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Passive Smoking in Childhood—Tobacco Smoke

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Abstract. Prevalence of cigarette smoking varies widely in different countries, ranging, at the age of 13, from 2% to 5% (Sweden, United States) to more than 30% (Australia, Uruguay). Even if the prevalence of smokers among male adolescents is decreasing in western countries, it is increasing among girls and, in developing countries, male adolescent smokers still reach 40% (and up to 70%–80%). The determination of saliva cotinine levels, a product of nicotine metabolism, is an useful indicator of exposure to passive or active smoking. In a study of 210 children aged 9–13 years, we found detectable levels of saliva cotinine in 13% of children who lived in nonsmoking families and denied being regular smokers and in only 60% of children living in families with heavy cigarette consumption. This wide variations of a marker of smoking exposure may explain the differences in reported consequences of tobacco smoke in investigations conducted in different places and on different target populations. We later studied the effects of environmental tobacco smoke (ETS) in a sample of 166 nine-year-old children. The relationship between parental smoking and degree of bronchial responsiveness in males was significant. Also, prick skin test reactivity to allergens was significantly increased in children of smoking parents. Many studies concerning the effects of ETS exposure seem to demonstrate that not only the lungs and not only children are affected even if the difficulty of the epidemiology in such a field must suggest caution in interpreting the results. However, on the basis of the present evidence, ETS exposure has to be considered a general toxic source for humans and its harmful effects appear even more unacceptable because, at least theoretically, they could be easily prevented.

Key words: Tobacco smoke—Passive smoking in children—Saliva cotinine—Smoking and atopy.

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Introduction

The evidence for a causal relationship between use of tobacco and ill health is overwhelming: cigarette smoking is considered to be responsible for increasing the incidence of lung cancer, of chronic bronchitis and emphysema, and of ischemic heart disease in men under 65 years of age [1]. Smoking has also been observed to be associated with an increase the risk for cancer and other disease of organs like the liver, kidneys, bladder, stomach, and brain [2].

As many of these diseases become increasingly more common with the process of aging, it has been suggested that an aging acceleration takes place in cigarette smokers compared to nonsmokers; for example, the age-cumulative cancer mortality curve in subjects who start the habit of cigarette smoking before the age of 15 can be completely superimposed on the curve of nonsmokers, if one assumes that smokers' rate of aging has been accelerated by 15 years [3].

In many western countries, governments and health authorities have undertaken actions to curtail cigarette consumption and tobacco advertising. However, cigarette smoking as a whole worldwide has not decreased [1].

In children, prevalence of cigarette smoking varies widely in different countries, ranging, at the age of 13, from 2% to 5% (Sweden, United States) to more than 30% (Australia, Uruguay) [4]. Relevant is the fact that even if it appears that in western countries there is a reduction of prevalence of smokers among male adolescents, the same trend is less marked among girls. In fact, in some countries prevalence of smoking among girls is increasing and, in developing countries, male adolescent smokers still reach 40% (and up to 70%–80%) [4].

Environmental Tobacco Smoke (ETS) Exposure

Tobacco smoke contains more than 100 substances: many of the substances that are thought to be harmful are present in higher concentration in sidestream smoke, that is, smoke produced from the burning end of cigarettes and released into the environment. Exposure to ETS is very frequent in adults (more than 60% in United States) and is probably even more frequent in children [5].

The health consequences of ETS inhalation for the population as a whole, and particularly for children [6], have been the subject of increasing public concern. In the United States, the Surgeon General published in 1986 a landmark report on this subject [7], which contains a thorough account of our present knowledge regarding this subject. As a consequence of that report, many states and the federal government now impose harsh restrictions on cigarette smoking in public places.

Although many organs seem to be affected, a considerable body of research has identified the lung as the main target of ETS inhalation. As with any other toxicologic problem, a first most important issue is that of the effective dose of active toxic substances that reach the individual and exert their effects. In the

case of ETS, this issue is complicated by the fact that many of the components that it contains are also present in other environmental sources of pollutants. A significant advance, however, has been the introduction of the determination of cotinine levels, both in serum and in other body fluids. Cotinine has the advantage of being exclusively the product of nicotine metabolism, which has no environmental sources other than tobacco smoke. This has been very important in children, in whom exposure has been qualitatively assessed by the use of questionnaires on parental smoking habits. A rough exposure to smoking and correlation with cotinine levels relationship has been described in children [8]. However, such a relationship has validity only in the specific setting where it is determined due to the fact that the true exposure of nonsmoking persons largely depends on the smoking habit (when and where) of smokers, indoor ventilation, season, house dimensions, etc. Cotinine, with a biologic half-life of approximately 12 h, cannot be considered a perfect indicator of environmental ETS exposure.

In our experience with confidential questionnaires in Central Italy and in Rome in 210 children aged 9–13 years, we found detectable low levels of saliva cotinine in 13% of children who lived in nonsmoking families and denied being regular smokers. This suggests that either other significant sources of ETS exposure exist outside the family, or that some children are unreported irregular active smokers. On the other hand, we found detectable cotinine in the saliva of only 60% of children living in families having (>40 cigarettes per day) cigarette consumption. We believe that even with the use of cotinine level determinations, it is very difficult to completely separate in children and adolescents exposure to actively inhaled tobacco smoke from ETS inhalation.

Environmental Tobacco Smoke and Lung Health in Children

The most significant effects of ETS have been found in infants. There can be little doubt at present that maternal cigarette consumption is related to a significant increase in the number and severity of lower respiratory illnesses during the first year of life [5, 8]. Even after controlling for confounders, this effect seems to have resisted intense research scrutiny [9–12]. The fact that effects have been mainly related to maternal and not paternal smoking has usually been attributed to the greater contact between mother and infant during the first months of life [13–16]. Support for this idea came from the observation that cotinine in the urine was higher in breast-fed compared with artificially fed infants: this was attributed to the most intimate contact between mother and breast-fed infants [16]. Of great interest is, however, the possibility that in utero exposure to cigarette components and their metabolites may be also be involved. Taylor and Wadsworth [17] in children aged 0–5 years reported a significant effect of smoking during pregnancy on rate of admission to hospital for lower respiratory tract diseases and incidence of bronchitis. Postnatal smoking by itself had no effect on admission to hospital and on incidence of bronchitis.

Maternal cigarette consumption during pregnancy is clearly associated with, among other factors, an increase in congenital malformations, stillbirths, spontaneous abortion, and a lower birthweight in the offspring [1, 2]. Relevant is the finding that maternal smoking during pregnancy is related to smaller body mass many years after birth because this may mean that the effects may not be erased by catch-up development later in life [29]. This has raised the hypothesis that maternal cigarette consumption during pregnancy may have different effects from those elicited by ETS inhalation [17]. It has been proposed that the former would have effects on lung structure that would permanently alter the pattern of lung development, justifying the lower rates of lung growth reported in longitudinal studies of lung function in children [18, 19]. Postnatal ETS inhalation, on the other hand, would both affect lung function and have an indirect effect on respiratory health by increasing allergic sensitization (see below).

Unfortunately, it is difficult to separate the possible effects of cigarette consumption during pregnancy from those of inhalation by the infant of his or her mother's cigarettes. In effect, most mothers who smoke during pregnancy also smoke during the infant's first year of life [6] and both pre- and postnatal maternal cigarette consumption may have similar effects on the infant's respiratory health. Large longitudinal studies of infants enrolled at birth and in whom accurate records of household cigarette consumption are available may help to solve this quandary.

In older children, the reported respiratory effects of ETS are more subtle than in infants. The most frequent finding has been a statistically significant (though slight and of not well-defined clinical importance) difference in lung function parameters derived from the flow-volume curve between children whose mothers smoke and those of nonsmoking parents [20, 21]. Results of studies comparing prevalence of respiratory illnesses and incidence of respiratory symptoms in older children exposed and unexposed to ETS have been less consistent than those of infants (reviewed in [7]). The cause of this apparent discrepancy in unknown. It is possible that structural characteristics of the lung may enhance the impaction and absorption by the infant's respiratory system of some of the most harmful components of tobacco smoke. Infants are also much more prone to have lower respiratory symptoms than older children during viral infections, probably due to the peculiar structure of their lung and airways [22], and this enhanced airway lability may certainly also apply to other possible environmental noxious stimuli such as ETS. Infants, for example, respond with far larger falls in maximum expiratory flows to doses of inhaled bronchoconstrictors (per unit lung volume) which hardly produce any effects in older children and adults [23]. Again, the cause of this "physiologic" hyperresponsiveness is unknown, but one cannot but suspect that it may in part explain the apparent age specificity of ETS effects on the respiratory system.

Further evidence in favor of the hypothesis that the effects of ETS may depend upon specific individual sensitivity of the respiratory system comes from data on the relationship between ETS exposure and bronchial hyperres-

ponsiveness in children. Two groups separately [24, 25] found that asthmatic children whose mothers smoke have enhanced bronchial responsiveness and increased incidence of obstructive symptoms when compared to asthmatic children of nonsmoking mothers. We [6] later studied a random population sample of 166 nine-year-old children and found that bronchial responsiveness was slightly but significantly increased in male (but not female) children of smoking parents. This predominance of smoking effect on males seemed consistent with the fact that asthma is more frequent in males than in females during childhood and bronchial hyperresponsiveness seems to be more frequent in males [26]. It also gave more credibility to the idea that health effects are dependent on individual bronchial labilities. Moreover, within our random sample, asthmatics were clearly those in whom the relationship between parental smoking and degree of bronchial responsiveness was strongest [6].

There is thus increasing evidence that the effects of ETS inhalation may differ in different individuals, and vary not only with the degree of exposure but also with the age, gender, and health status of the subject. Longitudinal studies of children at different ages may provide a specific demonstration of this pattern.

Environmental Tobacco Smoke and Allergic Sensitization

The cause of the increased bronchial responsiveness found in children of smoking parents is unknown. One would suspect that components of tobacco smoke may elicit nonspecific bronchial inflammation which would, in turn, increase the responsiveness of the bronchial tree. The evidence in favor of this nonspecific mechanism is scanty, and hardly explains why some subjects seem to be more sensitive than others to the effects of ETS. Very relevant in this sense is the finding that prick skin test reactivity to allergens is significantly increased in children whose parents smoke [27]. We confirmed this finding, again mainly in boys, and also found a dose-response effect; the weighted sum of the wheals elicited by the allergens was significantly correlated with the number of cigarettes smoked by parents [6]. Since bronchial responsiveness is correlated with skin test reactivity to allergens [28], these data seem to indicate that the mechanism through which ETS inhalation exerts its effects on the respiratory system may be more complex than what has been suspected until now, and may involve an enhancement of sensitization to specific allergens, probably in predisposed subjects.

Many studies concerning the effects of ETS exposure seem to have demonstrated that not only lungs and not only children are affected [29, 30] even if the difficulty of the epidemiology in such field must suggest caution in interpreting the results [31]. However, on the basis of the present evidence, ETS exposure has to be considered a general toxic source for humans and its harmful effects appear even more unacceptable because, at least theoretically, they could be easily prevented.

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