ORIGINAL PAPER

Performance and health assessment of the solid waste recycling centers in Jouybar and Qaemshahr counties, Iran (2018)

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ABSTRACT

The recycling and separation of waste from the source could reduce the amount of unusable waste. Workers in this sector are exposed to severe health complications. The present study aimed to assess the health status of waste recycling workshops in Jouybar and Ghaemshahr, Iran in 2018. In this descriptive, cross-sectional study, data were collected using a researcher-made questionnaire, the reliability of which has been confirmed. Among 400 workshops in the mentioned cities, 90 were selected via cluster sampling, and the questionnaires were completed. Data analysis was performed in SPSS version 24 and Excel software using the analysis of variance (ANOVA). The results indicated that 58% of the floors of the workshops, 71% of the walls of the workshops, and 70% of the ceilings of the non-sanitary waste collection workshops were preserved in accordance with the relevant regulations. However, 31% of wastewater contaminated the environment and agricultural lands in the vicinity of the workshops. Only 6% of the employees reported to have taken periodic examinations, and the majority of the workers used no work clothes and gloves. In addition, only 2.2% of the workers were vaccinated. Most of the studied workshops only performed a breakdown without making specific changes in the waste materials. According to the results, the health status of the waste recycling workshops and its workers was unfavorable. Therefore, I is recommended that regulators and policymakers be aware of the needs and vulnerabilities of these workers and identify the effective interventions for their health protection.

Keywords: Recycling, Solid waste, Waste separation, Waste management, Waste workers

Introduction

Waste recycling is considered to be a viable option for solid waste management.[1] The management of municipal solid waste is a substantial challenge in developing countries, especially in major cities.[2] Plastic consumption is on the rise, and plastics have changed the daily life of humans. In 2010, plastic production reached more than 300 million tons. Today, the most important concern in this regard is the unsustainable use of plastic by humans.[3]

Recycling and waste reduction are the only available methods for the recycling of the generated waste.[4] However, obtaining an accurate inventory of solid waste recycling is considered to be constant challenge due to the individual interests of stakeholders.[1] The incorporation of recovery and recycling methods into the production and conversion of recycling facilities is of paramount importance.[5] Waste recycling is a prominent approach to enhancing livelihood in the community, especially in marginalized populations.[6]

Solid waste recycling and recovery are among the most sustainable and effective systems in several growing cities in underdeveloped countries. In these countries, the greatest attention has been paid to the collection and disposal of waste regardless of waste recycling. However, waste recycling could generate income, increase the rate of

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employment, and reduce the amount of waste that should eventually be landfilled.[7]

The present study aimed to evaluate various municipal solid waste management scenarios (MSW) in Tehran, the capital of Iran based on five scenarios, including anaerobic digestion, garbage disposal with compost composition, burning, burning combined with compost, and anaerobic digestion combined with burning. According to the results, the anaerobic digestion and burning scenarios could exert adverse environmental effects on the human health and lead to environmental degradation. On the other hand, digestion of an anesthetic by burning was observed to be the scenario with the highest environmental compatibility in the future.[8] In a study conducted in Mashhad (Iran), the recovery potential of solid waste in this city was not properly considered. The amount of the recycled dry solid waste was reported to increase from 2.42% of total dry solid waste in 1999 to 7.22% in 2008.[9]

Recognition of the influential factors in recycling performance could increase the efficiency of recycling .[10] Increased production of household waste is due to population growth, urban development, and the improvement of living standards.[11] An important issue in this regard is the production of solid urban waste by households, which imposes the most significant costs on municipal waste management.[12]

Public participation in waste management and reducing waste production in developing countries has been underestimated.[13] Lack of attention to municipal solid waste management could also give rise to abnormal conditions, thereby threatening the health of the community and environment, especially in densely populated areas.[14]

Solid waste recycling is developing in many countries, while it remains an unofficial activity in some regions.[15] According to the literature, waste recycling and the reuse of solid waste reduce the burden on the environment and could be more beneficial compared to burning and landfill.[15, 16] Most of the individuals involved in waste recycling processes are unofficial workers or have poor socioeconomic status. Despite their significant share in waste management, the importance of their role in this field is overlooked.[17] Studies in various countries have indicated that the workers involved in recycling are exposed to a wide range of diseases, chemical hazards, and other vulnerabilities.[18]

In many countries, solid waste management is considered to be a major environmental issue.[19] According to the literature, there is no clear evidence regarding the health status of waste recycling and recycling workshops in Iran. The present study aimed to determine the health status and solid waste recycling patterns in solid waste recycling workshops in Jouybar and Ghaemshahr counties, which are located in Mazandaran province, Iran. The findings could be used to standardize and improve the health status of these workshops and similar workplaces in the other regions of the country.

Materials and Methods

This cross-sectional, descriptive study aimed to investigate the health status of waste recycling and solid waste recycling patterns in the recycling workshops in Jouybar and Ghaemshahr in 2018. The research units were selected via census sampling.

There were 400 waste recycling workshops in Jouybar and Ghaemshahr during the study period, 90 of which were selected randomly and without prior notice. Library studies, internet search, and the collection and extraction of the research results and filed surveys regarding the subject matter of the research were taken into account.

At the next stage, a checklist and a questionnaire were prepared for health, safety, and environmental standards. The preparation of the checklist of the current rules and standards for the management of medical wastes and similar wastes (approved with the code 15871/38459 dated 27 April 2008 by the Cabinet of Ministers) and checklist of the state of the environmental health workshops was assisted by the Ministry of Health. The checklist contained 45 items, and the questionnaire consisted of general and specific sections.

The general section of the questionnaire included general information and data on the

personnel status in terms of the management of waste recycling workshops. The specific section of the questionnaire consisted of four sections, including the health status of the personnel, transportation, construction status of the workshops, type of the implemented processes in the workshops, and their design and development. The cases to which the paragraphs of this checklist were generalized included the amending Article 13 of the Environmental Health Act regarding the repair and sanitation of the workshops, as well as the legal provisions related to the Occupational Health and Safety Act in the workshops (Article 5-26) and issues 1-7 of this law based on the Articles 27-56, documents of the Labor law of the Articles 85, 95, and three, and the Articles 100, 101, 105, 175, and 92 of the Labor Code, which were extracted and included in the checklist.

The recycling workshops of the sample population were visited, and the checklist was completed within three months of their activity period. Data analysis was performed in SPSS version 24 and Excel software using the analysis of variance (ANOVA), and the related charts were drawn.

Results and Discussion

According to the results of the present study, 58% of the floors of the workshops, 71% of the walls of the workshops, and 70% of the ceilings of the non-refurbished and unsanitary waste collection workshops could be improved in terms of the construction of waste collection workshops (Table 1).

Table 1. Construction status of workshops

Workshop building	Foam		Wall		Ceiling	
	Suitable and sanitary	Inappropriate	Proper and Sanitary	Inappropriate	Suitable and sanitary	Inappropriate
Workshop number	38	52	26	64	27	63
Percentage	42	58	29	71	30	70

According to the information in Table 2, most of the studied workshops had non-sanitary waste and waste disposal, which accounted for 69% of the workshops with sanitary wastewater, while 31% of the workshops had unsanitary waste disposal. In addition, 67% of the workshops had waste disposal waste, while 33% had unhealthy waste disposal. Sewage wells and sewage pipelines are essential to the transfer of sewage from the workshop, and wastewater must never enter the environment without control.

Table 2. Status of waste disposal and wastewater

Workshop environment	Wastewater		Garbage	
	Sanitary disposal	Non-sanitary disposal	Sanitary disposal	Non-sanitary disposal
Workshop number	62	28	60	30
Percentage	69	31	67	33

As is depicted in Fig. 1, 49% of the studied workshops had proper restrooms, 31% had sanitary napkins, and 20% had no restrooms, 49% of which were upgraded, and 31% lacked refurbishment. Moreover, 23% of the studied workshops had no restrooms, and 77% had toilets. It is also notable that 44% of the restrooms in the workshops had refinement conditions, and 33% lacked refinement. There were proper baths in 7% of the workshops, whereas 84% had no baths. In total, 14 workshops had a bath, and 7% (n=6) and 9% (n=8) were not upgraded.

Considering that 20 workshops had no toilet facilities, and 28 out of 90 workshops had non-conditioned toilets. Out of 90 workshops, 50 cases were unsanitary, indicating that 56% of the studied workshops had poor healthcare facilities and required the health surveillance of the city officials.

According to the information in Table 3, 42% of the studied workshops had restrooms, 58% were without restrooms, 13% of the restrooms had health care, and 29% lacked health care. A restroom is necessary for workers in workshops, and the restrooms for these workers must be in good health conditions and approved by health authorities.

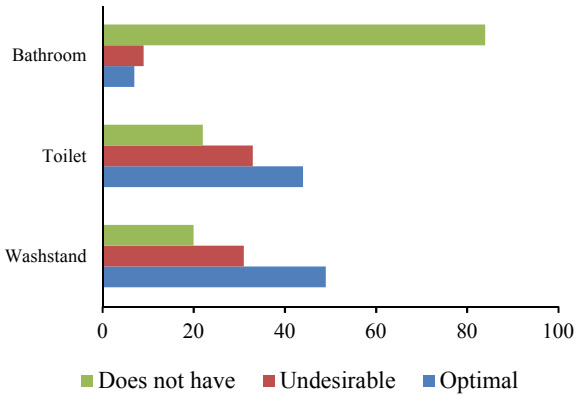

Fig. 1. Status of healthcare facilities

Table 3. Restroom of workers

Workshop environment	Rest room		
	Has a rest room		No room for rest
	Sanitary	Non-sanitary	
Total number	12	26	52
Percentage	13	29	58

According to the results of the study, 87% of the studied workshops had healthy and plumbed water, whereas 13% lacked safe and plumbed water. Since all the wells in these workshops are shallow allowing the penetration of leachate and surface waters, the workshops using well water (surface water) cause numerous health problems. Therefore, care should be taken to disinfect these waters and add chlorine in cooperation with health centers in order to reduce the risk of water contamination through the disinfection and chlorination of the wells.

According to the results of the present study, only 6% of the workers in the workshops performed periodic examinations and were aware of their health conditions, and 94% of the workers had no knowledge of their health status. According to the results, due to the significant pollution caused by the separation of waste and its recycling, periodic examinations are essential to informing the workers of their general health status in order to determine whether they are affected by diseases, contaminations or complications at the workplace. Professional treatments must be quick and minimize the risk of labor-related diseases, while preventing the transmission of diseases to others. Such periodic examinations should be carried out on the workers in waste recycling workshops every year, so that they could follow-up on their health in case of any abnormalities in their medical tests.

According to the information in Table 4, the majority of the workers in the studied workshops did not wear work gloves, while 13% wore work overalls, and 87% used no work slippers, while 34% had proper work gloves, 66% had unsuitable gloves, 6.6% used suitable shoes, and 93.5% had unsuitable shoes. In addition, some workers ate with infected hands during work, which causes the transmission of contamination and diseases via the digestive tract. Therefore, the provision of health training is essential for the workers in these workshops.

Table 4. Status of workers' clothes

Status of work clothes	Dressing gown		Gloves		Shoe	
	Work shirt	Lack of work wear	Suitable gloves	No suitable gloves	Has proper shoes	Lacks proper shoes
Number of workers	18	121	92	47	9	130
Percentage	13	87	66	34	6.5	93.5

The results of this study show, the majority of the workers were not vaccinated. Furthermore, they were at risk due to not using personal protective equipment while working. On the other hand, the materials that the workers were exposed to (e.g., hospital, industrial, and traditional wastes), which are collected by the Revolutionary Guard and transmitted to the workshops, are highly contaminated and pose severe risks of infectious, parasitic, and skin diseases to these individuals. Therefore, vaccination of these workers against tetanus, hepatitis B, influenza, and diphtheria seems critical. Only 2.2% of the unvaccinated workers received vaccination, whereas 97.8% did not vaccinate.

This study shows, 10.2% of the workshops recycled only carton and paper, 7.31% only recycled iron, 17% only recycled plastic, 2.43% recycled iron and plastic, 7.31% recycled all types of waste (with the exception of a few materials), and 63.52% recycled all types of waste. As a result, most of the workshops recycled all types of products rather than a particular type of waste. The survey of different types of recycling workshops shows that the highest amount of recovered iron is produced with 49.8% and the lowest product is lead with 0.7% (Table 5). The results of ANOVA indicated a significant difference in the number of the recycled materials (P=0.021). However, no significant difference was observed between the workshops in this regard (P>0.05).

Table 5. Types of recycled materials in workshops

Workshop recycling products (product type)		
Product type	Total amount	Percentage
Iron	27180	49.8
Zinc	1820	3.3
Plastic	15390	28.2
Aluminum	1860	3.4
Copper	1755	3.2
Paper	5590	10.2
Lead	400	0.7
Steel	635	1.2
Glass	0	0

Recycling and sustainable solid waste management could save millions of dollars in waste collection and disposal costs.[20] According to the findings of the current research, 90 workshops collected and sold 60 tons of waste daily, and the waste was obtained from non-sanitary disposal and disposal batch, which cost 2,100 dollars per day to be collected from municipalities. If the price per ton of waste was 285 dollars on average, the total economic revenue per ton of recycling is estimated at 320 dollars. In these workshops, an economic return of 60 tons is equivalent to 19,200 dollars per day. Recycling reduces approximately 50% of the waste volume, as well as the costs of waste collection systems. The results of economic appraisals have indicated that solid urban waste recycling is a productive and profitable process, which requires the organization and continuous monitoring of the responsible authorities.

According to the results of the present study, 77% of the workshops had no restroom, and only 23% had restrooms (Fig. 3). Considering that all the workshops had workers aged less than 20 years, they must have sanitary restrooms, and if they have no such conditions, they must attempt to improve the conditions in order to prevent the transmission and spread of diseases and parasitic contamination due to the unhealthy disposal of human waste. Considering that 20 workshops had no toilet facilities, and 28 workshops had non-conditioned toilets, it could be stated that 50 out of 90 workshops lacked sanitary facilities, indicating that 56% of the studied workshops had unfavorable hygienic services (Fig. 3); this issue must come to the attention of the city authorities.

According to the information in Table 2, 31% of the workshops had unsanitary waste disposal. Given the importance of the working conditions of recycling workshops and presence of contaminated materials in the form of recycled waste, the improper disposal of wastewater leads to numerous problems. It is also notable that in the absence of sewage wells in the floor of the workshop, pollution could be transmitted from the workshop and directed toward agricultural waterways and lands. Since this sewage is highly polluting and could give rise to many environmental issues, using sewage wells or sewage pipeline for the transfer of sewage is essential, so that sewage would never be released into the sewers in the environment.

According to the information in Table 6, considering that 60,700 kilograms of waste per 60 tons per day entered the workshops, and their separation was performed in unsafe conditions without appropriate personal protective equipment, the workers were at the risk of secondary contamination. Therefore, it is essential to separate the waste from the source and isolate hazardous wastes from less hazardous materials in order for the appropriate disposal of hazardous waste and to prevent the entry of such waste into the process of re-use. Various types of waste are disassembled and recycled at the studied workshops (Fig. 2).

Table 6. Amount of waste incoming to workshops

Waste type	Purchasedwaste (kg/day)	Percentage
Plastic	16650	27.4
Lead	450	0.8
Aluminum	2000	3.3
Zinc	2000	3.3
Glass	1000	1.6
Paper	6000	10
Steel	700	1.2
Copper	1900	3.2
Iron	30000	49.4
Total	60700	100

Fig. 2. Types of waste disassembled at recycling workshops

According to the evaluation of the MSW in the Indian capital, New Delhi, 17% of waste was shipped to recycling units, which could enhance employment in the community with proper organization.[14] In the management of waste recycling, in addition to the quantity and quality of plastic waste, the overall sustainability of the whole recycling chain should be evaluated before the start of operations. The recycling chain is optimized and can bring environmental and economic benefits to the community and those involved in this work.[21]

In the present study, it was urgent to provide restrooms for the recycling workers in the workshops with sanitary conditions approved by health authorities. Among the other possible sanitary reinforcements in the workshops were the repair of the ceilings and restoration of the walls. This study has shown, due to the high contamination caused by the separation of waste and recycling, it is essential that periodic examinations be carried out to inform workers on the health status of the occupants in order to detect possible illnesses, contaminations at work, and occupational complications. Such measures should be taken in order to reduce the possible health risks and prevent the transmission of diseases via the contact of the individuals. Periodic examinations must be carried out annually by the workers at the recycling workshops in order to ensure their follow-up in case of unhealthy conditions. The findings of the current research indicated that the majority of the workers employed in the waste recycling centers in Jouybar and Ghaemshahr received no periodical examinations and had no information about their health status, which is major concern in these recycling units, requiring immediate investigation and follow-up by health authorities. Most importantly, there should be long-term periodic examinations within one year, during which diseases may develop and transmit without the knowledge of the workers. Therefore, considering the variety of tools and collecting waste from contaminated sites, permanent monitoring and reducing the duration of periodic examinations can minimize the risks of work.

According to another study regarding waste recycling in Hong Kong, high investment costs, prolonged degradation periods, and the limited range of major barriers were addressed as the major issues in this regard.[4] Another study in Dar es Salaam (Tanzania) was focused on solid waste management, and the findings indicated that the waste production rate in the studied area was 0.36 kilogram per person per day, 14,600 kilograms of which constituted recyclable waste, and 55% of this volume could be recycled. Moreover, the results of the mentioned study demonstrated that waste recycling led to the reduction of the required waste for final disposal by 11%.[7]

Another research in this regard aimed to investigate the effects of heavy metals on the adults and children working in the electronics recycling sector. According to the findings, chromium, lead, and zinc had high concentrations in the skin samples of the workers. These heavy metals could exert deleterious effects on the health of the workers.[22]

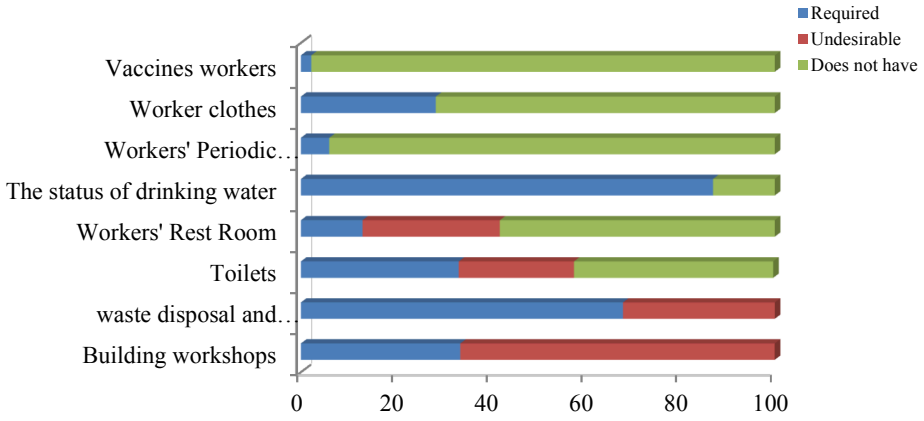

Fig. 3. Comparative diagram of environmental health factors in recycling workshops

Without the use of gloves, waste contamination could directly lead to disease transmission, and the sources from which the waste is collected or separated are unknown. In addition, lesions may occasionally occur due to the infections transmitted from the hospital wastes that are collected and disassembled. Some recycling workers even use contaminated food during work, which contributes to the transmission of diseases via the gastrointestinal tract. Therefore, the cooperation of other organizations is required in order to educate recycling workers and caretakers regarding the observance of hygiene rules during work and avoidance of food consumption at the workplace.

According to a research in Mongolia, a vast majority of the workers involved in waste recycling were exposed to several risk factors, such as homelessness, cold weather, lack of external support for recycling, social isolation, discrimination, and alcoholism. This population is subjected to numerous other issues and experiences various health risks, including stomach disorders, skin diseases, kidney and liver problems, back pain, cuts, burns, and fractures.[23] Since recycling workshops are mostly located in suburban areas, health authorities have difficulty accessing these facilities. Considering the work conditions in recycling workshops, these units must necessarily be outside of residential areas in order to minimize the health risks posed to residents. This requires continuous monitoring by the related organizations in order to reduce the contamination caused by these workshops.

As is depicted in Fig. 3, most of the workers in the studied workshops, as well as those involved in transportation, did not carry out job examinations, received no vaccinations, and did not use personal protective equipment. Therefore, the related organizations must attempt to provide the necessary health training in order to inform workers and caretakers on the observance of hygiene at work. The findings of a research conducted in Kathmandu (India) regarding the health of recycling workers indicated that 46.8% of the workers were vaccinated against tetanus, and only 7.5% were vaccinated against hepatitis.[17]

Due to the inadequate sanitation in the studied workshops in the present study (e.g., unsanitary bathrooms) and lack of access to clean water in these units, the training of the workers and operators is essential to the elimination of the mentioned health risks in accordance with health codes. For instance, provision of sanitary baths and restrooms in these workshop is of paramount importance. Furthermore, considering the unique working conditions of recycling workers and their constant contact with contaminated materials, it is essential that personal hygiene is properly observed by these individuals, so that diseases and contamination could not be transmitted to the community. Lack of improvement in the baths and restrooms of these units could lead to severe health issues as some of the workers in

most of these workshops are aged less than 20 years. Therefore, at least one shower must be provided in each workshop. Finally, it is recommended that these units be transferred to suburban areas, and proper health conditions be assured in waste recycling with the cooperation of the officials of the provincial departments.

Conclusion

According to the results, the health status of the waste recycling workshops and their workers was unfavorable. Therefore, policymakers need to be aware of the needs and vulnerabilities of this group and identify the effective interventions for their health protection. The results of the economic assessment indicated that solid urban recycling is a productive approach, which requires systematic management and supervision by the responsible authorities through constant monitoring.

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