing external control or pressure to eat were perceived as ineffective or counterproductive (Blissett, 2011; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; O'Connor et al., 2010; Wardle, Carnell, & Cooke, 2005) . In line with this results the present study found that even 'soft' pressure is contra-productive regarding the aim of increasing children's F&V intake.

Besides 'reminding encouragement' the findings also support the relevance of the social determinants 'parental modeling' and 'peer influence' for children's F&V intake. These results are conforming to previous studies (Cullen et al., 2001; Draxten, Fulkerson, Friend, Flattum, & Schow, 2014; Kristjansdottir et al., 2006; Reinaerts, Nooijer, Candel, & Vries, 2007; Wind et al., 2006). Surprisingly, the predictive value of F&V consumption of parents was relatively low. This might indicate that a child's perception of the behavior of its parents is more important than the actual behavior with the latter being likely performed to a considerable extent in the absence of the child. Regarding personal determinants the results indicates the ambiguous role of 'knowledge' for improving F&V intake. Nutritional knowledge can but does not have to

have an impact on children's dietary behavior. On the one hand, regarding children's awareness of the '5 a day recommendation' no association with children's F&V intake was found, while on the other hand more general nutritional knowledge, showed a significant but weak correlation. However, knowing different types of F&V proved to have high predictive value for children's F&V intake in all models. Looking at previous studies, it can be stated that other authors found as well controversial results with regard to the association of nutritional knowledge and dietary behavior and its role as a mediator in the scope of intervention studies (Brug et al., 2008; Lehto et al., 2014; Lytle et al., 2003; Resnicow, Davis-Hearn, Smith, Baranowski, & et al, 1997).

As previous studies, the present analysis confirms the role of preference for F&V intake of children (Cullen et al., 2001; Feeney, O'Brien, Scannell, Markey, & Gibney, 2014; Rasmussen et al., 2006; Resnicow et al., 1997; Wind et al., 2006), whereby the distinction between the construct of 'preferences' and 'liking' often remains unclear. In the present study, the construct 'liking' was assessed using pictures of twenty-four different F&V, that children evaluated on a 3-point emoticon scale, whereas 'preferences' were assessed using a 5-emoticon scales for fruits and vegetables, respectively. Just like 'preferences', the 'liking' construct was one of the strongest predictors of F&V consumption, but it did not remain significant combined with social determinants. This might be a hint, that the predictive value of this measure is overlaid by parental behavior (e.g. parental modeling). Even not significant in the presents of other variables belonging to the same group were 'attitudes towards F&V', 'self-efficacy for eating F&V' and 'trying of different types of F&V'. Particularly, with regard to the construct self-efficacy, this result was surprising, as according to theoretical and empirical research this determinant is considered as a crucial for F&V intake (Bourdeaudhuij et al., 2008; Luszczynska et al., 2016; Rasmussen et al., 2006; Santiago Rivera et al., 2013).

The analysis shows that the inclusion of a specific combination of personal determinants in the HLM estimation resulted in an improvement of the model fit and an increase in the explained level 1 variance of roughly 5 %. The same holds if social instead of personal predictors are considered in the analysis, suggesting that the two groups of determinants are of similar importance. By combining personal and social determinants, again model fit improved and explained level 1 variance further increases by roughly 2 %, indicating that addressing a combination of personal and social determinants is most promising in increasing children's F&V intake.

Finally, some limitations of this study need to be acknowledged. First, data collection was done through self-reported questionnaires. Although participants were assured anonymity, social desirability in responses might have played a role. Second, two of three dietary recalls were filled in by the pupils in the absence of the research team. Even though teachers were given specific instructions on how to guide students while completing the questionnaire, it cannot be excluded that teachers influenced children's answers. Additionally, as a retrospective dietary assessment was used, there is some potential for recall bias. Nevertheless, the decision for the 24 h recall was well considered. The questionnaire used, was a validated instrument and developed especially for 7-9 years old children. Third, a convenience sample was used, and thus selection bias might be an issue. Finally, due to the cross-sectional research design directionality of the relationships cannot be concluded. Longitudinal studies are needed to observe whether changes in determinants of F&V intake result in changes of the desired behavior.

Conclusion

The present study shows that personal as well as social determinants are associated with primary school children's F&V intake, with both groups of determinants being of similar importance. Thus, interventions promise to be especially effective in improving children's F&V intake if

they are successful in addressing personal as well as social factors. With respect to the former strengthening children's preferences towards F&V and imparting knowledge about the variety of F&V seems substantial. Regarding the latter, encouraging parents in acting as a role model is crucial. In addition, parent's awareness regarding the appropriate strategy towards their children's dietary behavior is important as likely even 'soft' pressure to eat F&V on children will not lead to the desired behavior, but rather the opposite. Future studies should be based on panel data to be able to investigate the interdependent relationship between children's behavior and social and personal determinants.

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