Heliyon 5 (2019) e01873

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.heliyon.com

Seroprevalence of HBV among Egyptian municipal solid waste workers

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ARTICLE INFO

Keywords:
Infectious Disease
Public health
HBV
Seroprevalence
Solid waste workers
HBsAg
Egypt

ABSTRACT

Background: Municipal solid waste workers (MSWWs) are potentially exposed to diverse hazards that are not merely a consequence of their occupation. Of particular concern are infectious diseases. The endemicity of hepatitis B virus (HBV) infection in Egypt suggests the possibility of disease transmission in MSWWs from improperly disposed hazardous materials found in the solid waste stream. To date, such transmission has not adequately been epidemiologically studied in Egypt.
Objective: To explore the seroprevalence of HBV among MSWWs in Egypt.
Methods: We conducted a descriptive cross-sectional study that included 1467 MSWWs recruited from the main municipality company in Alexandria, Egypt, in February 2018. The enrolled participants were categorized into two occupational groups (exposed; n = 1361 and non-exposed; n = 115) on the basis of their direct exposure to solid waste. The study procedure involved interviews using a predesigned questionnaire that covered general demographic information. Blood samples from all participants were tested for the hepatitis B surface antigen (HBsAg), a marker of active HBV infection, using a third-generation enzyme linked immunosorbent assay (ELISA).
Results: All MSWWs were male and had a mean age of 39.8 (±7.9) years. The majority were urban residents (72.8%) and engaged in solid waste collection (63.8%) or sorting (13.6%). The overall seroprevalence of active HBV infection was 1.5%. In total, 3.8% of the workers received the compulsory HBV vaccine during their infancy, meaning approximately 96.2% of the participants were at risk for HBV infection. Evaluating the availability and use of personal protective equipment revealed that most of the workers were provided with and wore overalls but not safety shoes, protective gloves, face masks, or helmets.
Conclusion: The present work suggests the possible transmission of HBV in workers exposed to municipal solid waste. This result necessitates the initiation of prophylactic HBV immunizations and the consideration of safer techniques for waste management.

1. Introduction

Solid waste created from human activities is collected, stored, handled and disposed of by municipal solid waste workers (MSWWs) who contribute greatly to reducing potential health risks to both the public and environment [1]. Nevertheless, these workers, regardless of their tasks (collection, sweeping, transportation, sorting, recycling, dumping or incineration) and their professional training, obviously engage in activities that pose a risk of infection because of the type of biohazardous materials that they contact [2, 3, 4, 5, 6].

Moreover, MSWWs are at high risk for occupational accidents, including injuries caused by improperly disposed needles, sharps, pins and broken glass. This risk of accidents further poses a potential threat for blood-borne pathogen transmission, particularly hepatitis B virus (HBV), hepatitis C virus (HCV) and human immunodeficiency virus (HIV) [7, 8, 9, 10]. MSWWs are particularly vulnerable due to a series of unfavourable social, cultural and environmental factors contributing to poor health and a poor quality of life. Moreover, to our knowledge, most preventive policies are directed at groups and populations with higher exposure risks, such as health care workers, and do not include marginal groups.

The association of blood-borne viral infection with a myriad of iatrogenic, behavioural and community-acquired risk factors was extensively studied. Throughout the world, little is known about the magnitude of infectious disease spread as a result of waste handling [10, 11, 12]. In the present study, we aimed to determine the seroprevalence of HBV infection among MSWWs in Alexandria, Egypt, and to emphasize the importance of adequate prophylactic and safety measures targeting

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https://doi.org/10.1016/j.heliyon.2019.e01873
Received 14 February 2019; Received in revised form 10 April 2019; Accepted 29 May 2019

this category of workers.

2. Methods

2.1. Study setting and design

A cross-sectional seroepidemiological survey was conducted among MSWWs recruited from the main municipality waste management company in Alexandria, Egypt in February 2018. This company was established in 2001 to manage all types of solid waste generated in all municipal districts of Alexandria from diverse sources, including residences, shops, agricultural areas, and industries, as well as medical wastes from laboratories and health care facilities. The municipal waste management company employs approximately 1500 workers who serve in different waste management sectors, such as waste collection, transportation, sorting and recycling, treatment, and incineration; at landfills; and in fertilizer production.

2.2. Study participants

The study included all current MSWWs who were employed for 1 year or more by the municipality. In total, 1476 full-time employees were enrolled in the study. The sample showed disproportionate variability in the number of workers in each work activity. Employees that did not come in direct contact with solid waste were also enrolled to compare the impact of waste handling as a risk for blood-borne viral infection. Enrolled participants were categorized into two occupational groups (direct exposure; $n = 1361$ and indirect exposure; $n = 115$) on the basis of direct contact with solid waste. The direct exposure group comprised those engaged in solid waste collection, street sweeping, sorting, solid waste loading, transfer and evacuation, solid waste incineration, dumping, landfilling, bin/scoop washing, and fertilizer production. The indirect exposure group included technical workers (mechanics, car and equipment maintenance workers, heavy equipment operators), transportation workers (vehicle/truck drivers), welders, inspectors, timekeepers, and other office workers who were involved in the waste management process but were only indirectly exposed to solid waste.

2.3. Interviews

A standardized predesigned questionnaire form was used to interview all participants. The data collection sheet covered general sociodemographic information about age, sex, residence, work activity and duration of work.

An inventory of personal protective equipment was completed with a checklist for all participants.

2.4. Serology

Three millilitres of blood was aseptically collected from each participant, and serum was separated according to the standard procedures. Serum was kept at a cool temperature until transport to the laboratory for serological testing on the same day. All sera were screened for hepatitis B surface antigen (HBsAg) using a third-generation enzyme linked immunosorbent assay (ELISA) (DIALAB®, Austria). Serological testing was performed following the manufacturer's instructions. Seropositive cases were further evaluated for viral DNA using PCR (TaqMan Real-Time PCR, Applied Biosystems).

2.5. Statistical analyses

After data collection, data sheets were revised for accuracy and completeness, coded and entered into the statistical software package SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). All statistical analyses were performed using two tailed tests and an alpha error of 0.05. The significance of the obtained results was judged at the 5% level ($p \leq 0.05$). Data were described using numbers, percentages, and means with standard deviations (SDs). We assumed a normal distribution of the data. Student's t test was used to compare means between two groups. Pearson's chi-square test was used to test for the association between two independent samples. Fisher's exact test was used when the expected values were small.

2.6. Ethical consideration

The study was approved by the institutional review board and ethics committee of the High Institute of Public Health, Alexandria University, Egypt. Permission to conduct the study was obtained from the Director of the company. The study conformed to the international research guidelines of the Helsinki Declaration. All MSWWs were informed about the aims and concerns of the study and were assured about the confidentiality, protection and anonymity of participants' data. Informed consent was voluntarily obtained from all participants after elaboration on the aims and concerns of the study. Those who were seropositive for HBV infection were referred to a specialized health care unit for further evaluation.

3. Results

3.1. Sociodemographics and serologic profiles

The study comprised a total of 1476 male MSWWs with a mean age of 39.8 ± 7.9 years. Data from the included subjects were used to describe the sociodemographic characteristics of the study population, detailed in Table 1. The majority of participants were urban residents (72.8%) and engaged in solid waste collection (63.8%) or sorting (13.6%). The mean duration of employment was 19.8 ± 7.8 years.

3.2. HBV serostatus

The seroprevalence of HBsAg and hence active HBV infection among the enrolled MSWWs was 1.5% (Fig. 1), although it varied among the different employee subgroups as follows: 59.1% in collectors; 18.2% in sorters; 9.1% in technical workers, supervisors and managers; 4.5% in drivers; and 0.0% in clerical staff who were not exposed to solid waste. Active infections were confirmed by detecting viral DNA with PCR (100.0%).

The majority of the HBV-seropositive workers were in the 35–50 years age group (68.2%), urban residents (77.3%), and engaged in solid waste collection or sorting (direct exposure to solid waste; 92.2%). However, the presence of HBV infection was not significantly associated with worker age, residence or the type of working activity. In total, 3.8% of the workers (up to 26 years of age) likely received the compulsory HBV vaccine during their infancy according to the national expanded programme on immunization (EPI); these workers were found free of HBV infection (0.0%). Accordingly, 96.2% of the workers did not receive the HBV vaccination during their childhood and thus were at risk of acquiring HBV infection.

3.3. Availability and use of personal protective equipment

Using a checklist, we found that most of the workers were provided with and wore overalls but not safety shoes, thick rubber gloves, face masks, or helmets (Fig. 2). All workers were picking up and performing solid waste sorting using their hands or metallic hocks (Fig. 3). Most of the workers reported a history of injury from needles or sharps disposed of in the waste stream.

4. Discussion

In Egypt, health care waste, including discarded syringe needles, bandages, swabs, plasters, and other types of infectious waste generated

Table 1
Sociodemographics and serologic profiles of the surveyed MSWWs.

	Total participants		HBV serostatus				p^{x^2}
			-ve		+ve		
	(n = 1476)		(n = 1454)		(n = 22)		
	no.	%	no.	%	no.	%	
Age (years)							
20-<35	406	27.5	400	27.5	6	27.3	0.5
35-<50	883	59.8	868	59.7	15	68.2	
50–60	187	12.7	186	12.8	1	4.5	
Mean ± SD	39.8 ± 7.9		39.8 ± 7.9		39.2 ± 6.5		t=0.4 p=0.68
Residence							
Urban	1074	72.8	1057	72.7	17	77.3	0.63
Rural	402	27.2	397	27.3	5	22.7	
Work activity							
Collector	942	63.8	929	63.9	13	59.1	0.91
Sorter	200	13.6	196	13.5	4	18.2	
Mechanic/electrician/welder/maintenance/technician	116	7.9	114	7.8	2	9.1	
Head supervisor/sector manager	71	4.8	69	4.7	2	9.1	
Driver/assistant driver	116	7.9	115	7.9	1	4.5	
Desk employee/clerical	31	2.1	31	2.1	0	0	
Duration of Work (mean ± SD)	19.8 ± 7.8		19.8 ± 7.9		19.2 ± 6.5		t=0.4 p=0.68
Exposure to solid waste							
Indirect exposure	113	7.8	115	7.8	2	9.1	0.82
Direct exposure	1361	92.2	1341	92.2	20	90.9	
HBV vaccination history (EPI since 1992)							
No	1420	96.2	1398	98.5	22	1.5	0.35
Yes	56	3.8	56	100	0	0	

p^{x^2}: p value for chi-square test.
t; Student's t test.
+ve; seropositive for HBV.
-ve; seronegative for HBV.

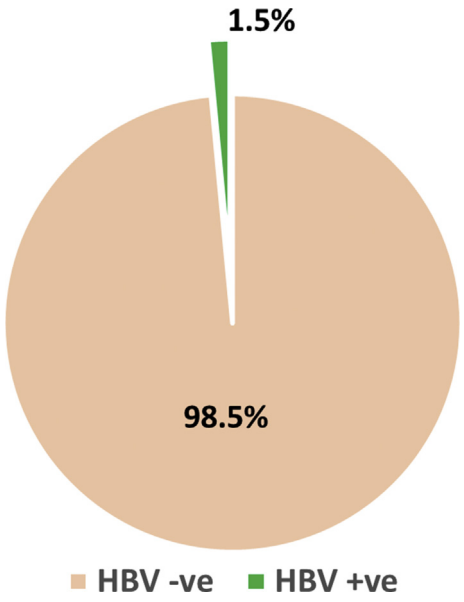

Fig. 1. HBV seroprevalence among MSWWs.

from households, health care centres, dental clinics and investigational laboratories, are often disposed of with the regular non-infectious waste [13]. MSWWs are at high risk of occupational accidents, including injuries caused by improperly disposed needles, sharps, pins and broken glass. This accidental injury risk increases the potential threat for blood-borne pathogen, particularly HBV, transmission [7, 8, 9, 10]. In the present study, 1.5% of the surveyed workers were seropositive for HBsAg. Seropositive workers were confirmed by PCR to have detectable HBV DNA and to have elevated liver enzymes [serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT)], denoting active viral infection.

Egypt has a moderate HBV prevalence (2–8%) [14]. As such, one could conclude that the MSWWs in the present study should have a reduced risk for infection due to their profession. However, this prevalence was estimated in 2007. In fact, the trend has likely changed over the last decade since HBV vaccination programmes have been established in Egypt, and the HBV vaccine has been part of the compulsory childhood vaccination programme since 1992. According to the demographic health survey conducted in Egypt in 2015 [15], the overall seroprevalence of HBsAg among the general population was 1%. In the present study, we found that the prevalence of HBV among the study population was higher than that among the general population, and a difference in the HBV infection rate between the exposed (collection and sorting) and non-exposed groups was clearly demonstrated. Moreover, the integration of the HBV vaccine, which is given to only children, in the childhood EPI occurred in 1992; therefore, those aged 26 years and younger in 2018 were likely vaccinated, while adults older than 26 years at the time of the study were unvaccinated. Thus, most of the evaluated MSWWs (96.2%) did not receive the compulsory HBV vaccination during their childhood and were considered at risk of acquiring HBV infection. Notably, none of the vaccinated workers (0.0%) were found to be seropositive for HBV infection. We cannot exclude the possibility that adults older than 26 years could have voluntarily received the vaccination. However, during interviews, all participants claimed that apart from the childhood vaccination, they had never received any kind of vaccination during their lifetime. Moreover, the HBV vaccination is provided free of charge only through the EPI; otherwise, it is provided at a high cost for voluntary vaccinations and cannot be afforded by such a group of workers whose salary was described as barely enough by our team in a previous work [13].

In a similar study that investigated the prevalence of HBV, HCV and HIV among MSWWs in Alexandria, Egypt, the overall seroprevalence of HBV was 36.1% [13]. The greater variation in the rate of infection among

Fig. 2. Example of PPE used by municipal solid waste workers in Egypt.

the two study populations (1.5% *vs* 36.1%), despite being conducted at the same municipality company, is attributed to different sample sizes. In the latter study, the author calculated the prevalence based on the presence of other serological markers of HBV exposure [anti-HBcAb (IgM and IgG), anti-HBsAb] that collectively denote active or past infection and viral clearance. However, the presence of HBsAg in the present study indicated active viral infection. Furthermore, the latter study used the immune complex dissociation technique [16] to detect the possible presence of occult HBV infection, which was reported to be 17.3%, although the seroprevalence of HBsAg was found to be 9.5%.

In a recent meta-analysis, the pooled proportion of HBsAb and HBcAb seropositivity among MSWWs considering all published studies was 14.2% (95% CI: 1.4–37.2%) and 24% (95% CI: 6–49%), respectively, with an overall risk of 2.39 (95% CI: 0.88–6.52) [11]. This result was

Fig. 3. Worker are not wearing proper PPE at the solid waste sorting facility in Alexandria and are performing hand picking without gloves (a-f). Red arrow in (a and b) points to a hook used by some workrs to pick the waste.

lower than the prevalence of HBV in municipal waste collectors in central Greece (23%) [8], in informal recyclable waste collectors in southeastern Brazil (34.4%) [10] and in MSWWs in Ethiopia (31.7%) [12].

The waste collectors collect residential and communal waste in addition to solid waste from investigational laboratories, private practitioners and dentists, intravenous drug users, and patients with diabetes that is not safely discarded. These activities are considered risky regarding collector risk for needle-stick injuries. The self-reporting of needle-stick injuries was of great significance in the present work. Almost all workers that engaged in solid waste collection and sorting activities had a history of needle-stick injury and described loose needles in the waste stream in uncontained disposal containers, ruptured sharp

containers, or overfilled waste bags. Needles originating from both residential and medical facility sources were identified. Improper waste segregation policies and practices favour blood-borne pathogen transmission. The MSWWs should have pre-employment quality training regarding hazardous waste handling so that this activity is conducted in a professional way.

4.1. Limitations of the study

As we were not able to include a control group in the present study, there was a lack of a specific exposure assessment. Analytical epidemiological follow-up studies are therefore needed to assess the magnitude of such health problems and their determinants. In the future, other HBV serological markers, including HBcAb, HBeAg, HBeAb and HBsAb, must be analysed to clearly define the virologic profile and immune status of the study population.

5. Conclusion

The present work eludes to the possible occupational risk of blood-borne viral infections among MSWWs. Strict compliance with established hygienic guidelines should be endorsed to avoid occupational HBV infections. This can be realized through prophylactic HBV immunization in this socially marginalized professional category. Additionally, those with needle-stick injuries and workers with a possible occupational exposure to a blood-borne pathogen should be referred to the nearest appropriate medical facility for a medical assessment within 2 h of the injury. Safer practices for waste management should be considered. The disposal of health care waste requires special attention since this can create major health hazards. Sharps containers should be readily available wherever sharps may be used, e.g., in pharmacies, homes, etc. Legal action should be taken against offenders with poor sharp disposal practices. Furthermore, supportive health services should be emphasized, and awareness programmes should be planned and implemented to improve the understanding of the value of this work and the importance of such jobs to the whole community.

Declarations

Author contribution statement

Ekram W. Abd El-Wahab: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Safaa Mohamed Eassa: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

ARRIVE guidelines

The current research does not involve any animal work.

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