

UNIVERSITY OF MINNESOTA

Racial/Ethnic Differences in Social Contact Patterns and Implications for COVID-19

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Abstract:

COVID-19 has devastated Black and Hispanic communities in the United States, impacting these groups much more than Whites and Asians. These racial disparities are primarily driven by unequal infection risks. Since COVID-19 is primarily transmitted through close person-to-person contact, it is important to study how and why interpersonal contacts vary by race and ethnicity. We analyze racial/ethnic differences in the duration of social contacts (a key risk factor for covid exposure) from 2019-2021 using the American Time Use Survey data. We examine differences in social contact durations by location (home, workplace, public (indoor and outdoor) and by race/ethnicity (Asian/Other, Black, Hispanic, and White). During the pandemic, Black people had a significantly lower duration of social contacts at home compared to Whites and other racial groups. In contrast, Black and Hispanic respondents had longer duration of social contacts at work compared to White respondents and these differences did not disappear after controlling for a host of factors. Studies that rely on occupation to determine workplace COVID-19 exposures may be underestimating the true magnitude of racial disparities. Differences in duration of social contacts in public indoor and outdoor locations other than respondents' workplace were not very large. Policies should focus on reducing workplace exposures to reduce COVID-19 racial disparities in COVID-19 exposures and cases. These policies will likely have spillover effects since high-risk individuals are more likely to live in multigenerational households and may have higher rates of contact with each other.

Keywords: social or interpersonal contact; occupational exposure; racial disparities; COVID-19; time use

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1 Introduction

COVID-19 devastated Black, and Hispanic communities in the United States during the first two years of the pandemic. During the first few months of the pandemic, the Black population had 1.5 to 3.5 times higher risk of SARS-CoV2 infection compared to White (Mackey et al., 2021). Similarly, Hispanics experienced elevated rates of SARS-CoV2 infections (with some studies reporting risks 20 times higher) compared to non-Hispanic White populations (Ahmed et al., 2020; Chamie et al., 2021; Mackey et al., 2021). In contrast, few studies report significant differences in the risk of infection between Asian and White populations. The large disparities in infections and cases for Black, Hispanic, and American Indian/Alaska Natives as compared with the rest of the population resulted in higher age-adjusted deaths rates during the first two years of the pandemic.

These racial disparities in COVID cases were not due to variation in testing rates (Rubin-Miller et al., 2020), differences in age composition (Zelner et al., 2021), or explained by underlying conditions or site of care (Ogedegbe et al., 2020; Rentsch et al., 2020) Instead, the racial disparities were primarily driven by unequal infection risk, which is the likely result of higher COVID-19 exposure (Zelner et al., 2021). In line with this, Nelson et al. 2022 find that those with higher numbers of social contacts were also more likely to test positive for SARS-CoV-2 antibodies compared to those with fewer contacts. Since SARS-CoV-2 is primarily transmitted through interpersonal contacts, it is important to study how and why these social contacts vary over time by race and ethnicity.

1.1 Measures of Social Contacts

Social contact or interpersonal contact is an interaction with another person when both people are physically present. This includes interactions that involve physical skin-to-skin contact

such as handshakes or kissing, and contacts such as two-way conversations (an exchange of at least three words) in close physical proximity (Dorélien, Venkateswaran, et al., 2021; Mossong et al., 2008). In the context of respiratory infectious disease, social contacts can also include activities/time spent in the presence of others (McCreesh et al., 2019, 2022). Social contact studies typically collect information on the respondents' age, gender, and often some other sociodemographic characteristics, the total number of contacts, and detailed information about contacts (Dorélien, Venkateswaran, et al., 2021; Jarvis et al., 2020; Nelson et al., 2022). This detailed information includes each contact's age, gender, location of the contact, and the nature of the contact (physical, conversational). Information is also collected on the duration of each contact. Social contact data is used to identify high-risk groups who may be most likely to spread or be infected during an outbreak. The information that is collected is also used to create age-structured contact matrices (matrices describing the average number of daily contacts between individuals in different age groups), which are used to parameterize models of respiratory disease spread (Dorélien et al., 2020; Hoang et al., 2019; Mossong et al., 2008). These models are in turn used to guide policy, such as the most effective non pharmaceutical interventions (NPIs), especially when vaccines are not yet available (Nelson et al., 2022).

Ideally, we would have detailed social contact data for the United States and would be able to disaggregate by race and ethnicity. This would allow policy makers to identify racial/ethnic groups most at risk of being exposed to and or transmitting COVID-19 as well as study the effects of different NPIs on overall case rates and on different racial/ethnic groups. Social contact data would also allow us to identify high risk locations/activities. Unfortunately, nationally representative data on racial differences in social contact patterns is limited. Prior to the pandemic there were very few studies of social contacts in the United States; therefore there is very little baseline data and very little social contact data that can be disaggregated by race/ethnicity (Dorélien, Venkateswaran, et al., 2021). During the pandemic, many of the social contact surveys were not based on nationally representative surveys or large enough to provide estimates by race/ethnicity (Dorélien, Venkateswaran, et al., 2021; Feehan & Mahmud, 2021; Kiti et al., 2021). In Minnesota, those in Black households had a higher mean number of contacts during the first wave of the pandemic (April-May 2020) compared to members of White households but that difference was not statistically significant (Dorélien, Venkateswaran, et al., 2021). Using a convenience sample that was intended to be representative of the US, Feehan and Mahmud (2021) found racial differences in contacts and that the rates varied across time. During their first survey round (April- May 2020) Black and Hispanics reported the highest number of non-household contacts; however, by the third survey round (September 2020) Whites reported the highest number of contacts. The only nationally representative US social contact survey conducted during the pandemic did identify racial/ethnic differences in the number of social contacts (Nelson et al., 2022). Specifically, they find that in Fall 2020 and Spring 2021, respondents coded as 'Other' (non-Hispanic, non-Black, non-White) had the largest number of contacts while Asians had the fewest social contacts. To summarize, racial/ethnic differences in social contacts have been documented in the US; however no consistent pattern emerges. Existing studies have not focused on analyzing racial/ethnic differences in contacts and none of the aforementioned studies had more than 500 respondents in the underrepresented racial/ethnic groups. Most importantly, previous work cannot document how social contacts changed during the pandemic, because none of these studies have pre-pandemic data.

1.2 Paper Contributions

The lack of social contact data means that it is difficult to identify what drives racial differences in exposure and therefore cases. The higher COVID-19 infection rates of Blacks and Hispanics may be due to a higher risk of exposure in any setting: in their homes, at their workplaces, on public transportation, or other settings. The main contributions of this paper are twofold. First, we disaggregate contacts by location and the race/ethnicity of respondents. This is important because the riskiness of social contacts vary by settings. In the next section, we review the literature on racial differences in COVID-19 exposures across different settings; however, few of these studies are based on actual social contact data. Second, we track how these differences in social contacts across racial groups changed during the pandemic, tracking patterns from the prepandemic period into the early and late pandemic.

We use data from the American Time Use Survey (ATUS), a large nationally representative sample, which contains more than 1,000 Black and Hispanic respondents during each survey year (see Table 1); this is larger than the samples in any other published studies of contact patterns in the United States (DeStefano et al., 2011; Dorélien, Venkateswaran, et al., 2021; Feehan & Mahmud, 2021; Nelson et al., 2022). Consequently, we have enough statistical power to detect racial differences in social contacts. In addition, we have multiple years of data (2019-2021), which allows us to document changes over time.

We also explore an understudied aspect of social contact patterns: the duration of contacts. For any given number of contacts, the exposure has to be long enough for disease transmission to occur (Cao et al., 2014). We do this by analyzing the racial/ethnic differences in the duration of social contacts. Duration of social contact is the total time spent (in minutes per day) doing an activity with others, or time spent in a location that is enclosed and others are always present (grocery store, church, riding on a bus, etc.). Duration of contact is one measure of interpersonal contacts; we know if the respondent is with at least one other person, but we do not have information on the total number of contacts. Data on duration of social contacts have been used to parameterize models of infectious disease transmission and have significantly improved model performance (Cao et al., 2014; Zagheni et al., 2008).

Specifically, we measure and describe the unconditional racial differences in the duration of social contacts, in household, workplace, and community locations. This is important because it reflects the actual experiences of people in different racial groups. Then we describe how the magnitudes of the racial gaps change after controlling for age, sex, employment status, household composition (number, multigenerational status), and presence of children under age 18. We also control for calendar-months (to account for seasonal patterns in contacts); state fixed effects (to account for differences in COVID-19 policies) and metro size. To better understand the role of occupational exposure in driving racial differences in workplace social contacts, we conduct a separate analysis based on employed individuals working on the diary day¹ and control for their occupation. The controls help us identify which selection and compositional factors are associated with the racial/ethnic differences in contact patterns.

We find that occupational exposures are likely the biggest drivers of racial disparities in COVID-19 exposures and cases. Black and Hispanics workers had a longer duration of workplace social contacts compared to White workers, and this difference increased during the pandemic. This higher level of workplace exposure may in turn make household contacts riskier for Hispanics and Black respondents, by creating primary infections that cause secondary spread of the disease.

¹ Diary day is the designated time diary day for which respondents report all their activities starting from 4am and ending at 4am on the following day.

After adding controls, the gap shrinks by a few minutes between Black and White workers but increases between Hispanic and White workers. During the pandemic, Black people had a significantly *lower* duration of social contacts at home compared to Whites and other racial groups; adding controls explains some but not most of the differences in duration of social contacts in the home. Racial disparities in exposures and cases do not appear to be driven by differences in contacts in public locations, or in outdoor and other settings.

1.3 Existing literature on racial differences in COVID-19 exposures by setting type

Exposures at home. Racial and ethnic differences in the size and age composition of households may explain differences in COVID-19 exposures in the home (Stokes & Patterson, 2020). If one member is exposed, the virus may spread to a larger number of household members in larger households. Larger household size may increase the risk of COVID-19 spread in Hispanic and Asian households. Racial/ethnic differences in the age composition of households can also play a role; older adults from some minority racial/ethnic groups are more likely to live in multigenerational households (Cross, 2018). The share of multigenerational households increased during the pandemic (Cohen, 2020; Thomeer et al., 2020). These multigenerational households are at heightened risk because they are more likely to contain working age household members, and the older adults are more likely to be interacting with young children (Patterson & Margolis, 2019). Household exposure does not occur in isolation; it is always driven by exposures occurring outside the home. Family members who worked outside the home during the pandemic can expose other family members to the virus. Therefore, racial differences in the fraction of household members working outside the home or in "essential" high risk occupations could contribute to racial disparities in exposure (Selden & Berdahl, 2020). There is evidence that "essential" workers are more likely to be women and racial/ethnic minorities (Robertson & Gebeloff, 2020).

Exposures in the workplace. The workplace is an especially important source of exposure; the only nationally representative social contact survey in the US found that the workplace accounted for more than 50% of social contacts during two survey periods (Nelson et al., 2022). Workplaces were also most likely to have respondents with very large numbers of contacts (Dorélien, Ramen, et al., 2021; Nelson et al., 2022). Consequently, the workplace is likely the most important source or racial differences in social contacts. While Nelson et al. (2022) documents racial differences in contact patterns, their focus was on changes in contacts between Fall 2020 and Spring 2021; they therefore did not focus on quantifying racial differences in contacts across different settings. Nevertheless, they and other studies note that racial and ethnic differences in COVID-19 exposures while working and in the workplace may be driven by differences in labor force status, occupation, and nature of the job (essential, front-line, high risk, etc.). Based on pre-pandemic data, Black, Hispanic, and Asian workers were slightly more likely to work in "essential" jobs compared to White workers (Selden & Berdahl, 2020). Not all essential workers experience the same COVID-19 risks. Black workers were more likely to work in the health care sector; Hispanics were overrepresented in the food sector; and Asians had the greatest share of essential workers with the ability to work from home (Selden & Berdahl, 2020). Hispanic and Black workers were also more likely to work in occupations requiring close contacts (Dorélien, Ramen, et al., 2021). Furthermore, within specific occupations, difference in occupational standing can influence COVID-19 exposure risks. Using data on potential COVID-19 risk factors based on pre-pandemic occupation data, Goldman et al (2021) found that Black and Hispanic frontline workers were under-represented in high-risk jobs (defined as occupations in highest quartiles or risk based on multiple O*NET data measures of exposure) but overrepresented in low-standing occupations (jobs with low education levels) in which workers may be less likely to utilize risk reduction strategies and therefore may have higher exposure to COVID-19. During the first years of the pandemic, one study found that in Massachusetts, Black and Hispanic workers had higher COVID-19 mortality rates than Whites within high-risk occupations, which supports the hypothesis that they have higher work contacts (Hawkins et al., 2021).

Exposures in public indoor settings, outdoors, and other people's homes. In addition to spending time with others at home and the workplace, people also interact with others at school, while commuting, when attending places of worship, while eating out, and when enjoying recreational activities. Consequently, racial differences in exposures could also be driven by differential social contact rates in these diverse settings. Prior to the pandemic, school settings represented a large share of social contacts for young individuals; however during the first years of the pandemic school closures meant that in-school contacts were significantly reduced (Dorélien, Venkateswaran, et al., 2021; Nelson et al., 2022). However there were important racial/ethnic differences in school modality (Camp & Zamarro, 2022): White students were more likely to attend school in person. Outside of school settings, it is not clear which racial and ethnic groups are likely to have more social contacts in public indoor settings or outdoors. Black and Hispanic populations may have more social contacts than Whites during the pandemic because they may be more likely to have to commute for work; on the other hand, studies indicate that Black and Hispanic groups were more concerned about COVID-19 so may have exhibited more avoidance behavior (Lin & Liu, 2022).

2 Data and Methods

2.1 Data

The main source of our data is the Bureau of Labor Statistics' American Time Use Survey (ATUS). The survey is conducted over telephone and collects time use diaries, where respondents are asked to recall their activities for 24 hours preceding the survey. The survey has been administered continuously throughout the year since 2003, with a brief pause during the start of the nationwide lockdown due to the COVID-19 pandemic. The data for 2019, 2020, and 2021 were obtained using the ATUS-X data available through IPUMS Time Use (Sarah M. Flood et al., 2022).

The sample for ATUS is drawn from respondents who have completed the full rotation for the Current Population Survey (CPS)². The ATUS is nationally representative and collects 8,000 to 10,000 observations per year on individuals of ages 15 and over. The sampling frame includes all civilian populations that are not institutionalized in prisons or nursing homes, or actively serving in the military (similar to the CPS). Weekends are oversampled in the ATUS (Saturday and Sunday make up 50 percent of the diary days). In the 24-hour time diary collected by ATUS, activities are described chronologically with the location where and with whom the activity was done. The ATUS also provides the duration of the activities in increments as small as one minute.

Our analytical sample has 27,158 observations. We employ the respective weights for each year. For analysis of data from 2020 and for comparisons with 2019, we use specific weights created for the observations collected in 2020. These special weights allow for consistent

 $^{^2}$ The Current Population Survey's sample rotation pattern is designed where households spend 8 months overall participating in the survey. Households spend 4 consecutive months in the sample, 8 months out of the sample, and 4 consecutive months back in the sample. ATUS samples from CPS households that have completed all 8 months in the sample rotation pattern.

comparison due to the brief discontinuity in data collection in 2020 due to the COVID-19 pandemic. After applying the appropriate weights, our analytic sample consists of 14,732 females (51.6%) and 12,426 males (48.4%). We group racial/ethnic categories into four groups in our sample—Non-Hispanic White, Non-Hispanic Black, Hispanic, and Non-Hispanic Asian/Other (about 70% of that group is Asian). In the paper we sometimes drop the prefix non-Hispanic; all racial categories that we use other than Hispanic are only those people who are not Hispanic. Demographic characteristics are similar between 2019 and 2021 in age, race/ethnicity, and household composition (Table 1A). However, the proportion of unemployed individuals out of all people changed in 2020. The proportion of respondents who were unemployed and not in the labor force was higher in 2020 and 2021 compared to 2019.

Table 1A. Demographic characteristics were similar across the survey years, however the proportion of unemployed and individuals in the labor force changed in 2020.

	2019		2020			2021		Total
		Weighted		Weighted		Weighted		Weighted
	N	proportion	Ν	proportion	Ν	proportion	Ν	proportion
		(in percent)		(in percent)		(in percent)		(in percent)
Sex								
Male	4,293	48.44	4,018	48.30	4,115	48.51	12,426	48.42
Female	5,100	51.56	4,712	51.70	4,920	51.49	14,732	51.58
Race/Ethnicity								
White	6.380	64.78	5.895	64.18	6.012	62.89	18.287	63.94
Black	1,186	11.99	1,020	12.11	1,100	12.14	3,306	12.08
Asian/Other	541	6.28	564	6.60	615	7.61	1,720	6.84
Hispanic	1,286	16.94	1,251	17.12	1,308	17.36	3,845	17.14
Employment Statu	IS							
Employed	45							
Atwork	5 428	60.49	4 737	57.09	5 066	58.05	15 231	58 61
Absent	2,420	2 69	7,757	3 18	251	3.05	812	2.96
Unemployed	212	2.05	205	5.10	251	5.05	012	2.50
On layoff	22	0.23	80	0.93	28	0.27	130	0.46
Looking	242	3 29	261	3 70	217	3 23	720	3 39
Not in labor force	3.429	33.29	3.363	35.10	3.473	35.39	10.265	34.57
	0,120	00.25	0,000	00110	0,170	00.00	10)200	0 1107
Marital Status								
Married								
Spouse present	4,503	49.53	4,279	49.21	4,400	49.98	13,182	49.59
Spouse absent	161	1.33	137	1.36	144	1.30	442	1.33
Widowed	875	5.71	778	5.67	830	5.29	2,483	5.55
Divorced	1,410	10.04	1,218	9.82	1,252	9.89	3,880	9.92
Separated	229	2.09	201	1.81	1/8	1.54	608	1.81
Never married	2,215	31.30	2,117	32.14	2,231	32.01	6,563	31.80
Household size								
1	2,517	14.93	2,209	15.29	2,391	15.77	7,117	15.33
2	2,985	34.64	2,911	33.30	2,991	33.44	8,887	33.82
3	1,419	18.17	1,371	18.97	1,376	17.93	4,166	18.33
4	1,459	17.41	1,353	17.74	1,350	17.66	4,162	17.60
5	671	9.09	574	9.03	598	9.21	1,843	9.12
6	220	3.33	206	3.27	211	3.52	637	3.38
7	79	1.37	60	1.21	79	1.64	218	1.41
8+	43	1.06	46	1.19	39	0.85	128	1.01
Presence of childr	en in ho	usehold						
Yes	3,408	36.59	3,047	36.39	3,103	35.72	9,558	36.23
No	5,985	63.41	5,683	63.61	5,932	64.28	17,600	63.77
Multigenerational	househ	old						
Yes	1.021	15.88	1.051	17.11	1.042	16.39	3.114	16.43
No	8,372	84.12	7,679	82.89	7,993	83.61	24,044	83.57
Age groups	267	7.04	267	7 02	240	7 70	1 000	7.04
70-74 TO-TA	30/	7.94	30/	7.82	340	7.70	1,080	7.84
20-24 25-20	551	۵.U2 در ه	324	1.92 0 ED	355	00.\ 0 20	1,030	7.93 0 E 1
20-34	5/1 761	0./3	498 700	0.5Z	544 753	0.5U 0 E 1	1,013	LC.0 د ۸ ס
30-34	00C	0.51	723	0.45 0 10	152	0.51	2,230	0.4Z 0.00
40-44	030 701	0.09 7 //	732	0.10 7 57	029 762	0.05 7 66	2,437	0.00 7 56
45-49	732	7.44	627	7.57	624	7.00	1 989	7.50
50-54	7/2	7.00 7 7 7	663	7.43	661	7.23	2 067	7.43
55-59	782	8.23	740	8.00	660	7.85	2,007	8.03
60-64	875	7.79	782	7.90	840	7.92	2,102	7.87
65-69	830	6.57	815	6.73	802	6.90	2.447	6.73
70-74	696	5.31	687	5.55	748	5.73	2.131	5.53
75+	1,052	8.19	979	8.40	1,111	8.58	3,142	8.39

Table 1B. There are differences across race/ethnicity especially in household composition and employment. For instance, Black respondents are more likely to be unemployed, live in single-person households and multigenerational households.

_	White			Black		Asian/Other		Hispanic	
	N	Weighted proportion	N	Weighted proportion	N	Weighted proportion	N	Weighted proportion	
		(in percent)		(in percent)		(in percent)		(in percent)	
Sex									
Male	8,565	48.40	1,331	45.90	832	49.06	1,698	50.03	
Female	9,722	51.60	1,975	54.10	888	50.94	2,147	49.97	
Employment Statu	s								
Employed									
At work	10,150	58.24	1,654	54.86	1,118	61.63	2,309	61.44	
Absent	558	3.05	98	2.94	43	1.93	113	3.09	
Unemployed									
On layoff	83	0.41	12	0.21	8	0.39	27	0.84	
Looking	386	2.67	137	5.35	64	4.67	133	4.21	
Not in labor force	7,110	35.64	1,405	36.64	487	31.39	1,263	30.43	
Marital Status									
Married	0 700	F 4 00	000	22 50	0.01	40.00	1 (20	44.22	
Spouse present	9,700	54.09	883	33.58	901	48.98	1,038	44.32	
Spouse absent	1 0 2 2	0.95	260	2.02	49	3.10	90 210	2.00	
Niuoweu	1,055	0.57	500	12.20	144	2.05	210	2.01	
Separated	2,020	10.46	146	15.20	144	5.25	4/1	7.57	
Nover married	272	26.90	1 1 1 0 0	40.66	460	20 50	1 262	2.78	
Never marrieu	5,041	20.90	1,190	40.00	409	50.50	1,205	41.12	
Household size									
1	4,712	16.33	1,333	22.43	271	10.02	801	8.71	
2	6,511	38.73	948	28.91	424	25.33	1,004	22.33	
3	2,706	17.80	463	20.23	357	21.08	640	17.86	
4	2,720	16.16	316	14.74	452	25.96	674	21.62	
5	1,101	7.08	152	7.66	127	8.49	463	17.99	
6	348	2.23	60	3.55	61	5.78	168	6.57	
7	122	0.94	22	1.48	21	2.31	53	2.78	
8+	67	0.72	12	1.00	7	1.03	42	2.15	
Presence of childre	en in hou	usehold							
Yes	6,086	30.59	857	34.94	891	46.61	1,724	54.02	
No	12,201	69.41	2,449	65.06	829	53.39	2,121	45.98	
Multigenerational	househo	bld							
Yes	1.695	13.54	559	24.10	248	20.31	612	20.24	
No	16.592	86.46	2.747	75.90	1.472	79.69	3.233	79.76	
	,		,		,				
Age groups	C1F	C 20	104	7 22	115	12.20	246	12.22	
15-19	612	0.29	104	7.32	112	12.20	240	12.23	
20-24	569	7.00	162	0.99	140	11.60	227	10.52	
25-29	954	7.74	202	7.13	202	11.57	200	11.25	
25 20	1,422	7.55	212	7.00	203	9.89 10.49	200	10.45	
33-39	1 /50	6.79	223	7.37	210	10.49	252	9.47	
40-44	1 227	0.78	252	7.98 7 67	244 150	۵ UU ۲0'19	220	0.00 10 05	
-J-+J 50-54	1 267	0.00 2 0/	204 277	2.02 2.06	115	5.00	309	10.02	
55-59	1 /50/	0.04 Q 17	221	0.00	102	5.74	200	0.09 6 57	
55-55 60-64	1 607	0.42 Q 50	201	9.30 70 0	100	J.29 1 77	293	5.30	
65-69	1 767	7 62	270	9.97 Q 10	100 Q1	4.72	201	3.20	
70-74	1 600	7.03 6.65	222	5,51	64	-1.03 2.62	170	5.50 2⊿a	
75+	2,526	10.65	349	7.36	69	2.00	198	2.45	
-	_,010	20.00	0.5	,		2.55		2.00	

2.2 Defining social contacts

Our main outcome of interest is the duration of social contacts in minutes. Within the respondent's home or yard, any activity done in the presence of another person is considered a social contact. We exclude personal activities and sleeping as they do not have information on whether the activity was done in the presence of another person. The ATUS has limited information on the number of contacts for activities taking place outside of the home. In line with Dorélien et al 2021 and Zagheni 2008, we define an activity as a social contact if 1) the activity was done with others; or 2) the activity took place in an indoor public location where others are always present. Examples of indoor public locations are stores, gyms, places of worship, schools, taxis, trains, and airplanes; examples of public locations that are not indoors include parks. We assume that even if the respondent is doing an activity alone in an indoor public setting there are others present. Consequently, our measure of social contacts captures close interpersonal contacts as well as some potential airborne transmission.

Locations coded as "Other" are every place where activities take place in the presence of others and are not coded as Home, Work, or Public. Other locations include someone else's home, outdoor locations (while walking, bicycling, other modes of transportation), and any other location where the respondent reported being in the presence of others. In our analysis we further disaggregate Other into outdoors and not-outdoors (someone else's home). This classification allows us to capture the potential for airborne transmission due to close contacts at someone else's home. It also allows us to examine whether respondents were able to mitigate some of the risks of airborne transmission by spending time outdoors.

2.3 Estimation Strategy

With our estimation strategy we aim to answer two questions. First, are there racial, and ethnic differences in the duration of social contacts across different settings? Second, how did they change during the first two years of the COVID pandemic? Therefore, we calculate the duration of social contacts in each location and by year. For our first set of results, we do not include any controls (although we did test the effect of controlling for structural factors such as day of the week, and which made no substantive difference). It is important to understand the unconditional racial differences, which reflect the actual differences in risks across groups. Nevertheless, we are also interested in identifying to what extent racial differences might be explained by differences in age, sex, living arrangements, calendar month, and work status. Previous studies have shown that socio-demographic factors and seasonality influence contact patterns (Dorélien, Ramen, et al., 2021; Feehan & Mahmud, 2021). We additionally control for state of residence and the size of the metro area as each state had different COVID-19 prevention protocols and more densely populated urban areas are often the first to be affected by the pandemic (Grenfell et al., 2001). To better understand the role of occupational exposure in driving racial differences in workplace social contacts, we conduct separate analyses based on a sample of employed individuals who are working on the diary day and control for their occupation and educational attainment in addition to the previous set of controls. We stratify all our analysis by year. When running our regression analyses, we use White respondents as our reference group to test whether there are differences between Whites and other racial/ethnic groups in duration of contacts in different settings.

Social contacts in our data are overdispersed, with a large share of our sample having zero social contacts and therefore zero duration of social contacts (Appendix A). Therefore, while controlling for the aforementioned factors, we run a set of OLS regressions as well as Zero Inflated

Negative Binomial (ZINB) regressions with robust standard errors, then analyze whether racial differences in duration of social contacts are still present (Cornwell, 2011). With the ZINB regression, we are looking at two different latent types of people in our data. One type has no social contacts due to a variety of socio-demographic characteristics. For example, those who do not have any social contacts at home are more likely to live alone. Similarly, those that have zero social contacts at the workplace are more likely to be unemployed. For these respondents, the ZINB model gives a predicted probability of having zero social contacts using logit regression. In the second part, the model uses a negative binomial regression to give the predicted duration of social contacts. This allows us to look at racial differences in duration of social contacts.

3 Results

As expected, the duration of time spent with others outside the home, especially in the workplace and public locations (ex. schools, churches...) was lower during the pandemic than in 2019; and the increase in time spent at home with others did not offset these declines. Respondents did not experience these changes in the same way; the magnitude of the decline varied by race/ethnicity (Figure 1).

Figure 1. Total duration (minutes per day) of social contacts by race/ethnicity and year as well as by location. Panel A.









3.1. Home

Social contacts at home, when considered independently, do not play a major role in creation of racial disparities in COVID-19 exposures. The racial distribution of contact patterns in the home do not mirror the observed racial patterns in COVID-19 cases. However, household composition can impact the overall risk of disease transmission from exposures in other locations.

In every year, Non-Hispanic Blacks spent less time with others at home compared to other groups; the difference is large and statistically significant (Figure 2). Compared to other groups, they are more likely to have zero contacts at home; conditional on any spending time at home with others, they have shorter duration of contacts. During the first year of the pandemic, all groups significantly increased the duration of social contacts at home except for Non-Hispanic Black. Specifically in 2020, Whites, Hispanics, and Asian/Others spent approximately 4 hours per day (~245 minutes) with household members compared to 2.8 hours (168 minutes) for Blacks. In the second year of the pandemic, the duration of social contacts at home declined slightly for Whites and Asian/Others, remaining close to 4 hours; compared to 2019, Black respondents spent statistically significantly more time at home with others (~28 minutes more), catching up to the trends we see in their counterparts in the other racial categories. In contrast, Hispanics reduced their duration of social contacts at home in 2021 compared to 2020 (~26 minutes).

As described in the estimation strategy (section 2.2), we also run ZINB regressions to better account for the over dispersion in our sample (Appendix D). The ZINB and OLS model results were qualitatively the same. For instance, in 2020 compared to White respondents, Black respondents were more likely (8.6 pp) to have zero social contacts at home. So conditional on having social contacts at home, we find that the Black-White difference in the duration of time spent with others at home is very similar to the OLS models. The ZINB results for the other

racial/ethnic groups are also very similar to the OLS regression results.

Figure 2. Bar graph showing mean duration of social contacts at home by year and race/ethnicity. Gray lines represent the 95% confidence intervals. The highlighted bars are statistically significantly different from White respondents after controlling for a host of covariates. [Appendix B contains a version of the figure that breaks down total duration of time spent at home by race and whether it is alone or with others. There is less variation in the total time spent at home between Black and White respondents but significant differences in whether that time was spent alone or with others.]



Duration of Social Contacts at Home

Does not control for demographic variables. Includes entire analytical sample

Table 2. OLS regression results documenting racial differences in duration of social contact at home between different racial groups and White respondents. Appendix D contains the ZINB model results with the same set of controls.

	Duration of Home Contacts						
	2019	2020	2021				
Black	-42.249 ***	-55.319 ***	-21.964 **				
	(8.445)	(9.890)	(9.680)				
Hispanic	-23.379 ***	-6.418	-24.932 ***				
	(8.689)	(9.690)	(8.646)				
Asian/Other	-30.519 ***	-11.859	12.979				
	(11.512)	(12.521)	(10.923)				
White	-	-	-				
Observations	9,393	8,730	9,035				
R-squared	0.218	0.264	0.240				

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls: Age groups, sex, employment status, household size, presence of children in the household, multigenerational household, state, calendar month, metro size, education, weekday

3.2. Public Indoor Locations

Racial disparities in exposures and cases are not likely driven by differences in social contacts in public enclosed locations as minority racial groups do not spend more time with others in public locations compared to Whites. In 2019, there were no statistically significant differences in time spent with others in public enclosed locations across the different racial ethnic groups (Figure 3). As expected, time spent with others in enclosed spaces significantly declined in 2020 (mean= 87 minutes, SD= 116) compared to 2019 (mean = 137 minutes, SD= 145.8). In 2020, Black and Asian/Other respondents experienced the largest decline (63 minutes and 80 minutes respectively) in duration of social contacts in public locations. In 2021, on average all racial

categories were spending more time with others in public locations compared to 2020, but these durations did not rebound to pre-pandemic levels.

When we look at patterns by age group for each race category, Black and Hispanic teenagers between 15-19 years old experienced the largest decline in social contacts in public locations (Appendix E). This is driven by Black and Hispanic school aged teenagers being less likely to attend school in person during the pandemic compared to White teenagers (Camp & Zamarro, 2022; Parolin & Lee, 2021).

Figure 3. Bar graph showing mean duration of social contacts in public locations by year and race/ethnicity. Gray lines represent the 95% confidence intervals. The highlighted bars are statistically significantly different from White respondents after controlling for a host of covariates.



Duration of Social Contacts in Public

Does not control for demographic variables. Includes entire analytical sample

Racial-ethnic differences in socio-demographic compositions do not have a large impact on our findings. However, after controlling for socio-demographic factors, Hispanics had a shorter duration of public contacts in 2019 compared to other groups. In contrast, Hispanics and Whites had similar duration of public contacts in 2020 and 2021 (Table 3 and Appendix D). Black and Asian/Other respondents spent ~16 minutes less in public locations than White respondents in 2020. In 2021, Black and Hispanic respondents did not differ significantly from White respondents, but the Asian/Other-White difference in duration of public contacts increased to ~24 minutes.

Table 3. OLS regression results documenting racial differences in duration of social contact in public enclosed locations between different racial groups and White respondents. Appendix D contains the ZINB model results with the same set of controls.

	Duration of Public Contacts						
	2019	2020	2021				
Black	-1.755	-14.489 ***	-8.600				
	(6.568)	(5.227)	(6.594)				
Hispanic	-10.898	-2.838	-8.347				
	(7.781)	(5.977)	(6.565)				
Asian/Other	-6.430	-16.046 **	-23.223 ***				
	(11.313)	(6.624)	(7.680)				
White	ref	ref	ref				
Observations	9,393	8,730	9,035				
R-squared	0.092	0.094	0.080				

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls: Age groups, sex, employment status, household size, presence of children in the household,

multigenerational household, state, calendar month,

metro size, education, weekday

The results from ZINB regressions are similar in magnitude and significance. Conditional on having contacts in public locations, Black respondents spent ~15 minutes less than White respondents in 2019. In 2020, compared to White respondents, all other racial groups are significantly more likely to have no public contacts. In 2021, Black and Asian/Other respondents are more likely to have no public contacts compared to Whites.

3.3. Other (outdoor locations or in someone else's home)

Other locations include all the locations that were not included in Home, Work, or Public Indoor locations. We disaggregate our analysis further into outdoors and not-outdoors (someone else's home). We present analysis for combined Other locations (Appendix F and G), and separate regressions for time spent outdoors with others and in someone else's home (Appendix G). Surprisingly, time spent outdoors with others did not increase during the pandemic for most racial/ethnic groups (and total time spent outdoors also decreased for all racial groups). While there are racial/ethnic differences in the duration of social contacts in outdoor or other locations, they are not driving the disparities in exposures. Each ethnic/racial group saw a decrease in the duration of social contacts in other locations, except for the Asian/Other group which increased their duration from 56 minutes in 2019 to 61 minutes in 2020. However, this difference is not statistically significant (Appendix F). In 2020, White and Asian/Other respondents have a greater duration of social contacts in other locations (~1 hour each) compared to Black and Hispanic respondents (45 minutes and 50 minutes respectively). In 2021, White and Black respondents' duration of social contacts in other settings declined slightly from 2020 levels, while there was an increase of about 10 minutes for Hispanics and a decrease of 10 minutes for Asians.

After controlling for covariates, there are racial differences in the duration of social contacts in outdoor locations (Appendix G). In 2019, Black and Asian/Other respondents spent

~10 minutes lower in outdoor locations with others compared to White respondents. This difference remained for Blacks in 2020 (difference of ~12 minutes), but the pattern for Asian/Others looked similar to Whites. Hispanics also spent significantly less time (~12 minutes) in outdoor locations with others compared to Whites in 2020. In 2021, this difference disappears for Hispanic and Asian/Other respondents, but Black respondents spent significantly lower durations of social contacts in outdoor locations compared to White respondents. The results from ZINB models are extremely similar to the results outlined here (Appendix D). In all three years analyzed, Black respondents are more likely to have no social contacts in outdoor or other locations compared to White respondents. It is important to note that these durations reflect the time spent outdoors with others and not the total duration of time spent outdoors. This pattern is surprising as we would have expected households to spend more time with others in outdoor locations during the pandemic as outdoor locations pose less risk of exposure compared to indoor enclosed public spaces or workplaces.

3.4. Work

Our findings indicate that the workplace and workplace activities play the biggest role in driving racial disparities in the duration of social contact. In this section we describe racial differences in where work took place and the extent to which it was done in the presence of others. Next, we focus on describing racial differences in duration of social contacts within the workplace, both for the overall sample and for employed individuals.

3.4.1 Work activities in different locations

On average the total duration of time working did not decline during the pandemic; in fact, it increased for most groups. Instead, the pandemic altered where work activities took place. Therefore, we analyze the different locations where work activities were conducted, *both in the*

presence of others and alone. Despite the pandemic, the majority of work activities take place in the presence of others and at the workplace. For all groups, time spent working in presence of others (regardless of location) declined during the pandemic and did not rebound in 2021; it has monotonically declined for Whites and especially Asians/Others. Conversely, as expected, total time spent working alone, especially at home, increased during the pandemic (Appendix H). This increase is most noticeable for Non-Hispanic Asian/Other respondents, who worked ~3 hours on average at home alone in 2020 (2.5 hours in 2021) compared to an average of 35 minutes in 2019. This is likely due to the kinds of occupations that Asian/Other respondents are engaged in. The top occupations for these respondents are Marketing occupations and Computer and Mathematical Science occupations, which are more suitable for remote working from home.

3.4.2 Social Contacts at the Workplace- Overall Sample

All racial groups reduced their duration of social contacts at their workplace during the pandemic, with White respondents initially experiencing the largest decrease (30%) in 2020 compared to 2019 (Figure 4). In 2021, Asian/Other respondents continued to reduce their duration of workplace social contacts (31% decrease compared to 2019); while there was a rebound for Hispanics. Relative to White respondents, on average Black respondents increased their duration of workplace social contacts but not to the same extent as Hispanic respondents (who always have the highest duration of workplace social contacts).

Work activities are the primary drivers of differences in workplace social contacts. For all race/ethnic categories, non-work activities (such as socializing and eating at the workplace) make up a small proportion (less than 5%) of the social contact duration at the workplace, and the duration of non-work activities with others declined during the pandemic (Appendix H).

The racial disparities in workplace social contacts are most evident among prime-age respondents. When we look at the age pattern of duration of workplace social contacts for each racial group, we find that the White respondents of working age (25-50 years) significantly reduced their duration of social contacts at the workplace in 2020 compared to 2019. Black respondents do not experience the same pattern (Figure 5).

Figure 4. Bar graph showing mean duration of social contacts in the workplace by year and race/ethnicity. Gray lines represent the 95% confidence intervals. The highlighted bars are statistically significantly different from White respondents after controlling for a host of covariates.



Does not control for demographic variables. Includes entire analytical sample

These racial differences in contact patterns are not primarily driven by compositional differences between the ethnic/racial groups. On the contrary, racial differences in duration of workplace social contacts are magnified after controlling for age, sex, household size, multigenerational household, presence of children in the household, employment status,

educational attainment, as well as weekday, calendar months and state fixed effects (regression not shown but available in Appendix G).





3.4.2 Employed respondents who worked on the diary day

To better analyze racial differences in workplace social contact patterns, we stratify the sample to only include respondents who are employed and who reported engaging in work-related activities on the time diary day. Total amount of time spent working at the workplace decreased during the pandemic. The racial pattern in the duration of social contacts mirrors the racial pattern in COVID-19 cases and mortality during this period (Aburto et al., 2022; Ndugga et al., 2022). We find that Black and Hispanic respondents had greater duration of contacts at work compared to White and Asian/Other groups in all survey years (Figure 6). Black and Hispanic respondents had the lowest decrease in social contact duration at the workplace, with a decrease of 42 min (13%) and 54 min (15%) respectively in 2020. Once we control for all of the covariates including occupation, we no longer find statistically significant Black-White differences in duration of

workplace social contacts during the pandemic (Table 4). This means that compositional differences that we control for explain much of the observed differences. In contrast, after adding the controls including occupation, the Hispanic-White difference in workplace social contact remains and grows during the pandemic (Table 4). We find the same qualitative results in the OLS and ZINB models, with the additional detail that Hispanics were significantly less likely to have 0 work contacts during the pandemic (Appendix D).

Figure 6. Bar graph showing mean duration of work (with others and alone) in the workplace by year and race/ethnicity. Gray lines represent the 95% confidence intervals. The highlighted bars are statistically significantly different from White respondents after controlling for a host of covariates.



Employed respondents who reported working on diary day

Table 4. OLS regression results documenting racial differences in duration of social contact in the workplace between different racial groups and White respondents. Includes only employed respondents who reported working on diary day. Appendix D contains the ZINB model results with the same set of controls.

	Duration of Work contacts					
	2019	2020	2021			
Black	30.74 *	25.56	27.33			
	(17.48)	(19.77)	(18.46)			
Hispanic	32.4 **	36.2 **	43.99 ***			
	(16.50)	(16.82)	(16.03)			
Asian/Other	-1.24	23.79	1.30			
	(21.51)	(20.66)	(18.54)			
White	ref	ref	ref			
Observations	3,237	2,801	3,043			
R-squared	0.14	0.20	0.20			

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Subsample of employed respondents who worked on diary day

Controls: Age groups, sex, household size, presence of children in the household, multigenerational household, state, calendar month, metro size, education, weekday

3.4.3 Intersectionality: Race, Gender, and Work

There are important gender and race interactions to note (Appendix I). For instance, the relative increase in duration of social contact at work for Hispanics in 2020 is driven by male respondents. And much of the 2021 rebound in work social contacts for Hispanics appears to be attributable to women from that ethnic group. In contrast, during all the years in our sample, Black women have significantly greater duration of social contacts at work compared to their White counterparts. Black men had a similar duration of social contacts at work as White men in 2019; during the pandemic Black men increased the duration of their workplace social contacts compared to White

men but the difference was not statistically significant. Asian/Other women have higher duration of work social contacts compared to White women; while Asian/Other men had lower duration of work contacts compared to White men, but for both sexes these differences were not statistically significant.

Discussion

Racial disparities in exposures and cases are not likely driven by differences in contacts at home, in public locations, or in outdoor and "other" settings. We find shorter duration of social contacts at home every year for Black respondents compared to other ethnic/racial groups. This finding is in line with the literature showing that black parents spend less time with children, likely because of the composition of Black households (Kendig & Bianchi, 2008), and or work constraints such as working multiple jobs (Presser, 2003). The trend of relatively short duration of time spent with others at home for Black respondents did not disappear in the pandemic and this is surprising because their children were at the same time less likely to be in school. There was very little increase on social contacts at home during the pandemic for Black respondents. However, lower social contact rates in this setting are not necessarily protective, because non-household member contacts are more important for COVID-19 exposure. Moreover, duration of social contact at home may be less meaningful for COVID-19 risk because of shared indoor air. Even if they are not in the same room, they may still be exposed (albeit less intensely).

Furthermore, the household composition (e.g., living in multigenerational households, increased likelihood of having essential worker household members) make it likely that although Black respondents have fewer contacts/exposures at home, the disease transmission risk during each exposure may be higher. Likewise, Hispanics may have higher risk of exposure at home because of their larger household sizes, multigenerational households, and employment combined

with high durations of home contacts, especially during the first year of the pandemic. Asians/Others experienced the biggest increase in duration of social contacts at home during the pandemic. This is primarily explained by their occupation: they were more likely to work from home, as well as the fact that they were less likely to live alone and most likely to live in households with children under 18 (Table 1B). Consequently, for Asians/Others the increase in social contacts at home was likely a protective factor against COVID-19 exposure.

Surprisingly, we find that racial disparities in exposures and cases are not likely driven by differences in contacts in indoor public spaces (such as schools and churches). Public contacts declined overall during the pandemic for all racial groups and did not rebound to pre-pandemic levels in the second year of the pandemic. Black and Asian/Others decreased the duration of public contacts by a greater extent than Whites and Hispanics in 2020. While lowering social contacts in public locations can be protective against transmission of diseases, there may be negative effects for people in some age groups. For example, the duration of public contacts dropped the most for school-aged Black respondents in 2020; this is problematic because school-going children may have faced learning losses due to closures of schools and reduced time in these public locations (Camp & Zamarro, 2022). Furthermore, given the fact that younger age groups were at lower risk of COVID-19 complications, the benefits of reduced social contacts may not have outweighed the cost.

We would have hypothesized that time spent outdoors with others would have increased during the pandemic, but it did not. Perhaps that reflects the lack of understanding that outdoor contacts are less risky even if within the initial 6-foot social distancing recommendations.

In line with the literature, we find that workplace social contacts likely drive the observed racial differences in COVID-19 exposures and cases. Most significantly, we provide actual

evidence of differences in contact patterns by race in the workplace. In contrast with the previous literature, we are not using occupation or education to *infer* how contacts differ by race/ethnicity: instead, we rely on observed data. We find that all racial groups reduced their duration of social contacts at work in 2020. However, compared with White respondents, Hispanics, and Black respondents were not able to decrease their duration of work contact to a similar extent during the pandemic. Specifically, Hispanics had the highest duration of workplace social contacts. The Hispanic-White difference increased during the pandemic (initially driven by Hispanic men, then followed by Hispanic women in 2021). During the first year of the pandemic, Hispanic women were more likely to be unemployed and not in the labor force (Moen et al., 2020), but we also find that those in the labor force significantly reduced their workplace social contacts. White and Asian respondents are better able to protect themselves from getting Covid-19 at work but not Black and Hispanic respondents. Future research focused on workplace social contacts would be needed to understand what is driving this.

Some of the racial disparities can be attributed to sociodemographic differences but in our overall sample and in our analysis of employed individuals working on diary day. However, we find that even after controlling for occupation there are large differences in duration of social contacts, especially between Hispanics compared and their white counterparts. This means that even within the same occupation categories, Hispanics had significantly greater duration of work contacts compared to their White counterparts. This implies that studies (such as Goldman et al., 2021) that only rely on occupation to determine workplace COVID-19 exposures may be underestimating the true magnitude racial disparities in these settings.

Our findings differ from other US social contact surveys for several key reasons. Nelson et al. (2022) found that non-Hispanic Others (not including Asians) followed by Blacks had higher

number of social contacts. They did not disaggregate contacts by location and race, although they did find that highest number of contacts occurred in the workplace. The Dorélien et al. (2023) study was based in Minnesota, whose composition of racial/ethnic groups are not nationally representative. The Feehan and Mahmud (2021) study was not nationally representative; and although they focus on non-household member contacts, their results by race/ethnicity still aggregate contact from heterogenous locations with different risks. If we focused on total duration of social contacts, we would have different results. Finally, all of these other studies did not focus on the duration of contacts but focused on the number of contacts.

There are a few important limitations in this analysis. First, because of the nature of our data source we only have information on the duration of contact, and no information on the number of contacts. Therefore, we don't know if someone is spending a lot of time with just one other person or with a large group. Conversely, previous studies have mostly reported only the number of contacts and not their duration. Depending on the infectious disease in question, duration of exposure may matter more than frequency of contacts (Cao et al., 2014). Ideally, future contact surveys should present findings on both duration and frequency of contacts. We also don't have any information on protective behaviors such as mask wearing, vaccination status, testing and quarantine protocols. Our data also does not give us information on the type of housing (free-standing house vs apartment/condo). This would have allowed us to better contextualize transmission risk at home. We assume that there is no differential measurement error in time used data by race/ethnicity. One solution we could have employed to test this source of bias is to compare differences in shares of time spent with others across different locations/activities instead of duration of time spent with others (McCullough et al., n.d.).

Conclusion

Although we focus on contacts that are meaningful for disease transmission, our findings are also relevant to research on social isolation, loneliness, and engagement. One takeaway of our research is that outside of the workplace, Black respondents were at higher risk of loneliness/isolation compared to other groups. Policies should focus on reducing workplace exposures to reduce COVID-19 racial disparities in cases and mortality rates. Our measures of employment status and occupation do not explain away racial differences in social contacts in the workplace. Future work will further analyze the role of occupation/employer type as well as the role of structural racism and employer discrimination. Workplace disparities are likely to have important spillover effects. Although our analysis stratified contacts/exposure risk by location, it is important to understand that links exist between exposures across different settings (Acevedo-Garcia, 2000). For instance, higher occupational exposure may result in higher per-contact risk of COVID-19 transmission at home for both Black and Hispanic respondents. Finally, social contact patterns are not static. While our analysis shows the dynamics of contact patterns during the pandemic, it is important to evaluate how social contacts continue to change over time, in order to identify high risk groups.

Appendices

Appendix A -Histograms showing the over dispersion of our sample in every location.

Appendix B- Bar graph showing duration at home- alone and in presence of others.

Appendix C- Regressions showing the bar graphs, with weekday controls added.

Appendix D - ZINB regression analyses

Appendix E- Duration of social contacts in Public indoor locations by age group for Black and White respondents.

Appendix F- Bar graph showing social contacts in Other locations.

Appendix G- Regressions for Other locations (includes Outdoor and Someone Else's home) and Workplace (all sample)

Appendix H- Figures showing proportion of work and non-work activities at the workplace; and locations where work activities were done- alone and in presence of others.

Appendix I- Intersectional analysis regressions- without controls and with all controls.

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APPENDIX A

Histogram showing overdispersion of social contacts in all locations.



Duration of Social Contacts

APPENDIX B

Bar graph showing the duration of time spent at home- alone and in presence of others.



Duration spent at home

These regressions represent the bar graphs in our analysis. Duration of social contacts at home for different racial groups are compared to duration of social contacts of White respondents.

	Duration of Home Contacts				
VARIABLES	2019	2020	2021		
Black	-56.603***	-77.554***	-44.962***		
	(8.527)	(10.145)	(9.839)		
Asian/Other	-25.315**	-0.286	10.675		
	(11.804)	(13.346)	(11.570)		
Hispanic	-12.688	2.744	-9.992		
	(8.506)	(10.396)	(8.527)		
Weekday	-63.344***	-74.137***	-68.871***		
	(5.498)	(6.235)	(5.968)		
Constant	260.659***	298.274***	280.749***		
	(4.596)	(5.262)	(5.142)		
Observations	9,393	8,730	9,035		
R-squared	0.024	0.031	0.022		
Robust standard errors in parenthe					

Note: Bar graphs do not control for survey conducted on a weekday.

Robust standard errors in parentheses

These regressions represent the bar graphs in our analysis. Duration of social contacts in public locations for different racial groups are compared to duration of social contacts of White respondents.

	Duration of Public Contacts				
VARIABLES	2019	2020	2021		
Black	-2.392	-17.800***	-3.494		
	(7.050)	(5.107)	(6.909)		
Asian/Other	18.615	-13.971*	-12.272		
	(11.965)	(7.298)	(7.883)		
Hispanic	4.491	-0.899	4.355		
	(7.286)	(6.420)	(6.652)		
Weekday	-7.260*	-1.405	-6.532*		
	(4.221)	(3.333)	(3.775)		
Constant	146.791***	94.939***	108.592***		
	(3.410)	(2.620)	(3.012)		
Observations	9,393	8,730	9,035		
R-squared	0.001	0.003	0.001		
Robust standard errors in parenthe	eses				

Note: Bar graphs do not control for survey conducted on a weekday.

Robust standard errors in parentheses

These regressions represent the bar graphs in our analysis. Duration of social contacts in the workplace for different racial groups are compared to duration of social contacts of White respondents.

	Duration of Work contacts				
VARIABLES	2019	2020	2021		
Black	-1.359	13.899	16.999		
	(9.894)	(10.859)	(10.411)		
Asian/Other	2.610	14.138	-0.884		
	(12.741)	(13.558)	(11.026)		
Hispanic	27.038***	33.984***	53.410***		
	(10.464)	(9.955)	(9.503)		
Weekday	128.612***	90.370***	86.996***		
	(5.321)	(5.123)	(5.019)		
Constant	41.128***	28.216***	30.895***		
	(3.725)	(3.615)	(3.692)		
Observations	9,393	8,730	9,035		
R-squared	0.065	0.042	0.045		
Delevated and and successful a second la se					

Note: Bar graphs do not control for survey conducted on a weekday.

Robust standard errors in parentheses

These regressions represent the bar graphs in our analysis. Duration of social contacts in other locations for different racial groups are compared to duration of social contacts of White respondents.

	Duration of Other contacts				
VARIABLES	2019	2020	2021		
Black	-18.525***	-18.938***	-17.591***		
	(5.159)	(5.392)	(4.209)		
Asian/Other	-17.106**	-4.314	-10.127		
	(7.041)	(10.872)	(6.163)		
Hispanic	-5.641	-14.440***	0.551		
	(5.569)	(4.929)	(4.963)		
Weekday	-42.311***	-32.358***	-43.468***		
	(3.766)	(3.898)	(3.646)		
Constant	102.971***	87.161***	91.994***		
	(3.171)	(3.384)	(3.313)		
Observations	9,393	8,730	9,035		
R-squared	0.021	0.015	0.026		
Robust standard errors in narenthe					

Note: Bar graphs do not control for survey conducted on a weekday.

Robust standard errors in parentheses

	20	2019 prob of 0		2020 prob of 0		2021 prob of 0	
	duration	contacts	duration	contacts	duration	contacts	
Black	-41.579 *** (10.592)	0.088 *** (0.016)	-54.107 *** (12.076)	0.086 *** (0.016)	-16.376 (11.360)	0.067 *** (0.016)	
Hispanic	-29.832 *** (9.684)	0.035 ** (0.017)	-10.779 (10.352)	0.026 (0.017)	-31.866 *** (9.602)	0.038 ** (0.016)	
Asian/Other	-37.499 *** (12.389)	0.036 (0.025)	-15.035 (12.699)	0.036 (0.024)	8.715 (11.416)	-0.030 (0.021)	
White	ref	ref	ref	ref	ref	ref	
Observations	9,393	9,393	8,730	8,730	9,035	9,035	

Zero Inflated Negative Binomial Estimations for Home Contacts

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	=0.0								
	20	2019		20	20	2021			
		prob of 0		prob of 0		prob of 0			
	duration	contacts	duration	contacts	duration	contacts			
Black	-4.634	0.003	-14.994 ***	0.036 *	-6.376	0.043 **			
	(6.292)	(0.014)	(5.038)	(0.019)	(5.628)	(0.018)			
Hispanic	-11.804 *	-0.023	-1.497	0.036 *	-5.506	0.006			
	(6.908)	(0.016)	(5.239)	(0.020)	(5.289)	(0.019)			
Asian/Other	-9.792	0.065 ***	-16.627 **	0.095 ***	-21.209 ***	0.081 ***			
	(9.387)	(0.021)	(6.690)	(0.024)	(6.662)	(0.023)			
White	ref	ref	ref	ref	ref	ref			
Observations	9,393	9,393	8,730	8,730	9,035	9,035			

Zero Inflated Negative Binomial Estimations for Public Contacts

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	20	2019 prob of 0		2020 prob of 0		2021 prob of 0	
	duration	contacts	duration	contacts	duration	contacts	
Black	-18.477 ***	0.051 **	-17.539 ***	0.083 ***	-18.773 ***	0.083 ***	
	(6.299)	(0.022)	(6.455)	(0.023)	(5.744)	(0.022)	
Hispanic	-6.107	0.032	-12.564 **	0.07 ***	1.221	0.026	
	(6.521)	(0.022)	(6.306)	(0.022)	(5.615)	(0.021)	
Asian/Other	-25.526 ***	0.093 ***	-13.391	0.038	-12.799 *	0.056 **	
	(7.386)	(0.029)	(8.619)	(0.028)	(6.606)	(0.026)	
White	ref	ref	ref	ref	ref	ref	
Observations	9,393	9,393	8,730	8,730	9,035	9,035	

Zero Inflated Negative Binomial Estimations for Other Contacts

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	2019 prob of 0		202	2020 prob of 0		2021 prob of 0	
	duration	contacts	duration	contacts	duration	contacts	
Black	0.625 (9.983)	0.000 (0.020)	6.082 (9.939)	-0.002 (0.020)	23.915 ** (9.948)	-0.039 ** (0.020)	
Hispanic	20.078 ** (9.820)	-0.024 (0.020)	17.72 ** (8.855)	-0.027 (0.018)	38.679 *** (8.342)	-0.076 *** (0.017)	
Asian/Other	-13.757 (12.017)	0.014 (0.024)	3.068 (11.482)	0.018 (0.023)	2.066 (11.506)	0.010 (0.024)	
White	ref	ref	ref	ref	ref	ref	
Observations	9,393	9,393	8,730	8,730	9,035	9,035	

Zero Inflated Negative Binomial Estimations for Work Contacts

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	zero innated negative binomial estimations for work contacts						
	2019		20	2020		2021	
	duration	prob of 0 contacts	duration	prob of 0 contacts	duration	prob of 0 contacts	
Black	32.19 * (17.39)	-0.06 * (0.03)	23.71 (17.99)	-0.03 (0.03)	25.84 (17.27)	-0.04 (0.03)	
Hispanic	31.24 * (16.92)	-0.05 (0.03)	35.42 ** (16.44)	-0.05 (0.03)	43.52 *** (15.51)	-0.08 *** (0.03)	
Asian/Other	-3.07 (21.71)	-0.01 (0.04)	27.47 (20.24)	-0.01 (0.04)	1.68 (20.08)	-0.01 (0.04)	
White	ref	ref	ref	ref	ref	ref	
Observations	3,237	3,237	2,801	2,801	3,043	3,043	

Zero Inflated Negative Binomial Estimations for Work Contacts

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

NOTE: Subsample of employed respondents who reported working on the diary day.

APPENDIX E

Duration of social contacts in public locations by age group for Black and White respondents.





APPENDIX F



	Duration of Other contacts			
	2019	2020	2021	
Black	-19.518 ***	-16.046 ***	-17.451 ***	
	(5.432)	(5.593)	(4.505)	
Hispanic	-7.845	-14.648 **	1.887	
	(6.410)	(6.054)	(5.610)	
Asian/Other	-22.484 ***	-11.548	-11.131 *	
	(7.081)	(10.348)	(6.315)	
White	ref	ref	ref	
Observations	9,393	8,730	9,035	
R-squared	0.052	0.047	0.052	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	Duration of Outdoor (Other) contacts			
	2019	2020	2021	
Black	-11.653 ***	-12.07 ***	-8.178 ***	
	(3.714)	(3.736)	(3.098)	
Hispanic	-3.410	-12.585 ***	-5.368	
	(4.861)	(4.212)	(3.588)	
Asian/Other	-9.117 *	-8.639	-5.430	
	(4.822)	(6.472)	(3.992)	
White	ref	ref	ref	
Observations	9,393	8,730	9,035	
R-squared	0.044	0.035	0.039	
		-		

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

	Duration of contacts at someone Lise's				
	Home (Other locations)				
	2019	2020	2021		
Black	-7.865 *	-3.976	-9.273 ***		
	(4.019)	(4.213)	(3.347)		
Hispanic	-4.435	-2.063	7.255		
	(4.464)	(4.136)	(4.480)		
Asian/Other	-13.367 **	* -2.909	-5.701		
	(5.373)	(7.515)	(4.502)		
White	ref	ref	ref		
Observations	9,393	8,730	9,035		
R-squared	0.041	0.042	0.040		

Duration of Contacts at Someone Fise's

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Controls: Age groups, sex, employment status, household size, presence of children in the household,

multigenerational household, state, calendar month, metro size, education, weekday

	Duration of Work Contacts					
	2019		2020		2021	
Black	4.497		17.425	*	18.888	**
	(8.939)		(9.594)		(9.348)	
Hispanic	23.958	**	16.34	*	36.138	***
	(9.534)		(9.318)		(8.882)	
Asian/Other	1.674		14.005		1.359	
	(10.605)		(11.930)		(9.870)	
White	ref		ref		ref	
Observations	9,393		8,730		9,035	
R-squared	0.311		0.248		0.248	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

APPENDIX H

Locations of work activities: These figures show the locations in which work activities were conducted in all the years by each race/ethnicity.







Duration spent engaged in work and non-work activities at the workplace in presence of others by employed respondents.



Duration of Social Contacts at Workplace: Work and Non-work activities

These regressions represent the duration of social contacts at work for female employed respondents. All groups are compared against White female employed respondents. Only weekday controls are used.

	2019	2020	2021
Black	63.85***	66.60***	47.38*
	(22.98)	(23.02)	(24.78)
Asian/Other	19.28	26.67	2.14
	(31.73)	(35.60)	(30.60)
Hispanic	37.76	41.34	94.19***
	(24.32)	(25.50)	(19.34)
Weekday	104.70***	39.91**	45.84**
	(16.91)	(17.55)	(18.05)
Constant	180.66***	181.98***	174.52***
	(15.54)	(16.27)	(16.93)
Observations	1,486	1,331	1,420
R-squared	0.03	0.01	0.03

Duration of Work Contacts- Female Employed respondents

Robust standard errors in parentheses

Respondents				
	2019	2020	2021	
Black	18.75	31.66	33.05	
	(23.96)	(23.26)	(22.92)	
Hispanic	33.03	-1.40	42.90 **	
	(24.34)	(23.21)	(20.92)	
Asian/Other	13.72	46.20	8.92	
	(30.94)	(30.49)	(26.12)	
White	ref	ref	ref	
Observations	1,486	1,331	1,420	
R-squared	0.21	0.29	0.26	

Duration of Work Contacts- Female Employed

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

These regressions represent the duration of social contacts at work for male employed respondents. All groups are compared against White male employed respondents. Only weekday controls are used.

Duration of Work Contacts- Male Employed Respondents					
VARIABLES	2019	2020	2021		
Black	10.54	48.57	39.65		
	(27.81)	(35.83)	(30.11)		
Asian/Other	-16.24	-2.92	-36.49		
	(26.76)	(33.13)	(26.79)		
Hispanic	51.06**	99.21***	89.95***		
	(20.19)	(23.21)	(21.37)		
Weekday	132.65***	69.51***	37.71**		
	(15.75)	(18.67)	(17.93)		
Constant	201.10***	171.71***	195.30***		
	(14.46)	(16.97)	(16.56)		
Observations	1,751	1,470	1,623		
R-squared	0.04	0.03	0.03		
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Robust standard errors in parentheses

	2019	2020	2021
Black	23.81	14.15	15.68
	(24.99)	(31.00)	(28.25)
Hispanic	45.66 **	60.34 **	27.87
	(21.53)	(24.31)	(24.10)
Asian/Other	-2.03	-3.77	-12.28
	(28.93)	(28.71)	(25.62)
White	ref	ref	ref
Observations	1,751	1,470	1,623
R-squared	0.18	0.22	0.23

Duration of Work Contacts- Male Employed Respondents

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1