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Smoking Cessation during Pregnancy and Relapse after Childbirth: The Impact of the Grandmother's Smoking Status

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Abstract *Objectives* Smoking during pregnancy can result in negative effects in exposed children. It is well established that the smoking status of husbands is a major predictor of smoking among pregnant women. It was investigated whether the smoking status of the women's parents and parents-in-law has an impact on smoking cessation during pregnancy and relapse after birth above the smoking status of the husband. *Method* An initial sample of 458 women and their husbands was assessed prospectively during a 17-month period after birth regarding smoking habits. Five months after birth the women and their husbands reported the smoking status of their own parents. *Results* Smoking during pregnancy was related to the smoking status of the women's husband and mother. Women with a husband and mother who smoke were more likely to continue smoking. Relapse after smoking cessation during pregnancy was related to the smoking status of the husband and the mother-in-law. The smoking status of the women's father and father-in-law was not related to smoking cessation or relapse. *Conclusion* The smoking status of the pregnant women's mothers and mothers-in-law is related to fetal and newborn's nicotine exposure. The findings suggest benefits of taking the smoking status of pregnant women's mothers and mothers-in-law into account in smoking prevention programs for pregnant women and mothers with infants.

Keywords Smoking cessation and relapse · Pregnancy · Grandparental smoking status · Smoking status of the husband

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Introduction

Smoking during pregnancy is well known as a potential risk factor for adverse effects in exposed children. Smoking is associated with negative outcomes of pregnancy (i.e., increased risk of ectopic pregnancy, spontaneous abortion, preterm delivery, perinatal mortality, sudden infant death syndrome (SIDS) and low average birth-weight for normal gestational age; [1]), deficits in cognitive functioning [2], behavioral problems and attention deficit and hyperactivity disorder in childhood [3, 4], and an increased risk of criminal arrest and psychiatric hospitalization for substance abuse disorder in adolescence and young adulthood [5, 6].

It is well documented that the smoking status of the husband is a major determinant of maternal smoking during pregnancy [7, 8]. Nafstad and colleagues [7] for instance found that the cessation rate among women who smoked early in pregnancy and who lived with a non-smoking husband was five times higher than for women with a husband who smoked. Moreover, the relapse rate one year after childbirth was three times higher among women who lived with a smoking husband.

However, the smoking status of the new grandparents—the woman's parents (WsP) i.e., the woman's mother (WsM) and father (WsF) as well as the women's parents-in-law (PIL) i.e., the woman's mother-in-law (MIL) and father-in-law (FIL)—has not yet been investigated as a risk factor for smoking during pregnancy.[1] There are reasons to expect an influence of the WsP and PIL on maternal smoking during pregnancy. This expectation is derived from two sources of evidence: First, there is a substantial body of evidence that parental smoking is a determinant of smoking initiation and maintenance in adolescence and young adulthood. Adolescents, whose parents created a non-smoking environment, were much less likely to smoke than their peers [9–12]. The effects of parental objection to smoking during adolescence can still be found at age 26 [13]. The explanation of these results draws on theories about development in context proposing that individual behavior is a function of multiple sources of influence on an intrapersonal, interpersonal, and community level [14], and social learning theory [15], which argues that individuals acquire social behavior by modeling or imitating others' behavior. According to Ary et al. [9] parents are among the most powerful models to initiate substance use in adolescence.

The second source of evidence leading to the expectation that the smoking behavior of the WsP and PIL has an influence on maternal behavior stems from social network studies which show that the birth of a child is a time when the relationship between young parents and their own parents becomes more intensive [16, 17]. Particularly the WsM often plays an important role providing information and practical support in childcare (i.e., looking after the child [17–19]). Because of this increase in contact one would assume that the behavior and norms of the WsP and PIL might also have an increased importance and influence on maternal behavior as for instance smoking during pregnancy and after birth. In addition to social learning theory, the influence of parental smoking on smoking during pregnancy can also be understood in terms of the social control theory [20] and in an evolutionary psychology framework [21]. The former perspective emphasizes the role of the family as a control instance preventing their offspring from indulging in deviant and unwise behavior, such as exposing an unborn or newborn child to nicotine. The latter perspective considers the grandparents securing the welfare of their grandchildren in order to optimize the survival chances of their kin [21]. Thus, we assume that the pregnant women's avoidance of risks for their unborn children is influenced by the norms and expectations of the WsP and the PIL. However, the power of the WsP and PIL to prevent their daughters and daughters-in-law from smoking during pregnancy is presumably low if they themselves do not abstain from smoking. Thus, we hypothesize that female smokers are more inclined to stop smoking and to stay abstinent when their own parents and parents-in-law are non-smokers. Furthermore, we expect that the smoking status of the WsM has a stronger impact on the daughter's smoking than the smoking status of the WsF. This hypothesis is based on the empirical evidence that mothers are reported to be more important role models for females in smoking initiation [22] and they maintain closer relationships to their daughters than fathers [23]. Furthermore, we expect the WsP to have a stronger influence compared to the PIL.

The purpose of this study is to investigate the impact of the WsP- and PIL-smoking on maternal smoking and smoking cessation during pregnancy and relapse in the first 17 months after childbirth above and beyond the impact of the smoking status of the husband.

Methods

Participants and Procedure

The participants were part of a longitudinal study designed to assess alcohol use and smoking during pregnancy and after childbirth. Women were eligible if the birth of their child was publicly announced between March and July 2004. Birth announcements were retrieved from official registers from four Swiss cantons, six different newspapers and websites of five hospitals. On a phone call the women were informed about the aims of the study. Women who gave consent to participate were sent a questionnaire and were followed-up longitudinally. The data presented in this study are based on self-administered questionnaires. The first assessment (t0) was 6 weeks, the second assessment (t1) 5 months, and the third assessment (t2) 17 months after childbirth. The changes of the sample size during the recruitment phase and over the course of the longitudinal study are displayed in Fig. 1.

The participants were living in 15 different Cantons in the German and French speaking parts of Switzerland. Because the questionnaires were only translated to German and French only women with knowledge in these two languages could be included in the study. There were proportionally less foreign women and women of lower education in the sample compared to the population of childbearing mothers in Switzerland [24, 25]. For a detailed description of the sample characteristics see Table 1.

Between the first assessment (t0) and the first follow-up (t1) there was selective attrition with regard to socio-economic status of the family (SES; Mann–Whitney $U = 12204.5$, $z = -3.32$; $p = 0.001$). Between the first follow-up (t0) and second follow-up (t1) the attrition was selective regarding the number of cigarettes the women

[1] The terms husband, PIL, MIL and FIL (for partner, parents-in-law, mothers-in-law and fathers-in-law of the women) will be used although the marital status of the couple (i.e., the women and her partner) was not addressed.

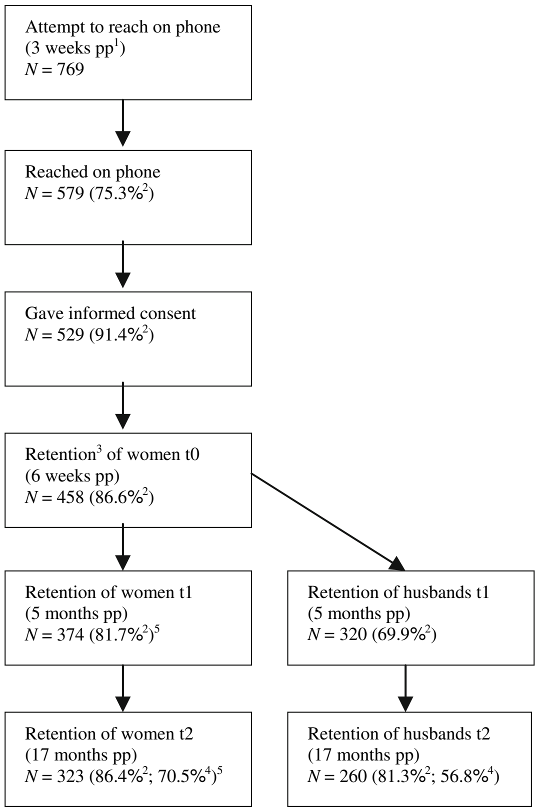

Fig. 1 Change of the sample size during the recruitment phase and over the course of the longitudinal study. [1]pp = post partum; [2]The percentage refers to the proportion compared to the sample size at t − 1 (the respective box above); [3]Retention = Number of participants who returned a questionnaire. A questionnaire was sent to all women who gave informed consent; [4]The second percentage refers to the proportion compared to the sample size at t0 ($N = 458$); [5]Due to missing values on major predictor variables and the criterion variable only 371 women and 299 women were included in the analysis of smoking behavior at t1 and t2, respectively. Furthermore, 51 women were pregnant again at t2 and had to be excluded from the analysis of relapse of smoking 17 months after childbirth

($t(453) = 2.03$; $p = 0.04$) and their husbands ($t(311) = 2.20$; $p = 0.03$) smoked per day after pregnancy recognition and regarding socio-economic status of the family (SES; Mann–Whitney $U = 20836.5$, $z = -2.72$; $p = 0.007$). Mothers who smoked more cigarettes after pregnancy recognition, whose husbands were smokers and who were of lower SES were more likely to drop out between the first follow-up five months and the second follow-up 17 months after childbirth.

Measures

Maternal Smoking

Six weeks after delivery (t0) the mothers reported how many cigarettes they smoked before pregnancy recognition, after pregnancy recognition and after childbirth (i.e., 6 weeks after birth). During both follow-up assessments 5 months (t1) and 17 months (t2) after delivery the women were questioned again how many cigarettes they smoked per day.

Table 1 Sample characteristics at t1 (5 months after birth)

	Value
N^{a}_{t1} (%)	374 (100)
Maternal demographic variables	
Citizenship	
Swiss[b] (%)	316 (86.3)
Other (%)	50 (13.7)
Language region	
German (%)	268 (71.7)
French (%)	106 (28.3)
Maternal age[c] Mean (SD)	32.4 (4.32)
Education[d]	
Secondary I (%)	20 (5.3)
Secondary II (%)	245 (65.5)
Tertiary (%)	109 (29.1)
Married/cohabiting[e] (%)	365 (99.5)
Married/cohabiting for 2 years or more (%)	359 (97.0)
Infant and obstetric variables	
Infant gender	
Male (%)	186 (50.3)
Female (%)	184 (49.7)
Parity	
Primiparous (%)	140 (38.6)
Multiparous (%)	223 (61.4)
Birth weight[f] Mean (SD)	3391 (467)
Low birth weight (<2,500 g) (%)	11 (3.0)
Preterm birth (<38 weeks gestation) (%)	47 (12.8)

[a] *N* varies because of missing values; among 374 women participating 5 months after birth 371 had reported their smoking status during pregnancy

[b] In the population of childbearing mothers in Switzerland 73.5% are of Swiss citizenship [25]

[c] On average, childbearing mothers in Switzerland are 31.0 years of age [26]

[d] Among the female population in the age of 25–39 years in Switzerland 13.5% have accomplished secondary education I (i.e., basic compulsory schooling), 59.4% secondary education II (i.e., finished apprenticeship or high school degree) and 27.1% tertiary education (degree from tertiary institution or university degree) [24]

[e] In the population of childbearing mothers in Switzerland in the year 2003 87.6% were married [27]. No national data on cohabitation with a partner after childbirth is available

[f] On average, birth weight in Swiss hospitals in the year 1992 was 3,322 g [28]

Smoking Status of the Husband

Five months after delivery (t1) the husbands reported how many cigarettes they smoked before pregnancy recognition, after pregnancy recognition and after childbirth (i.e., 5 months after birth). In case that the husband could not be asked, the women also reported the smoking status of the husband.

Smoking Status of the WsP and PIL

On the first follow-up (t1) the women and their husbands each reported the smoking status of their own mothers and fathers.

Socio-economic Status

Socio-economic status of the family was estimated relying on the reports of the occupational status of the women and their husbands. The occupations were coded according to the International Classification System of Occupations (ISCO-88 [29]) that includes four categories of skill levels. The ISCO-88 classification of occupations takes the skills into consideration, which are required to perform the job tasks. Skill Level 1 includes jobs requiring only primary education. Skill Level 2 relates to second stages of secondary education or on-the-job training and experience, Skill Level 3 relates to education beginning at the age of 17 or 18, and lasting four years with a qualification that is not equivalent to a university degree, Skill Level 4 relates to education beginning at the age of 17 or 18, lasting 4 years and leading to a university degree or university post-graduate degree.

Demographics

Six weeks after childbirth (t0) the women reported their age, parity (primi- versus multiparity) and educational attainment (including six different levels).

Emotional Support

Emotional support from the husband and from the family was assessed 6 weeks after birth (t0) with a scale containing Likert-type items (husband-version: seven items, Cronbach's $\alpha = .85$; family-version: three items, Cronbach's $\alpha = .89$) derived from an emotional support questionnaire [30] which measures the confidence of being supported and being able to discuss concerns without feeling criticized or rejected.

Instrumental Support

Instrumental support from the husband was assessed five months after birth (t1) using a six-item scale. On free response items the husbands reported estimates of the time they spend on a usual weekday on household chores and childcare and on a Likert-type scale they indicated their subjective estimates of their efforts in these two domains of instrumental support. The mothers also estimated their satisfaction with their husband's effort regarding household chores and childcare on a Likert-type scale. The six items were standardized and aggregated to an instrumental husband-support score (Cronbach's $\alpha = .77$). Instrumental support from the family was measured using a single-item scale assessing whether the mothers were supported by their family (except their husband) regarding household chores and childcare.

Analytic Rationale

Three analytical approaches were applied to reveal the influence of the smoking status of the WsP, the PIL and the husband on maternal smoking cessation during pregnancy and relapse after childbirth: First, smoking and smoking cessation during pregnancy was predicted with logistic regression analysis. This analysis was conducted with the subsample, which participated 5 months after childbirth (t1), when the predictors husband-smoking, WsP-smoking and PIL-smoking were assessed. Second, Kaplan–Meier survival analysis and the log-rank test were used to assess the occurrence of relapse and the duration of abstinence among the women who stopped smoking during pregnancy and who did not become pregnant again during the 17 months after birth ($n = 31$) stratified by the smoking status of the husband, the WsP and PIL. For each of the five main predictors of maternal smoking (i.e., WsM-smoking, WsF-smoking, MIL-smoking, FIL-smoking, and husband-smoking) a separate survival model was estimated. Third, the extent of smoking relapse after birth was studied within the group of women who stopped or reduced smoking during pregnancy ($n = 65$) applying multiple regression analysis to predict the change in the number of cigarettes smoked per day. The women who never smoked and the subgroup of women who became pregnant again during the 17 months after birth were excluded from both the analysis of occurrence and extent of relapse.

In the logistic regression approach, which was applied to predict smoking and smoking cessation during pregnancy maternal age, parity, maternal educational attainment, family SES and emotional and instrumental support from the husband and from the family were used as covariates beside the main predictors (i.e., WsM-smoking, WsF-smoking, MIL-smoking, FIL-smoking, and husband-smoking). To control for multiple covariates resulted in a reduction of the sample size due to missing values on several covariates. Therefore, the logistic regressions were

Table 2 Descriptives of maternal and paternal smoking at different stages of pregnancy and after childbirth

	% of smokers (Mean/SD of cigarettes/day among smokers)		McNemar test[a]	Paired sample T-test[b] (2-tailed)
	Women[c]	Husbands[d]		
Time period				
Before pregnancy recognition	20.2 (10/7)	31.0 (13/9)	10.26***	4.50***
After pregnancy recognition	10.2 (5/3)	28.9 (13/8)	43.91***	8.02***
6 weeks after childbirth	10.5 (7/6)			
5 months after childbirth	13.4 (7/5)	28.9 (12/8)	32.49***	6.37***
17 months after childbirth	24.2 (7/7)	29.7 (11/10)	4.49*	3.41***

[a] Pairwise comparison of the number of smokers among women and husbands

[b] Pairwise comparison of the number of cigarettes smoked per day by smoking women and husbands

[c] N_{women} varied between 371 and 373 for the first four time periods (i.e., "before pregnancy recognition", "during pregnancy", "6 weeks after child birth", "5 months after childbirth"). At 17 months after childbirth after exclusion of women with new pregnancies: $N_{women} = 244$

[d] $N_{husbands}$ varied between 310 and 311 for the first three time periods (i.e., "before pregnancy recognition", "during pregnancy", "5 months after childbirth"). At 17 months after childbirth after exclusion of participants with new pregnancies: $N_{husbands} = 192$

***$p < 0.001$; *$p < 0.05$

rerun with the covariates and predictors that reached marginal significance ($p < 0.10$) in the first run.

Results

Descriptives

Maternal and paternal smoking. More women than men were non-smokers before pregnancy recognition and among women who were smokers, there was a more pronounced reduction of smoking after pregnancy recognition than among their husbands: Whereas the number of smokers among women dropped from 20.2% to 10.2% (McNemar $\chi^2 = 33.23$; $p < 0.001$) the number of smokers among husbands dropped from 31.0% to 28.9% (Fisher's Exact Test, $p < 0.05$). The number of cigarettes smoked per day among mothers who continued to smoke during pregnancy dropped from 13 cigarettes per day to 5 cigarettes per day after pregnancy recognition ($F(1/37) = 81.37$; $p < 0.001$; $\eta^2 = .69$) whereas the number of cigarettes smoked by the husbands, who continued to smoke dropped from 14 cigarettes per day to 13 cigarettes per day ($F(1/88) = 5.15$; $p < 0.05$; $\eta^2 = .06$). Table 2 displays the frequencies of maternal and paternal smoking at different stages during and after pregnancy.

The participating women were classified into three groups according to their smoking status before pregnancy recognition and during pregnancy. Seventy-six percent of the women were non-smokers on all measurement occasions until 5 months after birth (the "non smokers"; $n = 282$), 8.6% reported smoking before and during pregnancy (the "smokers"; $n = 32$), 11.6% stopped smoking after pregnancy recognition (the "quitters"; $n = 43$).[2] Fourteen participants (3.8%) could not be classified as part of any above category. The "smokers", and the "quitters" differed in the average number of cigarettes they smoked per day before pregnancy recognition. The "smokers" consumed an average of 13 cigarettes per day while the "quitters" smoked seven cigarettes ($T(73) = 4.70$; $p < 0.001$ (2-tailed)). During pregnancy the "smokers" still consumed an average of five cigarettes per day. Seventeen months after childbirth most of the "quitters" had relapsed (76.5%) and smoked four cigarettes on average per day compared to 10 cigarettes per day among the "smokers" ($T(51) = 3.36$; $p < 0.01$ (2-tailed)).

WsP-smoking and PIL-smoking. Table 3 displays a crosstabulation of maternal smoking status during pregnancy by husband-smoking, WsP-smoking and PIL-smoking.

Prediction of Smoking and Smoking Cessation during Pregnancy

Logistic regression analyses were run to predict the smoking status during pregnancy (i.e., "non-smoker", "smoker", or "quitter").

"Non-smokers" versus "smokers". The logistic regression revealed WsM-smoking as a significant predictor of category membership after controlling for SES and husband-smoking. Women with a smoking mother had more than

[2] Seven women indicated that they have not been smoking before pregnancy recognition but smoked 17 months after child birth. They were subsumed to the group of "quitters" assuming that they had been smoking at some time before pregnancy. The results did not change when the analyses were rerun after these cases had been excluded.

Table 3 Crosstabulation of maternal smoking status during pregnancy by the smoking status of the husband and the grandparents

	Maternal smoking status				Total[a]
	Non-smoker n (%)	Quitter	Smoker	Not classified	
Husband[b]					
Non-smoker	220 (78.0)	23 (53.5)	7 (21.9)	9 (69.2)	259 (70.0)
Smoker	62 (22.0)	20 (46.5)	25 (78.1)	4 (30.8)	111 (30.0)
WsM					
Non-smoker	246 (88.2)	36 (83.7)	19 (59.4)	10 (71.4)	311 (84.5)
Smoker	33 (11.8)	7 (16.3)	13 (40.6)	4 (28.6)	57 (15.5)
WsF					
Non-smoker	234 (83.9)	33 (76.7)	22 (71.0)	10 (71.4)	299 (81.5)
Smoker	45 (16.1)	10 (23.3)	9 (29.0)	4 (28.6)	68 (18.5)
MIL					
Non-smoker	199 (85.4)	30 (76.9)	19 (70.4)	8 (80.0)	256 (82.8)
Smoker	34 (14.6)	9 (23.1)	8 (29.6)	2 (20.0)	53 (17.2)
FIL					
Non-smoker	187 (81.0)	28 (71.8)	21 (77.8)	8 (80.0)	244 (79.5)
Smoker	44 (19.0)	11 (28.2)	6 (22.2)	2 (20.0)	63 (20.5)

WsM = woman's mother, WsF = woman's father, MIL = woman's mother-in-law, FIL = woman's father-in-law

[a] *N* varied because of missing values

[b] The number of husbands, whose smoking status is known is higher in this table compared to Table 2 for missing values were substituted by maternal reports of their husbands smoking status

three times increased odds of smoking during pregnancy compared to women with a non-smoking mother. If the husband smoked the odds increased by more than 10. Among women whose own mother and husband both smoked, 10 out of 27 (37.0%) smoked during pregnancy compared to four women among 227 women (1.8%) whose mothers and husbands did not smoke. The predictors WsF-smoking and PIL-smoking were not related to smoking during pregnancy. The only covariate contributing substantively to the prediction of category membership was family SES. Women with lower SES were more likely to be "smokers". The other covariates (i.e., maternal age, parity, maternal educational attainment, and emotional and instrumental support from the husband and from the family) did not significantly contribute to the prediction of category membership.

"Quitters" versus "smokers". Again, WsM-smoking significantly increased the risk for the women to remain a smoker during pregnancy after controlling for SES and husband-smoking. Women whose mothers smoked were four times more likely to continue to smoke during pregnancy. Similarly, if a woman lived with a husband who smoked the odds increased by more than four. Among women who smoked before pregnancy recognition and whose own mothers and husbands smoked, only two out of 13 stopped smoking during pregnancy, compared to 17 out of 25 smokers whose mothers and husbands were non-smokers. Again, women with lower SES were more likely to be "smokers" than "quitters" and WsF-smoking and PIL-smoking was not related to smoking cessation. The other covariates (i.e., maternal age, parity, maternal educational attainment, and emotional and instrumental support from the husband and from the family) did not significantly contribute to the prediction of category membership (see Table 4).

Prediction of Smoking Relapse after Childbirth

Only a small minority of women succeeded in maintaining smoking abstinence until the second follow-up, 17 months after childbirth. The duration of abstinence among the women who quit smoking during pregnancy was estimated using the Kaplan–Meier method. No significant effect related to WsM-smoking (log-rank; $\chi^2(1) = 1.18, p > .20$), WsF-smoking (log-rank; $\chi^2(1) = 0.67, p > .20$), FIL-smoking (log-rank; $\chi^2(1) = 0.19, p > .20$), and husband-smoking (log-rank; $\chi^2(1) = 0.30, p > .20$) was found. However, an effect of MIL-smoking could be revealed. Women with a MIL who smoked were more likely to relapse earlier than women with a non-smoking MIL (log-rank; $\chi^2(1) = 4.51, p < .05$).

Using the multiple regression approach controlling for husband-smoking to estimate the extent of relapse, MIL-smoking ($\beta = .25$, $t(52) = 1.97$, $p = .05$) contributed

Table 4 Predictors of the smoking status of pregnant women: Logistic regression analysis

Predictors[a]	OR (95% CI)	p
"Non-smoker" versus "Smoker"[b]		
Husband-smoking	10.29 (4.12–25.70)	.001
WsM-smoking	3.12 (1.25–7.75)	.015
SES[c]	0.42 (0.24–0.76)	.004
"Quitter" versus "Smoker"[d]		
Husband-smoking	4.70 (1.47–15.07)	.009
WsM-smoking	3.92 (1.15–13.41)	.029
SES[c]	0.36 (0.18–0.74)	.005

WsM = woman's mother

[a] In a first run of the analyses the eight covariates (1) maternal age, (2) parity, (3) maternal educational attainment, (4) family SES, (5) emotional support from the husband, (6) emotional support from the family, (7) instrumental support from the husband, (8) instrumental support from the family were used beside the main predictors (i.e., WsM-smoking, WsF-smoking, MIL-smoking, FIL-smoking, and husband-smoking). The use of multiple covariates resulted in a reduction of the cases included in the analyses (reduction of the number of cases included in the analysis *"Non-smoker" versus "Smoker"*: from $N = 314$ to $N = 251$; reduction of the number of cases included in the analysis *"Quitter" versus "Smoker"*: from $N = 75$ to $N = 65$). The analyses were rerun with the covariates and predictors that reached marginal significance ($p < 0.10$) in the first run. The main indices of the first run and the second run of the logistic regression analyses do not differ substantively. Indices of the second run of the analyses are displayed

[b] Smoking status during pregnancy was dummy coded: 0 = "Non-smoker", 1 = "Smoker"

[c] Higher values reflect a "higher" Family Skill Level [29]

[d] Smoking status during pregnancy was dummy coded: 0 = "Quitter", 1 = "Smoker"; "Quitters" smoked before and stopped after pregnancy recognition

marginally to the rise in the number of cigarettes smoked per day. Husband-smoking contributed significantly to this rise ($\beta = .27$, $t(52) = 2.14$, $p < .05$).[3] Women with both a smoking husband and a smoking MIL, increased the number of cigarettes smoked per day by seven cigarettes on average in the first 17 months after childbirth compared to an increase of two cigarettes in their counterparts whose husbands and MIL did not smoke. WsP-smoking and FIL-smoking did not contribute significantly to the increase in the number of cigarettes smoked per day.

Discussion

Approximately one half of the women who smoked before pregnancy stopped after pregnancy recognition and a majority of the other half reduced the number of cigarettes smoked per day. Most of the women who stopped smoking during pregnancy relapsed within 17 months after birth. Consistent with earlier findings [7, 8], husband-smoking was an important predictor of maternal smoking during pregnancy and of the rise in the number of cigarettes smoked per day after birth.

New in this study is the focus on WsP-smoking and PIL-smoking, which could be shown to be related to maternal smoking behavior after controlling for husband-smoking. The results indicate that particularly WsM-smoking increased the risk of maternal smoking during pregnancy. WsF-smoking was not associated with the women's smoking during pregnancy or relapse after birth. This result is in line with our expectations and earlier findings that maternal smoking is more likely than paternal smoking to be transmitted to children, in particular to females [22]. Probably the most intriguing finding of this study is that MIL-smoking was related to smoking relapse after birth. This finding is in contrast to our expectation that WsM-smoking is more strongly related to maternal smoking cessation and relapse than MIL-smoking. However, this finding is in line with the notion that PIL attempt to influence the childcare behavior of their daughters-in-law to increase the survival chances of the offspring [21]. If the PIL do not meet the health related standard of smoking abstinence, they are no longer apt to prevent their daughters-in-law from smoking. However, it has to be considered that the influence of the MIL could only be found in women who were able to stop smoking during pregnancy. Among the "quitters", smoking of the husband and own mother was rather infrequent because these variables were strongly related to continued smoking.

[3] The same eight covariates were used in a first run of the multiple regression model as in the logistic regression approach. The only covariate contributing substantively to the prediction of the extent of relapse was maternal age. When maternal age, MIL-smoking and husband-smoking were entered simultaneously to the multiple regression model only husband-smoking remained significant ($\beta = .27$, $t(51) = 2.11$, $p < .05$) while the contributions of MIL-smoking ($\beta = .20$, $t(51) = 1.50$, $p > .10$) and maternal age ($\beta = -.21$, $t(51) = 1.58$, $p > .10$) to the prediction of the extent of relapse were no longer significant.

The interpretation of the results of this study is limited due to the small sizes of the subsample that continued to smoke and the subsample that stopped smoking during pregnancy. A second limitation is that the sample attrition between the first assessment and the second follow-up was not random but biased toward women and husbands who smoked less during pregnancy and were of higher SES. A third limitation is concerned with the measurement of the smoking status. Maternal smoking before and after pregnancy recognition was questioned retrospectively 6 weeks after childbirth. Moreover, WsP-smoking and PIL-smoking was reported by the women and their husbands. Repeated assessment of the maternal smoking status during pregnancy involving also biochemical verification and direct questioning of the WsP and PIL regarding their smoking status might reveal more accurate estimates of smoking. A further limitation is related to the ambiguity of the interpretation of the results: Because it was not assessed whether the WsM and MIL smoked in the presence of the new mothers it remains unresolved whether exposure to passive smoking accounts for the effects. Furthermore, the smoking histories of the WsP and PIL before, during and after the pregnancy were not assessed. Therefore, one can only speculate about the contiguity of smoking cessation among the new mothers and smoking cessation among the WsP and PIL. An ideal research design would include a standard smoking cessation counseling for mothers during pregnancy in a first intervention group, additional intervention with the woman's husband in a second group and additional intervention with the WsP and PIL in a third group. This research design would allow for comparisons of the effect of the standard smoking cessation counseling for women during pregnancy with counseling for both partners and counseling for both partners and their own parents.

There is still a considerable need for prenatal smoking cessation and postpartum relapse prevention interventions. The present study is to our knowledge the first to investigate the impact of WsP-smoking and PIL-smoking on maternal smoking cessation during pregnancy and relapse after childbirth. The findings suggest benefits of taking WsM-smoking and MIL-smoking as well as the smoking status of the husband into account when designing community-based approaches to smoking prevention among pregnant women to foster an environment that encourages spontaneous quitting during pregnancy and prevents relapse after childbirth.

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