A B S T R A C T

This subanalysis of the Canadian Human Activity Pattern Survey examines environmental tobacco smoke (ETS) exposure in non-smoking respondents relative to age, sex, socioeconomic status and prevalence of asthma. 2,381 respondents (response rate 64.5%) from Toronto, Vancouver, Edmonton and Saint John completed a 24-hour recall time-activity diary. For each activity and location, respondents were asked, "was there any smoking during the activity?" Among non-smoking adults, youth, children and asthmatics, the rates of ETS exposure were 32%, 34%, 30% and 42% respectively. Regarding the location of exposure, adults reported ETS exposure in various locations (work, bars and restaurants), including home. Children experienced the most exposure at home, primarily between 4 p.m. and midnight. Adults reported ETS mainly in the living room (16%) and vehicles (13%); for children, the living room (22%) and the bedroom (13%) were the most common locations. Determining characteristic time and location patterns for ETS exposure underpins educational strategies to help non-smokers avoid ETS exposure.

A B R É G É

Cette sous-analyse de l'étude intitulée 'Canadian Human Activity Pattern Survey' porte sur l'exposition à la fumée de tabac ambiante (FTA) chez les répondants non fumeurs selon l'âge, le sexe, la situation socio-économique et la prévalence de l'asthme. Un total de 2 381 répondants (taux de réponse de 64,5 %) à Toronto, Vancouver, Edmonton et Saint-Jean (N.B.) ont tenu un journal de 24 heures de leurs activités. Pour chaque activité et endroit, les participants ont répondu à la question : « Est-ce que quelqu'un a fumé durant l'activité? » Chez les non-fumeurs adultes, adolescents, infantiles et asthmatiques, les taux d'exposition à la FTA ont été respectivement de 32 %, 34 %, 30 % et 42 %. En ce qui a trait au lieu de l'exposition, les adultes ont rapporté des expositions en divers endroits (travail, bars et restaurants), y compris à la maison. Les enfants ont subi la plus grande exposition à la maison, surtout entre 16 h et minuit. Les adultes ont signalé la présence de FTA principalement au salon (16 %) et dans des véhicules (13 %); pour les enfants, le salon (22 %) et la chambre à coucher (13 %) étaient les locations les plus courantes. La détermination de contextes caractéristiques d'exposition à la FTA selon l'heure et le lieu peut étayer les stratégies éducatives visant à aider les non-fumeurs à éviter l'exposition à la FTA.

Environmental Tobacco Smoke Exposure Patterns: A Subanalysis of the Canadian Human Time-Activity Pattern Survey

Judith A. Leech, Kerri Wilby, Edmund McMullen

Environmental tobacco smoke (ETS) may be linked to a multitude of human health effects,¹⁻³ even apart from the possible increased risk of lung cancer in the non-smoking partners⁴⁻⁶ and children⁷ of smoking adults. Children, particularly, are at risk of respiratory tract symptoms and infections, exacerbations of asthma and recurrent otitis media.⁸⁻¹² In adults, passive smoking has been implicated as a significant risk factor in the development of cardiovascular and peripheral vascular disease.¹³ Legislation regarding workplace smoking has to some degree decreased the exposure of non-smokers to ETS, and education has to some degree decreased the overall smoking rates in some age groups.^{14,15} However, legislation is not applicable to many other indoor environments and there remain some 30% of Canadian adults who continue to smoke, putting not only themselves, but others too, at risk.¹⁶

The present analysis uses data from the Canadian Human Activity Pattern Survey (CHAPS) to examine associations and determinants of current exposure to environmental tobacco smoke.

METHODS

The survey instrument

The detailed methodology of CHAPS has been reported previously.¹⁷ In summa-

ry, a 24-hour time activity recall diary was administered by CATI technology, supplemented by an exposure assessment questionnaire. The survey instrument was developed at the University of Maryland Survey Research Centre for the United States' Environmental Protection Agency in a study designed to assess time-activity patterns throughout the continental USA.¹⁸ Minor modifications were made to fit the Canadian milieu.

Respondents listed all activities they could recall for a 24-hour period beginning at midnight the day prior to the interview. For each activity and location listed, the interviewer questioned the respondent as to whether anyone else present was smoking. In a supplemental questionnaire, respondents were asked if they smoked in the prior 24-hour period, how many cigarettes, cigars or pipes they smoked and where they smoked. This group of questions was used to determine smoking/non-smoking status. Casual smokers who did not report smoking during the 24-hour survey period would be classified in this analysis as non-smokers.

The population

The household random sampling technique has been described elsewhere.^{17,19} From November 1994 to January 1995, a sample of 390 people were interviewed in Toronto and Vancouver. From January 1995 to May 1995, a further 1,239 interviews were conducted in these cities, as well as in Edmonton and Saint John (NB). In July and August 1995, a further 752 interviews were conducted in Vancouver, Toronto and Saint John.

In households consisting of only adults 18 years of age or older, an adult was selected at random from among all adults

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residing there using the "next birthday" method. In households with both adults and children (respondents 17 years of age or younger), 60% of the time a child was selected at random from among the children living there using the "next birthday" method. The other 40% of the time, an adult was selected at random from among all adults living there.

For respondents under the age of 11, the adult in the household most knowledgeable about the child's activities was asked to complete a proxy interview for the child. For respondents ages 12 to 17, an adult respondent answered general questions pertaining to the household and some demographic questions but the youths answered the time diary themselves.

Data analysis

Results from the three time periods were merged and descriptive statistics were calculated using SAS.²⁰ Weights were calculated based on the number of phone lines into the house, the probability of having a child or adult respondent, and the probability of being interviewed based on the 1991 census data of the telephone exchange area. Descriptive statistics were calculated using the weights for time and location patterns for adults and children in relation to their smoking status and reported exposure to environmental tobacco smoke on the day of the diary. The main thrust of the analyses focuses on time spent exposed within hours of the day rather than percent of persons exposed. Thus, the bulk of the results focus on population or population subgroup exposure time.

The 114 location codes were combined into six major locations: at home, at work or school, in a bar or restaurant, indoors elsewhere, outdoors and in a vehicle. The bar or restaurant subdivision was specifically chosen because of the higher likelihood of ETS exposure in such locations.¹⁵ The "at home" category was further examined by location or room within the home because of the potential for altering behaviour if patterns of exposure are identified.

The exposure and location of exposure of children to ETS were examined in detail as children have both a higher risk of acute effects and a lesser ability to control their own environment. All subjects were asked if they have asthma. The subgroup of adults

TABLE I
Distribution of Respondents by Age and Sex

Age Group (Years)	Male	Female	Total
0-11	195	155	350
12-17	110	91	201
≥ 18	825	925	1750
Adult, age not given	30	48	78
TOTALS	1160	1219	2379

Values are missing for two adult subjects who declined to give their sex

TABLE II
Overview of Smoking Status and ETS Exposure Among Respondents

Age Group (Years)	Smoker	Non-Smoker (NS)	NS/ETS Non-Exposed	NS/ETS Exposed
0-11	2	348	244	104 (29.9%)
12-18	8	194	129	65 (33.5%)
≥ 18	457	1294	875	419 (32.4%)
Asthmatics	37	154	90	64 (41.6%)

and children who reported having asthma was examined separately to determine if individuals with asthma or families with asthmatic members behave differently with regard to smoking habits in the home. Because active smoking is known to vary by socioeconomic and educational status,¹⁶ we examined whether reported passive exposure to cigarettes in adults also varied by the educational status of the respondent.

RESULTS

The sample of 2,381 completed interviews represents a response rate of

64.5%. From an initial sample of 7,339 telephone numbers, 3,379 numbers were eliminated as either not active or not household phone numbers and the status of 267 telephone numbers could not be ascertained after 20 attempts. Of an eligible sample of 3,693 numbers, 469 numbers were never contacted, 565 people declined to be interviewed and 278 people were excluded due to language or hearing difficulties.

Table I shows the age and sex distribution of the population. In adults, the rate of asthma was 7%, while in children and youths it was 10%.

Table II shows the proportion of active smokers and non-smokers in relation to age and history of asthma. Among the non-smokers, the proportion reporting passive smoking at some time(s) during the 24-hour period ranges from 30% in children to 42% in asthmatics.

Figure 1 demonstrates that heavier smokers graded by number of cigarettes smoked spend more time in the day with others who are smoking. For example, up to 12% of smokers of more than 15 cigarettes per day report being where others are smoking for *more than eight hours of their day*. However, since the risk of active smoking clearly outweighs the risk of ETS for the smoker, the remainder of this analysis refers to ETS in the non-smoking group alone.

In Canada there is an inverse relationship between income adequacy and smoking prevalence.¹⁶ Subjects were grouped by category of highest level of education achieved according to the education levels of the 1994 Statistics Canada Survey. Using highest level of education achieved as a proxy for socioeconomic status, a one-way analysis of variance confirms more

smokers had a lower education level, but among non-smokers exposed to ETS there was no gradient of exposure based on education level achieved.

ETS exposure by location and time of day is shown in Figures 2 to 4 for adults, children, and asthmatic children, respectively. Each day is divided into 24 one-hour intervals and the mean percentage of each hour that non-smoking respondents reported some exposure to ETS in their 24-hour recall diary is shown. The different patterns in the histogram represent the distribution of this time into the six major locations into which activity patterns were grouped.

On average, non-smoking adults (n = 1,294) report from 1% to a maximum of 8% of each hour of the day spent exposed to ETS. Peak hours are at mid-day and evening (Figure 2). These exposures are in a variety of the six major locations, none predominating, although more time is spent at home. Among the youth category, 1% to 8% of hours are also spent exposed to ETS with slightly more exposure in the "indoors-other" and "outdoors" category compared with their adult counterparts.

A somewhat different pattern of exposure is seen in the 348 children. ETS exposure in those under 11 years occurs predominantly in the home, and mainly later in the day when mean exposure is as high as 10% of the hour (Figure 3). The parents of asthmatic children report a mainly afternoon and evening exposure at home as high as 28% of the time intervals. Asthmatic youth and adults report up to 16% of each hour exposed to ETS, with more exposure outdoors and in the later afternoon and evening at home than in children is now occurring in the workplace would not be reporting any ETS exposure in the workplace in this interview.

The location of ETS exposure is examined in more detail in Figure 5. For ETS episodes reported in adults, the living room (16%) is the main location for exposure with the automobile (13%) and the homes of others (9%) being the next two most commonly cited indoor locations. The in-vehicle exposure occurs predominantly during commuting times and may be a period of particularly concentrated exposure.

When some 215 ETS episodes in children were examined in the same manner, the living room was again the main indoor

location (22%), the *bedroom* was next at 13% and the homes of others was third at 9%. The bedroom is particularly striking

as the hours in question suggest this is due to adults smoking in the childrens' bedrooms in the early evening. The in-vehicle

exposure for children is less frequent than adults but still represents 8% of the episodes of ETS exposure, again likely at a very high concentration.

DISCUSSION

Sample respondents were selected by random digit dialing within certain prescribed geographic boundaries. The ownership of telephones in Canada is greater than 99% of homes²¹ but the cities surveyed do not represent the whole country in that no rural sampling was performed,

and there are different rates of active smoking in different provinces and communities. The overall survey response rate was very similar to time-activity surveys conducted by the California Air Resources Board and the National Human Activity Pattern Survey in the United States.^{18,22}

Any method for assessing ETS exposure is fraught with misclassification. Since this survey was not solely about cigarette smoking, we are unlikely to have had refusals or acceptances on the basis of active and passive smoking history. The question was, "Was there any smoking during this activi-

ty?" The actual exposure could have been for only a portion of that time period or out of doors and so the dose may have been very little or, conversely, there may have been several persons smoking in a relatively small space and so the exposure to ETS may have been very high during any single episode. Moreover, the proxy interviews for children may have underestimated ETS exposure because, often, the responding parent had not been with the child continuously throughout the 24-hour period. Conversely, the reporting of higher exposure rates in asthmatic children suggests the further possibility that if one is irritated by cigarette smoking or worried about it, one may be more aware of exposure and therefore report it more often. This would be supported by the higher rates of "outdoor" ETS reported by asthmatics as compared to non-asthmatics.

In the 12-18 year olds, only 4.1% reported smoking the previous day. This appears to be a low prevalence and may reflect the fact that youth were being asked at home, possibly with the parent nearby and/or that this age group may have lower rates of daily smokers. Based on older smokers, any under-classification of teenage smokers would likely overestimate ETS exposure in the non-smokers.

The extent to which historical measures of exposure reflect actual ETS personal exposure has been examined in a study by Phillips.²³ In the 80% of subjects who judged their ETS exposure as none or low, the personal particulate, serum nicotine and salivary cotinine agreed; however, when the ETS exposure history was judged to be moderate or high, there was a much wider range of average results in exposure and serum/saliva contents.

The consequent reservations about the *dose* of exposure need not influence our insight into the *pattern* of exposure. The pattern may be more helpful in designing public health and education strategies to decrease risk. Since children and asthmatics, two of the more susceptible subgroups to the adverse health effects of ETS, are reporting the bulk of their exposure occurs in the home, these results would support the American Medical Association's position in advising smokers that if they cannot quit they should at least not smoke in

their own homes.²⁴ The reporting of exposure to ETS in the bedrooms in the very young is particularly important because Sudden Infant Death Syndrome has also been linked to ETS.^{25,26}

Environmental tobacco smoke is one of the most easily identifiable air contaminants with which a wide variety of people come in contact every day. Although smoking in the workplace is now more controlled, this analysis demonstrates that many Canadians still report daily ETS exposure. It further suggests that prevention strategies based on avoidance of ETS, particularly in the home environment, would if successful eliminate significant amounts of such exposure, particularly in children and asthmatics. There is, to date, some evidence suggesting that home exposure per se is an important predictor of increased morbidity in children²⁷ and that alteration of such behaviour can indeed result in improved health outcomes.²⁸ Proscription of smoking in the home and particularly in the bedrooms of children, may successfully prevent some of the health consequences of ETS exposure.

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