ORIGINAL RESEARCH PAPER

Volume-8 | Issue-8 | August - 2019 | PRINT ISSN No. 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

A STUDY TO ASSESS THE QUALITY OF GROUND WATER IN THE RESIDENTIAL AREA NEAR GHAZIPUR LANDFILL AND ITS ASSOCIATION WITH GASTROINTESTINAL AND DERMATOLOGICAL DISORDERS

Health Science

Dr Tanya Jayal BDS, MPH, DHM Indian Institute of Public Health, affiliated to Shri Chitra Tirunal Institute of Medical Science

ABSTRACT

Background: Ghazipur landfill in Delhi is the oldest and the largest functional dumping ground in Asia. The ground water in the Ghazipur landfill area, containing leachates, is being used by slum households in the vicinity for various purposes. This study investigated the toxicity levels of the ground water in the vicinity of the landfill area and its consequent ill effects on the health of the users in terms of gastrointestinal and dermatological disorders.

Methodology: A community-based cross sectional study design was used with sample size of150 households (75 in Ghazipur and 75 in RK Puram). Stratified sampling was used. Data was collected for various demographic characteristics, sources of water and presence of gastrointestinal and dermatological problems among the family members. The study assessed the quality of water used for different purposes by taking water samples and testing them in an ISO certified lab. This study was funded by Centre for Environmental Health, Pubic Health Foundation of India.

Result : The toxic levels for elements such as Total hardness, chlorine, magnesium were higher than the permissible limits of the ground water samples of the Ghazipur community. The water quality in RK Puram had high levels of TDS, chlorine, sulphur, magnesium but the values were significantly less than Ghazipur.

The prevalence of dermatological disorders in Ghazipur was significantly higher (72 cases, 20%) than in the comparison area (15 cases, 4%) with P value <0.0001. The number cases of gastrointestinal tract diseases were almost similar in both the areas (60 in Ghazipur and 52 in RK Puram).

Conclusion : The study proved that the ground water in the vicinity of the dumping ground was not within permissible for household usage as well as consumption. It also showed that the prevalence of dermatological disease in the area near the dumping ground was significantly higher than that of an area with similar socioeconomic background.

KEYWORDS

Lechates, Landfill, Ghazipur, Rag pickers, Ground Water, Gastro intestinal disorders, Dermatological Disorders.

INTRODUCTION

Ghazipur landfill in the East Delhi district of New Delhi is the largest and the oldest landfill in the National Capital, started in 1984. The landfill occupies more than 70 acres of land and is more than 50 meters in height and contains approximately 130 lakh tonnes of unsegregated garbage. The Ghazipur landfill has not followed the CPCB norms and has consequently turned into a 'dumping yard' over the years. The landfill does not have a leachate (water that percolates through solid and leaches out some of the constituents) treatment facility because of which the by-products percolate into the ground water, leading to diseases.According to IL&FS Environmental Infrastructure & Services Ltd (IEISL), which is running a waste-to-energy plant on trial at the Ghazipur dump, the landfill generates approximately 1.4 million tons of toxic leachate run-off per day which flows into the Yamuna, and also contaminates the groundwater.(Chatterjee, 2016)

The Ghazipur dumping ground is the home to all the garbage accumulated by various sources in the nearby area, including household waste (wet and dry), municipal rubble, electronic waste, waste from the nearby industrial areas and hospital waste from the nearby medical facilities that are within three km radius of the dumping ground. All the illegal biomedical waste gets dumped at Ghazipur, causing an increase in chances of contamination of diseases like HIV and Hepatitis B among the rag pickers who segregate the waste with bare hands. The unsegregated dumping at Ghazipur has caused the organic waste to decompose over time, releasing toxic fumes like methane, sulphur and even benzene which cause foul smell, air pollution and increase in respiratory ailments among the local residents. The inorganic and electronic waste that is dumped at the landfill causes harmful chemicals such as arsenic, cadmium and mercury to leach from the dump and seep into the ground water. This groundwater is used by many local residents for cleaning, bathing and washing purposes and some even use it for drinking and without the use of any method of filtration.

The more serious health hazards are observed among rag pickers and manual scavengers who collect and segregate waste with bare hands. Many of these local residents who mostly belong to the below poverty line (BPL) community complaint of skin ailments and stomach disorders which is far more common than among people who are of the same socioeconomic status but live in other parts of the city.

Around 1500 families of rag pickers not only are at the risk of skin disorders due to acid leaks from discarded batteries and other organic products, but also have a high chance of contracting deadly diseases like HIV and Hepatitis B due to cuts and open wounds that occur during rag picking and segregation of waste with bare hands and feet. There have also been complaints among rag pickers of skin rashes, itching and irritation which lead to burning sensation and sometimes blood oozing wounds. The locals have also complained of high incidences of diarrhoea, cholera and typhoid along with other gastrointestinal disorders.

This paper highlights the toxicity of the constituents of ground water and the prevalence of disorders in the local residents as compared to a similar area and attempts to understand the perils of the locals.

METHODS

The study was a community-based cross-sectional study and had two main components:

1. Assessment of Quality of Water
2. Exploring association between use of ground water and skin / gastrointestinal diseases

The study was conducted around the Ghazipur dumping area, a locality of East Delhi district of the Delhi (exposed area), and the JJ colonies near Radha Krishna Puram, a locality of South West district of the state of Delhi (comparison area).The estimated sample size for the study was 150 households (75 households in each area). For representativeness, both the study areas were stratified into 4 zones – East, West, North and South, with 18-19 households in each zone.The study participants included all the family members within the selected household. Thus, the sample size of 150 households was completed with data of 660 individuals.Individuals residing in the study areas for one year or more and were willing to give consent for the study were included in the study. Temporary migrants (residing at study site for less than one year), people having a serious medical condition - a chronic or acute medical ailment such as diabetes, hypertension, ischemic heart disease, liver or kidney associated diseases and those who were unwilling to give consent for participation in the study were excluded.

The study participants were the entire selected household whose information was provided by the key informant who was available at the time of the household survey.

Household survey

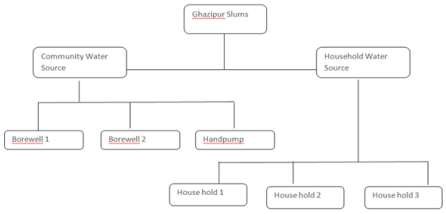
A local resident from the study area was selected and trained as a survey helper. In Ghazipur, the trained survey helper was the leader of the rag picker community and in RK Puram, an ASHA worker was trained as the survey helper. These individuals helped in building a rapport and convincing the household for co-operation during the survey.

While the study participants were the family members of the selected households, data for the survey was provided by a key informant above 16 years of age who was available at the time of the household survey. For the completion of the survey, a questionnaire was asked to the key informant. The three major sections in the questionnaire included the sociodemographic background, details about the different sources of water and their uses for different purposes as well as the filtration method used, and the disease histories. In this section, the key informants were asked about gastrointestinal disorders in the past 15 days (Diarrhoea, Jaundice, Typhoid, Cholera, Dysentery – where these were clinically diagnosed cases and the doctors report/prescription were verified) and dermatological disorders from the last one month (dermatitis, eczema, arsenicosis, alopecia, scabies- where eczema was taken as a clinically diagnosed case and the other disorders were considered after examining the lesion with hand held microscope and compared with reference image given by WHO). Consent was taken before administering the questionnaire.

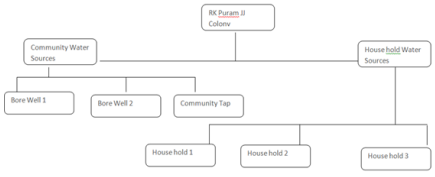
Sample testing

Water sampling was done to understand the quality of water used by the local residents for drinking as well as for household chores. Samples of water were strategically drawn from major sources in both exposed and comparison areas to assess quality of water for physical, chemical, heavy metal and biological parameters. For this, anecdotal information about the various sources of water was listed with the help of the community leaders and survey helpers.Then the water sources were stratified according to the following:

At Ghazipur slum, water samples were taken from the following sources:



RK Puram JJ colony, water samples were taken from the following sources:



Total of 12 samples were taken for testing to have generalized results. These samples of water were then given to an ISO certified laboratory for testing of the water for various characteristics such as:

- **Physical:** Color ,Taste, Turbidity, Odour, pH, TDS
- **Chemical:** Chloride, Calcium, Magnesium, Total Hardness, Fluoride, Nitrate, Cyanide, Sulphate, Sulphide, Phenolic compound, Anionic Detergents, Mineral Oil
- **Toxic Metals:** Iron, Copper, Manganese, Mercury, Cadmium, Molybdenum, Selenium, Arsenic, Lead, Zinc, Chromium, Aluminum, Nickel, Boron
- **Bacteriological Tests:** (E. Coli & Total Coliform)

RESULTS

The data collected was clean and compiled in Ms excel sheets and then analysed in STATA 14.1 software for analysis.
Various sections were analysed as follows:

Socio-demographic distribution

Socio demographic variables	Ghazipur	Percentage	RK Puram	Percentage
Gender of key informant	M: 43 F: 32	57.33 42.67	M: 71 F: 4	94.67 5.33
Duration of residency of families in study areas	1-2 Years: 0 2-4 Years: 6 5 or More Years: 69	0 8 92	1-2 Years: 2 2-4 Years: 10 5 or More Years: 63	2.67 13.33 84
Occupation of the Head of the Family	Daily wage worker: 17 Skilled worker: 1 Unskilled worker: 57 Professional: 0 Private job: 0	22.67 1.33 76 0 0	Daily wage worker: 12 Skilled worker: 49 Unskilled worker: 9 Professional: 0 Private job: 5	16 65.33 12 0 6.67
Head of the Family Monthly Income	Mean Income: 6573, SD: 1395		Mean Income: 8700, SD: 1854	

In Ghazipur, there were almost equal numbers of male and female key respondents (43 males and 32 females), where as in RK Puram the majority of the key informants were male (71). The family distribution was similar in the two study areas; in Ghazipur the average family size was 6, RK Puram had an average family size of 5 members. In both exposed and comparison areas, majority of the residents (69 in Ghazipur and 63 in RK puram) reported having lived for more than 5 years.

Detail of source of water

Source of water for daily use

Source of water for daily use	Ghazipur	Percentage	RK Puram	Percentage
Hand Pump	1	1.33	7	9.33
Bore Well	26	34.67	23	30.67
Municipal Tap Water	48	64	45	60
TOTAL	75	100	75	100

Source of water for consumption

Source of water for Drinking	Ghazipur	Percentage	RK Puram	Percentage
Hand Pump	0	0	7	9.33
Bore Well	0	0	14	18.67
Municipal Tap Water	75	100	61	81.33
TOTAL	75	100	75	100

All the households in both Ghazipur (100 percent) and 61 households in RK Puram (81.3 percent) used municipal tap water for all household chores.In RK Puram the situation is similar to that of Ghazipur where 45 households (60 percent) use municipal tap water for their regular household use. For drinking and cooking, it was found that all the selected households surveyed in Ghazipur consumed municipal tap water, where as in RK Puram there were 14 households (18%) that used bore well water for consumption. Only one out of the 75 households in Ghazipur used boiling as a method to purify the municipal tap water before consumption, whereas none of the 75 households surveyed in RK Puram use any method of purification before consuming the municipal tap water.

Results of the water sample tests

Ghazipur water toxicity result

	Drinking Water Tap water area 1	Drinking Water Tap water area 2	Drinking Water Tap water area 3	Bore well 1 Bhowapur	Bore Well 2 KabadiBasti	Hand Pump Kaushambi Park
Taste	Acc and Per	Acc and Per	Acc and Per	Non Agreeable	Non Agreeable	Non Agreeable
Color	Per only (5.36)	Per only (5.19)	Acc and Per	Non Per (20)	Non Per (21)	Non Per (25)
TDS	Acc and Per	Acc and Per	Acc and Per	Non Per(1760)	Non Per(1865)	Non Per(2750)
Calcium	Acc and Per	Acc and Per	Acc and Per	Only Per(133)	Only Per(164)	Only Per(191)
Chloride	Acc and Per	Acc and Per	Acc and Per	Only Per(435)	Only Per(465)	Non Per(1040)
Magnesium	Acc and Per	Acc and Per	Acc and Per	Only Per(88)	Only Per(75)	Only Per(72)
Sulphate	Acc and Per	Acc and Per	Acc and Per	Only Per(231)	Only Per(233)	Only Per (295)
Arsenic	Acc and Per	Acc and Per	Acc and Per	Acc and Per (0.006)	Acc and Per (0.001)	Acc and Per (0.001)
Total Alkalinity	Acc and Per	Acc and Per	Acc and Per	Only Per(383)	Only Per(422)	Only Per(256)
Total Hardness	Acc and Per	Acc and Per	Acc and Per	Non Per(700)	Non Per(773)	Non Per (778)
Total Coliform	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	14
Total E Coli	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected

In Ghazipur, the water collected from the three households that was used by the resident's for drinking purposes had all the values under both agreeable and permissible limits of the ISO and WHO standards of drinking water.

Toxic levels for elements such as **chlorine, magnesium, total hardness** higher than the permissible limits of the **ground water** samples of **Ghazipur.**

Water toxicity in RK Puram

	Drinking Water Area 1	Drinking Water Area 2	Drinking Water Area 3	Bore well 1 Ekta Vihar	Bore Well 2 Ravidas Camp	Community Tap Sonia Vihar
Taste	Agree and Per	Agree and Per	Agree and Per	Non Agree	Non Agree	Agree and Per
Color	Agree and Per	Agree and Per	Agree and Per	Only Per(7)	Agree and Per	Agree and Per
TDS	Agree and Per	Agree and Per	Agree and Per	Only Per(706)	Only Per(590)	Agree and Per
Calcium	Agree and Per	Agree and Per	Agree and Per	Only Per(102.1)	Only Per(88.8)	Agree and Per
Chloride	Agree and Per	Agree and Per	Agree and Per	Only Per(34.6)	Only Per(34.6)	Agree and Per
Magnesium	Agree and Per	Agree and Per	Agree and Per	Agree and Per	Agree and Per	Agree and Per
Sulphate	Agree and Per	Agree and Per	Agree and Per	Agree and Per	Only Per(330)	Agree and Per
Arsenic	Agree and Per	Agree and Per	Agree and Per	Agree and Per (0.01)	Agree and Per (0.01)	Agree and Per
Total Alkalinity	Agree and Per	Agree and Per	Agree and Per	Only Per(357)	Only Per(242)	Agree and Per
Total Hardness	Agree and Per	Agree and Per	Agree and Per	Only Per(400)	Only Per(311)	Agree and Per
Total Coliform	Not Detected	Not Detected	Not Detected	31	120	Not Detected
Total E Coli	Not Detected	Not Detected	Not Detected	Not Detected	5	Not Detected

In RK Puram the water used by the community for drinking had all the values under the acceptable and permissible limits of the ISO and WHO standards for drinking water.

High levels of **TDS, chlorine, sulphur, magnesium** were seen in ground water samples of RK Puram, but values significantly less than Ghazipur.

Gastro Intestinal disorders

	Ghazipur	Percentage	RK Puram	Percentage
Diarrhoea	45	13.04	43	13.65
Typhoid	4	1.15	7	2.22
Jaundice	3	0.86	1	0.31
Cholera	7	0.02	1	0.31
Dysentery	1	0.28	0	0
Total	60	17.39	52	16.50

The results from the survey showed that the prevalence of the total gastro intestinal tract disorders in the two communities were not significantly different. The prevalence of any GI tract disorders in Ghazipur was 17% whereas in RK Puram it was 16.5%.

The STATA results for the same showed a robust standard error of **0.34**, a z-value of **0.52** with a p value of **0.60**. Thus no significant association was found between the two. The association was not looked for the GI tract disorder as after the Lieutenant governors orders, the slum residents were shifted to the nearby slum where the source of drinking water changed from ground to municipal tap water.

Dermatological disorders

	Ghazipur	Percentage	RK Puram	Percentage
Dermatitis	48	13.9	15	4.76
Arsenicosis	3	0.86	0	0
Alopecia	10	2.89	0	0
Scabies	0	0	0	0
Eczema	11	3.11	0	0
Total Prevalence	72	20.86	15	4.76

The results from the survey showed a statistically significant difference in terms of prevalence of dermatological disorders. In Ghazipur the prevalence of any dermatological disorder (in 72 cases) was **20.8%** whereas in RK Puram for the same disorders (in 15 cases) the prevalence was only **4 .76%** (**p<0.0001**)

In order to understand the association between the outcome (dermatological disease) and exposure (ground water), a robust standard error test (adjusted for area) was performed. The data was adjusted to account for clustering of the disease within a household.

DISCUSSION

The results from this study showed that the ground water in Ghazipur area is not recommended for any use as per the WHO and ISO standards as the toxicity levels of total dissolved solids, magnesium, chlorine, calcium etc. are way above both acceptable and permissible limits. It was also observed that the residents of the slums in the vicinity of the Ghazipur dumping ground had significantly higher prevalence of dermatological disorders as compared to residents in a comparable socioeconomic status in other parts of Delhi.

This study could not show any significant association between the usage of ground water and the prevalence of the dermatological disease in the residents.

Socioeconomic Condition

Previous literature suggests that socio economic condition of an individual/ family has an impact on the prevalence of diseases. In developing countries, there is an inverse relationship between morbidity and social class (excluding chronic heart disease)(M G Marmot et al., 1987). In this study, the mean monthly income of the head of the family in the exposed area was also lower than the comparison area. It was also observed that the average family size in Ghazipur was larger than RK Puram. A study done in Baltimore USA showed that the family size has a significant association with the financial burden and larger family sizes are likely to add to the economic burden of the household. Also, it was observed that the individual prevalence of both gastrointestinal tract and dermatological

disorders in RK Puram were lower than Ghazipur. This correlates with previous literature, which suggests that morbidity is inversely proportional to socio economic status.(Wary, 1971)

The total number of cases of both the disease in RK Puram is lower than Ghazipur which co relates to the previous literature that morbidity is inversely proportional to socio economic status (when talking about the diseases observed in this study(M G Marmot et al., 1987)

Water Usage in the two localities and diseases

Around 1500 families of rag pickers, who used to live on the outskirts of the dumping ground, were recently asked by the MCD to shift to nearby slum areas in Bhowapur village, which is 1 km away from the site. Although they occasionally have access to municipal tap water but the toxicity of ground water which is used for other purposes have a detrimental effect on the health of the individual consuming it. The study showed that in case of drinking water, the entire population captured in Ghazipur slum did not consume the ground water that was toxic and used municipal tap water. The laboratory results confirmed that the municipal tap water had all the characteristics within the permissible limits. Hence, consumption of water and gastro intestinal disorders could not be associated with each other in this study.

With respect to the water that was used for daily chores, both the exposed and comparison area had 34 percent and 30 percent households respectively that reported use of ground water. This ground water in our study was reported to be filled with toxic elements beyond the permissible limits.

Elements such as calcium, chloride, magnesium, sulphate and Total dissolved solid were found to be higher than the permissible limit in Ghazipur (exposed) area. Study showed that the increased amount of elements such as Chlorine and Magnesium results in dermatological disorders in the individuals consuming it.(Adams, 2002).

In this study, the ground water in Ghazipur showed a dangerously high level of total dissolved hardness. A study done in Nottinghamshire found that there is a significant association between hardness of water and atopic eczema, which was also found to be higher in the Gzp population.(McNally et al., 1998)

Results of the inferential analyses between the use of ground water and presence of skin disorders showed that there was no significant association between the two. Being a cross sectional study, past exposure could not be measured which would lead to the association between exposure and outcome. Another possible reason for this could be that the use of water from different sources for different household purposes was not accurately reported by the key informants.

Although no significant association was proven between the dermatological disorders in the Gzp community with ground water usage, a detailed longitudinal study should be done for the same.

REFERENCES

1. A, T.R.K.R., Hemant, P., Nagendra, T., 2012. Prevalence and Risk Factors Associated with Gastro-Intestinal Tract Infections in Sikkim. J. Community Med. Health Educ. 2. https://doi.org/10.4172/2161-0711.1000174
2. Abd El-Salam, M.M., I. Abu-Zuid, G., 2015. Impact of landfill leachate on the groundwater quality: A case study in Egypt. J. Adv. Res. 6, 579–586. https://doi.org/10.1016/j.jare.2014.02.003
3. Adams, B.B., 2002. Dermatologic Disorders of the Athlete. Sports Med. 32, 309–321. https://doi.org/10.2165/00007256-200232050-00003
4. Ashbolt, N.J., 2004. Microbial contamination of drinking water and disease outcomes in developing regions. Toxicology 198, 229–238. https: //doi. org/10. 1016/j.tox. 2004 . 01.030
5. Bhattacharya, S., 2017. Fire breaks out at Delhi's Ghazipur landfill, no injuries reported - Times of India [WWW Document]. Times India. URL https:// times of india.indiatimes. com/city/delhi/fire-breaks-out-at-delhis-ghazipur-landfill-no-injuries-reported/articleshow/61083242.cms (accessed 3.30.18).
6. Bhattacharya, Yadav, S., Pankhuri, 2017. Ghazipur landfill collapse: Two killed as 50 tonnes of waste hurtles down Ghazipur landfill | Delhi News - Times of India [WWW Document]. URL https://timesofindia.indiatimes.com/city/delhi/two-killed-as-50-tonnes-of-waste-hurtles-down-ghazipur-landfill/articleshow/60332295.cms (accessed 2.20.18).
7. Carnwath, Lord, 2014. Judges and the Common Laws of the Environment—At Home and Abroad. J. Environ. Law 26, 177–187. https://doi.org/10.1093/jel/equ009
8. Chatterjee, P., 2016a. Delhi wastelands: 50 feet tall and growing, Ghazipur yard operates well beyond deadline | The Indian Express [WWW Document]. http://indianexpress. com. URL http://indianexpress.com/article/india/india-news-india/delhi-wastelands-50-feet-tall-and-growing-ghazipur-yard-operates-well-beyond-deadline/ (accessed 3.30.18).
9. Chatterjee, P., 2016b. Ghazipur, Bhalswa landfills are now off limits | The Indian Express [WWW Document]. URL http:// indian express. com/ article/cities/delhi/ghazipur-bhalswa-landfills-are-now-off-limits-4825925/ (accessed 4.14.18).
10. Cointreau, S., 2006. Occupational and environmental health issues of solid waste management : special emphasis on middle and lower-income countries (No. 33779). The World Bank.
11. Ecke H., Sakanakura H., Matsuto T., Tanaka N., Lagerkvist A., 2002. State-of-the-art treatment processes for municipal solid waste incineration residues in Japan. Waste Manag. Res. 18, 41–51. https://doi.org/10.1034/j.1399-3070.2000.00097.x
12. English, J.S.C., Dawe, R.S., Ferguson, J., 2003a. Environmental effects and skin disease. Br. Med. Bull. 68, 129–142. https://doi.org/10.1093/bmb/ldg026
13. English, J.S.C., Dawe, R.S., Ferguson, J., 2003b. Environmental effects and skin disease. Br. Med. Bull. 68, 129–142. https://doi.org/10.1093/bmb/ldg026
14. Ghosh, S., 2017. Green court raps AAP govt over Ghazipur landfill site - The Hindu [WWW Document]. URL http://www.thehindu.com/news/cities/Delhi/green-court-raps-aap-govt-over-ghazipur-landfill-site/article19952638.ece (accessed 4.14.18).
15. Goswami, S., 2017. As Ghazipur landfill shuts, Rani Khera new dumping site | delhi news | Hindustan Times [WWW Document]. www.hindustantimes.com. URL https://www.hindustantimes.com/delhi-news/as-ghazipur-landfill-shuts-rani-khera-new-dumping-site/story-J21l29AnJGIm7oTT7kgqhM.html (accessed 3.30.18).
16. Graeme, K.A., Pollack, C.V., 1998. Heavy Metal Toxicity, Part I: Arsenic and Mercury. J. Emerg. Med. 16, 45–56. https://doi.org/10.1016/S0736-4679(97)00241-2
17. Guerrero, L.A., Maas, G., Hogland, W., 2013. Solid waste management challenges for cities in developing countries. Waste Manag. 33, 220–232. https://doi.org/10.1016/j.wasman.2012.09.008
18. Guerrero, Maas, Hogland, L., Ger, William, 2013. Solid waste management challenges for cities in developing countries. Waste Manag. 33, 220–232. https://doi.org/10.1016/j.wasman.2012.09.008
19. Hazra, T., Goel, S., 2009. Solid waste management in Kolkata, India: Practices and challenges. Waste Manag. 29, 470–478. https://doi.org/10.1016/j.wasman.2008.01.023
20. Lippy, E.C., Waltrip, S.C., 1984. Waterborne Disease Outbreaks—1946-1980: A Thirty-Five-Year Perspective. J. Am. Water Works Assoc. 76, 60–67.
21. M G Marmot, M Kogevinas, Elston, and M.A., 1987. Social/Economic Status and Disease. Annu. Rev. Public Health 8, 111–135. https://doi.org/10.1146/ annurev.pu.08.050187.000551
22. Maheshwari, V., 2016. Article 21 Of The Constitution Of India - The Expanding Horizons [WWW Document]. www.legalservicesindia.com. URL http://www.legalserviceindia.com/articles/art222.htm (accessed 2.20.18).
23. Manohar, M., 2017. Waste dumping stops at Ghazipur on Delhi Lieutenant Governor's order - Times of India [WWW Document]. Times India. URL https://timesofindia.indiatimes.com/city/delhi/waste-dumping-stops-at-ghazipur-on-delhi-lieutenant-governors-order/articleshow/60343105.cms (accessed 2.20.18).
24. Martin, S., Griswold, W., 2009. Human health effects of heavy metals. Environ. Sci. Technol. Briefs Citiz. 15, 1–6.
25. McNally, N., Williams, H., Phillips, D., Smallman-Raynor, M., Lewis, S., Venn, A., Britton, J., 1998. Atopic eczema and domestic water hardness. The Lancet 352, 527–531. https://doi.org/10.1016/S0140-6736(98)01402-0
26. Mukherjee, S.C., Saha, K.C., Pati, S., Dutta, R.N., Rahman, M.M., Sengupta, M.K., Ahamed, S., Lodh, D., Das, B., Hossain, M.A., Nayak, B., Mukherjee, A., Chakraborti, D., Dulta, S.K., Palit, S.K., Kaies, I., Barua, A.K., Asad, K.A., 2005. Murshidabad—One of the Nine Groundwater Arsenic-Affected Districts of West Bengal, India. Part II: Dermatological, Neurological, and Obstetric Findings. Clin. Toxicol. 43, 835–848. https://doi.org/10.1080/15563650500357495
27. Organization, W.H., 2004. Guidelines for drinking-water quality: recommendations. World Health Organization.
28. Raj, et al, 2015. Sentiment Analysis of Swachh Bharat Abhiyan - ProQuest [WWW Document].URL https://search.proquest.com/ openview/45e3d573a7bdb96d6202f4fc806bd667/1?pq-origsite=gscholar&cbl=2043514 (accessed 4.14.18).
29. Ranjan Kaushal RajapureVikram A, T., 2012. Prevalence and Risk Factors Associated with Gastro-Intestinal Tract Infections in Sikkim. J. Community Med. Health Educ. https://doi.org/10.4172/2161-0711.1000174
30. Sakai, S., 1996. Municipal solid waste management in Japan. Waste Manag. 16. https://doi.org/10.1016/S0956-053X(96)00107-9
31. Tondel, M., Rahman, M., Magnuson, A., Chowdhury, I.A., Faruquee, M.H., Ahmad, S.A., 1999. The relationship of arsenic levels in drinking water and the prevalence rate of skin lesions in Bangladesh. Environ. Health Perspect. 107, 727–729.
32. Wary, J., 1971. Population pressure on families: family size and child spacing. | POPLINE.org [WWW Document]. URL https://www.popline.org/node/509433 (accessed 4.1.18).