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Parents modelling, peer influence and peer selection impact on adolescent smoking behavior: A longitudinal study in two age cohorts

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HIGHLIGHTS

- A three years longitudinal study based in two Portuguese adolescent cohorts.
- Parents' modelling effect on adolescent smoking behavior was not consistent.
- Peer influence and peer selection had an impact on adolescent smoking behavior.
- Peer influence and peer selection effects changed according to adolescent age.
- A developmental approach is relevant to explain adolescent smoking behavior.

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ABSTRACT

Understanding the key factors that influence smoking behavior, especially during adolescence, has a meaningful impact on public health. This study examined the impact of parent modelling, peer influence and peer selection on adolescent smoking behavior in two Portuguese cohorts followed for three years.

A questionnaire was delivered in classes and schools randomly selected, three times, one per year (cohort1: time1-7th, time2-8th, time3-9th; cohort2: time1-10th, time2-11th, time3-12th graders).

The sample included a total of 656 students (402 younger [time1 $M_{age} = 13.17$, $SD = 0.53$, 63.7% girls;] and 254 older [time1 $M_{age} = 16.20$, $SD = 0.53$, 65% girls]).

Longitudinal data were examined through an autoregressive cross-lagged model (ARCL). The model explained 35% of the variance in smoking behavior at T3 for the global sample (4% for the younger and 58% for the older).

Over time, in both cohorts, the percentage of never smokers decreased sharply and the percentage of regular smokers increased rapidly. We observed that participants in the older cohort had higher chances of smoking if their parents smoked. Nevertheless, we did not find a parental modelling effect in the longitudinal model. Peer influence and peer selection influenced smoking behavior. However, peer selection influenced the youngest group, both processes influenced the middle age group, and only peer influence influenced the oldest. Best friend and friends had a stronger impact on the younger while friends and same grade students had a stronger impact on the older. Prevention programs should regard these differences of interpersonal influences through adolescent development and specific strategies for different age groups should be considered.

1. Introduction

Smoking continues to be a leading cause of preventable death and disease (Carters & Byrne, 2013; WHO, 2013;2015). Most smokers started to smoke during adolescence, more than 60% initiated before the age of 18 years old, many became addicted after smoking a few

cigarettes (USDHHS, 1994, 2012; Duncan, Tildesley, Duncan, & Hops, 1995; Vitória, Kremers, Mudde, Pais Clemente, & De Vries, 2006). Preventing smoking initiation and regular smoking during adolescence is a highly relevant public health challenge.

Social learning theory developed the concept of social modelling which refers to the perceived behavior of others as a central source of

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influence in the observer's behavior (Bandura, 1977, 1986). Research indicates that a relevant factor on adolescents smoking is parents and peer influences (e.g., USDHHS, 1994, 2012; Vitória, Salgueiro, Silva, & de Vries, 2009; Vitória, Salgueiro, Silva, & de Vries, 2011; Haas & Schaefer, 2014).

The importance of parents modelling on adolescents smoking behavior is well established (e.g., Avenevoli & Merikangas, 2003; Bricker et al., 2006; Bricker, Peterson, Sarason, Andersen, & Rajan, 2007; De Vries, Engles, Kremers, Wetzels, & Mudde, 2003; Harakeh et al., 2010; Mercken, Sleddens, De Vries, & Steglich, 2013). For example, Leonardi-Bee, Jere, and Britton (2011) found an increased risk of smoking uptake in childhood and adolescence when at least one parent smokes, and this risk increased almost threefold when both parents smoke.

On the other hand, several studies have demonstrated the association between the smoking behavior of peers and individual smoking, such that having friends who smoke increases the probability of becoming a smoker (e.g., Ali & Dwyer, 2009; De Vries et al., 2003; Defoe, Dubas, Somerville, Lugtig, & van Aken, 2016; McDonough, Jose, & Stuart, 2016; Mercken, Candel, Willems, & de Vries, 2009; Mercken, Snijders, Steglich, Vartiainen, & De Vries, 2010). However, according to Kobus (2003), the role of peer influence has been overestimated and two of the reasons were the use of cross-sectional studies and limitations on data analysis that not reach more in-depth influence processes.

There is a body of evidence suggesting another process with impact on smoking behavior which is the similarity among peers and the selection of friends process (Ennett & Bauman, 1994; Go, Green Jr, Kennedy, Pollard, & Tucker, 2010; Hoffman, Monge, Chou, & Valente, 2007; Kobus, 2003; Mercken, Candel, et al., 2009; Steglich, Snijders, & Pearson, 2010; Urberg, Degirmencioglu, & Pilgrim, 1997; Urberg, Luo, Pilgrim, & Degirmencioglu, 2003). Peer selection occurs when adolescents choose their friends based on similar behavior during friendship formation (Ennett et al., 2006; Mercken, Candel, et al., 2009; Mercken, Snijders, Steglich, & de Vries, 2009). Several studies have demonstrated the importance of this process, showing a tendency for young people to select their friends based on smoking behavior similarities (Go et al., 2010; Mathys, Burk, & Cillessen, 2013; Mercken et al., 2010; Mercken, Candel, et al., 2009; Seo & Huang, 2012). In fact, most of the studies comparing peer influence against peer selection argue for the importance and impact of both (Ennett & Bauman, 1994; Green Jr. et al., 2013; Huang, Soto, Fujimoto, & Valente, 2014; Lakon, Hipp, Wang, Butts, & Jose, 2015; Osgood, Feinberg, & Ragan, 2015; Seo & Huang, 2012; Wang, Hipp, Butts, Jose, & Lakon, 2016). In this sense, it is increasingly important to identify the specific contribution of peer influence and peer selection processes on smoking behavior during adolescence and how these contributions evolve and change over time and according adolescent age. Furthermore, to improve insight into how peers influence adolescent smoking behavior, it may be interesting to broke down the concept of peers and to examine influences from best friend, friends and same grade students (e.g., Fujimoto & Valente, 2012; Vitória et al., 2006).

The present study aims to examine the role of parent modelling, peer influence and peer selection simultaneously and longitudinally in two cohorts of Portuguese adolescents followed for three years. Concerning the impact of social influence on smoking behavior across adolescence, the number of studies adopting a longitudinal approach is scarce and more longitudinal studies are much needed (Villanti, Boulay, & Juon, 2011). Regarding previous research published on Portuguese adolescents smoking behavior (e.g. Vitória et al., 2009, 2011), this study extends the age and grades range, including a new cohort of older participants, intending to observe both main processes of smoking behavior during adolescence: smoking initiation and smoking consolidation. This study was based in a sample of Portuguese adolescents stratified by region, while the others were based in a sample of adolescents from schools near Lisbon, the main urban area of Portugal.

This study has three main goals. The first is to describe the smoking behavior of participants. The second is to explore, simultaneously and

longitudinally, the processes of parents modelling and of peers (best friend, friends and same grade students) influence and selection, to better understand adolescent smoking behavior. The third goal is to examine if the impact of these processes differs based on age in these two cohorts (developmental differences).

2. Methods

2.1. Samples and data collection

This study used two age cohorts. The first was composed by adolescents from the 7th grade at the beginning of the study (T1) that were followed through the 8th(T2) and 9th(T3) grades (younger cohort, followed approximately from 13 to 15 years old). The second cohort was composed by adolescents from the 10th grade at T1 through 11th (T2) and 12th(T3) grades (older cohort, followed approximately from 16 to 18 years old). These two sets of school grades correspond to the two higher levels of the Portuguese compulsory educational system.

A total of 656 students answered the three questionnaires and participated in this study: 402 from the younger cohort (M_{age} at T1 = 13.17 years; SD = 0.53, 63.7% girls) and 254 from the older cohort (M_{age} at T1 = 16.20 years; SD = 0.53, 65% girls). The percentage of girls and boys did not differ by cohort, $\chi^2(1, N = 656) = 0.11$, $p = .74$.

The primary sampling frame included 67 randomly chosen schools that had 7th grade (first year of three of the third cycle) and/or 10th grade (first year of three of the secondary/high school) from Portugal Continental (schools from Azores and Madeira were excluded). From these 67 of schools, 58 were sequentially contacted (9 were not contacted because the defined minimum number of participants was reached). Nine schools refused to participate and 18 did not respond within the definite term. The remaining 31 schools provided one class (if they had only the third scholar cycle) or two classes (if they had third cycle and secondary) randomly chosen to participate in this study. Through this procedure, we reached the estimated number of adolescents necessary to fulfil the established minimum for the total of participants and the minimum number of participants per each of the five main administrative departments of the Portuguese Education Ministry.

On the first year of data collection (2011/2012), after providing information to parents and having their written and signed authorization, trained teachers administered the questionnaires after received an instruction manual and an administration protocol. In the next two follow-ups, in order to improve the quality of data gathering, questionnaires were administered by members of the project staff. The first questionnaire was delivered in the first year of the project between the end of the first scholar trimester and the beginning of the second scholar trimester. The second and third questionnaires were delivered in the third scholar trimester of the second and third years of the project.

This study received a formal authorizations from the Education Ministry (process n.º 0248100001) and from the Portuguese Data Protection Authority (authorization n.º 12,467/2011), and received ethical approval from the Ethics Committee of the Beira Interior University (process n.º CE-FCS-2011-004).

2.2. Questionnaire

2.2.1. Sociodemographic variables

Sociodemographic variables included in the questionnaire are: sex, date of birth, religion, parental education, profession of parents and household composition, to verify if participants lived with one or both parents.

2.2.2. Smoking behavior

Smoking behavior was categorized based on an algorithm already used in previous studies (e.g., Lotrean, Mesters, & de Vries, 2013; De

Jong, Candel, Segaar, Cremers, & de Vries, 2014; Cremers, Mercken, Candel, de Vries, & Oenema, 2015). The first question asked participants to choose the statement that best describes them out of 11 smoking-related statements. Then, self-reported smoking was cross validated using an algorithm composed by three additional questions: having smoked in the past 24 h, having smoked in the last week, and number of cigarettes smoked during their lifetime. Inconsistencies between the answers were resolved by coding the answer in the position that was closest to regular smoking. Based on this procedure, participants were classified in one of the following four categories: never smokers (never smoked a cigarette, not even one puff); non-smokers (experimental or regular smokers that do not smoke anymore); experimental smokers (smoking less than a cigarette a week); and smokers (smoking at least once a week).

2.2.3. Social influences

Social modelling was measured by participants' perceptions regarding the smoking behavior of parents and peers (best friend, friends and same grade students), similarly to previous studies (e.g., De Vries et al., 2003; Lotrean et al., 2013; Vitória et al., 2006, 2009, 2011). Smoking behavior of parents (mother and father) and best friend was classified in smoking or not smoking categories, and smoking behavior of friends and same grade students was measured on a scale that included: almost nobody; less than half; half; more than half; almost everybody. Following the approach of Lotrean et al. (2013), we analyzed perceived smoking behavior separately for each of the referents (i.e., mother, father, best friend, friends and same grade students).

2.3. Statistical analysis

Descriptive analyses and cross tabulation were performed to characterize participants' smoking behavior and its link to parental smoking behavior.

To examine the longitudinal relationships between parents social modelling, peer influences and selection and smoking behavior, an autoregressive cross-lagged (ARCL) model was explored. The ARCL is a model for longitudinal data, oriented 'to examine the structural relations of repeatedly measured constructs' (Selig & Little, 2012, p. 265). ARCL modelling gives autoregressive effects (i.e., 'the effect of a construct on itself measured at a later time'; Selig & Little, 2012, p. 265) and the cross-lagged effects (i.e., 'the effect of a construct on another measured at a later occasion'; Selig & Little, 2012, p. 266), while controlling prior levels of the construct that is being predicted, so the conclusion that a cross-lagged effect is due to a correlation between the constructs at a previous time can be ruled out (Selig & Little, 2012). In this sense, in what concerns the model explored in the present study, the cross-lagged effects of social modelling on smoking behavior allows us to infer the impact of the processes of the influence of parents and peers, while the cross-lagged effects of smoking behavior on social modelling regarding peer referents allow to infer the impact of peer selection processes.

To evaluate the model fit we considered the results of the χ^2 tests and various fit indices: incremental fit indices such as Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI); parsimony indices such as Parsimony CFI (PCFI); and absolute indices such as Root Mean Square Error of Approximation (RMSEA). In general, a score of CFI and a TLI between 0.8 and 0.9 means a poor fit and a score between 0.9 and 0.95 means a good fit; a score of PCFI between 0.6 and 0.8 means a good fit and superior to 0.8 means a very good fit; the value of RMSEA should be between 0.05 and 0.10 for an acceptable model and equal or less than 0.05 for a model that fits well (Arbuckle, 2008; Marôco, 2014). We imputed the missing values using linear regression as the multiple imputation algorithm.

To analyze the data in this study we used AMOS (version 22) for the ARCL model and IBM SPSS Statistics (version 22) for the rest of the data analysis.

3. Results

3.1. Attrition analysis

In the first year of data collection (T1), the questionnaire was completed by 1386 students in grades 7th and 10th. Of these, 907 (65.4%) completed the questionnaire again one year later (T2), 526 from the younger cohort and 381 from the older cohort, and 656 (72.3%) completed the questionnaire in the third year (T3), 402 from the younger cohort and 254 from the older cohort. The loss of participants through the study is due to three main reasons: 1) the school was not available anymore to participate; 2) students changed school and/or class; and 3) students missed school in the day of data collection.

We conducted a dropout analysis to compare participants that were in all the three waves with the others. Results showed a significant effect of dropout on smoking behavior on T2, $t(1306,454) = 6.29$, $p < .001$, $d = 0.34$, 95%CI [0.28,0.53], and on T3, $t(388,500) = 2.52$, $p = .012$, $d = 0.20$, 95%CI [0.05,0.42], with more smoking behavior among dropouts. There were no significant differences in terms of gender, age, religion, parental education and profession and household composition.

3.2. Smoking behavior

Regarding smoking behavior (Table 1), the percentage of never smokers decreased sharply over time in both cohorts: 82.6% to 65.4% in the younger; 59.8% to 46.1% in the older. On the other hand, the percentage of regular smokers increased rapidly: 3.5% to 9.9% in the younger; 11.1% to 16.5% in the older, with a peak between T2 and T3 in the younger cohort (from 4.7% to 9.9%).

3.3. Parents and participants smoking behavior

Regarding the association between parents and participants behavior (Table 2), in the younger cohort, there is a higher percentage of experimental smokers when at least one parent smokes (T1 = 3.4%, T2 = 6.0%, T3 = 7.1%) than when neither parent smokes (T1 = 2.1%, T2 = 2.5%, T3 = 4.3%). In addition, the percentage of non-smokers (have smoked in the past but stopped smoking) is smaller when one or both parents smoke (T1 = 9%, T2 = 12.8%, T3 = 16.4%) than when none smokes (T1 = 11.8%, T2 = 19.3%, T3 = 22.1%). However, none of these differences reach the statistical significance level of 0.05.

Concerning the older cohort, the differences between the two groups are more pronounced looking at the percentages of never smokers and regular smokers. There are much less never smokers in the group where at least one parent smoke (T1 = 48.7%, T2 = 41.5%, T3 = 36.6%) and much more regular smokers (T1 = 18%, T2 = 17.1%, T3 = 21.9%) than in the group where neither parent smokes (T1 = 64.9%, T2 = 57.5%, T3 = 52% for never smokers [$\chi^2_{T1} = 5.91$, $p < .02$; $\chi^2_{T2} = 5.74$, $p < .02$; $\chi^2_{T3} = 5.12$, $p < .03$] and T1 = 7.2%, T2 = 10.9% and T3 = 12.2% for regular smokers [$\chi^2_{T1} = 6.08$,

Table 1

Percentage of smoking behavior groups by time of data collection for each cohort.

	Younger cohort (n = 402)			Older cohort (n = 254)		
	T1	T2	T3	T1	T2	T3
Never smoker	82.6	73.6	65.4	59.8	51.2	46.1
Non-smoker	11.4	18.2	19.2	23.2	28.0	29.5
Experimental smoker	2.5	3.5	5.5	5.9	7.1	7.9
Regular smoker ^a	3.5	4.7	9.9	11.1	13.7	16.5

^a Regular smoker includes both weekly smokers and daily smokers.

Table 2

Percentage of smoking behavior groups by time of data collection for each cohort when neither parent smokes vs. when at least one parent smokes.

	Neither parent smokes						At least one parent smokes					
	Younger cohort (n = 218)			Older cohort (n = 136)			Younger cohort (n = 162)			Older cohort (n = 92)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Never smoker	83.2	73.8	64.6	64.9	57.5	52.0	84.8	75.9	66.4	48.7	41.5	36.6
Non-smoker	11.8	19.3	22.1	22.1	27.7	27.7	9.0	12.8	16.4	26.9	30.4	34.2
Experimental smoker	2.1	2.5	4.3	5.8	3.9	8.1	3.4	6.0	7.1	6.4	11.0	7.3
Regular smoker ^a	2.9	4.4	9.0	7.2	10.9	12.2	2.8	5.3	10.1	18.0	17.1	21.9

^a Regular smoker includes both weekly smokers and smokers. $p < .02$; $\chi^2_{T2} = 2.15$, $p = .14$; $\chi^2_{T3} = 3.71$, $p = .05$).

3.4. Longitudinal social influences

To explore, simultaneously and longitudinally, the processes and impacts of parents modelling, peer influence and peer selection, and to examine plausible differences between the two cohorts in these processes, we conducted an ARCL path analysis.

Fig. 1 shows the autoregressive and cross-lagged effects for the younger cohort while Fig. 2 shows the same model for the older cohort. Table 3 shows the parameter estimates of the cross-lagged effects for social modelling and smoking behavior.

All model fit indices showed an acceptable but modest fit (CFI = 0.882; TLI = 0.831; PCFI = 0.617; RMSEA = 0.063), except for the χ^2/df index that is over 4 ($\chi^2/df = 6.211$).

The model explained 35% of the variance of smoking behavior at T3 for the global sample. However, the explained variance in smoking behavior differs considerably by cohort: 4% at T3 for the younger and

58% at T3 for the older cohort.

Given that the students were distributed in classrooms, we tested whether the relationships of the variables significantly change if we statistically control for the classroom to avoid potential confounds. We did not find any effect; as expected the strength of the relationships tended to be slightly lower once we controlled for the effect of the classroom but every relationship that was statistically significant in the model, was still significant after we controlled for the classroom of the participants.

Furthermore, we explored the possibility that gender is playing a moderating effect in the relationship between social influence and smoking behavior but we observed that including gender did not improve the model.

For the younger cohort (Fig. 1 and Table 3), we did not find a significant effect of the smoking behavior of any of the parents on the smoking behavior of the participants. Similarly, we found that the smoking behavior of peers at T1 did not predict the smoking behavior of the participants at T2. However, we found a peer selection effect as

Fig. 1. Autoregressive cross-lagged model of social modelling behavior for the younger cohort (N = 402).

Fig. 2. Autoregressive cross-lagged model of social modelling and smoking behavior of the older cohort (N = 254).

the smoking behavior of T1 predicted the behaviors of best friends ($\beta = 0.11$, $p < .05$) and friends ($\beta = 0.12$, $p < .05$) at T2. Furthermore, we found that peers had an influence on behavior at T3 with a significant impact both of best friends ($\beta = 0.13$, $p < .01$) and friends in general ($\beta = 0.10$, $p < .05$).

For the older cohort (Fig. 2 and Table 3) the smoking behavior of parents is again not statistically associated with the behavior of the participants. Regarding peers, we found evidence of both peer influence and peer selection. There is an impact of the smoking behavior of best friends ($\beta = 0.13$, $p < .01$) and friends ($\beta = 0.16$, $p < .01$) on the participants' smoking behavior (i.e., peer influence) and there is an

relation between the participants' smoking behavior and the behavior of friends ($\beta = 0.18$, $p < .001$) and same grade students ($\beta = 0.21$, $p < .001$) (i.e., peer selection). Furthermore, we found peer influence both between T1 and T2 and between T2 and T3 for this older cohort whereas we only found peer influence after peer selection for the younger cohort (Table 3 and Fig. 1).

In this study, we have focused on predicting smoking behavior using the influence of parents and peers and we have done this without including individual differences as potential moderators. However, some could argue that gender might be playing a role, affecting differentially the influence of parents and peers on smoking behavior depending on

Table 3

Parameter estimates of the cross-lagged effects for social modelling and smoking behavior that were statistically significant.

Paths		Global sample		Younger cohort		Older cohort	
		B (β)	C.R.	B (β)	C.R.	B (β)	C.R.
T1 → T2	Best friend → Smoking behavior	0.46 (0.12)	3.61***	0.24 (0.06)	1.19	0.44 (0.13)	3.39***
	Friends → Smoking behavior	0.10 (0.10)	2.84**	0.03 (0.03)	0.72	0.17 (0.16)	3.80***
	Smoking behavior → Best friend	0.04 (0.11)	2.95**	0.04 (0.11)	2.22*	0.03 (0.09)	1.68
	Smoking behavior → Friends	0.21 (0.19)	5.38***	0.15 (0.12)	2.42*	0.18 (0.18)	30.11***
	Smoking behavior → Same grade students	0.15 (0.14)	3.87***	−0.01 (−0.00)	−0.20	0.21 (0.21)	28.13***
T2 → T3	Best friend → Smoking behavior	0.33 (0.10)	2.88**	0.52 (0.13)	2.85**	0.24 (0.08)	1.74
	Friends → Smoking behavior	0.12 (0.11)	3.42***	0.11 (0.10)	2.26*	0.15 (0.13)	2.87**
	Same grade students → Smoking behavior	−0.04 (−0.03)	−1.01	0.03 (0.02)	0.51	−0.11 (−0.09)	−2.19*
	Smoking behavior → Best friend	0.04 (0.11)	2.94**	0.05 (0.12)	2.49*	0.04 (0.11)	1.85
	Smoking behavior → Friends	0.13 (0.12)	3.12**	0.18 (0.16)	3.21**	−0.00 (−0.00)	−0.06

B: non-standardized coefficients; β : standardized coefficients; C.R.: critical ratio.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

whether the person is a girl or a boy. To explore if this is the case, we conducted multi-group tests assuming equal regression weights of every relation of the model between the groups of girls and boys. We found that the model has a better fit ($\chi^2_{(32)} = 57.65$; $p = .004$) when the regression weights are assumed to be equal. This result indicates that the model explains a social influence process that works similarly for boys and girls.

4. Discussion

Results showed a large increase of regular smokers in both cohorts: the rate of smokers increased from 5% at T1 to 10% at T3 in the younger and from 11% at T1 to 17% at T3 in the older. These results are consistent with previous findings demonstrating that the peak of smoking initiation occurs at this range of ages (USDHHS, 1994, 2012; Vitória et al., 2006; Matos, Simões, Camacho, Reis, & Social, 2015).

The ARCL model explained much more smoking behavior variance in the older cohort (58%) than in the younger (4%), suggesting that determinants other than social influences may be more relevant for younger children and for smoking behavior initiation as demonstrated by other studies (Cremers et al., 2015; Hoving, Reubsaet, & de Vries, 2007). A previous longitudinal study conducted in Portugal ten years earlier with a sample like our younger cohort and with similar model presented much better results on explained smoking behavior variance (Vitória et al., 2011). This difference in the results of two similar studies conducted with a time interval of 10 years suggests that changes happened in processes associated with adolescent smoking behavior. It may be relevant to consider that in the middle of this time interval the Portuguese tobacco control law banning the use of tobacco in public places was implemented. Our results support the hypothesis that measures like tobacco control laws can change the social influence impact on adolescent smoking behavior. Studies to test this hypothesis are needed.

Concerning the process of parents modelling, results are not consistent. In the descriptive analyses, the families in which at least one parent smokes were more likely to have adolescents smoking, which applies in particular to the older cohort, suggesting that parents influence is more relevant on smoking consolidation than on smoking initiation. These results are in line with previous studies, which had found that the parents smoking predicted the adolescents smoking behavior (De Vries et al., 2003; Vitória et al., 2009, 2011). However, the ARCL analyses did not show an effect of parental influence on adolescents smoking behavior. Similar inconsistencies were already reported in the literature on the relationship between parents and adolescents smoking (e.g., Avenevoli & Merikangas, 2003; De Vries et al., 2003). It may be that parent modelling was stronger at younger ages, which were not included in this study. Leonardi-Bee et al. (2011), for instance, showed an increased risk of smoking when one or both parents smoked, for children aged between two and 12 years old. Parental influence may also be affected by the existence of cultural differences between regions and countries as discussed in research already published (e.g., De Vries et al., 2003), indicating, for example, that mothers smoking behavior influence in adolescent smoking is stronger than fathers smoking behavior –prevalence of smoking among Portuguese women is low, and is lower in rural areas included in this study (Ministério da Saúde, 2017). Another explanation could be the already mentioned changes in social context caused by the implementation of tobacco control laws, which may have changed parental smoking behavior (e.g., less smoking in general and less smoking in front of their children) and on its influence in adolescent smoking behavior.

Both peer influence and peer selection showed an effect on adolescents smoking behavior, which is consistent with the results of previous studies (De Vries, Candel, Engels, & Mercken, 2006; Ennett et al., 2006; Mercken et al., 2010; Mercken, Candel, et al., 2009; Mercken, Snijders, et al., 2009). However, as this study is longitudinal and includes two different cohorts, interesting age differences were identified.

Among the youngest participants (from approximately 13 to 14 years old) only peer selection effect was significant. Then, between the ages of approximately 14 to 17 years old, both processes influenced behavior. Finally, among the oldest participants (approximately 17 to 18 years old) only peer influence had an effect on behavior.

Regarding the low effect of parental smoking in the participants age range, the low smoking behavior variance explained in the youngster cohort by the ARCL model, the absence of peer influence effect and the relevance of peer selection in this cohort, we can consider the hypothesis of changes occurring in processes that explain adolescent smoking behavior. For example, the denormalization produced by the tobacco control laws could reduce the impact of social influence processes, mainly measured by injunctive/subjective and descriptive norms, and increase the impact of individual and contextual factors (Gibbons, Houlihan, & Gerrard, 2009). Examples of individual factors could be impulsivity, reactive and emotional motivations or prototype images. Examples of contextual factors could be unexpected situations that adolescent have to deal with in everyday life.

Looking at these results, a developmental dynamic emerges. Parents influence had a higher impact on oldest participants which maybe was more pronounced in the behavior consolidation than in the behavior initiation. Both peer influence and peer selection processes contribute to explain smoking behavior, mainly in the range of 14 to 17 years old, which is in line with previous published research (e.g., Hall & Valente, 2007), but our results shown the existence of marked differences between younger (13 years old) and older (18 years old), since the impact of selection process prevails in the younger, while the impact of peer influence, mainly from friends, prevails in the older. Besides that, this study includes different types of peers (best friend, friends and same grade students) and results suggested that best friend and friends (micro-social or interpersonal level relations) had more impact on younger while friends and same grade students (social level relations) had more impact on older adolescents.

Overall, it can be concluded that adolescent smoking behavior is determined by multiple factors, which can be interrelated and come from different domains, including individual determinants, interpersonal influences and contextual factors, and that significant changes may occur over time on these factors and on their interrelations (De Vries et al., 2006; Defoe et al., 2016).

Some limitations of the present study can be reported. Firstly, since the study used self-reported measures, social desirability may have influenced participants answers. However, confidentiality was guaranteed to optimize the measurement. Secondly, most of the constructs were measured with only one item and smoking behavior report was not biochemical validated. Thirdly, as any longitudinal research, this study had a considerable participants dropout rate, which may limit results generalization. Specifically, the representation of smokers was lower than expected and of non-smokers was higher. Yet, dropouts should not have much impact on results since the sample was still large, and dropout rates were very similarly distributed among the different subgroups. Finally, there is a disproportion among boys and girls in both cohorts, hence, despite these differences were not statistically significant, a bias due to these differences may not be excluded.

Nonetheless, we believe that this longitudinal study with two cohorts of adolescents from a large age range provides relevant results to understand adolescent smoking behavior. Effectiveness of smoking prevention programs could be improved by tailoring their development to the age of the target group.

Declaration of Competing Interest

None.

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