

## Short Communication

## Mediators of the effectiveness of a kindergarten-based, family-involved intervention on pre-schoolers' snacking behaviour: the ToyBox-study

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**Abstract**

*Objective:* The present study aimed to explore the mediating role of family-related determinants on the effects of the ToyBox-intervention on pre-school children's consumption of healthy and unhealthy snacks.

*Design:* The ToyBox-intervention was a kindergarten-based, family-involved intervention with a cluster-randomized design, aiming to promote healthy lifestyle behaviours to prevent obesity at pre-school age.

*Setting:* Kindergartens (*n* 309) in six European countries.

*Subjects:* A total of 6290 pre-schoolers and their families participated in the ToyBox-intervention in 2012–2013 and data from 5212 pre-schoolers/families were included in the current analyses.

*Results:* Even though the total effect of the ToyBox-intervention on healthy and unhealthy snacking was not significant, the ToyBox-intervention significantly improved parental rule setting on children's unhealthy snack consumption (i.e. restriction of snacking while watching television and permission only at certain occasions) and parental consumption of unhealthy snacks, while it increased parental knowledge on snacking recommendations. Regarding healthy snacking, the ToyBox-intervention improved children's attitude towards fruit and vegetables (F&V). All previously mentioned family-related determinants mediated the intervention effects on pre-schoolers' consumption of healthy and unhealthy snacks. Almost all family-related determinants examined in the study were independently associated with pre-schoolers' consumption of healthy and unhealthy snacks.

*Conclusions:* The intervention was effective in improving relevant family-related determinants. Interventions aiming to promote F&V consumption and limit the consumption of unhealthy snacks in pre-schoolers should target on these mediators, but also identify new family-, school- or peer-related determinants, to enhance their effectiveness.

**Keywords**  
Snacking  
Fruits and vegetables  
Mediation  
Family determinants  
ToyBox-study

Several studies have shown an association between the consumption of energy-dense foods, such as sweets and

salty snacks, and excessive weight in pre-school children<sup>(1)</sup>. On the other hand, diets high in fruits and vegetables (F&V)

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have been associated with reduced risk for obesity in children<sup>(2)</sup>. The WHO and the US Department of Agriculture suggest the sparing consumption of unhealthy snacks, while the recommendation for F&V is at least five servings (approximately 400 g) daily<sup>(3)</sup>. However, intake seems to fall well short of these guidelines, both in the case of unhealthy snacks<sup>(4)</sup>, as well as in the case of vegetables<sup>(5)</sup>, with consumption among young children being particularly low<sup>(6)</sup>. In line with these observations, the ToyBox-study revealed that European pre-school children's intake exceeds the recommendation regarding unhealthy snacks, with consumption varying from 53.3 g/d in Greece to 73.1 g/d in Belgium<sup>(7)</sup>.

Improving children's dietary habits as early as possible is particularly important. Eating behaviour is formed in childhood, tracks over childhood<sup>(8)</sup> and persists into adulthood<sup>(9)</sup>. Thus, the adoption of healthy instead of unhealthy food choices early in life could provide lifelong benefits. In addition, there is growing evidence that poor diet in childhood can lead to health problems commonly observed in adults, such as diabetes<sup>(10)</sup>, obesity<sup>(11)</sup> and CVD<sup>(12)</sup>. As a result, interventions targeting early childhood, such as the Toy-Box study, could offer the maximum health benefits. Furthermore, consuming healthy snacks such as F&V instead of unhealthy snacks may contribute in controlling pre-schoolers' energy intake and body weight, since energy-dense food consumption has been found to be associated with higher BMI in young children<sup>(13)</sup>.

In the ToyBox-study, focus groups with parents and teachers of pre-school children were executed in six European countries. The findings of the focus groups identified parental modelling, availability of healthy snacks and certain parenting practices as determinants of pre-schoolers' dietary habits (report submitted to the European Commission). Following the intervention mapping protocol<sup>(14)</sup>, these findings were translated into practical strategies and were considered in the design of the ToyBox-intervention<sup>(15)</sup>.

So far, analysis of the results of the ToyBox-intervention has shown significant improvements in pre-schoolers' diet quality<sup>(16)</sup>. Because family dynamics including family rules, modelling support and encouragement are important determinants of children's health behaviour<sup>(17)</sup>, the present study aimed to shed light on the family-related mechanisms mediating the effect of the ToyBox-study on pre-school children's consumption of healthy and unhealthy snacks.

## Methods

### Participants

The ToyBox-study ([www.toybox-study.eu](http://www.toybox-study.eu)) aimed to develop, implement and evaluate a kindergarten-based, family-involved intervention to prevent obesity in pre-school children in six European countries (Belgium, Bulgaria, Germany, Greece, Poland and Spain). Pre-school children and their families were recruited from 309 kindergartens from three socio-economic groups, following a standardized approach, as described

elsewhere by Manios *et al.*<sup>(15)</sup>. The study was registered at [clinical-trials.gov](http://clinical-trials.gov) (identifier: NCT02116296). The study design has been described in detail elsewhere<sup>(15,18)</sup>.

### Procedure

The ToyBox-intervention had a cluster-randomized design and was conducted during the school year 2012–2013. Four energy balance-related behaviours were targeted, namely drinking, snacking, physical activity and sedentary behaviours, as well as their determinants<sup>(13,15,19)</sup>.

Four levels were used for implementation of the snacking component of the ToyBox-intervention. Level 1 included the availability of healthy snacks at class/kindergarten; level 2 included children's daily consumption of a healthy snack; level 3 included the execution of interactive classroom activities using a kangaroo hand-puppet as a role model; and level 4 included the delivery of two newsletters, two tip-cards and one poster to the parents/caregivers via the teachers. These newsletters, tip-cards and poster included key messages and practical tips on healthy snacking (e.g. F&V) instead of unhealthy choices (e.g. sweets and/or salty snacks)<sup>(15)</sup>. Levels 1 and 2 were conducted for the whole duration of the school year 2012–2013, whereas levels 3 and 4 were conducted over six weeks (i.e. during the first focus period between weeks 9 and 12, and during the repetition period between weeks 21 and 22)<sup>(18)</sup>. The ToyBox-intervention was implemented by kindergarten teachers, who attended three training sessions by the research staff of minimum one hour per session<sup>(20)</sup>.

### Instrumentation

The pre-test measurements were conducted in May/June 2012 and the post-test measurements were conducted after one year (i.e. May/June 2013). Parents/caregivers signed a consent form to participate in the study and were asked to fill out the Primary Caregivers' Questionnaire (PCQ) regarding sociodemographic factors, lifestyle behaviours and perinatal factors, as well as an FFQ<sup>(21)</sup>.

Snack consumption was assessed by combining the frequency as well as the average consumption for each item. Determinants of pre-schoolers' snack consumption were self-reported by the parents/caregivers in the PCQ, using Likert-type questions. More details on the questions used for assessing snack consumption as well as the determinants can be found in the online supplementary material, Supplemental Tables 1 and 2, while the questionnaire is available online at the ToyBox-study website ([www.toybox-study.eu](http://www.toybox-study.eu)) and was previously shown to be a reliable tool<sup>(22)</sup>.

### Data analysis

Descriptive statistics describing the baseline characteristics of the participating children per intervention or control group were conducted in the statistical software package

IBM SPSS Statistics version 23.0. Differences between these two groups were tested using independent *t* tests for continuous variables or  $\chi^2$  tests for dichotomous variables. Missing data were imputed for the food items under study using the 'multiple imputation' macro in IBM SPSS Statistics version 23.0.

Mediation effects were assessed with the bootstrapping procedure of MacKinnon *et al.*<sup>(23)</sup> via the following mediation analysis steps: (i) estimating the effect of the intervention on unhealthy snacking and F&V consumption ( $\tau$  coefficient); (ii) estimating the effect of the intervention on the proposed mediator ( $\alpha$  coefficient); (iii) estimating the effect of the mediator on unhealthy snacking and F&V consumption ( $\beta$  coefficient) adjusting for the intervention effect ( $\tau'$  coefficient); (iv) computing the indirect effect of the intervention on unhealthy snacking and F&V consumption via the proposed mediator ( $\alpha\beta$  coefficient); and (v) bootstrapping the sampling distribution of  $\alpha\beta$  and deriving a bias-corrected CI with 5000 bootstrapped sampling distribution. All models were adjusted for age, sex, maternal education, country, baseline level of unhealthy snacking and F&V consumption, and baseline level of the mediator. STDY standardization methods (which mean that standardization was based only on the dependent variable, and not on both the dependent and

independent variable because the independent variable (research group) was a binary variable) were applied. Adding a random intercept for kindergarten site did not improve the model fit and was therefore eliminated. Mediation analyses were run in Mplus version 8.0<sup>(20)</sup>.

## Results

Table 1 shows the baseline characteristics of the current study sample. Participating children were on average 4.75 years old, 49% were female and 61% had a mother with more than 14 years of education. Intervention and control group participants did not differ in terms of children's age, sex, parental age, unhealthy snack consumption, F&V consumption or any of the baseline values of the potential mediators, with the exception of intervention children having less educated mothers, more parental self-efficacy with a nagging child and higher parental F&V consumption than control participants at baseline ( $P=0.03$ ).

No significant total intervention effects were found on unhealthy snack consumption ( $c$  (unstandardized) =  $-2.41$ ; 95% CI  $-5.40, 0.39$  (data not shown for the unstandardized analysis);  $\tau$  (standardized) =  $-0.05$ ; 95% CI  $-0.12, 0.01$ ) or

**Table 1** Baseline characteristics (mean and standard deviation unless otherwise stated) of the participating pre-school children and their parents/caregivers per treatment arm. The ToyBox-study, May/June 2012

	Intervention group ( <i>n</i> 3360)		Control group ( <i>n</i> 1852)	
	Mean	SD	Mean	SD
<b>Demographics</b>				
Age, child (years)	4.7	0.43	4.7	0.45
Sex (% female)	48.5		48.8	
Age, parent (years)	35.7	5.0	35.6	4.8
Maternal education (% with maternal education >14 years)	60.0		63.1*	
<b>Behaviours</b>				
Unhealthy snack consumption, child (g/d)	85.2	52.3	83.5	47.8
F&V consumption, child (g/d)	240.3	134.2	241.6	131.3
<b>Determinants of healthy snacking</b>				
Child's F&V preference (-2, +2)	0.85	1.06	0.88	1.01
Availability of F&V as snacks (-2, +2)	1.01	0.89	1.03	0.88
Regular availability of F&V (-2, +2)	1.18	0.77	1.15	0.83
Parental rule: allowed to eat F&V as snacks without asking (-2, +2)	0.56	1.18	0.50	1.16
Parental knowledge on F&V recommendation (% indicating correct recommendation, i.e. 5 portions or ~400 g daily)	19.0		19.0	
F&V consumption, parent (portions/d)	2.12	2.32	1.99*	2.17
<b>Determinants of unhealthy snacking</b>				
I think eating sweet or salty snacks is not bad for my child (-2, +2)	-0.46	1.24	-0.41	1.26
I make sweet or salty snacks regularly available for my child (-2, +2)	-0.81	0.97	-0.84	0.97
My child is not allowed to snack while watching television (-2, +2)	-0.09	1.11	-0.02	1.11
My child is allowed to eat sweet or salty snacks only at certain occasions, i.e. birthdays (-2, +2)	-0.12	1.05	-0.09	1.05
I give sweet or salty snacks to my child as a reward or to comfort him (-2, +2)	-0.79	1.07	-0.82	1.06
If I prohibit my child to eat a sweet or salty snack I find it difficult to stick to my rules if he/she starts nagging (-2, +2)	-0.86	1.04	-0.95*	0.97
I find it difficult to restrain myself from eating sweet or salty snacks because of the presence of my child (-2, +2)	-0.70	1.14	-0.73	1.13
Parental knowledge on unhealthy snack recommendation (% indicating correct recommendation, i.e. none)	51.6		50.4	
Unhealthy snack consumption parent (portions/d)	0.26	0.29	0.25	0.25

F&V, fruit(s) and vegetable(s).

\*Significant difference between intervention and control groups based on independent *t* test for continuous variables or  $\chi^2$  test for dichotomous variables:  $P < 0.05$ .

F&V consumption ( $c = -1.59$ ; 95% CI  $-8.33, 5.00$ ;  $\tau = -0.01$ ; 95% CI  $-0.06, 0.04$ ). As shown in Table 2, the intervention was effective in improving parental rules on snacking while watching television and snacking recommendation (i.e. permission of unhealthy snacking only during special occasions), parental unhealthy snack consumption, parental knowledge on children's snacking recommendation and child's attitude towards F&V as reported by their parent. Several potential mediators were found to be related to changes in unhealthy snacking and F&V consumption. Changes in parental rules (i.e. restriction) on unhealthy snacking while watching television and in permission of unhealthy snacking only during special occasions, improvement of parental unhealthy snack consumption and improvement of parental knowledge on snacking recommendation mediated the intervention effect on snacking consumption, whereas improvement in child's attitude towards F&V as reported by their parent mediated the intervention effect on F&V consumption. Regarding interpretation of the results presented in Table 2, an example would be that an increase of 1 SD in the determinant 'If I prohibit my child to eat sweet/salty snack I find it difficult to stick to my rules if (s)he starts nagging' is associated with a decrease in unhealthy snack consumption of 0.07 SD, after adjusting for the intervention effect.

## Discussion

The ToyBox-intervention was a kindergarten-based, family-involved intervention aiming to prevent obesity at pre-school age via the promotion of healthy energy balance-related behaviours. The aim of the present study was to examine if the family-related determinants of snack consumption, which were identified and targeted in the ToyBox-study, mediated the effects of the ToyBox-intervention on pre-schoolers' consumption of healthy and unhealthy snacks.

The present study showed that several family-related determinants of snack consumption mediated the effects of the ToyBox-intervention on pre-schoolers' snack consumption. These mediators were parental rules (i.e. restriction) on unhealthy snacking while watching television, parental permission of unhealthy snacking only during special occasions, parental unhealthy snack consumption, parental knowledge on snacking recommendation and child's attitude towards F&V as reported by their parent. Our findings are in line with previous studies. More specifically, a recent review showed that food availability and parental offering of foods have been successfully modified by several interventions and linked to positive changes in child outcomes<sup>(24)</sup>. Furthermore, a systematic review conducted by van Stralen *et al.* found evidence for attitude, knowledge and habit strength as mediators of interventions targeting dietary behaviour<sup>(25)</sup>. In the case of the ToyBox-study, these determinants referred to the parents and teachers of the pre-school children, due to the children's young age. Moreover, there is accumulated

evidence highlighting that parental role modelling, which in the current study is depicted as limited parental F&V consumption, exerts a significant role in children's F&V consumption<sup>(26)</sup>.

The ToyBox-intervention had a positive effect on several family-related determinants regarding children's eating and snacking behaviour. Despite the strategies used to target these determinants being correctly and appropriately used, the ToyBox-intervention did not manage to significantly change children's snack consumption. This observation is in line with similar intervention studies<sup>(27)</sup>. These findings could be attributed to the fact that dietary behaviour is one of the most complex behaviours and there may be more family-, school- or peer-related determinants than those identified during the preliminary phase of the ToyBox-study (focus groups as well as systematic literature reviews) that might also have an important role in determining dietary choices. Moreover, the results of the process evaluation conducted within the ToyBox-intervention showed that many parents did not read the provided newsletters and the tip-cards, which might explain the non-significant intervention effects regarding pre-schoolers' snack food consumption (report submitted to the European Commission)<sup>(24,28)</sup>. Furthermore, the duration of the intervention might not be adequate to change children's snacking behaviour. Last but not least, like most school-based interventions, the ToyBox-intervention did not follow a personalized approach, thus was not tailored to individual needs and preferences that might further enhance its effectiveness.

Future intervention developers targeting pre-schoolers' snack consumption are recommended to target the determinants that were found to mediate the intervention effect as well as the intervention strategies used in the ToyBox-intervention to change them, since those strategies succeeded in improving the targeted determinants. However, more extensive research should be done in the field of pre-schoolers' snack food choices to capture the complete panel of determinants influencing pre-schoolers' snacking behaviour. Furthermore, investing more time and effort to follow a more personalized approach in the population subgroups that are at higher risk (e.g. in families with low socio-economic status or in families with medical history of non-communicable diseases) might be more effective. Developing strategies to increase participants' fidelity to the programme, such as making the material less burdensome or providing it via a web-based system, should also be considered in future public health initiatives.

## Limitations and strengths

The present study has some strengths and limitations. The strengths include the large study sample, the diversity of countries, regions and socio-economic groups included, the standardization of all study procedures and tools, as well as the assessment of all determinants found to be associated with pre-school children's snack consumption

**Table 2** Family-related mediators of healthy and unhealthy snack consumption (standardized). The ToyBox-study, May/June 2013

	$\alpha$	95 % CI	$\beta$	95 % CI	$a\beta$	95 % CI	$\tau'$	95 % CI
Healthy snacking								
My child likes to eat F&V as a snack	<b>0.06</b>	<b>0.01, 0.10</b>	<b>0.18</b>	<b>0.15, 0.21</b>	<b>0.01</b>	<b>0.00, 0.02</b>	-0.03	-0.08, 0.12
I often give F&V as snacks to my child	0.03	-0.02, 0.09	<b>0.15</b>	<b>0.13, 0.18</b>	0.01	-0.00, 0.01	-0.02	-0.07, 0.03
I make F&V snacks regularly available for my child	-0.02	-0.08, 0.03	<b>0.14</b>	<b>0.12, 0.17</b>	-0.00	-0.01, 0.00	-0.02	-0.06, 0.04
My child is allowed to eat F&V as snacks without asking	-0.02	-0.07, 0.04	<b>0.04</b>	<b>0.01, 0.07</b>	-0.00	-0.00, 0.00	-0.01	-0.06, 0.04
Parental F&V consumption	-0.01	-0.07, 0.04	<b>0.04</b>	<b>0.01, 0.06</b>	0.00	-0.00, 0.00	-0.01	-0.06, 0.04
Parental knowledge on F&V recommendation†	0.00	-0.09, 0.08	<b>0.35</b>	<b>0.29, 0.39</b>	0.00	-0.03, 0.03	-0.01	-0.09, 0.06
Unhealthy snacking								
I think eating sweet or salty snacks is not bad for my child	-0.13	-0.06, 0.04	<b>0.08</b>	<b>0.04, 0.13</b>	-0.00	-0.01, 0.00	-0.06	-0.12, 0.00
I make sweet or salty snacks regularly available for my child	-0.00	-0.06, 0.06	<b>0.09</b>	<b>0.06, 0.12</b>	0.00	-0.01, 0.01	<b>-0.07</b>	<b>-0.13, -0.01</b>
My child is not allowed to snack while watching television	<b>0.11</b>	<b>0.05, 0.16</b>	-0.03	-0.07, 0.00	<b>-0.00</b>	<b>-0.01, 0.00</b>	-0.06	-0.13, 0.00
My child is allowed to eat sweet or salty snacks only at certain occasions, i.e. birthdays	<b>0.11</b>	<b>0.05, 0.17</b>	<b>-0.05</b>	<b>-0.09, -0.02</b>	<b>-0.01</b>	<b>-0.01, -0.00</b>	-0.06	-0.12, 0.01
I give sweet or salty snacks to my child as a reward or to comfort him	-0.01	-0.07, 0.05	<b>0.04</b>	<b>-0.00, 0.07</b>	0.00	-0.00, 0.00	-0.06	-0.12, 0.01
If I prohibit my child to eat sweet/salty snack I find it difficult to stick to my rules if (s)he starts nagging	0.02	-0.05, 0.08	<b>0.05</b>	<b>0.02, 0.09</b>	0.00	-0.00, 0.01	<b>-0.07</b>	<b>-0.13, -0.00</b>
I find it difficult to restrain myself from eating sweet or salty snacks because of the presence of my child	-0.01	-0.06, 0.05	<b>0.05</b>	<b>0.01, 0.09</b>	0.00	-0.00, 0.00	<b>-0.06</b>	<b>-0.12, 0.00</b>
Parental snack consumption	<b>-0.07</b>	<b>-0.13, -0.01</b>	<b>0.14</b>	<b>0.10, 0.19</b>	<b>-0.01</b>	<b>-0.02, -0.00</b>	-0.05	-0.11, 0.02
Parental knowledge on snacking recommendation†	<b>0.16</b>	<b>0.09, 0.23</b>	<b>-0.11</b>	<b>-0.16, -0.07</b>	<b>-0.02</b>	<b>-0.03, -0.01</b>	-0.04	-0.10, 0.02

$\alpha$ , estimation of the effect of the intervention on the proposed mediator;  $\beta$ , estimation of the effect of the mediator on unhealthy snacking and F&V consumption;  $a\beta$ , computation of the indirect effect of the intervention on unhealthy snacking and F&V consumption via the proposed mediator;  $\tau'$ , estimation of the effect of the mediator on unhealthy snacking and F&V consumption adjusting for the intervention effect; F&V, fruit(s) and vegetable(s). All models were single mediation models adjusted for child's sex and age, maternal education, country, baseline values of snacking consumption and baseline values of the specific mediators. Bias-corrected bootstrapping using 5000 samples was conducted with the maximum likelihood estimator (except for categorical mediators indicated with †, which were conducted with the WLSMV indicator) using Mplus version 8.0. Standardized coefficients are shown using STDY standardization because of a binary independent variable. Significant associations are presented in bold font. The regression coefficients are presented in sd.

in the preliminary phases of the ToyBox-study. Furthermore, all measurements at pre- and post-test were taken during the same time period (i.e. May/June 2012 and 2013), thus limiting the potential seasonality effects on pre-schoolers' snack consumption. On the other hand, data were self-reported by the parents, resulting in potential recall bias or social desirability of the responses. However, the reliability of the used questionnaires has been previously tested, before the start of the intervention, and they were found to be reliable tools<sup>(22)</sup>. Furthermore, the data were collected in 2012–2013; however, this is to be expected from multicentre studies, which include complex procedures for data processing, handling and analysis. Even though attention on the health-related behaviours in young children is growing, the literature focusing on the pathways through which interventions such as the ToyBox-study improve health-related behaviours via family-related or other determinants is still scarce. Thus, the current study is strongly related and relevant to current policy and practice in order to improve the effectiveness of childhood obesity prevention programmes.

## Conclusions

Even though the total effect of the ToyBox-intervention on pre-school children's healthy and unhealthy snacking was not significant, the intervention was effective in improving parental rules on children's unhealthy snack consumption (i.e. restriction while watching television and permission only at certain occasions) and parental consumption of unhealthy snacks, while it increased parental knowledge on snacking recommendations. Regarding the consumption of healthy snacks, the ToyBox-intervention improved children's attitude towards F&V. All previously mentioned family-related determinants mediated the intervention effect on pre-schoolers' consumption of healthy and unhealthy snacks. These findings imply that future interventions aiming to promote F&V consumption and limit the consumption of unhealthy snacks in pre-schoolers should target these mediators, but also target more determinants and use more strategies, such as personalization, to enhance their effectiveness.

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### Supplementary material

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