Disparity in Occupational Health Risk During the Pandemic

Potential Misestimation and Its Implications for Health Policies

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Objective: This study clarifies potential misestimation of occupational risk caused by the dichotomy of frontline essential and nonessential occupations in prior studies. **Methods:** The linear regression is used to investigate the occupational risk in terms of incidence rate, hospitalization, and mortality on community level during the pandemic. **Results:** Overall, frontline essential occupations were positively associated with incidence rate, hospitalization, and mortality (156.06, 18.47, and 3.49; $P < 0.01$). Among essential occupations, however, education, training, and library occupations were negatively associated with them, whereas transportation, protective service, food preparation, and serving occupations were insignificantly associated with them. Moreover, among nonessential occupations, building and grounds cleaning, construction, and extraction occupations were positively associated with them. **Conclusion:** The dichotomy of frontline essential and nonessential occupations can bring overestimation and underestimation of occupational risk during the COVID-19 pandemic.

Keywords: frontline essential occupations, COVID-19, occupational risk, policy

Practitioners of different occupations are supposed to be faced with differentiated levels of infection risks during the COVID-19 pandemic on account of the disparate work nature and environment. The frontline essential workers, such as health care workers, teaching and child-care workers, transport and material-moving operators, cleaning and maintenance, and food handlers, are indispensable for the basic operation of society, without whom the safety, health, or welfare of society would be seriously impaired.[1] Essential workers are generally requested to physically show up in job positions, practice routine work, and have no telework opportunities.[2] They are less likely to keep social distance most of the time,[3] and more prone to contract COVID-19 on account of closer and frequent interactions with the public.[4,5] Prior studies show that essential workers, such as those in personal service industries and factory and machine operators, were at a higher risk of severe COVID-19 than nonessential workers who were thought to work more in home offices.[6] Moreover, the percentage of the population working in occupations, such as sales and retail, transport (bus/taxi drivers), and catering, was shown to be positively associated with COVID-19 mortality rates in England and Wales and Sweden, and those working in educational occupation had a lower mortality rate.[6] Some essential occupations, such as health care workers, may be at risk of exposure to patients tested positive.[7,8] Increased work intensity implies longer working hours, which put them at greater risk of infection during the pandemic.[9] On account of closer and frequent interactions with the public, the COVID-19 exposure risks to essential workers are more obvious and intensive. However, because some of nonessential workers can work at home and the nature of their work is not public oriented, the risk of infection they face seems to be sporadic and inconspicuous, leading to inadequate attention to their situation.[10] The likelihood of contracting COVID-19 among nonessential workers may be as high as among essential workers.[3] A survey conducted in six states in the United States has shown that the percentage of the population getting COVID-19 among essential workers is quite close to that among nonessential workers (31% vs 32%), which also applies to the results of mortality risk between them (18% for essential workers vs 19% for nonessential workers).[3]

Previous studies have paid much attention to the health risk of essential workers, but little to that of nonessential workers during the COVID-19 pandemic. Given the significant risks faced by essential workers during the COVID-19 pandemic, policymakers have implemented differentiated prevention schemes and strong occupational health and safety programs that have provided substantial and adequate guidance for essential occupations, but little for nonessential occupations.[11] Given that nonessential workers might also be confronted with a high level of COVID-19 infection risks, the differentiation in precaution and prevention policies based on essential/nonessential occupations might be somewhat misleading. Thus, it is also necessary to identify the health risks faced by nonessential occupations.

This study attempts to advance the existing literature in several respects. First, this study pays attention to the risks faced by nonessential occupations. The devoted efforts could enrich existing research that has focused mainly on the risks faced by essential occupations during the COVID-19 pandemic. Second, this study makes a fine-grained analysis by subdividing essential and nonessential occupations to help clarify the levels of risks faced by different occupations. This is an effective supplement to the previous analysis of simple occupation division. Third, this study identifies the incidence rate, hospitalization, and mortality risk faced by different occupations during the pandemic, which could help policymakers and social organizations tailor responses based on the level of risk faced by different professions in the pandemic to ensure the safety of workers and maintain the normal operation of society.

LITERATURE REVIEW

The Risk to Frontline Essential Workers During the Pandemic

In general, frontline essential workers are considered to be more vulnerable to COVID-19 and health problems based on a variety of exposure risks.[11–13] It is found that cumulative COVID-19 morbidity and mortality per capita are 3.3 and 2.5 times higher in the community with the highest proportion of essential workers than in the community

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with the lowest proportion of frontline essential workers in Toronto, Ontario, Canada.[14] Health care workers have more than 7 times the risk of severe COVID-19 than nonessential workers, and social care, education, and transport workers have more than twice higher risk than them.[12] It is documented that there is 15 times higher COVID-19 infection rate among emergency service staff, such as health care workers, firefighters, and police, than in the general population.[15] Evidence also reveals that infection rates are higher among food workers, especially those who work in the meat-packing industry, because of the long production lines and close proximity to colleagues.[16] Besides, it has also been found that because of the hazardous work conditions, sanitation workers are at greater risk of contracting COVID-19, respiratory diseases, and skin ailments, and their mortality rate is approximately 29% higher than that of the general public.[17]

Peculiar work nature and work environment make specific essential occupations prone to be infected with novel coronavirus.[18] For instance, workers in meat-processing factories must keep in closer proximity their coworkers along the fast-paced assembly line. The common phenomenon of shouting among them because of the noisy conditions could exacerbate transmission of COVID-19.[1] Refrigerated conditions also provide a favorable environment for novel coronavirus to grow at low temperatures, and meat-processing factories have thus become epidemic hotspots.[1] Moreover, inequitable barriers and socioeconomic vulnerabilities faced by essential workers also increase their infection risk.[19,20] A significant portion of essential workers, such as agricultural workers, sanitation workers, and food handlers, are faced with lower wages and precarious financial conditions, which limit their affordability of adequate personal protection equipment or their bargaining power to require employers to provide sufficient health and safety protection.[21] The lack of occupational rights and entitlements, such as paid sick leave, national insurance, and social security payments, also lends them in the plight of working with illness, which could increase the risk of outbreak within the workplace.[22] As such, essential workers are often exposed to higher risks and hazards, and corresponding policies are put forward to ensure protection measures for this group.[11,23,24]

Policy Interventions in the Risk Faced by Frontline Essential Workers in the Pandemic

The morbidity and mortality associated with COVID-19 borne by essential workers arouse wide attention, and accordingly, policymakers have enacted and implemented more effective health interventions to protect essential workers.[11,25,26] For example, essential workers and their households are targeted first in case of the vaccine prioritization strategy developed.[27] Onsite rapid testing and easy access to symptom assessment are designed within the workplace of essential workers to prevent transmission.[28] Through improvement of work design and technology development, work procedures of more and more essential workers can be implemented by telework.[29] For instance, novel coronavirus test shuttles have greatly reduced the risk of exposure for medical workers by conducting autonomous tests between test facilities and process facilities through artificial intelligence technology.[30] These interventions play a pivotal role in limiting transmission and controlling infection rates among essential workers.[31] In contrast, infection risks faced by nonessential workers have been ignored, and few preventive measures are designed specifically for them.[32]

Why Might Nonessential Occupations Also Face a High Level of Risks During the Pandemic

The reasons that nonessential workers face a high level of COVID-19 exposure risks are complicated, and only few studies have focused on it. Use of public transportation might be an important pathway to the COVID-19 exposure risk. It is revealed that there is no statistically significant difference in the frequency of public transportation use between essential workers and nonessential workers,[3] despite the widespread belief that "work from home" or "shelter-in-place" orders might reduce the frequency of getting outside for nonessential workers.[33] In fact, with the cancellation of business shutdown policies in some workplaces, more and more nonessential workers have to go to work in person.[34] In contrast, a considerable part of work of essential occupations can gradually be carried out through telework or even superseded by artificial intelligence.[26] Therefore, the need of essential and nonessential workers to perform legwork and use public transportation could be similar.[3]

Difference in perceptions of COVID-19 risks and homologous risk-reduction behaviors (eg, washing hands, wearing masks, keeping social distance, avoiding mass gathering, and reducing houseguests) between essential and nonessential workers, might be another reason why nonessential workers face the same or even higher level of infection risks than essential workers.[35,36] Overall, nonessential workers perceive a lower chance of contracting COVID-19 than essential workers, so their awareness of prevention and precautionary measures might be inadequate.[3,35] It has been reported that the percentage of nonessential workers who regularly wear masks in public places is approximately 60%, whereas that of essential workers who keep this habit is more than 70%.[3] In addition, the lack of targeted protection policies and deficient investment also contribute to infection rates among nonessential workers. A considerable infection risk of nonessential workers arises from proximity with coworkers in the enclosed spaces.[37] Therefore, it is imperative to improve ventilation and routine disinfection,[37] provide mass testing and convenient access to symptom assessment, and enhance vaccination coverage. However, these prevention and control measures aimed at transmission within the workplace of nonessential workers remain limited and inadequate.

MATERIALS AND METHODS

Data Description

Data used in this study come from the Chicago COVID-19 Community Vulnerability Index, 2021, which is published by the Chicago Department of Public Health (CDPH), which provides guidance, services, and strategies to make Chicago become a healthier and safer city. Vulnerability is defined as a combination of sociodemographic factors in the residential area, occupational factors, and cumulative COVID burden. These indicators are measured on the community level.

Variables

Dependent Variable

The dependent variables are measured on the community level, which are compiled by CDPH Disease Surveillance into three indicators, including diagnosed COVID-19 cases (rate per 100,000 population), COVID-19 hospital admissions (rate per 100,000 population), and COVID-19 mortality rate (rate per 100,000 population) during January to December 2020.

Independent Variable

The population percentage of different occupations on community level is taken as the independent variable. They are analyzed and compiled by CDPH based on Advisory Committee on Immunization Practices guidance and US Bureau of Labor Statistics Occupation Classifications. Occupations are classified into two categories (ie, essential workers and nonessential workers) by the Chicago COVID-19 Community Vulnerability Index program, and we comply with this classification.

Specifically, essential occupations include education (teachers, support staff), protective (fire, police, correctional officers), personal care (childcare workers, barbers, entertainment), farming agricultural workers, production (goods manufacturing, food production), transportation (public transit, airport truck, taxi), material moving (stockers

grocery store workers, warehouse, freight), and food service (restaurant, kitchen workers). Nonessential occupations include office and administrative support; management; business and financial; computer and mathematical; architecture and engineering; life, physical, and social science; community and social service; legal; arts, design, entertainment, sports, and media; health care practitioners; technical, building, and grounds cleaning; sales; construction and extraction; installation; maintenance; and repair. This study attempts to examine the associations between population distribution by different occupations and incidence rate, mortality risk, and hospitalization on community level.

Control Variable

Three indicators on community level are controlled in the regression analysis, as they are important determinants of mortality risk during the pandemic, which is demonstrated in previous studies,[38–40] including (1) the percentage of population excluding primary care providers, (2) the percentage of population aged >65 years, and (3) the percentage of population aged 18 to 64 years with more than one comorbid condition (ie, current smoking, obesity, diabetes).

Approach

The linear regression was applied in the analysis using Stata 16.0 (StataCorp, College Station, Texas). This study examined the associations between each occupation and incidence rate, mortality risk, and hospitalization. In addition, the associations between essential/nonessential occupations in aggregate and incidence rate, mortality risk, and hospitalization are also analyzed.

RESULTS

Table 1 shows that overall the percentage of people working in essential occupations is significantly and positively associated with incidence rate, hospitalization, and mortality risk on community level (156.06, 18.47, and 3.49; $P < 0.01$ for all). These results indicate that the communities with the higher proportion of people engaged in essential occupations are at a higher risk during the pandemic.

Table 1 shows that the percentage of people working in production and material-moving occupations are significantly and positively associated with incidence rate, hospitalization, and mortality risk on community level. Besides, the percentage of people working in farming, fishing, and forestry occupation is significantly and positively associated with incidence and mortality on community level.

What is worth noting is that the percentage of people working in education, training, and library are significantly and negatively associated with incidence rate, hospitalization, and mortality risk on community level. Besides, the percentage of people working in personal care and service occupation is significantly and negatively associated with incidence rate. These results show that although essential occupations face higher risks during the pandemic in general, the risks of some occupations are overestimated.

Moreover, the percentage of people working in transportation, protective service, and food preparation and serving occupation are insignificantly associated with incidence rate, hospital admission, and mortality on community level.

The results for different types of nonfrontline essential occupations are presented in Table 2. It is shown that the percentage of people working in management; business and financial; computer and mathematical; architecture and engineering; life, physical, and social science; legal; arts, design, entertainment, sports, and media; health care practitioners; and technical occupations are significantly and negatively associated with incidence rate, hospitalization, and mortality risk on community level. In addition, the percentage of people working in community and social service occupation is significantly and negatively associated with incidence on community level, and the percentage of people working in sales occupation is significantly and negatively associated with hospital admission on community level.

However, what is worth noting is that the percentage of people working in building and grounds cleaning, and construction and extraction occupations are significantly and positively associated with incidence rate, hospitalization, and mortality risk on community level. The percentage of people working in installation, maintenance, and repair occupations is significantly and positively associated with incidence and mortality on community level. In addition, the percentage of people working in community and social service industry is significantly and positively associated with hospital admission on community level during the pandemic.

DISCUSSION

Findings of this study indicate that essential occupations, in general, positively predict incidence rate, hospitalization, and mortality risk, although most nonessential occupations negatively predict them, which are consistent with prior studies.[6,41] However, the health risks faced by some types of essential occupations are found to be overestimated in this study, such as education, training, and library; personal care and service; transportation; protective service; food preparation; and serving occupations. In addition, this study reveals that some of nonessential workers, such as community and social service workers, are mistakenly perceived as having lower health risks because of their work nature without facing the public; however, they take a high level of risks during the pandemic. Proximity to their colleagues in the enclosed spaces renders them at increased risk of contracting COVID-19.[37] In contrast, through improved work design and technology development, a considerable part of work of essential occupations can be gradually performed by telework or even superseded by artificial intelligence[29,30]; therefore, the health risks to some of essential occupations are not as high as people supposed. Education sector is an example of this. Because of the rise in on-line teaching technology and the popularity of distance learning, remote education is feasible for both teachers and students, which greatly reduces the close interactions and the risks of infection. Therefore, differentiated precaution and prevention strategies based on rough division of essential and nonessential occupations might be somewhat misleading.

Accordingly, it is essential to ameliorate the extant prevention schemes. Prevention and prevention guidance during the COVID-19 pandemic should consider the actual levels of health risks of different occupations, rather than rely solely on the division of essential and nonessential occupations. More attention should be paid to nonessential occupations with higher health risks, and scientific guidance and support should be provided for them to improve effectiveness of precaution and prevention. Specifically, according to the findings of this study, it is suggested that, on the one hand, tailored prevention and control measures should be designed to limit transmission within the workplaces of nonessential workers, for instance, upgrading ventilation and improving routine disinfection, providing rapid on-site testing or mass testing, and convenient access to symptom assessment. On the other hand, policymakers should encourage nonessential workers to get vaccinated. Workplace-led vaccination strategy, as a supplement of the extant community-led vaccination strategy, can be leveraged to ensure more nonessential workers get vaccinated and to enhance vaccination coverage.

RESEARCH LIMITATION

This study still has some limitations. Compared with the individual level, the sample size of data on community level is relatively small, limiting the generalizability to some extent. In addition, this community-level study inevitably ignored individual situations. Given that cultural background and individual opinions on specific phenomena may lead to deviation, this limitation may affect the rationality of research. Future research can mine individual data to validate the results of this study from different perspectives. Moreover, the classification of occupational types is derived from the Standard Occupational Classification

TABLE 1. Association Between % Population Practicing Different Frontline Essential Occupations and Pandemic Risk (Number of Communities = 77)

	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality
	Frontline Essential Worker (in Aggregate)			Education, Training, and Library			Protective Service			Personal Care and Service			Farming, Fishing, and Forestry		
% Population of occupations	156.06**	18.47**	3.49**	−311.10**	−36.61**	−8.20**	1.30	11.72	1.09	−892.33**	27.86	0.28	7980.74**	379.24*	116.65**
Robust SE	37.59	3.53	0.59	88.20	11.59	2.02	67.19	10.47	1.35	224.09	26.29	3.77	2663.63	183.14	41.87
% No primary care providers	−35.35	4.37	0.18	1.46	8.71**	1.08	−18.27	6.82	0.60	−5.99	6.00	0.56	−48.72	4.94	0.12
Robust SE	39.40	3.88	0.70	44.04	3.97	0.70	47.95	4.44	0.83	43.53	4.51	0.84	43.14	4.42	0.79
% Age >65 y	−219.80**	17.67*	1.50	−113.70	30.21**	4.01**	−147.68	22.95	2.82	−156.83*	26.55*	3.13	−120.67	27.52*	3.51*
Robust SE	79.32	8.30	1.25	65.24	10.56	1.39	76.27	11.53	1.74	64.75	11.37	1.68	65.92	11.38	1.61
% Comorbid condition	−4.29	7.68**	1.05*	7.04	9.03**	1.20**	33.00	11.50**	1.83**	60.59**	11.24**	1.88**	25.54	11.74**	1.78**
Robust SE	21.08	2.52	0.42	22.82	2.76	0.42	21.28	2.25	0.38	22.00	2.55	0.42	18.02	2.27	0.38
Constant	5693.963**	−523.612**	−82.571**	10,100.09**	−3.51	24.56	7957.12**	−243.55	−30.82	9413.27**	−301.40	−32.42	8141.85**	−247.04	−29.25
Robust SE	1479.547	139.557	24.324	1972.18	176.71	31.58	1949.05	165.90	28.46	1893.65	174.99	29.80	1899.38	166.09	28.33
F statistics	5.16**	40.98**	35.08**	4.45**	28.31**	19.28**	1.60	20.70**	12.63**	5.38**	19.11**	12.59**	5.28**	21.67**	16.83**
				Production			Transportation			Material Moving			Food Preparation and Serving		
% Population of occupations				458.38**	35.38**	8.72**	117.52	37.13	4.01	676.15**	64.78**	12.65**	164.48	14.37	3.69
Robust SE				71.86	9.24	0.95	156.52	20.30	2.27	115.20	13.44	2.07	112.55	14.88	2.10
% No primary care providers				−23.46	5.99	0.46	−21.17	5.48	0.46	−52.66	3.09	−0.08	−14.88	6.69	0.64
Robust SE				28.35	3.49	0.47	46.40	3.75	0.77	33.44	3.33	0.62	45.83	4.39	0.78
% Age >65 y				−159.34*	25.32**	2.90**	−163.55*	21.12	2.57	−152.62**	25.74**	3.02**	−133.62	27.45*	3.43*
Robust SE				67.54	7.90	0.79	80.74	11.30	1.70	57.21	7.89	0.94	74.77	11.43	1.65
% Comorbid condition				17.22	10.87**	1.59**	25.36	9.66**	1.62**	−45.04	4.61	0.43	29.02	11.74**	1.80**
Robust SE				17.26	1.95	0.27	22.99	2.83	0.39	23.07	2.55	0.36	21.14	2.22	0.36
Constant				6458.29*	−371.48	−60.46*	8021.60*	−235.08	−29.72	9564.21*	−101.79	−1.88	6851.27*	−352.40	−56.77
Robust SE				1219.71	149.04	18.80	1910.49	134.12	26.55	1399.33	136.31	24.57	1920.30	174.94	26.99
F statistics				18.70**	28.58**	43.39**	1.50	35.78**	15.44**	16.09**	25.59**	24.43**	2.14	23.96**	19.07**

*$P < 0.05$; **$P < 0.01$.

TABLE 2. Association Between % Population Practicing Different Nonfrontline Essential Occupations and Pandemic Risk (Number of Communities = 77)

	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality	Incidence	Hospital Admission	Crude Mortality
	Office and Administrative Support			Management			Business and Financial			Computer and Mathematical			Architecture and Engineering		
% Population of occupations	−48.73	13.45	2.59	−354.52**	−43.40**	−7.72**	−390.64**	−41.34**	−8.76**	−767.06**	−42.66	−12.73**	−1148.01*	−192.04**	−34.30**
Robust SE	[145.40]	[13.48]	[2.18]	[66.9]	[8.21]	[1.29]	[88.38]	[9.13]	[1.31]	[210.63]	[22.90]	[3.87]	[509.12]	[55.21]	[8.18]
% No primary care providers	−17.95	6.28	0.54	−55.32	1.86	−0.25	−37.23	4.38	0.14	−21.49	6.21	0.51	−24.84	5.29	0.36
Robust SE	[47.57]	[4.47]	[0.84]	[38.63]	[3.54]	[0.66]	[39.67]	[3.93]	[0.69]	[40.96]	[4.43]	[0.81]	[44.55]	[3.98]	[0.74]
% Age >65 y	−143.25	25.13*	2.907	−196.73**	20.20*	2.05	−214.53**	19.14*	1.62	−182.32*	24.31*	2.54	−189.97*	19.12*	1.85
Robust SE	[74.94]	[11.10]	[1.57]	[70.50]	[7.93]	[1.13]	[75.36]	[9.10]	[1.27]	[70.92]	[10.90]	[1.51]	[80.67]	[9.06]	[1.33]
% Comorbid condition	40.06	10.17**	1.51**	−23.13	5.22*	0.66	−25.14	5.94	0.58	−39.03	8.09*	0.69	−0.68	6.45*	0.88
Robust SE	[29.56]	[3.26]	[0.53]	[22.32]	[2.79]	[0.44]	[23.60]	[2.99]	[0.47]	[28.80]	[3.24]	[0.55]	[27.35]	[3.06]	[0.50]
Constant	8126.34**	−302.96	−41.04	15,371.47**	651.92**	129.47**	14,415.32**	427.63*	112.81**	14,006.94**	80.66	68.48	11,582.31**	350.78	76.40*
Robust SE	[1963.54]	[166.76]	[29.82]	[2358.20]	[211.57]	[35.47]	[2384.42]	[201.92]	[32.99]	[2577.45]	[262.04]	[42.48]	[2780.22]	[229.91]	[37.98]
F statistics	1.88	19.21**	11.67**	8.63**	46.57**	30.24**	5.89**	32.57**	38.00**	4.07**	24.78**	17.75**	2.10**	25.19**	18.18**
	Life, Physical, and Social Science			Community and Social Service			Legal			Arts, Design, Entertainment, Sports, and Media			Health Care Practitioners and Technical		
% Population of occupations	−951.51**	−122.60**	−26.21**	−883.75**	85.84*	0.51	−1083.18**	−120.95**	−24.54**	−964.04**	−78.51**	−15.31**	−480.04**	−63.03**	−11.99**
Robust SE	[331.45]	[41.28]	[8.22]	[271.17]	[33.58]	[5.51]	[279.29]	[29.04]	[4.54]	[195.01]	[20.59]	[3.84]	[155.42]	[16.28]	[2.78]
% No primary care providers	16.79	10.91**	1.53**	−24.45	6.98	0.56	−41.51	3.80	0.03	−61.67	2.85	−0.13	−10.68	7.39	0.75
Robust SE	[45.24]	[3.84]	[0.70]	[44.14]	[4.44]	[0.83]	[37.70]	[3.62]	[0.64]	[37.41]	[4.08]	[0.73]	[43.31]	[4.11]	[0.76]
% Age >65 y	−132.01*	28.22**	3.54*	−87.90	20.48*	3.09	−181.89**	22.39	2.34	−286.69**	14.90	0.91	−111.95	30.90**	4.01**
Robust SE	[65.98]	[10.27]	[1.40]	[69.68]	[9.79]	[1.47]	[67.90]	[9.25]	[1.25]	[77.53]	[9.44]	[1.35]	[65.13]	[10.28]	[1.46]
% Comorbid condition	−3.07	7.44**	0.89*	46.98	10.75**	1.88**	−27.98	5.28	0.50	−10.54	8.55**	1.19**	−3.93	7.24**	0.96*
Robust SE	[22.92]	[2.71]	[0.40]	[20.48]	[2.46]	[0.43]	[24.28]	[3.17]	[0.47]	[20.20]	[2.61]	[0.41]	[22.71]	[2.70]	[0.44]
Constant	9314.85**	−80.77	5.47	8590.41**	−317.53	−32.33	13,516.02*	364.98	94.01**	15,150.73**	330.07	82.30**	11,339.66*	188.44	52.55
Robust SE	[1930.32]	[160.30]	[29.19]	[1888.89]	[163.65]	[29.46]	[2221.97]	[201.00]	[33.31]	[2329.89]	[212.06]	[36.49]	[2192.49]	[182.07]	[32.59]
F statistics	2.85*	26.30**	17.90**	3.16*	21.43**	12.61**	4.24**	36.11**	27.08**	6.55**	34.05**	16.39**	3.07*	32.18**	20.68**
	Building and Grounds Cleaning			Sales			Construction and Extraction			Installation, Maintenance, and Repair					
% Population of occupations	701.42**	41.91**	10.42**	−253.39	−21.71	−2.13	835.43**	23.11*	8.87**	1576.36**	25.27	12.54**			
SE	[127.71]	[14.17]	[2.35]	[158.85]	[23.92]	[3.49]	[80.13]	[11.36]	[2.00]	[140.29]	[24.23]	[4.04]			
% No primary care providers	−53.86	4.26	0.03	−28.33	5.527	0.48	−6.15	6.72	0.69	−6.14	6.58	0.66			
SE	[35.63]	[3.62]	[0.60]	[47.65]	[4.26]	[0.80]	[21.70]	[4.07]	[0.63]	[26.02]	[4.26]	[0.70]			
% Age >65 y	−90.44	29.65*	3.97*	−192.12*	22.41	2.75	−149.42**	26.19*	3.10*	−68.16	27.52*	3.75			
SE	[58.62]	[11.29]	[1.64]	[81.96]	[13.42]	[2.04]	[37.21]	[11.10]	[1.50]	[48.29]	[11.12]	[1.66]			
% Comorbid condition	−24.83	8.64**	1.03**	32.63	12.06**	1.88**	12.14	11.52**	1.66**	5.27	11.65**	1.67**			
SE	[21.88]	[2.38]	[0.36]	[20.84]	[2.31]	[0.40]	[13.00]	[2.22]	[0.32]	[14.44]	[2.19]	[0.36]			
Constant	7943.06**	−256.65	−32.16**	11,220.90**	23.89	−4.47	5583.59**	−321.52*	−57.15*	4860.64**	−305.51	−56.59*			
SE	[1420.93]	[135.77]	[20.90]	[3050.20]	[340.21]	[51.70]	[923.23]	[160.27]	[22.41]	[995.80]	[155.95]	[22.65]			
F statistics	10.19	38.52	33.13	1.99	21.84**	13.51**	33.44**	22.27**	23.84**	36.57**	21.95**	21.81**			

*$P < 0.05$; **$P < 0.01$.

by data possessor, which does not involve many informal occupations that are not included in the formal statistical category. During the pandemic in particular, many people have undergone work transition and are increasingly engaged in informal occupations, which cannot be timely tracked by this study. Future studies can supplement this point with more fine-grained investigations.

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