

Is the smokers exposure to environmental tobacco smoke negligible?

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Abstract

Background

Very few studies have evaluated adverse effect of passive smoking exposure among active smokers, probably due to the unproven assumption that dose of toxic compounds that a smoker inhales by passive smoke is negligible compared to dose inhaled by active smoke.

Methods

In a controlled situation of indoor active smoking, we compared daily benzo(a)pyrene (BaP) dose, estimated to be inhaled by smokers due to the main stream (MS) of cigarettes they have smoked, to the measured environmental tobacco smoke (ETS) they inhaled in an indoor environment. For this aim we re-examined our previous study on daily personal exposure to BaP of 30 newsagents, according to their smoking habits.

Results

Daily BaP dose due to indoor environmental contamination measured inside news-stands (traffic emission and ETS produced by smoker newsagents) was linearly correlated ($p = 0.001$ $R^2 = 0.62$) with estimated BaP dose from MS of daily smoked cigarettes. In smoker subjects, the percentage of BaP daily dose due to ETS, in comparison to mainstream dose due to smoked cigarettes, was estimated ($p = 95\%$) between 14.6% and 23% for full flavour cigarettes and between 21% and 34% for full flavour light cigarettes.

Conclusions

During indoor smoking, ETS contribution to total BaP dose of the same smoker, may be not negligible. Therefore both active and passive smoking exposures should be considered in studies about health of active smokers.

Background

Smokers inhale BaP and other toxic compounds present in the MS of their cigarettes [1], but if they smoke indoor, inevitably, they inhale also BaP and other toxic compounds present in ETS [2] themselves produce.

Several studies provide evidence of a causal association between passive smoking in non-smokers and lung cancer or ischemic heart disease [3-5].

Previous studies demonstrated that, by ETS, exposure to nicotine of smokers is 21,2 times more than exposure by ETS of non-smokers [6].

Notwithstanding these results, only a few studies have examined the adverse effects of passive smoking exposure among active smokers. Two of them [7, 8] found no significant difference, but a more recent study [9], that quantified more sensitively ETS exposure, concluded that ETS exposure of a current smoker is strongly associated with increased acute respiratory symptoms.

The low interest to study the role of ETS on smoker health is probably due to the assumption that the added dose of toxic compounds to smokers from their own passive smoking is negligible, compared to the dose they voluntarily inhale by their cigarettes. According to our bibliographic review, this assumption is not supported by any experimental measures.

To evaluate the role of ETS in total daily dose of carcinogens inhaled by smokers, a study regarding the personal exposures to benzo(a)pyrene of newsagents working in Genoa, Italy, was re-examined [10].

Newsagents were chosen because their personal daily exposures to air and ETS contaminants may be easily monitored, with very few confounders: a) Italian newsagents spend 12 hours a day in small (about 4 m²) naturally ventilated news-stands; b) news-stands are completely closed and only with a window to serve clients; c) only electric stoves are used for heating; d) news-stands are occupied by only one person, therefore ETS pollutants measured inside the news-stand are strictly correlated to the number of cigarettes each news agent declared to smoke. Personal sampling was carried out continuously for 24 hours, starting from the opening of news-stand, early in the morning. After their working-day, all the studied newsagents went back home, where they spent the rest of the sampling time.

Usually news-stands are placed near heavy traffic streets, therefore newsagents were exposed also to urban pollution, mainly produced by traffic emissions. Therefore, in this study, total BaP daily dose inhaled by actively smoking newsagents can be attributed to three main sources: urban traffic, ETS produced inside their stands and home, and MS from cigarettes they smoke.

The aim of this study was to estimate the contribution of ETS in daily total BaP dose of active smoker newsagents.

Methods

Detailed description of materials and methods used to measure daily BaP exposures of newsagents may be found in a previous published paper [10],

together with quality control practices .

Personal air samplers activated continuously for 24 h were used to collect, by filters, airborne particulate inside news-stands and in newsagents' residences.

Fifteen daily personal samples of active smokers and fifteen samples of no smokers collected in 1998, during the same seasonal period, were chosen for the present investigation. Smokers had a mean daily consumption of fourteen cigarettes (min: 6, max: 25) and, according to their statements, none of them, at home, was exposed to ETS produced by other smokers.

Environmental BaP (Env-BaP) doses (ng/day) were calculated multiplying each measured BaP exposure by the mean air volume that is estimated to be breathed daily by an adult during moderate activity (20 m^3) [11].

Therefore, Env-BaP dose includes BaP from urban sources and BaP from environmental tobacco smoke (ETS-BaP).

Daily BaP doses of smokers, inhaled by mainstream smoke (MS-BaP) were estimated by the declared cigarette daily consumption, multiplied by the mean BaP amount measured in the MS of full flavour (FF) and full flavour light (FFL) U.S. cigarettes, sold in 1998: 10.17 ng/cig (range: 7.89 – 12.81) and 6.75 (range: 4.92 – 8.07), respectively [1]. These values are acceptable for our study as six American cigarettes brands, included in the Swauger et al. study [1], are within the ten brands most sold in Italy and, according to their mean “tar” content, 88% of cigarettes sold in Italy in 1998 may be classified as FF (>10 mg tar /cig) and FFL (5–10 mg tar/cig) [12].

Correlations between measured Env-BaP and estimated MS-BaP daily doses, according to the two “tar“ categories were studied taking into account

variation coefficient of BaP yields in MS, according to Swauger et al. (2002) and accuracy of the sampling and analytical methods used to measure BaP air concentration [10].

Results and Discussion

The mean and standard deviation of Env-BaP doses of non-smoker and smoker newsagents were 18.2 ± 7.1 ng/d and 38.4 ± 12.4 ng/d respectively. Inhalation of the MS of fourteen cigarettes per day (the mean value of our smoker group), according to the tar cigarette category, increases the BaP dose by an additional 142.4 ng/day (FF) or 94.5 ng/day (FFL).

Figure 1 shows the correlation between measured Env-BaP and estimated MS-BaP doses, supposing all smoked cigarettes of FFL category. Env-BaP and MS-BaP doses are linearly correlated, the weighted least squares regression line and its 95% confidence limits (dotted curves) are shown in Fig. 1.

The regression equations for the two cigarette categories (FF and FFL) are the following:

$$\text{FF) Env-BaP} = 13.2 + 0.185 \text{ MS-BaP} \quad R^2 = 0.62; \quad p = 0.0015$$

eq. 1)

$$\text{FFL) Env-BaP} = 13.3 + 0.274 \text{ MS-BaP} \quad R^2 = 0.62; \quad p = 0.0015$$

eq. 2)

The 95% confidence interval of intercept (range: 8.8 – 17.8 ng/d) is not statistically different from the measured mean daily dose of Env-BaP (mean \pm s.d. 18.2 ± 7.3 ng/d) inhaled by no-smoking newsagents, due to urban air

pollution.

Smokers' Env-BaP dose increases linearly with their estimated MS-BaP dose (i.e. number of cigarettes daily smoked), according to eq. 1 and eq. 2. Therefore, slopes of the two regression equations permit to evaluate the ratio between the daily BaP dose due to the inhalation of mainstream of smoked cigarettes and the daily dose due to ETS produced by the same cigarettes. The 95% confidence interval for slope of eq. 1) is 0.146 – 0.230 and for slope of eq.2) it is 0.210 – 0.340.

This means that, if FF cigarettes were smoked, with a probability of 95%, daily dose of BaP inhaled by our smoker group, due to ETS, may be between 14.6 and 23.0 percent (mean: 18.5%) of the BaP dose due only to the mainstream smoke. If all smoked cigarettes are FFL, the estimated ETS contribution is between 21.0 and 34.0 % (mean: 27.4%).

Therefore, this study suggests that to correctly classify smokers, according to their total ambient air BaP exposures, ETS exposures cannot be ignored as well as exposures due to heavy air pollution.

The average smoker of this study (14 FF cigarettes/d) inhales daily 182 ng of BaP, so composed: 142.4 ng (78%) from MS, 26.3 ng (14.4%) from ETS, 13.3 ng (7.3%) from urban pollution.

In this example, the contribution to daily BaP dose due to ETS and urban air pollution is equivalent to smoking 2.6 and 1.3 FF cigarettes, respectively. There are some uncertainties in these estimations, particularly real inhalation rates during the different daily activities and different personal smoking behaviour [13] but our results are in good agreement with different mean urinary cotinine concentrations found [14] in subjects defined as heavy

active smokers ($3729 \pm 1070 \mu\text{g/l}$) and in non-smokers heavily exposed to ETS ($350 \pm 120 \mu\text{g/l}$) and it is noteworthy that, in this study, aimed to correctly distinguish non-smokers, passive and active smokers, the exposure of active smokers to ETS (i.e indoor ambient smoking with or without other smokers) was not considered.

Conclusions

Results of this study on BaP exposure of newsagents, according to their smoking habits, suggest that exposure to its own environmental smoke cannot be negligible, if smoking occurs in indoor environments. Therefore our conclusions are that both active and passive smoking contributions should always be considered in studies about health of active smokers and a possible question we suggest to submit to participant subjects may be: “How many hours daily do you smoke in closed environment and together with other smokers?”

Competing interests

The authors declare that they have no competing interests

Authors' contributions

FV have made substantial contribution to conception, design and interpretation of data

MTP contributed to acquisition, analysis and interpretation of data

AS carried out statistical analysis.

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Figures

Figure 1 - BaP daily dose from Environmental Sources versus BaP dose from Main Stream of daily smoked cigarettes

Figure shows linear correlation between daily dose of Env-BaP (by urban air pollution and environmental tobacco smoke) and MS-BaP dose (by mainstream of smoked cigarettes) of 15 no-smoking and 15 smoking newsagents, in Genoa, during 1998. MS-BaP dose was estimated from mean BaP content in full flavour light cigarettes mainstream [1]. Dotted curves define 95% confidence limits, according uncertainty of measured BaP air concentrations and variability of BaP quantity estimated in main stream of full flavour light cigarettes sold in USA and Italian market, from 1995 and 2000.

