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RESEARCH ARTICLE

Air Pollution Health Risk Based on AirQ+ Software Tool

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ABSTRACT

In this industrial era, the world and mostly developing countries is facing the health risk problem due to the poor air quality of our environment. The estimation of health risk assessment due to pollution is one of major concern for scientific society or organization. AirQ+ is a tool developed by WHO (World Health Organization, 2016) for evaluating the exposure and the health risk assessment due to pollution. It can deal with the accompanying mortality and morbidity of various air pollutants like $PM_{2.5}$, PM_{10}, NO_2, O_3 and black carbon (BC) with software approaches to evaluate the impacts of long term and short term exposure in ambient or indoor air for the targeted population of a specific area. This paper is an effort to introduce the concept and operating steps for batter understanding and effective implantation of AirQ+ tool.

Keywords- Air pollution, Health risk. Morbidity, Mortality, Transport Corridor.

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INTRODUCTION

Air pollution is a primary environmental issue of the urban region along with health problems like upper respiratory side effects (stuffy nose, sinusitis, sore throat headache, fever and red eyes) and lower respiratory side effects (wheezing, wet hack, dry hack, mucus, shortness of breath, trunk distress or torment) (Nagpure et al, 2014). It is an important determinant of health for some age groups as older, child, pregnant women and people with the disease, such as asthma, may be at high health risk when exposed to air pollution. Ambient air pollution is a complex mixture of pollutant. Particulate matter (PM), Ozone (O_3), nitrogen dioxides (NOx), sulfur dioxide (SO_2), black carbon, carbon monoxide, heavy metals or black smoke are proxies for the air pollutant mixture. Particulate matters have more concern as an air pollutant in developing countries, and it is characterized by a mass concentration of particles which is smaller than 2.5 µm ($PM_{2.5}$), 10 µm (PM_{10}), and the number of particles (ultrafine), or the chemical composition (black carbon, organic compounds and heavy metals). Figure 1 shows the global distributions of particulates matters of PM_{10} and $PM_{2.5}$ in various countries (Amato et al., 2009 and Ulrich et al., 2002).

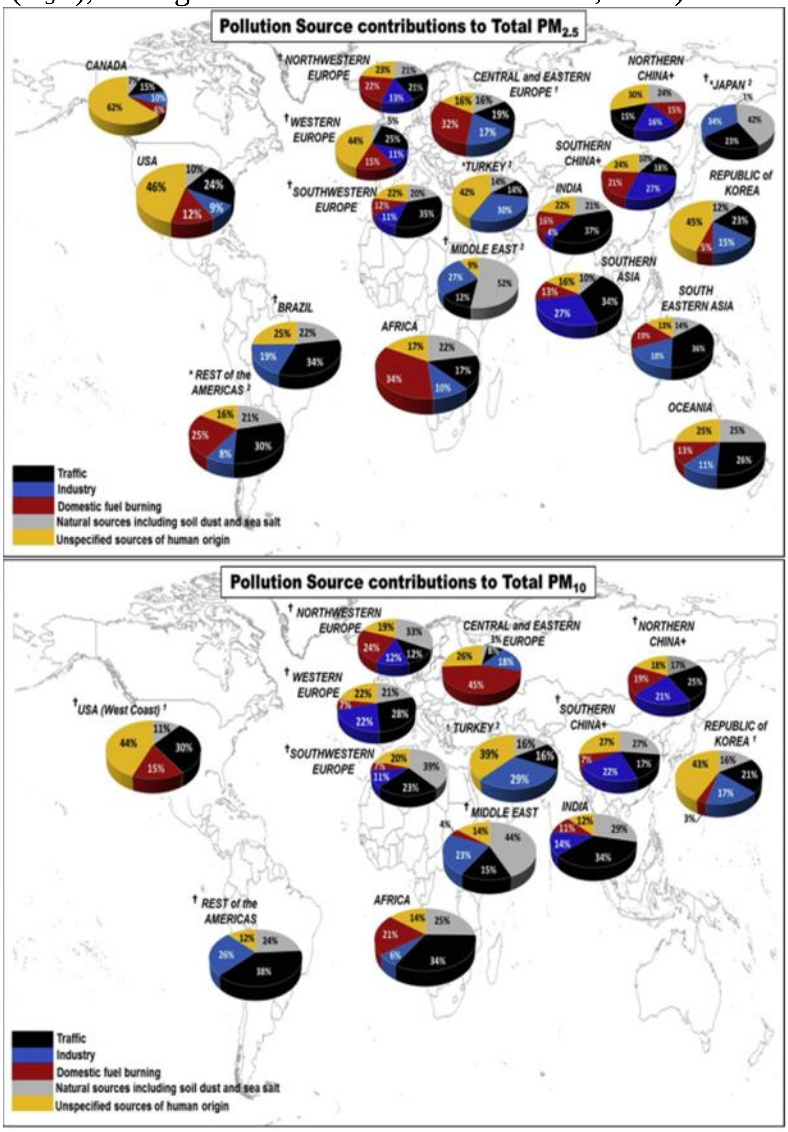

Fig-1. The global distribution of pollutants of particulate $PM_{2.5}$ and PM_{10}

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Epidemiological and toxicological studies have been shown as a robust indicator of risk associated with exposure to air pollutant from diverse sources in the different environment. For the implementation of more effective local, national, and global policies to reduce air pollution, Quantitative estimation of health risk assessment now becomes important for policy makers and stakeholder. Therefore, It is important to choose the appropriate policy question, specific pollutants of the area and targeted population in air pollution risk health assesment (APHRA).

Table 1. shows health risk assessment is a scientific evaluation of potential adverse health effects resulting from human exposure to air pollution and its aim to estimate the fate of exposure - past, current or future to air pollution. APHRA may be quantitative or qualitative which generally assesses (1) the amount of air pollution present (pollutant concentrations), (2) the amount of contact (exposure) of the targeted population, and (3) how harmful the concentration is for human health; e.g. the resulting health risks to the exposed population, (Maji et al., 2016 and Knibbs et al., 2011). In selecting an APHRA, the aim should be to maximize scientific rigor within the resources available (Bumett et al., 2014 and CPCB, 2012).

Several computer-based tools are available (AirQ+, AirCounts, Aphekon, EcoSense, etc.) that automate the process of an air pollution health risk assessment. Theses tools offer several advantages to the practitioner and end-user, with its simplicity like lowering the barrier to consistency, conducting assessments, comparability among assessments, and quality assurance.

Automated tools are typically preloaded with health and demographic data and concentration-response-functions (CRF), and some allow for user-specified inputs. Several number of research has been done to assess the health risk due to the air pollution with the help of AirQ+ (Nagpure et al., 2014 and Maji et al., 2016).

Table-1: Air pollutants, types of exposure and health endpoints handled by AirQ+(source: key feature of AirQ+ by WHO, 2016)

		Long-term					Short-term				Long-term
		$PM_{2.5}$	PM_{10}	NO_2	O_3	BC	$PM_{2.5}$	PM_{10}	NO_2	O_3	Solid fuel use
Mortality	Mortality, all (natural) causes	x		x		x	x		x	x	
	Mortality, ALRI (children 0-4)	x									x
	Mortality, COPD (adults 30+)	x									
	Mortality, COPD (women 30+)										x
	Mortality, COPD (men 30+)										x
	Mortality, IHD (adults 30+)	x									
	Mortality, IHD (women 30+)										x
	Mortality, IHD (men 30+)										x
	Mortality, LC (adults 30+)	x									
	Mortality, LC (women 30+)										x

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	Mortality, LC (men 30+)			x
	Mortality, Stroke (adults 30+)	x		
	Mortality, Stroke (women 30+)			x
	Mortality, Stroke (men 30+)			x
	Mortality, respiratory diseases	x	x	
	Mortality, CVDs		x	
	Post neonatal infant mortality, all-cause	x		
	Prevalence of bronchitis in children	x		
incidence	Prevalence of bronchitis symptoms in asthmatic children aged 5-14	x		
	Incidence of chronic bronchitis in adults	x		
	Incidence of asthma symptoms asthmatic children		x	
	Hospital admissions: CVD (including stroke)		x	
admissions	Hospital admissions, CVD (without stroke)		x	
	Hospital admissions: respiratory diseases		x x x	
	Work days lost, working age population only		x	
days lost	Restricted activity days (RADs)		x	
	Minor restricted activity days		x	

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RESEARCH METHODOLOGY/TOOL

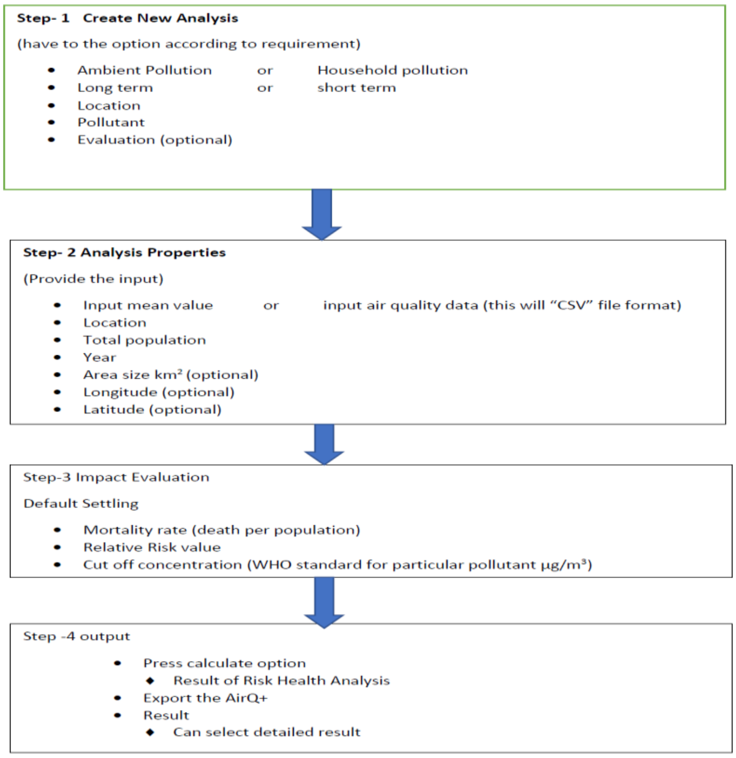

Fig-2: Flow digram of basline data input for AirQ$^+$.

AirQ$^+$ is a software tool tha use the integration of mathematical application and analysis of exposure of health risk. It works by logarithmical functions, matrix calculations (at least 40,000 matrix elements), statistical functions. AirQ$^+$ is usefull for any region/city/country to estimate, how much of a particular health outcome is attributable to selected air pollutants? And compared to the current scenario that what would be the change in health effects if air pollution levels changed in the future? All calculations performed by AirQ+ are based on methodologies and concentration-response-functions (CRF) established by epidemiological studies.

AirQ+ software tool is developed by World Health Organization (WHO), 18th May 2016 and it is open sources software with the capability of presenting health risk due to air pollution. It manages the pollutant like PM $_{10}$, PM $_{2.5}$, NO_2, O_3 and black carbon. AirQ$^+$ incorporates into an easy to understand route strategies to evaluate the impact of long-term and introduction of surrounding air contamination. It can also assess the effects of indoor air pollution related to solid fuel use (SFU). Different health result identified with mortality and morbidity both as far as the serious and endless condition can consider for the counts. The essential logical proof on the health impacts from encompassing primary from studies directed western Europe and North America. It has limitation too, but it will be easy to understand , to help the consideration with alert and includes master judgment (WHO, 2014b, WHO, 2014b and Braurer et al., 2012).

This paper introduces the concepts of the AirQ$^+$ and describes in broad terms how the health risks of outdoor and indoor air pollution and its exposure are estimated. It gives an overview of the general principles for the proper conduct of AirQ$^+$ for various scenarios and purposes. The output of AirQ$^+$, as a result, is an important integral component, and vital to ensure (1) that the

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main objectives are not lost and (2) that the results produced are understandable by policy makers and others who do not necessarily have a technical background or expertise in air pollution and health risk management.

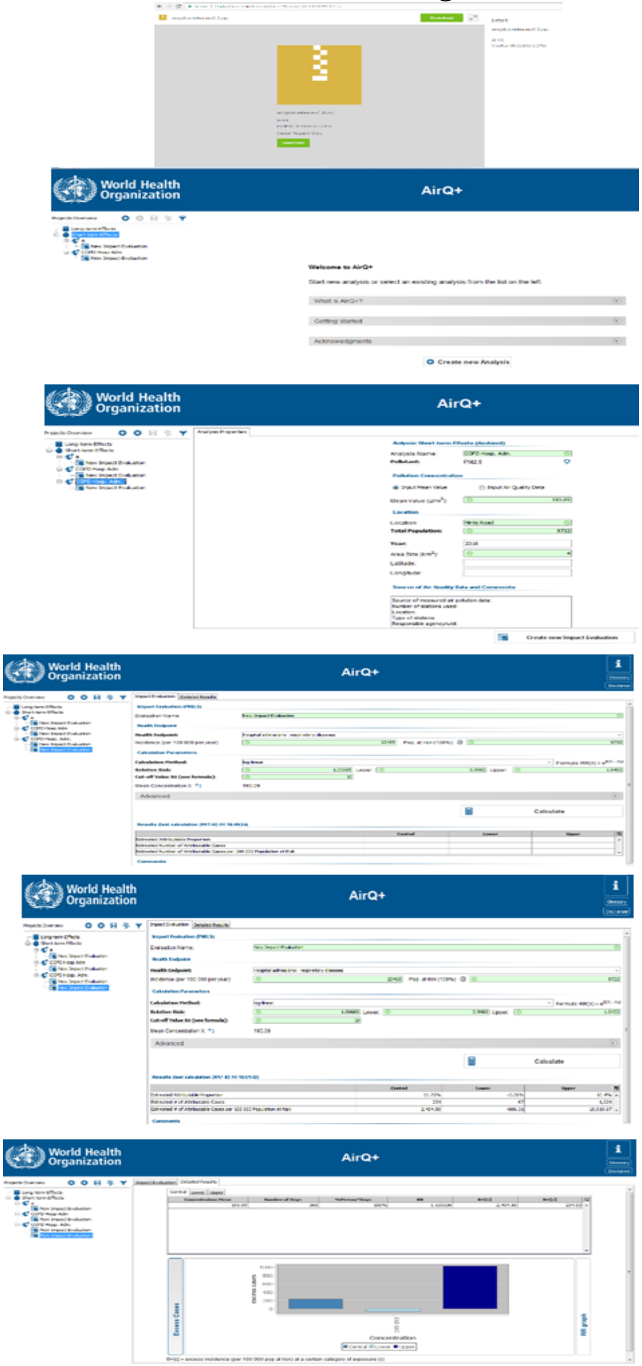

Fig-3: The flow digram for health risk assessment with AitQ^{+} model.

The concentration response functions used in the software are based on the systematic review of all studies available till 2013 and their meta-analysis.

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Installation and data input in AirQ$^+$

For installation of AirQ$^+$ tool, first, download the compressed Zip file and save it on the local hard drive of the computer system. The figure 2 and 3 represents six steps for the assessment of the 'air pollution health risk analysis' software tool to run. The root folder of AirQ$^+$ has three subfolders ('resources', 'dist' and 'datatest'), which must neither be moved on other subfolder nor deleted or rename for the proper functioning of the program. With double clicking on 'AirQPluse.jar', AirQ$^+$ tool can run. It is Java based technology and stands alone application having compatibility with Window 7, Linux/Ubuntu, and Apple Macintosh. AirQ$^+$ processes and stores the numerical values by using decimal points, even if the language and number format settings of the operating machine are different. It is possible to use 'CSV' files data input and output. 'CSV' stands for "comma separated values", but since commas are used as a decimal separator in various languages, this can lead to confusion. The separation character which is used by AirQ$^+$ is always the semicolon (;). For example- 7.5;8.002;17.3. AirQ$^+$ does not need to establish internet connectivity. It saves the data and results automatically and presents in a project tree for easy management. When the AirQ+ program is started for the first time, the entry window will be displayed like figure 4.

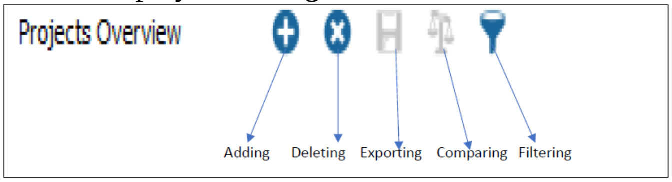

Fig- 4: Starting window display of AirQ$^+$ Model

AirQ$^+$ also has different entry field colour codes for data entry like White, Green, Yellow, and Red Colour (Table 2).

Table-2. Colour codes for data entry.

Colour	Description
White	The White colour of analysis properties of tab represents the optional data.
Green	Green colour represents or indicates the correct values in mandatory and voluntary fields. For AirQ+ Mandatory fields must be. Filled for computations.
Yellow	Voluntary fields it is strongly recommended to fill in those fields for documentation purposes. Voluntary fields are not necessary for the computation.
Red	If incorrect values are supplied in a mandatory field, the field turns red. For example, concentration mean values must not be negative

Input for AirQ$^+$

For air AirQ+ tool, input data have three major categories, 1) ambient air pollution, 2) household population , 3) Ozone: Ambient air quality has two option for input of pollutant concentration. One option is for long term exposure effects in which average concentration of a pollutant is needed and the second option is for short term exposure effects in which frequency of days with particular pollutant values are needed (Table 2). Data of targeted population at risk (e.g., the total number of adults aged ≥35 years) and a cut-off value of pollutant (standard value) for consideration in µg/m3 and relative risk (RRs) values should be provided. Relative risk value is calculated by the concentration-response-function (CRF), Which is enumerate the health impact of

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targeted population per concentration unit of a particular air pollutant. Typically, these CRFs establish in epidemiological studies. For ozone input, the user should provide the data same as in ambient air pollution in prescribed format. In household air pollution, the user needs to input Data for the population at risk, the percentage of the total targeted population using solid fuel (SFU) for cooking heating and lighting in indoor, health data, and relative risk (RRs) values. Health data is the baseline rates of health outcomes in the population studied. $AirQ^+$ have some default values like RRs, conversion facotr between $PM_{2.5}$ and PM_{10} at the nationnal level and worildwide statistics at the nationnal level.

RESULTS OUTPUT

It estimates the attributable proportion of cases, number of attributable cases, number of attributable cases per 100,000 population at risk, proportion of cases in each category of air pollutant concentration, and the years of life Lost (WHO, 2014b). One screen display of numerical values, including matrices form, it stored in CSV file and Microsoft Excel compatible with XML format. Any further processing like the production of graphs generates outside of AirQ+ in spreadsheet programs like Excel. AirQ+ can give fallowing output.

- Analysis of the City/Country/Area Data: ambient air pollution Specific pollutant long-term adult mortality
- Analysis of City/Country/Area Data: ambient air pollution, Specific pollutant, short-term mortality.
- Analysis of the City/Country/Area Data: ambient air pollution, a specific pollutant. Longterm, adult mortality use of the integrated exposure-response function (IER).
- Analysis of the City/Country/Area Data: ambient air pollution, Ozone, long-term, adult mortality.
- Analysis of the City/Country/Area Data: ambient air pollution, solid fuel use, long-term, children mortality
- Analysis of the City/Country/Area Life Table data, ambient air pollution $PM_{2.5}$ long term adult mortality, use of life tables.

The $AirQ^+$ represent an epidemiological reviews health risk; (Nagpure et al., 2014 and Maji et al., 2016). These air pollutants parameters (PM, NOx, CO, O_3, BC) show the relationship between air pollution and serious health exposure (Oftedal et al., 2008 and Schwela, 2000).

Limitations of $AirQ^+$

There is some limitation, which should be like other health risk assessment (HRA) tools, such as:

- It considers ambient air pollution monitoring data as a proxy indicator of population exposure
- $AirQ^+$ calculations do not account for multiple exposure cases or multipollutant scenarios and its morbidity estimates present low reliability due to difficult conformity in the assessment of health outcomes related to hospital admissions.
- Indoor air pollution RRs are based on studies carried out in situations of very high pollution level.

These models consider encompassing air contamination checking information as an exposure of pollutants on human health. Its calculation do not represents various investigation of cases or multi contamination situation in the environment. $AirQ^+$ also represents mortality, morbidity estimates, health outcomes; as well as low reliability due to difficult conformity related to hospital admissions. It is helpful for household air pollution relative health risk. Which

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depends the ambient air pollutants concentration is present in particular area.

CONCLUSION

This paper represents the how AirQ+ for health risk assessment. It works as a model for the assessment of health risk for mortality and morbidity of the person at the indoor and outdoor condition. It is discussed and compared with several studies conducted in various countries around the world for the risk assessment. It highlights the potential risk of air pollutants to human health. It also covers the several uncertainties; this approach successfully highlights the ambient air pollution exposure on people annually. World health organization also reported that reported that 90 % of people breathe air that does not comply with the WHO Air Quality Guidelines. The data presented here may carry significant uncertainties but constitute the best evidence available of data. AirQ+ helps estimate the exposure assessment due to particulate matter and other pollutants, as well as for burden of disease estimation. More epidemiological studies of the long-term effects of exposure to air pollution in low-income settings, where air pollution reaches unacceptable levels, are urgently needed to inform the exposure-response relationships population. Additional evidence on health outcomes currently not assessed in the analysis, because of lack of knowledge, is also crucial. Regarding monitoring and reporting, there is a huge gap in monitoring and reporting of air pollutants in low and middle-income regions, especially in Africa and Asia but also other regions. So the AirQ+ tool shows the important role to the estimation of the health risk and decision making for the developing countries. It is also helpful for the maintained air pollution regulations. This study also demonstrates the potential usefulness in estimating precise short term and long term health risk. It helps to take better suggestion to environmental health policy maker and proactively to implement prevention strategies to reduce health risk.

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