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A Brief Overview of Impact of Air Pollution on Children

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Good air quality is fundamental for living well. We reviewed some existing air monitoring data and literature related to Nepal and correlation of air quality, and the health status of children. Both indoor and outdoor air quality can be significant on health status of the population, especially outdoor areas where children play could be critical for their health. To increase official and public awareness, this overview attempts to provide a summary of the health of children and the level of air pollution in the Kathmandu, Nepal region. Our primary focus was Particulate Matter and its impact on human health. This form of air pollution has the most long-term negative impact on health status.

Globally, public concern is growing with respect to air quality. With the rise of air pollution in many cities across the world, the health status of adults and children are being negatively affected. While public policy has led to a reduction in air pollution in some economically powerful nations, the decline in the quality of the air in moderate and low-income societies is alarming, e.g. India and China. This paper describes how air quality has been correlated with lower health status and well-being of children in Nepal. Other factors that correlate with lower health status of children, e.g., nutrition, water pollution, and economic status were not the focus of this paper.

General Geography of Nepal

Nepal is a country with an estimated population of 30 million with

some one fifth of the population living in urban areas. The country can be divided into three geographic regions: The Himalayan region is covered in snow, the Middle Hill region is also mostly hilly areas and the Terai is plain land region. It has five types of climate. It is quite amazing that within the span of 200km from north to south, the climate of Nepal varies from arctic to tropical.

Frequently, cold air flows down from the mountains and is trapped under a 'layer of warmer air', thus a city such as Kathmandu has more air pollution than what might be assumed. This layering acts as a 'lid' and pollutants are trapped close to the ground for extended periods of time [1]. Kathmandu valley is surrounded by high mountains ranging from 2000 to 2800 meters from sea level [2]. The valley structure looks like a bowl which restricts the movement of wind thereby allowing pollutants in the air to



Photo Source:© Felix Dance / Flickr. <https://theculturetrip.com/asia/nepal/articles/why-is-kathmandu-in-the-midst-of-a-pollution-crisis/>

remain and to accumulate over time. This makes the valley particularly vulnerable to air pollution [3 and 4].

- Outdoor Air Pollution in Nepal

Kathmandu city and other south Asian capitals' air quality is worsening. [5]. The atmosphere of Kathmandu every morning is increasing the level of serious particulate matter pollution as well as the number of toxic gases in the air.

According to some researchers, the air in Kathmandu valley is a threat to human health [6].

Nepal is the eighth most polluted country of the world. Of the world's most polluted 30 cities, 22 are in India, according to research by IQ Air Visual, a Swiss-based group that gathers air-quality data globally. The remaining eight cities are all in Pakistan, Bangladesh and China. When comparing only national capitals, Kathmandu is included within ten most polluted capitals of the world in terms of pollution [7].

According to AIRVISUAL, an air quality index based in Switzerland (Airvisual.com), most air monitoring

stations near Kathmandu show unhealthy air quality with a range of 101-160 Particulate Matter (2.5 microns). This index also covers five air quality pollutants: Particulate matter (2.5 microns and 10 microns), carbon monoxide, sulfur dioxide, nitrogen dioxide and ground level ozone

One estimate indicates that some 37,399 people die every year in Kathmandu due the reason of air pollution. Kathmandu's particulate matter pollution increased from 45.9 micrograms per cubic meter in 2017 to 54.4 in 2018, which is an increase of 19 percent [8]. The local Rotary organization has been passing out masks to local police who direct traffic in the city for some years.

The list on Table 2 shows some examples of other cities in Nepal and their air quality on one given day. However, to secure government and community action, more local studies are needed to document the cause and effect relationship between children's environmental health status and air pollution in Nepal [10].

Table 1- Air quality descriptions.

Air Quality Value Levels in Numerical Terms	Meaning of Colors , Actions and Caution To Protect Health From Particulate Pollution
Good (0 to 50)	Air quality is considered satisfactory, and air pollution poses little or no risk. It's a great day to be active outside. No action needed.
Moderate (51-100)	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution. Some people who may be unusually sensitive to particulate pollution. Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups (101 to 150)	Members of sensitive groups may experience health effects. The general public is not likely to be affected. Sensitive groups include people with heart or lung disease, older adults, children and teenagers. People with heart or lung disease, children and older adults should reduce prolonged or heavy exertion.
Unhealthy (151 to 200)	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects. Everyone is needs to be concerned. The following groups should reduce prolonged or heavy exertion: • People with heart or lung disease • Children and older adults
Very Unhealthy(201-300)	Health alert: everyone may experience more serious health effects. Everyone needs to be concerned. The following groups should avoid prolonged or heavy exertion: • People with heart or lung disease • Children and older adults Everyone else should reduce prolonged or heavy exertion.
Hazardous	Health warnings of emergency conditions. The entire population is more likely to be affected. Everyone need to be concerned. Especially, people with heart or lung disease as well as children and older adults should be alerted . Everyone else should avoid prolonged or heavy exertion.

Table 2. Air Quality in Ten Cities in Nepal

Stations Air Quality Index	
Simara	178
Damak	92
Bhaisipati	87
Dhankuta	74
DHM, Pkr	73
PU Pkr	73
Nepalgunj	64
Shankapark	60
Dhulikhel	43
Dang	38

Figure Sources: Government of Nepal, Ministry of environment air quality monitoring. Date 3/29/2020. [http://pollution.gov.np/#/home?_k=5wzxmd\[17\]](http://pollution.gov.np/#/home?_k=5wzxmd[17])

In Table 1, six levels of health concerns are defined in terms of associated health effects of air pollutants. The effects can be a few hours or few days after breathing unhealthy air [9]. Air quality is not monitored in all parts of the nation. More monitoring is needed. Patan city has an estimated population of some 184,000 residents as of 2020 and Patan is one the three cities to make up Greater Kathmandu and is located in the Kathmandu Valley. Bhaishpati in Patan has an air monitoring station and shows a level of 87 pollution or moderate air pollution (See list above). Kathmandu and Bhaktapur along with Patan make up Greater Kathmandu with a combined population of over 1.6 million with the Kathmandu Valley (<https://www.worldometers.info/world-population/nepal-population/>).

While air pollution is mostly an urban issue, Simara, a relatively small city of some 10,000 residents, has the worst out-door air quality of those cities where monitoring exists with a level of 178 (See list above). Based upon discussion with government officials, this air pollution is mainly due to the illegal brick making kilns in Simara. In the nearby city of Siraha that is an account of how local families suffer from illegal brick kilns. (<https://myrepublica.nagariknetwork.com/news/locals-suffer-from-illegal-brick-kilns-in-the-middle-of-settlements>). All residents of Simara (also in Siraha) will experience health effects and members of sensitive groups may experience more serious health effects. Everyone in Simara and Siraha need to be concerned about children and older adults with compromised health with the level of air pollution in their cities.

Indoor Air Pollution

Nandasena, Wickremasinghe and Sathiakumar, in their article in 2013 show how indoor air pollution affects the respiratory health of children in the lower income communities. Cooking over an open fire in a room without proper ventilation is a major cause of indoor air pollution around the world. Our colleagues in Chapala, Mexico have been replacing inefficient stoves in homes to reduce indoor air pollution in the barrio of Tepehua, and thus, lowering the risk of respiratory illness one house at a time (www.tepehua.org). In a paper by Ranabhat, and colleagues on the consequences of indoor air pollution in rural areas of Nepal provided a review of the extent of indoor air pollution exists in Nepal and how to measure this pollution [12]. Below is photo of one home in Nepal where a family cooks over open fire in their home and thus, reducing the quality of the air in the home. This is a very common scenario that one can find in the poorest houses in the Tepehua Barrio in Chapala, Mexico.



Human Health

Study shows that air pollution has many effects on the health of both adults and children. The impact can be *in utero* and during early life may permanently change the body's functions like- physiology and metabolism- and lead to diseases in adult life [13]. Likewise, in comparisons the infants are particularly vulnerable because of their rapid growth and cell differentiation, immaturity of metabolic pathways and the development of vital organ systems. The central nervous system has unprotected barriers and a broad time window of conformation, leading to a long period of vulnerability in the developmental process and leave the younger population susceptible to any environmental insult [14].

The USC Children's Health Study also documents how children are at much greater risk of increased asthma and asthma attack. Ozone levels is especially important pollutant because of the negative impact they have on the respiratory tract and lungs [15]. In contrast to adults, most children prefer to live outdoors more hours per day where they can exert themselves to a greater degree. However, some children in poor housing situations face air pollution challenge in their homes as well as outside where they may play.

Conclusion

We have pulled together existing data and studies attempting to illustrate the relationship between health status and air pollution in Nepal. Not surprisingly, most data comes from urban area of Nepal. More information is needed in rural Nepal. The media is becoming

aware of the issue of air pollution and can become a partner in the process of stimulating community action to improve air quality in Nepal.

The CNN reporter Mary McDougall, in 2018 reported that more than 90% of world's children breathe toxic air, around 93% of the world's children under 15 years of age breathe polluted air and that puts their health and development at serious risk. There are some 1.8 billion children globally [16]. Around 120 million cases of childhood pneumonia were reported in 2010 and among of them 47.4 million cases were reported from South Asia [17]. It has been shown that childhood pneumonia is a major cause of mortality worldwide. In addition to outdoor air pollution, it has been document that indoor or household air pollution (HAP) is a major contributor to childhood pneumonia in low and middle-income countries [18]. Daily cooking using inefficient stoves that allow the smoke to remain in the house is harmful for adults and children.

Thus, we conclude that more monitoring devices to record air quality levels is needed in Nepal. Using the model of "citizen science" in partnership with various organizations across the world are available to assist Nepal to expand air monitoring. (luftdaten.info) [19]. Schools and universities in Nepal can become important partners in this effort. Building and installing low cost air monitoring devices can be integrated into science and technology educational programs. With university involvement, more studies on the relationship between air pollution and children's health status can be done in Nepal. Community support for improving air quality can

increase as monitoring and studies increase.

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