

Maternal Smoking and Smoking in Adolescents: A Prospective Community Study of Adolescents and Their Mothers

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Key Words

Maternal smoking · Smoking in adolescence · Nicotine dependence · Patterns of smoking

Abstract

The associations between maternal smoking and nicotine dependence and patterns of smoking and nicotine dependence in offspring were examined in a large community-based sample of adolescents. Data were derived from baseline and 4-year follow-up assessments of 938 respondents aged 14–17 years at the outset of the Early Developmental Stages of Psychopathology (EDSP) study, a prospective-longitudinal community study of adolescents and young adults and their parents respectively. Smoking and nicotine dependence in respondents were assessed using the Munich Composite International Diagnostic Interview (DSM-IV algorithms). Diagnostic information about smoking behavior in mothers was collected by independent direct diagnostic interviews with the mothers. In comparison to children of non- or occasionally smoking mothers, children of regularly smoking and nicotine-dependent mothers had higher probabilities of using tobacco as well as of developing nicotine dependence. For all ages under consideration, survival analyses revealed a higher cumulative lifetime risk of

regular smoking and nicotine dependence among these children. Maternal smoking during pregnancy seems to represent an additional risk for these outcomes in children, specifically with regard to the risk of developing nicotine dependence. Associations were comparable for sons and daughters. Our findings show that maternal smoking predicts escalation of smoking, development of nicotine dependence, and stability of smoking behavior in children. Implications for specific intervention and prevention efforts are discussed.

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Introduction

During recent decades, a vast number of studies investigated the question of how maternal substance use behavior influences substance use behavior in their offspring. A substantial number of studies showed that the offspring of mothers with problem drinking have an increased risk of developing problems with alcohol [1–8] as well as problems with other psychotropic substances [4, 5, 9–13]. Nicotine is the most often used psychotropic substance among women [14–16] followed by alcohol. Considerably research has focused on the relationship between maternal smoking during pregnancy and behavioral distur-

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bances [17–25], physical and respiratory health [26, 27] as well as neurobiological development in children [28, 29].

In contrast, considerably fewer studies have systematically examined the effect of maternal smoking – either during pregnancy or not – on differential aspects of the development of substance use behavior, specifically smoking behavior, in children. Most studies in this area addressed the question of whether maternal smoking influences smoking initiation in children during early or middle adolescence [21, 30–41], while relatively little attention has been given to the extent to which maternal smoking influences the child’s smoking behavior over time, such as transition into higher use categories (heavy smoking, nicotine dependence) or the probability of smoking cessation [42–44]. Although the findings of these studies suggest that maternal smoking increases the risk not only for smoking initiation during adolescence but also for a less favorable course of smoking behavior over time, several methodological limitations, such as predominant use of self-report questionnaires, child’s report on maternal smoking, use of selective samples, or exclusive use of cross-sectional data, restrain the significance of these reports. Notably, all previous studies did not distinguish between different ‘stages’ of smoking and nicotine dependence in evaluating such mother–child associations. Distinguishing between stages of smoking behavior, however, seems to be of particular importance, as recent research has shown that risk factors predicting smoking initiation may be different from those predicting the subsequent course of smoking behavior [45–47]. As far as we are aware, there is no study available that evaluated the influence of maternal smoking on smoking behavior in children by considering not only smoking but also the diagnosis of nicotine dependence in both mothers and children.

This article examines the mother–child associations of smoking and nicotine dependence in a prospectively assessed representative community sample of adolescents for whom diagnostic information about smoking and nicotine dependence in both mothers and children was collected by independent diagnostic interviews. Specifically, we examine the association between regular smoking and nicotine dependence in mothers and various aspects of smoking behavior and nicotine dependence (prevalences, age at first onset, progression, cessation) in the children. The effect of maternal smoking during pregnancy on children’s smoking behavior was additionally explored.

Methods

Design

The data presented stem from the Early Developmental Stages of Psychopathology (EDSP) project, a prospective-longitudinal study designed to collect data on the prevalence and incidence, familial and other risk factors, comorbidity, and course of mental disorders in a representative sample of originally 3,021 subjects aged 14–24 years. The study consists of a baseline investigation and 2 follow-up investigations. The parents of the baseline 14- to 17-year-olds were additionally assessed in a separate parent survey.

Sample

The EDSP builds on a random population sample from the 1994 government population registries of residents in Munich with an expected age range for the sampled subjects between 14 and 24 at the time of the baseline interview in 1995. Details about the sampling, representativeness, and sociodemographic characteristics of the whole EDSP sample have been reported elsewhere [48, 49]. At baseline, the response rate for the study sample of 14- to 17-year-olds (the ‘younger cohort’) was 74.3%. Two follow-up assessments were completed after the initial baseline investigation, covering an overall period of 3–4 years. The first follow-up study (T1) was conducted an average of 19.7 (range 15–25.6) months and the second follow-up study (T2) an average of 42 (range 34–50) months after the baseline investigation. The response rate for the baseline 14- to 17-year-olds was 88% at T1 and 84% at T2.

In the parent survey, direct diagnostic interviews were conducted with the parents of this younger cohort. As we were interested not only in familial psychopathology but also in early developmental information about the respondents, primarily the mothers were interviewed. Fathers were interviewed only if the mother was not available (dead or could not be located). The parents of 1,053 adolescents were interviewed directly (in 1,026 cases the mother, in 27 cases the father; response rate 86%). Nonresponse in parents was predominantly due to refusal to participate (12.9%), researchers’ failure to contact parents (0.7%), and parents’ lack of time (0.5%) [49]. The results reported in this article are based on those at baseline 14- to 17-year-olds who completed the whole study period and whose mothers participated in the parent survey (n = 938). These respondents represent the children in this report.

Diagnostic Assessment of Respondents

Diagnostic assessments at baseline and the 2 follow-up investigations (of the respondents) were based on the computer-assisted version of the Munich Composite International Diagnostic Interview, which allows for the assessment of symptoms, syndromes, and diagnoses of 48 mental disorders according to the DSM-IV along with information about onset, duration, severity, and psychosocial impairment (M-CIDI) [50]. Diagnostic findings were obtained using the M-CIDI/DSM-IV algorithms. Reliability and validity of the M-CIDI have been reported [48, 51–53]. For all assessments the M-CIDI was supplemented by a separate respondent’s booklet that included several scales and questionnaires to assess psychological constructs relevant to the study. All interviews were administered by highly trained clinical interviewers. A detailed overview of the constructs and assessment methods has been presented [49, 54, 55]. At baseline, the lifetime version of the M-CIDI was used. At each of the follow-up assessments, the M-CIDI interval version, which refers to the time period between the last interview and the present, was applied. For

the study sample considered in this report, the complete follow-up status T0–T2 was assessed from the aggregation of information obtained from the T1 and T2 interviews.

Diagnostic Assessment of Mothers

In the parent survey, the mothers of the younger cohort were independently assessed with the M-CIDI, providing direct diagnostic information about DSM-IV substance use and other mental disorders. Interviewers were blind to the diagnostic findings of the respective index proband. The parent M-CIDI was supplemented by 2 additional modules that provided (a) family history data for the non-interviewed parent and other family members of the index proband (not used in this report), and (b) detailed information about the offspring's perinatal, psychological and somatic conditions in infancy and early childhood.

Smoking Measures

For mothers and offspring, all diagnostic information concerning smoking behavior was collected in the M-CIDI nicotine section [for details, see 56, 57]. Although the M-CIDI defines tobacco products as cigarettes, cigars, pipes, snuff or chew, almost all mothers and respondents (99%) reported cigarettes as the only tobacco product used. Therefore, the terms smoking and tobacco use are used synonymously in this article.

Children's Smoking Status

Four categories were used to describe smoking status in children: (1) 'non-smoking' defines children who never used any tobacco product during their life; (2) 'occasional smoking' defines children who experimented with tobacco products but never smoked daily for a period of at least 4 weeks; (3) 'regular smoking' defines children who smoked daily for a period of at least 4 weeks, and (4) 'DSM-IV nicotine dependence' defines children who experienced 3 of the 7 symptoms for DSM-IV nicotine dependence within the same 12-month time period.

Maternal Smoking Status

Maternal smoking behavior was categorized as follows: (1) 'non/occasional smoking' defines mothers who stated that they had either never used any tobacco product at all or tried some tobacco product at least once but never smoked regularly (NON/OCC mothers); (2) 'non-dependent regular smoking' defines mothers who reported having smoked cigarettes daily for a period of at least 4 weeks during their life, but who never fulfilled DSM-IV lifetime criteria for nicotine dependence (REG mothers), and (3) 'nicotine dependence' defines mothers who reported regular smoking and who met DSM-IV lifetime criteria for nicotine dependence (NICDEP mothers). For the analyses concerning maternal smoking during pregnancy, the following categories were used: (1) 'non/occasional smoking', as above (NON/OCC mothers); (2) 'non-pregnancy smoking' defines mothers who reported lifetime regular smoking but who never smoked during pregnancy (PREG– mothers), and (3) 'pregnancy smoking' defines mothers who reported lifetime regular smoking and who smoked during pregnancy (PREG+ mothers). Smoking behavior during pregnancy was assessed within the direct parent interview by asking how often the mother of the proband had smoked during pregnancy: never; 1–2 times; 3–5 times; 6–100 times; every 2 weeks; weekly, or almost daily.

Statistical Analyses

Data were weighted to consider different sampling probabilities as well as systematic non-response at baseline. Analyses were performed using the Stata software package [58] and applying the Huber-White sandwich matrix for weighted data [59]. To estimate the associations between maternal smoking status and diagnostic outcome in offspring, logistic regressions with odds ratios (ORs) were used [60]. For the analyses of overall association between maternal smoking status and frequency of smoking in children, cumulative logistic regressions using cumulative odds ratios (CUMOR) were used [61]. Age at onset characteristics for regular smoking and nicotine dependence were examined with the Kaplan-Meier method [62]. Differences between curves were assessed with hazard ratios (HR) from the stratified Cox model for discrete time [63]. The interaction terms age × maternal smoking were added to the model when the proportional hazards assumption was violated. An interaction of age × maternal smoking with an HR of <1 indicates that children of smoking mothers have an earlier onset, e.g. of nicotine dependence, dependent on the fact that they report the outcome under consideration. For all age at onset analyses, information from all 3 waves (considering age at first onset of the respective outcome) was used. Sex and age of the children were controlled by including them as independent variables in the respective models. To examine possible gender differences in the effects of maternal smoking, all associations were tested for interaction with the gender of the offspring. Throughout the article, a p value of <0.05 is considered as statistically significant.

Results

Lifetime Prevalence of Smoking and Nicotine Dependence in Mothers and Children at Baseline

About half of the mothers reported that they had never smoked during their lifetime or that they had never used tobacco on a daily basis for a period of at least 4 weeks (NON/OCC mothers 46.3%; table 1). A total of 53.7% of the mothers reported that they had at some point smoked daily for at least 4 weeks. About one third of the mothers (35.3%) reported non-dependent regular smoking (REG mothers), and about one fifth (18.4%) fulfilled DSM-IV lifetime criteria for nicotine dependence (NICDEP mothers). At baseline, 34.0% of the respondents reported that they had never used any tobacco product during their lifetime. About half of the study sample (45.7%) reported occasional smoking, about one fifth of the sample were classified as regular smokers (20.2%), and 11.4% of the offspring were diagnosed as fulfilling DSM-IV lifetime criteria for nicotine dependence. At baseline, female respondents had a lower risk of shifting towards occasional and regular smoking compared to male respondents (CUMOR females vs. males = 0.73; 95% CI = 0.56–0.95). No gender difference could be observed at baseline regarding nicotine dependence (OR females vs. males = 1.00; 95% CI = 0.62–1.62).

Table 1. Lifetime prevalence rates of smoking behavior in mothers and children at baseline

	Frequency ¹			
	N	Nw	%w	95% CI ²
<i>Maternal smoking status</i>				
Non/occasionally smoking (NON/OCC)	429	428	46.3	42.8–49.8
Non-dependent regularly smoking (REG)	332	326	35.3	32.0–38.7
Nicotine dependence (NICDEP)	177	170	18.4	15.8–21.2
<i>Children's smoking status (baseline)</i>				
Non-smoking				
Males	154	136	30.0	25.8–34.6
Females	175	179	37.9	33.2–42.8
Total	329	314	34.0	30.8–37.4
Occasional smoking				
Males	239	220	48.7	43.8–53.6
Females	204	202	42.8	38.0–47.8
Total	443	422	45.7	42.2–49.2
Regular smoking (w/wo nicotine dependence)				
Males	85	96	21.3	17.4–25.8
Females	81	91	19.3	15.5–23.7
Total	166	187	20.2	17.5–23.4
DSM-IV nicotine dependence				
Males	45	51	11.2	8.3–15.0
Females	45	55	11.6	8.6–15.6
Total	90	106	11.4	9.2–14.1

¹ N = Unweighted number (n = 938); Nw = weighted number (n = 924); %w = weighted percentage; w/wo = with/without.

² The 95% confidence interval refers to the weighted numbers.

Table 2. Lifetime prevalence rates of smoking and nicotine dependence according to maternal smoking status at baseline

Children's smoking behavior at baseline	Maternal smoking status						REG vs. NON/OCC		NICDEP vs. NON/OCC		NICDEP vs. REG	
	NON/OCC (n = 429)		REG (n = 332)		NICDEP (n = 177)		CUMOR/ OR	95% CI	CUMOR/ OR	95% CI	CUMOR/ OR	95% CI
	n	%w	n	%w	n	%w						
Non-smoking	177	40.2	91	25.3	61	35.2						
Occasional smoking	199	44.1	161	48.3	83	44.9						
Regular smoking (w/wo nicotine dependence)	53	15.7	80	26.5	33	19.9	1.93*	1.43–2.60	1.38	0.94–2.02	0.72	0.48–1.06
Nicotine dependence	32	9.9	41	13.7	17	11.1	1.50	0.89–2.54	1.18	0.57–2.46	0.79	0.38–1.63

n = Number; %w = weighted percentages; OR = odds ratio; CI = confidence interval; CUMOR = cumulative odds ratio adjusted for age and gender effects; NON/OCC = non-/occasionally smoking mothers; REG = non-dependent regularly smoking mothers; NICDEP = nicotine-dependent mothers. * p < 0.05.

Baseline Prevalence of Smoking and Nicotine Dependence in Children according to Maternal Smoking Status

Assuming that there is a continuation of severity according to smoking status from no use, occasional to regular use, table 2 shows that, at baseline, children of

REG mothers reveal a significant shift towards higher smoking categories. No such result was found for children of NICDEP mothers. At baseline, however, no significant associations were found between maternal smoking status (either dependent or not) and nicotine dependence in children. All associations were additionally tested for interac-

Table 3. Changes in smoking patterns and nicotine dependence during the 4-year follow-up interval according to maternal smoking status

Changes in smoking during follow-up	Maternal smoking status						REG vs. NON/OCC		NICDEP vs. NON/OCC		NICDEP vs. REG	
	NON/OCC (n = 429)		REG (n = 332)		NICDEP (n = 177)		OR	95% CI	OR	95% CI	OR	95% CI
	n	%w	n	%w	n	%w						
<i>Progression</i>												
Onset of regular smoking among baseline non-smokers	22	9.9	13	11.8	14	21.6	1.05	0.47–2.34	2.84*	1.26–6.36	2.69*	1.09–6.61
Onset of nicotine dependence among baseline non-smokers or non-dependent regular smokers	39	8.6	55	18.2	33	19.4	2.36*	1.47–3.79	2.54*	1.58–4.35	1.08	0.64–1.81
<i>Cessation</i>												
Cessation/reduction (non- or occasional smoking) among baseline regular smokers	8	18.1	8	7.2	1	2.6	0.32*	0.11–0.90	0.10*	0.01–0.82	0.31	0.03–2.72

n = Number; %w = weighted percentages; OR = odds ratio; CI = confidence interval; NON/OCC = non-/occasionally smoking mothers; REG = non-dependent regularly smoking mothers; NICDEP = nicotine-dependent mothers. * p < 0.05.

tion with the gender of the child. No significant effects were found, indicating that associations are comparable for sons and daughters.

Progression and Reduction of Smoking in Offspring by Maternal Smoking Behavior

Table 3 reports the findings on the change over time in children's smoking status according to maternal smoking status. First, it was examined whether respondents with smoking mothers have an elevated odds of starting regular smoking or developing nicotine dependence during the follow-up period of 4 years when compared to the outcomes of those without smoking mothers. Among baseline non-smokers, the children of NICDEP mothers were more likely to become at least regular smokers (21.6%) when compared to the children of NON/OCC mothers (9.9%) and also when compared to the children of REG mothers (11.8%). The offspring of both REG and NICDEP mothers, however, were more likely to develop nicotine dependence during follow-up when compared to the children of NON/OCC mothers (19.4 and 18.2 vs. 8.6%). Testing all the associations for interaction with the gender of the children again revealed no significant effects.

Considering, then, the other direction of change, i.e., cessation and reduction of smoking behavior during the 4-year follow-up period (table 3), the children of NON/OCC mothers had a higher probability of moving from regular use at baseline to non- or occasional use during follow-up when compared to the children of REG and NICDEP mothers (18.1 vs. 7.2 and 2.6%). Although the

respective rates were considerably lower in the children of NICDEP mothers when compared to the children of REG mothers, rates did not differ significantly.

Smoking Behavior in Mothers and Age at Onset Characteristics for Regular Use and Nicotine Dependence

Figure 1 shows the age-specific cumulative probability of developing regular smoking in children according to maternal smoking status. In all 3 groups, the rates begin to increase after age 11 years, but the increase is steeper in the children of REG and NICDEP mothers. The peak incidence period for these offspring is between the ages of 13 and 16 years; then the rates plateau after age 19. By this age more than 50% of the children of REG and NICDEP mothers reported regular smoking. For the group of children of NON/OCC mothers, the rates increase more slowly and then plateau after age 19 years at a lower level (37%). Overall hazard rates for the children of REG mothers (HR = 1.64; 95% CI = 1.31–2.04) and NICDEP mothers (HR = 1.57; 95% CI = 1.20–2.04) were significantly different from those of the children of NON/OCC mothers. No differences were found between children of REG and NICDEP mothers, and no effects were found for the interactions of age × REG/NICDEP mother.

Figure 2 shows the children's age-specific cumulative incidence rates for DSM-IV nicotine dependence by maternal smoking status. For all 3 groups, the rates increase around age 13 years, again with steeper increases in the children of REG and NICDEP mothers. For the children of both REG and of NICDEP mothers, the curves in-

Fig. 1. Age at onset of regular smoking according to maternal smoking status: NON/OCC = non-/occasionally smoking mothers; REG = non-dependent regularly smoking mothers; NICDEP = nicotine-dependent mothers.

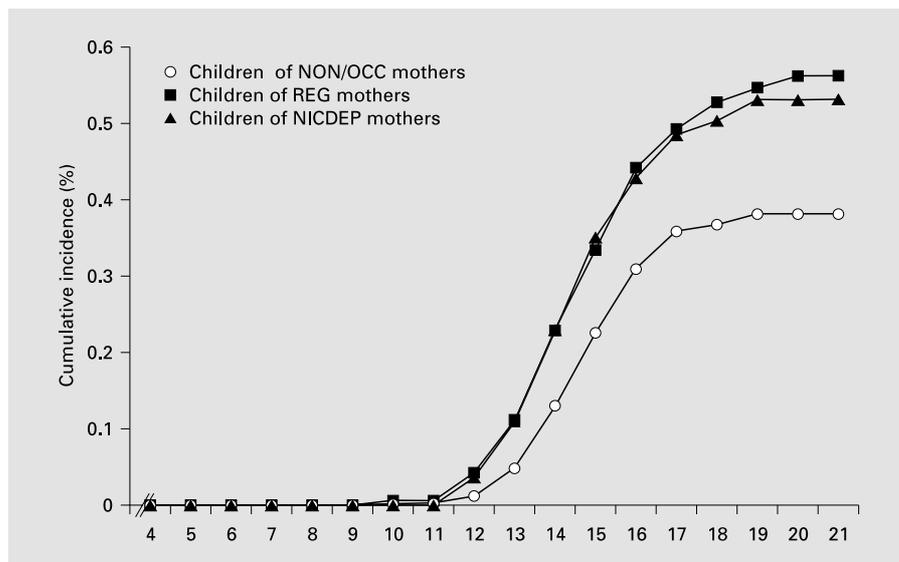
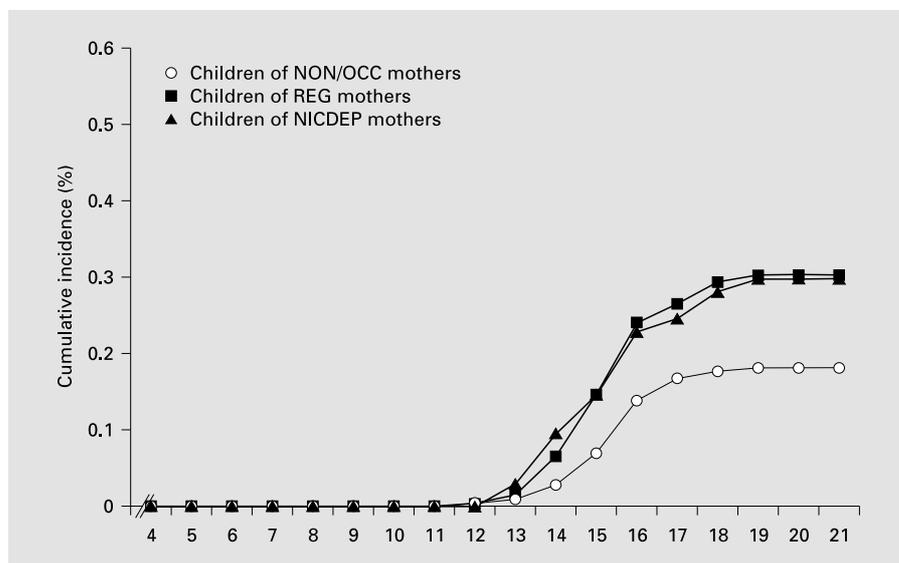


Fig. 2. Age at onset of nicotine dependence according to maternal smoking status: NON/OCC = non-/occasionally smoking mothers; REG = non-dependent regularly smoking mothers; NICDEP = nicotine-dependent mothers.



crease until age 19 years and then plateau at a relatively high level (30%). For the children of NON/OCC mothers, the curve also begins to increase at age 13 years, but plateaus at a lower level (18%) at age 17. The overall hazard rates for the children of REG mothers (HR = 1.77; 95% CI = 1.28–2.45) and NICDEP mothers (HR = 1.76; 95% CI = 1.20–2.56) were significantly different from those of the children of NON/OCC mothers. Again, no differences were found between the children of REG and NICDEP mothers, and no effects were found for the interactions of age × REG/NICDEP mother.

Maternal Smoking during Pregnancy and Smoking Behavior in Children

At baseline, the children of PREG– and PREG+ mothers reported a shift towards higher smoking categories when compared to the children of NON/OCC mothers (table 4). In addition, the children of PREG+ mothers had a higher risk than did the children of PREG– mothers.

At baseline the children of PREG+ mothers reported a significantly higher lifetime prevalence rate of nicotine dependence when compared to both the children of PREG– mothers (20.6 vs. 9.9%; OR = 2.54; 95% CI = 1.41–4.60) and the children of NON/OCC mothers (20.6

Table 4. Baseline prevalence of smoking and nicotine dependence according to maternal smoking status during pregnancy

Children's smoking behavior at baseline	Maternal smoking status						PREG- vs. NON/OCC		PREG+ vs. NON/OCC		PREG+ vs. PREG-	
	NON/OCC (n = 429)		PREG- (n = 340)		PREG+ (n = 169)		CUMOR/ OR	95% CI	CUMOR/ OR	95% CI	CUMOR/ OR	95% CI
	n	%w	n	%w	n	%w						
Never	177	40.2	109	31.0	43	24.1						
Occasional	199	44.1	172	50.9	72	39.5						
At least regular smoking	53	15.7	59	18.1	54	36.4	1.37*	1.03–1.83	2.85*	1.88–4.34	2.08*	1.37–3.15
Nicotine dependence	32	9.9	29	8.9	29	20.6	0.94	0.54–1.65	2.54*	1.41–4.60	2.71*	1.46–5.03

n = Number; %w = weighted percentages; OR = odds ratio; CI = confidence interval; NON/OCC = non-/occasionally smoking mothers (8 mothers from this group reported having smoked during pregnancy); PREG- = regularly smoking mothers who did not smoke during pregnancy; PREG+ = regularly smoking mothers who smoked during pregnancy: more than half (57.9%) of these mothers reported that they smoked almost daily; 5.9% weekly; 5.9% every 2 weeks; 15.4% 6–10 times; 7.1% 3–5 times, and 7.6% 1–2 times. * $p < 0.05$.

vs. 8.9%; OR = 2.71; 95% CI = 1.46–5.03). The age-specific cumulative probability of developing nicotine dependence in the children according to maternal smoking status during pregnancy was then analyzed. Here, the overall hazard rates of the children of PREG+ mothers were found to be significantly different from those of the children of NON/OCC mothers (HR = 2.69; 95% CI = 1.91–3.79) and from those of the children of PREG- mothers (HR = 1.97; 95% CI = 1.40–2.76). Hazard rates for the children of PREG- mothers did not differ from those for the offspring of NON/OCC mothers (HR = 1.37; 95% CI = 0.98–1.92). No differences were found between sons and daughters, and no effects were found for the interactions of age \times PREG+/PREG- mother.

Discussion

The goal of this study was to explore the effects of maternal smoking on various stages of smoking behavior in their children. As far as we are aware, this study is the first to examine cross-sectionally as well as prospectively the influence of maternal smoking on smoking behavior in the children by using a representative community sample and by considering not only smoking, but also the diagnosis of DSM-IV nicotine dependence in both mothers and children using identical assessment instruments.

The strengths of the study include: (1) exploration of mother-child associations in a representative community sample, unaffected by potential selection bias; (2) the focus on a sample of adolescents who were young enough at baseline so that the majority had not yet developed regular use or nicotine dependence, thus the effects of

maternal smoking on smoking onset and progression patterns could be examined prospectively and longitudinally; (3) standardized symptom and diagnostic assessment of smoking behavior and DSM-IV nicotine dependence in both mothers and children, and (4) independent diagnostic assessments of mothers and children, thus excluding informant bias.

Limitations of the study include the following: (1) Data on maternal smoking during pregnancy were based solely on retrospective maternal reports. It is quite possible that, as pregnancies had occurred about 14–17 years earlier, the data could be biased by recall or by underreporting. (2) Not all respondents had passed through the entire risk period for onset of regular smoking or nicotine dependence, thus the results cannot yet be considered as robust. However, the inclusion of 'false-negative' cases (i.e., cases that have not yet developed the smoking outcomes) probably resulted in an underestimation rather than an overestimation of associations. (3) These findings only apply to adolescents and young adults, no data are available about the dynamics after the age of 28 years.

Maternal Smoking and Stages of Smoking in Children

Our baseline data combined with the cumulative follow-up data demonstrate that the children of smoking mothers tend to have an increased risk of smoking more during adolescence compared to the children of non-/occasionally smoking mothers. By and large, these findings are in line with previous studies [37, 38, 64, 65]. It is noteworthy that, at baseline, we have not yet been able to demonstrate an effect of maternal smoking on nicotine dependence in children. However, such an effect emerged impressively during the 4-year follow-up period: the chil-

dren of at least regularly smoking mothers reported not only higher incidence rates of regular smoking, but also considerably higher incidence rates of nicotine dependence. We suspect that this effect was not found at baseline because the children had not yet passed through the entire risk period for onset of nicotine dependence. The effect of maternal smoking on smoking behavior in children is further demonstrated by our prospective findings concerning the offspring's reduction and progression of smoking during the 4-year follow-up interval. Compared to the offspring of non-/occasionally smoking mothers, the children of smoking mothers are not only more likely to develop a more malignant pattern of smoking, but also they are less likely to quit or to reduce smoking. Similar results have been reported by Zhu et al. [44], who found that maternal smoking predicts continued smoking among adolescents. Our results strengthen these previous findings. However, for the first time, the present study uses prospectively assessed data that have been collected in a representative community sample and also include nicotine dependence in the child as an outcome.

Onset of Smoking

Although the age at onset findings demonstrate that maternal smoking increases the risk for first onset of regular smoking and nicotine dependence in children, no evidence was found that maternal smoking additionally increases the risk of beginning regular smoking earlier or of having an earlier onset of nicotine dependence. According to these findings, maternal smoking does not seem to affect the age at initiation of smoking behavior in children, but rather the early course in terms of developing regular smoking and nicotine dependence. This finding indicates that non-familial factors, e.g., peer group influences, may play a more important role than maternal smoking in the age of first smoking.

Maternal Smoking vs. Maternal Nicotine Dependence

Unlike previous researchers, we assessed both maternal non-dependent smoking and maternal nicotine dependence. This approach allowed us to study possible differential effects of these various smoking patterns in mothers. According to our results, it does not seem to be of great importance whether the mother smokes regularly or meets DSM-IV criteria for nicotine dependence, as the effects on different smoking outcomes in the child were in almost all cases similar between these 2 groups. The exception was that the children of nicotine-dependent mothers were at a higher risk for onset of regular smoking during the follow-up period when compared to the chil-

dren of both non-/occasionally smoking and non-dependent smoking mothers. However, when combining baseline and follow-up data in the survival analyses, the children of both non-dependent regularly smoking mothers and nicotine-dependent mothers are at a higher risk of developing regular smoking when compared to the children of non-/occasionally smoking mothers. As no previous study has examined nicotine dependence in mothers, there is a need of further studies to replicate this finding.

Maternal Smoking during Pregnancy

Distinguishing regularly smoking mothers who also smoked during pregnancy from those who never smoked during pregnancy revealed that both are associated with a higher risk in the children of shifting towards occasional and regular smoking. With this result we confirmed previous findings that maternal smoking during pregnancy influences smoking behavior in children [35, 37, 40, 41]. Trying, then, to disentangle the effects of pregnancy and non-pregnancy smoking, we found that, although both conditions are associated with higher smoking rates in the children, maternal smoking during pregnancy seems to add an additional risk to the smoking behavior of the children. However, with respect to nicotine dependence as an outcome in the offspring, we found a somewhat different picture. Our baseline as well as our cumulative age-at-onset data revealed higher rates of nicotine dependence in the children of mothers who smoked during pregnancy compared to the children of both non-smoking mothers and those who did not smoke during pregnancy, while no effect could be demonstrated for no maternal smoking during pregnancy. Thus, an elevated risk in the children of developing nicotine dependence seems mainly to pertain to the children of mothers who smoked during pregnancy.

Differences in Associations between Sons and Daughters

Although we have found a main effect that, at baseline, sons had a higher risk of shifting towards occasional and regular smoking when compared to daughters, our findings revealed no evidence for gender differences in mother-child associations of smoking. Our findings are consistent with those of Pederson et al. [38], but some other researchers have reported a stronger association between maternal smoking and child's smoking behavior for girls than for boys [33, 37, 40, 66]. However, it has to be mentioned that the stratified analyses in these studies should be viewed with caution inasmuch as they did not test for

effects within the stratified models. As to date no other study has examined the possible gender-specific mother-child associations by testing for interaction effects, our results are not directly comparable with previous findings. In any case, our findings suggest that the impact of maternal smoking seems to be comparable for sons and daughters.

Explanations

The observed mother-child associations might be explained by several mechanisms, such as genetic [for review, see 67] and environmental factors [for review, see 68]. Our results argue for an overall mother-child transmission of smoking behavior, and lead to the conclusion that maternal smoking during pregnancy adds an additional risk specifically to the development of nicotine dependence. This increased risk suggests that in utero exposure to nicotine may influence the developing brain of the fetus and, thus, predispose the child's brain to subsequent addictive influences [35, 36]. However, it is also conceivable that this observed effect of maternal smoking during pregnancy on nicotine dependence in the child is the result of some other contextual factors that were not addressed in this article. Ultimately, our data do not allow us to determine to what extent and by what mechanisms the observed mother-offspring associations are mediated. This issue warrants future research.

Conclusions

To our knowledge, this is the first study to prospectively examine the mother-child association of smoking in a community-based sample of adolescents for whom

diagnostic information about smoking and nicotine dependence in both mothers and children was collected by independent diagnostic interviews. We have been able to show that the offspring of at least regularly smoking mothers are more likely to develop a more malignant course of smoking behavior and nicotine dependence when compared to the children of non-/occasionally smoking mothers. Further, maternal smoking during pregnancy seems to add an additional risk for these outcomes in the children, specifically for nicotine dependence. Our findings suggest that maternal smoking may be seen as an important marker of increased risk for smoking in both sons and daughters. They argue for specific intervention and prevention efforts in those children.

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