



TOBACCO CONSUMPTION AND SECONDHAND SMOKE EXPOSURE IN VEHICLES: A CROSS-SECTIONAL STUDY

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2011-000418
Article Type:	Research
Date Submitted by the Author:	27-Sep-2011
Complete List of Authors:	Curto, Ariadna Martínez-Sánchez, Jose Fernandez, Esteve; Institut català d'Oncologia, Tobacco Control Unit
Primary Subject Heading:	Public health
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, TOBACCO CONTROL

SCHOLARONE™
Manuscripts

View Only

1
2
3 **TOBACCO CONSUMPTION AND SECONDHAND SMOKE EXPOSURE IN VEHICLES: A**
4
5
6 **CROSS-SECTIONAL STUDY**

7
8 **Ariadna Curto^{a,d}, Jose M. Martínez-Sánchez^{a, b,c}, Esteve Fernández^{a,b,c}**

9
10 *^aTobacco Control Unit, Cancer Control and Prevention Programme, Institut Català d'Oncologia-*
11 *ICO, L'Hospitalet de Llobregat (Barcelona), Spain.*

12
13
14
15 *^bCancer Control and Prevention Group, Institut d'Investigació Biomèdica de Bellvitge-IDIBELL,*
16 *L'Hospitalet de Llobregat (Barcelona), Spain*

17
18
19
20 *^cDepartment of Clinical Sciences, Universitat de Barcelona-Campus de Bellvitge, L'Hospitalet del*
21 *Llobregat (Barcelona), Spain.*

22
23
24
25 *^dDepartment of Experimental and Health Sciences, Universitat Pompeu Fabra, Barcelona, Spain*

26
27
28
29
30
31 **Correspondence to:**

32
33 Jose M. Martínez Sánchez, PhD, MPH, BSc

34
35 Tobacco Control Unit, Cancer Control and Prevention Programme

36
37 Institut Català d'Oncologia-ICO.

38
39 Av. Gran Via de L'Hospitalet, 199-203, 08908 L'Hospitalet de Llobregat (Barcelona)

40
41 Tlf.: 93 260 73 35 (Ext.:3052)

42
43 E-mail: jmmartinez@iconcologia.net

44
45
46
47
48
49 **Keywords:** tobacco consumption, secondhand smoke, private cars, commercial vehicles

50
51
52
53
54
55
56
57
58
59
60
Words main text: 2590

ABSTRACT

Objectives: To estimate the prevalence of tobacco smoking and secondhand smoke (SHS) exposure in private cars, commercial vehicles and taxis in the city of Barcelona (Spain).

Design: We performed an observational study with a cross-sectional design (2011). We selected a systematic sample of 2442 private cars, commercial vehicles and taxis in 40 public roads regulated by traffic lights in all districts of Barcelona. We calculated the prevalence rates and 95% confidence intervals (95%CI) of smoking and SHS exposure in cars, and the corresponding odds ratio adjusting for the potential confounding variables.

Results: The prevalence of tobacco consumption was 5.5% (95%CI: 4.6-6.4) and it was greater for the commercial vehicles (9.8%; 95%CI: 7.1-12.5). The total prevalence of SHS exposure was 5.2% (95%CI: 3.8-6.6). 2.2% (95%CI: 0.5-3.9) of the passengers under 14 years old were exposed to SHS in vehicles.

Conclusion: This study highlights the need to promote public health measures aimed at reducing tobacco consumption in vehicles, especially in present of children, as well as compliance with the current Spanish law on health measures against smoking in commercial vehicles and taxis.

ARTICLE FOCUS

- Tobacco consumption and secondhand smoke (SHS) exposure in transportation deserves special public health attention because they are places of reduced dimensions, where the concentrations of SHS reached can be much higher than other environments.
- Tobacco consumption while driving is also a distraction that increases the risk of traffic accidents.
- Few studies have studied the consumption of tobacco and SHS exposure in vehicles through direct observation.

KEY MESSAGES

- Reducing smoking in vehicles in the presence of children has to be prioritized.
- Enforcement of smoking laws in commercial vehicles and taxis is needed.
- Smoking in vehicles should be recognized in the legislation as other distraction factors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The main limitation of this study derives from the inherent observer bias, especially in variables as age, where physical appearance can entail a misclassification by the observer.
- Also noteworthy is the difficulty of obtaining a truly random and representative sample of vehicles in circulation in a city.
- A strength of an observational study like this compared with studies based on the use of questionnaires is the lack of information bias that comes directly from the self-reported questionnaires.

- 1
2
3 - The feasibility of direct observations were tested through a pilot study, which
4
5 concluded that direct observation studies are a good resource for monitoring smoking
6
7 in the drivers of motor vehicles.
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

INTRODUCTION

Secondhand smoke (SHS) is a complex mixture of pollutants that includes toxic and irritant compounds, as well as carcinogenic substances.[1,2] SHS has been classified by the International Agency for Research on Cancer (IARC) as type I carcinogen to humans.[2] In 2004 it was estimated that 1% of global mortality (603000 deaths) was attributable to SHS exposure.[3] Specifically, in Spain, it is estimated that between 1228 and 3237 deaths from lung cancer and myocardial infarction were attributable to SHS exposure in 2002.[4] Although there is a dose-response effect and no level of SHS exposure can be considered safe,[5] the intensity of the exposure depends on how long you are exposed and the concentration of SHS in the air. In this way, tobacco consumption and SHS exposure in transportation deserves special attention because they are places of reduced dimensions, where the concentrations of SHS reached can be much higher than other environments (home, workplace or leisure as discos and bars).[6,7] Moreover, concentrations of particulate matter with diameter inferior to $2.5\mu\text{m}$ ($\text{PM}_{2.5}$) can be reached inside vehicles when there are people smoking [6-10] even exceeding the limits recommended by the Environmental Protection Agency (EPA).[11]

Few studies have studied the consumption of tobacco and SHS exposure in vehicles through direct observation.[12,13] To our knowledge, only a cross-sectional study using questionnaires has been done in Spain.[14] The objective of this study is to estimate the prevalence of tobacco consumption and SHS exposure in private cars, commercial vehicles, and taxis in the city of Barcelona.

METHODS

Sampling, sample size and site selection

A cross-sectional study was conducted through direct observation of the occupants of private cars, commercial vehicles, and taxis in the city of Barcelona. The fieldwork was conducted

1
2
3 during April and May 2011. For each of the 10 districts of Barcelona, we randomly selected 2
4 public roads of the 15 with greater traffic flow rates and 2 public roads of the 5 with greater
5 density of nurseries and primary and secondary education schools to ensure the presence of
6 children in vehicles. For the selection of the public roads we consulted the “Araña de Tráfico”
7 of 2011 of the Mobility Services Division of Barcelona City Council.[15] We selected a total of
8 40 public roads (4 per district, 2 with greater traffic flow rates and 2 with greater school
9 density). For each of the public roads, a traffic light was selected as an observation point
10 where a trained observer conducted the direct observation of the vehicles and recorded the
11 variables of interest in an *ad hoc* designed data collection sheet.
12
13
14
15
16
17
18
19
20
21
22
23

24 The theoretical sample size was of 2401 vehicles assuming an expected prevalence of 50% with
25 a 95% confidence interval and a precision of 2%. The strategy of selecting the sample size was
26 expected to assume different prevalences in relation to two previous studies:[12,14] 10% in
27 Italy and 20% in Spain. Finally we assume a 50% prevalence that maximizes the statistical
28 power in order to stratify the results by type of vehicle. The final sample size was 2442
29 vehicles. The distribution of the number of observations was made in proportion to the traffic
30 flow rates in each public road. The observations were made when the traffic light was red for
31 vehicles. We systematically selected the first two vehicles in the adjacent lane to the observer.
32 We excluded adjacent lanes which were exclusive for buses, taxis, and bicycles. The study
33 included any private car, commercial vehicle (tourism derivative, adaptive mixed vehicle and
34 vans with the presence of company logo or slogan) and taxi. We excluded from the study
35 buses, coaches, trucks, motorcycles, bicycles and other public service vehicles (ambulances,
36 police cars, driving school cars, etc.). We also excluded those cars that did not permit the
37 visibility of the occupants because they have tinted windows. When the vehicles did not meet
38 the inclusion criteria, we proceeded to the observation of the next vehicle in line. The
39 observations were made continuously with an average duration of one hour within the fixed
40 schedule (morning from 8 to 11h and afternoon from 17 to 19h) Monday through Friday.
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Study variables

We defined variables of driver, passengers, and vehicle. The driver variables studied were: tobacco consumption (yes/no), approximate age (18-34/35-64/≥65 years old) and sex (male/female). Passenger variables were: the total number of passengers, number of passengers who smoked and the number of passengers under 14 years old. Vehicle variables collected were: the type (private car/commercial vehicle/taxi), the number of open windows of the vehicle, and whether the driver's window was open (yes/no). We also collected contextual variables (day of the week, district, time, weather, and number of lanes of the public road).

The two main variables of study, tobacco consumption in drivers and passengers, were defined as the presence of any burning tobacco product in the hand or mouth of the driver or passenger. From these variables, two new variables were created: one that recorded the total tobacco consumption (driver and/or passenger) and the other SHS exposure, that is, if one occupant (driver or passenger) was exposed to SHS. District variable was recoded into 3 groups according to district socioeconomic status of the district in question.[16]

Prior to the fieldwork, we conducted a pilot study [17] to evaluate the feasibility of the observations and standardize the data collection sheet, as well as to analyze the degree of agreement between 2 observers in obtaining information. This pilot study demonstrated the feasibility of the direct observation designed and a perfect inter-observer concordance (Kappa index of 1.0) for monitoring the consumption of tobacco.

Statistical analysis

We performed a descriptive analysis of tobacco consumption and SHS exposure stratified by variables of driver, passengers, vehicle, and context. We calculated the prevalence of smoking and SHS exposure and their confidence intervals at 95% (95%CI).[18] We performed chi-square test (χ^2) to compare the prevalence rates. We fitted a logistic regression model to obtain the adjusted odds ratio (OR) and 95%CI of smoking in cars by drivers. All analysis were performed using the statistical package SPSS v.15.

1
2
3 This research did not use personal data or biological samples, so approval was not required by
4
5 the Ethics Committee of Bellvitge University Hospital.
6
7
8
9

10 RESULTS

11
12 We made 2442 observations, of which 71.1% were private cars, 19.7% commercial vehicles
13
14 and 9.2% taxis. More than half of the observations (53.9%) were conducted on public roads
15
16 with more than 2 lanes. 77.8% of drivers were men and most common age range was 36-64
17
18 years old (69.6%). Of all the vehicles observed, 62.6% went without passengers. There was a
19
20 passenger under 14 years old in 29.7% of the vehicles with passengers (11.1% of all vehicles).
21
22
23 53.4% of vehicles observed had all the windows closed.
24
25

26 Table 1 shows the prevalence of smoking and SHS total exposure of the driver and/or
27
28 passenger according to type of vehicle. The prevalence of tobacco consumption in vehicles
29
30 (private, commercial, and taxis) was 5.5% (95%CI: 4.6-6.4). The prevalence of tobacco
31
32 consumption was higher in commercial vehicles (9.8%, 95%CI: 7.1-12.5). The prevalence of
33
34 tobacco consumption among drivers was 4.7% (95%CI: 3.9-5.5) and 2.4% (95%CI: 1.4-3.4)
35
36 among the passengers, this difference was maintained according to vehicle type (table 1).
37
38 The overall prevalence of SHS exposure was 5.2% (95%CI: 3.8-6.6). The commercial vehicle
39
40 occupants were the most exposed to SHS (12.7%, 95%CI: 7.1-18.3), while in taxis was not
41
42 observed exposure to SHS in any occupant (driver or passenger). Passengers were slightly
43
44 more exposed to SHS than drivers (3.0% vs. 2.2%, $p=0.283$). This difference was three-fold in
45
46 commercial vehicles (9.7% vs. 3.0%, $p=0.024$). The prevalence of passengers under 14 years old
47
48 exposed to SHS in vehicles was 2.2% (95%CI: 0.5-3.9) (table 1).
49
50
51
52

53 Table 2 shows the prevalence of driver's tobacco consumption according to vehicle type,
54
55 variables of driver, vehicle and context. The prevalence of smoking in drivers was almost
56
57 twofold in men than in women (5.2% vs. 2.9%, $p=0.031$). There was a statistically significant
58
59 downward trend in the consumption of tobacco according to the age of the driver, although
60

1
2
3 this trend was not statistically significant in commercial vehicles and taxis. Although
4
5 consumption of tobacco in drivers was higher in districts with more socioeconomic deprivation
6
7 (5.2%, 95%CI: 3.8-6.6), this difference was not statistically significant. The overall prevalence of
8
9 tobacco consumption was higher in the morning than in the afternoon (5.3% vs. 3.8%,
10
11 $p=0.097$), especially in commercial vehicles (11.6% vs. 4.1%, $p=0.006$). The prevalence of
12
13 tobacco consumption among drivers was greater on cloudy days than sunny or shinnies,
14
15 regardless of vehicle type (table 2).
16
17

18
19 In bivariate logistic regression models we confirmed a stronger association of driver's tobacco
20
21 consumption when the driver was a man (OR=1.79, 95%CI: 1.05-3.07), had an age range of 18-
22
23 34 years old (OR=9.61, 95% CI: 1.31-70.53), was driving a commercial vehicle (OR=2.48, 95%CI:
24
25 1.66-3.69) and had his window open (OR=10.50, 95%CI: 5.86-18.82) (table 3). After adjusting a
26
27 saturated model with all potential confounders, this association was statistically significant
28
29 only for the driver's window open (OR=11.05, 95%CI: 6.08-20.09), time of the day (OR=1.83,
30
31 95%CI: 1.20-2.79) and weather (OR=1.69, 95%CI: 1.11-2.57) (table 3).
32
33
34
35
36
37

38 DISCUSSION

39
40 This is the first study in Spain that estimates the prevalence of tobacco consumption and SHS
41
42 exposure in transportation through direct observation of vehicles. The results of this study
43
44 show that the prevalence of tobacco consumption and SHS exposure in vehicles in the city of
45
46 Barcelona is high, especially in commercial vehicles.
47
48

49
50 The prevalence of tobacco consumption in vehicles observed in our study is similar to that
51
52 observed in studies carried out in Italy [12] and New Zealand,[13] which also made direct
53
54 observation of vehicles. However, SHS exposure in vehicles in our study (5.2%) is much lower
55
56 than that observed in the study of New Zealand (23.7%). The difference could be related to
57
58 social and contextual differences such as the different population size between municipalities
59
60 observed in Karori, Wainuiomata and Wellington, New Zealand (less than 410000 inhabitants)

1
2
3 and Barcelona, Spain (about 1.6 millions of inhabitants) and also different year in which the
4
5 studies were done.
6

7
8 The prevalence rates obtained in studies using questionnaires [14,19] are considerably higher
9
10 than those estimated in studies using direct observations as the present study. One possible
11
12 reason could be the inability of observational studies to monitor the entire car trip of the
13
14 driver, who could smoke at any time or even smoke more than one cigarette, which are
15
16 however caught in classical cross-sectional studies using questionnaires. This limitation could
17
18 lead to a potential underestimation of prevalence obtained in studies that use direct
19
20 observations.
21
22

23
24 On the other hand, tobacco consumption in our study was higher when any of the windows of
25
26 the vehicle was open, as in previous studies.[13] This may be due to the belief, on the part of
27
28 smokers, that the adverse health effects of tobacco consumption in vehicles are minimized
29
30 when a window is open.[20] However, although levels of PM_{2.5} are lower in vehicle ventilation
31
32 conditions, these levels are still unhealthy.[6,9,10]
33

34
35 The prevalence of SHS exposure in children was high compared to that observed in the Italian
36
37 study (0.9%).[12] This difference could be attributed to the fact that in our study half of the
38
39 public roads had high school density. This fact should be taken into account since children are
40
41 inevitably more vulnerable to the effects of SHS exposure.[21] In this sense, a study conducted
42
43 in Ireland [22] found an increased likelihood of developing respiratory and allergic symptoms in
44
45 children aged 13-14 years old exposed to SHS in vehicles, with wheezing as the most obvious
46
47 symptom. Therefore, it becomes clear the need to prioritize public health policies in Spain,
48
49 aimed at reducing tobacco consumption in private cars if children are present. Moreover, a
50
51 study conducted through telephone surveys in four countries (Australia, Canada, United
52
53 Kingdom and United States of America) concluded that the majority of smokers (more than
54
55 60%) would ban smoking in vehicles if children are present,[23] with higher approval of
56
57 smokers with less tobacco dependence and with young children (<5 years old) *versus* those
58
59
60

1
2
3 without children. This support for restricting smoking in vehicles is also found in studies carried
4
5 out among adolescents.[24,25]
6

7
8 The observed prevalence of tobacco consumption in commercial vehicles and taxis have been
9
10 especially high considering that the current Spanish legislation on tobacco (Law 42/2010) [26]
11
12 bans smoking in commercial vehicles and taxis because they are workplaces and even also
13
14 public places. Furthermore, since in our study the prevalence of tobacco consumption and SHS
15
16 exposure in commercial vehicles has been very high, like those seen in Italy,[12] enforcement
17
18 measures of the current legislation should be promoted.
19

20
21 On the other hand, tobacco consumption in taxis was never observed in the presence of
22
23 passengers. Although the passengers of taxis did not have direct SHS exposure, recent studies
24
25 [27,28] have highlighted the possible effects of exposure to the deposit and accumulation of
26
27 SHS particles on the surface of vehicle seats, air or dust. The involuntary inhalation, ingestion
28
29 or skin absorption of these surface and air particles is known as thirdhand smoke
30
31 exposure.[27] While there is still insufficient evidence to assess the health hazards from
32
33 thirdhand smoke, further studies should investigate its potential for exposure and its health
34
35 effects.
36
37

38
39 Tobacco consumption while driving is also a distraction that increases the risk of traffic
40
41 accidents.[29-31] It is estimated that, compared with non-smoking drivers, drivers who
42
43 smoked are 1.5 times more likely to have an accident.[32] Smoking distraction is associated,
44
45 among others, to the decrease in manual dexterity with the steering wheel, the attention
46
47 reduction when the cigarette is being lighted or put out and eye irritation caused by carbon
48
49 monoxide present in SHS, not to mention the lower perception of risk that smokers have at
50
51 wheel *versus* nonsmokers.[32] In this sense, a survey conducted by the Spanish National Road
52
53 Safety Observatory of General Directorate of Traffic [33] in 2005 revealed that 83.8% of the
54
55 interviewed drivers thought that tobacco consumption is a source of distraction while driving.
56
57
58 In addition, 76.8% thought smoking is a fairly or very dangerous behavior while driving. Given
59
60

1
2
3 the evidence of the health hazards of smoking while driving and the broad general perception
4 of risk by the population, this habit should be approached the same way as other distraction
5 factors recognized by the Spanish law as the use of mobile phones or other devices manually
6 operated, such as GPS systems.[34]
7

8
9
10
11
12 The main limitation of this study derives from the inherent observer bias, especially in
13 variables as age, where the biological variability regarding physical appearance can entail a
14 misclassification by the observer. However, the pilot study [17] carried out by two independent
15 observers showed an almost perfect agreement in the observation. We cannot disregard
16 selection bias, since the search for public roads with greater density of schools could over-
17 represent the presence of children in vehicles.
18

19 We have used logistic regression as a measure of association in a cross-sectional study.

20 However, the OR only overestimates the prevalence ratio when it is above 20%,[35] which is
21 not the case of our data. Also noteworthy is the difficulty of obtaining a truly random and
22 representative sample of vehicles in circulation in a city. Our sampling approach, designed to
23 be representative of all districts of Barcelona, was directed to minimize this limitation. A
24 strength of an observational study like this compared with studies based on the use of
25 questionnaires is the lack of information bias that comes directly from the self-reported
26 questionnaires.
27

28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
In conclusion, this study provides an estimation of smoking in cars and highlights the need to
promote public health measures aimed at reducing tobacco consumption in private cars,
especially in the presence of children, as well as the enforcement of measures to control
smoking in commercial vehicles and taxis.

CONTRIBUTORS

All authors contributed in the design of the study. AC collected the data, prepared the database and analyzed the data. JMMS and EF revised with her the results. All the authors contributed to the interpretation of results. AC drafted the manuscript, which was critically revised by JMMS and EF. All authors approved the final version.

ACKNOWLEDGMENTS

We acknowledge the collaboration of Mr. Ángel López Rodríguez for providing “la Araña de Tráfico” of the city of Barcelona.

COMPETING INTERESTS

The authors have no competing interests.

FUNDING

This project was funded by Instituto de Salud Carlos III, Government of Spain (RTICC RD06/0020/0089) and Ministry of Universities and Research, Government of Catalonia (grant 2009SGR192).

REFERENCES

- 1 US Environmental Protection Agency. Respiratory health effects of passive smoking: lung cancer and other disorders. Washington, DC: Environmental Protection Agency 1992:6-90.
- 2 International Agency for Research on Cancer. Monographs on the Evaluation of Carcinogenic Risks to Humans (vol 83). Tobacco Smoke and Involuntary Smoking 2002.
- 3 Öberg M, Jaakkola MS, Woodward A, et al. Worldwide burden of disease from exposure to secondhand smoke: a retrospective analysis of data from 192 countries. *Lancet* 2011;377:139-46.
- 4 López MJ, Pérez-Ríos M, Schiaffino A, et al. Mortality attributable to passive smoking in Spain, 2002. *Tob Control* 2007;16:373-7.
- 5 Dept. of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion Office on Smoking and Health. The Health Consequences of Smoking: a report of the Surgeon General. Washington, DC: Surgeon General 2004.
- 6 Jones MR, Navas-Acién A, Yuan J, et al. Secondhand tobacco smoke concentrations in motor vehicles: a pilot study. *Tob Control* 2009;18:399-404.
- 7 Vardavas CI, Linardakis M, Kafatos AG. Environmental tobacco smoke exposure in motor vehicles: a preliminary study. *Tob Control* 2006;15:415.
- 8 Rees VW, Connolly GN. Measuring air quality to protect children from secondhand smoke in cars. *Am J Prev Med* 2006;31:363-8.
- 9 Sendzik T, Fong GT, Travers MJ, et al. An experimental investigation of tobacco smoke pollution in cars. *Nicotine Tob Res* 2009;11:627-34.
- 10 Ott W, Klepeis N, Switzer P. Air change rates of motor vehicles and in-vehicle pollutant concentrations from secondhand smoke. *J Expo Sci Environ Epidemiol* 2008; 18:312-25.

- 1
2
3 11 US Environmental Protection Agency. National ambient air quality standards for
4 particulate matter; Final rule (report num. 71). Washington, DC: Environmental
5
6 Protection Agency 2006.
7
8
9
10 12 Sbrogiò L, Frison G, Tagliapietra L, et al. [Observed smoking in car: results of a study
11 of the Regional Health Prevention Service of Veneto, Northern Italy]. *Epidemiol Prev*
12 2010;34:43-7.
13
14
15
16 13 Martin J, George R, Andrews K, et al. Observed smoking in cars: a method and
17 differences by socioeconomic area. *Tob Control* 2006;15:409-11.
18
19
20
21 14 Lushchenkova O, Fernández E, López MJ, et al. [Secondhand smoke exposure in
22 Spanish adult non-smokers following the introduction of an anti-smoking law]. *Rev Esp*
23 *Cardiol* 2008;61:687-94.
24
25
26
27 15 Direcció de Serveis de Mobilitat, Ajuntament de Barcelona. Dades bàsiques de
28 mobilitat 2011. Available at: [http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/](http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/0,4022,173198596_257817017_1,00.html)
29 [0,4022,173198596_257817017_1,00.html](http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/0,4022,173198596_257817017_1,00.html). Accessed June 19, 2011.
30
31
32
33 16 Domínguez-Berjón MF, Borrell C. [Mortality and socioeconomic deprivation in the
34 census tracts and districts of Barcelona]. *Gac Sanit* 2005;19:363-9.
35
36
37
38 17 Martínez-Sánchez JM, Curto A, Fernández E. [Agreement between two observers in
39 the measurement of tobacco consumption, use of safety belt and cell phones in
40 vehicles]. *Gac Sanit* 2011 (in press).
41
42
43
44 18 Wilson EB. Probable inference, the law of succession, and statistical inference.
45 *Journal of the American Statistical Association* 1927;22:209-12.
46
47
48
49 19 Hitchman SC, Fong GT, Borland R, et al. Predictors of smoking in cars with
50 nonsmokers: findings from the 2007 Wave of the International Tobacco Control Four
51 Country Survey. *Nicotine Tob Res* 2010;12:374-80.
52
53
54
55 20 Kegler MC, Escoffery C, Butler S. A qualitative study on establishing and enforcing
56 smoking rules in family cars. *Nicotine Tob Res* 2008;10:493-7.
57
58
59
60

1
2
3 21 Bearer CF. How are children different from adults? *Environ Health Perspect* 1995;103
4
5 Suppl 6:7-12.

6
7 22 Kabir Z, Manning PJ, Holohan J, et al. Secondhand smoke exposure in cars and
8
9 respiratory health effects in children. *Eur Respir J* 2009;34:629-33.

10
11 23 Hitchman SC, Fong GT, Zanna MP, et al. Support and correlates of support for
12
13 banning smoking in cars with children: findings from the ITC Four Country Survey. *Eur J*
14
15 *Public Health* 2011;21:360-5.

16
17 24 Leatherdale ST, Smith P, Ahmed R. Youth exposure to smoking in the home and in
18
19 cars: how often does it happen and what do youth think about it? *Tob Control*
20
21 2008;17:86-92.

22
23 25 Leatherdale ST, Ahmed R. Second-hand smoke exposure in homes and in cars among
24
25 Canadian youth: current prevalence, beliefs about exposure, and changes between 2004
26
27 and 2006. *Cancer Causes Control* 2009;20:855-65.

28
29 26 Boletín Oficial del Estado. Ley 42/2010 por la que se modifica la Ley 28/2005 de
30
31 medidas sanitarias frente al tabaquismo y reguladora de la venta, el suministro, el
32
33 consumo y la publicidad de los productos del tabaco. Available at:
34
35 <http://www.boe.es/boe/dias/2010/12/31/pdfs/BOE-A-2010-20138.pdf>. Accessed
36
37 June 21, 2011.

38
39 27 Matt GE, Quintana PJ, Destailats H, et al. Thirdhand Tobacco Smoke: Emerging
40
41 Evidence and Arguments for a Multidisciplinary Research Agenda. *Environ Health*
42
43 *Perspect* 2011.

44
45 28 Matt GE, Quintana PJ, Hovell MF, et al. Residual tobacco smoke pollution in used cars
46
47 for sale: air, dust, and surfaces. *Nicotine Tob Res* 2008;10:1467-75.

48
49 29 Sacks JJ, Nelson DE. Smoking and injuries: an overview. *Prev Med* 1994;23:515-20.

50
51 30 Wen CP, Tsai SP, Cheng TY, et al. Excess injury mortality among smokers: a neglected
52
53 tobacco hazard. *Tob Control* 2005;14 Suppl 1:i28-i32.

1
2
3 31 Buñuel JM, Córdoba R, del Castillo M, et al. Smoking and nonfatal traffic accidents.
4
5 *Atención Primaria* 2003;31:349-53.

6
7 32 Brison RJ. Risk of automobile accidents in cigarette smokers. *Can J Public Health*
8
9 1990;81:102-6.

10
11 33 Observatorio Nacional de Seguridad Vial, Dirección General de Tráfico, Gobierno de
12
13 España. Si conduce, mejor no fume. Available at: [http://www.dgt.es/revista/archivo/](http://www.dgt.es/revista/archivo/pdf/num172-2005-Tabaco.pdf)
14
15 [pdf/num172-2005-Tabaco.pdf](http://www.dgt.es/revista/archivo/pdf/num172-2005-Tabaco.pdf). Accessed June 21, 2011.

16
17 34 Boletín Oficial del Estado. Ley 17/2005, de 19 de julio, por la que se regula el permiso
18
19 y la licencia de conducción por puntos y se modifica el texto articulado de la ley sobre
20
21 tráfico, circulación de vehículos a motor y seguridad vial. Available at:
22
23 <http://www.boe.es/boe/dias/2005/07/20/pdfs/A25781-25793.pdf>. Accessed June 21,
24
25 2011.

26
27 35 Schiaffino A, Rodríguez M, Pasarín MI, et al. [Odds ratio or prevalence ratio? Their
28
29 use in cross-sectional studies]. *Gac Sanit* 2003;17:70-4.

30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1 Prevalence (%) of tobacco consumption and SHS exposure in vehicles in the city of Barcelona, Spain (2011).

	TOTAL			PRIVATE			COMMERCIAL			TAXI		
	n	%	(95%CI) ^a	n	%	(95%CI) ^a	n	%	(95%CI) ^a	n	%	(95%CI) ^a
Tobacco consumption												
Driver and/or passenger	2442	5.5	(4.6-6.4)	1736	4.7	(3.7-5.7)	482	9.8	(7.1-12.5)	224	2.2	(0.3-4.1)
Driver	2442	4.7	(3.9-5.5)	1736	3.8	(2.9-4.7)	482	8.9	(6.4-11.4)	224	2.2	(0.3-4.1)
Passenger	913	2.4	(1.4-3.4)	685	2.6	(1.4-3.8)	134	3.0	(0.1-5.9)	94	0.0	(0.0-3.9)
SHS exposure												
Any occupant	913	5.2	(3.8-6.6)	685	4.3	(2.8-5.8)	134	12.7	(7.1-18.3)	94	0.0	(0.0-3.9)
Driver	913	2.2	(1.2-3.2)	685	2.3	(1.2-3.4)	134	3.0	(0.1-5.9)	94	0.0	(0.0-3.9)
Passenger	913	3.0	(1.9-4.1)	685	2.0	(1.0-3.0)	134	9.7	(4.7-14.7)	94	0.0	(0.0-3.9)
Passenger <14 years old	271	2.2	(0.5-3.9)	253	2.0	(0.3-3.7)	12	8.3	(1.5-35.4)	6	0.0	(0.0-39.0)

^a95% confidence interval

Table 2 Prevalence (%) of driver's tobacco consumption by vehicle type and variables of driver, vehicle and context in the city of Barcelona, Spain.

	TOTAL (n=2442)		PRIVATE (n=1736)		COMMERCIAL (n=482)		TAXI (n=224)	
	% (95%CI) ^a	p	% (95%CI) ^a	p	% (95%CI) ^a	p	% (95%CI) ^a	p
Sex		0.031		0.223		0.351		0.708
Male	5.2 (4.2-6.2)		4.2 (3.1-5.3)		9.2 (6.5-11.9)		2.3 (0.3-4.3)	
Female	2.9 (1.5-4.3)		2.9 (1.4-4.4)		3.8 (0.7-18.9)		0 (0.0-39.0)	
Age		0.002		0.001		0.945		0.345
18-34 years	6.6 (4.6-8.6)		6.1 (3.9-8.3)		8.4 (3.6-13.2)		5.3 (0.9-24.6)	
35-64 years	4.3 (3.3-5.3)		3.2 (2.2-4.2)		9.4 (6.3-12.5)		2.0 (0.1-3.9)	
≥65 years	0.7 (0.1-4.0)		0.8 (0.1-4.4)		0 (0.0-27.8)		0 (0.0-65.8)	
Socioeconomic status^b		0.628		0.277		0.585		0.268
Low	5.2 (3.8-6.6)		4.7 (3.1-6.3)		7.4 (3.7-11.1)		3.9 (0.1-7.7)	
Medium	4.3 (3.0-5.6)		3.1 (1.8-4.4)		9.3 (5.3-13.3)		1.2 (0.2-6.6)	
High	4.5 (2.7-6.3)		3.4 (1.5-5.3)		11.1 (4.6-17.6)		0 (0.0-8.8)	
Driver's open window		<0.001		<0.001		0.001		0.089
Yes	9.3 (7.6-11.0)		9.1 (6.9-11.3)		12.3 (8.6-16.0)		3.5 (0.5-6.5)	
No	1.0 (0.5-1.5)		0.6 (0.1-1.1)		3.3 (0.7-5.9)		0 (0.0-4.5)	
Time		0.097		0.947		0.006		0.150
Morning (8-11h)	5.3 (4.1-6.5)		3.8 (2.6-5.0)		11.6 (8.0-15.2)		0.9 (0.2-4.7)	
Afternoon (17-19h)	3.8 (2.6-5.0)		3.8 (2.4-5.2)		4.1 (1.1-7.1)		3.7 (0.1-7.3)	
Weather		0.230		0.506		0.855		0.004
Shiny-sunny	4.3 (3.3-5.3)		3.6 (2.6-4.6)		9.1 (5.9-12.3)		0.6 (0.1-3.3)	
Cloudy	5.4 (3.8-7.0)		4.3 (2.5-6.1)		8.6 (4.3-12.9)		7.1 (0.4-13.8)	

^a95% confidence interval^bAccording to socioeconomic status of district

Table 3 Crude and adjusted odds ratio (OR) and 95% confidence intervals (95%CI) of smoking in cars by drivers.

	cOR	(95%CI) ^a	p	aOR	(95%CI) ^a	p
Sex						
Male	1.79	(1.05-3.07)	0.033	1.46	(0.83-2.59)	0.193
Female	1	-		1	-	
Age						
18-34 years old	9.61	(1.31-70.53)	0.026	6.85	(0.92-51.18)	0.061
35-64 years old	6.11	(0.84-44.30)	0.073	5.12	(0.69-37.81)	0.109
≥65 years old	1	-		1	-	
Vehicle type						
Private	1	-		1	-	
Commercial	2.48	(1.66-3.69)	<0.001	1.36	(0.89-2.10)	0.158
Taxi	0.58	(0.23-1.45)	0.242	0.34	(0.13-0.86)	0.023
Socioeconomic status^b						
Low	1.15	(0.69-1.91)	0.605	1.18	(0.69-2.00)	0.548
Medium	0.93	(0.55-1.58)	0.801	0.98	(0.57-1.68)	0.930
High	1	-		1	-	
Driver's open window						
Yes	10.50	(5.86-18.82)	<0.001	11.05	(6.08-20.09)	<0.001
No	1	-		1	-	
Time						
Morning (8-11h)	1.40	(0.94-2.08)	0.099	1.83	(1.20-2.79)	0.005
Afternoon (17-19h)	1	-		1	-	
Weather						
Shiny-sunny	1	-		1	-	
Cloudy	1.27	(0.86-1.89)	0.231	1.69	(1.11-2.57)	0.014

cOR: crude odds ratio

aOR: adjusted OR derived from a logistic regression model adjusted for driver's sex, age and window, vehicle type, district, time and weather

^a95% Confidence interval^bAccording to socioeconomic status of district

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47

For peer review only

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.



TOBACCO CONSUMPTION AND SECONDHAND SMOKE EXPOSURE IN VEHICLES: A CROSS-SECTIONAL STUDY

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2011-000418.R1
Article Type:	Research
Date Submitted by the Author:	28-Oct-2011
Complete List of Authors:	Curto, Ariadna Martínez-Sánchez, Jose Fernandez, Esteve; Institut català d'Oncologia, Tobacco Control Unit
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Smoking & tobacco
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, TOBACCO CONTROL

SCHOLARONE™
Manuscripts

Peer Review Only

1
2
3 **TOBACCO CONSUMPTION AND SECONDHAND SMOKE EXPOSURE IN VEHICLES: A**
4
5 **CROSS-SECTIONAL STUDY**
6

7 **Ariadna Curto^{a,d}, Jose M. Martínez-Sánchez^{a,b,c}, Esteve Fernández^{a,b,c}**

8
9
10 ^a*Tobacco Control Unit, Cancer Control and Prevention Programme, Institut Català d'Oncologia-*
11 *ICO, L'Hospitalet de Llobregat (Barcelona), Spain.*

12
13
14 ^b*Cancer Control and Prevention Group, Institut d'Investigació Biomèdica de Bellvitge-IDIBELL,*
15 *L'Hospitalet de Llobregat (Barcelona), Spain*

16
17
18 ^c*Department of Clinical Sciences, Universitat de Barcelona-Campus de Bellvitge, L'Hospitalet del*
19 *Llobregat (Barcelona), Spain.*

20
21
22 ^d*Department of Experimental and Health Sciences, Universitat Pompeu Fabra, Barcelona, Spain*
23
24
25
26
27
28

29 **Correspondence to:**

30 Jose M. Martínez Sánchez, PhD, MPH, BSc

31 Tobacco Control Unit, Cancer Control and Prevention Programme

32 Institut Català d'Oncologia-ICO.

33 Av. Gran Via de L'Hospitalet, 199-203, 08908 L'Hospitalet de Llobregat (Barcelona)

34 Tlf.: 93 260 73 35 (Ext.:3052)

35 E-mail: jmmartinez@iconcologia.net
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Keywords: tobacco consumption, secondhand smoke, private cars, commercial vehicles

Words main text: 2816

ABSTRACT

Objectives: To estimate the prevalence of tobacco smoking and secondhand smoke (SHS) exposure in private cars, commercial vehicles and taxis in the city of Barcelona (Spain).

Design: We performed an observational study with a cross-sectional design (2011). We selected a systematic sample of 2442 private cars, commercial vehicles and taxis in 40 public roads regulated by traffic lights in all districts of Barcelona. We calculated the prevalence rates and 95% confidence intervals (95%CI) of smoking and SHS exposure in cars, and the corresponding odds ratio adjusting for the potential confounding variables.

Results: The prevalence of tobacco consumption was 5.5% (95%CI: 4.6-6.4) and it was greater for the commercial vehicles (9.8%; 95%CI: 7.1-12.5). The total prevalence of SHS exposure was 5.2% (95%CI: 3.8-6.6). 2.2% (95%CI: 0.5-3.9) of the passengers under 14 years old were exposed to SHS in vehicles.

Conclusions: This study highlights the need to promote public health measures aimed at reducing tobacco consumption in vehicles, especially in the presence of children, as well as compliance with the current Spanish law on health measures against smoking in commercial vehicles and taxis.

ARTICLE FOCUS

- Tobacco consumption and secondhand smoke (SHS) exposure in transportation deserves special public health attention because they are places of reduced dimensions, where the concentrations of SHS reached can be much higher than other environments.
- Tobacco consumption while driving is also a distraction that increases the risk of traffic accidents.
- Few studies have studied the consumption of tobacco and SHS exposure in vehicles through direct observation.

KEY MESSAGES

- Reducing smoking in vehicles in the presence of children has to be prioritized.
- Enforcement of smoking laws in commercial vehicles and taxis is needed.
- Smoking in vehicles should be recognized in the legislation as other distraction factors.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- The main limitation of this study derives from the inherent observer bias, especially in variables as age, where physical appearance can entail a misclassification by the observer.
- Also noteworthy is the difficulty of obtaining a truly random and representative sample of vehicles in circulation in a city.
- A strength of an observational study like this compared with studies based on the use of questionnaires is the lack of information bias that comes directly from the self-reported questionnaires.

- 1
2
3 - The feasibility of direct observations were tested through a pilot study, which
4
5 concluded that direct observation studies are a good resource for monitoring smoking
6
7 in the drivers of motor vehicles.
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

INTRODUCTION

Secondhand smoke (SHS) is a complex mixture of pollutants that includes toxic and irritant compounds, as well as carcinogenic substances.[1,2] SHS has been classified by the International Agency for Research on Cancer (IARC) as type I carcinogen to humans.[2] In 2004 it was estimated that 1% of global mortality (603000 deaths) was attributable to SHS exposure.[3] Specifically, in Spain, it is estimated that between 1228 and 3237 deaths from lung cancer and myocardial infarction were attributable to SHS exposure in 2002.[4] Although there is a dose-response effect and no level of SHS exposure can be considered safe,[5] the intensity of the exposure depends on how long you are exposed and the concentration of SHS in the air. In this way, tobacco consumption and SHS exposure in transportation deserves special attention because they are places of reduced dimensions, where the concentrations of SHS reached can be much higher than other environments (home, workplace or leisure **settings such** as discos and bars).[6,7] Moreover, concentrations of particulate matter with diameter inferior to 2.5µm (PM_{2.5}) can be reached inside vehicles when there are people smoking [6-10] even exceeding the limits recommended by the Environmental Protection Agency (EPA).[11] Few studies have studied the consumption of tobacco and SHS exposure in vehicles through direct observation.[12,13] To our knowledge, only a cross-sectional study using questionnaires has been done in Spain.[14] The objective of this study is to estimate the prevalence of tobacco consumption and SHS exposure in private cars, commercial vehicles, and taxis in the city of Barcelona.

METHODS

Sampling, sample size and site selection

A cross-sectional study was conducted through direct observation of the occupants of private cars, commercial vehicles, and taxis in the city of Barcelona. The fieldwork was conducted

1
2
3 during April and May 2011. For each of the 10 districts of Barcelona, we randomly selected 2
4
5 public roads of the 15 with greater traffic flow rates and 2 public roads of the 5 with greater
6
7 density of nurseries and primary and secondary education schools to ensure the presence of
8
9 children in vehicles. For the selection of the public roads we consulted the “Araña de Tráfico”
10
11 of 2011 of the Mobility Services Division of Barcelona City Council.[15] We selected a total of
12
13 40 public roads (4 per district, 2 with greater traffic flow rates and 2 with greater school
14
15 density). For each of the public roads, a traffic light was selected as an observation point
16
17 where a trained observer conducted the direct observation of the vehicles and recorded the
18
19 variables of interest in an *ad hoc* designed data collection sheet.
20
21

22 The theoretical sample size was of 2401 vehicles assuming an expected prevalence of 50% with
23
24 a 95% confidence interval and a precision of 2%. The strategy of selecting the sample size was
25
26 expected to assume different prevalences in relation to two previous studies:[12,14] 10% in
27
28 Italy and 20% in Spain. Finally we assume a 50% prevalence that maximizes the statistical
29
30 power in order to stratify the results by type of vehicle. The final sample size was 2442
31
32 vehicles. The distribution of the number of observations was made in proportion to the traffic
33
34 flow rates in each public road. The observations were made when the traffic light was red for
35
36 vehicles. We systematically selected the first two vehicles in the adjacent lane to the observer.
37
38 We excluded adjacent lanes which were exclusive for buses, taxis, and bicycles. The study
39
40 included any private car, commercial vehicle (tourism derivative, adaptive mixed vehicle and
41
42 vans with the presence of company logo or slogan) and taxi. We excluded from the study
43
44 buses, coaches, trucks, motorcycles, bicycles and other public service vehicles (ambulances,
45
46 police cars, driving school cars, etc.). We also excluded those cars that did not permit the
47
48 visibility of the occupants because they have tinted windows. When the vehicles did not meet
49
50 the inclusion criteria, we proceeded to the observation of the next vehicle in line. The
51
52 observations were made continuously with an average duration of one hour within the fixed
53
54 schedule (morning from 8 to 11h and afternoon from 17 to 19h) Monday through Friday.
55
56
57
58
59
60

Study variables

We defined variables of driver, passengers, and vehicle. The driver variables studied were: tobacco consumption (yes/no), approximate age (18-34/35-64/≥65 years old) and sex (male/female). Passenger variables were: the total number of passengers, number of passengers who smoked and the number of passengers under 14 years old. Vehicle variables collected were: the type (private car/commercial vehicle/taxi), the number of open windows of the vehicle, and whether the driver's window was open (yes/no). We also collected contextual variables (day of the week, district, time, weather, and number of lanes of the public road).

The two main variables of study, tobacco consumption in drivers and passengers, were defined as the presence of any burning tobacco product in the hand or mouth of the driver or passenger. From these variables, two new variables were created: one that recorded the total tobacco consumption (driver and/or passenger) and the other SHS exposure, that is, if one occupant (driver or passenger) was exposed to SHS. District variable was recoded into 3 groups according to district socioeconomic status of the district in question.[16]

Prior to the fieldwork, we conducted a pilot study [17] to evaluate the feasibility of the observations and standardize the data collection sheet, as well as to analyze the degree of agreement between 2 observers in obtaining information. This pilot study demonstrated the feasibility of the direct observation designed and a perfect inter-observer concordance for monitoring the consumption of tobacco and number of passengers under 14 years old (simple inter-observer agreement = 100% and Kappa coefficient = 1.0). The driver's age presented however the lowest inter-observer concordance (simple inter-observer agreement = 94.3% and Kappa coefficient = 0.865) [17].

Statistical analysis

We performed a descriptive analysis of tobacco consumption and SHS exposure stratified by variables of driver, passengers, vehicle, and context. We calculated the prevalence of smoking

1
2
3 and SHS exposure and their confidence intervals at 95% (95%CI).[18] We performed chi-square
4
5 test (χ^2) to compare the prevalence rates. We fitted a logistic regression model to obtain the
6
7 adjusted odds ratio (OR) and 95%CI of smoking in cars by drivers. All analysis were performed
8
9 using the statistical package SPSS v.15.

10
11 This research did not use personal data or biological samples, so approval was not required by
12
13 the Ethics Committee of Bellvitge University Hospital.

14 15 16 17 18 **RESULTS**

19
20 We made 2442 observations, of which 71.1% were private cars, 19.7% commercial vehicles
21
22 and 9.2% taxis. More than half of the observations (53.9%) were conducted on public roads
23
24 with more than 2 lanes. 77.8% of drivers were men and most common age range was 36-64
25
26 years old (69.6%). Of all the vehicles observed, 62.6% went without passengers. There was a
27
28 passenger under 14 years old in 29.7% of the vehicles with passengers (11.1% of all vehicles).
29
30 53.4% of vehicles observed had all the windows closed.

31
32 Table 1 shows the prevalence of smoking and SHS total exposure of the driver and/or
33
34 passenger according to type of vehicle. The prevalence of tobacco consumption in vehicles
35
36 (private, commercial, and taxis) was 5.5% (95%CI: 4.6-6.4). The prevalence of tobacco
37
38 consumption was higher in commercial vehicles (9.8%, 95%CI: 7.1-12.5). The prevalence of
39
40 tobacco consumption among drivers was 4.7% (95%CI: 3.9-5.5) and 2.4% (95%CI: 1.4-3.4)
41
42 among the passengers, this difference was maintained according to vehicle type (table 1).
43
44 The overall prevalence of SHS exposure was 5.2% (95%CI: 3.8-6.6). The commercial vehicle
45
46 occupants were the most exposed to SHS (12.7%, 95%CI: 7.1-18.3), while in taxis **there** was no
47
48 observed **tobacco consumption or occupant exposure to SHS**. Passengers were slightly more
49
50 **likely to be** exposed to SHS than drivers (3.0% vs. 2.2%, p=0.283). This difference was three-
51
52 fold in commercial vehicles (9.7% vs. 3.0%, p=0.024). The prevalence of passengers under 14
53
54 years old exposed to SHS in vehicles was 2.2% (95%CI: 0.5-3.9) (table 1).
55
56
57
58
59
60

1
2
3 Table 2 shows the prevalence of driver's tobacco consumption according to vehicle type,
4
5 variables of driver, vehicle and context. The prevalence of smoking in drivers was almost
6
7 twofold in men than in women (5.2% vs. 2.9%, $p=0.031$). There was a statistically significant
8
9 downward trend in the consumption of tobacco according to the age of the driver, although
10
11 this trend was not statistically significant in commercial vehicles and taxis. Although
12
13 consumption of tobacco in drivers was higher in districts with more socioeconomic deprivation
14
15 (5.2%, 95%CI: 3.8-6.6), this difference was not statistically significant. The overall prevalence of
16
17 tobacco consumption was higher in the morning than in the afternoon (5.3% vs. 3.8%,
18
19 $p=0.097$), especially in commercial vehicles (11.6% vs. 4.1%, $p=0.006$). The prevalence of
20
21 tobacco consumption among drivers was greater on cloudy days than sunny, regardless of
22
23 vehicle type (table 2).
24
25

26
27 In bivariate logistic regression models we confirmed a stronger association of driver's tobacco
28
29 consumption when the driver was a man (OR=1.79, 95%CI: 1.05-3.07), had an age range of 18-
30
31 34 years old (OR=9.61, 95% CI: 1.31-70.53), was driving a commercial vehicle (OR=2.48, 95%CI:
32
33 1.66-3.69) and had his window open (OR=10.50, 95%CI: 5.86-18.82) (table 3). After adjusting a
34
35 saturated model with all potential confounders, this association was statistically significant
36
37 only for the driver's window open (OR=11.05, 95%CI: 6.08-20.09), time of the day (OR=1.83,
38
39 95%CI: 1.20-2.79) and weather (OR=1.69, 95%CI: 1.11-2.57) (table 3).
40
41
42
43

44 DISCUSSION

45
46 This is the first study in Spain that estimates the prevalence of tobacco consumption and SHS
47
48 exposure in transportation through direct observation of vehicles. The results of this study
49
50 show that the prevalence of tobacco consumption and SHS exposure in vehicles in the city of
51
52 Barcelona is high, especially in commercial vehicles.
53
54

55 The prevalence of tobacco consumption in vehicles observed in our study is similar to that
56
57 observed in studies carried out in Italy [12] and New Zealand,[13] which also made direct
58
59
60

1
2
3 observation of vehicles. However, SHS exposure in vehicles in our study (5.2%) is much lower
4
5 than that observed in the study of New Zealand (23.7%). The difference could be related to
6
7 social and contextual differences such as the different population size between municipalities
8
9 observed in Karori, Wainuiomata and Wellington, New Zealand (less than 410000 inhabitants)
10
11 and Barcelona, Spain (about 1.6 millions of inhabitants) and also different year in which the
12
13 studies were done.

14
15 The prevalence rates obtained in studies using questionnaires [14,19] are considerably higher
16
17 than those estimated in studies using direct observations as the present study. One possible
18
19 reason could be the inability of observational studies to monitor the entire car trip of the
20
21 driver, who could smoke at any time or even smoke more than one cigarette. However, the
22
23 driver's consumption of tobacco during the entire journey can be obtained in classical cross-
24
25 sectional studies using questionnaires. This limitation could lead to a potential
26
27 underestimation of prevalence obtained in studies that use direct observations as it happens in
28
29 studies based on direct observations in bars, which have reported an almost three-fold greater
30
31 actual number of smokers in comparison with the number of smokers found through direct
32
33 observations.[20] This aspect should worthy be addressed in future studies.

34
35
36 On the other hand, tobacco consumption in our study was higher when any of the windows of
37
38 the vehicle was open, as in previous studies.[13] This may be due to the belief, on the part of
39
40 smokers, that the adverse health effects of tobacco consumption in vehicles are minimized
41
42 when a window is open.[21] However, although levels of PM_{2.5} are lower in vehicle ventilation
43
44 conditions, these levels are still unhealthy.[6,9,10,22]

45
46
47 The prevalence of SHS exposure in children was high compared to that observed in the Italian
48
49 study (0.9%).[12] This difference could be attributed to the fact that in our study half of the
50
51 public roads had high school density. This fact should be taken into account since children are
52
53 inevitably more vulnerable to the effects of SHS exposure.[23] In this sense, a study conducted
54
55 in Ireland [24] found an increased likelihood of developing respiratory and allergic symptoms in
56
57
58
59
60

1
2
3 children aged 13-14 years old exposed to SHS in vehicles, with wheezing as the most obvious
4
5 symptom. Therefore, it becomes clear the need to prioritize public health policies in Spain,
6
7 aimed at reducing tobacco consumption in private cars if children are present. Moreover, a
8
9 study conducted through telephone surveys in four countries (Australia, Canada, United
10
11 Kingdom and United States of America) concluded that the majority of smokers (more than
12
13 60%) would ban smoking in vehicles if children are present,[25] with higher approval of
14
15 smokers with less tobacco dependence and with young children (<5 years old) *versus* those
16
17 without children. This support for restricting smoking in vehicles is also found in studies carried
18
19 out among adolescents.[26,27]

20
21
22 The observed prevalence of tobacco consumption in commercial vehicles and taxis have been
23
24 especially high considering that the current Spanish legislation on tobacco (Law 42/2010) [28]
25
26 bans smoking in commercial vehicles and taxis because they are workplaces and even also
27
28 public places. Furthermore, since in our study the prevalence of tobacco consumption and SHS
29
30 exposure in commercial vehicles has been very high, like those seen in Italy,[12] enforcement
31
32 measures of the current legislation should be promoted.

33
34
35 On the other hand, tobacco consumption in taxis was never observed in the presence of
36
37 passengers. Although the passengers of taxis did not have direct SHS exposure, recent studies
38
39 [29,30] have highlighted the possible effects of exposure to the deposit and accumulation of
40
41 SHS particles on the surface of vehicle seats, air or dust. The involuntary inhalation, ingestion
42
43 or skin absorption of these surface and air particles is known as thirdhand smoke
44
45 exposure.[29] While there is still insufficient evidence to assess the health hazards from
46
47 thirdhand smoke, further studies should investigate its potential for exposure and its health
48
49 effects.

50
51
52 Tobacco consumption while driving is also a distraction that increases the risk of traffic
53
54 accidents.[31-33] It is estimated that, compared with non-smoking drivers, drivers who
55
56 smoked are 1.5 times more likely to have an accident.[34] **Distraction caused by smoking is**

1
2
3 associated to, among others, the decrease in manual dexterity with the steering wheel and the
4
5 reduction of attention to the road (when the cigarette is being lighted or put out and the eye
6
7 irritation caused by carbon monoxide present in SHS), not to mention the lower perception of
8
9 risk that smokers have at wheel *versus* nonsmokers.[34] In this sense, a survey conducted by
10
11 the Spanish National Road Safety Observatory of General Directorate of Traffic [35] in 2005
12
13 revealed that 83.8% of the interviewed drivers thought that tobacco consumption is a source
14
15 of distraction while driving. In addition, 76.8% thought smoking is a fairly or very dangerous
16
17 behavior while driving. Given the evidence of the health hazards of smoking while driving and
18
19 the broad general perception of risk by the population, this habit should be approached the
20
21 same way as other distraction factors recognized by the Spanish law as the use of mobile
22
23 phones or other manually operated devices, such as GPS systems.[36]

24
25
26 The main limitation of this study derives from the inherent observer bias, especially in
27
28 variables as age, where the biological variability regarding physical appearance can entail a
29
30 misclassification by the observer. However, the pilot study [17] carried out by two independent
31
32 observers showed an almost perfect agreement in the observation. We cannot disregard
33
34 selection bias, since the search for public roads with greater density of schools could over-
35
36 represent the presence of children in vehicles. Other potential limitations of the study derive
37
38 from the fact that fieldwork was conducted only in spring and in a precise time-window of the
39
40 day. The Spanish National Health Interview Surveys conducted among several waves during
41
42 one year have not shown seasonality in tobacco consumption (prevalence rates by waves for
43
44 several years are available at www.ine.es). Moreover, similar prevalence rates of smoking in
45
46 vehicles have been reported in autumn [12], which also suggests no seasonal differences.
47
48 Finally, we are not completely able to discern whether the time-window used for sampling in
49
50 our study is representative of the 24 hours of a whole day. While it is clear that during night
51
52 time there are less vehicles circulating, we do not know whether drivers who circulate during
53
54
55
56
57
58
59
60

1
2
3 our time-window for sampling smoke less or more than drivers circulating during the rest of
4
5 the day or night.
6

7 We have used logistic regression as a measure of association in a cross-sectional study.

8
9 However, the OR only overestimates the prevalence ratio when it is above 20%,^[37] which is
10
11 not the case of our data. Also noteworthy is the difficulty of obtaining a truly random and
12
13 representative sample of vehicles in circulation in a city. Our sampling approach, designed to
14
15 be representative of all districts of Barcelona, was directed to minimize this limitation. A
16
17 strength of an observational study like this compared with studies based on the use of
18
19 questionnaires is the lack of information bias that comes directly from the self-reported
20
21 questionnaires.
22
23

24 In conclusion, this study provides an estimation of smoking in cars and highlights the need to
25
26 promote public health measures aimed at reducing tobacco consumption in private cars,
27
28 especially in the presence of children, as well as the enforcement of measures to control
29
30 smoking in commercial vehicles and taxis.
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

CONTRIBUTORS

All authors contributed in the design of the study. AC collected the data, prepared the database and analyzed the data. JMMS and EF revised with her the results. All the authors contributed to the interpretation of results. AC drafted the manuscript, which was critically revised by JMMS and EF. All authors approved the final version.

ACKNOWLEDGMENTS

We acknowledge the collaboration of Mr. Ángel López Rodríguez for providing “la Araña de Tráfico” of the city of Barcelona.

COMPETING INTERESTS

The authors have no competing interests.

FUNDING

This project was funded by Instituto de Salud Carlos III, Government of Spain (RTICC RD06/0020/0089) and Ministry of Universities and Research, Government of Catalonia (grant 2009SGR192).

REFERENCES

- 1 US Environmental Protection Agency. Respiratory health effects of passive smoking: lung cancer and other disorders. Washington, DC: Environmental Protection Agency 1992:6-90.
- 2 International Agency for Research on Cancer. Monographs on the Evaluation of Carcinogenic Risks to Humans (vol 83). Tobacco Smoke and Involuntary Smoking 2002.
- 3 Öberg M, Jaakkola MS, Woodward A, et al. Worldwide burden of disease from exposure to secondhand smoke: a retrospective analysis of data from 192 countries. *Lancet* 2011;377:139-46.
- 4 López MJ, Pérez-Ríos M, Schiaffino A, et al. Mortality attributable to passive smoking in Spain, 2002. *Tob Control* 2007;16:373-7.
- 5 Dept. of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion Office on Smoking and Health. The Health Consequences of Smoking: a report of the Surgeon General. Washington, DC: Surgeon General 2004.
- 6 Jones MR, Navas-Acién A, Yuan J, et al. Secondhand tobacco smoke concentrations in motor vehicles: a pilot study. *Tob Control* 2009;18:399-404.
- 7 Vardavas CI, Linardakis M, Kafatos AG. Environmental tobacco smoke exposure in motor vehicles: a preliminary study. *Tob Control* 2006;15:415.
- 8 Rees VW, Connolly GN. Measuring air quality to protect children from secondhand smoke in cars. *Am J Prev Med* 2006;31:363-8.
- 9 Sendzik T, Fong GT, Travers MJ, et al. An experimental investigation of tobacco smoke pollution in cars. *Nicotine Tob Res* 2009;11:627-34.
- 10 Ott W, Klepeis N, Switzer P. Air change rates of motor vehicles and in-vehicle pollutant concentrations from secondhand smoke. *J Expo Sci Environ Epidemiol* 2008; 18:312-25.

- 1
2
3 11 US Environmental Protection Agency. National ambient air quality standards for
4 particulate matter; Final rule (report num. 71). Washington, DC: Environmental
5 Protection Agency 2006.
6
7
8
9 12 Sbrogiò L, Frison G, Tagliapietra L, et al. [Observed smoking in car: results of a study
10 of the Regional Health Prevention Service of Veneto, Northern Italy]. *Epidemiol Prev*
11 2010;34:43-7.
12
13 13 Martin J, George R, Andrews K, et al. Observed smoking in cars: a method and
14 differences by socioeconomic area. *Tob Control* 2006;15:409-11.
15
16 14 Lushchenkova O, Fernández E, López MJ, et al. [Secondhand smoke exposure in
17 Spanish adult non-smokers following the introduction of an anti-smoking law]. *Rev Esp*
18 *Cardiol* 2008;61:687-94.
19
20 15 Direcció de Serveis de Mobilitat, Ajuntament de Barcelona. Dades bàsiques de
21 mobilitat 2011. Available at: [http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/](http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/0,4022,173198596_257817017_1,00.html)
22 [0,4022,173198596_257817017_1,00.html](http://w3.bcn.es/XMLServeis/XMLHomeLinkPI/0,4022,173198596_257817017_1,00.html). Accessed June 19, 2011.
23
24 16 Domínguez-Berjón MF, Borrell C. [Mortality and socioeconomic deprivation in the
25 census tracts and districts of Barcelona]. *Gac Sanit* 2005;19:363-9.
26
27 17 Martínez-Sánchez JM, Curto A, Fernández E. [Agreement between two observers in
28 the measurement of tobacco consumption, use of safety belt and cell phones in
29 vehicles]. *Gac Sanit* 2011 (in press).
30
31 18 Wilson EB. Probable inference, the law of succession, and statistical inference.
32 *Journal of the American Statistical Association* 1927;22:209-12.
33
34 19 Hitchman SC, Fong GT, Borland R, et al. Predictors of smoking in cars with
35 nonsmokers: findings from the 2007 Wave of the International Tobacco Control Four
36 Country Survey. *Nicotine Tob Res* 2010;12:374-80.
37
38 20 Repace JL. Exposure Analysis. In: Ott WR, Steinemann AC, Wallace LA, eds. *Exposure*
39 *to Secondhand Smoke*. NY: Taylor & Francis Group 2007:201-35.
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- 1
2
3 **21** Kegler MC, Escoffery C, Butler S. A qualitative study on establishing and enforcing
4 smoking rules in family cars. *Nicotine Tob Res* 2008;10:493-7.
5
6
7 **22** Invernizzi G, Ruprecht AA, Mazza R, et al. [Smoking in car: monitoring pollution of
8 particulate matter, of organic volatile compounds and of carbon monoxide. The effect of
9 opening the driver's window]. *Epidemiol Prev.* 2010;34:35-42.
10
11
12 **23** Bearer CF. How are children different from adults? *Environ Health Perspect* 1995;103
13 Suppl 6:7-12.
14
15 **24** Kabir Z, Manning PJ, Holohan J, et al. Secondhand smoke exposure in cars and
16 respiratory health effects in children. *Eur Respir J* 2009;34:629-33.
17
18 **25** Hitchman SC, Fong GT, Zanna MP, et al. Support and correlates of support for
19 banning smoking in cars with children: findings from the ITC Four Country Survey. *Eur J*
20 *Public Health* 2011;21:360-5.
21
22 **26** Leatherdale ST, Smith P, Ahmed R. Youth exposure to smoking in the home and in
23 cars: how often does it happen and what do youth think about it? *Tob Control*
24 2008;17:86-92.
25
26 **27** Leatherdale ST, Ahmed R. Second-hand smoke exposure in homes and in cars among
27 Canadian youth: current prevalence, beliefs about exposure, and changes between 2004
28 and 2006. *Cancer Causes Control* 2009;20:855-65.
29
30 **28** Boletín Oficial del Estado. Ley 42/2010 por la que se modifica la Ley 28/2005 de
31 medidas sanitarias frente al tabaquismo y reguladora de la venta, el suministro, el
32 consumo y la publicidad de los productos del tabaco. Available at:
33 <http://www.boe.es/boe/dias/2010/12/31/pdfs/BOE-A-2010-20138.pdf>. Accessed
34 June 21, 2011.
35
36 **29** Matt GE, Quintana PJ, Destailats H, et al. Thirdhand Tobacco Smoke: Emerging
37 Evidence and Arguments for a Multidisciplinary Research Agenda. *Environ Health*
38 *Perspect* 2011.
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 **30** Matt GE, Quintana PJ, Hovell MF, et al. Residual tobacco smoke pollution in used cars
4
5 for sale: air, dust, and surfaces. *Nicotine Tob Res* 2008;10:1467-75.
6

7 **31** Sacks JJ, Nelson DE. Smoking and injuries: an overview. *Prev Med* 1994;23:515-20.
8

9 **32** Wen CP, Tsai SP, Cheng TY, et al. Excess injury mortality among smokers: a neglected
10
11 tobacco hazard. *Tob Control* 2005;14 Suppl 1:i28-i32.
12

13 **33** Buñuel JM, Córdoba R, del Castillo M, et al. Smoking and nonfatal traffic accidents.
14
15 *Atención Primaria* 2003;31:349-53.
16

17 **34** Brison RJ. Risk of automobile accidents in cigarette smokers. *Can J Public Health*
18
19 1990;81:102-6.
20

21 **35** Observatorio Nacional de Seguridad Vial, Dirección General de Tráfico, Gobierno de
22
23 España. Si conduce, mejor no fume. Available at: [http://www.dgt.es/revista/archivo/](http://www.dgt.es/revista/archivo/pdf/num172-2005-Tabaco.pdf)
24
25 [pdf/num172-2005-Tabaco.pdf](http://www.dgt.es/revista/archivo/pdf/num172-2005-Tabaco.pdf). Accessed June 21, 2011.
26
27

28 **36** Boletín Oficial del Estado. Ley 17/2005, de 19 de julio, por la que se regula el permiso
29
30 y la licencia de conducción por puntos y se modifica el texto articulado de la ley sobre
31
32 tráfico, circulación de vehículos a motor y seguridad vial. Available at:
33
34 <http://www.boe.es/boe/dias/2005/07/20/pdfs/A25781-25793.pdf>. Accessed June 21,
35
36 2011.
37

38 **37** Schiaffino A, Rodríguez M, Pasarín MI, et al. [Odds ratio or prevalence ratio? Their
39
40 use in cross-sectional studies]. *Gac Sanit* 2003;17:70-4.
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Table 1 Prevalence (%) of tobacco consumption and SHS exposure in vehicles in the city of Barcelona, Spain (2011).

Tobacco consumption	TOTAL			PRIVATE			COMMERCIAL			TAXI		
	n	%	(95%CI) ^a	n	%	(95%CI) ^a	n	%	(95%CI) ^a	n	%	(95%CI) ^a
Driver and/or passenger	2442	5.5	(4.6-6.4)	1736	4.7	(3.7-5.7)	482	9.8	(7.1-12.5)	224	2.2	(0.3-4.1)
Driver	2442	4.7	(3.9-5.5)	1736	3.8	(2.9-4.7)	482	8.9	(6.4-11.4)	224	2.2	(0.3-4.1)
Passenger	913	2.4	(1.4-3.4)	685	2.6	(1.4-3.8)	134	3.0	(0.1-5.9)	94	0.0	(0.0-3.9)
SHS exposure												
Any occupant	913	5.2	(3.8-6.6)	685	4.3	(2.8-5.8)	134	12.7	(7.1-18.3)	94	0.0	(0.0-3.9)
Driver	913	2.2	(1.2-3.2)	685	2.3	(1.2-3.4)	134	3.0	(0.1-5.9)	94	0.0	(0.0-3.9)
Passenger	913	3.0	(1.9-4.1)	685	2.0	(1.0-3.0)	134	9.7	(4.7-14.7)	94	0.0	(0.0-3.9)
Passenger <14 years old	271	2.2	(0.5-3.9)	253	2.0	(0.3-3.7)	12	8.3	(1.5-35.4)	6	0.0	(0.0-39.0)

^a95% confidence interval

Table 2 Prevalence (%) of driver's tobacco consumption by vehicle type and variables of driver, vehicle and context in the city of Barcelona, Spain.

	TOTAL (n=2442)		PRIVATE (n=1736)		COMMERCIAL (n=482)		TAXI (n=224)	
	% (95%CI) ^a	p	% (95%CI) ^a	p	% (95%CI) ^a	p	% (95%CI) ^a	p
Sex		0.031		0.223		0.351		0.708
Male	5.2 (4.2-6.2)		4.2 (3.1-5.3)		9.2 (6.5-11.9)		2.3 (0.3-4.3)	
Female	2.9 (1.5-4.3)		2.9 (1.4-4.4)		3.8 (0.7-18.9)		0 (0.0-39.0)	
Age		0.002		0.001		0.945		0.345
18-34 years	6.6 (4.6-8.6)		6.1 (3.9-8.3)		8.4 (3.6-13.2)		5.3 (0.9-24.6)	
35-64 years	4.3 (3.3-5.3)		3.2 (2.2-4.2)		9.4 (6.3-12.5)		2.0 (0.1-3.9)	
≥65 years	0.7 (0.1-4.0)		0.8 (0.1-4.4)		0 (0.0-27.8)		0 (0.0-65.8)	
Socioeconomic status^b		0.628		0.277		0.585		0.268
Low	5.2 (3.8-6.6)		4.7 (3.1-6.3)		7.4 (3.7-11.1)		3.9 (0.1-7.7)	
Medium	4.3 (3.0-5.6)		3.1 (1.8-4.4)		9.3 (5.3-13.3)		1.2 (0.2-6.6)	
High	4.5 (2.7-6.3)		3.4 (1.5-5.3)		11.1 (4.6-17.6)		0 (0.0-8.8)	
Driver's open window		<0.001		<0.001		0.001		0.089
Yes	9.3 (7.6-11.0)		9.1 (6.9-11.3)		12.3 (8.6-16.0)		3.5 (0.5-6.5)	
No	1.0 (0.5-1.5)		0.6 (0.1-1.1)		3.3 (0.7-5.9)		0 (0.0-4.5)	
Time		0.097		0.947		0.006		0.150
Morning (8-11h)	5.3 (4.1-6.5)		3.8 (2.6-5.0)		11.6 (8.0-15.2)		0.9 (0.2-4.7)	
Afternoon (17-19h)	3.8 (2.6-5.0)		3.8 (2.4-5.2)		4.1 (1.1-7.1)		3.7 (0.1-7.3)	
Weather		0.230		0.506		0.855		0.004
Sunny	4.3 (3.3-5.3)		3.6 (2.6-4.6)		9.1 (5.9-12.3)		0.6 (0.1-3.3)	
Cloudy	5.4 (3.8-7.0)		4.3 (2.5-6.1)		8.6 (4.3-12.9)		7.1 (0.4-13.8)	

^a95% confidence interval^bAccording to socioeconomic status of district

Table 3 Crude and adjusted odds ratio (OR) and 95% confidence intervals (95%CI) of smoking in cars by drivers.

	^c OR	(95%CI) ^a	p	^a OR	(95%CI) ^a	p
Sex						
Male	1.79	(1.05-3.07)	0.033	1.46	(0.83-2.59)	0.193
Female	1	-		1	-	
Age						
18-34 years old	9.61	(1.31-70.53)	0.026	6.85	(0.92-51.18)	0.061
35-64 years old	6.11	(0.84-44.30)	0.073	5.12	(0.69-37.81)	0.109
≥65 years old	1	-		1	-	
Vehicle type						
Private	1	-		1	-	
Commercial	2.48	(1.66-3.69)	<0.001	1.36	(0.89-2.10)	0.158
Taxi	0.58	(0.23-1.45)	0.242	0.34	(0.13-0.86)	0.023
Socioeconomic status^b						
Low	1.15	(0.69-1.91)	0.605	1.18	(0.69-2.00)	0.548
Medium	0.93	(0.55-1.58)	0.801	0.98	(0.57-1.68)	0.930
High	1	-		1	-	
Driver's open window						
Yes	10.50	(5.86-18.82)	<0.001	11.05	(6.08-20.09)	<0.001
No	1	-		1	-	
Time						
Morning (8-11h)	1.40	(0.94-2.08)	0.099	1.83	(1.20-2.79)	0.005
Afternoon (17-19h)	1	-		1	-	
Weather						
Sunny	1	-		1	-	
Cloudy	1.27	(0.86-1.89)	0.231	1.69	(1.11-2.57)	0.014

^cOR: crude odds ratio^aOR: adjusted OR derived from a logistic regression model adjusted for driver's sex, age and window, vehicle type, district, time and weather^a95% Confidence interval^bAccording to socioeconomic status of district

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest
Outcome data	15*	Report numbers of outcome events or summary measures
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.