Carpathian Journal of Earth and Environmental Sciences, July 2017, Vol. 12, No. 2, p. 395 - 402

PREDICTION MODEL ON ASBESTOS USE AS A RISK FACTOR FOR THE RESPIRATORY SYSTEM CANCER IN COMMUNITIES FROM NORTHERN ROMANIA

Elena MATEI[1], Daniel LUCHES[2], Vasile EFROS[3] & Despina SAGHIN[3]

[1]*Department of Human and Economic Geography, Bucharest University, N. Bălcescu Av., No 1, Bucharest, ROMANIA*
Emails: elena.matei@g.unibuc.ro
[2]*Department of Sociology, Timişoara West University, Pârvan Vasile Av., No. 4, Email: dluches@socio.uvt.ro*
[3]*Department of Geography, „Ştefan cel Mare" Suceava University, University Street, No 13, Suceava, Romania.*
Emails: vasile.efros@atlas.usv.ro, despina.saghin@usv.ro

Abstract: Although building materials based on asbestos were banned in Romania, some poor communities continue to use them mainly for housing roofs purposes. In this context, the study is focused on several selected settlements from Northern Romania, where population is potentially exposed to the asbestos pollution. The aim of the research is to find out a predictive model of the factors which potent the incidence of respiratory system cancer deaths in the last twenty-five years for an environment characterized by a high presence of mainly old asbestos roofs. Based on field observations and data collection a statistic multiple linear regression method was used in a background of death rate and proportion dying of a specific cause landscape. Results showed that the highest incidence of lung cancer deaths occurred in smoking and material particles pollution including asbestos of workspace conditions associated with asbestos households use. However, the model estimation needs to be continued by next studies based on a measurement of pollution levels, both indoor and outdoor exposure cases. Yet, the identified findings may help to build forecasting of sickness trends in communities asbestos roofing and in urge prevention and imposing co-environmental policy from local to national authorities for the decommissioning of these materials.

Keywords: asbestos roofs, lung cancer, death, lifetime's model, Northern Romania

1. INTRODUCTION

Asbestos, a mineral originating from the group of fibrous silicates has been known since the Antiquity. However, mainly four types: chrysotile-white [$Mg_3(Si_2O_5)(OH)_4$] (serpentine), crocilodite-blue [Na_2Fe_5 (Si_8O_{22}) $(OH)_2$]; amosite-brown [$(FeMg)_7$ (Si_8O_{22}) $(OH)_2$]; anthophyllite [$(MgFe)_7$ (Si_8O_{22}) $(OH)_2$] (amphibolites) use have extended after World War II (Moerman et al., 2011), particularly for brake linings, building materials, fire resistant clothing and insulation (Gergelová, et al., 2006; Kakooei et al. 2009; Bourgault et al., 2014). Although knowledge of the pathogenicity of asbestos fibers have linked them to asbestosis by 1930, to lung cancer by 1948-1950 and to mesothelioma since 1959, the last one being considered both an occupational and environmental disease (Braun, 2008; Moerman et al., 2011), in Romania until the 90's there were numerous building materials factories with asbestos processing departments at Bicaz, Oradea, Aleşd, Târgu Jiu, Fieni, Rîmnicu Sărat, Bucureşti, Medgidia. Among manufactured products containing asbestos we can enumerate the insulation materials, adhesives, considered to be more dangerous but also corrugated or flat asbestos-cement with potential pollution of soil, water and air through handling, deterioration or different works for cleaning, repairing or demolition. While the use for the first materials cannot be estimate, the last are visible in the settlements' landscape; because many residents have used them for house roofing, especially in areas with wetter and cool climates, being resistant both fire and humidity. The residential property roofing was specific during the communist regime, but also enhanced after 1990, when economic changes occurred with the closure of some factories and profile change or re-technologisation of others, which caused available building materials to be sold at very low prices. Although these materials containing asbestos have been banned in many world countries in the late twentieth century, in Romania, the first restrictions on the use of asbestos were introduced in 2003 by GD (Government Decision) no. 124 and in 2006 by GD no. 734, which however allow the use of asbestos products until the end of their life cycle (Matei et al., 2015). Thus, the counties that occupy first places in the use of corrugated material for roofing of houses, of public institutions or certain companies are: Botoşani, Suceava, Hunedoara, Maramureş, Iaşi, Vaslui, Neamţ etc.

Given that most studies have focused on analyzing the effects of asbestos in occupational environments, the present research focuses on the potential effects of out/indoor asbestos pollution on population health in several rural and urban settlements in the North-Eastern Region of Romania, i.e. Botoşani and Suceava counties. Here, the exposure to materials which contain asbestos could be considered higher, as they are often used for roofing of houses and subsidiary buildings, usually raised by householders themselves.

In addition, there are numerous studies that reveal the relation between the presence of asbestos and the occurrence of lung cancer, even of mesothelioma (Spirtas et al., 1988, Dodson et al., 1991, Bruno et al., 1996, Magnani et al., 2000, Metintas et al., 2002, Gorini et al., 2005, Luo et al., 2005, Suzuki et al., 2005; Hasanoglu et al., 2006, Marinaccio et al., 2007, Berk et al., 2013). It is also known that asbestos can also produce pulmonary abnormalities, such as pleural plaques and thickening, which are often asymptomatic and may not develop into serious illnesses (Barnes, 2008, Ates et al., 2010) or can cause pneumoconiosis (Haigh, 2006) or other extra pulmonary effects (Bunderson-Schelvan et al., 2011).

Moreover, the carcinologic effects are proven to be long lasting. There is a long latency period between inhalation and clinical disease (Rosell-Murphy et al., 2010), as the risk of suffering from a malignant mesothelioma increases with age, and depends on time of exposure, the level of exposure, as well as continuity of exposure (Peto et al., 1995). The latency period between the inhalation of asbestos fibers and ARD (Asbestos Related Diseases) is estimated to be around 15 years by Rosell-Murphy et al., (2010) or approximately 15–40 years, although there have been cases in which the mesothelioma cancer latency was as short as 5 years and as long as 50 years after the exposure to asbestos cancer occurred (Gato & Di Tanna, 2012). It is also recognized that not everybody that has been or is in contact with asbestos develops ARD (Rosell-Murphy et al., 2010), but most findings reveal that the non-work related exposures that can cause ARD are the consequence of fibers' inhalation when living near an asbestos source (Magnani et al., 2000, Senyiğit et al., 2000).

In recent years, in Europe, an increasing number of non/epidemiological studies have drawn attention on the cocarcinogenic potential of asbestos which needs to be considered as a possible health threat (Bunderson-Schelvan et al., 2011). While in Italy (Marinaccio et al., 2007; Gato & Di Tanna, 2012), and Germany (Hagemeyer et al., 2006) the work exposure studies prevail, in Spain (Rosell-Murphy et al., 2010), Poland (Szeszenia-Dąbrowska et al., 2012), Slovacia (Gergelová el al., 2006) environmental asbestos pollution as whole is analyzed including asbestos sheets for roofs.

Even the asbestos cement sheets (ACS), flat or corrugated, contain apparently low proportions of asbestos ranging from 12% till 18% (Bassani et al., 2007), taking into account the study of Marabini et al., (2002), we may estimate that 1000 m^2 of ACS are equivalent of 12,8 t asbestos mineral potential harmfully. Many authors proved that, in ice, wind conditions or in building, crushing operations (Tadas et al., 2011) became friable and airborne (Bassani et al., 2007, Hansen & Stang, 2009, Ansari et al., 2010, Kim et al., 2016). Others calculated the yearly amount of discharge by natural erosion (Zhang et al., 2016).

In Romania, the scarcity of asbestos pollution studies, except mass media, and of the environmental systematic measurements, together with the high frequency of roofing buildings by householders themselves, represent the starting point of this study. In this background, the paper aims to provide an explanatory model outlining the influence of factors that can help reduce the age of occurrence of death from lung cancer in roofing asbestos communities, having no information about its risk. Our research is thus based on the analysis of the death cases arising from lung cancer over the past 25 years in the selected communities. In this regard, the present study has as phased research aims: i) the comparative analysis of mortality dynamics in both urban and rural areas, and between settlements and national average;

ii) analysis of the incidence of mortality by cause of death, highlighting the carcinogenic respiratory diseases (lungs, bronchi, trachea, pharynx) in the selected settlements;

iii) rebuilding the array of (synergic) environmental factors for each identified case, in order to create a data base in lack of air pollution measurements for a predictive statistical analysis about the influence of risk factors in respiratory/lungs cancer death cases in the asbestos roofing communities, which can help further in-depth research upon disease occurrence as a result of the presence of asbestos in households and hence, urgent legislative measures can be enforced to ensure the right to a clean environment.

2. RESEARCH METHODS AND DATA SOURCES

For the present analysis, seven settlements in the geographical area of northern Romania were selected, where the density of households roofed with asbestos is presently very high, i.e. more than 1/5. Two of the selected settlements are located in mountain hollows, one in the sub mountain area; another in the higher elevation hilly area and three on slopes with eastern, southern and western aspects, on the E-W axis on the 48º N parallel, at a maximum distance of 100 km from one another. All the study sites are characterized by similar climate and living conditions (Fig. 1).

The first research step was obtaining approvals for data collection and on-site mapping. Data obtained from the local population register offices, respectively the death certificates, (Camus et al., 1998), were centralized based on causes of death from all diseases, on gender (gender) and age, for the last 25 years (1990-2014). For the respiratory system, since the collected data did not detail diagnosis, we took into account mortality caused by both pulmonary neoplasm (which prevailed), and neoplasm of the other airways.

As part of the analysis, the following indices were calculated:

a. *mortality index:*

$$Dr = \frac{D}{P} \cdot K \qquad (1)$$

where “D” is the number of deaths and “P” is population, K is 1000 inhabitants, (Dumitrache, 2004);

b. *mortality incidence by cause of death:*

$$Csr = \frac{Sd}{D} \cdot k \qquad (2)$$

Csr - proportion dying of a specific cause; Sd-a specific disease; D-number of deaths; k is 100, (Dumitrache, 2004).

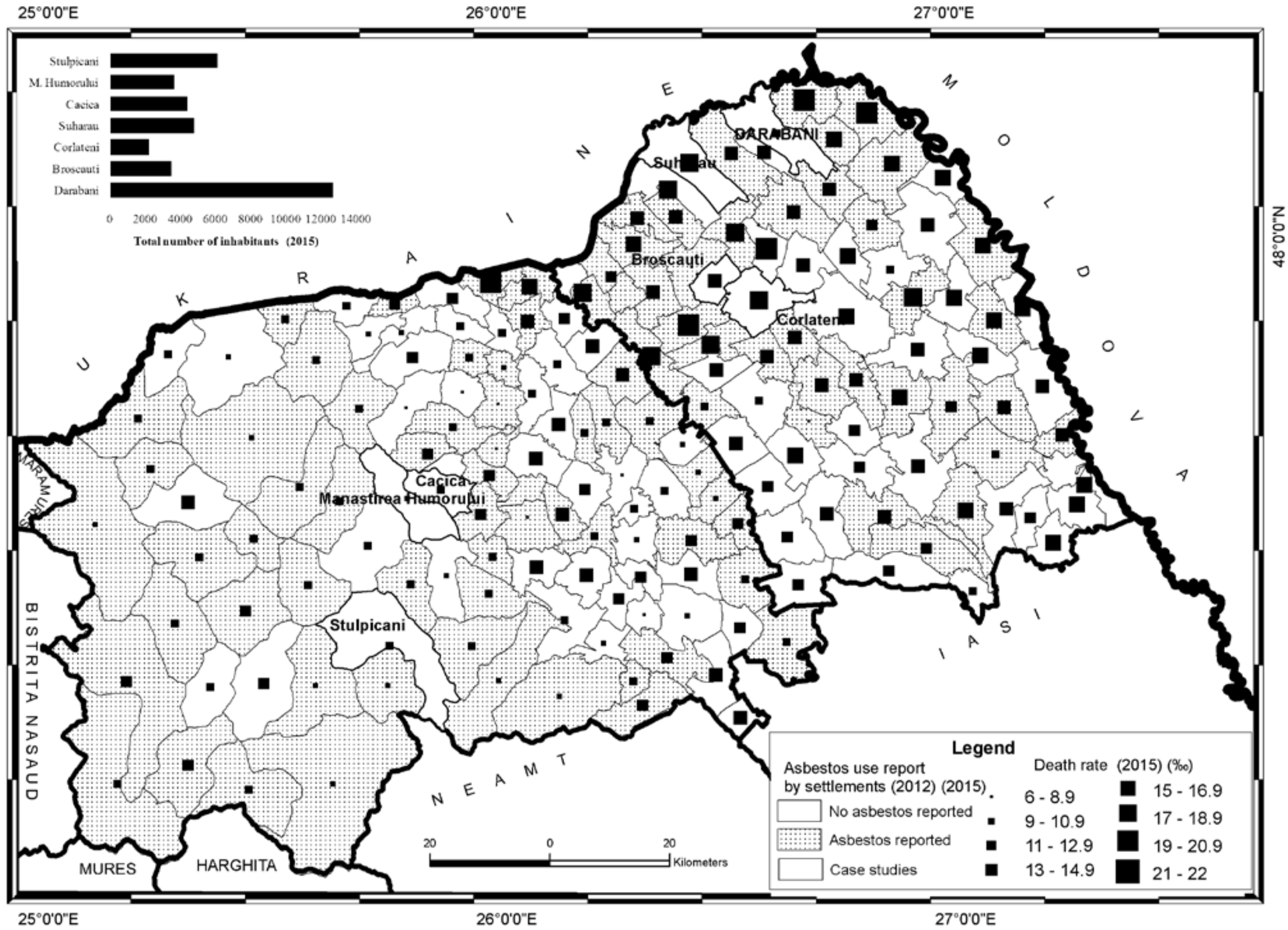

Figure 1. Death rate and asbestos use report by settlements in Suceava and Botoşani counties. Source of processed data: National Institute of Statistics (NIS), National Agency of Environmental Protection (NAEP) (2012), completed with field observations (2015).

To reconstruct the array of factors triggering or enhancing respiratory system cancer, we interviewed the population, the staff of post offices in the villages, town halls, schools located in the study area, which allowed us to identify in the field the households where people who died over the last 25 years from respiratory tumors were living. We then checked or reconstituted the use of asbestos for roofing of personal houses, subsidiary buildings and neighboring households. For each case a field investigation was conducted to reconstitute the main factors which potentially favor the occurrence of lung cancer. For professional PMs risk, we took into consideration mining, glass factory, textile, drivers and some cases from agriculture (Paglietti et al., 2016). This was useful in correlating asbestos pollution with work place and habits of the deceased (smoker, non-smoker) as important risk factors. To centralize and statistically process the information collected in the field, the Statistical Package for the Social Sciences (SPSS) v.20 (IBM, SPSS Inc., 2011) was used and the multiple linear regression (stepwise) was applied, plus descriptive statistics.

3. RESULTS AND DISCUSSIONS

Based on the analyzed data we found that all seven settlements have higher death rate values than the average of the rural/urban areas or of Romania (Fig. 2). Lung cancer specific mortality of all deaths caused by cancer shows alarming proportions, i.e. an average of 3.5% over the studied period, ranging between 13% (1991, Darabani), 12.1% (2000, Suharău), 17.7% (2002, Broscăuţi) (Fig. 3). Such numbers point towards the presence of a favoring factor of lung cancer occurrence in these cases.

Analysis of deaths by gender, using descriptive statistics, demonstrates that these conditions are frequent in male population (80.8%). The male-to-female ratio is 5:1 (Fig. 4.), while the age of the men ranged from 22 to 94 years (mean, 66.1 ± 10.9 years), women ranged from 16 to 90 years (mean, 71.2±12.4 years). This is because males are usually, involved in heavy labor in the household etc.

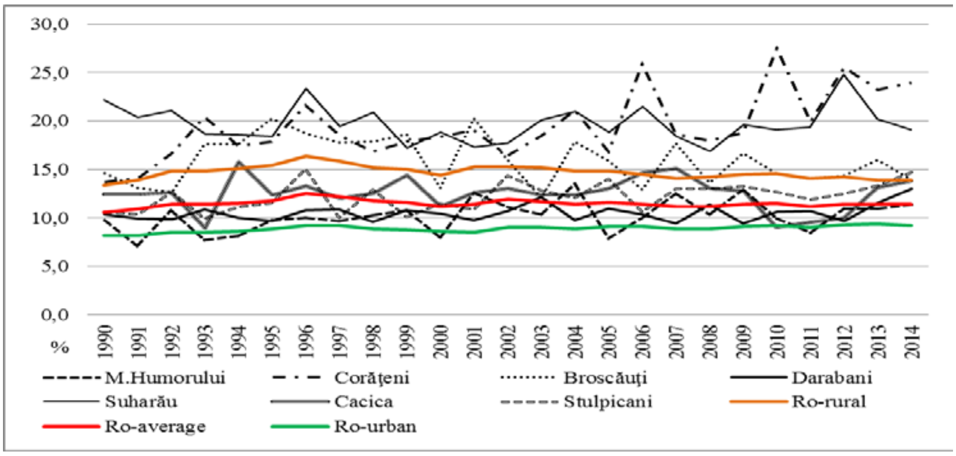

Figure 2. Comparative death rate between Romania and studied settlements (1990-2014). Authors' calculations after NIS data

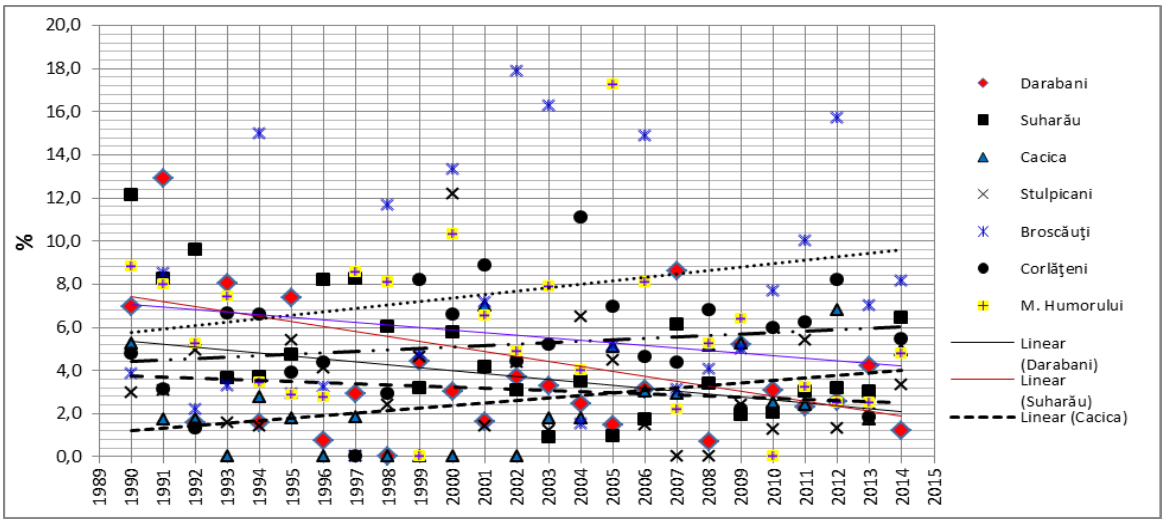

Figure 3. Comparative dying of a specific cause (lung cancer) trends in studied settlements (1990-2014), (%). The authors' calculations after the Mayor Halls' data.

Moreover, they also have a quite high associated risk, namely smoking (52.6%) given that smoking and other toxins increase the risk of asbestos-associated lung cancer (Rosell-Murphy et al., 2010). Nevertheless, the fact that respiratory system cancer also affects non-smoking women can be correlated with the presence of some factors, among asbestos use in the residential environment. In the case study, the mean age of death for non-smokers is 70.3±12.0, and decreased for smokers at 64.1±10.0.

To highlight the influence of analyzed factors on death rates, we observed that these settlements showed differences in the incidence of factors favoring lung cancer deaths (Table 1). If, generally, the age of the cohort involved in non-dangerous jobs is 68.3±11.4, varying from 16 to 94 years old, that under the workplace risk has a mean age of 64.1±10.8, with minimum 33 and maximum 90 years old. Consequently, Cacica and Stulpicani have a higher number of professional PMs risk as they are known by mining activities. Regarding the asbestos used in housing as risk factor, the average age of non-exposed cases ranged from 33 to 94 years, mean 68.3±11.1years, comparing with asbestos roofing houses mean of 64.8±11.6 years, starting from minimum 16 up to 90 years. We, also, geographically found that Stulpicani, Darabani, Cacica and Suharău have huge proportions of asbestos roofed houses, and the highest spreading of workspace buildings in build-up areas, many of them in an advanced state of deterioration or which became actual informal waste disposal places (Fig. 5).

For studied settlements, an aggregate indicator (risk index) was calculated, as a result of the influence exerted by the following factors: a lifetime smoking habit (noted “smoking”), a work place with high degree of exposure to risk of air pollution with material particles (MPs) (named “workplace”), house roofing with asbestos (named “house”), roofing of subsidiary buildings with asbestos, the existence of a house in the neighborhood with roof covered with asbestos (“neighborhood”), subsidiary buildings in the neighborhood roofed with asbestos (“subsidiary”).

To capture a potential statistical relationship between age at which death occurred and the risk index, the Bravais Person correlation coefficient was computed for all settlements. The values of correlation coefficients highlight the existence of a relationship of covariance (r = -0.319, p <0.000, N =546).

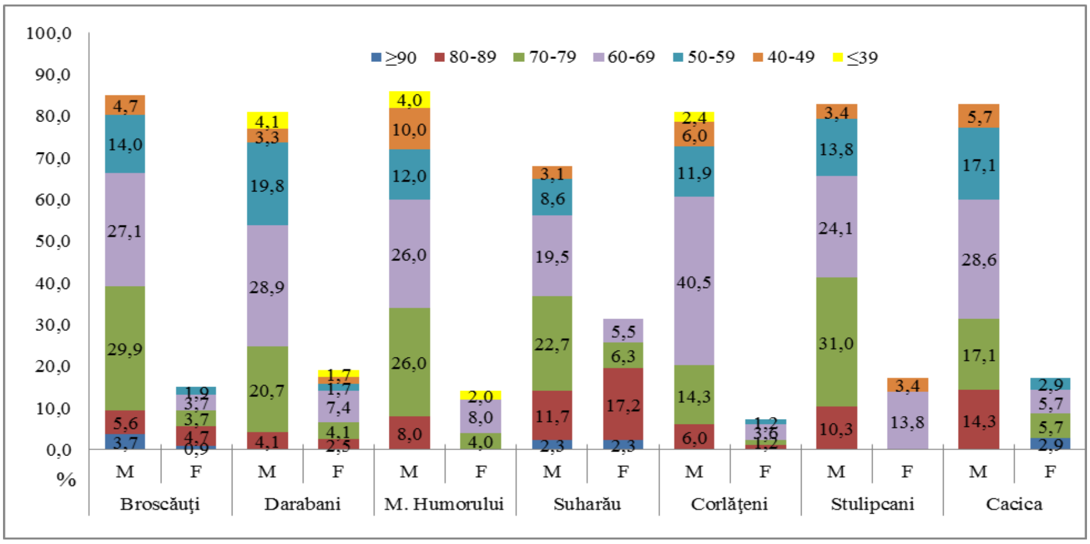

Figure 4. Mortality age groups by respiratory system cancer (1990-2014) The authors’ calculations after the Mayor Halls’ data.

Table 1. Reconstruction of potential factors cases in respiratory system cancer in studied settlements (1990-2014)

	Statistics of the cases (N=546)				
Settlements	Total cases	Professions with PMs risks (%)	Asbestos roofing houses (%)	Asbestos roofing subsidiary buildings (%)	Smokers (%)
Cacica	35	40.0	68.6	42.9	71.4
Suharău	127	5.5	38.6	13.4	37.0
Stulpicani	29	51.7	86.2	58.6	48.3
Darabani	119	29.4	56.3	50.4	58.0
Broscăuţi	103	28.2	3.9	24.3	73.8
Corlăţeni	85	37.6	16.5	36.5	47.1
M.Humorului	48	20.8	22.9	60.4	25.0

Note: Professions with PMs risks including asbestos: car and tractor driving, railways job, buildings, mining, textile working, glass working and agriculture inside the former Farming Machine Station or deposits.

Figure 5. The spreading of asbestos roofing and waste. Darabani town

To identify the influence of each factor on the age at which death occurred (criterion) we used a multiple regression analysis, where we opted to build a stepwise regression model. The decision to use such a model was made to gradually control the predictors, i.e. the influence exerted by factors such as systematic or occasionally exposure to asbestos through the dwelling of the house roofed with asbestos sheets, the habit of life-long smoking and not least having a work place with risk of exposure to asbestos. All four predictors were assessed because we could identify the specific houses and analyze the corresponding medical records. The factors *the existence of a house in the neighborhood that is covered with asbestos* have shown no covariance relation with the variable *age at which death occurred*, and consequently they were not considered influential predictors in the model. Analyzing the regression models constructed for all data (Table 2), we found for the *model 1*, where the smoking is the only predictor factor explained nearly 43.1% of the influence of external factor on the age at which death occurred. Regarding *model 2*, where 2 predictor factors were used the conjoined influence on age of death is only up to 26.8%. *Model 3* explained 21.2 % while *Model* 4 is lower, respectively 17%.

Regression equation for the last model is:

*Age of death = 72.501 years; -5.365*smoking; -2.3989*work place; -2.780*house roofed with asbestos; - 2.045* subsidiary* with asbestos.

In this case, the death risk is situated at approximate at 72 years if the influence of the four predictors is null, a value close to the Romanian life expectancy rate. But, if the predictor factors coexist, the death risk is around the age of 60. The riskiest factor is smoking, followed by air pollution at workplace, then, the use of asbestos in household buildings and subsidies. At a deeper analyzing, it may be observed that in these communities with many asbestos roofing practices, smoking remains the main risk but demonstration about its supra-additive effect (Markowitz et al., 2013) is impossible at this stage. The second predictive factor prevalence could be explained by people involved in sand quarries, salt mines, glass factory etc. considered MPs pollution environment. Analyzing the obtained model, we may say that it confirms our hypothesis that death is more likely to occur if the risks are higher (by risks we refer to the factors analyzed in the present study) giving a starting point for further studies on asbestos potential pollution.

Table 2. Constructed regression model.

Model		Cluster A				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	70.378	0.685		102.678	0.000
	smoking	-6.211	0.945	-0.271	-6.570	0.000
2	(Constant)	71.088	0.717		99.170	0.000
	smoking	-5.789	0.948	-0.253	-6.109	0.000
	workplace	-3.281	1.049	-0.129	-3.126	0.002
3	(Constant)	71.992	0.771		93.315	0.000
	smoking	-5.466	0.947	-0.239	-5.775	0.000
	workplace	-3.341	1.042	-0.132	-3.207	0.001
	house	-2.960	0.976	-0.124	-3.032	0.003
4	(Constant)	72.501	0.808		89.777	0.000
	smoking	-5.365	0.945	-0.234	-5.677	0.000
	workplace	-2.989	1.052	-0.118	-2.841	0.005
	house	-2.780	0.977	-0.116	-2.845	0.005
	subsidies	-2.045	0.988	-0.086	-2.069	0.039

Source: Extract from SPSS output

4. CONCLUSIONS

Analysis of deaths occurred from respiratory system tumors over the last 25 years was performed for 7 settlements located in the North-Eastern Region of Romania, where asbestos is commonly used as a building material for house roofing.

The study revealed that there is a statistical relationship between occurrence of respiratory system cancer, particularly lung cancer and environmental pollution in settlements with a high incidence of asbestos use, where population had no information about its danger for health, being involved in manipulation work during their life. Furthermore, our results highlighted the fact that this risk is multiplied by smoking habits which can be considered as the first factor, and the air pollution with MPs in work space. The existence of triggering or enhancing factors and can reduce life expectancy of these communities with almost 13 years.

The original contribution of the present research consists in the demonstration of a predictive statistical approach about the influence of risk factors in respiratory/lungs cancer death cases in the asbestos roofing communities from Northern Romania. We can rate the obtained results as satisfactory and a good starting point for further research. Predictions found can be useful instruments both in scientific research, and especially to facilitate risk management (Bourgault et al., 2014) in asbestos roof communities by local authorities and can be included in the strategies aimed at changing current laws which still allow continuance of asbestos use until the end of the product life cycle. Using this study, we may continue to a deeper analyze using air quality measurements and other ways of specific investigation.

Acknowledgements

The authors thank the local authorities of the communes: Stulpicani, Corlăţeni, Broscăuţi, Mânăstirea Humorului, Cacica and Darabani town, the family physicians from Cacica and Darabani, the employees of the Romanian Post Office, the teachers from Stulpicani and the local administrations workers who have facilitated data collection and fieldwork, and understood the importance of the study from a scientific standpoint, but also as feedback to communities who still use asbestos.
All co-authors had equal contributions in this paper.

REFERENCES

Ansari, F. A., Ashquin, M., Siddiqui, H., Prasad, R., Khan, M.I., & Ahmad, I., 2010. *Workplace atmospheric asbestos levels in different plants, manufacturing asbestos cement roofing sheets in India.* Atmospheric Pollution Research, 1, 128-131.

Ates, G., Yildiz, T., Akyildiz, L., Topcu, F., & Erturk, B., 2010. E*nvironmental asbestos-related pleural plaques in Southeast of Turkey*, Archives of Environmental & Occupational Health. 65, 34–37.

Bassani, C., Cavalli, R. M., Cavalcante, F., Cuomo, V., Palombo, A., Pascucci, S., & Pignatti, S., 2007. *Deterioration status of asbestos-cement roofing sheets assessed by analyzing hyperspectral data.* Remote Sensing of Environment, 109,361–378.

Barnes, J., 2008, *Courts and the Puzzle of Institutional Stability and Change. Administrative Drift and Judicial Innovation in the Case of Asbestos*. Political Research Quarterly, 61, 4, 636-648, Sage.

Berk, S., Yalcin, H., Dogan, O. T., Epozturk, K., Akkurt, I. & Seyfikli, Z., 2013. *The assessment of the malignant mesothelioma cases and environmental asbestos exposure in Sivas province, Turkey*. Environ Geochem Health, DOI 10.1007/s10653-013-9518-y.

Bourgault, MH., Gagné, M., & Valche, M. 2014. *Lung cancer and mesothelioma risk assessment for a population environmentally exposed to asbestos.* International Journal of Hygiene and Environmental Health, 217, 2–3, 340–346.

Bunderson-Schelvan, M., Pfau, J.C., Crouch, R., & Holian, A., 2011. *Nonpulmonary Outcomes of Asbestos Exposure.* Journal of Toxicology an Environmental Health, Part B, 14, 122–152.

Braun L., 2008. *Structuring silence: asbestos and biomedical research in Britain and South Africa,* Race & Class, 50, 1, 59-70, Sage.

Bruno, C., Combat P., Maiozzi, P., & Vetrugno, T., 1996. *Accuracy of death certification of pleural mesothelioma in Italy*, Eur J Epidemiol, 12, 4, 421–423. doi:10.1007/BF00145308.

Camus, M., Siemiatycki, J., & Meek, B., 1998. *Nonoccupational exposure to chrysotile asbestos and the risk of lung cancer*. N Engl J, Med, 338, 22, 1565–1571.

Dodson, R. F., Williams, M.G, Jr., Corn, C.J., Brollo, A., & Bianchi, C., 1991, *A comparisonof asbestos burden in lung parenchyma, lymph nodes, and plaques*. Ann. NY Acad.Sci. 643, 53–60.

Dumitrache, L., 2004. *Starea de sănătate a populaţiei României, O abordare geografică (The health state of the Romanian population. A geographical approach, In Romanian)*, Univers Enciclopedic Publishing House, Bucharest.

Gato, M.P., & Di Tanna, G.L., 2012. D*istribution and trends in mesothelioma mortality in Italy from 1974 to 2006.* Int Arch Occup Environ Health. 86, 489–496, DOI 10.1007/s00420-012-0780-6.

Gergelová, P., Šulcová, M., & Hurbánková, M., 2006. *Asbestos exposure and its health effects, in Donnelly, K.C., and Cizmas, H., Leslie (eds.),* Environmental Health in Central and Eastern Europe, 97-104. Springer, Netherlands.

Gorini, G., De Gregorio, G., Silvestri, S., Chellini, E., Cupelli, V., & Seniori Costantini, A., 2005. *Survival of malignant pleural mesothelioma cases in the Tuscan Mesothelioma Register, 1988–2000: a population-based study*, European Journal of Cancer Prevention, 14, 3, 195-199

Government Decision No 124/2003 (30.01.2003), o*n the prevention, diminution and control of environment pollution with asbestos in Romania, Official Gazette, no 109, 20 February, 2003, In Romanian. Hotărârea de Guvern, Nr 124 (30.01.2003), privind prevenirea, reducerea şi controlul poluării mediului cu azbest, 2003,* Monitorul Oficial, nr.109 din 20 Februarie, 2003.

Government Decision No 734/2006, (07.06.2006), *amending Government Decision no.124 / 2003 on the prevention, reduction and control of environmental pollution by asbestos, Official Gazette, no.519/15.06.2006. In Romanian Hotărârea de Guvern nr. 734/2006 (07.06.2006) pentru modificarea Hotărârii Guvernului nr.124/2003 privind prevenirea, reducerea şi controlul poluării mediului cu azbest*, Monitorul Oficial, nr.519/ 15.06.2006.

Haigh, G., 2006. *Asbestos House: the secret history of James Hardie Industries,* Gideon Haigh Scribe Publications, Melbourne, 21.

Hagemeyer, O., Otten, H., & Kraus, T., 2006. *Asbestos consumption, asbestos exposure and asbestos-related occupational diseases in Germany*. Int Arch Occup Environ Health, 79, 613–620,

Hansen, K.F. & Stang, B.D., 2009. *Safety against formation of through cracks of profiled fibre-reinforced cement sheets for roofing.* Construction and Building Materials, 23, 334–339.

Hasanoglu, H.C., Yildirim, Z., Ermis, H., Kilic, T., & Koksal, Nu., 2006. *Lung cancer and mesothelioma in towns with environmental exposure to asbestos in Eastern Anatolia*. Int. Arch. Occup. Environ. Health, Springer-Verlag, 79, 1, 89–91.

Kakooei, H., Yunesian, M., Marioryad, H., & Azam, K., 2009. *Assessment of airborne asbestos fiber concentrations in urban area of Tehran, Iran*. Air Qualifications Atmospheric Health, 2, 39–45.

Kim, S-Y., Kim, Y-C., Kim, Y. & Hong, W-H., 2016. *Predicting the mortality from asbestos-related diseases based on the amount of asbestos used and the effects of slate buildings in Korea.* Science of the Total Environment, 542, 1–11.

Luo, S., Mu, S., Wang, J., Zhang, Y., Wen, Q., & Cai, S., 2005. *A study on risk of malignant neoplasm and environmental exposure to crocidolite.* Journal of Sichuan University, 36, 1, 105–107.

Magnani, C., Agudo, A., Gonzalez, C.A., Andrion, A., Calleja, A., Chellini, E., Dalmasso, P., Escolar, A., Hernandez, S., Ivaldi, C., Mirabelli, D., Ramirez, J., Turuguet, D., Usel, M., & Terracini, B., 2000. *Multicentric study on malignant pleural mesothelioma and non-occupational exposure to asbestos.* Br J Cancer, 83, 1, 104-11.

Marinaccio, A., Scarselli, A., Binazzi, Alessandra, Altavista, P., Belli, S., Mastrantonio, M., Pasetto, R., Uccelli, R., & Comba, P., 2007. *Asbestos related diseases in Italy: an integrated approach to identify unexpected professional or environmental exposure risks at municipal level.* Int Arch Occup Environ Health, 81, 993–1001.

Marabini, A., Fonda, A., & Plescia, P., 2002. *Amianto manuale tecnico e operativo.* In Consiglio Nazionale delle Ricerche (Eds.) (18–25). Rome. (Italy).

Markowitz, S.B., Levin, S.M., Miller, A., & Morabia, A., 2013. *Asbestos, Asbestosis, Smoking, and Lung Cancer New Findings from the North American Insulator Cohort.* American Journal of Respiratory and Critical Care Medicine, 188, 1, 90-96.

Matei, E., Cocoş, O., Manea, G., & Vijulie, I., 2015. S*ocial perception of passive pollution by asbestos in Darabani town, Botoşani County, Romania*. Environmental Engineering and Management Journal, 14, 5, 1137-1142.

Metintas, M., Ozdemir, N., Hilerdal, G., Uçgun, I., Metintas, S., Baykul, C., Elbek, O., Mutlu, S. & Kolsuz, M., 1999. *Environmental Asbestos Exposure and Malignant Pleural Mesothelioma*. Respir. Med., 93, 349–355.

Metintas, S., Metintas, M., Ucgun, I., & Oner, U., 2002 *Malignant mesothelioma due to environmental exposure to asbestos: follow-up of a Turkish cohort living in a rural area.* Chest, 122, 2224–2229.

Moerman, Lee, Laan, C., & Sandra L., 2011. *Accountability, asbestos and indigenous rights: The case of Baryulgil*, Accounting History, 16, 4, 439–457, Sage.

Paglietti, F., Malinconico, S., Conestabile della Staffa, B., Bellagamba, S., De Simone, P., 2016. *Classification and management of asbestos-containing waste: European legislation and the Italian experience,* Waste Management, 50, 130–150.

Peto, J., Hodgson, J.T., Matthews, F.E., Jones, J.R., 1995. *Continuing increase in mesothelioma mortality in Britain*. Lancet, 345(8949), 535-9.

Rosell-Murphy, M., Abós-Herràndiz, R., Tarrés, J., Martínez-Artés, X., García-Allas, I., Krier, I., Cantarell, G., Gallego, M., Orriols, R., & Albertí, C., 2010. *Prospective study of asbestos-related diseases incidence cases in primary health care in an area of Barcelona province.* BMC Public Health, 10, 203, 2-9.

Senyiğit, A., Babayiğit, C., Gökirmak, M., Topçu, F., Asan, E, Coşkunsel, M., Işik, R, & Ertem. M., 2000. *Incidence of malignant pleural mesothelioma due to environmental asbestos fiber exposure in the Southeast of Turkey.* Respiration, 67, 610–614.

Spirtas, R., Connelly, R. R. & Tucker, M. A., 1988. S*urvival patterns for malignant mesothelioma: The seer experience.* Int. J. Cancer, 41, 525–530, doi:10.1002/ijc.2910410409.

Szeszenia-Dąbrowska, N., Sobala, W., Świątkowska, B., Stroszejn-Mrowca, G., & Wilczyńska, U., 2012. *Environmental Asbestos Pollution – Situation in Poland.* International Journal of Occupational Medicine and Environmental Health 25, 1, 3 – 13.

Suzuki, Y., Yuen, S. R., & Ashley, R., 2005. *Short, thin asbestos fibers contribute to the development of human malignant mesothelioma: pathological evidence.* International. Journal of Hygiene and Environmental Health, 208, 201–210.

Tadas, P., Dainiu,s M., Edvinas, K., Linas, K., Maksim, K., & Axel, Z., 2011. *Comparative characterization of particle emissions from asbestos and non-asbestos cement roof slates.* Building and Environment, 46, 2295-2302.

Zhang, Y-L., Kim, Y-C., & Hong, W-H., 2016. *Visualizing distribution of naturally discharged asbestos fibers in Korea through analysis of thickness changes in asbestos cement slates,* Journal of Cleaner Production, 112, 607-619.

Received at: 23. 04. 2016
Revised at: 29. 12. 2016
Accepted for publication at: 11. 01. 2017
Published online at: 26. 01. 2017