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Systematic observation of mask adherence and distancing (SOMAD): Findings from Philadelphia

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ABSTRACT

Adherence to guidelines for face coverings and physical distancing are critical strategies to stem the COVID-19 pandemic but are not uniformly followed. Understanding factors associated with adherence to mask-wearing and physical distancing may help guide future control efforts. We conducted an observational study using Systematic Observation of Mask Adherence and Distancing (SOMAD) in August 2020 in parks, playgrounds and commercial streets in each of 10 City Council Districts in Philadelphia, PA. Wearing a mask correctly varied by setting with highest adherence in commercial areas and lowest in playgrounds. Almost 17% wore visible masks that did not cover the nose and/or mouth. There were multiple disparities in correct mask use. Females had higher rates than males (unadjusted relative risk = 1.40, $p < .0001$) and seniors higher than any other age group (unadjusted chi-square $p < .0001$). Asians wore masks correctly the most often [adjusted log odds ratio (LOR) = 0.53 compared with non-Hispanic white, $p = 0.02$]. Correct mask-wearing was higher in areas with a higher population density (adjusted LOR = 0.03 per one thousand/square mile, $p = 0.02$) and lower in higher poverty areas (adjusted LOR = −0.01, $p = .03$). Disparities in adherence to mask wearing and physical distancing likely reflect differences in perception of risk by gender, age group, and race/ethnicity. While the risk of COVID-19 transmission is lower in outdoor settings, it is unlikely to be zero. The lower rates of mask use by males and minority groups suggest increased efforts are needed to enhance adherence to recommended guidelines.

1. Introduction

Face coverings and physical distancing are vital strategies to control the COVID-19 pandemic as they limit the ability of infected persons to spread virus-containing respiratory droplets (Chu et al., 2020). The public, however, has received mixed messages about wearing masks. Quantifying adherence may help guide intervention strategies.

Systematic direct observation is a reliable method of measuring a variety of individual characteristics and behaviors (McKenzie, 2016; McKenzie and van der Mars, 2015). The technique entails data collectors recording a limited number of visible characteristics of the individuals they observe. Respondent burden and reactivity are both eliminated as observers do not interact with subjects. In some settings, reactivity is a concern, if people change their behaviors because they become aware of being observed (McKenzie, 2016; McKenzie and Welk, 2002).

To understand more about adherence to recommendations, we created a tool for systematic observation of mask adherence and distancing (SOMAD). We designed it specifically to capture the characteristics of individuals, thus making it possible to compare face covering and physical distancing by gender, age group, race/ethnicity, physical activity levels, and location. We confirmed its reliability and implemented it in one jurisdiction, the City of Philadelphia, PA.

2. Methods

Systematic observation of mask adherence and distancing (SOMAD) builds on decades of studies using direct observation (McKenzie et al., 1991a, 1991b, 2006c). We focused on two types of public settings where there is the potential for people to be near and interact with others. One setting is a path or sidewalk, where data collectors observe individuals

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passing by a specific point, such as a commercial street sidewalk, walking path or trail. The second setting is an identifiable space, such as a playground or park segment, where data collectors can systematically scan individuals. Observers record the characteristics of each individual they see.

Using Google Forms, observers enter data about individuals at the moment they are observed. Besides documenting the setting, eight variables were collected for each person observed: 1) Age group (infant/toddler ages 0–2), child (3–12), teen (13–19), adult (20–59), and senior (>=60); 2) Gender, 3) Apparent race/ethnicity (white, black, Asian, Latino, able to determine); 4) Physical activity level (sedentary, moderate, vigorous) based on the intensity at the moment of observation; 5) Transportation mode (on wheels, not on wheels); 6) Face covering adherence (mask on correctly covering nose and mouth, mask partially on, mask not on, but visible, and no mask visible); 7) Group size information (alone, in group of 2, group 3–5, group 6–9, group 10+); and 8) Physical distance at least 6 feet from others (yes, no).

All observers wore masks that covered their noses and mouths and maintained at least a six-foot distance from others. To assess reliability, we conducted testing on 5 daily visits with 34 different observation events (i.e., separate time periods) using 8 different observers, with 2 observers independently and simultaneously observing the same setting. Between August 11, 2020 and August 30, 2020 we visited three types of outdoor public spaces (commercial streets, neighborhood parks, and playgrounds) in 10 City Council Districts. The park and playground sites in each district were initially visited and those with the greatest attendance were chosen for observation. Commercial streets were chosen by examining the City of Philadelphia's geographic information systems data to identify those that included intersections with high commercial activity and a higher density of transit stops. We then selected a convenience sample of streets based upon the observed volume of pedestrians, with the busiest commercial streets chosen in each district.

The days of the week and times of the day selected were based on a schedule tested for SOPARC (System for Observing Play and Recreation in Communities) where the selection of different days and times was validated to estimate park use over an entire week (McKenzie et al., 2006; Cohen et al., 2011). Our observations occurred on a weekday and weekend in each setting. The study was deemed exempt by the RAND IRB.

We conducted a descriptive analysis of the findings and used Chi-squared tests to examine differences in mask adherence and physical distancing by socio-demographic characteristics. We obtained neighborhood information from the American Community Survey (ACS) 5-year estimate data (USCensus, 2012). We fitted multiple logistic regression to model the binary outcomes of proper usage of face coverings and being at least 6 feet from others versus individual-level and location-level predictors. We used the generalized estimating equations method to account for correlated repeated measures in each location. We ran both multinomial and binomial models comparing different levels of mask adherence. A binary approach was chosen for inclusion because the protections offered by incorrect mask use or no use do not differ significantly and could both be compared to correct mask use.

Because of the time-sensitivity of the data, we shared the preliminary findings from this data collection with the local health department as soon as they were available.

3. Results

3.1. Reliability testing

Inter-observer reliability of the SOMAD tool was high except for two of the 4 levels of mask adherence. Recording of "partial covering" (i.e., only nose or mouth covered) and "mask visible, but not covering either mouth or nose" had low agreement separately, but high when they were combined. Overall, the measurement errors between two observers were less than 10% among all variables at the event level. When aggregated to the day, measurement errors were less than a 1.2% difference across all variables (see Table 1).

3.2. Mask adherence in Philadelphia, PA

We observed 4,606 individuals in 30 locations within the 10 Council districts. They were 52.7% male, 49.6% white, 35.8% African American 4.4% Latinx, and 6.5% Asian. Overall, 43% wore masks correctly, 17% wore them incorrectly, 40% had no masks at all, and 42.8% were a distance of least 6 feet from others (Table 2).

Females were more likely to wear masks correctly than males (51.4% vs. 36.6% $p < .0001$) and seniors were more likely to wear them correctly than other age groups ($p < .0001$). Asians were the most adherent to wearing masks correctly (63%) and Hispanic and African Americans (35%) the least ($p < .0001$). People engaged in moderate physical activity were more likely to wear masks than those sedentary or engaging in vigorous physical activity (48.6% vs 21.7% and 20.4%; $p < .0001$). Those on wheeled vehicles (e.g., bicycles, strollers), were less likely to wear masks than those on foot (24.7% vs. 45.0% $p < .0001$).

Males were more likely to be at least 6 feet from others than females, and seniors were more likely to maintain that distancing than all other age groups. Hispanics were the least likely racial/ethnic group to be physically distanced. Those on wheels and those engaging in vigorous activity had a higher prevalence of physical distancing compared to those not on wheels or who were sedentary or moderately active, respectively.

People on commercial streets were more likely to wear masks correctly than those in parks or playgrounds ($p < .0001$), but they were also more likely to wear them incorrectly. Mask wearing was higher on the weekends than on weekdays (46.9% vs. 39.2% $p < .0001$), but physical distancing was lower on weekends (31.4% vs 54.6%, $p < .0001$). There were also differences among Council Districts in mask adherence, with those in Districts 5, 6 and 10 about half as likely to wear masks as those in Districts 1, 2 and 3. ($p < .001$). A higher frequency of physical distancing was observed in Districts 6 and 9.

Our model of mask adherence confirmed disparities in correct mask use by age group, gender, race/ethnicity, physical activity level, transport mode, and setting. Population density was associated with greater mask adherence (log odds ratio = 0.03, $p = .02$) while neighborhood household poverty was associated with less (log odds ratio = -0.01, $p = .03$) (Table 3). There were no meaningful differences in the important predictors of partial mask wearing and no mask wearing between the multinomial models and the binomial model (data not shown).

Compared to other race/ethnicities, the modeling of physical distancing showed that Hispanics were less likely to be 6 feet from others (log odds ratio = -0.60, $p = .004$). Those engaged in sedentary physical activity were less likely to keep this distance compared to those in vigorous activity (log odds ratio = -0.91, $p = .05$). Those on wheels were more likely to have a 6 ft. distance from others than those on foot (log odds ratio = 1.13, $p = .008$) (Table 3).

Table 1
Reliability results of Systematic Observation of Mask Adherence and Distancing: (average of maximum absolute difference in sample probabilities between two independent observers across all events or visits).

Variable	By event (n = 29)	By visit (n = 5)
Mask (3 levels)	5.7%	0.9%
Race (5 levels)	9.8%	1.2%
Gender (3 levels)	4.2%	0.5%
Age (5 levels)	3.9%	0.4%
PA (3 levels)	7.4%	0.8%
Transport (2 levels)	2.6%	0.2
Group (5 levels)	7.7%	0.7%
Distancing (2 levels)	7.7%	0.5%

Table 2
Mask and Physical Distancing Adherence in Philadelphia, PA.

	N 4606	Mask on Correctly N = 1988	Incorrect Use N = 768	No mask seen N = 1850	p- value (chi-sq.)	At least 6 ft from others N = 1972	p-value (chi-sq.)
Overall		43.2%	16.7%	40.2%		42.8%	
Gender							
Male	2435	36.6%	17.7%	45.7%	<0.0001	45.5%	0.0002
Female	2118	51.4%	15.5%	33.1%		39.9%	
Non-Binary/Unknown	44	15.9%	4.5%	79.5%		29.6%	
Age Group							
Toddler	153	6.5%	2.6%	90.8%	< 0.0001	28.7%	<0.0001
Child	519	28.3%	8.7%	63.0%		28.9%	
Teen	224	21.0%	15.2%	63.8%		47.5%	
Adult	3218	46.2%	18.7%	35.1%		44.0%	
Senior	481	60.3%	16.8%	22.9%		51.8%	
Apparent Race/ethnicity							
Non-Hispanic White	2286	47.0%	14.3%	38.7%	<0.0001	43.5%	<0.0001
Non-Hispanic Black/African American	1651	35.2%	21.1%	43.7%		44.3%	
Non-Hispanic Asian	300	63.0%	14.0%	23.0%		35.3%	
Hispanic/Latinx	203	35.0%	13.3%	51.7%		29.9%	
Unknown/unable to determine	120	38.3%	9.2%	52.5%		38.3%	
Physical Activity Level							
Sedentary	603	21.7%	18.4%	59.9%	<0.0001	31.8%	<0.0001
Moderate	3682	48.6%	17.1%	34.2%		43.7%	
Vigorous	318	20.4%	8.5%	71.1%		53.1%	
Mode of transport							
On wheels (e.g. bicycle, scooter, skates)	421	24.7%	17.1%	58.2%	<0.0001	62.7%	<0.0001
Not on wheels	4131	45.0%	16.7%	38.2%		41.3%	
Group Size							
Not in a group (alone)	1672	46.9%	19.2%	33.9%	<0.0001	82.2%	<0.0001
2	1355	43.8%	14.2%	42.0%		20.9%	
3 to 5	1039	34.0%	14.6%	51.4%		23.3%	
6 to 9	71	28.2%	8.5%	63.4%		50.7%	
10 or more	27	48.1%	0.0%	51.9%		48.2%	
At least six feet from other people							
Yes	1970	43.2%	17.3%	39.5%	0.5530	–	
No	2629	43.2%	16.2%	40.6%		–	
Setting							
Commercial street	2162	51.3%	20.9%	27.8%	<0.0001	51.8%	<0.0001
Neighborhood park	1579	43.4%	12.7%	43.9%		33.0%	
Playground	865	22.3%	13.5%	64.2%		38.3%	
Day of Week							
Weekday (M−F)	2263	39.2%	17.6%	43.2%	<0.0001	54.6%	
Weekend	2343	46.9%	15.8%	37.3%		31.4%	
City Council District							
1	854	55.2%	22.6%	22.2%	<0.0001	23.5%	<0.0001
2	726	57.3%	9.9%	32.8%		51.2%	
3	549	51.7%	14.4%	33.9%		27.3%	
4	462	33.1%	14.1%	52.8%		51.1%	
5	403	25.3%	21.1%	53.6%		33.3%	
6	450	28.4%	22.2%	49.3%		68.7%	
7	229	35.8%	15.3%	48.9%		40.6%	
8	376	47.6%	18.4%	34.0%		51.7%	
9	321	33.6%	15.6%	50.8%		60.8%	
10	236	27.5%	8.5%	64.0%		37.7%	

3.3. Local impact of results

The Philadelphia health department issued a press release and released a new flyer describing what makes a good mask and updated City guidelines on how and when to wear a mask (PhiladelphiaHealthDept., 2020).

4. Discussion

The SOMAD tool appears to be reliable and requires minimal training and practice. Our observations of mask wearing and distancing to prevent COVID-19 spread were all in outdoor locations, settings providing lower risk of exposure than indoor settings, so the low adherence rates may not be surprising.

The variation in mask adherence and physical distancing we found is concerning in that it likely reflects different perceptions of risk among different populations. This indicates a need for better information and for campaigns that directly target those less likely to wear masks or maintain a 6-foot distance from others. In addition to persistent media messages, signage in multiple places may help remind people of the importance of face coverings and distancing.

Of note is the significant proportion (17%) of those with masks not wearing them correctly. These individuals were apparently aware of the importance of masks but possibly lacked the behavioral skills, knowledge, and/or persistence to fully and consistently protect themselves. Improper use by having the nose and/or mouth exposed is tantamount to not wearing a mask at all. Fussing with masks by pulling them up or down or frequently taking them on and off adds additional transmission risks if people touch areas that contain viral particles.

A limitation of our SOMAD method is that it was not possible to determine the family/social relationships among those in close proximity. In some cases, people close to others with or without masks may have been household members. Therefore, in some cases, not wearing a mask use or physical distancing may have been appropriate. Because the observations focused on outdoor settings, the adherence behavior does not reflect the entire population of Philadelphia, but only those who

Table 3
Models predicting correct mask use and physical distancing: estimates are log odds ratios.

	Mask Adherence			Physical Distance >=6 ft.		
	Estimate	SE	p-value	Estimate	SE	p-value
Intercept	−1.70	1.40	0.23	1.19	1.28	0.35
Age Group						
Toddler (0–2)	−2.30	0.49	<0.0001	−0.21	0.32	0.52
Child (3–12)	−0.98	0.28	0.0005	−0.29	0.28	0.29
Teen (13–19)	−1.23	0.28	<0.0001	0.16	0.22	0.48
Adult (18–59)	−0.57	0.17	0.0006	−0.24	0.17	0.15
Senior (60+)	—	—	—	—	—	—
Gender						
Female	0.52	0.07	<0.0001	0.14	0.10	0.14
Non-Binary/Unknown	0.01	0.52	0.99	−0.63	0.43	0.15
Male	—	—	—	—	—	—
Race/Ethnicity						
Non-Hispanic Black/African American	−0.31	0.15	0.036	0.07	0.14	0.65
Non-Hispanic Asian	0.53	0.24	0.029	−0.01	0.24	0.97
Hispanic/Latinx	−0.36	0.23	0.11	−0.60	0.21	0.004
Unknown/unable to determine	0.36	0.22	0.10	0.18	0.29	0.53
Non-Hispanic White	—	—	—	—	—	—
Physical Activity Level						
Sedentary	−0.16	0.29	0.57	−0.91	0.35	0.01
Moderate	0.84	0.22	0.00	−0.75	0.40	0.06
Vigorous	—	—	—	—	—	—
Group setting						
Not in a group	0.6	1.30	0.90	1.28	1.56	0.41
Group of 2	0.20	1.32	0.88	−1.46	1.22	0.23
Group of 3 to 5	0.14	1.34	0.92	−1.48	1.27	0.24
Group of 6 to 9	−0.15	1.33	0.91	−0.36	1.34	0.79
Group of 10 or more	—	—	—	—	—	—
Physical Distancing						
6-feet from others	−0.06	0.17	0.72	—	——	——
Transportation mode						
On wheels	−0.58	0.19	0.0025	0.65	0.24	0.008
Mask Adherence						
Wore a mask correctly	—	——	—	−0.06	0.17	0.72
Weekday: yes	−0.15	0.20	0.45	0.34	0.26	0.19
Geographic Setting						
Commercial Street	1.19	0.27	<0.0001	−0.16	0.41	0.69
Neighborhood Park	1.05	0.26	<0.0001	−0.39	0.46	0.40
Playground	—	—	—	—	—	—
Population density (1,000/sq. mile)	0.03	0.01	0.02	−0.01	0.02	0.83
Percent households below poverty	−0.01	0.01	0.03	0.00	0.01	0.78

tend to spend time in the types of areas observed.

5. Conclusion

While the risk of COVID-19 transmission is lower in outdoor settings, it is unlikely to be zero. The new more infectious variants are of concern and have even resulted in new recommendations for people to wear two masks (Brooks et al., 2021). The main driver of spread is person-to-person, and transmission is likely to occur when an infected person without a mask is in close contact with others who also lack face coverings (Klompas et al., 2020; Wiersinga et al., 2020). Undoubtedly, spread can occur both indoors or outdoors when an infected person without facial covering is physically close to those who lack immunity or masks.

The policy implications of lower rates of mask use by males and minority groups suggest increased efforts are needed to enhance adherence to recommended guidelines. Improved, more comfortable masks that require less skill for appropriate fitting would be helpful. In addition, people may require additional feedback, as they may not be aware that their nose or mouth are uncovered. Stronger regulations and monitoring may also be helpful. If mask and distancing adherence cannot be improved, greater efforts to accelerate vaccination efforts will be needed.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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