

## The longitudinal link between mothers' and adolescents' snacking: The moderating role of television viewing



Nina van den Broek<sup>a, \*</sup>, Junilla K. Larsen<sup>a</sup>, Maaïke Verhagen<sup>a</sup>, Rob Eisinga<sup>b</sup>, William J. Burk<sup>a</sup>, Jacqueline M. Vink<sup>a</sup>

<sup>a</sup> Behavioural Science Institute, Radboud University, Nijmegen, The Netherlands

<sup>b</sup> Radboud Social Cultural Research, Radboud University, Nijmegen, The Netherlands

### ARTICLE INFO

#### Article history:

Received 8 March 2017

Received in revised form

25 August 2017

Accepted 6 October 2017

Available online 7 October 2017

#### Keywords:

Snacking

Adolescence

Mothers

Television viewing

Longitudinal

### ABSTRACT

A large proportion of adolescents eats too many energy-dense snacks, which is detrimental for their current and future health. To understand how to promote healthy dietary behaviors in adolescents, we need to identify factors that affect their snacking. While previous cross-sectional work has shown mother-child similarities in eating behavior, longitudinal studies are lacking. Hence, the first aim of this study was to examine whether maternal snacking predicted changes in adolescents' snacking over time. A second aim was to examine whether adolescents' television viewing magnified the strength of this longitudinal association. Television viewing may increase the motivation to eat the snacks consumed by mothers later on, for example through food advertisement exposure and mindless eating. To address both aims, 2051 adolescents ( $M_{\text{age}}$  baseline = 13.81; 51.5% boys) were asked to report on their snacking and television viewing three times, with intervals of one year. Moreover, a subsample of mothers of adolescents ( $N = 1080$ ) reported on their snacking at baseline as well. The results indicate that maternal snacking indeed predicts adolescents' snacking over time and that this effect is more pronounced among adolescents who watch a great amount of television. These findings attest to the importance of mothers in forming adolescents' snacking, not only concurrently but also prospectively. Additionally, this study highlights the relevance of assessing other home environmental factors that may influence maternal effects on their children's snacking.

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In the last decades, adolescents' caloric intake from energy-dense snacks has increased substantially (Larson & Story, 2013). This is alarming, given that energy-dense snacks, such as potato chips, candy, and cookies, tend to be high in sugar and fat, but low in nutritional value. Although some debate still exists, the World Health Organization (WHO, 2003) reported that the existing evidence is convincing enough to state that snacking (i.e., the intake of energy-dense snack foods) promotes weight gain, which has obvious negative health consequences (Daniels, 2006). It is imperative to invert this trend and to establish healthy dietary behaviors in adolescents, given that their dietary habits track into adulthood and become increasingly resistant to change (Lien, Lytle, & Klepp, 2001). To attain this goal, we need to better understand factors that affect adolescents' snacking over time.

The social environment has proven to play a major role in explaining adolescents' snacking (e.g., De la Haye, Robins, Mohr, & Wilson, 2013; Salvy, De la Haye, Bowker, & Hermans, 2012). Specifically, parents are among the most important determinants of adolescents' snacking. Previous studies have mainly focused on the important role mothers play, and have shown that mothers and their children show similarities in snacking (Wang, Beydoun, Li, Liu, & Moreno, 2011). It has been suggested that mothers can set a snack consumption example and that they can establish norms regarding the amount and frequency of snacking (Herman & Polivy, 2005). However, previous studies have been limited by their cross-sectional design (Wang et al., 2011). Studies that include multiple measurement points over time are needed to shed more light on whether maternal snacking affects their children's snacking later on as well. To the best of our knowledge, this study is the first to take this step by assessing whether maternal snacking predicts adolescents' snacking over time.

For future prevention and intervention research, it is also crucial

\* Corresponding author. Behavioural Science Institute, Radboud University, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands.

E-mail address: [n.vandenbroek@pwo.ru.nl](mailto:n.vandenbroek@pwo.ru.nl) (N. van den Broek).

to identify factors that magnify the effect of maternal snacking on adolescents' snacking over time. One of the factors that possibly moderates this longitudinal association is adolescents' television viewing. Television viewing is among the most popular leisure-time activities for adolescents all over the world (Currie et al., 2012). Notably, maternal snacking may be more likely to affect adolescents' snacking when adolescents watch television a lot. More specifically, television viewing can lead to exposure to food advertisements (Story & French, 2004), which is related to increased motivations to snack and actual snacking (Buijzen, Schuurman, & Bomhof, 2008; Chernin, 2008), and to mindless eating, in which consumption of available food is increased due to distraction by the viewing content (Ogden et al., 2013). Critically, both effects of television viewing can promote the motivation to eat the unhealthy snacks available through maternal snacking later on. As such, it can be expected that adolescents who watch a great deal of television are more inclined to adopt their mothers' snacking habits.

## 1. The current study

Taken together, the current study had two innovative aims. The first aim was to examine whether maternal snacking predicted changes in adolescents' snacking one and two years later. It was hypothesized that maternal snacking at baseline was positively related to adolescents' snacking one and two years later. The second aim was to examine whether adolescents' television viewing moderated the longitudinal link between maternal and adolescents' snacking. While research has provided evidence for direct effects of television viewing on adolescents' snacking (Barr-Anderson, Larson, Nelson, Neumark-Sztainer, & Story, 2009; Pearson, Ball, & Crawford, 2011), its interaction with maternal snacking has not been assessed yet. It was hypothesized that the longitudinal mother-child association in snacking was magnified among adolescents with a high level of television viewing.

## 2. Method

### 2.1. Participants and procedure

The adolescents in the present study were part of the large-scale Dutch longitudinal project "Mental Health and Health Habits" (Larsen et al., 2012). In this longitudinal cohort study, three waves of data were collected with one-year intervals (2007–2009). Participants were recruited from seven randomly selected secondary schools in rural ( $n = 3$ ) and urban ( $n = 4$ ) areas in the south-east of the Netherlands. A total of 90 classrooms (on average 13 classrooms per school;  $SD = 4.81$ ) participated, with an average of 23 students per classroom ( $SD = 4.40$ ). A flowchart of adolescents' participation in the three waves is presented in Fig. 1. Reasons for drop-out were parents or children denying permission to participate in the study, moving away to another school, or being absent on the day of testing. At Time 1, boys ( $n = 1056$ ) and girls ( $n = 995$ ) were approximately equally represented. Most participants were born in the Netherlands (95.9%), had at least one parent born in the Netherlands (94.1%), and were living with both parents in intact, non-divorced families (89.2%). All participants attended regular secondary education and were in their first or second year (i.e., Grades 7 and 8) at Time 1 ( $M_{age} = 13.81$ ;  $SD_{age} = 0.72$ ; age range = 11.41 to 16.85).

The study protocol was approved by the Institutional Review Board of the Radboud University, Nijmegen, The Netherlands. A passive parental consent procedure was used in which a letter describing the prospective study with three measurement waves was mailed to 2216 parents. The parents were asked to return an e-

mail or make a phone call if they did not want their child to participate. Before participation in the study, students were informed that participation was voluntary and that answers would be confidential and anonymous. At all time points, adolescents completed a 10-page survey during classroom hours, and height and weight were measured out of sight of classmates. A numeric code was used to identify adolescents at all time points.

Parents were additionally asked to fill out a short questionnaire on their own health behavior and well-being at Time 1. Of the 2051 students who participated at Time 1, 1237 of their parents (87.4% was mothers) completed and returned the questionnaire. In the current study, we only used the information on mothers' snacking.

### 2.2. Measures

**Adolescents' and mothers' snacking.** Snacking was defined as the consumption of sweet or savory palatable food products. It was measured with five questions of the Fat list (a brief food frequency questionnaire) that refer to the consumption of energy-dense snacks (Van Assema, Brug, Ronda, & Steenhuis, 2001). The questions assess participants' intake of (1) (pea)nuts, (2) chips, cheese, and sausages, (3) pastry, cake, and large cookies, (4) candy bars, and (5) chocolate. The Fat list has proven to be a valid instrument in assessing differences in total and saturated fat (Van Assema et al., 2001), and both the total list and the current selection of items have been used frequently (e.g., Wouters, Larsen, Kremers, Dagnelie, & Geenen, 2010). For all five items, the frequency of intake during a regular week was reported on an 8-point scale ranging from 1 (*never or less than one day a week*) to 8 (*seven days a week*), with each score in between (scores 2 till 7) reflecting intake on one to six days a week. To obtain a single sum score for snacking, the five items were averaged and multiplied by five. Only responses of participants that contributed at least four items to this sum score were considered valid. Adolescents completed the list at all three time points and their mothers completed the list only at the first time point.

**Television viewing.** To assess television viewing, adolescents were asked to rate the amount of television viewing on a regular school day and weekend day separately on an 8-point scale. Adolescents were asked whether they watched television (almost) never, less than 30 min, 30 min to an hour, one to two hours, two to three hours, three to four hours, four to five hours, or more than five hours per day. Similar scales have been used previously and have proven to be a reliable and valid way to measure television viewing in large cohort studies (Barr-Anderson et al., 2009). In order to obtain a single score for television viewing, first the mean amount of minutes was calculated per response category to estimate the mean amount of television in minutes on school days and weekend days. For instance, the third response category (30 min to an hour) was scored as 45 min of television viewing. Second, the average amount of minutes watched on school days was multiplied by 5 and on weekend days by 2. Third, the total amount of minutes viewing per week was calculated and divided by 7 to obtain a single score for average daily amount of television viewing. Adolescents completed these items at all three time points.

**Covariates.** Several covariates were assessed at Time 1. As unhealthy food consumption seems to be more frequent in older, in lower educated, and in overweight youth (Hill et al., 2008; Reedy & Krebs-Smith, 2010; Wouters et al., 2010), adolescents' age (as derived from date of birth and date of measurement), education (1 and 2 = pre-vocational education; 3 and 4 = intermediate education; 5 = intermediate-to-high education; 6 = pre-university education) and age- and gender-specific Body Mass Index (zBMI; scores calculated using CDC 2000 growth charts (Kuczmarski et al., 2002)) were included as covariates. Moreover, since food

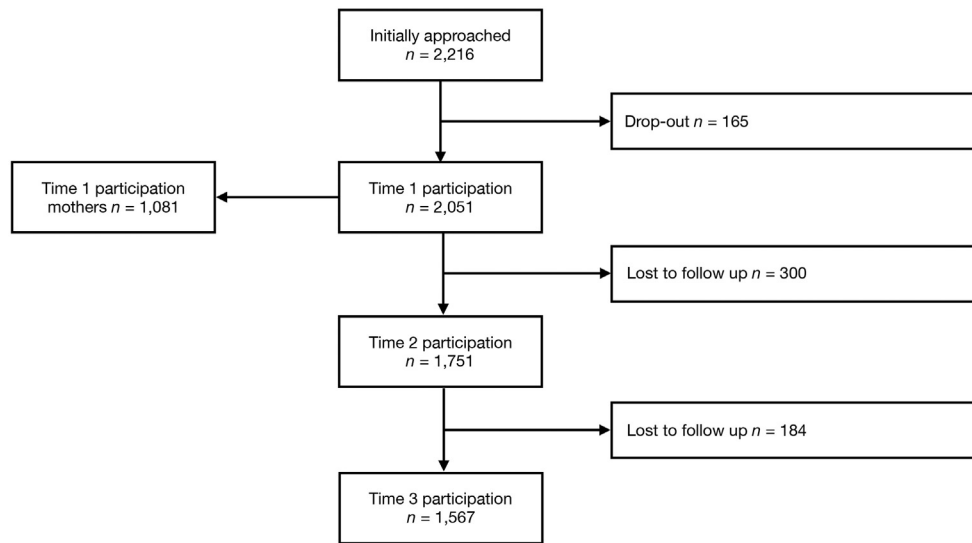


Fig. 1. Participant flow over the measurement points.

consumption patterns seem to vary by ethnicity and gender (Reedy & Krebs-Smith, 2010; Wouters et al., 2010), adolescents' ethnicity (0 = both parents born in the Netherlands; 1 = at least one parent not born in the Netherlands) and gender (0 = boys; 1 = girls) were also included.

### 2.3. Data analysis

First, Pearson's correlation coefficients between the covariates, mothers' snacking at Time 1, and adolescents' television viewing and snacking at all time points were obtained along with descriptive statistics (i.e.,  $M$  ( $SD$ ) or percentages). Second, two series of hierarchical linear regression analyses were performed: one with adolescents' snacking at Time 2 as the dependent variable and one with adolescents' snacking at Time 3 as the dependent variable. Independent variables were entered in a stepwise manner. In Step 1, covariates and adolescents' baseline snacking (at Time 1) were included. In Step 2, main effects of adolescents' television viewing at Time 1 and mothers' snacking at Time 1 were entered into the analysis. In Step 3, the two-way interaction term between mothers' snacking and adolescents' television viewing at Time 1 was tested. All independent variables were handled in a continuous manner and were standardized before inclusion. Third, statistically significant interactions were further examined using simple slopes analysis, by plotting the association between mothers' snacking at Time 1 and adolescents' snacking at Time 2 or 3, separately for high ( $M + 1 SD$ ) and low ( $M - 1 SD$ ) values of television viewing at Time 1 (Aiken & West, 1991). We also repeated these analyses using difference scores in snacking as the dependent variable (i.e., from Time 1 to Time 2 and from Time 1 to Time 3), which led to equivalent results and will thus not be reported here.

The regression analyses were performed using the lavaan package (Rosseel, 2012) in the R statistical program (R Core Team, 2016). The lavaan package was utilized to account for missing values (i.e., maternal snacking scores and attrition) and to deal with potential issues involving the non-normal distributions of the snacking variables. More specifically, full information maximum likelihood (FIML) was used to estimate each regression model for the entire analytic sample and the Huber-White covariance adjustment (MLR) was applied to the standard errors of each parameter. Statistical significance was inferred by a  $p$ -value less than 0.05. We did not account for nesting in classes or schools,

because the intraclass correlation coefficients of both grouping factors in both dependent variables (i.e., adolescents' snacking at Time 2 and 3) were very close to zero.

## 3. Results

### 3.1. Concurrent associations with snacking

Bivariate correlation coefficients between all measures and descriptive statistics (i.e.,  $M$  ( $SD$ ) or percentages) are presented in Table 1. The correlation coefficients showed that mothers' snacking at Time 1 was positively related to adolescents' snacking at Time 1 ( $r = 0.14$ ,  $p < 0.001$ ). This indicates that when mothers snacked more often at Time 1, their children snacked more often at Time 1 as well. Furthermore, positive concurrent correlations were found between television viewing and adolescents' snacking at all time points ( $r = 0.25$ ,  $r = 0.18$ , and  $r = 0.19$ , all  $p < 0.001$ ), revealing that adolescents who watched a great deal of television also snacked more often at the same point in time.

### 3.2. Maternal snacking and adolescents' snacking

Table 2 presents the results of both series of regression analyses. While a positive trend was observed, Step 2 of both analyses showed that television viewing at Time 1 was not significantly associated with adolescents' snacking at Time 2 and 3, controlled for covariates and baseline snacking. Maternal snacking at Time 1 was found to be positively related to adolescents' snacking at Time 2 and 3. These results indicate that maternal snacking is robustly associated with adolescents' snacking one and two years later.

### 3.3. Moderating role of adolescents' television viewing

In Step 3 of the first regression analysis, it was found that the interaction term between maternal snacking and adolescents' television viewing at Time 1 was statistically significant. This indicated that television viewing at Time 1 moderates the link between maternal snacking at Time 1 and adolescents' snacking at Time 2. Notably, this interaction term remained significant in a reduced model without covariates. To interpret this interaction, adolescents' snacking at Time 2 was regressed on maternal snacking at Time 1 at high and low levels of adolescents' television

**Table 1**  
Pearson correlation coefficients between the main variables in the current study.

	M	SD	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Age T1	13.81	0.72	–0.32***	0.04	0.15***	–0.04	–0.03	0.14***	0.05*	0.06*	0.12***	0.07**	–0.02
(2) Education T1 <sup>a</sup>	<sup>a</sup>			–0.09***	–0.11***	–0.02	0.05	–0.20***	–0.14***	–0.13***	–0.10***	–0.09***	0.02
(3) zBMI T1	0.46	1.07			0.14***	–0.07**	–0.04	0.07**	0.03	0.05*	–0.17***	–0.24***	–0.22***
(4) Ethnicity <sup>b</sup>	<sup>b</sup>					0.02	0.05	0.06**	0.02	–0.01	0.15***	0.09***	0.09***
(5) Gender <sup>c</sup>	<sup>c</sup>						–0.03	–0.01	–0.02	–0.01	–0.09***	–0.16***	–0.16***
(6) Mothers' snacking T1	10.26	4.01						0.01	0.02	0.03	0.14***	0.18***	0.16***
(7) Television viewing T1	107.82	63.85							0.62***	0.52***	0.25***	0.18***	0.14***
(8) Television viewing T2	106.57	63.43								0.65***	0.15***	0.18***	0.16***
(9) Television viewing T3	105.14	62.75									0.13***	0.15***	0.19***
(10) Snacking T1	13.04	5.85										0.59***	0.54***
(11) Snacking T2	13.21	5.80											0.64***
(12) Snacking T3	12.98	5.88											

Note. \*  $p < 0.05$ . \*\*  $p < 0.01$ . \*\*\*  $p < 0.001$ . T1 = Time 1; T2 = Time 2; T3 = Time 3.

<sup>a</sup> 1 and 2 = prevocational education (20.7%), 3 and 4 = intermediate education (21.7%), 5 = intermediate-to-high education (23.3%), and 6 = pre-university education (34.3%).

<sup>b</sup> 0 = native Dutch (85.1%) and 1 = ethnic minority (14.9%).

<sup>c</sup> 0 = boys (51.5%) and 1 = girls (48.5%).

**Table 2**  
Standardized coefficients of Mother's snacking and Adolescent's television viewing at T1 as predictors of adolescents' snacking at T2 and T3.

	Snacking T2			Snacking T3		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Age T1	–0.01	–0.01	–0.01	–0.07**	–0.07**	–0.07***
Education T1 <sup>a</sup>	–0.05*	–0.05*	–0.06*	0.02	0.02	0.02
zBMI T1	–0.16***	–0.16***	–0.16***	–0.14***	–0.14***	–0.14***
Ethnicity <sup>b</sup>	0.03	0.02	0.03	0.05*	0.05	0.05
Gender <sup>c</sup>	–0.11***	–0.11***	–0.11***	–0.13***	–0.13***	–0.13**
Snacking T1	0.57***	0.54***	0.55***	0.52***	0.52***	0.52***
Mother's snacking T1		0.09**	0.09***		0.08**	0.08**
Television viewing T1		0.04	0.04		0.04	0.04
Mothers' snacking T1 x Television viewing T1			0.09 <sup>d</sup> ***			0.07 <sup>d</sup>
$R^2$	0.40	0.41	0.42	0.36	0.36	0.37
$\Delta R^2$		0.01	0.01***		0.01*	0.01*

Note. \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ . T1 = Time 1; T2 = Time 2; T3 = Time 3.

<sup>a</sup> 1 and 2 = prevocational education, 3 and 4 = intermediate education, 5 = intermediate-to-high education, and 6 = pre-university education.

<sup>b</sup> 0 = native Dutch and 1 = ethnic minority.

<sup>c</sup> 0 = boys and 1 = girls.

<sup>d</sup> Remained stable in a reduced model without covariates.

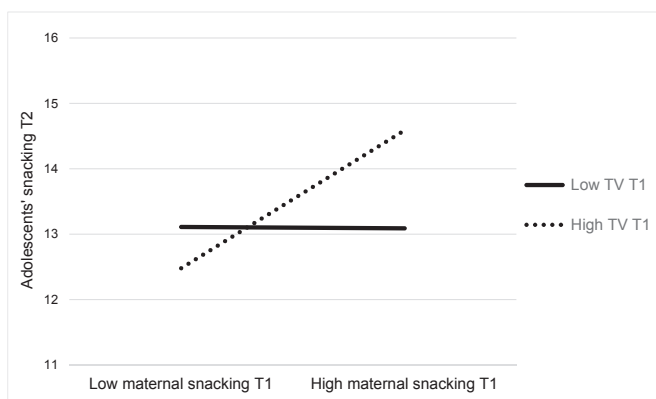
viewing at Time 1 (see Fig. 2). Simple slopes analysis revealed that the association between maternal snacking at Time 1 and adolescents' snacking at Time 2 was only significant at high levels ( $M + 1$  SD) of adolescents' television viewing at Time 1 ( $b = 1.05$ ,  $SE = 0.24$ ,  $p < 0.001$ ) and not at low levels ( $M - 1$  SD) of television viewing at

Time 1 ( $b = -0.01$ ,  $SE = 0.20$ ,  $p = 0.95$ ). The interaction term in Step 3 of the second regression analysis showed a similar pattern as in the first analysis, but was not statistically significant ( $p = 0.059$ ).

#### 4. Discussion

Previous cross-sectional studies have shown that mothers and their children report similar snacking behavior (Wang et al., 2011). So far, not a single study has examined whether maternal snacking predicts changes in adolescents' snacking later on, which limits our understanding of the impact mothers have in forming adolescents' snacking over time. Therefore, the current study examined whether maternal snacking was prospectively linked to adolescents' snacking. Moreover, to further our understanding of the conditions under which maternal influence on adolescents' snacking occurs, it was assessed whether adolescents' television viewing moderates maternal influence on adolescents' snacking over time.

As expected, our results indicate that maternal snacking predicts adolescents' snacking over time. Although the positive association between baseline maternal snacking and later adolescents' snacking behavior was rather small, the association was revealed to be robust, with similar positive associations found over one and two years. This longitudinal association between maternal snacking and adolescents' snacking underscores the importance of maternal



**Fig. 2.** Simple slopes describing adolescents' snacking at Time 2 (y-axis) predicted by the two-way interaction between maternal snacking at Time 1 (x-axis) and adolescents' television viewing (TV) at Time 1.

snacking in determining adolescents' snacking. One important mechanism that may explain this association is adolescents' modeling of their mothers' snacking, in which adolescents directly observe and copy their mothers snacking through social learning (Cruwys, Bevelander, & Hermans, 2015). Related to this, conformity to the prevailing descriptive and injunctive norms at home (i.e., established guidelines on what is appropriate regarding snacking; (Cialdini, Reno, & Kallgren, 1990; Higgs, 2015)), may also explain the prospective link between mothers' and adolescents' snacking. Moreover, the role of shared mother-child genetics (e.g., Llewellyn, Trzaskowski, Van Jaarsveld, Plomin, & Wardle, 2014) should not be neglected in explaining similarities in maternal and adolescents' snacking.

Also, as expected, the strength of the link between maternal and adolescents' snacking was not similar for all adolescents. More specifically, the effect of maternal snacking on adolescents' snacking was most pronounced among adolescents who watched television more often, compared to adolescents who watched television less often. This effect could be caused by direct effects of television viewing on snacking, through snack advertisement exposure (Story & French, 2004) and mindless eating (Ogden et al., 2013), which can both increase motivations to eat the snacks consumed by mothers. The moderating effect of television viewing could also signify that mothers who allow their children to watch a great deal of television, also allow their own snacking to affect their children's snacking through other unhealthy parenting practices. This idea is in line with previous work showing that maternal practices for allowing weight-related behaviors among their children (e.g., snacking and television viewing) cluster together (Rodenburg, Oenema, Kremers, & Van de Mheen, 2013). As adolescents may be more likely to adopt their mothers' snacking habits when mothers perform more unhealthy parenting practices, it is worthwhile to assess the moderating effects of more specific maternal practices at home, such as food parenting practices (Sleddens et al., 2014) and food availability at home (Campbell et al., 2007). Regardless of the precise mechanisms, this study indicates that it is useful to not only assess actual snacking behavior, but also the broader home environment.

While some previous studies (Barr-Anderson et al., 2009; Pearson et al., 2011) have found a statistically significant link between adolescents' television viewing and snacking over time, in the present study only a trend was found for this prospective association. Notably, these previous studies were conducted among non-European (i.e., American and Canadian) adolescents, while our study was performed among European (i.e., Dutch) adolescents. The effects of watching television on snacking over time might differ due to differential exposure to food advertisements with comparable amounts of viewing television. Critically, when watching a similar amount of television, American and Australian adolescents watch approximately three to four times more food advertisements than Dutch adolescents (Goris, Petersen, Stamatakis, & Veerman, 2010). This difference in exposure to food advertisements might be among the explanations why non-European adolescents snack more after watching television than Dutch adolescents.

Our study has several strengths. First, the current study employed a large sample size, ensuring sufficient power to detect relatively small, but relevant, effects (Wang et al., 2011). A second strength was that adolescents' and maternal snacking were both based on self-report, limiting issues of biased projections of similarities (Brown et al., 2009). This increases the validity of the effects that we have found. However, some limitations should be acknowledged as well. First, snacking and television viewing were based on self-reports, which may be biased due to social desirability and lack of specificity (Subar et al., 2015). While this may

lead to underreporting of for example (snack) intake (Subar et al., 2015), similar self-report scales have been used often and show good validity (Barr-Anderson et al., 2009; Van Assema et al., 2001; Wouters et al., 2010). Nevertheless, innovative methods, such as the use of smartphones or wearable devices that can capture real-time snacking and sedentary behavior while reducing respondent burden might be promising alternatives (Rollo et al., 2016). Second, we did not obtain information on maternal snacking at the second and third time point, which prevented us from testing bidirectional associations between snacking of mothers and their adolescent children. Third, this study relied on a healthy sample of relatively well-educated adolescents with homogeneous cultural background. Therefore, our findings may not generalize to adolescents who differ regarding education, ethnicity, and socio-economic status. Future work could benefit from assessing the prospective link between maternal and adolescents' snacking who live in higher-risk obesogenic environments (i.e., adolescents from low socio-economic status or with overweight mothers).

Our study highlights several additional avenues for future research. In this study, we chose to focus exclusively on maternal snacking to build on previous work and to make use of the largest part of our parental snacking data. However, as recent research indicated that fathers also influence adolescents' food intake (e.g., Hall et al., 2011), future work could distinguish between father-child and mother-child dyads. Also, given that peers start to play a critical role during adolescence, it is imperative that future studies start to incorporate both socialization agents to assess their joint and interactive roles in the formation of adolescents' snacking. Future studies could benefit from the use of more measurement points over a longer period of time, for example to assess potential development differences in social influence over time. Moreover, while our insights into the temporal pathways of maternal and adolescents' snacking was increased by the use of multiple measurements over time, causality cannot be inferred. Associations can also arise from environmental or genetic confounding. To test for causality, experimental studies manipulating mothers' snacking are critical. Television viewing, as well as other potential moderators, could be added as an additional experimental factor to assess their moderating role in maternal effects on adolescents' snacking.

In conclusion, maternal snacking seems to play an important role in explaining adolescents' snacking over time, especially among adolescents who watch a lot of television. Future studies need to assess other factors in the home environment to shed more light on the processes that magnify (or mitigate) maternal effects on adolescents' snacking. Moreover, as adolescents' social environment does not only include one's mothers, it is critical that other socializing agents (i.e., fathers, peers, siblings, teachers) are included in future work as well. While more work is needed, this study was an important step in showing that maternal snacking predicts adolescents' snacking over time, and that television viewing strengthens this prospective association. It appears fruitful for future work to not only focus on actual snacking behavior, but on the home environment as a whole.

#### Declaration of submission

The work presented in this manuscript has not been published previously and is not under consideration for publication elsewhere. Additionally, this work has not been submitted or peer-reviewed previously.

#### Conflicts of interest

The authors have no conflicts of interest to declare.

## Acknowledgements

This study was supported by the Netherlands Organization for Scientific Research (NWO Veni Grant 451-05-013).

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