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ASSESSMENT OF EXPOSURE TO INDOOR AIR POLLUTANTS IN SCHOOLS: WHO PILOT SURVEY IN ALBANIA

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ABSTRACT

Schools are the second most important indoor environment for children after their homes. The WHO has coordinated the development of a standardised methodology for national surveys in schools aimed at assessing exposure to health risk factors in school environments; these include indoor air pollution, smoking, poor sanitation and hygiene. National surveys were proposed to characterise the distributions of exposure levels within the country. Surveys confirmed progress towards targets set in Parma.

Purpose: The aim of this pilot survey was to test the proposed survey design and data collection methods, to produce preliminary data characterising exposure levels in Albanian children and school to school variations in exposure, and to the transfer of technology that will help to develop local capabilities for prospective national surveillance in Albania.

Design/methodology/approach: The pilot survey tested the methodology in different environments to produce sufficient data to assess exposure to environmental factors in Albanian schools. This was done by testing general characteristics of the school building, student population, ventilation rate, NO_2,

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Formaldehyde, Benzene, access to properly maintained and serviced sanitary facilities, hygiene practices in student smoking on school pupils, etc.

Findings: Poor quality and insufficient quantity of sanitation facilities, insufficient availability, poor operation and maintenance, high rates of exposure to mould and dampness, chemical pollution.

Conclusion: It appears that the problems identified in this survey were not due to a lack of regulations or standards, but rather due to insufficient inspections, surveillance and enforcement.

***Keywords*:** chemical pollution; indoor environment; mould and dampness; ventilation.

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INTRODUCTION

Schools are the second most important indoor environment for children after their homes. The WHO has coordinated the development of a standardised methodology for national surveys in schools aimed at assessing exposure to health risk factors in school environments, such as indoor air pollution, smoking, poor sanitation and hygiene (Lee et al., 2002; Wallance, 1996). This project tested the proposed methodology. Results were essential for finalising the WHO methodology and allowed the assessment of the level of exposure to Albanian children. National surveys were proposed to characterise the distributions of exposure levels within the country. Surveys confirmed progress towards targets set in Parma (Wallance, 1996).

Objectives

1. The main objective of this pilot survey was to test the proposed survey design and data collection methods.
2. The second objective was to produce preliminary data characterising exposure levels in Albanian children and school to school variations in exposure.
3. The training and transfer of technology that will help to develop local capabilities for prospective national surveillance in Albania.

Methodology

The scale of this pilot study was determined by the need to test the methodology in different environments and to produce sufficient data to assess the exposure to environmental factors in Albanian schools. The sample size was limited. Two groups of urban and rural clusters were considered suitable to represent different socio-economic conditions and types of construction. The study period was from December 2011 to March 2012.

There were 12 selected and enrolled schools in 3 geographic clusters (4 schools in each cluster): Tirana – urban and rural clusters (2 clusters); Elbasan – urban cluster (1 cluster). Three 3 classrooms in each school are selected for monitoring air pollution and ventilation rate – 36 classrooms in total (see Table 1 below).

Sampling in this pilot study was not by a random selection of schools. The important purpose of this pilot study was to characterise the variability of exposure levels; it was therefore advisable to select schools of various types representing all the major types of school buildings and conditions that were found in Albania. Technicians inspected every class: they measured its volume, described the potential sources of emission, installed CO_2 loggers and passive diffusive models to measure the concentrations of NO_2, formaldehydes and benzene (WHO Regional Office for Europe, 2000, 2006). Samplers were present in the classrooms for one week in each selected school. It is important to note that normal ventilation, heating and air conditioning practices and clearance activities continued unaltered.

One outdoor sampling site was selected at each school for monitoring the same chemical pollutants (formaldehyde, NO_2 and benzene) and CO_2 levels. Passive diffusion samplers were placed in special shelters and a CO_2 logger was placed outdoors, or indoors with tubing to the outdoors through a sealed opening.

Table 1 Summary of data collected

Parameter or type of data	*Data collection method*	*Number of observations, Albania*
General characteristics of school buildings, student population	Interview with school administration, inspection of school	12 schools (12 buildings)
Ventilation rate	CO2 data loggers, occupancy diaries	36 classrooms
NO2	Passive Gradko samplers	36 classrooms, 12 outdoor sites
Formaldehyde	Passive Radiello samplers	36 classrooms, 12 outdoor sites
Benzene	Passive Radiello samplers	10 classrooms, 8 outdoor sites
Exposure to mould and dampness	Visual inspections; surface moisture measurements	186 classrooms
Access to properly maintained and serviced sanitation facilities	Inspection of sanitation facilities, questionnaire for pupils	42 toilets inspected, 660 questionnaires
Hygiene practices in pupils	Questionnaire for pupils	660 questionnaires
Pupils smoking in school		
Mode of transportation to school		

Source: Geithersburg (2005).

A survey team visited 12 schools and conducted data collection in accordance with protocols provided by the WHO:

- Field data collection involved the following:
  - Inspect each school's buildings including all rooms and premises.
    - floor area;
    - number of rooms;
    - history of repairs and renovations, etc. and
    - heating, ventilation, air conditioning systems, kitchens, toilets and sanitation facilities, smoking policies and rules.

The interview with a contact person took approximately 30 min. They then:

- interviewed a member of the school administrator;
- conducted interviews with a teachers;
- administered a questionnaire survey in three classes at each school;
- administered a questionnaire survey to a subset of school employees at each school and
- conducted air quality monitoring in each school for one week with regard to:
  - the measurement of its volume;
  - the description of potential sources of emissions;
  - the installation of CO_2 loggers and passive diffusion samples;
  - the measurement of the concentrations of NO_2, formaldehyde and benzene.
- Promptly entered all survey data from the paper form into computer databases.

RESULTS

This is a discussion of the analysis undertaken of risk factors for exposure to harmful factors in Albanian classrooms, and an assessment of potential adverse impacts on health and learning.

CO_2 and ventilation rate

In all 36 classrooms in 12 schools, CO_2 levels were above the limit recommended in Germany (1000 ppm) most of the time. Ventilation rates were much lower than the 7 lps pp recommended in the USA and Finland.

Albanian pupils spent, on average, only approximately 5% of their classroom time at CO_2 levels below 1000 ppm. In some schools, pupils spent a substantial proportion of time at CO_2 exceeding 5000 ppm. The exposure levels in Albania were the highest among the five countries that conducted pilot surveys in schools using the WHO methodology.

It appears that the main reason for very poor ventilation was the lack of adequate heating and, as a result, very low indoor air temperature during the cold season. In some classrooms, air temperature in the morning was below 10°C.

Chemical indoor air pollutants

Concentrations of NO_2 and formaldehyde were well below the WHO guideline limits in all classrooms surveyed. The level of benzene was rather high in one classroom in a rural school. For this carcinogenic compound, the WHO does not recommend a specific limit; the recommendations are formulated in terms of excess lifetime cancer risk. Long-term exposure to benzene at a level of 1.7 μg/m^3 is associated with 1 per 100,000 excess lifetime cancer risk.

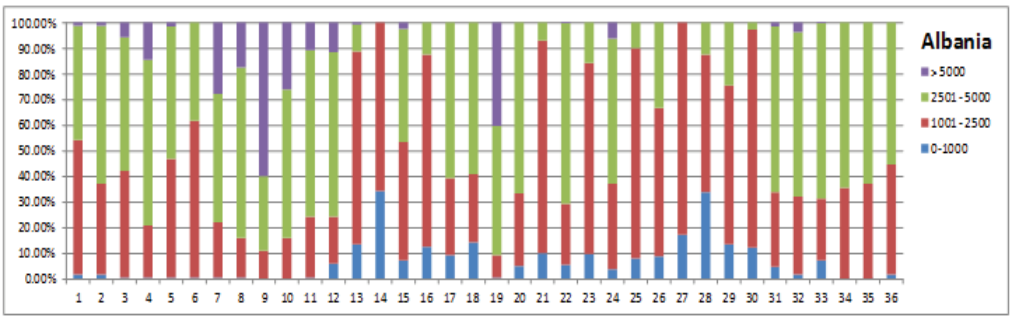


Figure 1 Percentage of person-time pupils spent at different intervals of CO_2 concentration (ppm) in classrooms in the Albanian school survey (36 classrooms in 12 schools numbered consecutively)

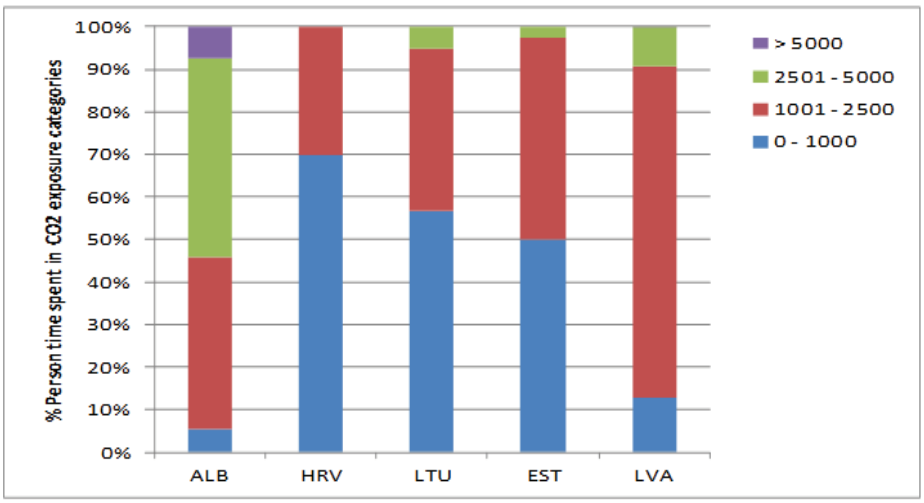


Figure 2 Distributions of exposure to CO_2 in the five countries that conducted surveys in schools using the WHO methodology (% of person-time spent at various CO_2 concentration intervals, ppm)

Table 2 Summary of concentrations of indoor air pollutants in Albanian schools, μg/m3

Pollutant	*Classrooms*		*Outdoor sites, mean (SD)*
	Mean (SD)	*Max*	
NO_2	9.4 (5.9)	25.7	15.0 (11.5)
Formaldehyde	8.2 (4.7)	15.9	3.5 (1.6)
Benzene	6.1 (8.1)	28.3	3.5 (2.4)

Source: WHO Regional Office for Europe (2006).

The survey included four rural schools. All of them had heating units in classrooms using combustion of wood or natural gas. Carbon monoxide was also detectable in most classrooms in rural schools but not in urban schools. One classroom in a school with natural gas-based heating units, which had a high level of benzene, also had elevated levels of CO during morning hours suggesting the effect of indoor combustion. The peak levels of CO in some classrooms exceeded 9 $\mu g/m^3$ (the WHO standard for an 8-hr mean). However, the 1-hr mean standard of 35 $\mu g/m^3$ was not reached in any classrooms.

Mould

Mould problems were widespread in Albanian schools. It was estimated that pupils spend 42% of person-time in indoor premises that have mould and dampness problems.

Despite having a relatively dry climate, Albania had the highest rate of exposure among the five countries surveyed.

Water Sanitation and Hygiene (WASH) in schools

While all schools surveyed had sanitation facilities, and all of them were connected to piped water sources and sewage, the survey demonstrated serious problems with the availability of toilets (insufficient numbers of toilet sets/urinals), maintenance and operation and very poor pupil satisfaction with privacy and quality of toilets.

The WHO guidelines state that there should be at least 1 toilet seat per 25 girls and at least 1 toilet seat and 1 urinal per 50 boys (WHO Guidelines for Indoor Air Quality, 2009). The results of this survey demonstrate that a majority of pupils attend schools with an insufficient number of toilets. While the situation was similar in rural and urban schools, it appears that girls are at a greater disadvantage compared to boys.

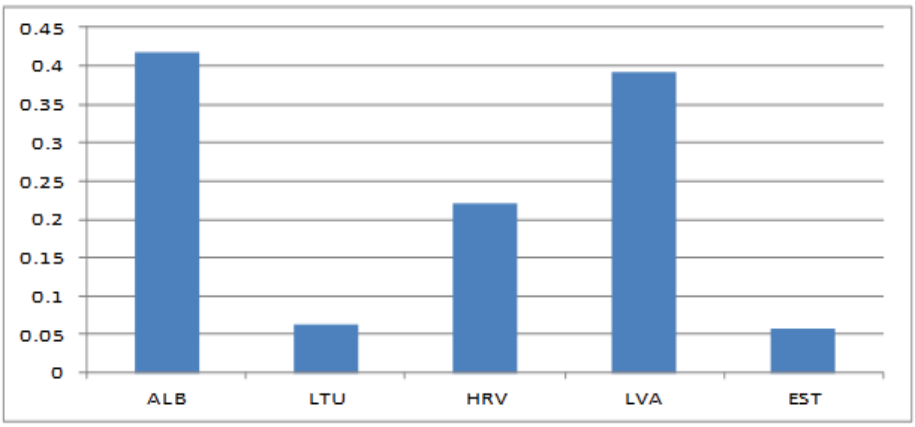
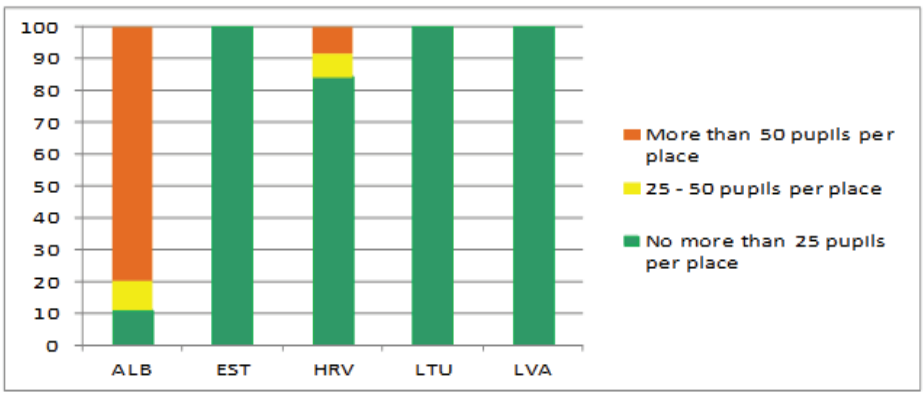


Figure 3 Comparison of mould exposure rates in national surveys in schools

Table 3 Percentage of pupils in the Albanian survey attending schools that meet the WHO guidelines on the availability of toilets in schools (green), or that are not in compliance (yellow for no more than double the ratio of pupils per toilet seat and orange for more than double the ratio of pupils per toilet seat)

Gender	*Rural/urban status*	*No more than 25 pupils per place*	*25–50 pupils per place*	*More than 50 pupils per place*
All	All	5.7	19.5	74.8
All	Urban	6.1	19.3	74.6
All	Rural	4.4	20.2	75.4
Boys	Rural	8.2	0.0	91.8
Boys	Urban	11.7	12.2	76.1
Boys	All	10.9	9.4	79.7
Girls	Rural	0.0	43.2	56.8
Girls	Urban	0.0	27.1	72.9
Girls	All	0.0	30.6	69.4

A. Boys



B. Girls

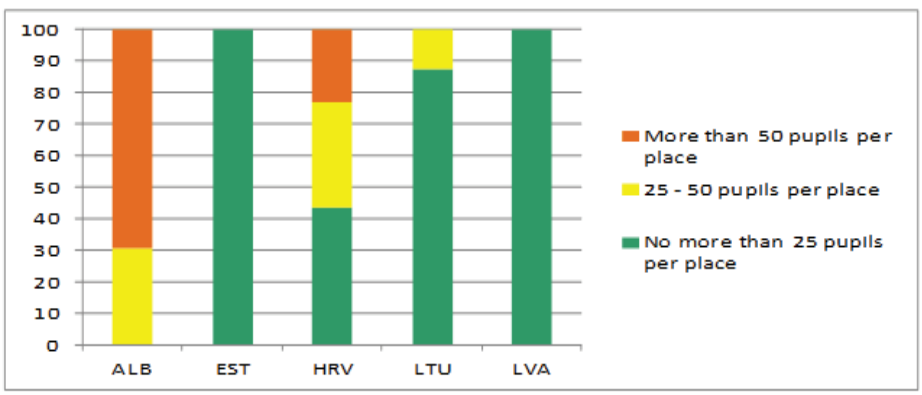


Figure 4 Availability of school toilets – comparison of countries

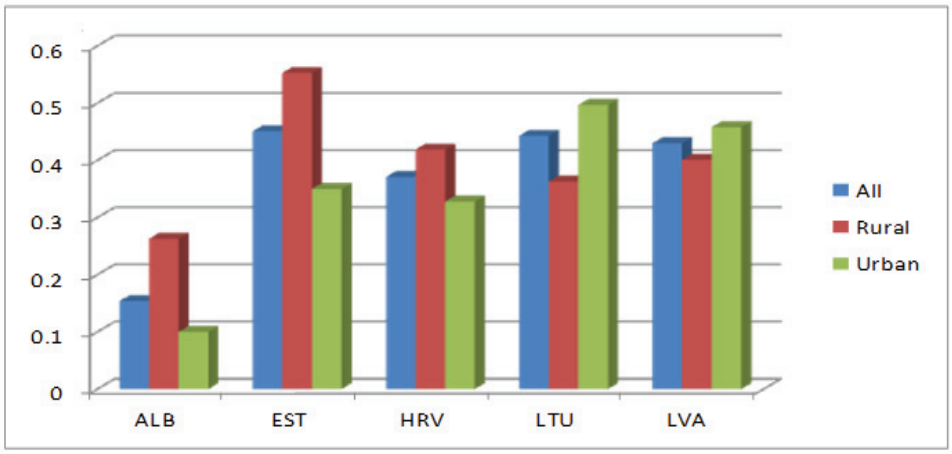


Figure 5 Satisfaction with toilets: proportion of positive answers to questions about overall satisfaction with toilets and daily toilet usage. Results of pupil questionnaire survey

Albanian pupils had the lowest levels of satisfaction with toilets and daily usage of school toilet facilities among the five countries surveyed. The situation was considerably worse in urban schools compared to rural schools.

Smoking in schools

The pilot survey included only primary schools. Thus, the overall smoking rate was rather low. However, the analysis of age-specific smoking rates helps to compare the smoking onset age and smoking recruitment dynamics in different countries. Compared to other countries, age-specific smoking rates in Albanian schools were relatively low (not shown).

Mode of transportation to schools

Among all countries surveyed, Albania had the highest proportion of pupils walking to school, both in rural and urban areas. At the same time, the use of bicycles was very low in both rural and urban areas, suggesting the need to facilitate the use of this active transportation mode. Further information on the presence of bicycle lanes, secure parking places at schools and other infrastructure would need to be collected in order to identify specific deficiencies. Preliminary visual inspections did not detect parking spaces for bicycles at schools or dedicated bicycles lanes in Tirana and Elbasan (the two cities surveyed).

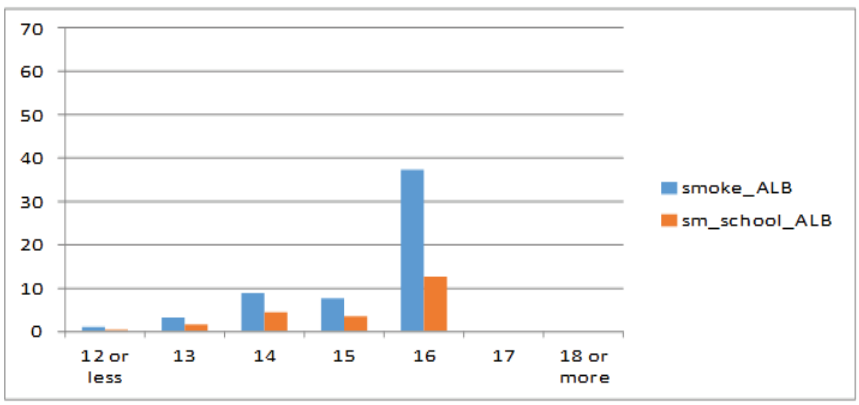
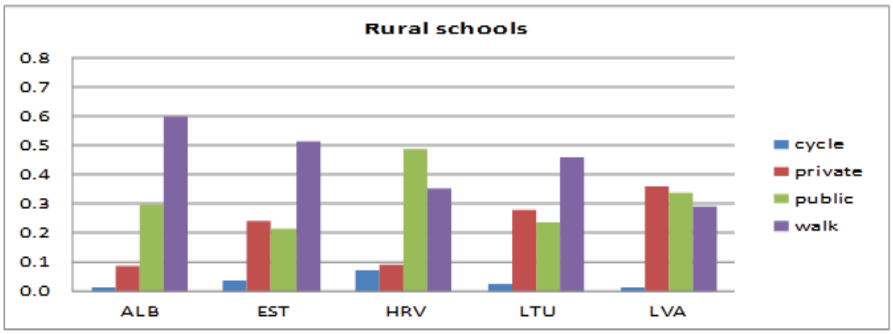


Figure 6 Percentage of pupils who reported overall smoking and smoking in school or on school grounds by age – data from Albanian survey

A. Rural schools



B. Urban schools

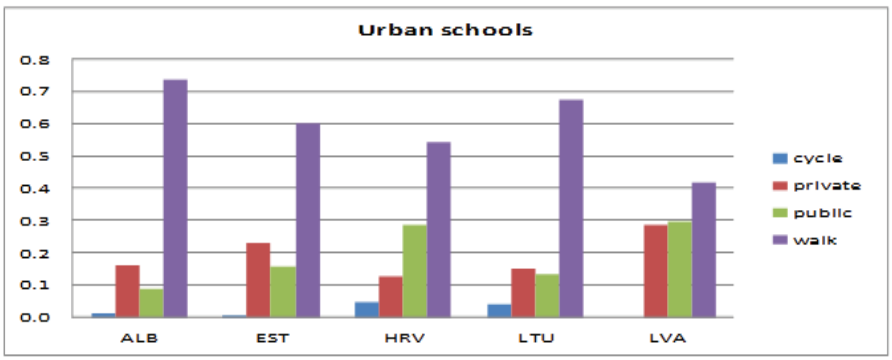


Figure 7 Mode of transportation to schools according to the data from pupils' questionnaires – comparison of countries

CONCLUSIONS

The main problems identified were the following:

- Poor quality and insufficient quantity of sanitation facilities:
  - insufficient availability;
  - poor operation and maintenance and
  - lack of privacy.
- Very poor ventilation in classrooms during the cold season resulting in high levels of CO_2 (high air stuffiness).
- Very low indoor temperature in many classrooms during the cold season.
- Elevated levels of benzene and CO in some classrooms in rural schools due to the use of indoor combustion sources for heating.
- High rate of exposure to mould and dampness in schools.

The WHO environmental health policy questionnaire (March 2014) demonstrated that Albania has generally adequate policies on WASH in schools and on IAQ in schools. It appears that the problems identified in this survey are not due to a lack of regulations or standards, but rather due to insufficient inspections, surveillance and enforcement (Ontario Recreation Facilities Association Inc., 2011).

RECOMMENDATIONS

- *WASH in schools*: improve school inspections and follow-up actions after the detection of deficiencies. One approach may be to incorporate the standard toilet/hand wash facility checklist developed by the WHO in regular school inspections conducted by municipal hygiene inspectors. Provide training

to inspectors; work with school principals to ensure that problems are addressed.

- *Mould and dampness in schools*: continue regular inspections using the WHO methodology and equipment (surface moisture monitors) procured for the WHO survey in schools. Use the available online materials (WHO IAQ guidelines for moulds, US EPA tools and guidelines on mould in schools and mould remediation) to develop programmes aimed at eliminating mould exposure.
- *Poor ventilation in classrooms*: educate school administrators and teachers about the importance of adequate ventilation. Continue monitoring using the CO_2 monitors procured for the WHO survey. Re-visit schools with particularly high CO_2 levels in classrooms. Consider using inexpensive traffic light type CO_2 indicators for educating pupils and teachers.
- *Benzene and CO in classrooms*: re-visit schools that use indoor combustion sources. Ensure adequate removal of combustion products and ventilation in classrooms. Educate teachers about health risk factors associated with indoor combustion.

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BIOGRAPHICAL NOTES

Elida Mataj gained her PhD at the University of Studies, Faculty of Medicine, Public Health Department in Milano-Italy (2008–2012), and is currently a Lecturer at the Faculty of Medicine, Albanian University Tirana, Albania. Epidemiologist Doctor at the Institute of Public Health, at the Department of Health and Environment since 1999. Has supervised one MSc student was a supervisor in the implementation of national infectious disease information system (ALERT), organised by the WHO, the Ministry of Health and the Public Health Institute 2000. Supervised a national project on the "Evaluation of vaccine coverage in the population" organised by WHO, Ministry of Health and the Public Health Institute. Supervised in the application of measles and rubella vaccine in the 0–15 year age group, organised by UNICEF, the Ministry of Health and the Public Health Institute. Co-ordinator of the project supported by the Ministry of Education and Science entitled: Indoor air pollution and health impact in Albanian schools (2007–2009). Was the co-ordinator of the project supported by Regional Environmental Agency (REC) entitled: "Health risks associated with the use of swimming pools" (2009–2010) and was coordinator and project manager of the study entitled: "Assessment of exposure to indoor air pollutants in schools – WHO pilot survey in Albania", organised by the WHO Office, Bonn, Germany (2011–2013). Author and co-author of many publications.

Genci Dervishi is a Master of Sciences in Public Health, Specialist of Public Health, has developed many research projects on the nutrition of the Roma community and the nutrition on Students of University of Sports. Has also undertaken research on the use of marijuana in high schools in Tirana. He is the co-author of the publications "Albania Report on Occupational Safety and Health", "Assessment on water, sanitation and hygiene needs in Shkodra and Dibra", "Assessment of Energy Efficiency in Health Facilities in Albania and Piloting an Efficiency Plan for Healthcare Facilities. He is a specialist of Environmental epidemiology and air quality control

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Pranvera Kasaj is a Chemist in the Laboratory of Instrumental Analyses, Department of Health and Environment since 2000. She graduated in Industrial Chemistry, at the Faculty of Natural Science. She has been part of many projects with a focus in the health impact of indoor and outdoor air pollution, in school institutions supported by Ministry of Education and WHO. In addition, she is part of a working group of annual Air Quality Monitoring in Albania. She has attended many training courses in the quality assurance of analyses including: "Quality in South East Europe: Obstacles and Opportunities" Radljica, Slovenia, "Accreditation-recognition of competence" Slovenian European Natural Sciences Research Centre (SENARC) 2006–2008. She is co-author of 24 publications.

Andrey Egorov is a World Health Organization, Regional Office for the European Centre for Environment and Health (ECEH). Environment and Health Information System, WHO European Centre for Environment and Health, WHO Regional Office for Europe. He is the author of many publications and Coordinator of many projects in Eastern European countries.

Samira Mataj is a Medical Doctor, a specialist in the Biochemical-Clinical Laboratory. She is co-author of several published articles and has participated in several national and international conferences.