

# Occupational health problems of municipal solid waste management workers in India

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## ABSTRACT

**Aims:** The present study aimed to assess the occupational health problems of municipal solid waste management workers.

**Material and Methods:** Cross-sectional descriptive study was conducted among solid waste management workers of Kerala, India. All workers (408) were included the study of which 313 (77%) participated. Data were collected by direct interview and clinical examination using a structured questionnaire. The observed morbidity like respiratory diseases, eye diseases, dermatological problems and nail infections were elicited by clinical examination. The point prevalence of other occupational related health events present either during the study time or during 1 month recall period and that occurred ever after entry in present occupation was collected by self-reported complaints and doctors diagnoses.

**Results:** The mean age was  $42.5 \pm 7.2$  years. The observed morbidity like respiratory diseases, eye diseases, dermatological problems, nail infections were high ranged from 21% to 47%. The reported prevalence of occupation related morbidities like falls (63.6%), accidents (22%), injuries (73.2%), and water-vector borne disease (7.1%) were high. The current prevalence of musculoskeletal morbidities showing that all major joints are involved (17-39%).

**Conclusions:** The work related health-problems were reported to be high. The prevalence of Respiratory, dermatological, eye problems and injury, musculoskeletal problems were reported to be high among municipal solid work handlers. Measures are needed to improve the work environment of waste handlers by ensuring availability protective gears based on ergonomic principles, clean drinking water and washing and sanitation facilities during working hours.

**Key words:** Ergonomics, municipal solid waste, occupational health, occupational injury and accidents, work related health hazards

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## INTRODUCTION

Municipal solid waste is an outcome of economic productivity and consumption and includes wastes from households, commercial establishments, institutions, markets, and industries and its handling and disposal is a growing environmental and public-health concern.<sup>[1-3]</sup> Population growth and economic development have brought increasing

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amounts of solid waste to urban areas.<sup>[4]</sup> Solid waste management encompasses a wide range of activities including, Collecting garbage; collection, sorting recyclable materials; collection and processing of commercial and industrial waste.<sup>[1]</sup> Risks occur at every step in the process, from the point of collection at homes, during transportation and at the sites of recycling or disposal.<sup>[4]</sup> They are exposed to occupational health and accident risks related to the content of the materials they handled, emissions from those materials, and the equipments being used.<sup>[4]</sup> In areas, infectious medical wastes and toxic industrial wastes are not segregated from domestic waste, the waste collectors are exposed to a wide array of risks.<sup>[4]</sup> As a result of their exposure to multiple risk-factors they suffer high rates of occupational health-problems.<sup>[3,5]</sup> Most diseases (Water borne, air born, Contact) have exposure pathways and most injuries have contact pathways (hepatitis B virus [HBV], human immunodeficiency virus [HIV], Tetanus).<sup>[3,4]</sup> Making waste technologies more contained, reducing contaminant emissions, changing working methods to interrupt the pathways and using of protective clothing can reduce risks.<sup>[4]</sup>

In developing countries, the waste discharged for collection is seldom stored in closed containers and is dumped on the ground directly, requiring that it be shovelled by hand, or left in an open carton or basket to be picked up by hand.<sup>[1]</sup> Workers, therefore, have significantly more direct contact with solid waste than their counterparts in high-income countries, who predominantly handle sealed plastic bags and covered dustbins.<sup>[1]</sup> The exposure to the health-risks were not yet identified as a special occupational problem. In most high-income countries data on health and accident consequences is inadequate, and in developing countries almost non-existent. In developing countries like India, there has been little study of the health and injury incidence of solid waste workers. Most of the reviewed studies suffer from limitations related to poor exposure assessment, and lack of information on relevant confounders.<sup>[2]</sup> Waste work is overridden by the social, economic, and environmental deprivations and also involves gender issues.<sup>[6]</sup> The working conditions for women sweepers are often very poor, they may have no protective wears or equipments but few complain about the situation.<sup>[6]</sup> In these contexts, to understand and assess the health-risks involved in municipal solid waste management, a study was conducted among women Municipal solid waste workers in Kerala state, India where the problem has worsened due to high consumption pattern and per capita solid waste generation and low per capita availability of land.<sup>[7]</sup>

## SUBJECTS AND METHODS

The cross-sectional descriptive study was conducted among solid waste management workers of Calicut Corporation area, Kerala, India in 2010. Kozhikode Corporation has an area of 82.67 sq km with 436,527 population (2001 Census). The per capita waste generation is estimated to be 477 gm/day.<sup>[8]</sup> About 250 tonnes

of Municipal solid waste is generated in Kozhikode corporation every day of which 47% is domestic from house-holds, 24% from commercial establishments and hotels, 9% street sweepings, 6% from construction sites and 3% from slaughter houses. Out of this about 120-150 tonnes is collected by the corporation every day.<sup>[8]</sup> The solid waste management in the city was initiated in the year 2004. Women from the financially backward families (Below poverty line (BPL)) who are the members of the Community Based Organizations (CBOs) of Kudumbashree (Women Self Help Groups) are engaged household waste collection and transport to the transit points.<sup>[7]</sup> The workers organize door to door collection of the waste from households and shops; segregate and load it into vehicles which are then transported to secondary collection points and unloaded. From these points it is directly transported to the solid waste treatment plant where it is processed and converted to manure.<sup>[9]</sup> Considering the reported prevalence of respiratory problems of 70%<sup>[11]</sup> with a precision of 5% and 95% confidence level the minimum sample size was 252. In total there are 68 women CBO groups with 408 members and all workers were included and invited for screening camps. To ensure accessibility 4 regional screening camps were arranged within a month period (Sundays). From the screening camps the data were collected by the investigators by direct interview and clinical examination using a structured questionnaire. The study protocol was approved by institutional ethics committee. Written informed consent was collected from all. Total 313 (77%) persons attended the camp and data from all reported (100%) were collected and analyzed. To eliminate the confounding effect of seasonal variation the study was conducted within a month period and to avoid inter-personal errors all the data were collected by same persons.

The observed morbidity like respiratory diseases, eye diseases, dermatological problems and nail infections were elicited by clinical examination. The point prevalence of other occupational related health events present either during the study time or during 1 month recall period and that occurred ever after entry in present occupation was collected by self-reported complaints and doctors diagnoses, which include water borne disease like jaundice, typhoid, leptospirosis, Vector borne disease malaria, dengue, road traffic accidents, falling with waste, injury with sharps, fire, chemicals and animal bites.

Statistical analysis was performed using Epi info and SPSS software (version 17.0). An independent sample *t*-test was used for the comparison of continuous variables and Chi-square test for qualitative variables. *P*-value below 0.05 was considered as statistically significant. Ninety-five per cent confidence intervals (95% Confidence interval (CI)) for the measures of association were calculated and reported.

## RESULTS

The mean age was  $42.5 \pm 7.2$  years (24-65 years) with average experience of  $4.8 \pm 0.7$  years and 96% had more than 4-year service. All were full time workers working 7 days/week average

working hours of  $6.2 \pm 1.7$  h/day and monthly income of INR  $1889.4 \pm 914.7$ . On an average they collected waste from 55 points. 89% were currently married and 55% had no regular occupation before entry to current job.

The observed morbidity of the workers like respiratory diseases, eye diseases, dermatological problems, nail infections were given in Table 1, which were high, ranged from 21% to 47%. The point and period prevalence of occupation related morbidities like accidents, injuries, and water-vector borne disease were given in Table 2 of which the former have high incidence. The current prevalence of musculoskeletal morbidities was given in Table 3 showing that all major joints are involved.

## DISCUSSION

All were women, belonged to BPL families with permanent residence status in the corporation area and no habit of tobacco or other addictions, 96% had service for more than 5 years. The selection bias, confounders are eliminated. Hospitalization is a non-fatal health out-come that is considered to be relatively free from errors associated with reporting illness can be used as proxy indicator of severe morbidity. The hospitalization rate of 13.1% during the period corresponds to 27.5 per 1000 person years which is higher than general population 21.<sup>[10]</sup> The cause of absenteeism among (23%) was due their own illness. Data from India reported that compare to others from the same housing areas waste handlers have relative risk 2.5 of morbidity.<sup>[11]</sup>

Studies in several countries have postulated a relationship between working at open dumps and increased respiratory illness and abnormal lung function tests.<sup>[1,3]</sup> The increased risk of respiratory disease is related to exposure to organic dusts containing high concentrations of bacteria and fungi, biologically active agents, gases, bio-aerosols.<sup>[4]</sup> Waste collection is conducted in high traffic density, and in developing countries, vehicle emissions are not controlled. This occupation is physically strenuous, resulting in high pulmonary ventilation and requiring workers breathing through their mouth rather than nose.<sup>[1]</sup> Studies have shown that relative energetic loads, expressed as oxygen consumption, are significantly higher for waste collectors

than recommended limits.<sup>[12]</sup> The waste pickers of Calcutta experienced a 71% incidence of respiratory disease, compared to only 34% in the control group<sup>[11]</sup> and in Bombay 25% of the waste workers had coughs and 26% experienced dyspnea.<sup>[13]</sup> The higher prevalence was also reported from other parts of the world like Manila,<sup>[4]</sup> New York,<sup>[14]</sup> Geneva.<sup>[15]</sup> Though compared to other studies we have less prevalence of respiratory complaints it was higher than the general population of 3%.<sup>[10]</sup> The increased incidence is biologically plausible and indicated in other epidemiological studies.<sup>[1,3,4]</sup>

In our study, 36.4% had any skin lesion, which may be due to allergic (Dermatitis, eczema) or infectious causes (Bacterial, fungal) and infected ulcers directly caused by organic or chemical wastes and injuries. This was similarly reported from Bombay and from other countries.<sup>[4,11,15,16]</sup>

It is the first time any study reported high incidence of nail infection among waste handlers. 47% had nail infection of either fingers or toes of which most were due to fungal infection (Paronychia) and lesions with secondary bacterial infection which was worsened by frequent wetting due to direct contact with waste. As reported elsewhere,<sup>[4]</sup> here also washing facilities were not provided for them at the work intervals or at the end of the day. The containers, vehicles, temporary storage points, treatment yard has to be washed daily and the washed water collected in septic tanks, which was not done anywhere in the state.<sup>[9,16]</sup> The relationship between exposure to solid waste and increased health risk is greatest where the contact between the solid waste worker and waste is greatest and the level of protection least.<sup>[4]</sup> 78.5% complained that they were getting unsegregated mixed wastes from the houses. In developing countries, solid waste workers and waste pickers routinely touch the waste while collecting

**Table 1: Prevalence of observed morbidity**

Morbidity	Number	Percentage	95% CI
Respiratory disease (Infections/allergies)	60	21.0	16.00-25.2
Eye problems	104	33.2	27.8-38.5
Skin problems	114	36.4	31.0-42.0
Nail infections	147	47.0	41.2-52.5
Genitourinary problems	105	33.5	28.1-38.9

CI: Confidence interval

**Table 2: Prevalence of reported morbidities**

Events/morbidity	Current (within 30 days)			Past (after entry in service)		
	Number	%	95% CI	Number	%	95% CI
Hospitalization	2	0.6	0.1-2.6	41	13.1	9.8-17.8
Road accidents	03	1	0.2-0.3	69	22	17.1-26.5
Falls	11	3.5	1.9-6.4	199	63.6	57.8-68.8
Injury with sharps	16	5.1	3.1-8.4	229	73.2	67.7-77.8
Animal bites	2	0.6	0.1-2.6	30	9.6	06.3-13.1
Fire burns	0	0	0-0	05	1.6	0.4-03.4
Chemical Injury	1	0.3	0-2.1	08	2.6	01-04.8
Water borne disease <sup>#</sup>	1	0.3	0-2.1	17	5.5	2.0-10.3
Mosquito borne disease <sup>§</sup>	0	0	0-0	2	0.6	0.1-02.6

<sup>#</sup>Typhoid, hepatitis, leptospirosis, <sup>§</sup>Dengue, malaria, CI: Confidence interval

**Table 3: Prevalence of present musculoskeletal morbidity**

Joint affected	Present during the examination		
	Number	%	95% CI
Low back	103	32.9	28.0-38.7
Neck	54	17.3	13.4-22.1
Shoulder	93	29.7	24.9-35.4
Elbow	83	26.5	21.9-32.0
Wrist	61	21.7	17.5-27.0
Knee	123	39.3	34.3-45.5
Ankle	70	22.4	18.1-27.7
Musculoskeletal disorders*	177	56.5	48.2-62.7

\* One person may have more than one joints involved; CI: Confidence interval

and sorting without wearing gloves and, stepping on waste wearing only sandals.<sup>[3]</sup> They are also exposed to a number of pathogens (bacteria, fungi, viruses, parasites and cysts), toxic substances (endotoxins and beta-glucans), chemicals that come from the waste itself and from its decomposition.<sup>[3]</sup>

One-third had eye problems. In India 89% and 15% had eye problems from Bombay, Calcutta respectively.<sup>[13,17]</sup> Most of the eye problems were burning sensation, watering redness, and itching of the eyes. The temporal association (6-18%) and strength of association (relative risk 1.7) of this occupation with eye disease were reported earlier.<sup>[4,18]</sup>

In our study, compared to the women workers in the state<sup>[19]</sup> high incidence of genito-urinary symptoms (25% vs. 33.5%) were reported, caused either by infections of reproductive tract or urinary tract. In an earlier study on women workers, decreased in-take of water and delayed emptying of bladder were found to be risk-factors (Odds ratio-OR 1.1-2.1) for associated urinary symptoms.<sup>[19]</sup> This was attributed to lack of toilet and drinking water facilities at working areas, which has been similarly reported from other developing countries.<sup>[18,20]</sup> Contrary to the findings of a study among general women workers (OR 3.15 95% CI 1.2-8.6.  $P = 0.04$ ), there was no difference between married and unmarried women (OR 1.19 95% CI 0.38-4.02.  $P = 0.74$ ) in incidence, pointing that towards the sole influence of occupation.<sup>[19]</sup>

Contrary to the reported high prevalence of diarrheal diseases from Bombay, Calcutta, Bangalore, New Delhi,<sup>[13,11,21]</sup> only 2% of the participants reported diarrheal diseases during last 1 year, which was also similarly reported from other Asian country Taiwan.<sup>[22]</sup> This may be due to good awareness and good food hygiene practices along with the use of sanitary latrine by the community making the chances of faeces contamination less. Nine cases of typhoid (3%), five cases of hepatitis (1.6%) Hepatitis A Virus (HAV) were reported among them. Through aerobic and anaerobic microbial action the waste decomposes to form leachate which has low pH and because of their sensitivity to the low pH most of the fecal bacteria and viruses die-off.<sup>[23]</sup> Enteric bacteria were isolated more frequently in flies from refuse dumps.<sup>[24]</sup> According to a published review paper no individual case reports of contracting hepatitis or increased risk of hepatitis among

solid workers were reported from any part of world.<sup>[5]</sup> Absence of regular bathing after job have found to be significant statistical association with skin diseases ( $P = 0.041$ ), jaundice ( $P = 0.043$ ), diarrhoea ( $P = 0.001$ ). Wastes provide breeding sites for insects and rodents of varied species.<sup>[25]</sup> Rodents, domestic animals at the site and waste from slaughter houses along with skin injuries expose them to the risk of contracting leptospirosis.<sup>[24]</sup> Three (0.1%) cases of leptospirosis were reported among them.

One case each of malaria and dengue were reported. *Aedes aegypti* the dengue vector mosquito favors small, clean water pools for breeding, including containers, tires, and tin cans found in waste piles.<sup>[25]</sup> Compared to plastics and pots the physicochemical characteristics of coconut shells favor mosquito breeding,<sup>[26]</sup> which were available in plenty in solid wastes of these area.

In developing countries due to poor working conditions and lack of protection gear accident rates among solid waste workers are generally high<sup>[27]</sup> and a major health effect associated with the job has been shown to be injuries caused by work-related accidents.<sup>[28]</sup> Majority have given history of falls and injury. Similar to our findings 82% of waste workers reported wounds in Katmandu, Nepal.<sup>[29]</sup> Compared to general workers the reported relative risk of injuries were 1.3 in Rumania<sup>[4]</sup> and 5.6 in Denmark.<sup>[15]</sup> As previously reported from the country<sup>[13]</sup> here also the most common injury experienced by waste worker was puncture wound. 70% of them received waste containing sharps and 83% plastics. None of our participants were reported to be HIV, HBV positive, Only 3 had received HBV vaccine. The risk of HIV, HBV infection after puncture has been estimated to be about 0.3%, 3% respectively.<sup>[30]</sup> A review paper also reported absence of significant risk of acquiring HBV by solid waste workers due to less needle stick injuries.<sup>[5]</sup> Though 77% had taken prophylaxis against Tetanus, 36 (16%) out of the 228 injured had never taken Tetanus toxoid (TT).

The incidence of occupational accidents in waste collection workers has been found to be higher than the general work-force.<sup>[31]</sup> The accidents are either falls with loads of waste (64%) or road traffic accidents (22%). Majority had falls which was promoted by slippery surroundings, and rain falls. Most of the road accidents were due to human or mechanical errors. Poor vehicle maintenance, brake failure, or driver failure were the causes of most vehicle accidents. As their main operational problem 59% complained the off the road vehicle problem. U.S. Department of Labor reported that solid waste collectors had the seventh most dangerous job in the USA with relative risk of 10 with all industry workers.<sup>[27]</sup>

Compared to general population the incidence of animal bite was high (9.6%). 24.9% complained that pet animal like dogs and cats were creating hindrance to collecting waste. The animal bites were from dogs, cats and rats. From Calcutta, 49% reported dog bite and 16% reported rat bite.<sup>[17]</sup> Since the

waste is dumped in open places or kept in open containers, they attract animals. A more important factor could be the fact that the pets are not caged or chained in the area.

Waste collection work is characterized by heavy weight lifting, which affects major joints.<sup>[1,4]</sup> There is substantial risk for low back pain and musculoskeletal disorders of the neck, shoulders and arms.<sup>[1,4]</sup> Several studies on waste collection movements have demonstrated that mechanical loads on the skeleton frequently exceeded maximum acceptance limits recommended; throwing waste bags resulted in high shear forces on the spine and carrying loads resulted in excessive torque to the shoulder resulting in increased incidence of musculoskeletal problem.<sup>[30,32]</sup> The joints affected in the order of predilection are knee, back; shoulder, elbow, ankle and neck (range 39-17%). Higher joint problem were also reported from Indian cities Bombay, Calcutta and Bangalore.<sup>[4,15]</sup> The strength of association as relative risk for musculoskeletal problems was reported to be in the range 1.9 to 4.<sup>[32,33]</sup> Review of the global literature provide strong evidence that low-back disorders are associated with work-related lifting and forceful movements with high odd ratios ranging from 2.2 to 11.<sup>[33]</sup> The musculo skeletal problems are worsened by in appropriate ergonomics, the non-availability of worker friendly and women friendly tools and equipments.<sup>[16]</sup> The mean height of workers were  $150 \pm 8$  cm and 14.4% were malnourished (Body mass index < 18.5). Without considering the appropriateness the corporation authorities often purchase unsuitable vehicles which are too high or heavy bins which are difficult to lift.<sup>[16]</sup> As reported from other developing countries here also open trucks/auto rickshaws are used for collection with high loading heights making the potential for injury greater.<sup>[4]</sup>

## CONCLUSION

The prevalence of Respiratory, dermatological, eye problems and injury, musculoskeletal problems were reported to be high among municipal solid work handlers. Since our study was a cross-sectional study temporality, causation of the health out-comes were not proved and the actual incidence could not be recorded. As with any occupational health study due to the “healthy worker effect,” those workers with severe morbidity may leave the job resulted in under reporting. Measures are needed to improve the work environment of waste handlers by ensuring availability protective gears, clean drinking water and washing and sanitation facilities during working hours. More ergonomic principles should be incorporated. A system of health recording and routine surveillance among solid waste workers should be implemented. Local medical schools and occupational health institutes should be encouraged to study the health of solid waste workers in comparison with appropriate baseline control populations due to the significant deficiency of epidemiological data in this sector along with further follow-up studies.

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## REFERENCES

1. Cointreau-Levine S, Listorti J, Furedy C. Solid waste. In: Herzstein JA, Bunn WB, Fleming LE, Harrington JM, Jeyaratnam J, Gardner IR, editors. *International Occupational and Environmental Medicine*. 1<sup>st</sup> ed. St. Louis: Mosby; 1998. p. 620-32.
2. Porta D, Milani S, Lazzarino AI, Perucci CA, Forastiere F. Systematic review of epidemiological studies on health effects associated with management of solid waste. *Environ Health* 2009;8:60. Available from: <http://www.ehjournal.net/content/8/1/60>. [Last cited 2012 Aug 20].
3. Athanasiou M, Makrynos G, Dounias G. Respiratory health of municipal solid waste workers. *Occup Med (Lond)* 2010;60:618-23.
4. Cointreau-Levine S. *Occupational and Environmental Health Issues of Solid Waste Management. Special Emphasis on Middle-And Lower-Income Countries. Urban papers*. Washington D.C: World Bank Group, Urban Sector Board; 2006. Available from: <http://www.worldbank.org/INTUSWM/Resources/up-2.pdf>. [Last cited 2012 Aug 01].
5. Toohar R, Griffin T, Shute E, Maddern G. Vaccinations for waste-handling workers. A review of the literature. *Waste Manag Res* 2005;23:79-86.
6. Furedy C. Women and solid wastes in poor communities. 16<sup>th</sup> WEDC conference infrastructure for low income communities. 1990 Aug 27-31; Hyderabad, India; 1990. Available from: <http://www.gdrc.info/docs/waste/006.doc>. [Last cited 2012 Jul 09].
7. State Planning Board. Chapter. *Environment and Development: Economic Review 2008*. Thiruvananthapuram: Government of Kerala; 2008. p. 153.
8. Varma RA. Status of municipal solid waste generation and technology options for treatment with special reference to Kerala. In: Babu Ambat, Vinod TR, Ravindran KV, Sabu T, editors. *Environmental Sanitation, Health and Hygiene. Proceedings Kerala Environment Congress; 2008 Apr 22-24; Kerala, India*. Thiruvananthapuram: Center for Environment and Development; 2008. p. 23-43.
9. Kozhikode Corporation. *Kozhikode. Solid waste management, 2010*. Available from: <http://www.kozhikodecorporation.org/index.php/swm>. [Last cited 2012 Sep 18].
10. Jayakrishnan T, Jeeja MC. *Disease Burden of Kerala. Research Report*. Thrissur: Society for Social Health Action and Research; 2007. p. 10-27.
11. van Eerd M. Chapter. *The Occupational Health Aspects of Waste Collection and Recycling an Inventory Study in India*. UWEP Working Document. Part II. Gouda, Netherland: WASTE; 1997. p. 25-30.
12. Cimino JA. Health and safety in the solid waste industry. *Am J Public Health* 1975;65:38-46.
13. Tandon R. A study on the working conditions and occupation hazards at the dumping sites of Bombay. *Occup Environ Health* 1994;1:9-17. Available from: [http://www.pria.org/publication/occupational Environmental health, 1994](http://www.pria.org/publication/occupational%20Environmental%20health,%201994) (English) pdf. [Last cited 2012 Sep 09].
14. Gelberg KH. Health study of New York City Department of Sanitation landfill employees. *J Occup Environ Med* 1997;39:1103-10.
15. Poulsen OM, Midtgard U. Bioaerosol exposure and health problems. In: *Proceedings of the International Meeting for Waste Collection and Recycling; 1996 Sep 13-14; Koge, Denmark*.
16. Reghunandan VR. *Solid waste management in small and medium towns in Kerala: A review on the critical control points and quality assurance*.

- In: Ambat B, Vinod TR, Ravindran KV, Sabu T, editors. Environmental Sanitation, Health and Hygiene. Proceedings Kerala Environment congress; 2008 Apr 22-24; Kerala, India. Center for Environment and Development; 2008. p. 204-13.
17. Jaithli H. Health Problems. A Rapid Assessment Survey of the Health and Environmental Impacts of Solid Waste Recycling. Calcutta: Centre for Study in Man and Environment; 1996. p. 36-42. Available from: <http://pria.org/publication/A%20Rapid%20Assessment%20Survey%20of%20the%20Health%20and%20Environment%20Impacts%20of%20Solid%20Waste%20Recycling.pdf>. [Last cited 2012 Aug 10].
  18. Anonymus. Scavenger Activities and Health Hazards to Scavengers. West Germany: German Agency for Technical Cooperation; 1986. p. 38.
  19. Jeeja J. A gender based study on sanitation facilities and attributed ill health of working women in Kerala. In: Ambat B, Vinod TR, Ravindran KV, Sabu T, editors. Environmental Sanitation, Health and Hygiene. Proceedings Kerala Environment Congress; 2008 Apr 22-24; Kerala, India. Thiruvananthapuram: Center for Environment and Development; 2008. p. 175-9.
  20. Berry M, Bove F. Birth weight reduction associated with residence near a hazardous waste landfill. *Environ Health Perspect* 1997;105:856-61.
  21. Huisman M. The position of waste pickers in solid waste management. In: Baud I, Schenk H, editors. *Solid Waste Management: Modes, Assessments, Appraisals, and Linkages in Bangalore*. New Delhi: Manohar; 1994. p. 46-104.
  22. Yang CY, Chang WT, Chuang HY, Tsai SS, Wu TN, Sung FC. Adverse health effects among household waste collectors in Taiwan. *Environ Res* 2001;85:195-9.
  23. Bessonov AS. Trichinellosis in the USSR (1983-1987), tendency to spreading. *Wiad Parazytol* 1992;38:147-50.
  24. Khin Nwe Oo, Sebastian AA, Aye T. Carriage of enteric bacterial pathogens by house flies in Yangon, Myanmar. *J Diarrhoeal Dis Res* 1989;7:81-4.
  25. Listorti JA. Lessons for Sub-Saharan Africa Infrastructure Projects?. Bridging Environmental Health Gaps: Working Paper No. 20. The World Bank Africa Technical Department; 1996 May. Washington DC, USA: The World Bank; 1996. p. 64.
  26. Rao BB, Harikumar PS, Jayakrishnan T, George B. Characteristics of *Aedes (Stegomyia) albopictus* Skuse (Diptera: Culicidae) breeding sites. *Southeast Asian J Trop Med Public Health* 2011;42:1077-82.
  27. Institute for Solid Wastes of the American Public Works Association, US Environmental Protection Agency. Chapter 8. Solid Waste Collection Practice. 4<sup>th</sup> ed. Chicago, Illinois, USA: Slavik Printing Company; 1975. p. 322-45.
  28. Krajewski JA, Tarkowski S, Cyprowski M. Hazardous health effects in communal waste collection and disposal workers. *Med Pr* 2000;51:159-72.
  29. Feachem RG, Bradley DJ. Health Aspects of Excreta and Wastewater Management. Sanitation and Disease: Chi Chester, UK: John Wiley and Sons; 1983. p. 501.
  30. Pruess A, Giroult E, Rushbrook P. Health and safety practices for health-care personnel and waste workers. In: *Safe Management of Wastes from Health-care Activities*. Geneva, Switzerland: World Health Organization; 1999. p. 226.
  31. Rushton L. Health hazards and waste management. *Br Med Bull* 2003;68:183-97.
  32. Poulsen OM, Breum NO, Ebbelhøj N, Hansen AM, Ivens UI, van Lelieveld D, *et al.* Collection of domestic waste. Review of occupational health problems and their possible causes. *Sci Total Environ* 1995;170:1-19.
  33. Barrera R, Navarro JC, Mora JD, Domínguez D, González J. Public service deficiencies and *Aedes aegypti* breeding sites in Venezuela. *Bull Pan Am Health Organ* 1995;29:193-205.

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