OPEN ACCESS

ORIGINAL RESEARCH

Tobacco smoking among chrysotile asbestos workers in Asbest in the Russian Federation

Ann Olsson ,[1] Evgeny V Kovalevskiy,[2,3] Madar Talibov ,[1] Monika Moissonnier,[1] Graham Byrnes,[1] Liacine Bouaoun,[1] Sara J Schonfeld,[4] Eleonora Feletto,[5,6] Sergey V Kashanskiy,[7] Evgenia Ostroumova,[1] Hans Kromhout ,[8] Igor V Bukhtiyarov,[2,3] Joachim Schüz[1]

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/oemed-2019-106263).

For numbered affiliations see end of article.

Correspondence to
Dr Ann Olsson, Section of Environment and Radiation, International Agency for Research on Cancer, Lyon 69372 cedex 08, France; olssona@iarc.fr

Received 15 October 2019
Revised 24 February 2020
Accepted 18 April 2020
Published Online First 12 May 2020

ABSTRACT

Objectives A historical cohort study of cancer mortality is being conducted among workers in a chrysotile mine and its enrichment factories in the town of Asbest, Russian Federation. Because individual-level information on tobacco use is not available for Asbest Chrysotile Cohort members, a cross-sectional survey of smoking behaviours was conducted among active and retired workers.
Methods Self-administered questionnaires were completed by active workers during meetings organised by occupational safety personnel. Retired workers completed questionnaires during meetings of the Veterans Council or were interviewed via telephone or in person. Of the respondents, 46% could be linked to the Asbest Chrysotile Cohort. Among those, logistic regression models were used to assess associations between smoking and cumulative dust exposure.
Results Among men, smoking prevalence was high and relatively consistent across birth decades (average, 66%), and was similar in workers across all levels of cumulative dust exposure (p trend, 0.44). Among women, the prevalence increased from <10% in those born before 1960 to 30% in those born after 1980, and smoking was associated with exposure to dust versus not exposed to dust (p value, 0.006), but did not vary appreciably across workers in different cumulative dust exposure categories (p trend, 0.29).
Conclusions Our study suggests that cross-sectional surveys may be a useful tool for understanding the potential health impact from smoking in occupational cohorts, including possible confounding by smoking. This survey showed that adjustment at the age group level among women is needed to reduce residual confounding and account for smoking patterns, which have changed substantially over time.

Key messages

What is already known about this subject?

- Occupational cohort studies often lack data on study participants' individual smoking habits; if smoking is related to the exposure and the outcome of interest it may confound the results.

What are the new findings?

- This survey among retired and current workers at a chrysotile asbestos mine and enrichment factories in the Russian Federation shows that the potential confounding of results in men is unlikely, while it remains a concern in women as their smoking habits have changed substantially over time and differ between those working in non-production parts and production parts of the company.

How might this impact on policy or clinical practice in the foreseeable future?

- This survey shows that it is useful to conduct surveys in specialised workforces to capture smoking patterns in men and women across birth cohorts.

Check for updates

To cite: Olsson A, Kovalevskiy EV, Talibov M, *et al*. *Occup Environ Med* 2020;**77**:623–627.

INTRODUCTION

A historical cohort study was launched in 2013 of cancer mortality among current and former workers of the Joint Stock Company (JSC) Uralasbest, which runs the world's largest operating chrysotile asbestos mine and its enrichment factories in Asbest, Sverdlovsk Region, Russian Federation.[1] Cohort members comprise all workers in the mine, factories, autotransport, external rail, central laboratory and explosives unit at JSC Uralasbest that were employed for at least 1 year between 1975 and 2010. Detailed work histories were derived from company records, and vital status at end of follow-up was ascertained from official sources such as the Pension Fund, the Federal Migration Service and Civil Act Registration Office providing the date and cause of death of those deceased in Sverdlovsk Region. The overall aim of the cohort study is to characterise associations between occupational exposure to chrysotile asbestos and site-specific cancers.[1] Most of the cancers in the study (lung, larynx, pharynx, stomach, colon and rectum, and ovary) are associated with tobacco smoking, suggesting that adjustment for tobacco smoking is needed in analyses of association between chrysotile exposure and cancer mortality.[2] Smoking patterns are influenced by various factors including occupational status and tobacco control policies such as full or partial workplace bans; yet individuals may compensate for workplace smoking restrictions by smoking more before or after work.[3 4] Therefore, relying on national smoking surveys to estimate the potential impacts of smoking in industrial

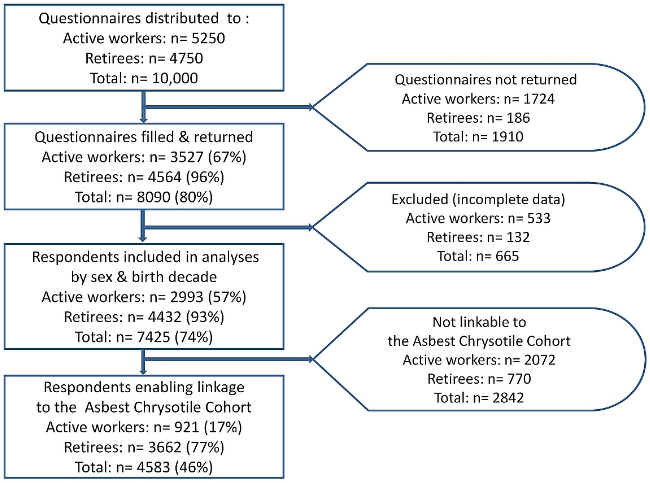

Figure 1 Flow chart describing the data collection events in the JSC Uralasbest tobacco survey. JSC, joint stock company.

cohorts may not be reflective of workers' individual behaviour. As cohort members included those who were already employed in 1975 and workers who were hired between 1975 and 2010, we conducted an independent survey of smoking behaviours in JSC Uralasbest among active and retired workers which would largely represent cohort members. Hence, in this analysis, we report the results from a cross-sectional survey on smoking behaviour to assess (1) the overall smoking prevalence in this special workforce and (2) whether smoking patterns vary by (2a) age and sex among active and retired workers and (2b) by categories of cumulative occupational dust exposure among those that could be linked to the cohort via names and date of birth.

Table 1 Selected characteristics of respondents included in the analysis of the JSC Uralasbest tobacco survey

Respondents' characteristics	All N (%) n=7425	By sex N (%) Men (n=3692)	Women (n=3733)
Birth year			
≤1940	1560 (21.0)	491 (13.3)	1069 (28.6)
1941–1950	1478 (19.9)	644 (17.4)	834 (22.3)
1951–1960	1810 (24.4)	821 (22.2)	989 (26.5)
1961–1970	963 (13.0)	563 (15.2)	400 (10.7)
1971–1980	785 (10.6)	514 (13.9)	271 (7.3)
≥1981	829 (11.2)	659 (17.8)	170 (4.6)
Active or retired workers			
Active workers	2993 (40.3)	2096 (56.8)	897 (24.0)
Retired workers	4432 (59.7)	1596 (43.2)	2836 (76.0)
Mode of data collection			
Meeting	3823 (51.5)	2436 (66.0)	1387 (37.2)
Telephone	1582 (21.3)	691 (18.7)	891 (23.9)
Home	2020 (27.2)	565 (15.3)	1455 (39.0)
Linked to Asbest Chrysotile Cohort*			
No	2842 (38.3)	1612 (43.7)	1230 (32.9)
Yes	4583 (61.7)	2080 (56.3)	2503 (67.1)
Smoking status			
Never	4636 (62.4)	1244 (33.7)	3392 (90.9)
Ever	2789 (37.6)	2448 (66.3)	341 (9.1)
Average number of cigarettes smoked per day (among ever-smokers)			
≤10	761 (27.3)	634 (25.9)	127 (37.2)
>10	1422 (51.0)	1355 (55.4)	67 (19.6)
Missing	606 (21.7)	459 (18.7)	147 (43.2)

*Survey participants identified themselves by putting their full name on the questionnaire allowing linkage to the Asbest Chrysotile Cohort.
JSC, joint stock company.

METHODS

Survey administration

The smoking survey was conducted between January and June 2017. Paper questionnaires were distributed among active and retired workers of JSC Uralasbest. Before distribution, the people responsible for administering the questionnaires were trained by an occupational safety engineer to ensure consistency in the delivery and completion. Details of the survey's distribution were recorded, including meeting dates, workplace, number of attendees, questionnaires returned, details of administering personnel and date of questionnaire transfer to the local data entry team.

The Asbest Chrysotile Cohort is a historical cohort study where the enrolment was based on company records and the follow-up was based on record linkages from official sources. Therefore, no individual contact with or consent from study participants was required. Participation in this survey was voluntary and could be anonymous, so no consent forms were obtained.

Study population

Active workers were invited to voluntarily participate in the survey during the mandatory occupational safety meetings at JSC Uralasbest, and questionnaires were administered to retired workers during events arranged by the Veterans Council for its ~6000 members. Pensioners who did not attend any organised events were contacted by a Veterans Council assistant at home. The assistant telephoned the pensioner to arrange a time to visit them, or went directly to their home and knocked on the door. When it was not possible to make a home visit, the survey was completed over the phone (figure 1). Of the total of 8090 completed questionnaires, we excluded 665 due to incomplete information (eg, incoherent information, missing sex or age) and duplicate questionnaires (if worker participated in two meetings or events), resulting in 7425 respondents (response rate, 74%) in the overall analyses, of which 40% were active and 60% were retired workers. For the analysis of smoking in relation to cumulative dust exposure, 4583 respondents (46% of survey participants) could be linked to the individual exposure information in the Asbest Chrysotile Cohort because survey participants identified themselves by providing their full names on their returned survey questionnaires (figure 1).

Survey questionnaire

The aim was to determine smoking behaviour, and this was ascertained using three questions: 'Have you smoked at least 100 cigarettes in your entire life?', 'Have you ever been a daily cigarette smoker, for a period of at least half a year?' and 'Do you currently smoke cigarettes on a daily basis?' If a respondent answered 'yes' to any of the smoking questions, they were categorised as an ever-smoker. If they were an ever-smoker, starting age, stopping age and number of cigarettes smoked in a typical day were in addition ascertained. Respondents were also asked for their date of birth, sex, work history (eg, age at start, years worked in total, and main profession at JSC Uralasbest and at other enterprises) and to optionally include their full names (first, patronymic and last names).

All answers from paper questionnaires were entered into a computer database by the data entry team. To assess the data entry quality, 57 problematic (eg, containing contradictory information) and 40 randomly selected questionnaires were scanned and sent to the International Agency for Research on Cancer (IARC) for double entry and comparison with the original data entry.

Occupational dust exposure

The exposure assessment and assignment for the workers in the Asbest Chrysotile Cohort is derived from a large database of dust measurements.[5] Measured occupational dust concentrations were systematically collected by the company's central laboratory across the factories (from 1951) and the mine (from 1964). An industry-specific job exposure matrix was constructed based on the measurements. When measurements were not systematically collected or available for a given period, exposure was modelled and extrapolated to cover all relevant years for all jobs. Estimated annual dust exposures by occupation were linked to each cohort member by job history within the company.

Statistical analyses

Participants were categorised as never-smokers or ever-smokers (smoking status) based on self-reported smoking behaviour. Trend tests in ever-smoking prevalence across birth decade (≤1940, 1941–1950, 1951–1960, 1961–1970, 1971–1980, ≥1981) were assessed. Logistic regression models were then fitted to estimate odds ratios (ORs) and 95% CIs for the relationship between smoking status and cumulative dust exposure. Continuous cumulative dust exposure was categorised into four categories: non-exposed (no occupational dust exposure) and terciles (<49.8, 49.8–97.3, >97.3) of cumulative dust exposure (mg/m^3-years). The terciles were assessed with cumulative dust exposure considering all professionally exposed workers. Models were adjusted for birth year (<1950, 1950–1970, >1970) and were performed separately by sex and by work area (mine/autotransport/external rail/explosion unit, enrichment factory/central laboratory, or both). Tests for linear trend in ORs were conducted treating the categorised cumulative dust exposure variable as an equally spaced ordinal variable in the logistic regression models. Associations between smoking and exposure to dust were also investigated using the exposure as a binary variable (exposed vs non-exposed). Homogeneity of ORs in those who were exposed was examined using a Wald-type test statistic comparing the model with a linearly restricted one, testing the null hypothesis of similar ORs for all exposed.

All analyses were performed using R statistical software V.3.4.3 (R Foundation for Statistical Computing, Vienna, Austria). P values are two sided, and the significance level was set to 0.05.

RESULTS

Smoking prevalence by birth decade and sex

Table 1 describes the characteristics of survey participants (3692 men and 3733 women), among whom 66% of men and 9% of women were ever-smokers. Among men, smoking prevalence was highest (>70%) in those born in 1961–1980, and slightly lower in earlier and later birth decades (p trend, 0.00015). Among women, the prevalence of ever-smokers increased steadily by birth decade, from <10% in women born before 1960 to 30% in those born after 1980 (p trend <0.0001) (Figure 2A, online supplementary table 4).

Among ever-smokers reporting average number of daily cigarettes (1989 men and 194 women), the majority of men (>70% in men born after 1950) reported smoking >10 cigarettes per day, whereas women generally reported smoking ≤10 cigarettes per day (Figure 2B, online supplementary table 4). The proportion of women smoking >10 cigarettes per day was higher among younger women than among older women.

Quality of data entry

Assessment of the quality of the data entry, that is the double data entry with comparison, demonstrated 100% consistency for questions related to smoking behaviour. Although work history was also correctly entered, this information was not sufficiently detailed to allow linkage to the cohort. Consequently, we restricted the analyses on smoking in relation to occupational dust exposure to respondents who could be linked to the Asbest Chrysotile Cohort via their full name and date of birth.

Smoking prevalence in relation to dust levels

Table 2 reports associations between levels of cumulative dust exposure and the risk of being an ever-smoker, and includes only respondents who revealed their identity on the questionnaire and thereby could be linked to the Asbest Chrysotile Cohort (n=4583 workers), for whom we estimated individual

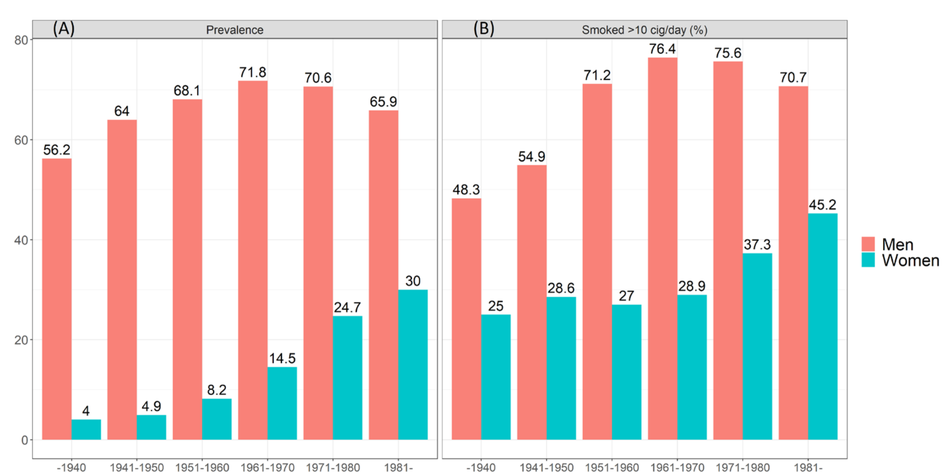

Figure 2 (A) Smoking prevalence among respondents (n=7425) in the JSC Uralasbest Tobacco Survey by birth decade and sex, and (B) percentage of ever-smokers (n=2183) who reported smoking an average of >10 cigarettes per day, by birth decade and sex. JSC, joint stock company.

Table 2 OR and 95% CIs of smoking by cumulative dust exposure, using tercile cut-off points, in the JSC Uralasbest tobacco survey

Cumulative dust exposure	Smoking status					
	Ever		Never			
(mg/m^3-years)	N	row %	N	row %	OR *	95% CI
Men						
No occupational exposure	70	68.6	32	31.4	1.00	
<49.8	491	70.4	206	29.6	1.01	0.64 to 1.58
49.8–97.3	502	67.0	247	33.0	0.99	0.62 to 1.54
>97.3	334	62.8	198	37.2	0.90	0.56 to 1.43
P value non-exposed versus exposed					*0.91*	
P for trend					*0.44*	
P for trend in exposed †					*0.67*	
Women						
No occupational exposure	10	3.2	305	96.8	1.00	
<49.8	49	7.1	643	92.9	2.11	1.09 to 4.49
49.8–97.3	48	7.5	591	92.5	2.57	1.33 to 5.47
>97.3	63	7.4	794	92.6	2.92	1.53 to 6.17
P value non-exposed versus exposed					0.006	
P for trend					0.002	
P for trend in exposed †					0.29	

*Adjusted for birth year (<1950, 1950–1970, >1970).
†Test for homogeneity in ORs among exposed.

cumulative occupational exposure to dust while working at the company.

There was a significant positive linear trend between cumulative dust exposure and smoking (p trend, 0.002) for women, but not for men (p trend, 0.44) (table 2). The observed difference in the proportion of smokers in women was between those that were not professionally exposed (3%) versus those professionally exposed to dust (from 7.1% to 7.5%) (p value, 0.006). Among the professionally exposed women, no (positive) trend was seen (p trend, 0.29).

The analyses on smoking in relation to cumulative dust exposure were repeated by work area, that is, for workers in the mine only, enrichment factories only, and both. The results were similar to the overall results but less precise; see online supplementary file, tables 1–3.

When restricting the model to heavy smokers (>10 cigarettes/day) in men (data not shown); (1) no association between dust exposure and smoking was found (p value, 0.23); and (2) no support for heterogeneity of ORs across dust categories in those who were professionally exposed was found (p value, 0.51). Women who reported smoking >10 cigarettes per day were too few to perform this analysis (n=17 ever-smokers).

DISCUSSION

Principal findings

This cross-sectional survey on tobacco smoking among 2993 current and 4432 retired workers of JSC Uralasbest showed consistently high smoking prevalence in the male workforce (ranging from 56% to 72% by birth decade), particularly among those born in 1961–1980. Among women, there was lower but increasing smoking prevalence in recent birth decades (ranging from 4% in early to 30% in late birth decades). Smoking prevalence in women differed significantly between those professionally exposed and those not professionally exposed, and this needs to be accounted for in the forthcoming risk analysis in the Asbest Chrysotile Cohort. Nevertheless, smoking was not associated with levels of cumulative dust exposure in either women or men.

Comparison with other studies

Our results are consistent with three national general population surveys in the Russian Federation conducted in 1996 and 2004 for the New Russia Barometer programme, and in 2008–2010 for the Global Adult Tobacco Survey.[6–8] Similar to our findings, smoking prevalence was high and relatively stable among men, with a peak in smoking prevalence (74%) in men born in the 1960s. Among women, increasing smoking prevalence was observed among younger generations. The Russia Longitudinal Monitoring Survey (1992–2003) confirmed that smoking among women has increased, especially in the least educated and in women living in rural areas.[9] Although not representative of the Russian population, our results show similar patterns in this specialised workforce, namely employees of a chrysotile-producing industry, which is as such an interesting finding. Both our results and the national surveys, however, should be interpreted with caution for the elderly, because they are more likely to have died if they were heavy smokers compared with never-smokers at the same age, and therefore, smokers may be under-represented in any survey at old age.

Strengths and limitations

Strengths of our survey include a large number of respondents, and the linkage with individual exposure estimates of cumulative dust for almost half of the respondents as they were successfully linked to the Asbest Chrysotile Cohort study. Only 10% of questionnaires from active workers were not used, due to incomplete data. Because these self-administered questionnaires were filled in during mandatory meetings at the workplace, it cannot be ruled out that some of the workers were conservative in their responses due to the perception that documenting unhealthy behaviours could lead to negative consequences from their employer. This may explain why only 17% of the invited active workers identified themselves by putting their names on the questionnaire, enabling linkage to the Asbest Chrysotile Cohort. Data collection among retired workers took place at meetings, in homes, or via telephone interviews, so the completeness and consistency were generally better and only

3% of the pensioners' questionnaires were excluded due to poor quality.

Assessing smoking behaviour retrospectively may be subject to recall bias, and perhaps even more so among the eldest age groups who in this survey showed the lowest prevalence of smoking. However, Brigham *et al* have examined the reliability of retrospective tobacco use measures and concluded that 'few differences in the reliability of recall were apparent between sexes and between age groups'.[10] So we interpret underrepresentation of smokers in the oldest age group rather as a survivor effect because smokers in these age groups might have died more often prior to survey administration than the never smokers.

We analysed the association between smoking status and mode of data collection, finding that women who smoked were more often interviewed at home than those who never smoked (p value, 0.009). One potential explanation could be that smokers experience worse health and therefore do not participate in events of the Veterans Council. A large proportion (~60%) of people included in our survey did not answer the question about current smoking status, which is why we based the'"ever-smoker' status on a group of questions (see the Methods section).

These survey findings should be used to inform tobacco prevention programmes at JSC Uralasbest, especially because the proportion of female smokers is increasing.

CONCLUSION

In this survey on smoking behaviours in an industrial workforce, we confirm similar patterns as in published national surveys from the Russian Federation. In addition, we observed that smoking behaviour in current and retired workers at JSC Uralasbest does not appear to be associated with levels of cumulative dust exposure. Hence, in the risk analyses of cumulative dust exposure and cancer mortality, confounding by smoking may not be a major issue even for the tobacco-related cancers. However, adjustment at the age group level is needed to reduce residual confounding and account for smoking patterns among women, which have changed substantially over time. Furthermore, identification of age, sex and calendar time-specific patterns in this workforce being similar to national trends suggests that these patterns are likely to apply to other collectives of workers in the Russian Federation. The observed high smoking prevalence spanning over decades suggests that in general Russian male workforces have high tobacco-related disease burdens.

Author affiliations
[1]Section of Environment and Radiation, International Agency for Research on Cancer (IARC), Lyon, France
[2]Federal State Budgetary Scientific Institution "Izmerov Research Institute of Occupational Health", Moscow, Russian Federation
[3]I.M. Sechenov First Moscow State Medical University (Sechenov University), Moscow, Russian Federation
[4]Radiation Epidemiology Branch, National Cancer Institute Division of Cancer Epidemiology and Genetics, Bethesda, Maryland, USA
[5]Cancer Research Division, Cancer Council New South Wales, Woolloomooloo, New South Wales, Australia
[6]School of Public Health, Sydney Medical School, The University of Sydney, Sydney, New South Wales, Australia
[7]Yekaterinburg Medical Research Center for Prophylaxis and Health Protection in Industrial Workers, Yekaterinburg, Russian Federation
[8]Institute for Risk Assessment Sciences, Utrecht University, Utrecht, The Netherlands

Acknowledgements The work by Schonfeld on this manuscript was supported by the Intramural Research Program of the US National Cancer Institute, National Institutes of Health. The authors are grateful to Karen Muller for language editing.

Contributors Material preparation was performed by EVK, SJS, EO, MM, EF and JS; data collection was coordinated by EVK, SVK and IVB; the dust exposure assessment was conducted by EF and HK; and data management and analysis were planned and performed by JS, MT, GB, AO, MM and LB. The first draft of the manuscript was written by AO, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding This survey is funded by the Ministry of Health of the Russian Federation in the framework of the Federal Target Program 'National System of Chemical and Biological Safety of the Russian Federation' of 2009–2014 and of 2015–2020.

Disclaimer Where authors are identified as personnel of the International Agency for Research on Cancer/World Health Organization, the authors alone are responsible for the views expressed in this article, and they do not necessarily represent the decisions, policy, or views of the International Agency for Research on Cancer/World Health Organization.

Competing interests EVK and SVK reported receiving, on behalf of their institutes and personally through consulting firms, payments from companies to evaluate exposure to asbestos and risk of asbestos-related disease in those workplaces. All other authors have no competing interests to declare. For full transparency, EVK reported participation as an occupational and environmental health expert as part of the delegation of the Russian Ministry of Health at multiple World Health Assembly meetings as well as at the Conference of the Parties to the Basel and Rotterdam Conventions. EVK and SVK reported attending meetings organized by the International Chrysotile Association and reported that all expenses for attendance were paid by their respective institutes.

Patient consent for publication Not required.

Ethics approval The cohort was approved by the IARC Ethics Committee (IEC) in September 2012 (No. 12–22) and the IEC monitors the progress of the cohort study on an annual basis.This survey was approved by IEC in July 2016 (No. 16–24) and by the Federal State Budget Scientific Institution Research Institute of Occupational Medicine in Moscow on 19 October 2016.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The data are not publicly available.

ORCID iDs
Ann Olsson http://orcid.org/0000-0001-6498-2259
Madar Talibov http://orcid.org/0000-0002-6548-358X
Hans Kromhout http://orcid.org/0000-0002-4233-1890

REFERENCES

1. Schüz J, Schonfeld SJ, Kromhout H, *et al*. A retrospective cohort study of cancer mortality in employees of a Russian chrysotile asbestos mine and Mills: study rationale and key features. *Cancer Epidemiol* 2013;37:440–5.
2. IAfRo C. *IARC monographs on the evaluation of carcinogenic risks to humans, volume 100 E. personal habits and indoor combustion*. Lyon, France: IARC, 2009. http://publications.iarc.fr/122
3. Kuntz B, Kroll LE, Hoebel J, *et al*. [Time trends of occupational differences in smoking behaviour of employed men and women in Germany : Results of the 1999-2013 microcensus]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2018;61:1388–98.
4. Dunbar MS, Shiffman S, Chandra S. Exposure to workplace smoking bans and continuity of daily smoking patterns on workdays and weekends. *Addict Behav* 2018;80:53–8.
5. Schonfeld SJ, Kovalevskiy EV, Feletto E, *et al*. Temporal trends in airborne dust concentrations at a large chrysotile mine and its Asbestos-enrichment factories in the Russian Federation during 1951-2001. *Ann Work Expo Health* 2017;61:797–808.
6. McKee M, Bobak M, Rose R, *et al*. Patterns of smoking in Russia. *Tob Control* 1998;7:22–6.
7. Bobak M, Gilmore A, McKee M, *et al*. Changes in smoking prevalence in Russia, 1996-2004. *Tob Control* 2006;15:131–5.
8. Giovino GA, Mirza SA, Samet JM, *et al*. Tobacco use in 3 billion individuals from 16 countries: an analysis of nationally representative cross-sectional household surveys. *Lancet* 2012;380:668–79.
9. Perlman F, Bobak M, Gilmore A, *et al*. Trends in the prevalence of smoking in Russia during the transition to a market economy. *Tob Control* 2007;16:299–305.
10. Brigham J, Lessov-Schlaggar CN, Javitz HS, *et al*. Reliability of adult retrospective recall of lifetime tobacco use. *Nicotine Tob Res* 2008;10:287–99.