Smoking during pregnancy: a difficult problem to face. Results of a French multi-center study

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Summary

Introduction. *Smoking tobacco during pregnancy is a preventable risk factor for adverse pregnancy outcomes. The aim of the study was to assess the impact of an information and training program implemented by the perinatal network of Auvergne, France, on smoking during pregnancy.*

Methods. *A multi-center before-and-after population-based study, based on two cross-sectional surveys, was carried out between July 2003 and June 2004, and between December 2008 and January 2010. Pregnant women aged over 18 years, with a fluent command of written and spoken French, were eligible. The main outcome was the prevalence of pregnant women who smoked daily. The preventive program consisted of informing women and healthcare providers and training healthcare providers. Multivariate analysis was performed by means of manual logistic regression and crude and adjusted Odds Ratios were calculated.*

Findings. *"Before" and "after" surveys involved 1027 and 720 women, respectively. In the "after" survey, a higher percentage of women smoked daily at the time of diagnosis (43.49% vs 51.94%, adjusted Odds Ratio 1.45 [1.10; 1.90]) and during the third term (40.53% vs 51.94%, adjusted Odds Ratio 1.62 [1.24; 2.12]). Environmental tobacco smoke exposure among non-smokers was higher in the "after" survey: 52.83% vs 69.57% adjusted Odds Ratio 1.95 [1.54; 2.47].*

Conclusions. *The program did not reduce smoking during pregnancy. Exposure to environmental tobacco smoke increased. French public health authorities should introduce a new policy aimed specifically at tackling tobacco use during pregnancy and exposure to second-hand smoke, and which takes into account the entire environment of pregnant women.*

Introduction

It is well documented that maternal smoking during pregnancy is a preventable risk factor for adverse pregnancy outcomes. Tobacco interferes with the development of brain structures, which results in a higher risk of low birth weight, stillbirth, pre-term delivery and placental detachment [1-3]. There is also evidence of an association between tobacco consumption during pregnancy and both infant mortality and the risk of nicotine dependence during adolescence [3, 4]. In addition, several studies have identified environmental tobacco smoke (ETS) as a risk factor for adverse effects on both fetuses and children [1-3, 5, 6].

The Prochaska cycle of the process of change has been applied to the various stages of tobacco dependence: pre-contemplation, contemplation, preparation, action, maintenance and relapse. Pregnant women commonly go through the Prochaska cycle from the pre-contemplation to the contemplation stages. McBride et al. identified pregnancy as an appropriate moment to stop smoking [7] and advocated developing preventive procedures during this period.

A national survey conducted in France in 2010 showed that tobacco consumption remained a major health problem and, in particular, that consumption had increased among women [8]. The Association of Users of Computerized Data in Paediatrics, Obstetrics and Gynaecology (AUDIPOG) reported in 2008 that, although consumption was lower during pregnancy, 14% of pregnant women still smoked.

Two special interest groups at the university hospital of Clermont-Ferrand, Auvergne, France – the DATAMATER group, a regional hospital research program, and the CAFE group, an inter-regional hospital research program - and the perinatal network of Auvergne (Réseau de Santé Périnatale Auvergne-RSPA) have been working on tobacco consumption during pregnancy [9-11]. They developed an information and training program targeting the general public and healthcare providers, to deal with tobacco use in pregnant women.

The main aim of the present study was to assess the im-

pact of the program on reducing tobacco consumption during pregnancy.

Methods

This study was approved by the ethics committee of Clermont-Ferrand (N°2003-AU509 for the "before" survey and 2007-AU 735 for the "after" survey).

THE PERINATAL NETWORK OF AUVERGNE

Auvergne is a rural region of south-central France with an estimated population of 1 343 964 , i.e. 2.1% of the French population (http://www.insee.fr/fr/bases-de-donnees). Auvergne currently has 10 maternity units (3 level-I with obstetric units only, 6 level-II with obstetric and neonatology units and 1 level-III with obstetric, neonatology and neonatal hospitalization units). Maternity units were reorganized between 2003 and 2009, and six units were closed. The number of births in 2003 and 2004, during the period of the "before" survey, was 13769 and 13779, respectively, and in 2008 and 2009, during the period of the "after" survey, 13852 and 13849, respectively. The rate therefore remained stable over time (http://www.insee.fr/fr/themes/detail.asp?reg_id=99&ref_id=etat-civil-naissances). Created in 1994, the RSPA includes all healthcare professionals working in the gynecology-obstetric and paediatric units of the maternity hospitals of Auvergne, 364 healthcare providers working in local mother-and-child protection centres and in the surgeries of general practitioners (Gps), and outpatient gynecologists (https://www.auvergne-perinat.org/). The RSPA aims to improve pregnant women's health through better coordinated management, the improvement of quality of care and the development of preventive and educational procedures. To this end, it manages computerized medical records throughout the regional area and organizes yearly scientific meetings to present its research and actions to its members.

PATIENTS

Women aged 18 years or more, with a fluent command of spoken and written French, who lived in the administrative area of Auvergne and had given birth to a baby after at least 22 weeks of gestation (or 500 grams in weight) were deemed eligible for the study. They were recruited at the maternity hospitals at the time of delivery or in the immediate post-partum.

METHODS

A multi-center cross-sectional before-and-after population-based study was conducted. The "before" survey was performed between July 2003 and June 2004 in 16 maternity hospitals, and the "after" survey between December 2008 and January 2010 in 11 such facilities. The month in which the survey should be carried out in each maternity hospital was randomly selected by the statisticians of the university hospital of Auvergne. Data were collected over four consecutive weeks.

Questionnaires were composed of items regarding the women's social characteristics, the course of pregnancy and delivery conditions. Women were questioned about daily smoking before pregnancy, on diagnosis of pregnancy, in the third term and during the immediate postpartum. Yes/no items investigated ETS at home, at work and in the company of family or friends.

The main outcome was the prevalence of pregnant women who smoked daily.

All participants gave their informed consent to be enrolled. The surveys were approved by a French ethics research committee (N°2003-AU 509 for the "before" survey and 2007-AU 735 for the "after" survey).

INFORMATION AND TRAINING PROGRAM

The information and training program was implemented by the RSPA, and was addressed both to women and their family circles and to healthcare professionals. It was divided into three waves: information of the women and family circles, information and training of the healthcare providers (Fig. 1). Healthcare providers were midwives, obstetricians, gynecologists, pediatricians, psychiatrists and general practitioners.

The first wave consisted of publicizing the results of the "before" survey in regional newspapers in September 2004 and June 2008. The RSPA website created the session "addictive behavior" in February 2007 and, in April 2007, published the national guidelines on addictive behavior during pregnancy. The RSPA then produced a poster in collaboration with communication advisers and smokers. The poster was displayed in the waiting rooms of regional maternity hospitals, in local mother-and-child protection centers, and in the surgeries of general practitioners (GPs) and outpatient gynaecologists. It was sent to healthcare professionals in January 2008.

The second wave began in June 2005 with one RSPA "scientific day" of training devoted to tobacco consumption during pregnancy. In May 2007, the actions implemented by the RSPA to deal with tobacco consumption during pregnancy were presented to participants in the "scientific day" of the Perinatal Prevention Research Information Association (*Association Périnatalité Prévention Recherche Information* – APPRI).

The third wave was composed of two sessions (Level 1 and Level 2) of continuous medical training and education (CME). The aims of the Level 1 session were to explain tobacco dependence, to train healthcare personnel in the management of pregnant women smokers at all stages of the Prochaska cycle, and to improve the screening of pregnant women. Level 2 sessions aimed to strengthen the knowledge of healthcare professionals who had already attended session 1, and was based on medical histories, role plays, advice on prescribing, and an introduction to cognitive behavioral therapies. An instrument to measure carbon monoxide levels was given to participants after the Level 2 session. All the sessions were held over two days, 6 hours a day, by a specialist in addictions. Five Level 1 sessions and four Level 2 sessions were held, beginning in December 2007 and Sep-

Fig. 1. Chronology of the surveys and the information and educational program.
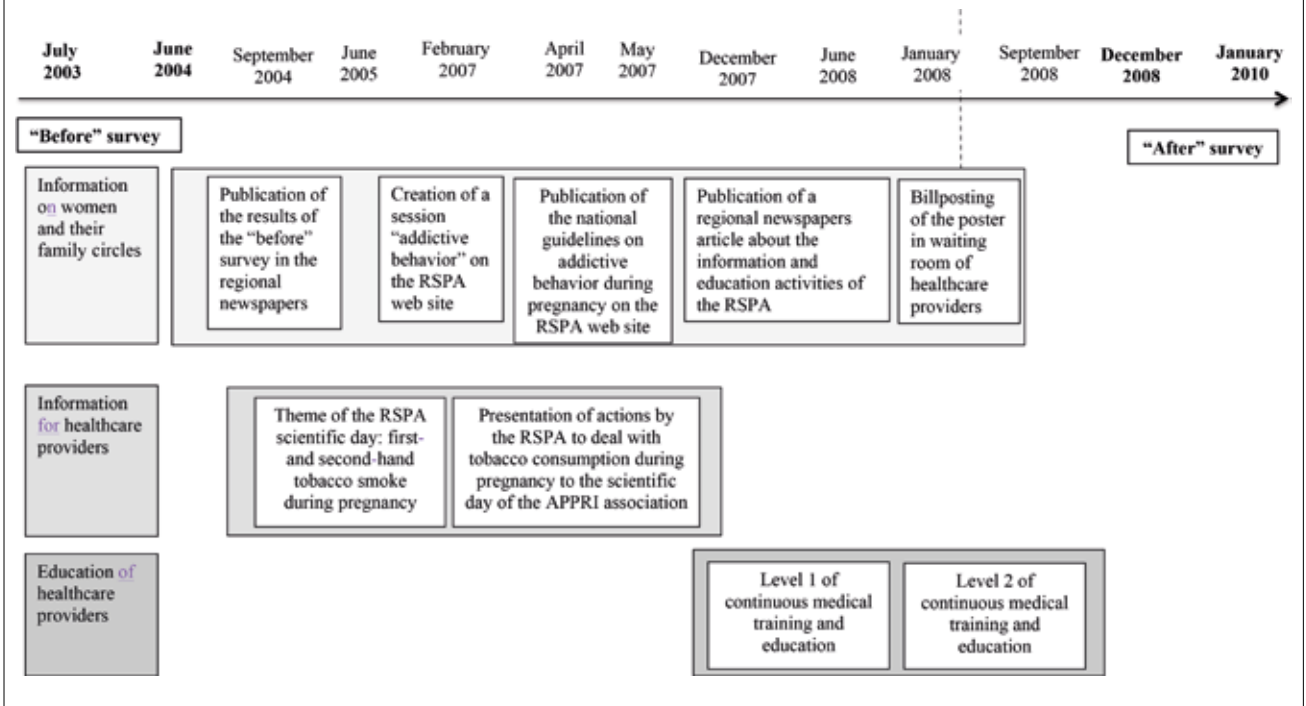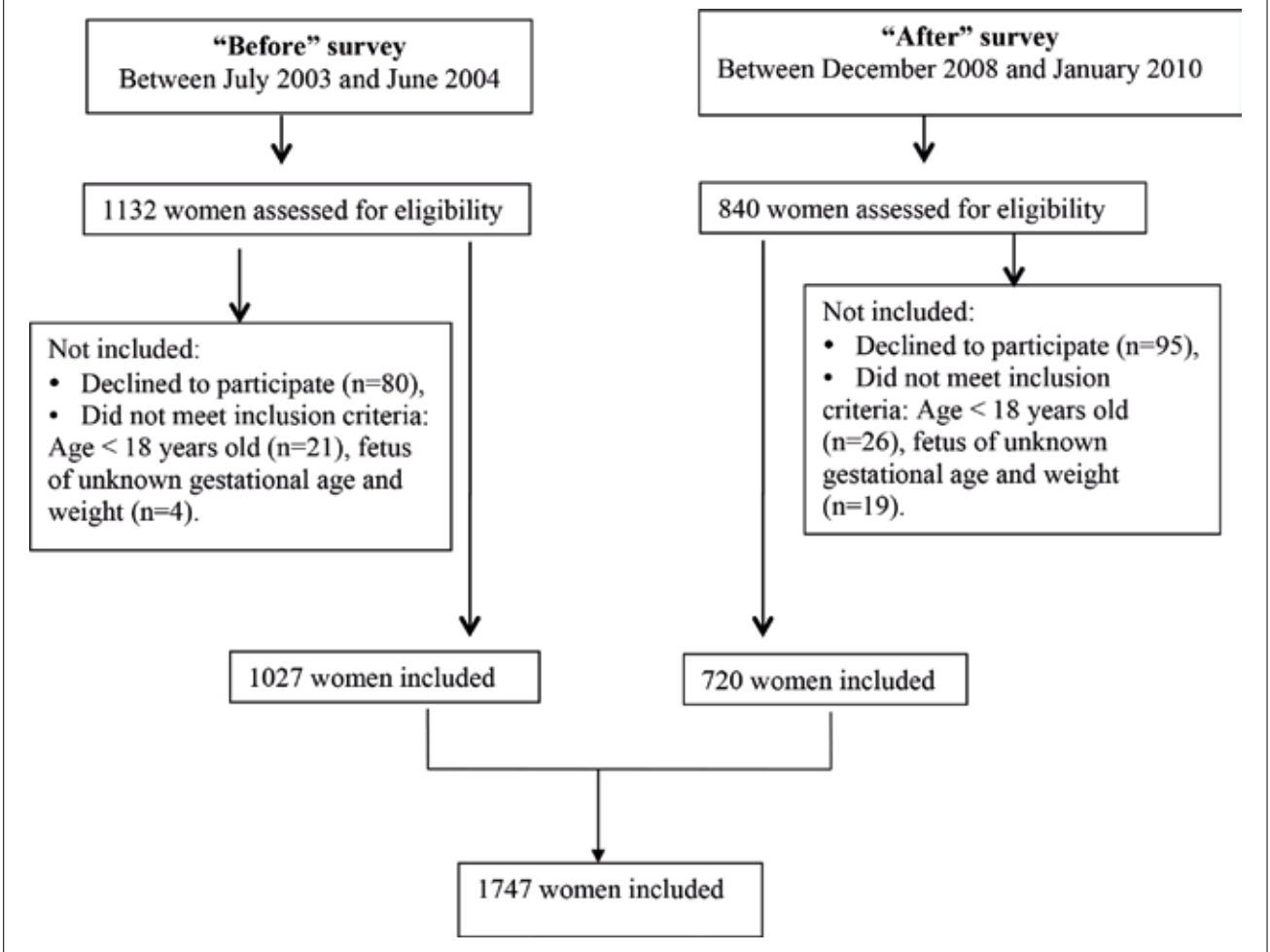

Fig. 2. Flow chart of women involved in the "before and after" study.

tember 2008, respectively. Fifty-eight healthcare professionals took part in Level 1 and 14 in Level 2.

STATISTICAL METHODS

Descriptive analysis was performed to assess the women's characteristics and the prevalence of smoking. As the samples from the "before" and "after" surveys were non-comparative, a Mantel-Haenszel method was used to identify any socio-demographic and medical variables that might be confounding factors. A threshold of 10% was applied in the Mantel-Haenszel method. Bivariate analysis was performed by means of logistic regression and calculation of crude Odds ratio (OR) and adjusted Odds ratio (aOR) with their 95% Confident Intervals (95% CI) for qualitative variables, and by means of Student's t-test for quantitative variables. Multivariate analysis was then performed by means of manual logistic regression, taking into account all significant interactions. Tobacco smoking was compared before pregnancy, at the time when pregnancy was diagnosed, during pregnancy and in the post-partum period, taking into account the confounding factors previously identified. Crude Odds ratio (OR) and adjusted Odds ratio (aOR) with their 95% CI were calculated on confounding factors. A significance threshold of 5% was applied in all the statistical analyses. Statistical analysis was performed by means of SAS software (V9.3. SAS Institute Inc., Carry, NC, 2002-2003).

Results

Of the 1132 eligible women in the "before" survey and the 840 eligible women in the "after" survey, 1027 and 720, respectively, were finally included in the present study (Fig. 2).

The descriptive analysis showed no significant difference in socio-demographic characteristics between the "before" and "after" groups; the only exception concerned occupational status, in that a higher percentage of women were in employment in the "after" survey: 73.42% *vs* 80.06%, OR 1.45 [1.15; 1.83]. Regarding the women's medical data, a significant difference was

observed only for parity, which was higher in the "before" survey: 64.97% *vs* 52.48%, OR 0.60 [0.49; 0.73]. Concerning the data on newborns, the only difference observed was in the 5-minute Apgar score, with lower Apgar scores in the "after" group: 1.37% *vs* 2.92% OR 2.17 [1.09; 4.29] (Tab. I).

Two confounding factors were identified by the Mantel-Haenszel method: occupational status and parity. In the multivariate analysis, occupational status was the sole explanatory variable that had an effect.

The trend in tobacco consumption indicated that a higher percentage of women in the "after" survey continued smoking: 43.49% *vs* 51.94%, aOR 1.45 [1.10; 1.90] on diagnosis; 40.53% *vs* 51.94%, aOR 1.62 [1.24; 2.12] during the third term, and 39.87% *vs* 46.46% aOR 1.31 [1.00; 1.72] in post-partum period. The majority of women quit smoking spontaneously before the diagnosis rather than after (Tab. II).

Pregnant women involved in the "after" survey were more exposed to at least one kind of ETS: 63.58% *vs* 75.24% aOR 1.74 [1.41; 2.15] overall and 52.83% vs. 69.57% aOR 1.95 [1.54; 2.47] among non-smokers. They were also more exposed to ETS at work and in the company of family or friends (Tab. III).

Discussion

MAIN RESULTS

The information and training program failed to reduce tobacco consumption during pregnancy. One unexpected finding was the higher exposure of pregnant women to ETS at work and with family or friends.

COMPARISONS WITH OTHER STUDIES

Previous studies have identified distinct trends in tobacco consumption during pregnancy, including a significant rate of "spontaneous quitters" before pregnancy or at the time of diagnosis [12]. Four studies have assessed the efficacy of training programs on healthcare professionals – midwives and the personnel of obstetric and pediatric units – and medical students [13-16]. Un-

Tab. I. Descriptive and bivariate analysis of socio-demographic, medical and newborn data among the 1027 and 720 women included in the "before" and the "after" surveys.

	"Before" survey % [mᵃ ± sdᵇ] (Nᶜ)	"After" survey % [mᵃ ± sdᵇ] (Nᶜ)	Odds Ratio CI (95%)
Age of the mothersᵈ	[29.73 ± 4.87] (*1027*)	[29.71 ± 5.19] (*720*)	-
Family status (couple)	95.52 (*1027*)	95.55 (*719*)	1.01 [0.63; 1.60]
Occupational status (work)	73.42 (*1027*)	80.06 (*697*)	1.45 [1.15; 1.83]
Age on first cigaretteᵈ	[16.44 ± 2.85] (*607*)	[16.18 ± 2.88] (*367*)	-
Parity (≥ 1)	64.97 (*1019*)	52.48 (*707*)	0.60 [0.49; 0.73]
Type of pregnancy: single	98.44 (*1027*)	98.16 (*708*)	0.85 [0.40; 1.77]
Weeks of gestation at birth	[39.17 ± 1.55] (*1027*)	[39.24 ± 1.56] (*715*)	-
≥ 37 weeks	95.81 (*984*)	94.83 (*678*)	0.80 [0.51; 1.26]
Birth weightᵉ	[3261.74 ± 498.91] (*1024*)	[3243.5 ± 508.4] (*717*)	-
5-Minute Apgar score < 7	1.37 (*1023*)	2.92 (*720*)	2.17 [1.09; 4.29]

ᵃm: mean; ᵇsd: Standard Deviation; ᶜN: number of women with information on the variable; ᵈage in years; ᵉbirth weight in grams.

Tab. II. History of smoking before, during and after pregnancy among the 1027 and 720 women included in the "before" and the "after" surveys, according to occupational status.

	"Before" survey 2003-2004 n[a] (%)[b] N[c]	"After" survey 2008-2010 n[a] (%)[b] N[c]	Crude Odds Ratio [CI[d] 95%]	Adjusted Odds Ratio[e] [CI[d] 95%]
Before pregnancy	407 (67.05%) **(607)**	253 (70.28%) **(360)**	0.81 [0.67; 0.99]	0.83 [0.67; 1.01]
Diagnosis of pregnancy	264 (43.49%) **(607)**	187 (51.94%) **(360)**	1.40 [1.08; 1.82]	1.45 [1.10; 1.90]
Third term	246 (40.53%) **(607)**	187 (51.94%) **(360)**	1.59 [1.22; 2.06]	1.62 [1.24; 2.12]
Post-partum period	242 (39.87%) **(607)**	164 (46.46%) **(360)**	1.31 [1.00; 1.71]	1.31 [1,00; 1.72]
	Stop smoking rate	Stop smoking rate		
Diagnosis of pregnancy	143 (35.14%) **(407)**	89 (35.18%) **(253)**	1.00 [0.72; 1.39]	1.00 [0.72; 1.40]
Third term	39 (14.77%) **(264)**	19 (10.16%) **(187)**	1.53 [0.85; 2.75]	1.51 [0.84; 2.71]
Post-partum period	5 (2.03%) **(246)**	27 (14.59%) **(185)**		
	Relapse rate	Relapse rate		
Third term	21 (6.12%) **(343)**	19 (10.98%) **(173)**	1.89 [0.99; 3.62]	1.85 [0.95; 3.58]
Post-partum period	1 (0.28%) **(361)**	4 (2.41%) **(166)**		-

[a]n: number of individuals in that response category; [b]%: percentage; [c]N: number of individuals with information on the variable; [d]CI: Confident Interval; [e]according to women's occupational status.

like the present study, these studies revealed a beneficial effect of the training program. The survey involving midwives revealed a positive impact on the number of cigarettes smoked a day [13]. The study performed in obstetric and pediatric units showed that healthcare providers changed their behaviour, though the difference was not statistically significant for all the outcomes measured [14]. Finally, the two studies involving medical students showed an impact on the students' confidence and attitude to dealing with tobacco consumption during pregnancy [15, 16].

Concerning exposure to at least one kind of ETS, the self-reported prevalence among non-smokers in the "after" survey (69.2%) was higher than that recorded by Aurrekoetxea in Spain (55.5%) [17]. In the present study, ETS exposure at home (23.35%) did not differ from the values measured by Aurrekoetxea in Spain (24.7%) and the WHO report for EU15 (25%) [17, 18]. By contrast, ETS exposure at work (32.15%) was higher than the values registered by Aurrekoetxea in Spain (9.8%) and the WHO report for EU15 (13%) [17, 18].

IMPLICATIONS

The rate of spontaneous quitters before pregnancy or on diagnosis remained moderate. The advice and support of physicians are reported to be effective in encouraging patients to give up smoking [19]. Training healthcare professionals is also recognized to have a positive effect on smoking cessation, although none of the 15 studies included in the recent Cochrane review targeted pregnant women [20]. The consensus is that anti-smoking interventions are effective on the both outcomes of both mothers and babies and should be implemented in all maternity hospitals [12]. It is important to take advantage of this 'teachable moment', to use the term of McBride et al. [7], because, if the opportunity is passed up, the rate of smoking cessation will be significantly lower for several years [21]. Consequently, prevention programs such as that organized by the RSPA are of great value. However, they could be considerably improved. First, such programs should target not only physicians but also medical students, through the use of both classic training methods and web-based training [22]. Sec-

Tab. III. Exposure to environmental tobacco smoke among the 1027 and the 720 women involved in the "before" and the "after" surveys and among non-smokers.

	"Before" survey n[a] (%)[b] N[c]	"After" survey n[a] (%)[b] N[c]	Crude Odds ratio [CI[d] 95%]	Adjusted Odds ratio[e] [CI[d] 95%]
Overall population				
At home (yes)	376 (36.61%) **(1027)**	24 (31.77%) **(705)**	0.81 [0.66; 0.99]	0.86 [0.70; 1.05]
At work (yes)	237 (31.43%) (754)	197 (37.38%) **(527)**	1.30 [1.03; 1.65]	-
With family or friends (yes)	495 (48.20%) **(1027)**	461 (66.91%) **(689)**	2.17 [1.78; 2.65]	2.26 [1.84; 2.78]
At least one type of tobacco exposure	653 (63.58%) **(1027)**	538 (75.24%) **(715)**	1.74 [1.41; 2.15]	-
Among non-smokers				
At home (yes)	168 (22.64%) **(742)**	117 (23.35%) **(501)**	1.04 [0.8; 1.36]	1.07 [0.82; 1.41]
At work (yes)	144 (25.31%) **(569)**	127 (32.15%) **(395)**	1.40 [1.05; 1.86]	-
With family or friends (yes)	275 (37.06%) **(742)**	282 (57.55%) **(490)**	2.30 [1.82; 2.91]	2.36 [1.86; 2.99]
At least one type of tobacco exposure	392 (52.83%) **(742)**	349 (69.57%) **(509)**	1.95 [1.54; 2.47]	-

[a]n: number of individuals in that response category; [b]%: percentage; [c]N: number of individuals with information on the variable; [d]CI: Confident Interval; [e]according to women's occupational status

ond, they should make healthcare professionals aware of pregnant women's environment (familial and occupational status, deprivation), psychological health and ETS, in order to identify those women's needs [3, 23]. Particular attention should also be paid to pregnant women's partners [3, 24, 25]. Indeed, it is noteworthy that, during a woman's pregnancy, her partner also goes through the Prochaska circle. Interventions should therefore aim at helping couples to definitively quit smoking. Third, preventive programs could also provide specific support for women who continue to smoke by including face-to-face interventions and group therapy. Incentive measures and other strategies, such as physical activity, also seem to have a positive impact on tobacco consumption [1, 12, 26-29]. Fourth, the program should also target the couple at different time-points, such as before pregnancy (pre-wedding and family planning consultations) and in the post-partum period, which is a high-risk period for smoking relapse.

STUDY LIMITATIONS

The study has certain limitations. First, "before" and "after" surveys should be performed in exactly the same conditions. Assessment of the impact of the program may have been distorted by the public health measures against tobacco consumption introduced by the French government. The price of a packet of cigarettes increased by about 40% between 2002 and 2004, during the period of the "before" study (http://www.inpes.sante.fr/10000/themes/tabac/consommation/marche-tabac.asp). In addition, a ban on smoking in public areas was imposed by decree in November 2006 and enforced in February 2007 and January 2008, before the "after" survey. The presence of strong legal regulations may explain the increase in ETS exposure between the "before" and "after" surveys. This increase might have impaired the effects of our prevention program. Second, the preventive program was assessed by means of a multi-center population-based survey without a control group. Third, no secondary outcomes were measured, such as those included in the Cochrane review (percentage of follow-up appointments made, percentage of self-help materials given, number of "quit dates" prescribed), an omission that prevented us from identifying the positive effect of the program [12]. Fourth, the inclusion criterion of a fluent command of spoken and written French might have excluded immigrant women, who are more exposed to tobacco consumption and ETS [30]. Finally, the information poster may have given rise to feelings of guilt that were counterproductive.

Conclusions

In conclusion, the information and training program seemed not to have reduced tobacco smoking during pregnancy. Moreover, unexpectedly high levels of ETS were revealed. Consequently, government authorities in France need to introduce new public health policies aimed specifically at tackling the problem of tobacco use and exposure to ETS during pregnancy. Programs

that are too broad may leave out parts of the population, as shown by the increase in ETS exposure.

The solution is therefore to build pregnancy-based programs and to prevent smoking among men and women who are going to have children (such as pre-wedding intervention). We also need a better understanding of the image of tobacco and its dangers and how people consider its harmful effects on fetuses. Questions related to the environment of pregnant women also need to be addressed. Impact measurement and cost-effectiveness analyses of every program should be undertaken in order to assess how best to implement the strategies.

Public health stakeholders should be aware that some of the programs usually developed may not reach their objectives, and that any newly funded program should focus more closely on specific targets and provide strong evidence of efficacy.

Acknowledgements

Authors' contributions

FV conceived and designed the original idea of the research. SL and MB performed the data quality control and optimized the informatics database. SL performed the statistical analyses. MB, SL, LG and FV evaluated the results. MB, SL, LG and FV wrote the article. All Authors revised the manuscript and gave their contribution to improve the paper. All authors read and approved the final manuscript.

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