Health hazards related to Soba sewage treatment plant, Sudan

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Abstract

The aim of this study was to determine the health hazards acquired by the residents nearby Soba sewage treatment plant. A descriptive cross-sectional study was carried out in Soba locality, Khartoum, Sudan. An interviewer-administrated questionnaire was assigned to 462 residents of the area living in four geographically distributed squares around the sewage plant. The data was analyzed in SPSS; Cronbach's alpha reliability scale of measurement was used to check the internal validity of six variables related to the quality of life. A logistic regression analysis was used to assess the relationship between the health hazards and the quality of life. Among the 462 residents, difficulty in breathing (37.9%) and nausea (37.2) were the principal health hazards. Moreover, the residents had a satisfactory level of awareness (88.7%) about the health hazards. The utmost impact on the quality of life was psychological (97.2%). It was statistically correlated with the reported factors, which impacted the quality of life in the district as revealed by the Cronbach's alpha reliability test with absenteeism (P=0.026), disability (P=0.014), socialization (P=0.032) and death (P=0.016). A logistic regression analysis revealed chemical hazards had a statistically significant association (P<0.05) with quality of life of the residents of Soba district. The study strongly entails the fact that sewage treatment plants crave exceptional consideration from the concerned responsible authorities, together with the fact that the evolved health threats should be confronted with immense responsibility as soon as possible.

Introduction

Sewage is the used water of a community and can include domestic and industrial wastewater. It is more than 99% water, but the remainder contains ions, suspended solids and harmful bacteria that must be removed before the water is released into the sea.[1] Sewage treatment plant is defined as structures and appurtenances that receive raw sewage and bring about a reduction in organic and bacterial contents of the waste to render it less dangerous and less odorous.[2] Sewage is a major carrier of disease (from human wastes) and toxins (from industrial wastes). The safe treatment of sewage is thus crucial to the health of any community. The treatment of wastewater is divided into three phases:[1] pre treatment, primary treatment and secondary treatment.

The pre-treatment phase use screening to remove large solids as rags and sticks (diameter >2 mm). The primary treatment phase of wastewater includes two stages the pre-aeration and the sedimentation. During the pre-aeration stage, the wastewater is aerated by air pumped through perforated pipes near the floor of the tanks. This makes water less dense causing grit to settle out, and also provides dissolved oxygen for the bacteria to use later in the process. The second stage of the primary treatment phase is named sedimentation. Water then flows slowly and smoothly through sedimentation tanks were suspended solids fall to the bottom and scum rises to the surface, while clarified effluent passes on. Solids are removed from the bottom of the tanks by scrappers, and scum is washed off with water jets. Finally, scum and solids are brought to a common collection point where they are combined to form *sludge* and sent off for secondary treatment. At the end of secondary treatment, all effluent, both solid and liquid, is sufficiently safe to be released into the environment. During the treatment of solids, sludge from sedimentation tanks is digested anaerobically in large tanks, and further digested in lagoons, before being dried in dewatering beds. Sludges from digesters are then sent to lagoons for about a year, and finally to dewatering beds. During this time, all pathogens are killed by sunlight. Finally, it can be used as a soil conditioner, but currently simply landfilled. For treatment of liquids, they are either sent directly to open-air oxidation ponds, or sent to fixed growth reactors before pond oxidation. In fixed growth reactors, organics are reduced to carbon dioxide, methane and small amount of foul-smelling hydrogen sulphide. From the bottom of the fixed growth reactors, effluent is piped out of the secondary sedimentation tanks where sludge is removed. Liquid is then sent for pond oxidation. In the pond, algae use solar energy to produce oxygen from carbon dioxide and water, and bacteria use oxygen to break down remaining organics to simple molecules such as carbon dioxide and ammonia. The sun also destroys pathogenic bacteria, while the wind ensures even mixing so that all parts of the ponds are aerobic. Treated effluent is then released at each high tide.

The specific hazard associated with each process varies depending on the design of the treatment plant and the chemicals used in the different processes, but the types of hazards can be classified as:[3] physical, microbial and chemical. Physical hazards include confined spaces, inadvertent energizing of machines or machine parts and trips and falls. The result of an encounter with a physical hazard can often be immediate, irreversible and serious, even fatal. Regarding the microbial hazards, although bacteria are often added to alter the solids contained in wastewater, the hazard to sewage treatment workers comes primarily

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from exposure to microorganisms contained in human and other animal waste. The three main categories of microbes relevant to this discussion are fungi, bacteria and viruses. All three of these can cause acute illness such as respiratory distress, abdominal pain and diarrhea, as well as chronic diseases such as asthma and allergic alveolitis. Chemical hazards in sewage treatment plants arise from the decomposition of organic material, which results in the production of hydrogen sulphide and methane, from toxic waste dumped down the sewer lines and from the contaminants produced by operations performed by the workers themselves. Hydrogen sulphide (also known as sewer gas) is usually found in waste treatment plants. It biochemically interferes with the electron transport mechanism and blocks the utilization of oxygen at the molecular level. The result is asphyxiation and ultimately death due to the lack of oxygen in the brainstem cells that control the breathing rate. On the other hand, methane, in addition to displacing oxygen, is explosive. Another serious chemical hazard in sewage treatment plants is gaseous chlorine. Gaseous chlorine is extremely irritating to the alveolar portion of the lungs. Inhalation of higher concentrations of chlorine can cause inflammation of the alveoli of the lung and produce the adult respiratory distress syndrome, which has a 50% death rate. Several studies have been conducted in different districts around the world to address this matter of contention, with each one reaching a different conclusion.[4-8] On top of that, problems with sanitations are evident throughout Sudan. Only 28% of Khartoum region are connected to sewage systems, which means that only a quarter of the population (estimated to be 6,228,342 people as at 2016) is covered with sewage systems. This shortage is attributed to the explosive growth and overstretch that has took place in Khartoum,[9] with a resultant failed operation of Soba sewage treatment plant. Thus, this research was conducted to perceive how this disputed point is influencing the health of Soba sewage treatment plant residents, and the encompassing environment, with the intent of elucidating recommendations to the authority, to indulge in composing a solution for this public health issue.

Ethical considerations

The Review committee Board of the University of Medical Sciences and Technology authorized the research and authorization was obtained from the State Ministry of Health. All participants were well informed and agreed to participate freely in the research.

Materials and Methods

A community-based cross-sectional study was performed on a sample of 462 people residing in Soba district, South of Khartoum, Sudan (Figure 1) during the period of 8th to 15th September 2015. Soba district population was distributed in nine squares, from which four were selected at first level by using Google Earth Pro 7.1.2.2041 to ensure their representative spatial distribution around the sewage treatment plant (Figure 2). Within the selected squares, participants were randomly selected from households following a well informed consent. A standardized questionnaire was administrated by eight researchers to collect data on sociodemographic characteristics such as gender, age and length of residency in Soba. Health problems as respiratory, gastro-intestinal, dermatological, psychological and cerebral nervous system disorder were collected as well as knowledge and awareness towards health risks and preventive measures. The participants also provided information on the quality of life in their respective squares. The University of Medical Sciences and Technology institutional review board approved the study. All data were entered with a data entry template designed in Epi Info TM 7.1.5.0, free available software in the public domain developed by the Center of Disease Control and Prevention (CDC). The data cleaning, description and analysis were performed through the statistical package for social sciences, SPSS 21 for MS Windows (SPSS, Chicago, IL, USA). The reliability of the scale of measurements was assessed by use of Cronbach's alpha internal validity test and a logistic regression was performed.

Figure 1. Soba sewage treatment plant.

Table 1. Sociodemographic characteristics of the study participants.

Variable	Number	%
Gender	462	100.0
Male	211	45.7
Female	251	54.3
Age group	462	100.0
12-19 years	51	11.0
20-27 years	139	30.1
28-35 years	85	18.4
36-43 years	65	14.1
44-51 years	51	11.0
>=51 years	71	15.4
Marital status	462	100.0
Married	288	62.3
Single	166	36.0
Divorced	5	1.1
Widow	3	0.6
Have children	462	100.0
No child	203	43.9
1-5 children	186	40.3
>5 children	73	15.8
Have schooling children	462	100.0
No child	267	57.8
1-5 children	173	37.4
>5 children	22	4.8
Residence	462	100.0
Square 19	63	13.6
Square 20	135	29.2
Square 22	137	29.7
AL-fath -1	127	27.5
Length of stay in the square (years)	462	100.0
<1 year	51	11.0
1-5 years	176	38.0
6-10 years	117	25.0
>10 years	118	26.0

Results

Of the 462 participants, 54.3% were females and 45.7% were males. They were aged between 12 and 81 years with a mean age of 35 years ±15. Their years of residency around the sewage treatment plant of Soba ranged from less than one year to 30 years with a mean of 7.2 years ±5.8. Of the participants (n=462) 11.0% lived in their respective square around the plant for less than one year, 38.0% for one to five years and the remaining 51.0% had a length of stay above 5 years. Regarding their marital status, 62.3% were married and 56.1% had children (Table 1).

Health problems (Table 2) were reported by 83.3% of the participants (n=462), they were absent in 16.5% and 0.2% did not answer the question related to the existence or absence of a health problem. The prevalence of the health problems reported by the participants (n=385) were respectively psychological (91.2%), respiratory (62.6%), gastro-intestinal (61.0%), Cerebral nervous system (47.3%), dermatological (26.8%), and other health problems were 7.0%. The most frequently reported psychological problems were discomfort and irritability by respectively 98.9% and 78.9% of the participants (n=351). The respiratory problems reported by 241 participants were difficulty in breathing (72.6%), cough (57.3%), shortness of breathing (45.2%), and wheezing (7.9%). Gastro-intestinal problems (n=235) ranked in third position with predominantly nausea (73.2%) and stomachache (56.6%). Diarrhea and vomiting were reported respectively by 33.2% and 27.2%. Headaches (96.7%) and migraine (5.5%) were the cerebral nervous system problems from which 182 participants suffered from. The dermatological problems reported by 183 participants were skin itching (39.9%), allergy (37.2%) and wound (3.3%). Other health problems reported by 27 participants were conjunctivitis (44.4%), urinary problem (25.9%), sinusitis (22.2%) and fatigue (7.4%).

The knowledge of the participants towards the relation between the health problems and hazards were assessed using a scale of measurement of the awareness. Of the 462 participants, 17.7% had a good knowledge; it was moderate for 31.6%, poor for 39.2% and 11.5% were not aware about the risk to which they were exposed. Chemical and microbial hazards were responsible for the health problems in their squares for respectively 81.6% and 72.9% of the 462 participants. None of participants reported physical hazards as potential causes of the health problems.

Regarding the preventive measures applied by the participants, hands washing prior to the preparation of food was applied by almost all of (98.0%) the participants (n=461); 66.5% were vaccinated (n=460) among which 53.8% for tetanus and 16.9% for hepatitis. Of the 262 participants who responded to the question on having children, 11.8% had their children playing

Table 2. Health problems reported by the study participants.

Variable	Number	%
Health problems	462	100.0
Yes	385	83.3
No	76	16.5
No answer	1	0.2
Psychological problem (n=351)	351	91.2
Discomfort	347	98.9
Irritability	277	78.9
Tension	138	39.3
Depression	3	0.9
Respiratory problem (n=241)		
Difficulty in breathing	175	72.6
Cough	138	57.3
Shortness breathing	109	45.2
Wheezing	19	7.9
Other respiratory problems	6	2.5
Gastro-intestinal problem (n=235)		
Nausea	172	73.2
Stomach ache	133	56.6
Diarrhea	78	33.2
Vomiting	64	27.2
Other gastro-intestinal problem to specify		
Central nervous system problem (n=182)	3	1.3
Headache	176	96.7
Migraine	10	5.5
Dermatological problem (n=183)		
Skin itching	73	39.9
Allergy	68	37.2
Wound	6	3.3
Other health problems (n=27)		
Conjunctivitis	12	44.4
Urinary problem	7	25.9
Sinusitis	6	22.2
Fatigue	2	7.4

Figure 2. Selection of squares mostly affected by Soba sewage treatment plant.

Table 3. Inter correlation matrix between the variables affecting the quality of life as reported by the participants (n=462).

	Psychologically	Absenteeism	Recurrent illness	Disability	Socially	Death
Psychologically	1	0.026	0.163	0.014	0.032	0.016
Absenteeism	0.026	1	0.332	0.131	0.069	0.034
Recurrent illness	0.163	0.332	1	0.073	0.171	–0.01
Disability	0.014	0.131	0.073	1	0.132	0.283
Socially	0.032	0.069	0.171	0.132	1	0.11
Death	0.016	0.034	-0.01	0.283	0.11	1

Table 4. Logistic regression predicting the quality of life from age, immunization, clinical signs, and chemical hazards.

Variable	B	S.E.	Wald	df	P-value	Odds ratio
Age	0.044	0.0	1.929	1	0.165	1.046
Vaccinated	0.056	0.7	0.006	1	0.936	1.057
Respiratory	–1.044	0.9	1.372	1	0.241	0.352
Gastro-intestinal	1.149	0.9	1.52	1	0.218	3.156
Central nervous system	–0.413	0.9	0.202	1	0.653	0.662
Psychological	0.938	0.9	1.138	1	0.286	2.555
Chemical	3.836	1.1	12.541	1	0.000	46.333
Constant	0.299	1.0	0.086	1	0.769	1.348

around the sewage treatment plant.

Participants were asked on how the health hazards affect their life. 97.2% of the participants (n=462) complained firstly about the psychological impact of the sewage treatment plant. Followed by recurrent illness due to proximity with the sewage treatment plant (55.2%). Absenteeism at work ranked third with 12.8%. Of the 462 participants 3.5% reported to be embarrassed when receiving guest in their home. The proximity of the sewage treatment plant was reported to be a cause of death and disability by respectively 0.9% and 0.6% of the participants.

Cronbach' alpha reliability scale measurement was performed to assess the internal validity of the variables collected in relation to the quality of life (Table 3).

Based on the factors affecting the life of the residents, a logistic regression model was elaborated to measure the impact on the quality of life. This outcome variable was developed based on the psychological impact, absenteeism, recurrent illness, disability, social impact and death.

The logistic regression model revealed that chemical hazards are the health hazards, which are statistically associated with the quality of life of Soba squares residents (chi-square=12.541; P=0.000) (Table 4).

Discussion and Conclusions

The respiratory and gastro-intestinal problems were the most frequent infirmities. The investigators happen to believe that a conceivable clarification for this finding is the presence of copious flies in the study district, that tend to convey diverse disease-causing agents from the treatment plant to the nearby neighborhoods, in addition to the by-products from the treatment plant. More than that, psychological problems exclusively discomfort and irritability were predominant, which was magnified by the lack of the elementary life essentials.

The health problems happened to be worst the closer the neighborhood was to the treatment plant. In addition, during the field operation it was noted that the level of knowledge and the living standards were declining.

The foremost impact declared by the residents was psychological attributable also the bad smell emerging from the treatment plant. Consequently, occupants could not benefit from their well-constructed houses nor could they sell them to buy new ones in environmentally safe neighborhoods.

Recurrent illness was another dominating impact, with consequent absenteeism from work as another surpassing burden.

The findings disclosed in this study point out the certainty that sewage treatment plants deserve special attention, as well as emphasizing the importance of finding a solution for this rather bothersome public health concern in the near future.

The researchers happen to believe, that their study could more impact the national and international concerns in providing the nature and levels of measurements of chemical and microbial hazards identified.

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