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Original Research

Risks and risk mitigation in waste-work: A qualitative study of informal waste workers in Nepal

Sujata Sapkota [a,*], Andrew Lee [b], Jiban Karki [a,b], Prabina Makai [a], Saraswati Adhikari [a], Nita Chaudhuri [c], Astrid Fossier-Heckmann [c]

[a] PHASE Nepal, Dhadhikot, Suryabinayak-4, Bhaktapur, Nepal
[b] School of Health and Related Research, The University of Sheffield, Regent Court, 30 Regent Street, Sheffield 4DA, UK
[c] Médecins Du Monde, 62 Rue Marcadet, 75018, Paris, France

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ABSTRACT

Objectives: To explore how informal waste workers (IWWs) working in Kathmandu Valley perceive risks associated with waste work and what they do to mitigate them.
Study design: Qualitative Study Design.
Methods: A mix of one-to-one semi-structured interviews (n = 18) and focus group discussions (n = 4) with IWWs were undertaken. Participants were recruited purposively using snowball sampling. All interviews and discussions were audio-recorded, transcribed verbatim, translated and subsequently analysed thematically.
Results: The IWWs perceived discrimination and health risks as the main risks associated with waste work. IWWs reported considerable stigma and discrimination not only from the wider society but also from family members and within their own profession. Similarly, the occupational risks most frequently recognized were physical injuries and cuts from working with waste. However, the potential risks from hazardous chemicals present in or generated from waste were not articulated by participants. Mitigation strategies to combat the risks included avoidance, greater care and the use of informal means of "protection". Awareness of the importance of personal protective equipment (PPE) was limited. The key barriers to the use of PPE identified included costs, the lack of easy availability of PPE and the inconvenience of working with PPE.
Conclusions: The vulnerability of informal waste workers in Nepal is multifaceted. A range of policy and regulatory measures, along with interventions that promote greater social inclusion and occupational support are needed to promote IWW's health and safety.

1. Introduction

Globally, the human population is increasingly urbanized. In South Asia, Kathmandu is one of the fastest growing cities and, unsurprisingly, is experiencing the associated consequences of unbridled urbanization. One ramification is the increased generation of solid wastes, such as garbage, refuse, sludge and other discarded material resulting from residential, commercial, agricultural operations, and from community activities [1]. It is estimated that the population of Kathmandu produces over 500 metric tons of solid wastes daily [2]. This creates a significant waste management challenge and the city has struggled for decades to find a sustainable solution [3,4]. Currently, the approach adopted has been to sweep, collect and dump, and the majority of solid waste is deposited at dumping sites.

Formal recycling activity is scant but informal waste workers (IWWs) process around 10% of solid wastes in Kathmandu city and 15% in the wider Kathmandu Valley area [4]. In Kathmandu Valley and Sisdole (the main dumping site managed by the Kathmandu Metropolitan City (KMC) municipal council), it is estimated that 15,539 waste workers are engaged in waste collection, waste separation, waste rickshaw pulling, sweeping and waste carrying [4]; most of this workforce are IWWs [5,6]. IWWs often operate in precarious working conditions with low incomes and lack of social protection [7]. In addition to being exposed to waste: a health hazard in itself, poor hygiene practices, the lack of effective

* Corresponding author. Dadhikot, Suryabinayak-4, Bhaktapur, PO Box. 12888, Nepal.
E-mail addresses: ss.phase09@gmail.com, sapkota_sujata@hotmail.com (S. Sapkota), andrew.lee@sheffield.ac.uk (A. Lee), j.karki@sheffield.ac.uk (J. Karki), prabina.m@phasenepal.org (P. Makai), saraswati.a@phasenepal.org (S. Adhikari), nita.chaudhuri@medecinsdumonde.net (N. Chaudhuri), astrid.fossier-heckmann@medecinsdumonde.net (A. Fossier-Heckmann).

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protection from occupational and environmental hazards, and poor living conditions, put IWWs at significant health risks. A quantitative baseline survey of 1278 IWWs in the Kathmandu Valley conducted in 2018 found that many were insufficiently protected against occupational hazards associated with their work [8]. They were reported to have poor access to and use of formal personal protective equipment (PPE) [8], such as face masks, gloves and safety boots, rendering them highly vulnerable to injuries, infections and chronic health conditions. Their work was associated with stigma, and mental ill health was also prevalent [8]. However, little is known about how IWWs perceive and deal with the attendant risks associated with waste work.

Human behaviour is a complex phenomenon determined by a multitude of factors, including environmental factors (such as social support/barriers, ability to change one's own environment), behavioural factors (such as skills, practice and self-efficacy) and cognitive/personal factors (such as, knowledge, perceptions, expectations and attitudes) [9]. To understand health and safety behaviours of people working informally in the waste-industry, it is imperative to understand how they perceive risk associated with waste work and what factors influence their behaviour. This qualitative study sought to understand how these waste workers perceived the risks associated with their work, and risk mitigation strategies they adopted to protect themselves from these risks.

2. Methods

We conducted a qualitative study involving face-to-face semi-structured interviews and focus group discussions (FGDs) with IWWs working in three Kathmandu Metropolitan City managed waste-management and landfill sites: Shantinagar, Teku and Sisdole.

2.1. Participants selection and recruitment

Purposive sampling was conducted to recruit a diverse range of IWWs, taking into consideration participants' age, gender, nationality (Nepali and non-Nepali) and type of waste work they performed. In addition, snowball sampling was also employed to augment the recruitment to ensure the sample had adequate representation from these different subgroups. Potential participants were informed of the purpose of the study and invited to participate. Interested participants were then contacted individually and given further details of the study and its objectives. A written information sheet was also provided that explained the purpose of the study, process of data collection, and use and dissemination of the data (including anonymisation of their personal data and responses). For illiterate participants, the research objectives and processes, as stated in the written information sheet, were described verbally. Written consent was obtained from the participants who could read and write. For participants who were unable to read and write, the consent form was read out to the participants and verbal consent was audio-recorded.

2.2. Data collection

The interviews and FGDs were conducted based on the protocols developed by the research team. The protocols developed in English were later translated to Nepali by researchers at PHASE Nepal. Prior to data collection, three pilot interviews were conducted with IWWs to test the protocols.

2.2.1. Interviews

Interviews were conducted individually and face-to-face. These took place at a local urban health clinic or health post, or at the waste worker's workplace, at the convenience of the participants. A total of 18 interviews were conducted. Individual interviews ranged between 10 and 37 minutes, with an average interview time of around 21 minutes.

2.2.2. Focus group discussions

A total of four focused group discussions were conducted: two in Shantinagar Urban Health Clinic, one in Sisdole Health Post and one Teku Urban Health Division, Kathmandu Metropolitan City. The focus groups had between nine to fourteen participants. Two focus groups were conducted with male IWWs, and the other two were mixed gender groups.

Both the interviews and FGDs were conducted in Nepali language by Nepali researchers from PHASE Nepal (with support from Médecins du Monde (MdM) Nepal staff). All interviews and FGDs were audio-recorded with the participants' consent.

2.3. Data analysis

The audio-recorded interviews and FGDs were transcribed verbatim and subsequently translated into English. The translated interviews and FGDs were then thematically analysed, using an inductive approach [10] and descriptively summarized. The participants' responses were coded as 'themes' and then categorized into two thematic categories: 1) Perceived risks associated with waste work, and 2) Responses to risks. In addition to the researcher who led on the data analysis, several transcripts were also independently coded by two other researchers to ensure the consistency and validity of the findings. All of the themes were reviewed and any divergent categorizations were resolved by the researchers following further discussion until consensus was achieved.

2.4. Ethics, data protection and patient confidentiality

Ethical approval was obtained from the Nepal Health Research Council in October 2017 (reference no. 388/2017). For data protection, data were recorded using an encrypted/password-protected recorder. The recordings were transferred onto an encrypted computer within a week of the interview/FGD and immediately erased from the recording devices after transfer. The participants' personal details, including any potentially identifiable or sensitive information were anonymised in all transcripts.

A fuller description of methodology has been provided elsewhere [11].

3. Results

3.1. Participants' demographics

A total of 67 informal waste workers (IWWs) participated in the study. The participants were mostly male (71.2%), married (70.2%) and aged between 16 and 69 years. Twelve participants (~17.9%) were of Indian nationality. Among those who identified themselves as Nepali, nearly half (45%) originated from the *Madhesh*[1] region. The demographic details of the participants are presented in Table 1.

3.2. Risks and risk-mitigation strategies

The IWWs interviewed perceived their work to be "very *risky*", and often "*very dangerous* "and "*difficult*". They identified discrimination and health hazards associated with waste work, as the main risks of their occupation (Fig. 1). In response, they adopted several strategies to mitigate these risks, including avoidance of the risks, use of 'protection' and self-care.

3.2.1. Perceived risks associated with waste work

3.2.1.1. Discrimination. IWWs identified discrimination as one of the main risks associated with waste work. Most of the discrimination

[1] Geographically, the *Madhesh* is the southern plains ('Terai') region in Nepal.

Table 1
Participants' demographics.

	Interview participants (n=18)	FGD participants (n=49)	All participants (n=67)
Age			
Range	18-65 years	16-69 years[a]	16-69 years
Mean	36.5 years	37.7 years[a]	
Median	36 years	36.5 years[a]	
Gender			
Male	13	35	48 (71.6%)
Female	5	14	19 (28.4%)
Nationality			
Nepali	13	42	55 (82.1%)
Indian	5	7	12 (17.9%)
Education status			
Illiterate	8	23	31 (46.3%)
Literate	10	26	36 (53.7%)
Marital Status			
Married	10	37	47 (70.2%)
Never married	3	7	10 (14.9%)
Widow/ Separated/ Divorced	3	5	8 (11.9%)
Not reported	2	-	2 (3.0%)

[a] Age of one participant was missing; age calculations were based on the sample of 48.

Fig. 1. Thematic categories and associated themes.

reported came from members of the public or their families and relatives. However, waste collectors also reported discrimination at work from the 'scrap dealers' (Table 2, Q1).

IWWs reported experiencing verbal abuse (being called by derogatory names and profanity) as well as physical abuse (being slapped). Verbal abuse appeared to be a common occurrence. In addition, they reported being the victims of crime (e.g. robbery), or occasionally wrongly accused of theft (Table 2, Q2).

The discrimination was not just due to their occupation but also their place of origin. Waste workers were abused for being of Indian nationality or for belonging to the *Madheshi* (people from the Madhesh region) community, and treated as an outsider (Table 2, Q3).

Discrimination, whether observed, experienced or perceived, were reported by some IWWs as the cause of mental stress, low self-esteem and stigma in the IWWs. Consequently, they tended not to speak openly about their occupation (Table 2, Q4).

3.2.1.2. Health risks. In addition to discrimination, IWWs identified various health risks such as injuries from cuts from metal and glass scraps, needle-stick injuries, road traffic accidents and dog bites. Traffic accidents and physical injuries from vehicles and machines used in waste management were observed to be common occurrences at the waste

Table 2
Representative quotes.

Sub-themes		Sample Quotes
Theme 1: Perceived risks associated with waste-work		
Discrimination	**Q1**	*"Some people scold [us] and behave badly (towards us). Some use offensive language. Some people cheat. Some people scold. The scrap dealers also shout at me. I feel bad when people behave in that way, that really hurts. It is the saddest part …. Everyone looks down on us saying we are working with waste. People are disrespectful. They think that I cheat them. … [My] relatives also look down on me … and scold me saying that I am doing an awful job. People use vulgar words to scold me and say that I should be cheated and beaten."* (I3, Male)
	Q2	*This is a very risky job … if someone steals something and I am there, people catch me and blame me. They slap me as well. They take me into police custody. They ask for money. That's why this job is so risky.* (I5, Male)
	Q3	*"Some people behaved nicely but some people scold us … They call us 'Madhishe'. As we have to shout to let people know we are there for collecting scraps, people complain that we disturb them and they use bad words. They say, ' …. don't come here again you Madhishe'"* -([FGD1, P2, Male)
	Q4	*"If I share this with my relative or villagers they will hate us saying you are working in waste. They say, 'did you not get any other job in Kathmandu? … how can you work in that waste?' … There is bad smell … Even we don't say that we work in the waste in our children's school. If we share this in their school, teachers, parents and our children's friends will look at our children in a different way. We never talk openly about our job due to discrimination in society. In the early days of my work if people knew that you are working in waste it was very difficult to get a room in Kathmandu. My children go to a private boarding school but I never told my children's teacher or principal that I am working in waste due to shame and discrimination in society. If other people hear what I am saying they will treat my children in a different way."* (FGD4, P8, Female)
Health Risks	**Q5**	*"During menstruation, I feel it is so difficult to do this work. I have to do the work anyway. It is very difficult … My uterus had moved before[a]. This is my sister … She didn't let me carry [heavy loads] for one week. My brothers were called, (I got) checked up, x-rayed. I took medicines for 15 days. My uterus had moved."* (I8, Female)
Theme 2: Responses to risks associated with waste-work		
Risk avoidance	**Q6**	*"I have to accept such behaviours as I come from a different place. I don't do anything (to respond), I just work. I am not here for a fight. There is nowhere to complain about it. I stay silent and move on as if nothing has happened, continue my work, collect waste and go to the scrap dealer. That's it."* (I3, Male)
	Q7	*"I have to walk carefully and slowly, and by the side (of the road). I might hit something while carrying waste so I have to be safe while walking. I have to work in a safe way. No one knows what happens on the road … and there are frequent iron and glass cuts. To prevent that, I have to wear gloves. But I don't have gloves. So, I do it with bare hands. If there are cuts, I wash them with soap and water. If I want, I put Dettol. Otherwise, I put Kerosene."* (I3, Male)
Use of protection	**Q8**	*"I use a glove on one hand, right hand. I don't wear it on the left hand, I wear it on the right hand. I wear a mask. I use a handkerchief. Then, I use a cap to stay away from the sun. And then uniform and shoes. I wear shoes to keep my feet safe - normal shoes. I search for them in the waste*

(*continued on next page*)

Table 2 (*continued*)

Sub-themes	Sample Quotes	
		and wear them. … (I wear gloves on the right hand) because I don't use this hand [Left hand] to pick up waste … I pick only with the right hand. I don't pick with the left hand." (I16, Male)
	Q9	*"People use PPE more in the winter to be safe from the cold but it is difficult to wear in the summer and rainy season. In the rainy season gloves get wet and it's hard to work. They slip from the hand as well. In summer it is too hot to wear gloves and boots at work."* (I5, Male)
Self-care and health-seeking behaviours	**Q10**	*"I go to the hospital for vaccination after being injured or cut or pricked"* (FGD1, P7, Male with agreement from other participants)
	Q11	*"I (get vaccinated) every six months to be safe"* (FGD1, P1, Male)
	Q12	*"I never took TT vaccination. I am scared to have TT"* (FGD1, P3, Male)

[a] We interpreted this to likely describe "uterine prolapse".

dumping sites, such as at Sisdole. IWWs also frequently experienced other health issues such as coughs, colds, diarrhoea and fevers, as well as ergonomic hazards such as body-ache and backaches. Women found it difficult to work during their menstrual periods (Table 2, Q5). Waste work could also aggravate other reproductive health issues in women.

For IWWs who lived at scrap dealer sites, health risks were also identified from living in 'unhygienic' conditions as they often lived in a confined space where they would cook, eat and sleep. Less commonly reported health hazards included respiratory issues that they linked to *"bad smells"* emanating from the waste, and the waste-site environment such as dust. Of note, none of the IWWs interviewed identified health risks from hazardous chemicals likely to be present in the waste. In addition, there seemed to be little awareness of the threat of blood-borne infections.

3.2.2. Responses to risks associated with waste-work

3.2.2.1. Risk avoidance. *"Staying away"* and *"working carefully"* were the commonly reported means by which IWWs managed the risks associated with their work; several reported that they chose to ignore or just *"accept"* the risks. With regards to public discrimination and abuse, the IWWs (and especially those from India or the *Madhesh* region) felt they could not respond or retaliate (Table 2, Q6). Similarly, IWWs would *"stay away"* from and *"be careful"* of dogs to avoid being bitten, and from vehicles to avoid being hit. Care was advised while handling waste, particularly those containing or likely to contain glass and syringes (Table 2, Q7).

3.2.2.2. Use of protection. To reduce health risks, IWWs reported they would use 'protection'. However, their perception and understanding of what worked as protection, and how they used protection, varied considerably between participants. The 'protection' used ranged from proper personal protective equipment (PPE) such as gloves and masks, to informal items such as casual shoes, clothes and pieces of clothing wrapped around their mouths and noses at work. Gloves and masks (standard or makeshift) were the most commonly reported protective equipment used. However, eye protection and protective items such as aprons and coveralls were not reportedly used. The IWWs said they often used gloves and shoes found in the waste (Table 2, Q8). Female IWWs appeared more likely to use PPE, particularly gloves and masks (standard or makeshift masks), compared to male IWWs. Some female IWWs described how they would cover their faces with their shawls which they felt not only provided them with protection from the waste, but also helped them not to be recognized. Masks were reported to be preferably used when there was "*lots of dust*" and gloves only when "*picking syringes and glass*" or when it was "*provided or available*". There appeared to be seasonal variation too in the use of 'protection' (Table 2, Q9). PPE, as well as full-body attire and shoes, were most likely to be used during the winter for the added purpose "*to be safe from the cold*".

Table 3
Barriers to regular use of the personal protective equipment.

Barriers	Sample quotes
Inconvenient to work with PPEs	• *"It is difficult to speak. [We] have to shout as part of our work, saying, 'Tin (steel), falam (iron), bottle and papers'. At that time, it is difficult to shout if you wear a mask"* **(I2, Male)**
	• *"Ten to 15 of my friends use PPE. Two to three of my friends do not use [it]. They pick up things with bare hands. They have allergies when they wear gloves. If they use boots, they will have a burning sensation in their face-feet. They say that they don't want to use masks while picking waste because it is difficult to breathe."* **(I5, Male)**
Unaffordable (for sustained use)	• *"I think it's not possible to wear gloves all the times … It tears a lot. It gets dirty. How many gloves I would (have to) throw and buy? It is expensive as well … … Perhaps, gloves made from iron will be durable. There are no gloves made of iron. Only plastic ones are available and they are not that strong. Glass cuts happen through plastic (gloves)."* **(I16, Male)**
Wearing PPE is not a work norm	• *"We didn't use it from the beginning and nobody uses it. So, why do I (need to) use them?"* **(I14, Male)**
	• *"There is no use of eye glasses. If I use glasses my owner say that I am a big person. They mock me!"* **(I2, Male)**
Perception that PPEs are not necessary for all, or at all times	• *"I have not used (PPE) because I don't need to wear them as I work at the scrap dealer and I feel comfortable working without wearing them. I don't collect wastes. Waste collectors bring wastes and they have already sorted them. I just arrange the waste, weigh and sell them to the customers."* **(I7, Male)**

Despite describing PPE as beneficial, the IWWs interviewed did not use them regularly. Multiple reasons were offered by those interviewed for why PPE was not regularly used (Table 3). These included the inconvenience of working with PPE, the lack of affordability for sustained use, PPE use not being a work norm, social norm or a norm instituted by government for waste work, and the perception that PPE use was not always necessary.

3.2.2.3. Self-care and health-seeking behaviours. For most minor injuries, self-care was a commonly reported response. In terms of formal healthcare services, the IWWs would seek these out for specific purposes. These included, for example: Tetanus Toxoid (TT) vaccination, or antibiotic treatment for infections resulting from cuts or injuries, and anti-rabies vaccination following dog bites. However, there was considerable variation in participants' understanding as to when TT vaccination was indicated. Most thought that TT vaccination was required following an injury caused by metal lacerations. Some erroneously thought that vaccination was necessary every 6 months irrespective of the occurrence of injuries (Table 2, Q10-Q12). A few incorrectly believed that TT vaccination was only necessary for 'big' cuts or injuries but not for 'small' injuries. For injuries perceived to be 'minor', several IWWs said they would usually apply antiseptics or other 'home' remedies such as kerosene which they believed had antiseptic effects.

Occasionally, the IWWs said they might approach a 'medical' provider for 'medicines'. Their choice of health facilities was influenced by three common factors: waiting times, their accessibility and costs. For minor ailments, the IWWs would usually go to the nearest 'private clinic' or other 'medical' provider for quick treatment so that their work-time was not affected much. Healthcare facilities that were nearer to their

homes or workplaces were preferred. In the government health facilities, waiting times were reportedly longer which meant that the IWW were less likely to receive prompt treatment. However, for injuries and diseases that require more specialist healthcare, they preferred government health facilities as these would be cheaper than the private sector providers.

4. Discussions

In many low- and- middle income countries such as Nepal, waste-management practices and work safety measures tend to be poor [12–14]. Waste workers in these settings experience considerable risks to their health and safety [14,16]. This situation is considerably worse for informal waste workers who operate in hazardous conditions for whom there are fewer safeguards. In addition, poor living conditions, limited access to public services, and the lack of social networks and support are not uncommon for these workers [17]. Consequently, they are amongst the most vulnerable persons in society.

IWWs are also often from distinct social groups or ethnic minorities that are marginalized [17]. Our study found that stigma and discrimination associated with waste work is prevalent; discrimination and social exclusion of waste workers in Nepal has also been previously reported [8, 18]. The marginalization and discrimination faced by IWWs further compounds the physical risks experienced with additional mental and emotional stresses. The discrimination experienced is further augmented by identity politics. Many IWWs were migrant workers from India and from the Madhesh region in Nepal. Despite almost half of Nepal's population living in the Terai region [19], referred to as the 'Madhesh', a common assumption is that *Madhesis* are Indian. This arises from the sociological identity lens that implicitly separate the *Madheshi* (from the other Nepali) and understand them as 'people of Indian origin' [20,21] because of the cultural similarities and cross-border connections they share with neighbouring India. The Madheshi are frequently assumed to be migrants and not "true" Nepalis. The stereotypes associated with being a Madheshi are then used as a reason for bullying people coming from and belonging to the 'Madhesh'. Firm steps against discriminatory acts against the IWWs are needed to minimize the adverse effects on them.

Although the *informal* waste workers of our study recognized the danger of common physical ailments, needle prick injuries and metal cuts during waste work, they seemed unaware of the potential risks from hazardous chemicals and from blood-borne infections. This echoes findings from study conducted by Marahatta et al. of a similar lack of awareness and lack of effective safety mechanisms in the *formal* (municipal) waste sector in Nepal [22]. It appears that 'visible' physical health risks are more acutely perceived than those risks that are not visible or have a long latency and chronicity to them. Indeed, the latter may pose a more life-threatening risk to IWWs than they realize, e.g. cancers, heavy metal poisoning, Hepatitis B or HIV infection [15]. This highlights a potential knowledge and awareness gap. Interventions that can effectively address this gap in knowledge and awareness, such as 'educative skill-raising trainings' [23] may be helpful. Effective risk communication to informal waste workers are recommended to mitigate risks and promote better health and safety practice [24].

Informal waste workers scavenge or carry out basic recycling processes with little protection. Many of their risk mitigation measures articulated in this study are unlikely to adequately protect them. Although it is difficult to accurately estimate the level of protection IWWs have, it is likely to be poor. Not only is their understanding of protection and of PPE limited, how the protections are reportedly used were also highly inconsistent [25]. Our study found that the use of PPE for safety is neither a priority nor normal practice amongst IWWs in Nepal. Risk perception

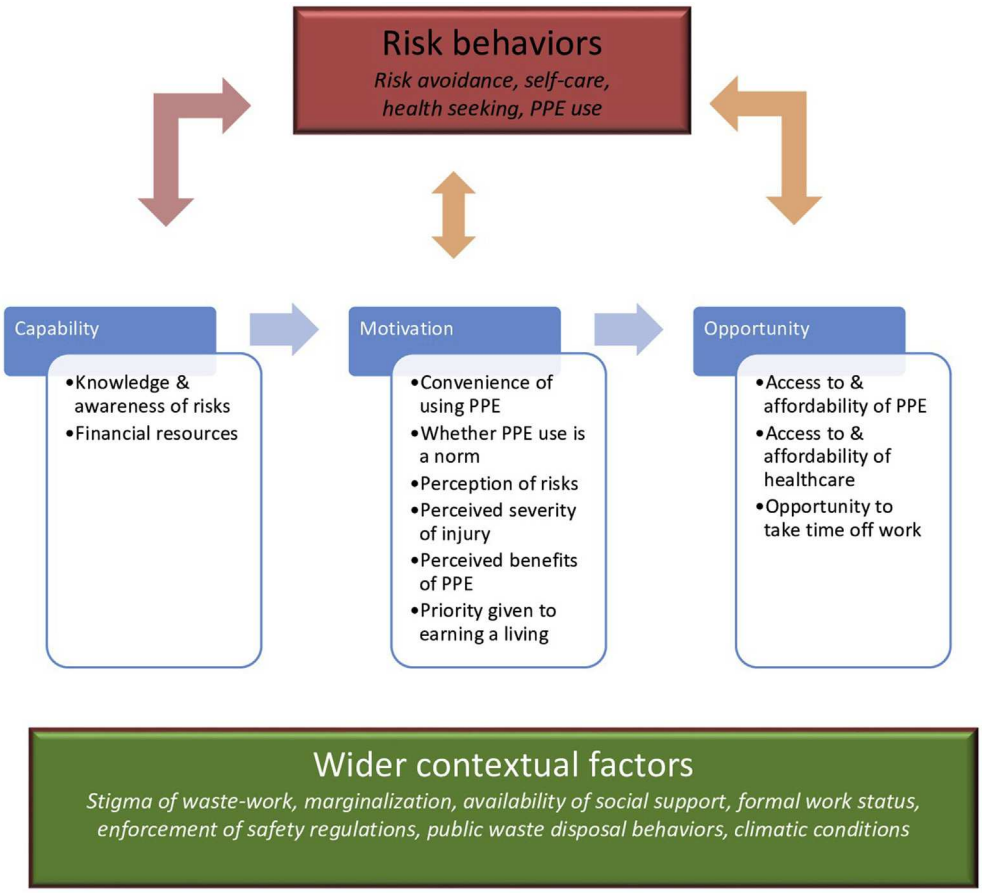

Fig. 2. Vulnerability determinants for informal waste-workers.

and thereby risk mitigation behaviour is influenced by what is important within the life of each individual IWW. Destitute IWWs are likely to prioritize the need to generate income over their personal safety. Their vulnerability can be summarized as in Fig. 2, as adapted from the COM-B behaviour change model [26].

In many developing countries, wastes are dumped indiscriminately and unsorted. In order to reduce the potential hazard of wastes, proper waste segregation has been advocated [14,15]. However, despite the Government of Nepal passing the Solid Waste Management Act 2011 [27] mandating 'waste segregation at source', it is poorly implemented [3]. Consequently, IWWs may be exposed to many biological and chemical risks (for example, different vapours, smoke, fumes, dust, chemical substances and infectious materials) [28]. The hazards posed are significant. Interventions that can minimize 'direct exposure' to wastes are critical. These prevention interventions could include, for example, family education, home visits and communication, establishing formal recycle centres [23,24,29], at source segregation as well as PPE provision for the IWWs. In addition, strong mechanisms to regulate hazardous waste and medical wastes are needed. The legalization of IWWs' status and their incorporation in the municipal waste-management system have also been suggested as ways to reduce harassment towards waste workers and to improve their health and safety at work [30]. What also emerged from our study was the need for further research to ascertain whether individual level interventions around risk perception and protection behaviours would be more efficacious compared to regulatory mechanisms or societal interventions that address waste disposal practices.

4.1. Limitations of the study

There are inherent limitations associated with any self-reported data. For example, there is the possibility of attributing positive events and outcomes to one's own agency, but attributing negative events and outcomes to external forces. Similarly, exaggerating the outcomes or embellishing events as more significant than it is in actuality. Some of the interviews were conducted in the IWWs workplace settings which could potentially introduce respondent bias for fear of any recriminations from their employers. The interviews were conducted in Nepali and translated prior to coding. Although there is a possibility that some cultural context might have been lost in the translation, this was minimized through the use of Nepali researchers to conduct the interviews and lead on the data analysis. Additionally, as the interviews were conducted in Nepali, Indian IWWs may have found it less easy or comfortable to communicate in. The Indian IWWs may also have been less willing to speak out because of their migrant status. Wherever possible, a private space was sought for the interviews to mitigate these limitations, but this was not always possible as the participants may have felt under duress to earn their daily income and to carry on working in their workplaces. It is also important is note that this study was conducted alongside a broader project supporting IWWs implemented by PHASE Nepal and MdM Nepal. IWWs were therefore likely to be familiar with the organisation. While this made recruitment easier, it might have influenced participants' responses. That said, the researchers were not involved in project implementation and did not know the IWWs beforehand.

5. Conclusions

Most citizens do not give a second thought to what happens to their rubbish that somewhere down the line may be placing others at risk. The occupational risks experienced by informal waste workers are considerable, in part exacerbated by the lack of safeguards, awareness and means to protect themselves, particularly in low- and middle-income countries. Their vulnerability is multifaceted and it is likely that a range of policy and regulatory measures are required in addition to interventions that promote greater social inclusion and occupational support are needed. Their work recycling and reusing waste has considerable environmental and societal economic benefits. Informal waste workers perform a hidden public service that deserves greater recognition and protection.

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Ethical approval

Ethical approval for this study was received from Nepal Health Research Council, Kathmandu, Nepal.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Nita Chaudhuri and **Astrid Foster-Heckman** are the employees at Médecins du Monde, the funding organisation. **Andrew Lee** is the editor of the journal of Public Health in Practice. The other authors declare that they have no conflict of interest to disclose.

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References

[1] M.A. Franklin, Solid Waste Stream Characteristics, Handbook of solid waste management, 2003, 3-1.
[2] M.B. Dangi, C.R. Pretz, M.A. Urynowicz, K.G. Gerow, J.M. Reddy, Municipal solid waste generation in Kathmandu, Nepal, J. Environ. Manag. 92 (1) (2011) 240–249, https://doi.org/10.1016/j.jenvman.2010.09.005.
[3] M.B. Dangi, E. Schoenberger, J.J. Boland, Assessment of environmental policy implementation in solid waste management in Kathmandu, Nepal, Waste Manag. Res. 35 (6) (2017) 618–626, https://doi.org/10.1177/0734242X17699683.
[4] M.B. Dangi, E. Schoenberger, J.J. Boland, Foreign aid in waste management: a case of Kathmandu, Nepal, Habitat Int. 49 (2015) 393–402, https://doi.org/10.1016/j.habitatint.2015.06.010.
[5] C. Rijal, A. Kishor, N.K. Bhattarai, A Study on the Collection of Waste PET Bottles in the Kathmandu Valley. Kathmandu: Himalayan Climate Initiative, 2014 November [Internet] [cited 2019 December 30]. Available from, http://www.himalayanclimate.org/images/projectMultipleSubPage/GaHteA%20Study%20%20on%20Waste%20PET%20Botlles%20-%20internal%20doc1.pdf.
[6] M.B. Dangi, R.R. Cohen, M.A. Urynowicz, K.N. Poudyal, Report: searching for a way to sustainability: technical and policy analyses of solid waste issues in Kathmandu, Waste Manag. Res. 27 (3) (2009) 295e301, https://doi.org/10.1177/0734242X08094951.
[7] R. Agarwala, Informal workers' struggles in eight countries, Brown J. World Aff. 20 (2013) 251 [Internet] [cited 2019 December 30]. Available at, https://krieger.jhu.edu/sociology/wp-content/uploads/sites/28/2012/02/Informal-Workers-Struggles-in-Eight-Countries.pdf.
[8] M. Black, J. Karki, A.C.K. Lee, P. Makai, Y.R. Baral, E.I. Kritsotakis, A. Bernier, A. Fossier Heckmann, The health risks of informal waste workers in the Kathmandu Valley: a cross-sectional survey, Publ. Health 166 (2019) 10–18, https://doi.org/10.1016/j.puhe.2018.09.026.
[9] S.K. Gibson, Social learning (cognitive) theory and implications for human resource development, Adv. Develop. Hum. Resour. 6 (2) (2004) 193–210, https://doi.org/10.1177/1523422304263429.

[10] D.R. Thomas, A general inductive approach for analyzing qualitative evaluation data, Am. J. Eval. 27 (2) (2006) 237–246.
[11] J. Karki, et al., Qualitative Study: Perceptions of risks and risks mitigation strategies in waste workers in Nepal. Scientific Report, in: Médecins du Monde, PHASE Nepal & The University of Sheffield, 2019.
[12] I.C. Nnorom, O. Osibanjo, Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries, Resour. Conserv. Recycl. 52 (6) (2008 Apr 1) 843–858, https://doi.org/10.1016/j.resconrec.2008.01.004.
[13] O.O. Oguntoyinbo, Informal waste management system in Nigeria and barriers to an inclusive modern waste management system: a review, Publ. Health 126 (5) (2012 May 1) 441–447, https://doi.org/10.1016/j.puhe.2012.01.030.
[14] H. Yang, M. Ma, J.R. Thompson, R.J. Flower, Waste management, informal recycling, environmental pollution and public health, J. Epidemiol. Community Health 72 (3) (2018 Mar 1) 237–243, https://doi.org/10.1136/jech-2016-208597.
[15] A.K. Ziraba, T.N. Haregu, B. Mberu, A review and framework for understanding the potential impact of poor solid waste management on health in developing countries, Arch. Publ. Health 74 (1) (2016 Dec) 55, https://doi.org/10.1186/s13690-016-0166-4.
[16] J. Gutberlet, A.M. Baeder, Informal recycling and occupational health in Santo André, Brazil, Int. J. Environ. Health Res. 18 (1) (2008 Feb 1) 1–5, https://doi.org/10.1080/09603120701844258.
[17] D.C. Wilson, C. Velis, C. Cheeseman, Role of informal sector recycling in waste management in developing countries, Habitat Int. 30 (4) (2006 Dec 1) 797–808, https://doi.org/10.1016/j.habitatint.2005.09.005.
[18] P. Gautam, Social life cycle assessment of solid waste management in Kathmandu City Nepal, in: Proceedings of the Life Cycle Management 2011 Conference, Berlin, 2011 [Internet] [cited 2019 December 25] [Available from, https://pdfs.semanticscholar.org/3ca0/e645208e3ae5d318d235c953741a3cf002bd.pdf.
[19] Population National, Housing Census, National Report Volume I. Kathmandu, Nepal, vol. 2011, Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal, 2011.
[20] C.P. Singh, Origin and development of Madheshi movement in Nepal, Proceedings of the Indian History Congress: January 72 (2011) 1047–1053.
[21] M. Subedi, T.R. Gautam, How homogenous are the Madhesis? Implications for inclusive and affirmative agendas, Journal of Development and Administrative Studies 24 (2016) 25–38, https://doi.org/10.3126/jodas.v24i1-2.19665.
[22] S.B. Marahatta, D. Katuwl, S. Adhikari, K. Rijal, Knowledge on occupational health hazard and safety practices among the municipal solid waste handler, JMMIHS 3 (1) (2017) 56–72, https://doi.org/10.3126/jmmihs.v3i1.19179.
[23] G. Hosny, S. Samir, R. El-Sharkawy, An intervention significantly improve medical waste handling and management: a consequence of raising knowledge and practical skills of health care workers, Int. J. Health Sci. 12 (4) (2018) 56.
[24] M.O. Asibey, O. Amponsah, V. Yeboah, Solid waste management in informal urban neighbourhoods. Occupational safety and health practices among tricycle operators in Kumasi, Ghana, Int. J. Environ. Res. 29 (6) (2019) 702–717, https://doi.org/10.1080/09603123.2019.1569211.
[25] C. Ohajinwa, P. Van Bodegom, M. Vijver, W. Peijnenburg, Health risks awareness of electronic waste workers in the informal sector in Nigeria, Int. J. Environ. Res. Publ. Health 14 (8) (2017 Aug) 911, https://doi.org/10.3390/ijerph14080911.
[26] S. Michie, L. Atkins, R. West, The Behaviour Change Wheel. A Guide to Designing Interventions, first ed., Silverback Publishing, Great Britain, 2014, pp. 1003–1010.
[27] Government of Nepal, Solid waste management act [Internet] Cited at December 30, 2019 Available from, http://extwprlegs1.fao.org/docs/pdf/nep137767.pdf, 2011.
[28] S. Laitinen, T. Rantio, Exposure to Dangerous Substances in the Waste Management Sector, Finnish Institute of Occupational Health, Finland, 2016.
[29] M. Heacock, B. Trottier, S. Adhikary, K.A. Asante, N. Basu, M.N. Brune, J. Caravanos, D. Carpenter, D. Cazabon, P. Chakraborty, A. Chen, Prevention-intervention strategies to reduce exposure to e-waste, Rev. Environ. Health 33 (2) (2018) 219–228, 2018.
[30] B. Gonzenbach, A. Coad, Solid waste management and the Millennium Development Goals, Collaborative Working Group on Solid Waste Management in Low-And Middle-Income Countries, 2007, p. 34. St. Gallen, Switzerland.