

<http://www.pjbs.org>

**PJBS**

ISSN 1028-8880

**Pakistan  
Journal of Biological Sciences**

**ANSI***net*

Asian Network for Scientific Information  
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

## Domestic Solid Waste Management and its Impacts on Human Health and the Environment in Sharg El Neel Locality, Khartoum State, Sudan

<sup>1</sup>A.M. Abdellah and <sup>2</sup>Q.I. Balla

<sup>1</sup>Al-Lahawi for Research Consultation and Investment, Safa Trading Center, West of Saad Gishra, Khartoum North, Sudan

<sup>2</sup>Sharg Al Neel Locality, Khartoum State, Sudan

---

**Abstract:** Due to rapid urbanization in Khartoum State, Domestic Solid Waste (DSW) management remains the biggest obsession that recurrently attracts the attention of the concern authorities and stakeholders. As one of the seven localities comprised the state, the Sharg El Neel Locality was chosen to study the DSW management efficiency. The materials and methods employed in collection of data is a package of techniques, one of which was by conducting interviews using structured and unstructured questions mainly directed to appropriate persons i.e., householders and particular government employees directly engaged in DSW management operations. The main findings reached in this study were that local authorities lack the necessary capacities to handle the immense problems of DSW management. Shortages of funds, inadequate number of workers, lack of transport and facilities and weakness of attitudes of respondents found to be among factors hindering the DSW management. Accordingly, proper scheduled and timing, well-trained public health officers and sanitary overseers and strict sustainable program to controlling flies, rodents, cockroach and other disease vectors are essential to properly managing DSW. Otherwise, problems resulting from solid waste generation in the study area will be magnitudized and the surrounding environment will definitely be deteriorated.

**Key words:** Solid wastes management, urbanization, disease vectors, environment, sanitary overseers

---

### INTRODUCTION

In the last few decades, there was a significant increase in DSW generation in the capital of the Sudan. This is largely because of rapid population growth and a rather economic development in the country. Due to rapid growth of urban population in the Sudan, as well as constraint in resources, the management of solid waste poses a difficult and complex problem for the society and its improper management gravely affects the public health and degrades environment. Waste has been defined by Tchobanoglous *et al.* (1993) and Weitz *et al.* (2002) as any solid or semi-solid substance or object resulting from human or animal activities which the holder discards or intends or is required to discard and constitutes a hazard for living beings and all that sustains life. Ladu *et al.* (2011) reported that rapid population growth and the widespread use of disposable containers contribute significantly to solid waste accumulation. Currently, as stated by Williams (2005), there are two principal options for managing such DSW-landfill disposal or incineration in waste-to-energy facilities. However, Rushton (2003) reported that concerns have been raised that emissions

from both landfills and incinerators may pose environmental health risks that make both options less than optimal. Furthermore, Moy *et al.* (2008) reported that waste-to-energy treatment is a better option than landfilling due to the differences in non-cancer and cancer health risks and it should be noted that more expensive technology currently exists in landfilling that would make the waste-to-energy emissions even lower, thus further favoring this option from a health risk perspective. The wrong DSW management decisions can impact the release of Greenhouse Gas (GHG) emissions that contribute to global climate change. GHG emissions can trap heat in the atmosphere and lead to warming the planet and changing its weather (Weitz *et al.*, 2002). It has been reported (Cointreau, 2006; Ladu *et al.*, 2011) that the more commonly noticed occupational health and injury issues in DSW management are: Back and joint injuries, respiratory illness, infections from direct contact with contaminated material, dog and rodent bites, or eating of waste-fed animals, puncture wounds leading to tetanus, hepatitis and HIV infection, injuries at dumps due to surface subsidence, underground fires and slides, headaches and nausea from anoxic conditions where

disposal sites have high methane, carbon dioxide and carbon monoxide concentrations and lead poisoning from burning of materials with lead containing batteries, paints and solders. In previous studies of workers at New York City's former DSW incinerators, it was identified elevated levels of biomarkers for metal (lead) and organic (dioxins) contaminants of incinerator ash in some individuals (Schechter *et al.*, 1991; Malkin *et al.*, 1992); more recent studies have followed up on this approach and confirmed elevated levels of dioxins in incinerator workers in other countries (Kumagai and Koda, 2005; Shih *et al.*, 2006). In Sharg El Neel Locality in general and Haj Youssef Administrative Unit in particular, the environmental health were drastically deteriorated because of lack of environmental health programs, lack of organized DSW collection system and lack of properly constructed drainage system. Therefore, the general objective of this study was to investigate the DSW management in the study area. Whereas the specific objectives include: determining the capacity of institution, dealing with the impact of DSW on the environmental and human health, assessing environmental health legislations regarding DSW management, identifying the refuse characteristics and properties, evaluating the present method and functional elements of DSW management and identifying relationship between DSW and diseases.

## MATERIALS AND METHODS

**Location and climate of the study area:** The area lies in Haj Youssef Administrative Unit which is one of the seven administrative units that comprised Sharg El Neel Locality. Haj Youssef is located in the Western part of the locality. Climatically classified as semi-desert area with rainy season extends from July to October, the average annual rain fall is 150 mm with maximum peak (200 mm) in August, the dry season extends from April to July, the temperature is 38°C with a maximum peak of 45°C, the Winter Season extends from November to March, the mean temperature is 25°C but it tends to decrease gradually until reaches its lowest point at 16°C and the relative humidity is about 50%.

**Population and locality facilities:** According to census 2008, the population of the locality is about 868,147; number of houses is estimated at 95000. The study area has enough paved roads that facilitate smooth movement of vehicles especially that of waste collection, there are eight main roads in the study area, each road about two thousands meters in length. Manpower staff and equipment in the field of waste collection in the study area were estimated as follows: drivers are 49 people, money

collectors (150); number of vehicles is about 28 vehicles. The total budget is estimated at 385000 SDG and the collected fees is 345000 SDG with subsidy of 40000 SDG. About 4000 meter in length, nine draining cannel were excavated throughout the study area to drain rainy water, most of them are not well-leveled, leaving pools of stagnant rainy water that constitutes a hazardous source of a variety of water-borne diseases.

**Data collection:** The research project is an exploratory undertaking, which utilizes both primary and secondary data, the data was acquired directly from the field work involving a combination of methods, namely interviews using questionnaire, face to face interviews and personal observations and secondary data were derived from documentaries, journals, magazine, Internets, theses, books, government reports, workshops and conferences.

**Survey sampling:** In order to investigate solid waste generation in the locality, a stratified random sampling was adopted as the most appropriate method of drawing up the sample size of the population under study. The census data was obtained from the Sharg- Elneel Survey Department-1999. The study area taken for this study consists of eight blocks lies between Street No.1 (Share-Wahid) and "Radmia Street", all of these blocks are within the third-class classification residential area, the blocks are as follows: block one, three, five, nine, eleven, nineteen, fifteen and thirteen which comprising 397, 365, 397, 420, 365, 420, 397 and 365 household, respectively. Of all the above mentioned blocks, fifty percent of which were selected randomly due to their characteristics similarity i.e., standard of living, population, income, life style, type of building materials. For this study, we selected blocks of one, five, eleven and fifteen, the total households of the selected blocks is amounted to 1556 household and then 10% of each of the four blocks was selected and the final amount of households studied was to be 155.

**Interviews and questionnaires planning:** The three experienced public health officers who have been working in the field of DSW management in the locality under the study were trained to fill the questionnaire and to write down their observation in a note book, suggestion of residents also were recorded, as well as their opinion and how much degree of satisfaction by the services provided to them. Registration and documents were revised and direct interview was done. Formal interview to obtain data were conducted with the head of household using several

types of questions including: yes-no question, multiple choice and open ended questions centered on policy planning resources for execution and coordination between government units. The questionnaire investigated three types of data: (1) information of age, household size, level of income, education states, (2) questions on types, sources, quantities and components of DSW and (3) questions on waste management, public and environmental health hazards, disease vectors, rodents and diseases. As well, informal interview (face to face) with community leaders was conducted to collect data along with personal observation.

**RESULTS AND DISCUSSION**

**Distribution of respondents according to age, educational level, size of household and total income:** Investigation and questionnaire (Table 1) indicates that there were 134 out of the 155 household (87%) in the study area have their inhabitants' ages ranged between 40 and 50 year-old. According to the research, it was revealed that 49% of the inhabitants have never attended schools whereas only 10% have studied high institutions, thus reflecting the poor attitudes towards DSW management in the area under the study. Since the area under the study is classified as a third-class, 82% of the houses found to be having their sizes of 380 m<sup>2</sup>. Regarding to the income of the household respondents, 68% of them have their income found to be ranged between 60 and 80 thousand Sudanese pounds per a year. Generally, the income of the household respondents indicating the general composition of solid waste being generated.

**Distribution of respondents according to satisfaction with DSW management:**

According to the research, it was found that 80% of households' residents said that they were satisfied with the service provided to them and pay for it regularly while the rest (20%) were not either satisfied or pay for it (Table 2). Referring to Table 2, the investigation revealed that there were 75% of official employees said that trucks used for domestic waste collection are sufficient and the rest (25%) said not and proposed more trucks to get rid of waste disposal properly. In regard to using open burning method as an acceptable treatment to fast get rid of domestic waste, 80% of official employees said yes for open burning methods while only 20% were disagree with this way to treat domestic waste, reflecting weakness of environmental culture even among those who engaged with DSW management. Previous studies assessed health risks of waste-to-energy facilities and landfills areas and found that cancer risks ranging at different levels distributed across different populations (those around the landfill, those along the truck route and those around the facilities) (Rao *et al.*, 2003; Redfearn and Roberts, 2002; Eschenroeder and von Stackelberg, 1999; OME, 1999; Moy *et al.*, 2008). As presented in Table 2, it is found that there were 65% of official employees do not receive any protective measures during dealing with domestic waste collection whereas only 35% of them said they have inadequate protective measures and complaining that they were directly collecting solid waste with their bared hands, exposing themselves to a variety of occupational health-risk diseases. Workers and waste pickers handling solid waste throughout the world are exposed to

Table 1: Distribution of respondents according to questionnaire on domestic solid waste management conducted in the haj youssef administrative unit (n = 155)

Questionnaire parameters questioned to households (n = 155)											
Category	Age (year)		Educational level			Size of household (m <sup>2</sup> )			Total income (thousand SDG/year)		
	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
20-30	9	6	NAS*	77	49	360	16	10.3	<60	12	11
30-40	7	4	PS*	19	13	380	127	82.0	60-80	106	68
40-50	134	87	SS*	44	28	400	12	7.70	80-100	32	21
>50	5	3	HI*	15	10	>400	0	0.00	>100	0	0

NAS\*: Never attended school, PS\*: Primary school, SS\*: Secondary school, HI\*: High institution, SDG: Sudanese pound

Table 2: Distribution of respondents according to questionnaire on domestic solid waste management conducted in the haj youssef administrative unit

Questionnaire parameters questioned to households (n = 155) and official employees (n = 20)																	
Households' satisfaction with paying service fees			Official employees' satisfaction with sufficiency of waste collection trucks			Official employees' awareness of open method as a source of health hazard			Official employees' satisfaction with protective measures			Official employees' satisfaction with salary			Official employees' satisfaction with adequacy of fund for maintenance and supervision		
Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
Yes	124	80	Yes	15	75	Yes	16	80	Yes	7	35	Yes	11	55	Yes	17	85
No	31	20	No	5	25	No	4	20	No	13	65	No	9	45	No	3	15

**Table 3: Distribution of respondents according to questionnaire on domestic solid waste management conducted in the haj youssef administrative unit**  
Questionnaire parameters questioned to households (n = 155) and official employees (n = 20)

Households' amount of waste generation (kg)			Households' using containers for waste management			Households' frequency of waste collection			Official employees' opinion of responsibility of public and environmental health			Official employees' answering: the methods of waste collection used			Official employees' answering: the state of public and environmental health		
Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
1/day	27	17	GA*	137	88	weakly	34	22	GA*	12	60	HH*	17	85	Very good	7	35
2/week	13	8	PS*	4	3	2/weak	116	75	PS*	5	25	CSP*	2	10	Good	11	55
2/month	115	75	IH*	14	9	1/month	5	3	IH*	3	15	ID*	1	5	Bad	2	10

GA: Government authorities, PS: Private sector, IH: Individual household, HH: House to house, CSP: Container in specific place, ID: Indiscriminate dumping

occupational health and accident risks related to the content of the materials they handle, emissions from those materials and the equipment being used (Cointreau, 2006). Rather a half (45%) of the staff engaged with DSW management replied that their salaries are not adequate to meet their responsibilities and the increasing prices of commodities necessary to survive. The study also revealed that 85% official employees said that funds allocated for maintenance and supervision is quite enough whereas only 15% said the opposite and attributed deficit of DSW management to the inadequate funding deducted for waste collecting.

**Distribution of households according to amounts of waste-generating and frequency of waste-collecting:**

According to the research (Table 3), 17% household said that they were generating and disposing one kg per day, 8% estimated their waste generation to be reaching two kg per week whereas 75% said the waste generation in the study area is only reached two kg per month. These differences and conflicting views among residents about the amount of waste they generating indicate the low cultural sensitivity towards DSW management. Most of households (88%) said that they are used to use containers belonging to government authorities to transport domestic waste in a rate of 2 times weakly (75%) while only 5% said that their waste has been collected once a month. About 22% household said that their DSW is generally be collected once every week, thus demonstrating the wide spread of different types of waste dispersing throughout the study area.

**Distribution of official employees' opinion about the state of public and environmental health management in the study area:**

Most of official employees' opinion (60%) said that government authorities should be responsible for public and environmental health and some of them (5% and 3%) included private sector and individual household (respectively) to participate in this responsibility. In regard to DSW collection methods, about 85% official employees said that house to house is the method used

generally for collecting waste in the study area, 10% said container in specific place and 5% indicated indiscriminate dumping. About 35% official employees estimated the general status of public and environmental health to be good and 55% said it was very good whereas only 10% indicated that the status in the study area was extremely bad (Table 3).

**Distribution of households according to type and source of domestic solid waste and its seasonal impact:**

Questionnaire revealed that about 57% of citizens disposed rubbish wastes as their common solid wastes, 26% garbage wastes, 5% for each of institution waste and agricultural waste, 4% ashes wastes and 3% especial waste. Most of these wastes were coming from residential area (78%), 2% from commercial area, 1% from industry, 15% were agriculture wastes and 5% resulted from incineration. According to the questionnaire, 55% of the respondents said that disposed wastes are usually increased during dry season whereas 30 and 15% indicted that solid wastes are increased in spring and wet season, respectively (Table 4). Generally, the amount and quality of waste generated by a household depends on the level of income and size of household. A household with a higher income can afford better quality food that renders much waste. A household with a large number of tender tends to virtually consume all the food leaving very little waste that can no longer be utilized in any conceivable way. The higher the standard of living, the higher the consumption rate and the larger the amount of waste disposed. Countries with higher incomes produce more waste per capita and per employee and their wastes have higher portions of packaging materials and recyclable wastes (Cointreau, 2006).

**Distribution of official employees' opinion about the general state of public and environmental health management in the study area:**

According to the research, the main method of solid wastes management that most commonly applied in the study area is sanitary landfill, as said by 55% of the respondents questioned

**Table 4: Distribution of respondents according to questionnaire on domestic solid waste management conducted in the haj youssef administrative unit**  
 Questionnaire parameters questioned to households (n = 155) and official employees (n = 20)

Households' answering the: type of solid waste			Households' answering the: source of solid waste			Official employees' opinion of the final method of waste management			Official employees' opinion of some impact of dump area			Official employees' observation of flies, rats...surrounding dump area			Official employees' observation of seasonal variation of solid waste		
Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%	Category	Frequency	%
Rubbish	89	57	RA*	121	78	UOD*	3	15	Odor	13	65	Flies	12	60	Dry season	11	55
Ashes	6	4	CA*	3	2	OB*	4	20	AN*	4	20	R and D*	3	15	Spring	-	-
	6	30															
EW*	5	3	IND*	2	1	SI*	11	55	FH*	3	15	CK*	2	10	Wet season	3	15
Garbage	39	26	AG*	22	14	CO*	2	10	WP*	0	0	L and H	3	15	-	-	-
IW*	8	5	INS*	7	5	INC*	0	0	AP*	0	0	-	-	-	-	-	-
AW*	8	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

EW: Especial waste, IW: Institution waste, AW: Agricultural waste, RA: Residential area, CA: Commercial area, IND: Industry, AG: Agriculture. UOD: Uncontrolled open dump, OB: Open burning, SI: Sanitary landfill, CO: Composting, INC: Incineration, AN: Aesthetic nuisance, FH: Fire hazard, WP: Water pollution, AP: Air pollution, R and D: Rats and dogs, CK: Cockroaches, L and H: Livestock and humans

and 20% claimed that they are dumped while 15% official employees said that solid wastes are disposed in uncontrolled open dumped and burned in open areas within the residential area. Observation revealed that inhabitants disposed DSW unburned in open spaces nearby residential area and left for long time waiting for trucks, exposing the area to a variety of health hazards. The negative impact of these accumulated waste dumping area that spread throughout the study area has also been included in the questionnaire, 65% respondents said it was characterized by some characteristics such as odor, aesthetic nuisance (20%) and 15% said it causes fire hazard and no one of respondents included realized its potential impact on water and air pollution. Questionnaire also included some aesthetic characteristics surrounding dumping areas, 60% of official employees said they were continuously observing flies, 15% observed rats and dogs, 10% cockroaches and 15% livestock and homeless street-boys (Table 4). For the waste-to-energy facility and landfill disposal, major air pollutants of concern were considered to be: dioxins and related compounds (combined as TEQ), mercury, cadmium, lead, PM, HCl, SO<sub>2</sub> and NO<sub>x</sub> (NRC, 2000; Rushton, 2003).

**General observation on environmental health related to DSW management in the study area:** According to standard of living of population in the study area, it was observed that waste generated per week is about 5.38 kg and most of households storing wastes in small plastic sacs or in sugar empty bags that have already been used. These waste bags were usually left to store inside the kitchen and sometimes were to put in front of the house waiting to be taken by refuse trucks. Delay of refuse trucks, due to sudden accidents, leads to rotting wastes and most often scattering by animals' action or by homeless street boys, searching for something to eat or to take to sailing, leaving unpackaged-wastes to stink and

thereafter constituting eyesores and health hazards throughout the study area.. Inadequately financing and fund availability in the study area is seemed to be among factors negatively affects community services related to waste management and therefore, leads to accumulation of DSW and consequently deteriorates general health services. Increase minimum wages positively affect community services related to DSW management and therefore, motivates labors and attract more workers to participate in the environmental field. Acceptable salaries of payments necessary to support the public health workers and to meet their increasing needs. Adequate funds enable environmental health departments to purchase refuse trucks, spare parts, equipment and therefore, regulate refuse transportation. The public health departments in the locality have inadequate tucks and labors which cannot cover the ever-growing bulk of solid waste output in the study area. The most and serious challenging factors faced DSW management is the hotbeds-gathering-waste that resulted from both uncontrolled new buildings and empty lands allocated for housing. The continuous damage of drinking water supply network contributes significantly to waste gathering and aesthetically harms the environmental health. According to public health inspector, however, diseases most commonly observed in the study area are: diarrhea, malaria, viral disease, eye diseases and skin allergic diseases.

**Prevention and control of environmental health diseases related to DSW management in the study area:** The public and environmental director reported that the prevention and control of environmental disease is being done primarily through the elimination of disease carrying pathogens such as vector, rodent and vermin. There are measures should be obliged to, when operating the use of pesticide inside households or on land operation.

Pesticide generally used in the study area such as that of mosquito control, disinfection of housing of ill person as of T.B., cholera, or any communicable disease is recommendable and should be carefully managed. Spray of household flies, larva at breeding site, control of rodent and cockroaches is a key factor for the application of health standards in the study area. According to the study observation, there are significant shortages of insecticide and disinfection that provided by the Khartoum State Cleaning Project (KSCP) to sustain the elimination of environmentally transmitted diseases in the locality. Special attention should be paid after and during rainy season to drain standing pools, cleaning grass and flies gathering places. Integrated efforts of official institutions, social community corporations and stakeholders are key factors leading to properly managing DSW and prosperous community services.

#### **Complaints of the workers in the DSW management:**

During conducting this study, we asked the respondents about their complaints and objections to the DSW managing, the following are some them:

- The job is so heavy, nasty and hazardous to human health and lack of protective measures, e.g., uniform, boots, shoes, hand gloves, goggles, cap... etc
- Wages and salaries are very low and even irregularly paid
- Incentive such as preventive and medical checkup allowances are not provided
- Mistreatment by some member of the public (homeless street boys) is commonly reflected in social degradation for manual handling of refused mixed with body waste
- Mistreatment through the regular recovery of the cost of any spoiled or ruined refuse collection and disposal equipment which is taken from the pay of particular employee is institutionalized
- Incentives such as transport, accommodation and social allowance are inadequate
- Provision of essential commodities usually given to workers such as sorghum, sugar, soaps, salt, oil are in short supply and difficult to secure
- Promotions, including job advancement and enrichment, are lacking
- Spread of some environmental diseases among workers such as malnutrition, eye diseases, back pains, accidents, injuries, swelling, skin itches, colds and burns skin diseases, chest pains resulting of handling waste and heavy scraps... etc

#### **CONCLUSION**

It is revealed that the DSW generation in the study area varied according to a variety factors. Among which, the income of the household respondents which indicating the general composition of solid waste generation. The generation of solid waste tended to increase by the increase of income, most of the household (75%) said that they are generating and disposing two kg per day. About 57% of citizens in the study area disposed rubbish wastes as common solid wastes, 26% garbage wastes, 5% for each of institution waste and agricultural waste, 4% ashes wastes and 3% especial waste. Most of these wastes were coming from residential area (78%), 2% from commercial area, 1% from industry, 15% were agriculture wastes and 5% resulted from incineration, 55% of the respondents said that waste-disposing is usually increases during dry season whereas 30% indicted that DSW increases in spring.

To properly managing DSW, coordination and integrated participation of the different governmental authorities close to private sectors needs to be significantly improved, waste managers should be recommended to connect community people with the waste issues and their direct impact on environmental health. Convince community people to avoid unnecessary needs as possible and encourage them to reuse and recycle waste inside house, once waste is in a source, it is pretty easy to manage. The major issue is to spread and raise awareness among individuals through public media in order to minimize their needs as possible, convince community families to give surplus to those in need of your neighbors and relatives and encourage them to treat and recycle waste locally inside home and to realize that what humans put in front of the house-yard that eventually will get back into your room. It could be better DSW managing by engaging the private sector to invest connectedly with environmental authorities in the field. Here are a number of connections that need to be considered:

- Emphasize local waste management issues to be taught at all levels of formal and informal education
- Spread knowledge of the different waste management issues around the country cities in order to be known considerably among all of society sectors and connect people with religion to respect natural environment
- Improve adult education through national media, educational institutions, town meetings, organization of official and popular symposia etc

- Promote waste management approaches, including engaging stakeholders in priority setting and implementation
- Help people understand the connection between waste management and environmental health by enlightening them how what they do in their house-backyard
- There is urgent need of public awareness about waste generation. There should be awareness at all levels of society, which will motivate them to change their casual habits which creates waste

#### **ACKNOWLEDGMENT**

The authors acknowledge the assistance of all those who contributed to this study.

#### **REFERENCES**

- Cointreau, S., 2006. Occupational and environmental health issues of solid waste management: Special emphasis on middle and lower-income countries. Washington, DC., USA.
- Eschenroeder, A. and K. von Stackelberg, 1999. Health risks of landfilling versus combustion of municipal solid waste: An Illinois comparison. Proceedings of the Annual Meeting and Exhibition for Submission to the Air and Waste Management Association's, June 20-24, 1999, Missouri, USA.
- Kumagai, S. and S. Koda, 2005. Polychlorinated dibenzo-p-dioxin and dibenzofuran concentrations in serum samples of workers at an infectious waste incinerator plant in Japan. *J. Occup. Environ. Hyg.*, 2: 120-125.
- Ladu, J.L.C., X. Lu and M.A. Osman, 2011. Solid waste management and its Environmental impacts on human health in Juba town-South Sudan. *Nat. Sci.*, 9: 27-35.
- Malkin, R., P. Brandt-Rauf, J. Graziano and M. Parides, 1992. Blood lead levels in incinerator workers. *Environ. Res.*, 59: 265-270.
- Moy, P., N. Krishnan, P. Ulloa, S. Cohen and P.W. Brandt-Rauf, 2008. Options for management of municipal solid waste in New York City: A preliminary comparison of health risks and policy implications. *J. Environ. Manage.*, 87: 73-79.
- NRC, 2000. Waste Incineration and Public Health. National Academy Press, Washington DC., USA.
- OME, 1999. Environmental Risks of Municipal Non-Hazardous Waste Landfilling and Incineration. Ontario Ministry of the Environment, Environmental Sciences and Standards Division, Standards Development Branch, Toronto, Canada.
- Rao, R.K., I. Chaudhuri, M. Garcia, B. Stormwind and B. Ruffle, 2003. Multiple pathway health risk assessment of a municipal waste resource recovery facility in Maryland. *EM Magazine*, August, 2003, pp: 21-26.
- Redfearn, A. and D. Roberts, 2002. Health Effects and Landfill Sites. In: *Environmental and Health Impact of solid Waste Management Activities*, Hester, R.E. and R.M. Harrison (Eds.). Royal Society of Chemistry, UK., pp: 103-140.
- Rushton, L., 2003. Health hazards and waste management. *Br. Med. Bull.*, 68: 183-197.
- Schechter, A.J., R. Malkin, O. Papke, M. Ball and P.W. Brandt-Rauf, 1991. Dioxin levels in blood of municipal incinerator workers. *Med. Sci. Res.*, 19: 331-332.
- Shih, T.S., H.L. Chen, Y.L. Wu, Y.C. Lin and C.C. Lee, 2006. Exposure assessment of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in temporary municipal-waste-incinerator maintenance workers before and after annual maintenance. *Chemosphere*, 64: 1444-1449.
- Tchobanoglous, G., H. Theisen and S.A. Vigil, 1993. *Integrated Solid Waste Management: Engineering Principles and Management Issues*. 2nd Edn., McGraw-Hill International, New York, USA., ISBN-13: 9780070632370, Pages 978.
- Weitz, K.A., S.A. Thorneloe, S.R. Nishtala, S. Yarkosky and M. Zannes, 2002. The impact of municipal solid waste management on greenhouse gas emissions in the United States. *J. Air Waste Manage. Assoc.*, 52: 1000-1011.
- Williams, P.T., 2005. *Waste Treatment and Disposal*. John Wiley and Sons, USA.