AUCTORES
Globalize your Research

Clinical Medical Reviews and Reports

Shanti Lal Choubisa *

Open Access

Review Article

Are Coal-Based Thermal Power Plants safe for Human Health in Case of Fluoride Poisoning in India? People need to be Careful and Alert

Shanti Lal Choubisa [1,2]

[1]Department of Advanced Science and Technology, National Institute of Medical Science and Research, NIMS University Rajasthan, Jaipur, Rajasthan 303121, India.

[2]Former Department of College Education, Government of Rajasthan, Jaipur, Rajasthan, India.

***Corresponding Author:** Shanti Lal Choubisa., Department of Advanced Science and Technology, National Institute of Medical Science and Research, NIMS University Rajasthan, Jaipur, Rajasthan 303121, India.

Received Date: May 28, 2025; **Accepted Date:** June 02, 2025; **Published Date:** June 12, 2025

Citation: Shanti Lal Choubisa, (2025), Are Coal-Based Thermal Power Plants safe for Human Health in Case of Fluoride Poisoning in India? People need to be Careful and Alert, *Clinical Medical Reviews and Reports,* 7(3); **DOI:**10.31579/2690-8794/263

Abstract

Fluoride poisoning or fluorosis in humans is endemic in most of the rural areas of India due to consumption of fluoridated water. Groundwater in these areas is contaminated with fluoride in excess of the recommended value of 1.0 ppm or 1.5 ppm. Millions of people in the country suffer from fluoride poisoning due to drinking fluoridated water. But the health of people living near coal-fired thermal power plants (TPPs) in the country is also not safe and they have also been found to be suffering from fluoride poisoning. There are approximately 300 coal-fired TPPs) in operation in the country for power generation, most of which are located near freshwater reservoirs. These consume more than 859.25 million tonnes of fossil coal annually. The combustion of coal in these TPPs emits fluoride-containing toxic gases such as HF, SiF4, and CF4 into their surrounding environment and causes industrial fluoride pollution. This contaminates forests, crops, water, soil, and air. Fly ash, generated in TPPs is also a potential source of fluoride contamination. Fluoride up to 12.6 mg/kg has been detected in fly ash in the country. Slurry water discharged from fly ash ponds and water reservoirs near TPPs has been found to contain fluoride up to 9.94 ppm and 4.7 ppm, respectively. Due to prolonged fluoride exposure, more than 50% of children have been found to suffer from fluorosis in the vicinity of TPPs. However, most people are unaware of the health problems due to exposure to industrial fluoride emissions and fluoridated water in areas of TPPs. In fact, there is still a lack of research studies on fluoride toxicity from coal-based TPPs in the country. Through this editorial, the author has tried to draw the attention of the concerned departments, researchers, environmentalists, and NGOs towards the chronic fluoride poisoning or adverse effects on health caused by coal-based TPPs in the country.

Keywords: coal combustion; fluoride; fluoride poisoning; fluorosis; fly ash; groundwater; health; industrial fluoride pollution; reservoir; slurry water; thermal power plants; toxicity

Introduction

In India, especially in rural areas, the main cause of fluoride poisoning in the form of fluorosis (hydrofluorosis) is the consumption of fluoridated water for drinking and cooking. In these areas, the main sources of drinking water are hand- pumps, bore- wells, and deep dug-wells. Water from most of these sources is contaminated with fluoride [1,2] and many of them have fluoride levels higher than the recommended level of 1.0 mg/l or 1.5 mg/l [3-5]. Hence, millions of people in the country suffer from fluoride poisoning or fluorosis by drinking water from these sources. However, endemic hydrofluorosis has been widely studied in the country, especially in the tribal area, in the state of Rajasthan [6-11] where almost all drinking water sources are contaminated with high levels of fluoride [12-14]. Interestingly, due to the easy availability of water from these drinking water sources in rural areas, most of the livestock owners have started providing water from these groundwater sources to their domestic animals such as cattle (Bos taurus), water buffalo (Bubalus bubalis), sheep (Ovis aries), goat (Capra hircus), horse (Equus caballus), donkey (E. asinus). Due to this, fluoride poisoning is not only deteriorating the health of these animals [15-27] but also causing economic loss to livestock farmers [29]. The second largest cause of fluoride poisoning in the humans and animals in the country is the result of regular exposure to “industrial fluoride pollution” caused by coal-burning industries such as thermal power plants (TPPs) and brick kilns [29-33]. Other sources of industrial fluoride pollution in the country are industries of manufacturing or producing steel, iron, aluminium, zinc, phosphorus, chemical fertilizers, glass, plastics, cement and hydrofluoric acid [34]. Fluoride in gaseous form from these sources is released into the surrounding environment and contaminates fresh water reservoirs, soil, air, agricultural crops, and forest vegetation. Prolonged exposure to such industrial fluoride pollution leads to fluorosis (industrial fluorosis) in both humans [35-38] and animals [39-46]. Nevertheless, industrial fluorosis is restricted to the vicinity of TPPs. Recent studies also show that fluoride poisoning is also found in agricultural and horticultural crops if they come in contact with industrial fluoride pollution and fluoridated irrigation water. This destroys the crops and causes huge economic losses to the cultivators or farmers [33]. However, in the country, there have been substantial research studies on fluoride toxicity in both humans and animals due to exposure to fluoridated water as compared to industrial fluoride emissions. But there has been minimal research on fluoride toxicity or fluorosis in humans due to industrial fluoride pollution and water contamination with fluoride from TPPs in the country. The present editorial focuses on whether human health is safe in case of fluoride poisoning from TPPs in the country and highlights its possible adverse health consequences in humans. Also, the author has tried to draw the attention of the concerned departments researchers, environmentalists, and NGOs towards the chronic fluoride poisoning or adverse effects on health caused by coal-based TPPs in the country.

Status of TPPs and their surrounding ecosystems in India

According to a recent information provided by the Ministry of Power, Government of India, there are approximately 300 coal-fuelled thermal power plants (TPPs) in operation in the country for power generation [47]. These TPPs require a continuous supply of fossil coal fuel and fresh water to operate. Therefore, they are set up in areas or regions where coal and water are easily available. This is the reason why most of the TPPs in India are set up around perennial freshwater ecosystems or aquatic habitats such as dams, rivers, lakes, large ponds, etc. (Figure 1). But it is not necessary that coal mines are generally found in the vicinity of TPPs. However, TPPs located in Singrauli region of central India where both coal mines and large reservoir are found. It is one of the ideal regions for setting up TPPs in the country. The Singrauli region is an important hub for thermal power generation, particularly coal-based power plants. The region borders three states i.e. Uttar Pradesh in the north, Madhya Pradesh in the west and south, and Chhattisgarh in the east. Three major super thermal power stations are located in the region i.e. Singrauli, Vindhyachal and Rihand. These plants use coal from local mines and water from the Rihand reservoir. Many TPPs in the country are also surrounded by agricultural, grassland, and forest ecosystems (Figure 1).

Figure 1: Fluoride contamination occurs in soil, lotic and lentic fresh water reservoirs (a,b,and c), ground water, air, agricultural crops (d), and forest ecosystems (e) through smoke or emissions, fly ash and fly ash ponds of TPPs in India. If villagers and their domestic animals are exposed to these potential sources of fluoride for a long time, they may suffer from fluoride poisoning or fluorosis.

Fluoride contamination from TPPs

According to the latest data, a total of 859.25 million tonnes of fossil coal is consumed annually in coal-based TPPs in the country [48]. Actually, these natural fossil coals are rich in fluorine/fluorides. Its concentration range in most coals is 20–500 μg g−1, with an average value of about 150 μg g−1 [49-51]. The fluoride content in Indian coals generally ranges between 10−20 g/ton [52, 53]. When coal is burned in TPPs for production electricity or power, many types of toxic gases are also released into the environment. Among these, fluoride-containing toxic gases, such as hydrogen fluoride (HF), silicon tetrafluoride (SiF4), and carbon tetrafluoride (CF4), are also emitted into the atmosphere [49,51]. The emission of these fluoride-containing gases or fluoride emission not only contaminates the soil, air, and water ecosystems, but also contaminates the grassland, agricultural and horticultural crops, and forest ecosystems found in their surrounding areas. Another dangerous aspect of this is that food grains and crop fodder also get contaminated with fluoride due to fluoride emissions and fluoridated irrigation water. TPPs fluoride emissions or pollution and fluoridated fresh water, food grains, and crop fodder are potential sources of fluoride exposure for humans and domestic animals. According to a recent report by the Central Electricity Authority, Thermal Civil Design Division, Ministry of Power, Government of India, coal-based TPPs in India generate about 233 million metric tons of coal fly ash annually. This figure is rising steadily, with predictions suggesting it could exceed 300 million tonnes by 2025 [54]. This represents a significant environmental challenge due to the need for land-based disposal and the potential for heavy metal and fluoride leaching into groundwater. Fly ash, a fine powder, is the primary byproduct of coal combustion, accounting for about 80% of the total coal ash generated while the remaining 20% is bottom ash. Interestingly, most people do not know that this fly ash also contains fluoride. Coal fly ash from TPPs in India has varying fluoride content depending on the quality of the coal. Generally, the concentration of fluoride in fly ash ranges from 0.73 to 1.27 ppm. However, studies have also shown that fluoride levels in fly ash from Indian power plants in some locations can be as high as 12.6 mg/kg [29]. The specific fluoride content in fly ash may depend on factors such as the type of coal, the location of the power plant, and the combustion process. This fluoride-rich fly ash is typically transported in dry form or as a wet slurry to silos or ash ponds near the TPP, respectively. Wet slurry or fly ash ponds are also potential sources of fluoride contamination. Through leaching from fly ash, fluoride can be released into soil and water, which can ultimately reach groundwater aquifers. This contamination can be linked to the proximity of ash ponds to groundwater sources. Slurry water from ash ponds is typically discharged into freshwater reservoirs located near TPPs. In this way, water in reservoirs also becomes contaminated with fluoride. Slurry water from ash ponds of some TPPs has fluoride concentrations in excess of 10.0 ppm [29]. Similarly, water of reservoir near to TPP has also found fluoride content 4.7 ppm in Singauli region. Groundwater and fresh water (reservoirs) contaminated with fluoride are potential sources of fluoride exposure for human and animals.

Fluoride poisoning risk from TPPs?

It is evident that TPPs are responsible for causing fluoride contamination in diverse ecosystems such as air, soil, vegetation, agricultural crops, fresh water (reservoirs) and groundwater of their surrounding areas through various means as discussed above. If people living around TPPs are regularly exposed to any of them over a long period of time, fluoride poisoning is possible and they may develop fluorosis disease [1, 55, 56]. However, greater chances for the genesis of fluorosis are due to prolonged exposed to fluoridated groundwater and industrial fluoride emission or pollution from TPPs. In India, chronic fluoride intoxication or fluorosis has been widely studied and reported in people consuming groundwater containing fluoride levels above 1.0 mg/L or 1.5 ppm [57-59]. Fluorosis can also develop in domestic animals if they drink such fluoride contaminated groundwater and water from reservoirs near TPPs [60-62]. In any region, whether people are suffering from chronic fluoride intoxication or not is easily recognizable because of the presence of staining of teeth (dental fluorosis), characterized by diffuse hypocalcification that usually appears as bilateral, striated and horizontal opaque light to dark brown stripes on the tooth surface (Figure 2).

Figure 2: Dental fluorosis in childern due to fluoride poisoning is characterized by hypocalcification that typically appears as bilateral, striated, and horizontal opaque light to dark brown stripes on the tooth surface.

These pigmented stripes are relatively more contrasting in appearance and are more clearly visible on the incisors in children and adolescents than in older subjects. Dental fluorosis may also be seen in the form of light to deep brownish spots, patches, and fine dots or granules on the enamel of teeth. Interestingly, this is the first and earliest sign of chronic fluoride poisoning and once it appears it remains permanently and not reverse by any treatments. Due to prolonged exposure to fluoride contaminated sources or through excessive fluoride intake and inhalation, fluoride gets deposited on the bones of the skeleton and causes various changes such as periosteal exostosis, osteoporosis, osteosclerosis, and osteophytosis [63,64]. These changes in the bones are also known as skeletal or osteo-fluorosis. Over time, these changes gradually develop various physical abnormalities (Figure 3).

Figure 3: Skeletal fluorosis in old women due to fluoride poisoning showing common deformities: kyphosis, invalidism, genu-varum syndrome, paraplegia, crippling, and crossing or scissor-shaped legs.

Excessive fluoride accumulation in muscles also reduces mobility and causes lameness. Severely affected individuals often walk with a limp. In its advanced stages, neurological complications such as paraplegia and quadriplegia and genu-varum (outward bending of legs at the knee) and genu-valgum (inward bending of legs at the knee) syndromes develop, and this is the worst form of skeletal fluorosis which is not curable and persists for life. Fluoride poisoning is not restricted to teeth and bone organs but it can also impact on various soft organs of the body. Due to which several health complaints like gastrointestinal discomforts (intermittent diarrhoea or constipation, abdominal pain, flatulence, etc.), urticaria, tendency to urinate frequently (polyuria), excessive thirst (polydipsia), impaired endocrine and reproductive functions, teratogenic effects, renal effects, genotoxic effects, apoptosis, excitotoxicity, asthma, itching in the genitals, lethargy, muscle weakness, bronchitis with severe cough, burning sensation in the nose, irregular reproductive cycles, abortions, and stillbirths are possible [55,56]. These are the initial symptoms of chronic fluoride intoxication and is not necessary that all these health consequences appeared at the same time in a fluorosed subject. Another dangerous aspect of fluoride exposure is that it can also cause diverse neurological ailments or cognitive effects on children during their development, including reduced learning and memory ability, decreased intelligence or low intelligence quotient (IQ), mental retardation, dementia, headache, paralysis, quadriplegia, lethargy, insomnia, depression, polydipsia, polyuria, etc. [55,56, 58].The multiple adverse effects of fluoride on the developing brain of the foetus, newborns, and children and its various neurological toxic effects have also been recently critically reviewed [58]. Another potential negative aspect of fluoride toxicity is that it accelerates hematological changes, red blood cell death and anaemia [65-67]. The most of tribal people are living in the vicinity of TPPs and many of them are suffering with sickle- cell anaemia (Hb-SS) and α and β-thalassemia diseases [68-72]. These hereditary blood diseases cause tribal children to develop anaemia, often resulting in death. Therefore, it is also possible that chronic fluoride intoxication may be an additional factor in increasing anaemia in tribal children suffering from sickle-cell anaemia and beta-thalassemia diseases, leading to premature death of children. However, research studies are still needed in the country on relationship between these fatal diseases and fluoride poisoning in tribal individuals. In India, except for a few studies, there have been no comprehensive studies on chronic fluoride intoxication due to exposure to various sources of fluoride from TPPs such as fluoride emission and fluoride contaminated water [73,74]. Recent studies have clearly shown that due to exposure to fluoride contaminated water and fluoride pollution from TPPs, 50% of children in Singrauli area of central India have been found to suffer from fluoride intoxication or fluorosis [29]. Hence, there is a need for more research studies on fluoride intoxication or fluorosis not only in humans but also in domestic animals living in various areas where TPPs are operating. The findings of such studies will be useful in formulating health policies at the national level to protect the health of people and their domesticated animals from fluoride poisoning from TPPs in the country. Interestingly, people in the country are generally not aware of fluoride poisoning from TPPs. Therefore, they need to be careful and alert. There is also a need to pay more attention to this health problem in India.

Conclusion

There are approximately 300 coal-fired TPPs operating in the country. These consume 859.25 million tonnes of coal annually for power generation. During combustion of these coals, toxic gases containing fluoride such as HF, SiF_4, and CF_4 are also emitted into the surrounding environment contaminating water, soil, air, agricultural crops, grasslands, forest, etc. which are potential sources of fluoride exposure for humans and animals. Fly ash generated from TPPs is also a potential source of fluoride contamination as it contains significant amounts of fluoride. The slurry water of most fly ash ponds and the water in the reservoirs near TPPs also contain high levels of fluoride. If people living near TPPs are exposed to these fluoride contaminated sources for a long time, they develop fluoride poisoning or fluorosis, a disease about which most people are still unaware. Therefore, people living near TPPs need to be careful and cautious. There is also a need to do more research on this subject in the country.

Competing interest

The author has no conflict of interest.

Acknowledgement

The author thanks to Prof. Darshana Choubisa, Department of Prosthodontics and Crown & Bridge, Geetanjali Dental and Research Institute, Udaipur, Rajasthan 313002, India for help.

References

1. Choubisa, S. L. (2018). A brief and critical review on hydrofluorosis in diverse species of domestic animals in India. Environmental Geochemistry and Health, 40(1): 99-114.
2. Choubisa, S. L. (2018). Fluoride distribution in drinking groundwater in Rajasthan, India. Current Science, 114(9): 1851-1857.
3. Adler, P., Armstrong, W. D., Bell, M. E., Bhussry, B. R., Büttne, r W., et al. (1970). Fluorides and human health. World Health Organization Monograph Series No. 59. Geneva: World Health Organization.
4. I. C. M. R. (Indian Council of Medical Research) (1974). Manual of standards of quality for drinking water supplies. Special report series No. 44. Indian Council of Medical Research, New Delhi, India.
5. B. I. S. (Bureau of Indian Standards). (2012). Indian standard drinking water-specification. 2nd revision. New Delhi: Bureau of Indian Standards. p. 2.
6. Choubisa, S. L., Choubisa, D. K., Joshi, S. C., Choubisa, L. (1997). Fluorosis in some tribal villages of Dungarpur district of Rajasthan, India. Fluoride, 30(4): 223-228.
7. Choubisa, S. L. (2001). Endemic fluorosis in southern Rajasthan (India). Fluoride, 34(1): 61-70.
8. Choubisa, S. L., Choubisa, L., Choubisa, D. K. (2001). Endemic fluorosis in Rajasthan. *Indian Journal of Environmental Health*, 43(4): 177-189.
9. Choubisa, S. L. (2012). Fluoride in drinking water and its toxicosis in tribals, Rajasthan, India. Proceedings of National Academy of Sciences, India Section B: *Biological Sciences*, 82(2): 325-330.
10. Choubisa, S. L. (2018). A brief and critical review of endemic hydrofluorosis in Rajasthan, India. Fluoride, 51(1): 13-33.
11. Choubisa, S. L. (2022). Status of chronic fluoride exposure and its adverse health consequences in the tribal people of the scheduled area of Rajasthan, India. Fluoride, 55(1): 8-30.
12. Choubisa, S. L., Sompura, K., Choubisa, D. K., Pandya, H., Bhatt, S. K., Sharma, O. P., et al. (1995). Fluoride content in domestic water sources of Dungarpur district of Rajasthan. *Indian Journal of Environmental Health*, 37(3): 154-160.
13. Choubisa, S. L., Sompura, K., Choubisa, D. K., Sharma, O. P. (1996). Fluoride in drinking water sources of Udaipur district of Rajasthan. *Indian Journal of Environmental Health*, 38(4): 286-291.
14. Choubisa, S. L. (1997). Fluoride distribution and fluorosis in some villages of Banswara district of Rajasthan. *Indian Journal of Environmental Health*, 39(4): 281-288.
15. Choubisa, S. L. (1999). Chronic fluoride intoxication (fluorosis) in tribes and their domestic animals. *International Journal of Environmental Studies*, 56(5): 703-716.
16. Choubisa, S. L. (1999). Some observations on endemic fluorosis in domestic animals of southern Rajasthan (India). Veterinary Research Communications, 23(7): 457-465.
17. Choubisa, S. L. (2007). Fluoridated ground water and its toxic effects on domesticated animals residing in rural tribal areas of Rajasthan (India). *International Journal of Environmental Studies*, 64(2): 151-159.
18. Choubisa, S. L., Choubisa SL (2010) Osteo-dental fluorosis in horses and donkeys of Rajasthan, India. Fluoride, 43(1): 5-10.
19. Choubisa, S. L. (2010). Fluorosis in dromedary camels of Rajasthan, India. Fluoride, 43(3): 194-199.
20. Choubisa, S. L. (2012). Status of fluorosis in animals. Proceedings of National Academy of Sciences, India Section B: *Biological Sciences*, 82(3): 331-339.
21. Choubisa, S. L., Choubisa, S. L., Modasiya, V., Bahura, C. K., Sheikh, Z. (2012). Toxicity of fluoride in cattle of the Indian Thar Desert, Rajasthan, India. Fluoride, 45 (4): 371-376.
22. Choubisa, S. L. (2013). Fluorotoxicosis in diverse species of domestic animals inhabiting areas with high fluoride in drinking waters of Rajasthan, India. Proceedings of National Academy of Sciences, India Section B: *Biological Sciences*, 83(3): 317-321.
23. Choubisa, S. L. (2013). Fluoride toxicosis in immature herbivorous domestic animals living in low fluoride water endemic areas of Rajasthan, India: an observational survey. Fluoride, 46(1): 19-24.
24. Choubisa, S. L. (2013). Why desert camels are least afflicted with osteo-dental fluorosis? Current Science, 105(12): 1671-1672.
25. Choubisa, S. L. (2021). Chronic fluoride exposure and its diverse adverse health effects in bovine calves in India: an epitomised review. *Global Journal of Biology, Agriculture and Health Sciences*, 10(3): 1-6. Or 10:107.
26. Choubisa, S. L. (2022). A brief review of chronic fluoride toxicosis in the small ruminants, sheep and goats in India: focus on its adverse economic consequences. Fluoride, 55(4): 296-310.
27. Choubisa, S. L., Choubisa, D., Choubisa, A. (2023). Fluoride contamination of groundwater and its threat to health of villagers and their domestic animals and agriculture crops in rural Rajasthan, India. *Environmental Geochemistry and Health*, 45: 607-628.
28. Choubisa SL. (2024). A brief and critical review of skeletal fluorosis in domestic animals and its adverse economic consequences. *Journal of Dairy and Veterinary Science*, 16(4): 1-8, 555942.
29. Usham, A. L., Dubey, C. S., Shukla, D. P., Mishra, B. K., Bhartiya, G. P. (2018). Sources of fluoride Contamination in Singrauli with special reference to Rihand reservoir and its surrounding. *Journal Geological Society of India*, 91:441-448.
30. Choubisa, S. L. (2023). Industrial fluoride emissions are dangerous to animal health, but most ranchers are unaware of it. *Austin Environmental Sciences*, 8(1):1-4, id 1089.
31. Kamyotra, J. S. (2023). Brick kilns in India. Central Pollution Control Board, Delhi, India, pp 1-57.

32. Choubisa, S. L. (2025). Can smoke from coal-fired brick kilns in India cause fluorosis in domestic animals? If yes, then livestock owners need to be made aware. *Biomedical and Clinical Research Journal*, 1(2); 1-7.
33. Choubisa, S. L. (2025). Can emissions from coal-fired brick kilns harm agricultural crops in India? *Journal of Toxicological Studies*. 3(1): 2969.
34. Choubisa, S. L., Choubisa, S. L., Choubisa, D. (2016). Status of industrial fluoride pollution and its diverse adverse health effects in man and domestic animals in India. *Environmental Science and Pollution Research*, 23(8): 7244-7254.
35. Bhawsar, B. S., Desai, V. K., Mehta, N. R., et al. (1985). Neighbourhood fluorosis in western India part II: population study. Fluoride, 18(2): 86-92.
36. Desai VK, Saxena DK, Bhavsar BS, et al. Epidemiological study of dental fluorosis in tribal residing in fluorspar mines. Fluoride, 1988; 21(3): 137-141.
37. Choubisa, S. L., Choubisa, S. L., Choubisa, D. (2015). Neighbourhood fluorosis in people residing in the vicinity of superphosphate fertilizer plants near Udaipur city of Rajasthan (India). Environmental Monitoring and Assessment, 187(8): 497.
38. Choubisa, S. L. (2025). Risk of fluorosis and other health hazards in humans from coal-fired brick kilns in India: People need to be aware. *Clinical Medical Reviews and Reports*. 7(1): 1-7.
39. Swarup, D., Dwivedi, S. K., Dey, S., Ray, S. K. (1998). Fluoride intoxication in bovines due to industrial pollution. *Indian Journal of Animal Science*, 68: 605-608.
40. Patra, R. C., Dwivedi, S. K., Bhardwaj, B., Swarup, D. (2000). Industrial fluorosis in cattle and buffalo around Udaipur, of the India. *Science of Total Environment*, 253:145-150.
41. Swarup, D., Dey, S., Patra, R. C., Dwivedi, S. K., Ali, S. L. (2001). Clinico epidemiological observations of industrial bovine fluorosis in India. *Indian Journal of Animal Science*, 71:1111-1115.
42. Choubisa, S. L. (2015). Industrial fluorosis in domestic goats (Capra hircus), Rajasthan, India. Fluoride, 48(2): 105-115.
43. Jena, C. K., Gupta, A. R., Patra, R. C. (2016). Osteo-dental fluorosis in cattle reared in villages on the periphery of the aluminium smelter in Odisha, India. Fluoride, 49(4 Pt 2): 503-508.
44. Pati, M., Parida, G. S., Mandal, K. D., Gupta, A. R., Patra, R. C. (2020). Clinico-epidemiological study of industrial fluorosis in calves reared near aluminium smelter plant, at Angul, Odisha. Pharmacy Innovation Journal, 9(6): 616-620.
45. Choubisa, S. L. (2023) Industrial fluoride emissions are dangerous to animal health, but most ranchers are unaware of it. *Austin Environmental Science*, 8(1):1-4, id 1089.
46. Choubisa, S. L. (2023). A brief review of industrial fluorosis in domesticated bovines in India: focus on its socio-economic impacts on livestock farmers. *Journal Biomed Research*, 4(1):8-15.
47. C. E. A. (Central Electricity Authority). (2024). Thermal Civil Design Division, Ministry of Power, Government of Inda, New Delhi, India.
48. ICID (India Climate and Energy Dashboard). (2024). National Institute of Transforming India (NITI Aayog), Government of India, New Delhi, India.
49. Li, W., Lu, H., Chen, H., Li, B. (2005). Volatilization behavior of fluorine in coal during fluidized-bed pyrolysis and CO2-gasification. Fuel, 84(4): 353-357.
50. Liu, G., Zheng, L.G., Duzgoren-Aydin Nurdan, S., Gao, L.F. (2006). Toxic trace elements As, F and Se in Chinese indoor coals combustion and their health implications. Reviews of Environmental Contamination and Toxicology, 189:.89-106.
51. Sredović I., Rajaković, Lj. (2010). Pyrohydrolytic determination of fluorine in coal: A chemometric approach. *Journal of Hazardous Materials*, 177 (1-3): 445-451.
52. Yadav, K., Raphi, M., Jagadevan, S. (2021). Geochemical appraisal of fluoride contaminated groundwater in the vicinity of a coal mining region: *Spatial variability and health risk assessment*. Geochemistry, 81(1), 125684.
53. Ghosh, R., Majumder, T., Ghosh, D. N. (1987). A study of trace elements in lithotypes of some selected Indian coals. *International Journal Coal Geology*, 8(3): 269-278.
54. C. E. A. (Central Electricity Authority). (2021). Thermal Civil Design Division, Ministry of Power, Government of Inda, New Delhi, India.
55. Choubisa, S. L. (2022). The diagnosis and prevention of fluorosis in humans (editorial). *Journal of Biomedical Research and Environmental Sciences*, 3(3): 264-267.
56. Choubisa, S. L. (2022). How can fluorosis in animals be diagnosed and prevented? *Austin Journal of Veterinary Science and Animal Husbandry*, 9(3): 1-5, id1096.
57. Choubisa, S. L. (2024) A brief review of fluoride-induced bone disease skeletal fluorosis in humans and its prevention. *Journal of Pharmaceutics and Pharmacology Research*, 7(8): 1-6.
58. Choubisa, S. L., Choubisa, D., Choubisa, A. (2024). Are children in India safe from fluoride exposure in terms of mental health? This needs attention. *Journal of Pharmaceutics and Pharmacology Research*, 7(11); 1-6.
59. Choubisa, S. L., Choubisa, D., Choubisa, P. (2023). Are tribal people in India relatively more susceptible to fluorosis? More research is needed on this. *Pollution and Community Health Effects*, 1(2):1-10.
60. Choubisa, S. L. (2023). A brief and critical review of endemic fluorosis in domestic animals of scheduled area of Rajasthan, India: focus on its impact on tribal economy. *Clinical Research in Animal Science*, 3(1):1-11.
61. Choubisa, S. L. (2023). Chronic fluoride poisoning in domestic equines, horses (Equus caballus) and donkeys (Equus asinus). *Journal of Biomed Research*, 4(1):29-32.
62. Choubisa, S. L. (2023). A brief review of endemic fluorosis in dromedary camels (Camelus dromedarius) and focus on their fluoride susceptibility. *Austin Journal of Veterinary Science and Animal Husbandry*, 10(1):1-6, 1117.
63. Choubisa, S. L. (1996). Radiological skeletal changes due to chronic fluoride intoxication in Udaipur district (Rajasthan). *Pollution Research*, 15(3): 227-229.
64. Choubisa, S. L. (2022). Radiological findings more important and reliable in the diagnosis of skeletal fluorosis. *Austin Medical Sciences*, 7(2):1-4, id1069.

65. Agalakova, N. I., Gusev, G. P. (2013). Excessive fluoride consumption leads to accelerated death of erythrocytes and anaemia in rats. *Biological Trace Element Research*, 153(1-3): 340-349.
66. Yasmin, S., Ranjan, S., D'Souza, D. (2014). Haematological changes in fluorotic adults and children in fluoride endemic regions of Gaya district, Bihar, India. *Environmental Geochemistry and Health*, 36(3): 421–425.
67. Pornprasert, S., Wanachantararak, P., Kantawong, F., et al. (2017). Excessive fluoride consumption increases haematological alteration in subjects with iron deficiency, thalassaemia, and glucose-6-phosphate dehydrogenase (G-6-PD) deficiency. *Environmental Geochemistry and Health,* 39(4): 751-758.
68. Jain, R. C., Andrew, A. M. R., Choubisa, S. L. (1987). Sickle cell and thalassaemic genes in tribal population of Rajasthan. *Indian Journal of Medical Research*, 78: 836-840.
69. Jain, R.C., Choubisa, S. L., Acharya, A., Andrew, A.M.R., Chhaparwal, J.K., Joshi, K.C. (1984). Incidence of G-6-PD deficiency in the tribal population of southern Rajasthan. *Journal of Association of Physicians of India*, 32(3): 266-267.
70. Choubisa, S. L. (2009). Sickle cell haemoglobin, thelasseamia and G-6-PD enzyme deficiency genes in Garasiya tribe inhabited malaria endemic areas of Sirohi district, Rajasthan (India). *Journal of Communicable Diseases*, 41(1): 13-18.
71. Choubisa, S. L., Choubisa, A. (2021). Status of erythrocyte genetic disorders in people of desert and humid environments, Rajasthan, India: focus on natural selection in tribals against malaria. Proceedings of Indian National Science Academy, 87(3); 433-445.
72. Choubisa, S. L. (2023). How do sickle cell genes protect tribal people from deadly malaria? Is this a type of natural selection? *Annals of Hematology and Oncology*,10 (5), 1-6, 1437.
73. Gautam, A. Tripathi, R.C. (2005). Fluoride testing and fluorosis mitigation in Sonbhadra district. Peoples, Science Institute, Dehradun, pp.1-11.
74. Tourangeau, P. C., Gordon, C. C., Carlson, C. E. (1997). Fluoride emissions of coal-fired power plants and their impact upon plant and animal species. Fluoride (United States), 10:2. 6421148.

DOI:10.31579/2690-8794/263