

UC Berkeley Center for Labor Research and Education
November 2020

Physical Proximity to Others in California's Workplaces: Occupational Estimates and Demographic and Job Characteristics

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1. Introduction

After six months of economic lockdown to contain the spread of COVID-19 and unprecedented [job loss](#) and [unemployment](#), California has now entered what will likely be a prolonged period of experimentation with reopening the economy to greater and lesser degrees. The stakes could not be higher. California's success in containing the coronavirus and saving lives will rest on our collective ability to sustain rigorous public health measures, supplement federal safety net programs to reduce economic pain, and establish and enforce robust workplace safety regulations.

From the standpoint of the labor market, two challenges stand out. First, the workplace has emerged as a central site of infection transmission.¹ This has been true from the outset, with reports of infection outbreaks in essential workplaces such as [health care facilities](#), [grocery stores](#), [warehouses](#), [nursing homes](#), [public transit](#), and [meat packing plants](#), exacerbated by uneven or wholly absent measures to ensure worker safety. As more and more workers return to work, policymakers need to understand the full range of jobs at risk of infection.

Second, it is clear that the COVID-19 pandemic is exacerbating deep health and labor market inequalities for communities of color. As is true nationally, Black and Latino/a infection and mortality rates in California are significantly higher than White rates.² Employment in high-risk jobs is undeniably a contributing factor to race-based differences in infection rates, even though insufficient data in the US means that researchers have not been able to directly establish the link so far.

In this research brief, we build on our [previous research](#) on essential workers, but use new data and broaden the analysis to the full range of occupations in the California labor market to help answer these questions: As the economy reopens, what levels of COVID-19 exposure risk will workers face when they return to their workplace? What are the demographic characteristics of these workers? And what jobs do they hold?

Unfortunately, direct data on infection rates at the occupational level are not available. We therefore analyze an occupation-level measure of the degree of physical proximity of workers to co-workers and customers at their jobs.³ We emphasize that physical proximity to others is only one factor that can affect a worker's risk of exposure to the coronavirus in the workplace, especially given our rapidly evolving understanding of how the virus is transmitted. The actual risk of coronavirus exposure is also influenced by many other factors, such as workplace ventilation, cleaning protocols, provision of protective gear, public health measures, and employers' leave policies and other actions to mitigate risk. That said, workers' physical proximity to others is an important measure to examine in our ongoing attempts to better understand workplace exposure to the coronavirus.

Brief summary of key findings

- Under a scenario of full reopening, we estimate that about two-thirds of California's workers would be employed in occupations entailing "moderately close" (e.g., arm's length) to "very close" (e.g., near touching) physical proximity to other people. About a third would be employed in occupations entailing "slightly close" proximity to others (e.g., ranging from a shared office to a private office).
 - These findings are best interpreted as relative estimates. Occupations requiring "slightly close" physical proximity entail some level of exposure risk for their workers, but likely less than those requiring "moderately close" and "very close" physical proximity.
- Not surprisingly, the majority of health care and personal care occupations entail "very close" proximity to others, as do teaching occupations. Occupations that primarily entail "moderately close" physical proximity include sales, social service, material moving, production, and transportation jobs. Many professional occupations, but also a number of manual occupations, primarily entail "slightly close" proximity to others.
- Occupational segregation by gender, race, and ethnicity in the labor market results in markedly different patterns of workplace physical proximity.
 - Women of all races/ethnicities are significantly more likely than men to be employed in occupations with "very close" physical proximity to others--on the order of twice as likely. Men in every race/ethnic group are significantly more likely to be employed in occupations with "moderately close" proximity to others.
 - However, there is additional variation by race and ethnicity; for example, Black and Latino/a workers of both genders have low rates of working in occupations entailing "slightly close" physical proximity to others, compared to White and Asian workers.
- Low-wage workers are more likely to be employed in occupations requiring "moderately close" and "very close" physical proximity to others, compared to higher-paid workers.
- Workers employed by state and local government, and nonprofits, are more likely to be employed in occupations entailing "very close" physical proximity to others, compared to private-sector workers.
- The large majority of workers in occupations that require either "moderately close" or "very close" physical proximity likely are not able to work remotely.

- Not surprisingly, front-line essential workers (as designated by state regulation) are overrepresented in occupations requiring “moderately close” and “very close” physical proximity, and most are likely unable to work remotely.

2. Data and methods

Currently, we do not have representative data at the occupational level on COVID-19 infection and mortality rates in California. Instead, many researchers are attempting to develop proxies for on-the-job risk of COVID-19 infection.⁴ Building on this work, we analyze an occupation-level measure of workers’ physical proximity to co-workers and customers at their jobs. We also analyze an occupation-level measure of the potential ability to work remotely, as a risk mitigation option that could be used for some occupations. We emphasize that these measures are only two factors that can affect a worker’s risk of exposure to the coronavirus in the workplace, especially given our rapidly evolving understanding of how the virus is transmitted. The actual risk of coronavirus exposure is also influenced by many other factors, such as workplace ventilation, cleaning protocols, provision of protective gear, public health measures, and employers’ leave policies and other actions to mitigate risk.

Our measures of physical proximity and potential for remote work are calculated at the occupation level, using data from the Occupational Information Network (O*NET) dataset, a national database of a wide range of occupational characteristics. Here we briefly review the measures; see the technical appendix for more details.

1. **Physical proximity:** Our measure uses an O*NET question that asks respondents to identify how physically close they are to other people when they do their jobs. We collapse O*Net’s occupational scores on this question into three categories: those requiring work in “very close proximity” to others (e.g., near touching); those requiring work in “moderately close proximity” (e.g., arm’s length) to others; and those where workers are at “slightly close proximity” to others (e.g., shared office; private office). Again, we are not able to assess occupations’ actual infection risk. But workers in occupations requiring work in “moderately close” or “very close” proximity to others are likely to have a higher risk of contracting COVID-19 than workers that do not work closely with other people.
2. **Potential for remote work:** We classify occupations into two categories: those that could potentially be performed remotely, and those that could not. We adopt this categorization from [Dingel & Neiman \(2020\)](#); it is based on a series of questions about the tasks entailed by an occupation, and whether they could be done remotely. This is a potential measure; it is based on the features of occupation rather than employer’s policy, and does not measure whether a given worker is actually working remotely, and as such is not a measure of actual risk.

We merge these occupation-level measures with the 2018 American Community Survey (ACS), which provides data on California’s workers and their job and demographic characteristics. Note that the O*NET and American Community Survey data reflect characteristics of occupations and the California labor market before the COVID-19 pandemic and are therefore not able to capture changes resulting from it.

3. The distribution of physical proximity in the California labor market

We begin by describing levels of estimated physical proximity in the full range of occupations in the state’s labor market, under a scenario of a fully-reopened economy. We reiterate that our physical proximity measure is just one factor affecting potential exposure to the coronavirus in the workplace; many other features of how workplaces are organized and employers’ policies ultimately determine actual exposure.

Table 1 shows the percentage of workers in California employed in our three occupational physical proximity categories. About two-thirds of workers are employed in occupations that we estimate entail “moderately close” proximity (47.6%) and “very close” proximity (22.1%) to other people, compared to workers employed in occupations that we estimate entail “slightly close” physical proximity to others (30.3%).

Table 1. Distribution of workers across different levels of occupational physical proximity, California, 2018

	Distribution of workers across physical proximity categories (row percentages)			Total
	Slightly close proximity	Moderately close proximity	Very close proximity	
All workers	30.3	47.6	22.1	100.0

Source: Authors’ analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

Table 2 examines our physical proximity measure for broad occupational groups. In Panel A, we first show the occupational distribution within each physical proximity category (column percentages).

Table 2. Distribution of occupations within & across physical proximity categories, California, 2018

Panel A	Distribution of workers within each physical proximity category (column percentages)			Share of all workers
	Slightly close proximity	Moderately close proximity	Very close proximity	
Management Occupations	25.6	4.1	2.4	10.3
Business and Financial Operations Occupations	13.7	3.0	0.0	5.6
Computer and Mathematical Occupations	9.6	2.2	0.0	4.0
Architecture and Engineering Occupations	5.5	1.7	0.0	2.5
Life, Physical, and Social Science Occupations	2.2	0.9	0.0	1.1
Community and Social Service Occupations	0.2	3.2	0.8	1.7
Legal Occupations	3.2	0.2	0.0	1.1
Educational Instruction and Library Occupations	0.1	3.4	18.3	5.7
Arts, Design, Entertainment, Sports, and Media Occupations	3.6	1.9	0.6	2.1
Healthcare Practitioners and Technical Occupations	0.0	1.3	21.7	5.4

Table 2 (continued)

Panel A	Distribution of workers within each physical proximity category (column percentages)			Share of all workers
	Slightly close proximity	Moderately close proximity	Very close proximity	
Healthcare Support Occupations	0.1	0.0	8.9	2.0
Protective Service Occupations	0.0	2.4	4.8	2.2
Food Preparation and Serving Related Occupations	0.0	6.5	14.0	6.2
Building and Grounds Cleaning and Maintenance Occupations	8.5	2.1	0.0	3.6
Personal Care and Service Occupations	0.0	1.1	16.0	4.1
Sales and Related Occupations	2.4	18.3	0.1	9.5
Office and Administrative Support Occupations	16.0	15.5	1.3	12.5
Farming, Fishing, and Forestry Occupations	4.9	0.0	0.5	1.6
Construction and Extraction Occupations	0.0	6.7	5.9	4.5
Installation, Maintenance, and Repair Occupations	0.3	5.3	0.1	2.6
Production Occupations	1.9	9.2	0.8	5.1
Transportation Occupations	0.1	5.7	3.6	3.5
Material Moving Occupations	1.9	5.2	0.0	3.0
Total	100.0	100.0	100.0	100.0

Panel B	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
All workers	30.3	47.6	22.1
Management Occupations	75.8	19.0	5.3
Business and Financial Operations Occupations	74.4	25.6	0.0
Computer and Mathematical Occupations	73.7	26.3	0.0
Architecture and Engineering Occupations	67.3	32.7	0.0
Life, Physical, and Social Science Occupations	60.1	39.9	0.0
Community and Social Service Occupations	2.7	86.9	10.4
Legal Occupations	89.3	10.7	0.0
Educational Instruction and Library Occupations	0.7	28.3	71.0
Arts, Design, Entertainment, Sports, and Media Occupations	51.9	41.7	6.4
Healthcare Practitioners and Technical Occupations	0.0	11.1	88.9
Healthcare Support Occupations	1.3	0.0	98.7
Protective Service Occupations	0.4	51.6	47.9

Table 2 (continued)

Panel B	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
Food Preparation and Serving Related Occupations	0.0	50.1	49.9
Building and Grounds Cleaning and Maintenance Occupations	71.7	28.3	0.0
Personal Care and Service Occupations	0.0	12.7	87.3
Sales and Related Occupations	7.8	91.9	0.3
Office and Administrative Support Occupations	38.7	59.0	2.3
Farming, Fishing, and Forestry Occupations	91.3	1.3	7.3
Construction and Extraction Occupations	0.2	70.9	28.9
Installation, Maintenance, and Repair Occupations	4.0	95.4	0.7
Production Occupations	11.2	85.5	3.3
Transportation Occupations	1.0	76.5	22.4
Material Moving Occupations	19.0	81.0	0.0

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

In the “very close” physical proximity category, Healthcare Practitioners and Technical Occupations, including detailed occupations such as Registered Nurses and Physicians, account for 21.7% of the workers in that category. Healthcare Support Occupations such as Nursing and Medical Assistants constitute an additional 8.9% of the “very close” category--overall, health care workers constitute 30.6% of the California workforce employed in occupations entailing “very close” physical proximity to others.

The second biggest group in the “very close” category is Educational Instruction and Library Occupations (18.3%), which includes detailed occupations such as Teachers, Teaching Assistants, and Library workers. Other important occupational groups in this category include Personal Care (16.0%) and Food Preparation (14.0%) jobs.

In the “moderately close” physical proximity category, Sales and Related Occupations constitute 18.3% of the workforce (e.g., Retail Salespersons and Cashiers), followed by Office and Administrative Support Occupations (15.5%) and Production Occupations (9.2%). In the “slightly close” physical proximity category, the largest group is Management Occupations (25.6%), followed by Office and Administrative Support Occupations (16.0%) and Business and Financial Operations Occupations (13.7%).

Panel B of Table 2 shows the percentage of each occupation’s workers employed in each of the three physical proximity categories (row percents). Not surprisingly, the majority of healthcare and personal care occupations entail “very close” proximity to others, as do education occupations. Occupations primarily requiring “moderately close” physical proximity include sales, community/social service, production, installation/maintenance, material moving, and transportation jobs.

Finally, many professional occupations entail “slightly close” proximity to others, such as architects and engineers, lawyers, managers, and computer programmers. But a number of nonprofessional occupations also entail “slightly close” physical proximity, such as some farming jobs and building and grounds cleaning jobs.

4. Worker characteristics

We next analyze variation in our estimated physical proximity measure by worker characteristics. Once again, our analysis includes all occupations in the California labor market, under the scenario of a fully-reopened economy.

Table 3 shows the percentage of workers in California within each occupational physical proximity group. In this table we are asking, for example, what is the gender distribution of workers employed in occupations with “slightly close” physical proximity to others in the workplace.

Overall, disproportionate employment in occupations with moderate to high levels of physical proximity to others are particularly evident for women; for workers of color; and for workers with less education than a bachelor’s degree.

Table 3. Demographic characteristics of workers in each occupational physical proximity level, California, 2018

	Distribution of workers within each physical proximity category (column percentages)			Share of all workers
	Slightly close proximity	Moderately close proximity	Very close proximity	
Gender				
Women	45.0	39.9	62.6	46.5
Men	55.0	60.1	37.4	53.5
Race/ethnicity				
Black	4.3	5.3	6.7	5.3
Latino/a	30.7	44.9	36.2	38.7
Asian	20.2	13.2	17.8	16.3
White	41.6	33.5	35.9	36.5
America Indian & Alaskan Native	0.2	0.3	0.3	0.3
Other	3.0	2.7	3.2	2.9
Age				
18-24	6.5	16.0	13.3	12.5
25-34	25.2	26.0	27.9	26.2
35-54	46.9	39.8	40.7	42.1
55-64	16.7	14.3	13.7	14.9
65+	4.7	4.0	4.4	4.3

Table 3 (continued)

	Distribution of workers within each physical proximity category (column percentages)			Share of all workers
	Slightly close proximity	Moderately close proximity	Very close proximity	
Nativity				
US born	63.7	66.5	68.0	66.0
Foreign born	36.3	33.5	32.0	34.0
Education				
Less than high school	7.1	9.8	5.4	8.0
High school	19.6	35.9	26.8	28.9
Some college/Associate's degree	20.0	27.4	31.6	26.1
Bachelor's degree	33.0	17.8	22.9	23.5
Graduate degree	20.4	9.0	13.4	13.4

Note: Percentages are column percentages, percentaged within each demographic characteristic. All race/ethnicity categories other than Latino/a are non-Hispanic only.

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

Specifically, relative to their population share, women are significantly overrepresented in occupations with “very close” physical proximity to others (62.6%, compared to their overall 46.5% share of the workforce). Men are underrepresented in these occupations (37.4%, compared to their overall 53.5% share of the workforce). By contrast, men are significantly overrepresented in occupations with “moderately close” physical proximity to others (60.1%), while women are underrepresented in these occupations (39.9%).

Relative to their population share, Asian and Black workers are overrepresented in occupations with “very close” proximity to others. Latino/a workers make up a disproportionate share of the workers in occupations with “moderately close” proximity to others (44.9%, compared to their overall 38.7% share of the workforce). On the other end of scale, White workers and Asian workers are overrepresented in occupations with the lowest level of physical proximity, while Black and Latino/a workers are underrepresented in them. No strong patterns are evident for American Indians and Alaskan Natives, or for the Other group.⁵

The age distributions within each occupational physical proximity category do not show strong differentials; occupations with “moderately close” physical proximity tend to employ somewhat younger workers, and occupations entailing “slightly close” physical proximity tend to employ somewhat older workers.

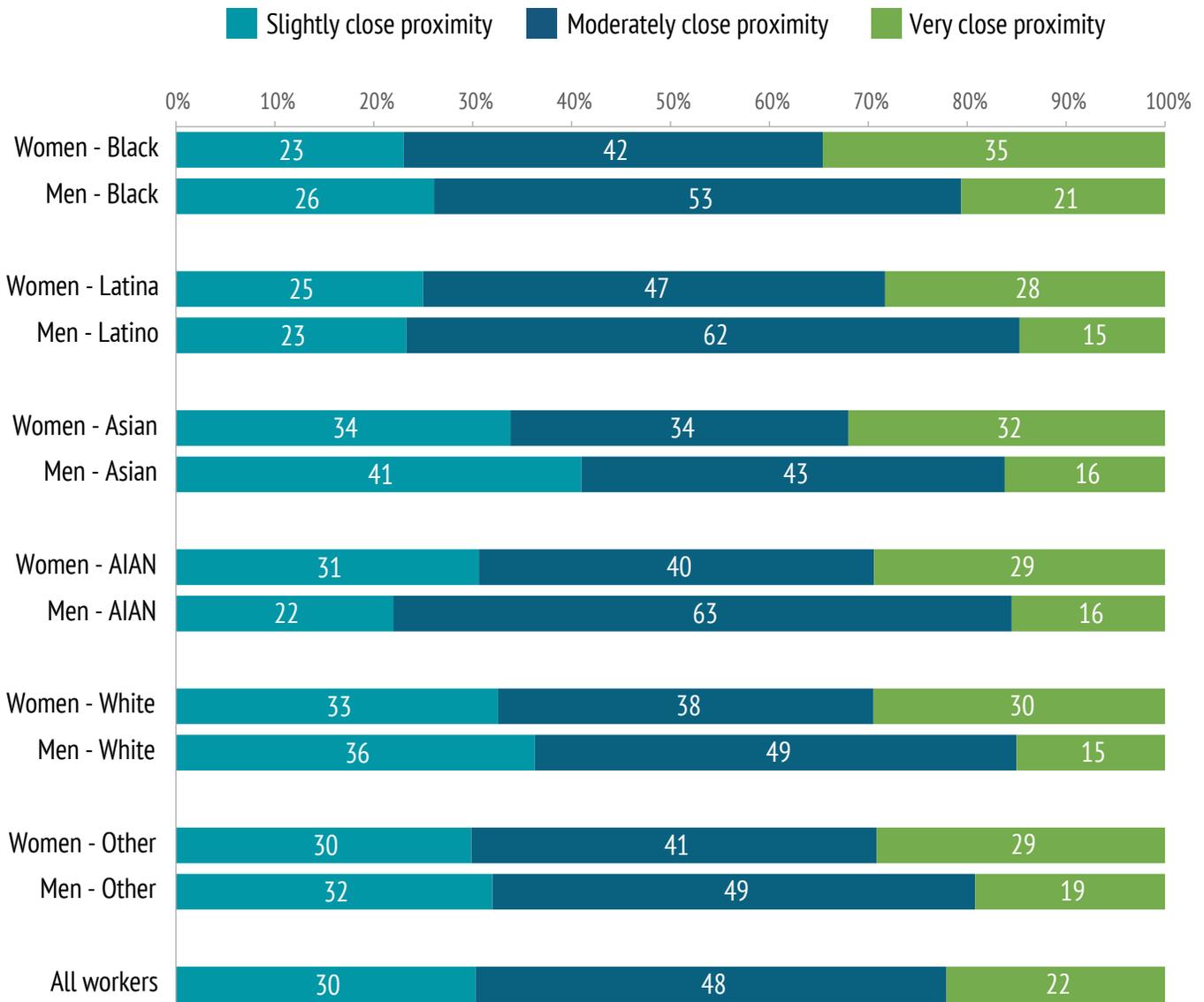
US-born and foreign-born workers do not appear to differ significantly in levels of occupational physical proximity. Note however that we do not have data on workers’ documentation status, where other research suggests high rates of employment of undocumented workers in higher-risk occupations.⁶

Finally, Table 3 shows that workers with some college education or an associate’s degree are overrepresented among occupations with “very close” physical proximity to others (31.6%, compared to their overall 26.1% share of the workforce). Workers with a high school degree make up a disproportionate share of workers in occupations with “moderately close” physical proximity at work (35.9%). Workers with a bachelor’s or graduate degree are overrepresented among workers in occupations with the lowest level of physical proximity at work.

The intersection of race, ethnicity, and gender

In Figure 1, we show the estimated distribution of occupational physical proximity *within* gender and race/ethnicity groups. Here we are asking, for example, among Black women, what percent are employed in each of the three physical proximity groups.

Figure 1. Percent of workers employed in occupations with different levels of estimated physical proximity to others, California, 2018



Note: All race/ethnicity categories other than Latino/a are non-Hispanic only.

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

Overall, women in every race/ethnic group are significantly more likely than men to be employed in occupations with “very close” physical proximity to others—on the order of about twice as likely (with the exception of the Other group). Conversely, men in every race/ethnic group are significantly more likely to be employed in occupations with “moderately close” proximity to others. Gender differences are less consistent when it comes to employment in occupations with “slightly close” proximity to others, and in particular, Black and Latino/a workers of both genders have low rates of working in these occupations.

But there are also within-gender differences. For example, Black and Asian women are more likely to be working in occupations with “very close” physical proximity to others, compared to women of other races/ethnicities. Latina workers are more likely to be employed in occupations with “moderately close” physical proximity to others, compared to other women. Black and Latina women are both less likely to be working in occupations with “slightly close” physical proximity to others; on the other hand, White and Asian women are overrepresented in these occupations. Among men, Black, Latino, and American Indian and Alaskan Native (AIAN) men are more likely to be employed in occupations with “moderately close” physical proximity, while White and Asian men are more likely to be employed in occupations with “slightly close” physical proximity to others.

It is important to understand that the sorting of workers into different occupations based on gender and race/ethnicity drives these findings. Recall that our physical proximity measure is estimated at the occupation level, so all demographic variation in the physical proximity measure reflects differences in the occupational concentration of those groups. Therefore we here provide a brief illustration of the types of occupational sorting that underlie the patterns in Figure 1.⁷

First, it is clear that the disproportionate concentration of women in care-giving and customer-facing service jobs accounts for their higher rates of employment in occupations requiring high levels of physical proximity, relative to men (with variation by race and ethnicity). Specifically:

- **Black women** have high rates of employment in health care jobs (such as nurses and nursing assistants), personal care aides, and education jobs (K-12 teachers and teaching assistants). These occupations typically require “very close” physical proximity to others. Black women also have high rates of employment as retail workers, cashiers, office workers, social workers, and security guards; these occupations typically require “moderately close” physical proximity to others. Common occupations with “slightly close” physical proximity include managers, accountants and bookkeepers, human resources workers, and housekeeping cleaners/janitors.
- **Latina women** have relatively high rates of employment in health care jobs (such as nursing assistants and medical assistants), personal care aides, waiters, and education jobs (such as K-12 teachers, teaching assistants, and childcare workers). These occupations typically require “very close” physical proximity to others. Latina women also have high rates of employment in retail, as well as office jobs and garment industry jobs; these occupations typically require “moderately close” physical proximity to others. Common occupations with “slightly close” physical proximity include housekeeping cleaners/janitors, agricultural workers, and administrative assistants.
- **Asian women** have high rates of employment in health care jobs (such as nurses, nursing assistants, and pharmacy technicians), as well as personal services jobs (such as personal care aides, manicurists, and hairdressers). These occupations typically require “very close” physical proximity to others. Asian women also have high rates of employment in customer service and retail, as well as office jobs and garment

industry jobs; these occupations typically require “moderately close” physical proximity to others. Common occupations with “slightly close” physical proximity include accountants and bookkeepers, managers, software developers, and administrative assistants.

- **White women** have high rates of employment in health care jobs (such as nurses and nursing assistants), restaurant, and personal care aides, as well as education jobs (such as K-12 teachers). These occupations typically require “very close” physical proximity to others. White women also have high rates of employment as sales and retail workers, office clerks, post-secondary teachers, and education and childcare administrators; these occupations typically require “moderately close” physical proximity to others. Common occupations with “slightly close” physical proximity include accountants and bookkeepers, managers, and administrative assistants.

Second, it is clear that the disproportionate concentration of men in blue-collar and professional jobs accounts for their higher rates of employment in occupations requiring “moderately close” or “slightly close” physical proximity, relative to women (with variation by race and ethnicity). Specifically:

- **Black men** have high rates of employment as truck drivers, security guards, laborers and stockers, and retail jobs; these occupations typically require “moderately close” physical proximity to others. Common occupations for Black men entailing “slightly close” physical proximity include managers, accountants, computer occupations, and janitors. Common occupations entailing “very close” physical proximity include K-12 teachers, police officers, restaurant jobs, personal care aides, construction, and mass transit bus drivers.
- **Latino men** have high rates of employment as truck drivers, construction workers, retail workers, landscapers, production workers, and laborers and stockers; these occupations typically require “moderately close” physical proximity. Common occupations entailing “slightly close” physical proximity include managers, agricultural workers, janitors, and truck and tractor operators. Common occupations entailing “very close” physical proximity include restaurant jobs, construction jobs, police officers, and K-12 teachers.
- **Asian men** have high rates of employment as software developers, accountants, and managers, as well as engineers; these occupations typically require “slightly close” physical proximity to others. Common occupations for Asian men entailing “moderately close” physical proximity include truck drivers, as well as retail jobs, production jobs, and laborers and stockers. Common occupations entailing “very close” physical proximity include physicians, nurses, restaurant jobs, and personal care aides.
- **White men** have high rates of employment as managers, software developers, accountants, and lawyers; these occupations typically require “slightly close” physical proximity to others. Common occupations for White men entailing “moderately close” physical proximity include truck drivers, laborers and stockers, sales workers, managers, and jobs in retail. Common occupations entailing “very close” physical proximity include K-12 teachers, police officers, firefighters, restaurant jobs, physicians, and construction jobs.

These brief summaries only scratch the surface of a complex matrix of occupational segregation by gender, race, and ethnicity in the California labor market. In fact, occupational segregation remains widespread in the U.S.⁸ The forces that drive occupational segregation range from outright discrimination, legacies of decades of discriminatory employment policies, and current social and economic factors shaping career choices (that

themselves represent institutionalized racism, sexism, and nativism), affecting a wide range of job quality and career outcomes. And now, occupational segregation also has the potential to result in different levels of workplace exposure to the coronavirus for different gender and race/ethnicity groups.

5. Job characteristics

In this section, we look more closely at the job characteristics of the three categories of occupational physical proximity in terms of wage levels and industrial, sectoral, and geographical distributions. Here we are asking, for example, what percent of low-wage workers fall into each of the three physical proximity groups.⁹

Overall, our estimates suggest that workers who have a low-wage job, who work in certain industries such as health care and social assistance, who work for state and local government, or who work in certain geographical areas such as the Inland Empire, are more likely to be employed in jobs requiring higher levels of physical proximity to others.

For example, as shown in Table 4, while 81.2% of low-wage workers are in occupations requiring “moderately close” and “very close” physical proximity to others, the percentage of medium/high-wage workers who fall into those categories is 64.2%.

Table 4. Distribution of job characteristics across different levels of occupational physical proximity, California, 2018

	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
All workers	30.3	47.6	22.1
Wage level			
Low-wage	18.8	56.6	24.6
Medium/high wage	35.8	43.3	20.9
Industry			
Agriculture, Forestry, Fishing, and Hunting	73.4	21.9	4.7
Construction	20.7	60.8	18.5
Manufacturing	40.1	58.2	1.7
Wholesale Trade	37.2	60.1	2.8
Retail Trade	12.6	83.5	3.9
Transportation and Warehousing and Utilities	23.1	62.1	14.9
Information	49.5	46.9	3.5
Finance and Insurance	63.5	31.8	4.7
Real Estate and Rental and Leasing	30.3	67.9	1.9

Table 4 (continued)

	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
Professional, Scientific, and Technical Services and Management of Companies	70.2	27.2	2.6
Administrative and support and waste management services	37.5	59.4	3.1
Educational Services	15.1	39.8	45.1
Health Care and Social Assistance	17.0	21.9	61.0
Arts, Entertainment, and Recreation	26.4	46.2	27.4
Accommodation and Food Services	9.8	49.0	41.2
Other Services	29.9	45.0	25.1
Public Administration	35.5	32.2	32.3
Military	25.2	57.0	17.8
Sector			
Private sector	31.5	50.5	17.9
Non-profit sector	30.9	37.8	31.2
Federal government	31.2	45.5	23.3
State government	26.1	36.4	37.6
Local government	20.6	35.7	43.7
Geography – place of work			
Superior California	28.0	47.7	24.3
North Coast	28.3	47.7	24.0
San Francisco Bay Area	39.0	41.3	19.7
Northern San Joaquin Valley	25.6	50.9	23.5
Central Coast	31.2	46.9	21.9
Southern San Joaquin Valley	27.9	47.9	24.3
Inland Empire	21.8	54.8	23.4
Los Angeles	27.8	49.8	22.4
Orange County	32.7	47.6	19.7
San Diego - Imperial	29.8	46.7	23.5

Note: Low-wage is defined as wages lower than \$14.68 per hour in 2018 dollars, or two-thirds of the state's median full-time wage.

Census definitions for California regions available at <https://census.ca.gov/regions/>

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET).

See Technical Appendix for details.

Table 4 also shows that industries vary significantly in terms of physical proximity in the workplace. The Health Care and Social Assistance industry has the highest percentage of workers in the “very close” physical proximity category (61.0%), while the Retail Trade industry has the highest percentage of workers in the “moderately close” category (83.5%). In contrast, 73.4% of workers in the Agriculture, Forestry, Fishing, and Hunting industry are employed in occupations requiring “slightly close” physical proximity.

At the sector level, Table 4 shows that State and Local Government workers, as well as workers employed by nonprofits, have the highest rates of employment in occupations requiring “very close” physical proximity—not surprisingly, given the prevalence of healthcare, personal care aides, and education occupations in these sectors. Private-sector employees have the highest percentage of workers in occupations requiring “moderately close” and “slightly close” physical proximity to others.

Finally, to examine geographic differences in estimated occupational physical proximity, we use information about respondents’ place of work in our American Community Survey sample, categorized into ten geographical regions.¹⁰ (Detailed estimates by county are listed in Technical Appendix Table A.1).

Table 4 does not show dramatic differences across the regions, with two exceptions. First, 39.0% of the San Francisco Bay Area workforce is employed in occupations that require “slightly close” physical proximity to others. Second, in the Inland Empire, only 21.8% of workers are employed in such occupations, while 54.8% work in occupations requiring “moderately close” physical proximity (the highest percentage among all the ten regions).

6. Working remotely

As has been widely discussed, some occupations can potentially be performed remotely and could therefore reduce the risk of coronavirus exposure—if those workers are allowed to do so by their employers, which is not guaranteed or automatic.

In Table 5 we show, within each physical proximity category, the percentage of workers that could potentially work remotely. Again, a reminder that this occupation-level measure only captures the *potential* for remote work; actual ability to work remotely depends on occupational content, workplace organization, policy responses to the COVID-19 pandemic, and, importantly, employer decision-making (see the Technical Appendix for more detail on this measure).

Table 5. Distribution of workers’ occupations that could potentially be done remotely, within each level of physical proximity, California, 2018

Occupations where workers are:	Distribution of workers within physical proximity categories (column percentages)			Share of all workers
	Slightly close proximity	Moderately close proximity	Very close proximity	
Potentially able to work remotely	75.0	29.6	24.0	42.1
Potentially not able to work remotely	25.0	70.4	76.0	57.9
Total	100.0	100.0	100.0	100.0

Source: Authors’ analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

We estimate that overall, more than half of the California workforce, or 57.9%, is employed in occupations where remote work is likely not feasible. But the potential ability to work remotely is not evenly distributed. In occupations requiring “very close” physical proximity to others, more than three quarters of workers (76%) are likely not able to work remotely. Similarly, in occupations requiring “moderately close” physical proximity to others, 70.4% of workers are likely not able to work remotely. By contrast, in occupations requiring “slightly close” physical proximity to others, fully 75% could potentially work remotely.

While these two measures (physical proximity and the potential for remote work) are correlated, they are not the same. Some occupations requiring “very close” physical proximity could potentially be performed remotely (such as Teaching Assistants and Recreation Therapists). And some occupations requiring “slightly close” physical proximity must be performed in person (such as Industrial Truck and Tractor Operators), and could therefore still entail risk (for example, from commuting to work, or changing uniforms in the locker room).

Table 6 shows the potential for being able to work remotely, by demographic characteristics. We find that men, Latino/a workers, American Indian and Alaskan Native workers, young workers, foreign-born workers, workers with an associate’s degree or less, and low-wage workers all have high rates of employment in occupations where they are unlikely to be able to work remotely.

Table 6. Percent of workers in occupations that could, and could not, potentially be done remotely, California, 2018

	Percent of workers in occupations where workers are: (row percentages)	
	Potentially able to work remotely	Potentially not able to work remotely
All workers	42.1	57.9
Gender		
Women	48.7	51.3
Men	36.5	63.5
Race/ethnicity		
Black	41.4	58.6
Latino/a	26.9	73.1
Asian	50.5	49.5
White	54.1	45.9
America Indian & Alaskan Native	37.2	62.8
Other	49.9	50.1
Age		
18-24	27.5	72.5
25-34	42.5	57.5
35-54	44.9	55.1
55-64	44.4	55.6
65+	48.0	52.0

Table 6 (continued)

	Percent of workers in occupations where workers are: (row percentages)	
	Potentially able to work remotely	Potentially not able to work remotely
Nativity		
US born	46.4	53.6
Foreign born	33.8	66.2
Education		
Less than high school	7.3	92.7
High school	24.5	75.5
Some college/ Associate's degree	37.2	62.8
Bachelor's degree	64.4	35.6
Graduate degree	75.0	25.0
Wage level		
Low-wage	23.6	76.4
Medium/high wage	51.0	49.0

Note: All race/ethnicity categories other than Latino/a are non-Hispanic only.

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

7. Essential workers

If infection rates increase in California and parts of the economy are shut down again, “essential” workers as designated by Governor Newsom will still remain on the job. In Table 7, we show estimated levels of physical proximity for essential workers (which we estimate constitute 43.8% of the California workforce), compared to all other workers. In this table, we use the definition of front-line essential workers adopted in our [previous report](#).

Table 7. Distribution of front-line essential workers across occupational physical proximity levels, California, 2018

	Distribution of workers across physical proximity categories (row percents)		
	Slightly close proximity	Moderately close proximity	Very close proximity
Front-line essential workers	16.8	55.7	27.5
All other workers	40.8	41.3	17.9
All workers	30.3	47.6	22.1

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET). See Technical Appendix for details.

Table 7 shows that the large majority of front-line essential workers (83.2%) are employed in occupations requiring “moderately close” and “very close” physical proximity; for all other workers, this percentage is 59.2%. Only 16.8% of front-line essential workers are employed in occupations requiring “slightly close” physical proximity. Moreover, we estimate that 81.1% of front-line essential workers are employed in occupations where remote work is likely not feasible, compared to 39.8% for all other workers (not shown).

8. Conclusion

In order to better understand workplace exposure to the coronavirus, we have analyzed data on the extent of physical proximity to others in California’s workplaces, under the scenario of a fully-reopened economy. But the *actual* exposure risk that workers face going forward will be determined by public health measures and by public policies ensuring that firms create safe and healthy workplaces for their employees. For example, worker advocates [have called for](#) implementation of COVID safety measures in the workplace, including not only physical distancing, but changes in staffing, work pace, and scheduling to allow distancing; installation of protective barriers; access to time and supplies for handwashing; provision of appropriate personal protective equipment; and guaranteed paid time off if sick or needing to quarantine. Employers will need to both comply with state and local regulations, and work hard to create a workplace that is as safe as feasible. Unfortunately, there currently is significant variation in what employers are doing to protect their workers.¹¹ As [research](#) has shown, an important part of the strategy to ensure the safety of California’s workers is to provide a central voice for workers in identifying unsafe practices and developing solutions.

Technical Appendix

Data sources

Our information on workers' individual and job characteristics draws on the IPUMS-USA extract of the American Community Survey (ACS) 1-year sample for 2018. Our ACS sample comprises 18+ year-olds, with non-zero earnings in the past year, who were not self-employed or unpaid family workers, and who were at work last week or had a job but were not at work last week. The ACS sample is restricted to individuals who live and work in the state of California.

Our information on occupational physical proximity to others and the ability to work remotely is based on Occupational Information Network (O*NET) data. O*NET is a survey of a random sample of U.S. workers of almost 1000 occupations, asking a wide range of questions regarding the knowledge, work activities, abilities, and skills required in each occupation. We use the O*NET 24.2 dataset, released February 2020; note however that O*NET updates its occupational measures on a rolling basis and some of the raw input data dates back before 2018.

Measures

Following [Mongey et al. \(2020\)](#) we measure the occupational physical proximity to others based on [Question 21 in the Work Context Questionnaire](#) that is asked of workers: "How physically close to other people are you when you perform your current job?" Possible answers range from "I don't work near other people (beyond 100 ft.)" (score: 0), to "I work with others but not closely (e.g., private office)" (score: 25), to "Slightly close (e.g., shared office)" (score: 50), to "Moderately close (at arm's length)" (score: 75), to "Very close (near touching)" (score: 100). Occupations are then assigned the average of the responses. We calculate standardized scores at the occupational level using [the formula specified by O*NET](#). We merge these occupation-level scores to our IPUMS dataset (this step requires several occupational code crosswalks).

To create our physical proximity measure, we categorize and label occupations with scores of 0-50 as "slightly close" proximity occupations; occupations with scores above 50 and up to 75 as "moderately close" proximity occupations; and occupations with scores above 75 as "very close" proximity occupations. These labels are adopted from O*NET, based on the upper bounds of the category cut points. We verified this labeling by closely inspecting the occupations falling into each of our three categories. We do not create a separate category for the lowest quantile (score 0-25) because only a small fraction of workers (less than 1%) fall in this range.

To measure the potential ability to work remotely at the occupational level, we follow [Dingel & Neiman \(2020\)](#), who use 17 different questions about occupations, such as the importance of performing general physical activities (Q16A) and exposure to disease or infection at least once a week (Q29). For each occupation, the authors collapse average responses to each O*NET question into a binary (one or zero) variable, with one indicating that the occupation cannot be performed remotely. If any of the 17 measures for a given occupation are equal to one, the occupation is considered to have low potential for remote work.

Our geographic measure categorizing the respondent's place of work is based on the [ten California regions](#) defined by the Census. To link each worker to a region, we use the worker's place of work from the ACS, which records the location of the respondent's primary workplace, and use [Geocorr 2018](#) to link the place of work to the county. Since the measurement unit of the place of work sometimes contains multiple counties and is not

always consistent with the 10 regions defined by Census, there are three counties that are grouped differently in our study compared to the Census definition: Inyo, Trinity, and Del Norte. The following table shows the distribution of the three occupational physical proximity categories within each county:

Table A.1 Distribution of workers across different levels of occupational physical proximity, by county, California, 2018

	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
All counties	30.3	47.6	22.1
Alameda	33.8	46.8	19.4
Alpine, Amador, Calaveras, Inyo, Mariposa, Mono & Tuolumne	22.1	49.2	28.7
Butte	25.4	47.6	27.0
Colusa, Glenn, Tehama & Trinity	30.7	47.7	21.6
Contra Costa	30.2	45.0	24.8
Del Norte, Lassen, Modoc, Plumas & Siskiyou	25.6	47.2	27.2
El Dorado	27.6	48.1	24.3
Fresno	25.5	49.3	25.2
Humboldt	27.5	48.2	24.3
Imperial	22.1	47.6	30.2
Kern	30.0	46.7	23.2
Kings	22.2	47.0	30.8
Lake & Mendocino	26.2	50.2	23.6
Los Angeles	27.8	49.8	22.4
Madera	33.8	36.6	29.5
Marin	29.7	45.1	25.2
Merced	31.7	44.3	24.0
Monterey	30.4	44.8	24.7
Napa	30.2	47.3	22.5
Nevada & Sierra	19.6	53.2	27.2
Orange	32.7	47.6	19.7
Placer	25.5	48.0	26.5
Riverside	22.4	54.0	23.6
Sacramento	30.4	45.9	23.7

Table A1 (continued)

	Distribution of workers across physical proximity categories (row percentages)		
	Slightly close proximity	Moderately close proximity	Very close proximity
San Bernardino	21.2	55.5	23.3
San Diego	30.1	46.7	23.3
San Francisco	43.8	36.8	19.4
San Joaquin	23.9	56.3	19.8
San Luis Obispo	27.4	50.1	22.5
San Mateo	40.9	41.3	17.8
Santa Barbara	34.8	43.0	22.2
Santa Clara	44.5	37.9	17.6
Santa Cruz	29.7	50.6	19.7
Shasta	20.3	53.5	26.3
Solano	23.3	50.0	26.7
Sonoma	28.3	47.1	24.6
Stanislaus	23.9	50.6	25.5
Sutter & Yuba	22.6	48.9	28.5
Tulare	31.0	46.8	22.2
Ventura	31.3	48.2	20.6
Yolo	27.9	53.1	19.0

Source: Authors' analysis of 2018 IPUMS American Community Survey (ACS) and 2018 Occupational Information Network data (O*NET).
See Technical Appendix for details.

Endnotes

- 1 For example, [Lan, et al. \(2020\)](#) analyze government reports from six Asian countries in 40-day periods and find that work-related transmission accounted for 47.7% of early cases and 14.9% of total (690) local cases. [Lewandowski \(2020\)](#) finds that 20-25% of the cross-country variance in numbers of COVID-19 cases and deaths in European countries can be attributed to occupational exposure risks. In California, [San Diego County reports](#) that more than 30% of the confirmed cases are workplace-related.
- 2 See the results from the California Health Interview Survey in the [UCLA Center for Health Policy Research \(2020\)](#). Nationally, the [Centers for Disease Control and Prevention \(CDC\) \(2020\)](#) estimate that Black and Latino/a COVID-19 infection rates are 2.6 and 2.8 times higher, and mortality rates are 1.1 and 2.1 times higher, respectively, compared to White rates.
- 3 A [study of infections by occupation](#) in Europe found that workers with higher levels of physical proximity had a higher risk of infection.
- 4 See [Dingel & Neiman \(2020\)](#); [Mongey, Pilossoph, & Weinberg \(2020\)](#); [Leibovici, Santacreu, & Famiglietti \(2020\)](#); [Kearney & Pardue \(2020\)](#); and [Baker, Peckham, & Seixas \(2020\)](#).
- 5 "Other" includes respondents who report "other" race, or two or more races.
- 6 Such as maids and housekeeping cleaners, construction workers, cooks, and food preparation workers, as shown in [Pastor & Scoggins \(2020\)](#) and [Passel & Cohn \(2016\)](#).
- 7 Contact authors for detailed results. We are not able to analyze occupational sorting for American Indian and Alaskan Native workers because of insufficient sample sizes.
- 8 For reviews of the literature on occupational segregation, please see [Stainback & Tomaskovic-Devey \(2012\)](#), [Hegewisch & Hartmann \(2014\)](#), [Gould, Schieder, & Geier \(2016\)](#), and [Cortes & Pan \(2017\)](#).
- 9 Low-wage is defined as wages lower than \$14.68 per hour in 2018 dollars, or two-thirds of the state's median full-time wage, a [commonly used metric](#).
- 10 We adopt Census definitions for California regions at <https://census.ca.gov/regions/>, with minor adjustments. Please see the Appendix for details.
- 11 For example, [The Shift Project](#) finds that there is significant variation across service-sector companies in access to paid sick leave.

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Acknowledgements

This research was supported by grants from The James Irvine Foundation and The California Wellness Foundation. The authors thank Laura Stock for generously sharing her expertise in workplace health and safety with us; in addition, she and Sara Hinkley, Ken Jacobs, Laurel Lucia, and Manuel Pastor provided valuable feedback on this research brief. All errors are our own.

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Suggested Citation

Huang, Kuochih, Tom Lindman, Annette Bernhardt, and Sarah Thomason. *Physical Proximity to Others in California's Workplaces: Occupational Estimates and Demographic and Job Characteristics*. UC Berkeley Labor Center, November 2020. <https://laborcenter.berkeley.edu/publication/physical-proximity-to-others-in-californias-workplaces/>.

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