



Early childhood predictors of early onset of smoking: A birth prospective study



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HIGHLIGHTS

- One in six participants first smoke cigarettes at or before 14 years.
- Maternal education and marital circumstances predict earlier onset of smoking.
- Maternal smoking or drinking are linked with earlier tobacco smoking in children.

ARTICLE INFO

Keywords:

Cigarette smoking
Age of onset
Predictor
Early childhood

ABSTRACT

Objective: Early onset of smoking is associated with subsequent abuse of other substances and development of negative health outcomes. This study aimed to examine early life predictors of onset of smoking in an Australian young cohort.

Methods: Data were from the Mater Hospital and University of Queensland Study of Pregnancy (MUSP), a population-based prospective birth cohort study (1981–2012). The present study is based on a cohort of 3714 young adults who self-reported smoking status and age of onset of smoking at the 21-year follow-up. Of these, data were available for 3039 on early childhood factors collected between the baseline and 14-year follow-up of the study.

Results: Of 3714 young adults, 49.6% (49.9% males and 49.3% females) reported having ever smoked cigarettes. For those who had ever smoked, mean and median ages at first smoke were 15.5 and 16.0 years, respectively. In multivariate Cox proportional hazard analysis mother's education, change in maternal marital status, maternal cigarette smoking and alcohol consumption, maternal depression and child externalizing when the child was 5 years statistically significantly predicted early onset of smoking.

Conclusions: The data suggest that individuals exposed to personal and environmental risk factors during the early stage of childhood are at increased risk of initiation to cigarette smoking at an earlier age. Identification of the pathways of association between these early life factors and initiation to cigarette smoking may help reduce risk of tobacco smoking in adolescents and its adverse consequences.

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1. Introduction

Cigarette smoking remains the most common preventable risk factor contributing to illness, disability and death. In Australia, more than 13.0% of 18 and 19 year old adolescents smoked daily in 2010 (Australian Institute of Health & Welfare, 2011). Early age of onset of tobacco smoking is a predictor of lower academic achievement and behavioral problems at school (Ellickson, Tucker, & Klein, 2001), as well as later legal and illegal drug abuse (Grant, 1998;

Hanna, Yi, Dufour, & Whitmore, 2001). Research has also shown that earlier age of smoking onset is associated with increased risk of physical and mental health impairments, including anxiety and depression (Hanna et al., 2001; Jamal, Van der Does, Penninx, & Cuijpers, 2011), cardiovascular diseases (Hegmann et al., 1993; Planas et al., 2002), and respiratory problems (Henderson, 2008) and cancer (Palmer et al., 1991). Most research suggests that the rate of smoking initiation after age 21 is very low (Chen & Kandel, 1995), although there might be a subgroup of late-onset smokers who start smoking immediately after completing high school (Chassin, Presson, Rose, & Sherman, 1996). The identification of individuals at risk for early onset tobacco smoking is an important public health priority and should help prevent the development of wide range of associated health outcomes.

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In light of the high recidivism among adult smokers who try to quit (Chassin et al., 1996) and the evidence that most smokers begin smoking before the age of 21 years, preventive efforts need to target adolescents. Early childhood, the adolescent period have been described as sensitive or even critical periods (Bornstein, 1989), particularly in terms of psycho-social development. Knowledge of factors associated with the early initiation of smoking, and in particular early childhood factors, can help develop effective preventive programs (Coie et al., 1993; Hawkins, Arthur, & Catalano, 1995; Mrazek & Haggerty, 1994). There has been extensive research to investigate various interpersonal and intrapersonal factors that predict smoking behavior in adolescents and young adults (Becklake, Ghezze, & Ernst, 2005; Choi, Harris, Okuyemi, & Ahluwalia, 2003; Conrad, Flay, & Hill, 1992; Milberger, Biederman, Faraone, Chen, & Jones, 1997; Voorhees, Schreiber, Schumann, Biro, & Crawford, 2002; Zhang, Wang, Zhao, & Vartiainen, 2000). Findings of the relevant studies indicate that children

who are exposed to lower socio-economic status, family problems, including family disruption and conflict, a family history of substance use, and parental antisocial behavior are more likely to smoke tobacco, in both adolescence and early adulthood (Conrad et al., 1992). They also suggest that a person's mental health and problem behaviors (Voorhees et al., 2002), including attention deficit hyperactivity disorder in childhood (Milberger et al., 1997; USDHHS, 1998), are associated with early initiation of cigarette smoking.

While a variety of psycho-social risk factors have been studied previously including socio-demographic, environmental, behavioral, and personal factors, the available studies mainly focus on the relationship between a selected group of risk factors and tobacco smoking. In addition, in different studies, many of these factors are considered individually or in small groups, yet these factors are likely to be correlated and measure the same underlying cause. Specifically, there remains a paucity of knowledge to prospectively examine the association between early childhood factors

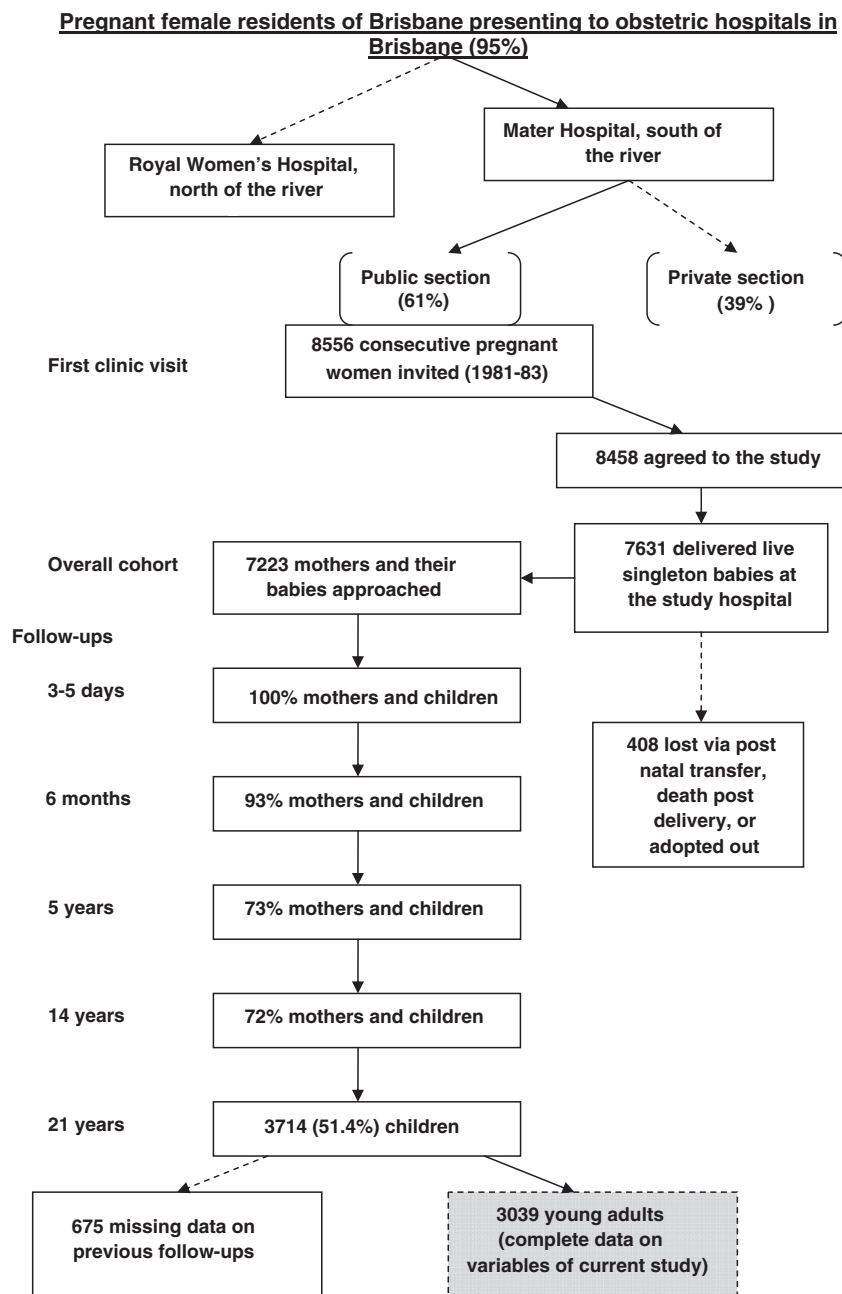


Fig. 1. Sampling frame and follow-ups of MUSEP.

and age of initiation to cigarette smoking. The present study uses data from a prospective birth cohort study to explore the relationship between several potential risk factors measured over the early life course of a child and onset of cigarette smoking.

2. Material and methods

2.1. Participants

Data for this study were taken from the Mater-University of Queensland Study of Pregnancy (MUSP), a pre-birth cohort study which recruited pregnant women attending one of two major obstetric hospitals in Brisbane, Australia (Keeping et al., 1989; Najman et al., 2005). The women who were recruited were consecutive public patients invited to participate over the period 1981–3 and were an average 18 weeks gestation at the recruitment interview. Baseline data were collected at the first antenatal visit from 7223 consecutive women who gave birth to live singleton babies and were followed up at 3–5 days, 6 months, and 5, 14 and 21 years after the birth (Fig. 1). Both mothers and their children were assessed at the follow-ups. Additional details of sampling and study methodology have appeared elsewhere (Najman et al., 2005). The present analyses used data from the baseline, 5, 14 and 21 year follow-up surveys. Written informed consent from each mother was obtained at all phases of data collection and from each young adult at the 21-year follow-up of the study. Ethics committees at the Mater Hospital and The University of Queensland approved each phase of the study.

2.2. Measurements

2.2.1. Tobacco smoking and age of onset

The participants smoking status was measured by asking “Which of the following best describes your smoking status now?”. The options were: I have never smoked; I used to smoke; I now smoke occasionally; and I now smoke regularly. The extent of smoking by young adults at the 21-year follow-up was assessed via the average number of cigarettes smoked per day during the week preceding the survey. Subjects were subsequently divided into three categories: non-smokers, smokers of less than 10 cigarettes per day and 10 or more cigarettes per day. A third question sought “at what age did you begin cigarette smoking?”.

2.2.2. Young adults' characteristics

The frequency and quantity of alcohol consumption at the 21-year follow-up was measured with the following questions: “how often do you drink alcohol?” and “how much alcohol do you usually drink at those times?”. The respondents were divided into three groups: no alcohol use, up to one drink (glass) and more than one drink per day.

Current cannabis use by the participants was assessed at the 21-year follow-up via a self-report questionnaire in which they were asked, “In the last month how often did you use cannabis, marijuana, pot, etc.?” Options for response were; have never used before, used but not in the last month, used once or so in the last month, used every few days and used every day. Young adults were then divided into three groups, never used; occasional use; and frequent use (used at least every few days).

Young adults' highest level of education was assessed using a range of options from primary school to university. Subjects were then categorized into three groups: post high school education (tertiary education), completed high school and incomplete high school.

Young adults were asked whether they had a ‘paid job’ at the time the survey was conducted. They were grouped into the categories: paid job and no paid job. They also indicated whether they were attending any education institution with the answers being: no, yes (full-time or part-time). Using these two latter variables, we created a composite variable that divided the participant into three groups: those who had a paid job and were attending an educational

institution (as reference category); those who had either a paid job or were undertaking education, and those who had neither.

At the 21-year follow-up, the young adult's symptoms of problem behavior were measured using the Young Adult Self-Report (YASR) version of the CBCL (Achenbach, 1997). The YASR is a questionnaire for individuals aged 18–30 years which contains 114 problem behavior items that can be scored on eight sub-scales, including internalizing and externalizing. In the current study, there was a very good internal reliability for both internalizing (Cronbach's alpha = 0.92) and externalizing (Cronbach's alpha = 0.87). For the current analysis cases of problem behavior at the 21-year follow-up were defined using 10% cut-offs of scores on the relevant scale.

At the 21-year follow-up participants were also asked whether they had to go to court for something they did. The answers were then dichotomized into yes and no categories.

2.2.3. Early childhood predictors

Maternal socio-demographic background, including age (below 20 and 20 years or older); and education (post high school, completed high school and incomplete high school) were assessed when the child was born. Maternal marital status was assessed at the 5-year follow-up [married or de-facto (living together), single, and separated, divorced or widowed (SDW)].

At the 14-year follow-up changes in maternal marital status in the last seven years were obtained using questions requesting frequency of divorce, separation from partner and change of partner. A composite scale was then recoded to three levels, no change, one or two changes, and three or more changes.

The quality of maternal marital relationships at 5 years was assessed using a short form of the Dyadic Adjustment Scale (DAS) (Cronbach's alpha = 0.88) (Spanier, 1976). Subsequently, mothers were classified into three categories, 1 – those who had good adjustment, 2 – a relationship characterized by moderate adjustment or disagreement, and 3 – those who were divorced, separated, widowed or never married (un-partnered mothers).

Maternal tobacco and alcohol consumption were also assessed at the 5-year follow-up. Cigarette smoking was assessed according to the number of the cigarettes they smoked over the 7 days prior to the survey (non-smoker, smoking 1–19 and 20+ cigarettes per day). We also obtained information on frequency (from never to daily) and quantity (from 0 to 7+ glasses) of alcohol consumption. They were then divided into three categories (abstainers, ≤ 1 glass and > 1 glass per day).

Maternal anxiety and depression at the 5-year follow-up were assessed using the short form of the Delusions-Symptoms-States Inventory (DSSI) (Bedford & Foulds, 1978). The DSSI has been widely used and its validity has been established (Morey, 1985) against the DSM-III (American Psychiatric Association, 1980). In the MUSP the DSSI items were administered to the mother in the form of a self-report questionnaire, which included the seven-item anxiety (Cronbach's alpha = 0.76) and depression (Cronbach's alpha = 0.79) sub-scales.

Symptoms of problem behaviors in children at the 5-year follow-up were derived using the Child Behavior Check List (CBCL), which is a maternal report questionnaire for subjects aged 4–18 years, and asks about behavioral problems in the last 6 months (Achenbach, 1991). Several validation studies have been published on the CBCL and factor analyses and reliability estimates of subscales appear to be consistent with Achenbach's original data (Achenbach, 1991; Achenbach & Edelbrock, 1983). Subscales used in the current study included internalizing (including social withdrawal, anxiety and depression) and externalizing (including aggression and delinquency) behavior. In the current study, there was a very good internal reliability for both internalizing (Cronbach's alpha = 0.76) and externalizing (Cronbach's alpha = 0.83). For the current analysis, cases of problem behavior at the 5-year follow-up were defined using 10% cut-offs of scores on the relevant scale.

2.3. Statistical analysis

For statistical analysis, we used STATA v.11.2 (STATA Corp. Texas 77845, USA) with $P = 0.05$ considered as significance level. We primarily used chi-square tests to examine the young adult characteristics of the participants according to their smoking status. For the association between early childhood factors and age of initiation to smoking Kaplan–Meier survival analyses (Kaplan & Meier, 1958) and Cox proportional-hazards models (Cox, 1972) were used. As the event of interest was observed in some participants, the censoring variable for age of initiation to smoking was created considering individuals who remained abstinent by the 21-year follow-up. A series of univariate and multivariable Cox proportional-hazards analysis was conducted to examine the independent association between early childhood factors and age of initiation to tobacco smoking. Childhood factors included gender, mother's age and education, mother's marital status, quality of marital relationship and changes in marital status, mother's smoking, alcohol consumption, anxiety and depression, and child internalizing and externalizing. The most parsimonious model was created using backward, stepwise Cox proportional-hazards model to identify independent predictors of onset of smoking. Variables with a P value of less than 0.50 were entered into the model, and those with a P value of less than 0.10 were retained.

The characteristics incorporated into the final Cox proportional-hazards model for onset of cigarette smoking were mother's education, changes in maternal marital status, maternal smoking, alcohol consumption and depression, and child externalizing behavior at 5 years. The proportional hazards assumption that risk remains constant over time was assessed using the Grambsch and Therneau test of the Schoenfeld residuals (Grambsch & Therneau, 1994). There was no evidence that the proportional hazard assumptions were violated for either the covariate-specific regressions or the final multivariate model.

3. Results

3.1. Participants characteristics

At the 21-year follow-up, 3714 young adults (age range: 18.2–24.3 years) completed a questionnaire about current smoking status and the age of initiation to smoking. Of those, 1873 (50.4%) reported never smoked before. Of 1841 participants who reported ever tobacco smoke, 12.3% were ex-smokers, while the other 37.3% were current smokers. Mean and median age at the time of first tobacco smoke was 15.5 (SD = 2.1) and 16.0 years, respectively. 15.3% and 34.3% reported first cigarette smoking at or before 14 years and 15 years or older, respectively. Table 1 displays the general characteristics of the participants at the 21-year follow-up. In general, compared with those who never smoked cigarettes, participants who had ever smoked were more likely to, use cannabis frequently (22.0% vs. 2.7%), have lower levels of education (32.3% vs. 9.4%), exhibit greater symptoms of internalizing (12.5% vs. 7.5%) and externalizing behavior (14.2% vs. 4.1%), and attend court (25.1% vs. 7.1%) in early adulthood.

3.2. Hazard proportional models

Fig. 2 compares the cumulative incidence of onset of smoking according to early childhood factors. Probability of onset of smoking at a given age was higher in individuals whose mother had lower level of education, had frequent changes in their marital status, smoked cigarettes, drank alcohol, or were recognized depressed during offspring early stage of development. For instance, almost 37% of the participants whose mothers had three or more changes in marital status had begun smoking by 15 years of age, compared to 20% of those whose mother did not change marital status (Fig. 2b). It is also noted that greater symptoms of externalizing behavior in early childhood was associated with greater risk of early onset of smoking.

Table 1
Young adults' characteristics by ever smoking ($n = 3556$).

Variables ^b	Ever cigarette smoking		P^a
	No ($n = 1787$) N (%)	Yes ($n = 1769$) N (%)	
Gender			0.828
Female	950 (53.2)	93.4 (52.8)	
Male	837 (46.8)	835 (47.2)	
Alcohol consumption			<0.001
None	485 (27.1)	704 (39.8)	
≤1 glass/day	1125 (63.0)	969 (54.8)	
>1 glasses/day	177 (9.9)	96 (5.4)	
Current cannabis use			<0.001
Never	1340 (75.0)	462 (26.1)	
Occasional use	398 (22.3)	926 (52.4)	
Frequent use	49 (2.7)	381 (21.5)	
Highest level of education			<0.001
Post high school	528 (29.6)	411 (23.2)	
Completed high school	1099 (61.5)	787 (44.5)	
Incomplete high school	160 (8.9)	571 (32.3)	
Current job and education			<0.001
Both	63.8 (35.7)	332 (18.8)	
Either	986 (55.2)	1052 (59.4)	
Neither	163 (9.1)	385 (21.8)	
Internalizing behavior			<0.001
Normal	1649 (92.3)	1548 (87.5)	
Top 10%	138 (7.7)	221 (12.5)	
Externalizing behavior			<0.001
Normal	1713 (95.9)	1516 (85.7)	
Top 10%	74 (4.1)	253 (14.3)	
Court attendance			<0.001
No	1664 (93.1)	1325 (74.9)	
Yes	123 (6.9)	444 (25.1)	

Note:

^a P value obtained with chi-square tests.

^b Assessed at the 21-year follow-up.

Table 2 presents the results of the Cox proportional-hazard modeling of the risk for onset of cigarette smoking due to early childhood factors included in the study. In univariate analysis, mother's age, mother's education, maternal marital status, quality of maternal marital relationship, changes in maternal marital status, maternal smoking and alcohol consumption, maternal mental health, and child externalizing behavior during the early stages of child development predicted early initiation of smoking. Children whose mothers experienced three or more changes in marital status between the 5 and 14-year follow-ups of the study were two times more likely (HR = 2.00; 95% CI: 1.60–2.51) to smoke cigarettes at an earlier age relative to others. Similarly, children whose mothers had lowest levels of education were at an increased risk (HR = 1.63; 95% CI: 1.37–1.96) of starting to smoke cigarettes at an earlier age. A relatively strong association was also found for early onset of smoking among children whose mothers smoked 20 or more cigarettes per day (HR = 1.37; 95% CI: 1.20–1.58) or drank more than a glass of alcohol per day (HR = 1.42; 95% CI: 1.14–1.78) at the 5 year follow-up. Table 2 also shows that children who were categorized in the top 10% of externalizing behavior at 5 years were at increased risk (HR = 1.33; 95% CI: 1.14–1.60) of initiation to smoking compared with others.

In the final multivariate model there were 6 predictors which were independently and significantly associated with initiation to smoking at an earlier age (see Table 2). Children whose mothers' level of education was incomplete high school were almost 55% more likely to report early initiation to smoking (HR = 1.54; 95% CI: 1.29–1.84). More frequent changes in maternal marital status remained a strong and significant predictor of early onset of smoking (HR = 1.85; 95% CI: 1.49–2.35), and maternal heavy smoking (HR = 1.17; 95% CI: 1.01–1.36) and depression (HR = 1.28; 95% CI: 1.03–1.58) were significantly associated with offspring's earlier initiation to tobacco smoking. Further, 5 year old children who exhibited extreme externalizing behavior

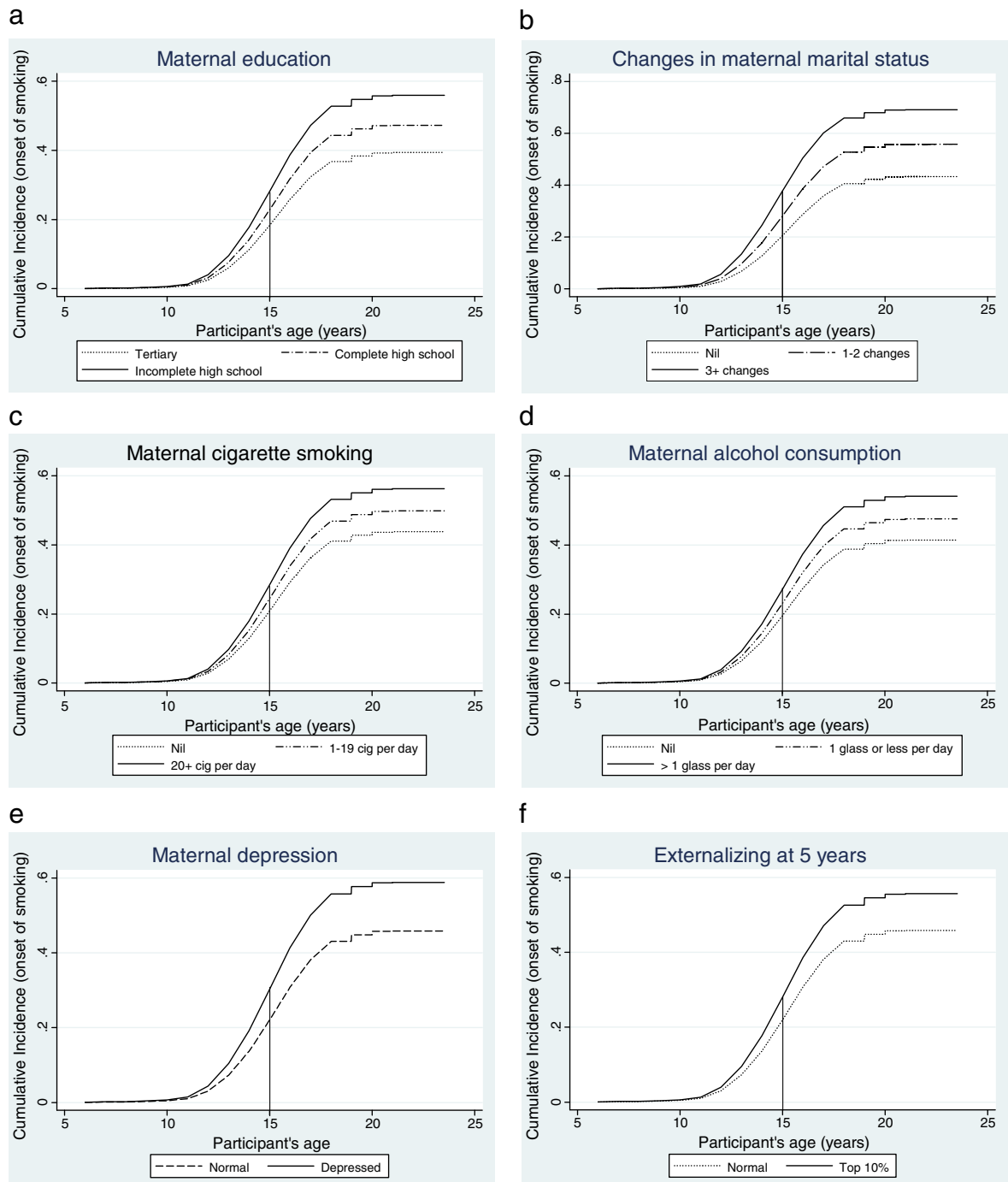


Fig. 2. Cumulative incidence of onset of smoking by: a) maternal education; b) changes in maternal marital status (between the 5 and 14-year follow-ups); c) maternal cigarette smoking at child 5 years; d) maternal alcohol consumption at child 5 years; e) maternal depression at child 5 years; and f) child externalizing behavior at 5 years.

were at increased risk of early initiation to smoking independent of other variables (HR = 1.22; 95% CI: 1.03–1.45).

4. Discussion

The present study is one of the few prospective studies that explores the association of a variety of environmental and intrapersonal factors in early childhood and initiation to cigarette smoking in a birth cohort. Unlike most of the previous research (Conrad et al., 1992) that has included participants older than 10 years, in the present study the data on early childhood factors were prospectively collected during the first few years of the child's life. The study finds that individuals who

are exposed to a disadvantaged environment during the early stages of development are at greater risk of smoking cigarettes at an earlier age. The data suggest that maternal education, changes in maternal marital status, maternal smoking, maternal alcohol consumption, and maternal depression when the child is 5 years old, and the child's externalizing behavior predict increased risk of early initiation to smoking.

Our findings of ever (49.5%) and current smoking (37.3%) among young adults are comparable with the prevalence of smoking in 20–29 years age group in the 2004 National Drug Strategy Household Survey (Australian Institute of Health & Welfare, 2005). In 2004 survey, 43.1% of 20–29 years old Australian reported ever smoking tobacco (mean age = 15.9 years), of whom 29.6% were current smoker. The

Table 2
Cox proportional hazards model for age of onset of cigarette smoking (n = 3039).

Predicting variables ^a	Unadjusted		Adjusted ^d	
	Hazard ratio	95% CI	Hazard ratio	95% CI
Gender				
Female	Ref		Ref	
Male	1.00	0.90–1.11	1.00	0.90–1.10
Mother's age ^b				
20+ years	Ref		Ref	
<20 years	1.28	1.11–1.49	1.10	0.94–1.28
Mother's education ^b				
Post high school	Ref		Ref	
Completed high school	1.34	1.17–1.54	1.29	1.13–1.49
Incomplete high school	1.63	1.37–1.96	1.54	1.29–1.84
Mother's marital status				
Married/de-facto	Ref		Ref	
Single	1.38	0.96–2.00	1.13	0.77–1.66
SDW	1.31	1.14–1.51	0.98	0.82–1.17
Mother's quality of marital relationship				
Good adjustment	Ref		Ref	
Moderate/poor adjustment	1.20	1.05–1.37	1.00	0.87–1.16
Unpartnered	1.30	1.09–1.56	1.00	0.83–1.22
Mother's change in marital status ^c				
Nil	Ref		Ref	
1–2 changes	1.47	1.30–1.66	1.39	1.23–1.57
3+ changes	2.00	1.60–2.51	1.85	1.49–2.35
Mother's cigarette smoking				
Nil	Ref		Ref	
1–19 cig per day	1.36	1.20–1.55	1.24	1.10–1.43
20+ cig per day	1.37	1.20–1.58	1.17	1.01–1.36
Mother's alcohol consumption				
Nil	Ref		Ref	
≤1 glass/day	1.24	1.08–1.42	1.21	1.06–1.39
>1 glasses/day	1.42	1.14–1.78	1.25	0.99–1.56
Mother's depression				
Normal	Ref		Ref	
Depressed	1.47	1.22–1.76	1.28	1.03–1.58
Mother's anxiety				
Normal	Ref		Ref	
Anxious	1.23	1.08–1.39	1.02	0.88–1.19
Child internalizing behavior				
Normal	Ref		Ref	
Top 10%	1.13	0.97–1.32	1.01	0.85–1.19
Child externalizing behavior				
Normal	Ref		Ref	
Top 10%	1.33	1.14–1.56	1.22	1.03–1.45

Note: hazard ratios represent the risk of the outcome among individuals according to the categories of early childhood factors obtained from Cox proportional hazards model.

^a Assessed at the 5-year follow-up unless otherwise indicated.

^b Assessed at child's birth.

^c Assessed at the 14-year follow-up for the number of changes in maternal marital status between 5 and 14 year follow-ups.

^d Adjusted for other predicting variables, the final model was created using backward, stepwise Cox proportional-hazards model to identify independent predictors of onset of smoking.

findings of early childhood predictors of onset of smoking are in agreement with most of the previous research that suggested socioeconomic status, family disruption, parental substance use and child behavior as predictor of offspring's early smoking (Conrad et al., 1992; Voorhees et al., 2002; Zhang et al., 2000). However, our data contradicts with the findings of a recent longitudinal study (Wium-Andersen, Wium-Andersen, Becker, & Thomsen, 2010) that did not find an association between parents' smoking, alcohol consumption, socioeconomic status, maternal marital status, and offspring's age at onset of smoking. The existing difference in the findings of the two studies might be due to the difference in participants' age.

Most of the previous research has studied the impact of parents' marital status at a certain time on offspring's problem behavior and smoking. One significant contribution of our research to the existing literature is that it shows changes in maternal marital status during an important period of child development as a predictor of offspring onset of smoking. Further, this study suggests that maternal mental

health, and particularly depression when a child is 5 years predicts that child's initiation of smoking.

The data in this population-based study suggest that about half the population of young adults had ever smoked tobacco and a significant proportion of young people begin smoking before 15 years of age. The present study suggests a variety of exposures that may contribute to the early initiation of tobacco use. Our study confirms the importance of family environment and specifically marital transition and parents' substance use in prediction of onset of smoking in offspring, as we found that children who were reared in these families were more likely to begin cigarette smoking at an earlier age.

4.1. Mechanism of associations

Frequent changes in maternal marital status influence parent–child relationships and make adolescents more lonely or emotionally vulnerable (Wallerstein, 1991; Wallerstein & Kelly, 1980), leaving them susceptible to peer pressure and hence to use of illegal drugs (Guo et al., 2002; Hoffmann, 1993). It is possible that marital disruption and reconstruction affect parental supervision and control of the children and this may enhance the child willingness to use illicit drugs (Chen, Storr, & Anthony, 2004). The finding that maternal substance use predicts early onset of smoking by children accords with the various social theories (social learning and social control) that suggest children of substance users would be likely to begin using substances themselves, perhaps due to modeling by parents (Bandura, 1977; Hirschi, 1969). The association between externalizing behavior and early onset of smoking can be explained by several possibilities. The first possible explanation is that both are separate manifestations of common causal factors (Akers, 1984), either genetic (Iacono, Carlson, Taylor, Elkins, & McGue, 1999) or environmental (Moffitt, 2006), or some combination of them. Alternatively, it seems plausible that externalizing behavior in early childhood places individuals at risk for early initiation of tobacco smoking because their behavior problems alienate them from ordinary youth groups while fostering affiliation with more deviant teenagers. It is, moreover, reasonable to suspect that a child's peer group may influence the development of substance use, including smoking, in early adolescence.

4.2. Limitations

Notwithstanding its contribution to the literature, the findings of the current study can be affected by certain limitations. First, although all of the offspring had reached the age of risk for initiating tobacco smoking, it could be suggested that not all smokers may have commenced smoking. While this may be true it is unlikely to greatly impact on our findings. National Australian data indicate that the mean age of initiation of smoking is 15.9 years – the vast majority of tobacco users will have commenced using before the age of 21 years (Australian Institute of Health & Welfare, 2005).

Secondly, there is a possibility that loss to follow-up has influenced our findings and produced misleading results. Loss to follow-up in this study was associated with maternal education, maternal un-partnered marital status, and maternal cigarette smoking at child 5 years, all predicting offspring's age of onset of smoking. Given that those lost to follow-up have higher levels of adverse health outcomes, our findings are likely to be conservative and may underestimate the true effect of the risk factors examined here. In another paper (Najman et al., 2005) we have modeled the likely impact of many levels of attrition on our findings. These scenarios consistently indicate that attrition tends to slightly underestimate the strength of association, but does not change the substance or direction of the findings. However, caution is necessary when interpreting the findings of this study and inferring the results to the general population.

Third, although reflecting a wide range of early childhood factors associated with initiation of smoking, the current study did not have access to paternal data, nor it could not assess the effect of other environmental

(e.g. peer relationship), genetic and biological factors on the development of cigarette smoking in offspring. Replication of this study with a large prospective study that includes genetic data would explore the robustness of the findings presented here.

4.3. Conclusion

A substantial proportion of individuals begin cigarette smoking at early ages. Results from our study suggest a significant association between a selected group of risk factors in early childhood and early initiation to smoking. If the association between early childhood factors included in this study and onset of smoking is causal, it is plausible to assume that effective intervention programs that target the modifiable risk factors such as parental substance use and child externalizing may prevent early onset of smoking and its subsequent outcomes. Tobacco control programs are warranted to consider the impact of early childhood family environment on the onset of smoking in young smokers. There is a need for investigations to explore the mechanism of association between early childhood factors and onset of tobacco use.

Role of funding source

Funding for this study was provided by the National Health & Medical Research of Australia (NHMRC). The NHMRC had no further role in study design; in the collection, analysis, and interpretation of data; in writing this manuscript, or in the decision to submit the paper for publication.

Contributors

R. Hayatbakhsh conceptualized the manuscript, conducted the analysis and wrote the first draft. A.A. Mamun assisted with statistical analysis. G.M. Williams, M.J. O'Callaghan and J.M. Najman have been chief investigators of the study from 1981 and critically reviewed the manuscript. All authors contributed to and have approved the final manuscript.

Conflict of interest

None of the authors of this manuscript has any conflict of interest or financial relationship to declare.

Acknowledgment

We thank all participants in the study, the MUSP data collection team, and Greg Shuttlewood, and University of Queensland who has helped to manage the data for the MUSP.

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