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Risk exposure to SARS-CoV-2 and workers' risk perception in non-healthcare setting in Hong Kong, Nanjing and Wuhan: A qualitative multi-site study

Exposición al SARS-CoV-2 y la percepción del riesgo de los trabajadores en entornos no sanitarios de Hong Kong, Nanjing y Wuhan: Un estudio cualitativo multisitio

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Abstract

Introducción: Understanding risk perception that hinges on health-protective behaviors is central to strategies for prevention.

Aim: To classify the pattern of potential risk of worker exposure to SARS-CoV-2, and to assess its association with risk perception among non-healthcare workers in Hong Kong, Nanjing and Wuhan.

Methods: In a multi-site, qualitative study, we conducted individual in-depth interviews and mini focus group discussions with employees (without supervisory role), managerial staff and self-employees from Hong Kong (n=87), Nanjing (n=60), and Wuhan (n=60) between June 2020 and March 2021. Audios were transcribed and categorized by themes following Grounded Theory approach.

Results: We identified seven major types (Type A-G) of potential risk exposure pattern by category of parameters. The risk perceptions decreased among Type A workers, working at fixed location in office, and no/little contacts with clients/customers, and increased among workers having the concern of asymptomatic characteristics of SAR-CoV-2, daily contact with large size of the unfamiliar crowds, unhygienic behaviors of clients/customers, and use of public transportation to commute to work. The notion that the sense of safety deriving from the implementation and adherence with safety measures despite stringency, and trust with the government was most frequently reported in Nanjing and Wuhan.

Conclusion: This study examines COVID-19 risks and risk perceptions among non-healthcare workers in Hong Kong, Nanjing, and Wuhan. Variations in risk perceptions were found, influenced by factors such as work patterns and safety measures. Trust in government and concerns about international contacts were common themes. The findings emphasize the need for targeted interventions, mental health support, and inclusive policies to address occupational health disparities and promote workplace safety.

Resumen

Introducción: Comprender la percepción del riesgo que condiciona conductas de protección de la salud es fundamental para la prevención.

Objetivo: Clasificar el patrón del riesgo de exposición de los trabajadores al SRAS-CoV-2 y su asociación con la percepción del riesgo entre los trabajadores no sanitarios.

Métodos: Estudio cualitativo multisitio. Realizamos entrevistas en profundidad y minigrupos de discusión con empleados, personal directivo y autoempleados de Hong Kong (n=87), Nanjing (n=60) y Wuhan (n=60) -junio 2020-marzo 2021-. Los audios se transcribieron y clasificaron por temas con enfoque de la teoría fundamentada.

Resultados: Se identificaron siete tipos de patrón de exposición (Tipo A-G) al riesgo potencial. Las percepciones de riesgo disminuyeron entre trabajadores de tipo A que trabajaban en oficina y sin contacto con clientes y aumentaron entre trabajadores preocupados por características asintomáticas del SAR-CoV-2, contacto diario con multitudes, comportamientos antihigiénicos de clientes y uso de transporte público para ir al trabajo. La sensación de seguridad por aplicación y cumplimiento de medidas de seguridad y la confianza en el gobierno fue más frecuente en Nanjing y Wuhan.

Conclusiones: Se hallaron variaciones en las percepciones del riesgo, influidas por factores como pautas de trabajo y medidas de seguridad. Fueron comunes la confianza en el gobierno y la preocupación por los contactos internacionales. Se requieren intervenciones específicas, apoyo a la salud mental y políticas integradoras para abordar las disparidades en salud laboral y promover la seguridad en el lugar de trabajo

Key Study Facts

Objective	To construct a theoretical framework for the risk exposure and perception patterns among non-healthcare workers during Covid-19
Study design	A multi-site qulitative study
Source of data	Participants were recruited from online platforms, private firms and the Wuhan Occupational Disease Prevention and Control Institute
Population/Sample	Participants were recruited in Hong Kong (n=87), Nanjing (n=60) and Wuhan (n=60).
Statistical analysis	Grounded theory approach
Main finding	There are seven types of potential exposure patterns classified by environment, working locations, contact with workmates, and contact with customers/clients. Stringent safety measure implementation and adherence, coupled with the sense of trust towards the government, determine the risk perception

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Introduction

The Coronavirus Disease 2019 (COVID-19), first emerged in Wuhan, China, in December 2019, caused by the SARS-CoV-2 virus. Since then, it has spread globally, infecting millions of people and resulting in a significant number of deaths. At the time of writing, there have been174,425,356 confirmed cases and nearly 3.8 million deaths worldwide (1). The transmission of the virus primarily occurs through direct, indirect, or close contact with infected individuals, mainly through respiratory droplets (2,3). This has led to challenges across various occupations, with frontline healthcare workers being particularly susceptible (4-6).

While healthcare workers have been recognized as having a heightened risk of exposure to COVID-19, there is growing evidence that non-healthcare workers, especially those in frontline and essential roles, also face increased occupational risks (7-9). Recent research has shown that low-skilled, essential, or frontline workers are particularly vulnerable to exposure (10). Outbreaks have been found in sectors such as manufacturing, construction, wholesale trade, tourism, retail and hospitality, transport and security, and food packaging and processing, in factories and office settings among the EU countries, as well as Utah and Sinapore (11-13).

Accessing the level of risk exposure is important for guiding occupational health and management plans. However, currently there is no consensus on the classification of occupational risk factors for COVID-19. The World Health Organization (WHO) (14) and Occupational Safety and Health Administration (OSHA) (15) provide 4-tier risk-exposure levels (i.e., low, medium, high, and very high) based on the level of contacts and extant of exposure involved in occupational activities. Some governments, such as Australia, emphasize the need to consider business-specific risks beyond general risk assessments, while the European Agency takes a sector-specific approach to identify risk factors (16,17). However, there is a lack of standardized parameters for classifying risk factors applicable across different settings.

Risk perception plays a crucial role in determining individuals' health-protective behaviors and strategies for preventing and controlling infectious diseases (18,19). Factors including hazard features, knowledge, personal experience and social norms can shape an individual's perception of risk (20-22). Existing literature afford the attention to risk perception regarding to COVID-19 in healthcare setting (23-25), however, little work has been focused on the non-healthcare setting. In this study, we aim to identify, analyze and present a classification of exposure risk of workers to SARS-CoV-2, and to assess its association to risk perception among non-healthcare workers located in Hong Kong, Nanjing, and Wuhan. This study is useful for developing a comprehensive COVID-specific preventive protocol for risk exposure assessment and management, informing workplace safety policies, and facilitating future risk communication efforts based on the experiences of workers from various industries.

Materials and Methods

Study design

Qualitative methods are effective strategies for exploring and understanding complex social phenomenon in the context of health. This study was administered in individual in-depth interviews (IDI) that prompts detailed responses and focus group discussions (FGD) that ensures a collection of multiple perspectives. A combination of both was designed to complement each other. By convention that FGD is a group composing between six and eight participants (26), we limited the size to two as mini FGD, a relevant strategy in qualitative research design (27), in respect to complying to social distancing rules implemented at each city, and to ensure safety and protection of our participants.

Study sites

The three cities are selected based on a diversity of their geographic regions (Table 1) and

Table 1. Geographical descriptions and industries of study settings

Location	Hong Kong [#1]	Nanjing [#2]	Wuhan [#3]
	Southern coast of China	**East region**	**Central region**
Population	7.5 m	8.5 m	over 8 .9 m
Population density	17,311 people /sq mi	3,183 people /sq mi	3,200 people /sq mi
Geographical features	Several cross-border checkpoints connecting with Shenzhen in China	Interlinked to other major cities, such as Shanghai, Hangzhou, Wuhan, Beijing and Tianjin, by intercity commuter rail service and high-speed rail	Railway network serves as the Railway Hub in connecting varied major cities in China
Key industries	Financial services, tourism, trading and logistics, and professional services and other producer services	Iron-and-steel, finance, tourism, textiles, food processing and other light industries	Automotive, technology, chemicals, engineering manufacturing, life sciences, and retail

Sources: #1. The Government of Hong Kong Special Administrative Region. Hong Kong: The facts. Employment. Available from: https://www.gov.hk/en/about/abouthk/factsheets/docs/employment.pdf. #2. Nanjing Population Demographics. Available from: https://worldpopulationreview.com/world-cities/nanjing-population. #3. Wuhan Population Demographics. Available from: https://worldpopulationreview.com/world-cities/wuhan-population

epidemiological situations. Epidemiologically, the first COVID-19 case was reported in Wuhan in December 2019, and it has swiftly emerged as the epicenter that has cases spiraled to 50,363 people and caused 3,869 deaths in the city (28). To battle against the virus, the central government of China imposed a lockdown in Wuhan and other cities in Hubei since 23 January 2020. Nanjing has a relatively low COVID-19 incidence (93 cases and zero deaths), with preventive and control measures are in place throughout the outbreak (29). Hong Kong, a city deeply scared by the SARS outbreak that killed 299 back in 2003, public health measures are in place since the first COVID-19 case reported in January 2020. It has accumulated infected cases of 11,881, and 210 deaths (as of 15 June 2021) (30).

Recruitment

Participants meeting the following criteria: (1) adults at age of 18 or above, with (2) full-time or part-time job status, and (3) have been working for a period of more than one month at the time of the conduction of the study, were purposively sampled. We recruited managers (supervisor, department in-charge) and employees (without supervisory role) from 17 industrial sectors, representing both the managerial and frontline role of industries for qualitative interviews.

In Hong Kong, participants were recruited by engaging a collaborated workplace representative group, which disseminated the Study Information and referred those who expressed interest to our research team for interview arrangement. Additional recruitment strategies were adopted approximately two months following the initiation of the study, to maximize enrolment. Online recruitment by advertising in social media platform (i.e., Instagram), and a snowball sampling procedure were integrated. Willing and eligible participants were invited to participate. Similar recruitment strategies were adopted in the other two cities. We engaged private firms in Nanjing, We invited eligible and interested workers, who attended the Wuhan Occupational Disease Prevention and Control Institute for health examination, to join this study. Snowball sampling has been used to reach the hard-to-reach targeted industries in these two cities.

Ethics approval

This study was approved by Survey and Behavioural Research Ethics Committee in Hong Kong (Reference No. SBRE-19-792); Ethics and Human Subject committee of Nanjing Medical University (Reference No.: [2020]554) in Nanjing; and Ethics and Human Subject committee of Tongji Medical College, Huazhong University of Science and Technology (Reference No.: [2020] S212) in Wuhan. Conduct of the study was in compliance with the Declaration of Helsinki.

Data collection procedures

A semi-structured interview guide was developed on the basis of relevant literature (31), and research experiences of Research Team members to ensure consistency. It was composed of four subtopics to address workers' experience during COVID-19 namely: (i) knowledge of COVID-19; (ii) risk perception of COVID-19 in the workplace; (iii) experiences and views towards safety measures implemented in the workplace; and (iv) views towards the role of employer and government in protecting workers' safety, using open-ended questions. Probes regarding site-specific questions were used to clarify and elaborate their experiences and views. Training sessions on qualitative study for the Research Team members across three cities had been provided online. Following written informed consent procedure, IDI and mini FGD were primarily conducted in the meeting room of the workplace representative group and research institutes. They were conducted by interviewers: research investigators, research assistants and student helpers based in the 3 cities. Our data collection method evolved as using face-to-face modality became a major challenge during the pandemic. Phone and online interviewing (i.e., zoom, facetime) were conducted with those who preferred suspension of in-person contact due to the threat of the virus. We applied various approaches to ensure data collected through phone and online modes were compatible with that of the face-to-face: (i) allowing sufficient length of time that resembles closest to face-to-face mode; (iii) audio-recording the interviews to obtain the same types of data (i.e., audio) for transcription. They were conducted in the language of Cantonese, a local dialect in Hong Kong, and

Mandarin in Wuhan and Nanjing. Each IDI and mini FGD, lasted around 20-60 minutes and 30-90 minutes respectively, were audiotaped. Participants in HK received HK$100 (~US$13) supermarket coupon, whereas those in Nanjing and Wuhan received a small gift valued at RMB 90-100 (~US$14-15) as a token of appreciation. Data collection continued until saturation has been reached to ensure that diverse views from each study site were represented.

Data analysis

Audios were transcribed verbatim in Chinese, and reviewed by cross-city research assistants and student helpers who were native speakers of the language. An experienced qualitative researcher supervised data analysis that includes the following procedures. We began by developing a coding framework based on pre-defined categories of risk exposure pattern, risk perception and safety concerns. Three rounds (a total of nine transcripts from three cities) of coding process were conducted through engaging six Research Team members (two from each city) who had been trained with qualitative data analysis. The codebook was progressively refined by stages, with approximately 85% intercoder reliability [ref] achieved upon completion of the third round of coding. The refined coding framework was used to code the remaining transcripts. Cleaned transcripts were entered in NVivo 12 qualitative data analysis software for data management and coding. In particular, the categorization of risk exposure pattern was referred to scientific evidence [ref] to determine how the detailed information to be classified. The pattern of potential risk exposure built were compared and contrasted to the risk perception and safety concerns by themes, within and between the three cities, following the Grounded Theory approach (32). The analytical process was reiterative, involving data saturation assessment, discussion and agreement between Research Team members towards a generation of themes.

Results

Participants' characteristics

A total of 207 workers between June 2020 and March 2021 across three cities participated our qualitative study, with 183 IDI and 12 mini FGD were held with 87 participants in Hong Kong (14 declined, 4 not reachable), 60 in Nanjing (36 declined, 9 not reachable), and 60 in Wuhan (12 declined, 1 not reachable). Of 207 participants, 60.4% were employees (without supervisory role), 27.5% managerial staff and 12.1% self-employees. Participants' demographics were similar across sites (Table 2).

Classification of potential risk exposure pattern

Potential risks of worker exposure to SARS-CoV-2 were identified based on qualitative accounts detailed by our participants. They were classified by category and sub-category of parameters including environment, locations, contact with workmates, and contact with clients/customers, which were then further classified into subtypes based on intensity of contact (i.e., frequencies and duration). (Table 3).

Association between potential risk exposure pattern and risk perception in Hong Kong

This section focused on workers' perception of risks associated with the potential risk exposure pattern (Table 4). The risk perception appears to be relatively lower for Type A than the remaining types, with a majority reporting low to medium level. Reasons: They felt safer for being non-frontline staff without the need to contact with the public (Q1). They were also pleased with the quantity and extent of measures, particularly the work-from-home policies (Q2), and workmate's willingness to adhered to measures in helping to maintaining workplace safety (Q3).

The perceived risk level for Type B ranged between medium and high. Reasons: Concerns about materials they touched and working environments they were exposed to. Cleaners working in various settings (i.e., domestic homes, office buildings and hotels),sub-type B2,expressed a sense of helplessness due to the frequent handling of potentially contaminated (Q4). They also considered working in a garbage room without proper ventilation system to be a high-risk setting (Q5). For sub-type B1, Interior Decorators felt safer at their workplace because of their safe work habits, such as refraining from work while unwell, and their habitual practice of hand hygiene. Additionally, a product packaging worker trusted the current good safety practices and believed that the work environment adequately protected her against the coronavirus (Q6). However, concerns about transmission risk via taking public transportation to work were extensively discussed within this group (Q7).

Type C reported a wide range of perceived risk levels, varying from medium to very high. Reasons: Trust in the use of face masks (Q8) and the ability to adhere to protective measures (Q9). These reasons were commonly reported by cloth manufacturer and retailers, sales, and cashiers. The Cloth Manufacturer and Retailers, in particular, felt less threatened by COVID-19 due to their familiarity with their customers. However, participants at younger age and receiving higher education in this sub-type more frequently expressed worries about the asymptomatic nature of SAR-CoV-2, despite the implementation of thorough precautionary measures in their work settings (Q10).

Overall, Type D had a low to very low level of perceived risk. Despite providing close-contact services, Masseurs, Hairdressers, Ice-skating Instructor, and Yoga Teacher expressed high levels of confidence in their work. They trusted the contacted customers (i) who were small in quantity (Q11), and (ii) with ability to adhere with face covering and hand hygiene (Q12). The beauticians, however, held differing viewpoints, as they were concerned about the potential health risks posted by customers with extensive social connections (Q13).

Most responses for Type E fell between medium- and high-level risk perception. Reasons: The most common recurring theme among these workers was the contact they had with a large number of people in inherently crowded and busy work settings. Teachers from sub-type E2 felt they were at higher risk than other professional job roles due to the challenges of maintaining physical distancing among young teens in school settings (Q14). Workers in childcare settings expressed intense stress from helping children to with mask usage during tea breaks, where strict adherence to

Table 2. Sociodemographic of participants in three cities

Characteristics	Hong Kong (N= 87)		Nanjing (N= 60)		Wuhan (N= 60)	
	n	%	n	%	n	%
Gender						
Female	45	51.7	31	51.7	24	40.0
Male	42	48.3	29	48.3	36	60.0
Age (years)						
18-29	13	15.0	15	25.0	12	20.0
30-39	19	21.8	24	40.0	22	36.7
40-49	21	24.1	17	28.3	17	28.3
50-59	24	27.6	3	5.0	8	13.3
60+	10	11.5	1	1.7	1	1.7
Place of birth						
Hong Kong	76	87.4	0	0.0	0	0.0
Macau	1	1.1	0	0.0	0	0.0
Mainland	10	11.5	60	100.0	60	100.0
Marital Status						
Single	35	40.2	12	20.0	13	21.6
Married	49	56.4	48	80.0	46	76.7
Divorced	2	2.3	0	0.0	1	1.7
Widowed	1	1.1	0	0.0	0	0.0
Educational level						
Primary school	5	5.7	0	0.0	2	3.3
Secondary school	32	36.8	12	20.0	21	35.0
College or university	50	57.5	48	80.0	36	60.0
Unspecified	0	0.0	0	0.0	1	1.7
Employment status						
Employee (without supervisory role)	51	58.6	42	70.0	32	53.3
Managerial staff	17	19.6	16	26.7	24	40.0
Self-employee	19	21.8	2	3.3	4	6.7
Years of experience working in the industry						
<3	12	13.8	9	15.0	11	18.3
3 - 5	9	10.3	21	35.0	11	18.3
6 - 10	16	18.4	15	25.0	19	31.8
11 - 15	13	15.0	6	10.0	8	13.3
≥16	37	42.5	9	15.0	11	18.3
Monthly income*						
Low-ranged	19	21.8	1	1.7	6	10.0
Middle-ranged	37	42.5	17	28.3	23	38.3
High-ranged	30	34.5	42	70.0	30	50.0
Unspecified	1	1.2	0	0.0	1	1.7
Medical insurance						
Yes	60	69.0	59	98.3	55	91.7
No	27	31.0	1	1.7	5	8.3

Perceived health status						
Poor	0	0.0	0	0.0	0	0.0
Fair	22	25.3	3	5.0	10	16.6
Good	29	33.3	16	26.7	31	51.7
Very good	32	36.9	41	68.3	15	25.0
Extremely good	3	3.4	0	0.0	4	6.7
Unspecified	1	1.1	0	0.0	0	0.0
Chronic conditions						
Yes	26	29.9	9	15.0	16	26.7
No	61	70.1	51	85.0	44	73.3

*Classification of low- middle- and high-ranged incomes in Hong Kong is based on 2020 Report on Annual Earnings and Hours Survey [Source #1]: Low-ranged (<25th percentile) = ~HKD15,000 (~ USD1,900); Middle-ranged (25th-75th percentile) = ~HKD15,000-30,000 (~ USD2,400 - 3,900); High-ranged (>75th percentile) = ~HKD30,000 (~ USD3,900).

*Classification of low- middle- and high-ranged incomes in Nanjing and Wuhan is calculated with reference to 2021 Monthly Income Report in Nanjing [Source #2] and in Wuhan [Source #3]: Low-ranged (~ <25th percentile) = ~RMB3,000 (~ USD470); Middle-ranged (~ 25th-75th percentile) = ~RMB3,000-6,000 (~ USD470-930); High-ranged (~ >75th percentile) = ~RMB6,000 (~ USD930)

Sources: #1. 2020 Report on Annual Earnings and Hours Survey. Available from: https://www.censtatd.gov.hk/en/data/stat_report/product/B1050014/att/B10500142020AN20B0100.pdf. #2. 2021 Monthly Income Report in Nanjing. Available from: https://salarycalculator.sinaapp.com/report/%E5%8D%97%E4%BA%AC. #3 2021 Monthly Income Report in Wuhan. Available from: https://salarycalculator.sinaapp.com/report/%E6%AD%A6%E6%B1%89

Table 3. Classification of potential risk exposure pattern by parameters of environment, locations, contact with workmates, and contact with customers/clients

Environment	Locations	Contact with workmates	Contact with customers/clients
- Predominantly indoor	- Fixed location at the same premise (office)	- Brief and infrequent contact with small number (<10) on daily basis	- No/little contacts
- Mixed indoor and outdoor	- Fixed location at the same premise (non-office)	- Brief but frequent contact with large number (>10) on daily basis	- Brief but frequent contact with large number (>10) on daily basis
- Predominantly outdoor	- Varying locations of work at the same premise (non-office)	- Prolonged contact with variable number on irregular basis	- Frequent and prolonged close-contact
	- Varying locations of work and primarily outdoor at non-office setting	- No/little contacts	- Frequent contact with large number (> 10) with occasional prolonged contact with few of them on daily basis
	- Varying locations of work and primarily indoor of premises (e.g., office, shops, performing art centres, social service centres)	- Brief but frequent contact with small number (<10)	- Frequent but brief contact with a large number (> 10)
	- Varying locations of work and primarily indoor of people's homes	- Brief but frequent contact at variable number	
	- Varying locations of work and primarily inside vehicles	- Brief and infrequent contact at variable number	
	- Fixed location at the same site	- Frequent contact with large number (> 10) with occasional prolonged contact with few of them on daily basis	
		- Brief and infrequent contact with large number (> 10) on daily basis	
		- Brief but frequent contact with large number (>10) on daily basis	

sanitary measures for young children was not possible, (Q15).

Workers from this sub-type EI provided a more critical evaluation of their risks. They specifically pointing that contacting customers from abroad, as required by their job activities, could be a high-risk factor (Q16, Q17). They raised concerns about the potential for in-flight spread of the virus via indirect contact and shared air and environmental conditions (Q18). Despite the implementation of protective measures, occupations like Immigration Officers, Health Surveillance Assistant and Security Guard reported fear of being infected (Q19) and onward transmission to family members (Q20) when closure or work-from-home was not possible.

Workers from type F typically worked indoor and outdoor, often having face-to-face contact with many people in the public. Their risk perception also varied by types of risk exposure pattern as illustrated below:

• Sub-type F1 indicated their risk perception from low to medium level, which is the lowest within Type F. They were unconcerned about the risk of contracting the virus despite the size of the group of strangers they were in contact. Reason: They felt safer to work in outdoor where fully open spaces with fresh air were believed to dilute the virus (Q21). Additionally, they viewed outdoor masking required among the public as an effective measure in reducing transmission (Q22).

• Sub-type F2 rated their risk perception from medium to very-high-level. Reason: Reporters expressed fear of risk exposure through performing job tasks that required visiting different places including premises where COVID-19 cases were identified (Q23). A courier, on the other hand, was worried about handling disinfected materials that could have been touched by an infected person (Q24).

• Most of the participants from sub-type F3 believed they faced a low or medium level of risk. Reason: They were confident with the arrangements of work-from-home and staggering shifts and that their risks could be eliminated (Q25). An Opera Singer was pleased with the requirement of 72-hour pre-performance COVID-19 testing and the implementation of social distancing among the audience (Q26).

• Participants from sub-type F4, providing in-home services reported perceived medium-level of risk. Reason: Clear COVID-response plan and comprehensive safety measures outweighs the potential occupational risk. For example, Technicians providing in-home repair services felt safer to work with the support of clear guidelines and available protective resources (e.g., protective gear), even when working in homes customers were undergoing home isolation(Q27). Similarly, Social Workers providing in-home community services felt substantially safer due to measures that reduced contact-length and distance with long-term-care patients who were considered at risk of infection due to frequent visits to hospitals (Q28).

• F5: Reason: Our participants in occupation of Bus driver and Terminal supervisor reported a higher perceived potential exposure in enclosed spaces with central ventilation (Q29). The perceived threat of COVID-19 remained high because of the difficulty in dealing with passengers who refused to wear masks, especially when mask-wearing rules were not enforced in public (Q30). Participants also expressed concerns about the perceived lack of comprehensive safety measures implemented by their companies (Q31).

• Concerns about increased coronavirus risk via worker-worker contact was the most recurrent theme for sub-type F2 and F5, and Type G. And the most common concern of transmission via lunch (Q32), tea (Q33), or cigarette breaks (Q34), or day-to-day operations (Q35) were raised by participants in occupations of Reporter, Taxi driver and Construction Safety Supervisor and Terminus Supervisor respectively.

Association between potential risk exposure pattern and risk perception in Nanjing and Wuhan

We do not observe the link between workers' risk perception and potential risk exposure pattern in Nanjing and Wuhan. Overall, the majority of participants in Nanjing (80.0%) and Wuhan (68.3%) perceived themselves to be at low risk for COVID-19, but 15.0% in Nanjing and 28.3% in Wuhan felt they were at medium risk, and 5.0% in Nanjing and 3.4% in Wuhan perceived they were at high risk. Fewer concerns relating to job activities that required frequent worker-customer contact were reported among Nanjing and Wuhan than in Hong Kong. Concerns about worker-worker contact were also fewer in Nanjing and Wuhan than in Hong Kong. Reasons: There were more positive evaluations and trusts in the government's capability to respond to outbreaks at both local and central levels in Nanjing and Wuhan. The stringent measures implemented in these cities were seen as comprehensive and adequate in creating safe working environments (Q36, Q37). In particular, the introduction of closed management (Q38, Q39), division of areas in risk-levels (Q40, Q41), and the mandatory nationwide system of colored "Health Code" (Q42, Q43) governing everyday life of people in were considered effective in curbing the virus in the community level. Workers in these two cities reported high adherence to other measures as well, including regular COVID-19 testing at the workplace (Q44, Q45), isolation rooms for suspected cases in work premises (Q46. Q47), monitoring of dining-in services in staff canteens (Q48, Q49), and the use of shuttle bus services to reduce risk exposure during commuting (Q50, Q51).

However, distrust in the capability and use of the strategies in managing the risks by the government was frequently reported in Hong Kong, especially regarding border management (Q52), and the scarce supply of anti-COVID resources at the beginning of the outbreak (Q53). Many workers in Hong Kong expected prompt responses from the government, drawing from the lessons learned during the SARS outbreak (Q54), and some were expecting government to increase efforts to bring self-employees, who were often exclusive from organizational assistance, back to work safely (Q55).

Across three cities, the vast majority of workers embraced mask-wearing, social distancing and hand hygiene as the key measures for risk reduction (Q56, Q57, Q58). While the effectiveness of mask-wearing was widely discussed, participants in all three cities reported high adherence (Q59, Q60), with a few in Hong Kong expressing doubts due to perceived uncontrollability of local and overseas outbreaks (Q61). Workers in Wuhan and Nanjing felt

Table 4. Workers' risk perception by types of potential risk exposure pattern

		Hong Kong		Nanjing		Wuhan	
		Occupation	**PR***	**Occupation**	**PR***	**Occupation**	**PR***
A1	Environment:	Bank Staff	VH	Administrative Officer	L	Manager (Public Utility)	M
	Predominantly indoor	Clerks of Works	M	Designer	L	Manager (Public Utility)	M
	Locations:	Coordinator (Public Utility)	M	Engineer (Telecommunication)	L	Shop Owner (Printing)	M
	Fixed location at the same premise (office)	Director	L	Financial Manager	L		
	Contact with workmates:	Immigration Officer	M	Financial Manager	L		
	Brief and infrequent contact with small number (<10) on daily basis	Quality Assurance Controller (Food Industry)	M	Manager (Public Utility)	L		
	Contact with customers/ clients:	Supplies Officer	L	Office Clerk	L		
	No/little contacts	Supplies Officer	L	Phone Sales	L		
				Phone Sales	L		
				Programmer	L		
				Property Manager	L		
				Researcher	M		
				Risk Manager (Insurance Company)	L		
				Shop Owner (Printing)	M		
A2	Environment:	Housekeeping Supervisor (Hotel)	M	Customer Service Manager (Bank)	L	Administrative Staff (University)	M
	Predominantly indoor	Manager (Printing Company)	L	Engineer (Semi-Conductor)	L	Manager (Auto Company)	L
	Locations:	Manager (Social Service)	L	Human Resource Manager (Manufacturing Industry)	L	Manager (Cold Chain Company)	L
	Fixed location at the same premise (office)						
	Contact with workmates:	Museum Curator	M	Manager (Manufacturing Logistics)	L	Manager (Construction)	L
	Brief but frequent contact with large number (>10) on daily basis	Office Worker (Printing Company)	M	Manager (Telecommunication Company)	L	Manager (Construction)	L
	Contact with customers/ clients:	Senior Human Resource Officer (Insurance Company)	M	Office Clerk	L	Manager (Electromechanical Factory)	L
	No/little contacts			Office Clerk	L	Manager (Factory)	L
				Office Clerk	L	Manager (Food Factory)	L
				Programmer	L	Manager (Food Factory)	L
				Worker (Trading Industry)	L	Manager (Tech Company)	M

A2						Manager (Technical Department)	M
						Office Worker	M
						Office Worker	L
						Office Worker(Construction)	L
						Office Worker (Construction)	L
						Office Worker (Public Utility)	M
						Office Worker (Tech Company)	M
						Office Worker (University)	L
						Office Worker (University)	L
B1	Environment:	Dishwasher (Hotel)	H	Engineer (Machinery Industry)	L	Factory Worker	L
	Predominantly indoor						
	Locations:						
	Fixed location at the same premise (non-office)	Dishwasher (Hotel)	H	Engineer (Machinery Industry)	L	Factory Worker	L
	Contact with workmates:	Interior Decorator	M	Operator (Oil Refinery)	L	Factory Worker	L
	Prolonged contact with variable number on irregular basis	Interior Decorator	M	Operator (Oil Refinery)	L	Factory Worker	L
	Contact with customers/ clients:	Laundry Attendant (Hotel)	M	Worker (Auto Company)	M	Worker (Cold Chain Company)	L
	No/little contacts	Worker (Product Packaging)	H				
B2	Environment:	Cleaner	H				
	Predominantly indoor	Cleaner	H				
	Locations:	Local Domestic Helper	M				
	Fixed location at the same premise (non-office)	Local Domestic Helper	M				
	Contact with workmates:						
	No/little contacts						
	Contact with customers/ clients:						
	No/little contacts						
C	Environment:	Cashier (Restaurant)	M	Airport Temperature Screener	L	Sales (Accessories Shop)	L
	Predominantly indoor	Cloth Manufacturer and Retailer	L	Marketing Sales	M	Sales (Fruit Shop)	L
	Locations:	Cloth Manufacturer and Retailer	M	Receptionist (Hotel)	L	Sales (Fruit Shop)	L
	Fixed location at the same premise (non-office)	Receptionist (Dance Studio)	H	Vendor (Wet Market)	L	Sales (Fruit Shop)	L
	Contact with workmates:	Sales	VH			Sales (Printing Shop)	L

C	Brief but frequent contact with small number (<10)	Sales (Jewellery Shop)	M			Sales (Printing Shop)	L
	Contact with customers/ clients:	Sales (Jewellery Shop)	M			Shop Owner (Accessories)	L
	Brief but frequent contact with large number (>10) on daily basis					Shop Owner (Fruit)	L
						Shop Owner (Printing)	L
D	Environment:	Beautician	VH	Beautician	L		
	Predominantly indoor	Beautician	VH	Manager (Beauty Salon)	L		
	Locations:	Beautician	VL				
	Fixed location at the same premise (non-office)	Hairdresser	L				
	Contact with workmates:	Hairdresser	L				
	No/little contacts	Ice-skating Instructor	L				
	Contact with customers/ clients:	Masseur	L				
	Frequent and prolonged close-contact	Masseur	VL				
		Masseur	M				
		Yoga Teacher	L				
E1	Environment:	Manager (Coffee Shop)	M	Kindergarten Supervisor	L	Manager (Hotel)	M
	Predominantly indoor						
	Locations:						
	Varying locations of work at the same premise (non-office)	Primary School In-charge	H	Manager (Farmers' Market)	H	Manager (Restaurant)	M
	Contact with workmates:	Primary School Principal	M	Manager (Hotel)	H	Room Attendant (Hotel)	M
	Brief but frequent contact at variable number	Restaurant Owner	VL	Manager (Hotel)	L	Room Attendant (Hotel)	L
	Contact with customers/ clients:	Restaurant Owner	H	Manager (Restaurant)	L	Room Attendant (Hotel)	L
	Frequent contact with large number (> 10) with occasional prolonged contact with few of them on daily basis						
E2	Environment:	Crew	VH	Lecturer/Researcher	L	Lecturer	L
	Predominantly indoor	Crew	H	Teacher	L		
	Locations:	Crew	H	Teacher	L		
	Varying locations of work at the same premise (non-office)	Health Surveillance Assistant	H	Teacher	L		
	Contact with workmates:	Immigration Officer	L	Teacher (Kindergarten)	L		
	Brief and infrequent contact at variable number	Immigration Officer	M	Teacher (Kindergarten)	L		

E2	Contact with customers/ clients:	Lecturer (Part-time)	H				
	Frequent contact with large number (> 10) with occasional prolonged contact with few of them on daily basis	Receptionist and Waiter (Hotel)	M				
		Security Guard	H				
		Security Guard	L				
		Security Guard	H				
		Security Guard	M				
		Teacher (Kindergarten)	H				
		Teacher (Kindergarten)	VH				
		Teacher (Secondary School)	H				
		Teacher (Secondary School)	M				
F1	Environment:	Air-conditioning Maintenance Worker	M	Real Estate Agent	M		
	Mixed indoor and outdoor						
	Locations:						
	Varying locations of work and primarily outdoor at non-office setting						
	Contact with workmates:						
	No/little contacts	Broadband Technician	M	Real Estate Agent	L		
	Contact with customers/ clients:	Customer Service Assistant (Internet Provider)	L				
	Frequent but brief contact with a large number (> 10)	Real Estate Agent	M				
F2	Environment:	Courier	H	Courier	M	Courier	L
	Mixed indoor and outdoor						
	Locations:	Reporter	M	Courier	H	Courier	L
	Varying locations of work and primarily outdoor at non-office setting	Reporter	VH			Courier	L
	Contact with workmates:	Terminus Supervisor	H			Manager (Courier)	L
	Frequent contact with large number (> 10) with occasional prolonged contact with few of them on daily basis					Manager (Courier)	L
	Contact with customers/ clients:					Manager (Courier)	L
	Frequent but brief contact with a large number (> 10)						
F3	Environment:	Insurance Consultant	VL	Fireman	M	Village Party Branch Secretary	L

	Mixed indoor and outdoor	Insurance Consultant	VL	Fireman	M	Village Party Branch Secretary	L
F3	Locations:	Marketing Sales	H	Food Inspector	M	Village Worker	M
	Varying locations of work and primarily indoor of premises (e.g., office, shops, performing art centres, social service centres)	Opera Singer	M	Outreach Worker (Charity Group)	L		
	Contact with workmates:	Outsourcing Cleaning Service Owner	M	Public Administration Officer	L		
	Brief and infrequent contact with large number (> 10) on daily basis	Sales Manager	M				
	Contact with customers/ clients:	Social Worker (Community)	L				
	Frequent but brief contact with a large number (> 10)	Social Worker (Community)	M				
F4	Environment:	Engineer (Public Utility)	M	Community Manager	L	Community Manager	L
	Mixed indoor and outdoor						
	Locations:						
	Varying locations of work and primarily indoor of people's homes	Social Worker (Palliative Care)	M			Community Manager	H
	Contact with workmates:	Technician (Public Utility)	M			Community Worker	M
	Brief and infrequent contact with large number (> 10) on daily basis					Community Worker	M
	Contact with customers/ clients:					Community Worker	L
	Frequent but brief contact with a large number (> 10)					Worker (Public Utility)	M
F5	Environment:	Bus Driver	H	Taxi Driver	L		
	Mixed indoor and outdoor						
	Locations:						
	Varying locations of work and primarily inside vehicles						
	Contact with workmates:						
	Brief and infrequent contact with large number (> 10) on daily basis	Taxi Driver	VL				
	Contact with customers/ clients:	Taxi Driver	H				
	Frequent but brief contact with a large number (> 10)	Taxi Driver	H				
G	Environment:	Construction Safety Supervisor	L	Construction Safety Supervisor	L	Construction Worker	L
	Predominantly outdoor						

G	Locations:						
	Fixed location at the same site						
	Contact with workmates:						
	Brief but frequent contact with large number (>10) on daily basis						
	Contact with customers/ clients:	Hawker	L	Engineer (Construction)	L	Construction Worker	M
	No/little contacts			Engineer (Construction)	L	Farmer	H

*PR: = Perceived Risk. The perceived risk levels are rated in the scale of VH for "Very High", H for "High", M for "Medium", L for "Low" (L), and VL for "Very Low".

that their risk were substantially lowered due to the stabilized epidemiological situation, which encouraged them to continue adhering to preventive measures (Q62). Some workers in office environment even expressed confidence in removing their masks at work (Q63). While workers in Nanjing and Wuhan mostly believed in the role of the collective efforts of the staffs in reducing the occupational risks (Q64, Q65), those in Hong Kong emphasized the need for individual self-regulation as the cornerstone of a healthy workplace environment during the COVID-19 pandemic (Q66), despite pockets of concerns as illustrated in the last part of the Result section.

Workers in the three cities highlighted concerns about contact with customers from overseas, or/and workmates who had returned from business trips (Q67, Q68, Q69). These concerns were more prevalent in Hong Kong and Nanjing and less so in Wuhan. In Nanjing and Wuhan, the implementation of area divisions based on risk levels led to workers in certain occupations (e.g., taxi drivers, hotel receptionists, engineers) perceiving these interactions as risk factors due to higher chances of contact with customers or migrant workers from other regions of China (Q70, Q71). Couriers in Nanjing, Hong Kong, and to a lesser extent in Wuhan, expressed a high risk perception due to frequent handling packages during deliveries, which protective measures might not be able to provide adequate protection (Q72, Q73, Q74).

Overall, the interviewed workers in Nanjing and Wuhan, and to a lesser extent in Hong Kong, reported a sense of safety. Most workers in Nanjing and Wuhan expressed faith in their narratives. Those in Nanjing used the word, "confidence" to describe their feelings (at the time of data collection) because of the alleviation of risks by safety measures (Q75). A majority of workers in Wuhan has shifted from "deeply concerned" to "reassurance" and "confidence" due to perceived controllability despite the severe epidemic situation had occurred (Q76). A very few remained fear about infection or re-infection for the potential exposure to asymptomatic infection in which infected cases were often "silent" and "invisible" (Q77). In Hong Kong, a general sense of fear was observed among workers who perceived a medium to very-high level of risk, with the biggest fear arising from the probability of infecting their family members (Q78). Frontline workers (e.g., bus drivers, cleaners) reported sense of helplessness (Q79). Some of the other interviewees reported overwhelmed feelings of unpredictability and uncertainty caused by the asymptomatic nature of the coronavirus (Q80), the perceived uncontrollability of local outbreaks (Q81), and the lack of clear scientific evidence (Q82).

Discussion

This study represents a pioneering effort in assessing the occupational risks of COVID-19 among non-healthcare workers in Hong Kong, Nanjing, and Wuhan. This is the first study to assess COVID-19 occupational risks by categorizing risk factors into potential risk exposure patterns, and its association to risk perception among non-healthcare workers. Findings from this study show within- and between-site risk perceptions variation with discussing underlying reasons among workers. In Hong Kong, participants' risk perceptions were heterogenous differing by types of potential risk exposure pattern we classified and the safety measures available. In-office workers (Type A1 and A2), having the ability to work remotely, did not feel at risk. We suggest that these perceptions were derived from differences in feasibility of work-from-home option that fundamentally produced sense of safety. Working in office implies an access to telecommuting that allows workers to telework in another location. In contrast, participants providing essential work (e.g., cleaners, security guards, bus drivers, primarily from Type B2, E2, F5), reported high-level of perceived risk, with concern of handling waste that were potentially contaminated, or frequent contact with large number of unfamiliar persons in work setting that were inherently crowded and busy. Current studies have shown that knowledge (33), socio-economic differences (34) have an impact on perceived COVID-19 risk. Work-from-home occupations are more likely to experience high physical proximity that suggests health disparity in the COVID-19 context (35). In fact, studies in Sweden (36), the U.K. (37), and the US (38) show a mortality rate among frontline workers, and the lack of equipment and inability to fully practice social distance was one of the major causes (39,40). Essential workers rendering a large segment of workforce are, however, less able to meet remote-work feasibility conditions than their higher wage counterparts. Policy actions such as increased capacity to reach essential workers for COVID-19 testing and contact tracing, vaccine strategy, and needs assessment are urgently needed to narrow health inequality in the society.

Findings show a vast majority of participants in Nanjing and Wuhan perceived that they were at low risk, in contrast to those Hong Kong who perceived themselves at varied level of risk with a wide range of concerns. Our data shows generally positive views and high levels of sense of safety in Nanjing and Wuhan, with overall satisfaction with the comprehensive and rigorous safety measures undertaken

despite stringency. In contrast, many Hong Kong participants cited numerous examples of potential risk factors in the workplace, including poor ventilation, the needs to work in varied locations (e.g., visiting high-risk premises or provision of in-home services), workers-worker contact (e.g., lunch-, tea- or cigarette breaks), and worker-customer contact. Participants also provided reasons and explanations for high-perceived risk levels, which include the threat from asymptomatic characteristics of SAR-CoV-2, the fear about the large size of the unfamiliar crowds they were required in contact daily, unhygienic behaviors of clients/customers, and use of public transportation to commute to work. Despite overall low-perceived risk in Nanjing and Wuhan, the most common and important concern shared by the three cities was exposure via contact with customers from overseas or workmates returned from business travels. Concerns about contacting workmates from other regions of China was singled out in narratives from Nanjing and Wuhan. Such pattern of responses shows the fear of risk exposure via contacting "non-locals", residing in regions both within and outside of China, which shed lights on the rising concern on health risks arose from human mobility, hospitality and international business. While the spread of COVID-19 in China is substantially in control through drastic measures implemented (41,42), accelerated global collaboration is urgently in need to build and sustain global community of health, in which global work activities will resume normal. We should also remain cautious for the emergence of the phenomenon of "othering" (an anthropological term referring to the creation of boundary between "us" and "them") (43) when fear about "non-locals" persist. Community health education, aside aggressive safety measures, will contribute to reducing stigma and inequality potentially caused by social exclusion. In addition to the within-country context, it is crucial to acknowledge that the phenomenon of "othering" extends beyond national borders. Research has identified instances of anti-Asian attitudes and xenophobic behaviors in the United States (44). These findings highlight the need for comprehensive public health campaigns to address and combat hostility and discrimination. Efforts should be made to raise awareness, promote inclusivity, and foster a sense of global community, in order to create a society where discrimination is actively rejected.

Another important theme was the differences in the trust about the government's ability in controlling the coronavirus, which influenced participants' perceived risk level. The notion that the sense of safety deriving from the implementation and adherence with safety measures despite stringency, and trust with the government was most frequently reported in Nanjing and Wuhan, contrasting to the distrust and dissatisfaction with government's reported in Hong Kong. There were clearly differences in the way the threat of coronavirus was addressed by government because of differing circumstances in each city. The approach and degree of control exerted varied, in which the attempts and forces were most intense in epicenter. Indeed, findings about Hong Kong from this study is consistent with several surveys indicating low public trust with the government because of political turmoil in 2019 (45,46). It is also noteworthy that the participants in Hong Kong were more likely to report sense of unpredictability and uncertainty because of asymptomatic characteristics of the coronavirus, and perceived uncontrollability of the local outbreaks. This is of particular concern as many studies have shown that risk perception can trigger fear, psychological distress (47), and vulnerability (48). Therefore, it is highly important to develop programs addressing mental health concerns and providing psychological support to improve mental health outcomes. While political, historical, and cultural factors can influence the level of trust individuals have in their government and confidence in public policies, it is important to recognize that a prompt and effective response to public concerns can serve as an opportunity to rebuild that trust. Implementing stringent policies during critical periods can provide a sense of protection and demonstrate the government's commitment to safeguarding public health. By prioritizing the well-being of the population and addressing concerns in a timely manner, governments have the potential to regain public confidence and strengthen the bond between the state and its citizens.

Methodologically, our study demonstrated the feasibility of identifying and classifying risks via a qualitative approach that involved different stakeholders who voiced their concerns regarding COVID-19 in work setting. With the detailed descriptions we collected, we classified a set of risk factors into seven major types that incorporates consideration of parameters including work environment, locations, and contacts stemming from frequency and number of contacts with workmates and customers. Our qualitative data provide an overview of the types of potential risk exposure pattern, which is more descriptively and explanatory adequate as an essential risk assessment component. Assessing COVID-19 risks and establishing preventive measures for risk management in the future are expected to be part of business planning to support safe return-to-work (47,48). Future research on risk assessment that best use a combination of mixed method approach will be needed to broaden risk assessment and strengthen COVID-19 recommendations or guidelines that prevent the risk in the workplace.

Limitation

Several limitations of this study merit consideration. First, the differential combination of sampling techniques in each city may have affected the reliability of the study. It may also be subject to selection bias as the participants were recruited primarily through a workers' representative group in Hong Kong, and the collaborated research institutes in Nanjing and Wuhan. The views of the workers interviewed in this study must be interpreted with caution, especially as they come from different healthcare, social and political systems, with different approaches to manage health crisis. Because of differences of epidemiological situation at the time of data collection, participants in Hong Kong, where was experiencing the Third Wave, may have the stronger views than those in Nanjing and Wuhan. Findings for Nanjing's and Wuhan's must also be interpreted in caution, as the length of interview duration was shorter than in Hong Kong due to differences of training and capacity of interviewers. Conclusions based on IDI and mini FGD with only limited types of managerial staff, particularly in Hong Kong, may not fully capture the broader views of public holding similar position from varied industries. Despite these limitations, our study addresses gaps of knowledge by attending to the concerns of workers, whose voices must be considered for risk management plan development.

Conclusion

Given the threat of COVID-19 remains fierce, it is imperative that we address the risk perception and safety concerns of non-healthcare workers. Exploring the perspectives of workers from multi-sites shed lights on diversity of risk perception in relation to the potential risk exposure pattern, and the perceived capacity of the government in dealing with the health crisis. The insights gleaned through this work exemplify the likelihood of health disparity of essential workers arose from increased risk at workplace, and the emergence of "othering" that requires policy actions and community health education to overcome. Risk assessment in the workplace requires identification and classification of risk factors, this study have identified seven major types of potential risk of exposure in the workplace in considering the multiple elements, which hold broader applicability of risk assessment across settings.

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