Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original Article

Factors associated with mask use in New York City neighborhood parks during the COVID-19 pandemic: A field audit study

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ABSTRACT

Background: Mask use is a cost-effective measure to decrease COVID-19 transmission. Mask mandates intend to increase mask compliance but are often ambiguous when it comes to public outdoor spaces.
Methods: We used a field audit study to examine mask use in New York City neighborhood parks during COVID-19. 1453 park visitors were observed in 13 parks during July–August 2020 using a modified and validated park use audit tool (System for Observing Play and Recreation in Communities) that included items on general and proper mask use (i.e., mask covering both nose and mouth). Generalized estimating equation regression was used to determine the association between proper mask use and demographic (sex and age) and behavioral (physical and social activity) variables, while adjusting for community-level covariates.
Results: Overall, 39.0% of park visitors used masks (24.4% properly, 14.6% improperly). Females (p = 0.023), adults (p = 0.025), and seniors (p = 0.006) showed higher rates of proper mask use compared to males and younger visitors. Physical and social activity were not significantly associated with proper mask use.
Conclusion: There is a need for improved messaging regarding the proper use of masks among males and younger people. This is particularly important for future surges of new COVID-19 variants or other public health crises similar to COVID-19. Future research should focus on developing and evaluating targeted public health messages regarding mask use.

Introduction

The Centers for Disease Control and Prevention (CDC) COVID Data Tracker published on Jan 15, 2022 showed that more than 65 million Americans have contracted the coronavirus disease 2019 (COVID-19) and that more than 845,000 lives have been lost due to associated health complications [1]. New York City (NYC) was among the first epicenters in the first phase of the epidemic in the U.S. during March–May 2020, with a total of 203,000 cases and an average reported case-fatality rate of 32.1% among hospitalized patients due to limited health care capacity [2]. To date, 1 in 5 NYC residents have contracted COVID-19 and more than 35,000 residents have died from this disease [3].

Black and Latino communities, in particular, account for a disproportionate number of cases and show mortality rates that are 3.7 and 2.6 times higher, respectively, compared to white communities [4]. Potential explanations for these disparities include the fact that members of Black and Latino communities are disproportionally employed in essential occupations, have a higher prevalence of chronic conditions yet lower access to health care, and are more likely to live in crowded housing with fewer community resources [4,5]. These structural disparities suggest continued inequitable impact of COVID-19 among minority communities.

COVID-19 is primarily transmitted through respiratory droplets and aerosols expelled when an infected person speaks, breathes or sneezes [6,7]. This transmission may occur asymptomatically or pre-symptomatically, contributing to the exponential spread globally; however, it can be mitigated by the simultaneous implementation of population-wide mask use and social distancing [6]. Mask use is the

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most cost-effective population-wide measure that can be easily implemented and will continue to be important in the foreseeable future in light of vaccination hesitancy and if similar public health crises should occur [6–8]. However, mask efficacy is highly dependent on proper use and mask compliance in the population [6,9].

One effective method in increasing mask compliance is the implementation of state mandates [10,11], as New York State did, which required every person older than two years to wear a mask in public spaces and when social distancing could not be maintained [12]. However, the mandate did not address public outdoor settings specifically, such as parks, plazas, streets, and other open spaces. In these settings social distancing is theoretically possible, if size permits, but may not be always maintained. This is of particular importance since, in NYC, park use continues to be an important aspect of daily life among residents. The perceived importance of parks in NYC has in fact increased due to their relevance to physical and mental wellbeing and the small spaces in which most New Yorkers live [13].

Furthermore, urban green spaces have shown protective effects against depression and COVID-19 related worries [14]. However, the urban outdoor settings may be limited in size and social distancing may be difficult to maintain. This, in combination with ambiguous state mask mandates for these settings, poses a risk for poor mask adherence. In addition, current research has been focused on indoor settings and has mainly utilized self-reports. There have been calls for more research using naturalistic observation in outdoor settings [15]. Research has also been limited in minority communities most affected by COVID-19. Thus, the goal of this study was to investigate, using a validated field audit methodology, the prevalence of mask use and demographic and behavioral factors associated with proper mask use in a sample of low-income, minoritized neighborhood parks in NYC, which park users frequent for physical activity as well as socialization and relaxation. Specifically, we examined the role of sex, age, and physical and social activity in relation to proper mask use.

Methods

Data collection

This study used secondary data from the ongoing Physical Activity and Redesigned Community Spaces (PARCS) Study, a study of neighborhood parks in low-income areas of NYC. Details of the PARCS study have been described elsewhere [16]. This paper utilized data collected in Summer 2020. As part of the PARCS Study, the System for Observing Play and Recreation in Communities (SOPARC) was conducted to document park usership and park usage in neighborhood parks [17]. SOPARC is a reliable and valid observational system for outdoor settings in which trained researchers conduct visual scans of pre-determined areas in parks [13,18]. Two researchers employed by NYC Department of Parks and Recreation (NYC Parks) visited 13 recently renovated neighborhood parks in the Bronx, Queens, Manhattan, and Brooklyn on four different dates between July 16 and August 22, 2020, during daytime, including weekdays and weekends. At the time of observation, a statewide mask mandate was implemented, which required every person older than two years to wear a mask in public spaces and when social distancing cannot be maintained [12]. The data were collected by observation of park visitors. Two visual scans of parks were conducted on each visit day. In total, 104 visual scans were done across all the parks. Each scan lasted between 1 and 62 min, depending on the volume of observed park visitors, which ranged between 5 and 189 park visitors. A total of 1453 park visitors were observed.

The PARCS study received approval from the Institutional Review Board of the City University of New York. However, SOPARC audits are based on field observations in public spaces and are thus not considered human subject research. As the SOPARC data used were collected by the city and shared with the authors of this paper for research, the current paper is considered secondary data analysis in nature. Funding did not provide a conflict of interest for this study.

Measures

Individual-level factors

During each observation, researchers recorded the date and time of the visit, the sex (male or female) and age (≤ 12 years, 13–20 years, 21–59 years, ≥ 60 years) of each park visitor, and the nature of physical activity (sitting, standing, walking or vigorous activity) and/or social activity (being engaged with and in close proximity to other people or not) in which each park visitor was observed. Vigorous physical activity was recorded based on external signs, such as sweating or heavy breathing [17]. A single variable on mask use behavior (primary outcome) with 1) proper mask use (masks fully covering mouth and nose), 2) no mask use, and 3) improper mask use (masks worn under the nose or under the chin), was added to the usual SOPARC protocol administered in summer 2020 given the rising COVID-19 epidemic and interest in supporting positive public health outcomes in NYC. Masks were defined as any kind of facial covering, including cloth masks, surgical masks, N95 masks, or face shields.

Community-level factors

Community-level factors were included as covariates and drawn from secondary community-level data associated with PARCS study sites based on a Cadastral-based Expert Dasymetric System (CEDS) [19] that estimated population characteristics using the American Community Survey 2011–2016. A neighborhood was defined as within a 0.3-mile Euclidean buffer around each park. Covariates included park size, the total number of park visitors, mean household income (< $20,000 vs. ≥ $20,000 based on the mean annual income cutoff in public housing in NYC) [16], the neighborhood ethnicity composition, and the borough of each park. The neighborhood ethnicity composition was described by the percentage of Black residents and the percentage of Latino residents, as these were the predominant minority groups populating the park's neighborhoods.

Statistical analysis

Chi-square analyses were first conducted to explore differences in mask use by individual-level characteristics. Subsequently, in regression analysis, the mask use variable was reduced from three to two levels by combining people who did not wear a mask and people who wore a mask improperly, consistent with previous literature emphasizing proper use of masks as the most effective protection against COVID-19 [9]. We also reduced the age variable to "youth" (≤ 20 years), adults (21–59 years) and seniors (≥ 60 years). Generalized Estimating Equation (GEE) was used to estimate prevalence ratios (PR) of proper mask use by individual-level factors, adjusting for park neighborhood-level covariates and accounting for the clustering of observations within parks. Because we could not exclude the possibility that some of the same individuals could be captured in two separate scans on a given park visit by the research team, we conducted sensitivity analyses, using the same GEE model, and stratifying by the two SOPARC scans from each of the two independent researchers. These analyzes showed no differences between the visual scans of the two independent researchers. Therefore, results reported in this paper combined both visual scans.

Descriptive statistical analyses were conducted with SPSS v.27 (Chicago, IL) while the GEE model was conducted with SAS v.9.4 (Cary, NC). The α level was set at < 0.05.

Table 1
Characteristics of study parks and their neighborhoods.

	Mean	SD[b]
Park-level characteristics		
Park size (acres)	1.04	0.61
Park users (persons per park visit)	28	20
Neighborhood-level characteristics		
Ethnic composition		
Latino households (%)	29.11	18.22
Black households (%)	20.21	22.71
Mean household income ($)	26,841.48	10,880.92

[b] SD = Standard Deviation

Results

Characteristics of park neighborhoods and users

A total of 1453 park visitors were observed across 13 different neighborhood parks in NYC. Five parks were located in Brooklyn, four parks in the Bronx, three parks in Queens, and one park in Manhattan. Table 1 shows the characteristics of these neighborhood parks.

Total park users for each individual park for each visit averaged at 28 people (SD = 20). The parks' average size was 1.04 acres (SD = 0.61). The percentage of Latino and Black households in the neighborhood around the parks averaged at 29.1% (SD = 18.2%) and 20.2% (SD = 22.7%), respectively. However, note that Latino and Black households tend to concentrate in different neighborhoods; 7 of the 13 park neighborhoods were > 50% Latino or Black. The mean annual household income was $26,841.48 (SD = $10,880.92).

Descriptive statistics for sex, age group, physical activity, social activity, and mask use, are shown in Table 2.

Overall, 39.0% of park users wore a mask. However, masks were used properly by 24.4% of all park users, while 14.6% of park users did not wear masks properly. In Table 3, proper mask use was significantly associated with sex, age group, physical activity, and social activity.

In bivariate analyses, 27.1% of females vs. 21.9% of males ($p = 0.021$) and ~ 30% each of adults and seniors vs. 12.1% of teenagers and 18.7% of children ($p < 0.001$) wore masks properly. Those who were standing (33.9%) as opposed to walking (25.9%), sitting (23.2%), or engaging in vigorous activity (20.0%) were more likely to be wearing masks properly ($p < 0.001$). In addition, those who were not engaged in social activity were more likely than those who were to be wearing masks properly (31.0% vs. 21.9%, $p < 0.001$).

Table 2
Individual-level factors of park users.

	n	%
Sex		
Female	682	46.9%
Male	771	53.1%
Age group		
Child (≤ 12 years old)	530	36.5%
Teen (13–20 years old)	124	8.5%
Adult (21–59 years old)	682	46.9%
Senior (≥ 60 years or older)	117	8.1%
Physical activity		
Sitting	568	39.1%
Standing	274	18.9%
Walking	112	7.7%
Vigorous	499	34.3%
Social activity		
Yes	1060	73.0%
No	393	27.0%
Mask use		
Proper mask use	354	24.4%
No mask use	887	61.0%
Improper mask use	212	14.6%

Table 3
Pearson Chi-Square tests (2-sided) between mask use and individual-level factors.

	Proper mask use (%)	No mask use (%)	Improper mask use (%)	p-value
Sex				**0.021**
Male	21.9	64.3	13.7	
Female	27.1	57.3	15.5	
Age group				**< 0.0001**
Child (≤ 12 years)	18.7	74.0	7.4	
Teenager (13–20 years)	12.1	75.8	12.1	
Adult (21–59 years)	30.1	52.3	17.6	
Senior (≥ 60 years)	29.9	37.6	32.5	
Physical activity				**< 0.0001**
Sitting	23.2	54.9	21.8	
Standing	33.9	54.4	11.7	
Walking	25.9	63.4	10.7	
Vigorous	20.0	71.1	8.8	
Social activity				**< 0.0001**
Yes	21.9	64.9	13.2	
No	31.0	50.6	18.3	

Table 4
Multivariable GEE analysis on factors associated with proper mask use.

	Prevalence ratio	Lower CI[b]	Higher CI	P-value
Individual-Level Factors				
Sex				
Male (referent)				
Female	1.208	1.027	1.421	**0.023**
Age group				
Youth (≤20 years, referent)				
Adult (21–59 years)	1.636	1.064	2.515	**0.025**
Senior (> 60 years)	1.784	1.184	2.688	**0.006**
Physical activity				
Sitting (referent)				
Standing	1.313	0.930	1.854	0.122
Walking	1.166	0.830	1.639	0.375
Vigorous	1.138	0.877	1.476	0.331
Social activity				
No (referent)				
Yes	0.848	0.652	1.103	0.218
Community-Level Covariates				
Park size	5.798	2.220	15.141	**< 0.0001**
Total park users	0.996	0.993	1.000	**0.048**
Borough				
Brooklyn (referent)				
Bronx	0.137	0.030	0.636	**0.011**
Manhattan	4.321	2.462	7.587	**< 0.0001**
Queens	4.970	2.507	9.849	**< 0.0001**
Ethnic composition				
Percent Latino	1.037	1.022	1.052	**< 0.0001**
Percent Black	0.978	0.961	0.995	**0.017**
Mean household income				
< $20,000 (referent)				
≥ $20,000	1.402	0.390	5.043	0.605

[b] CI = Confidence Interval

Regression results

Results of the multivariate GEE analysis, adjusting for park and neighborhood covariates, are shown in Table 4.

Females were more likely to wear masks properly than males (PR = 1.208, 95% CI = 1.027–1.421). Adults (21–59 years) and seniors (≥ 60 years) were more likely to wear masks properly compared to young people of up to 20 years (PR = 1.636, 95% CI = 1.064–2.515 and

PR = 1.784, 95% CI = 1.184–2.688, respectively). Physical and social activity were no longer statistically significant in the multivariate model.

Discussion

This study contributes to knowledge on observational mask adherence in outdoor settings in the U.S. To our knowledge, this is one of the first studies investigating mask use in NYC outdoor settings such as neighborhood parks during the COVID-19 pandemic. Understanding factors driving mask compliance is essential in terms of future emergency and pandemic preparedness. Therefore, in dense and urban settings such as NYC, research on mask use in public outdoor spaces is particularly needed. This study is unique in its focus on minority communities and that it addresses an urgent need to better understand the factors that influence mask compliance to tailor public health messages to groups especially at risk. Our results showed that the willingness to wear masks in outdoor settings in NYC was appreciable; however, greater public health efforts are needed to increase proper mask-wearing, especially among males and the youth.

Our results showed that 39% of park users wore a mask, including 24.4% that showed proper use of masks, suggesting a general potential for improved public health messaging regarding the correct use of masks. This recommendation is consistent with previous research emphasizing the need for continuing public health efforts regarding the proper use of mask to increase effectiveness against the transmission of COVID-19, particularly in vulnerable communities [20,21]. Moreover, low rates of mask adherence may be explained by ambiguities in interpreting the NYC mask mandate in outdoor settings and differences in individual's risk perception in indoor vs. outdoor settings [22]. On one hand, current research shows reduced likelihood of transmission in outdoor settings due to the dilution of aerosols, possible transient exposure, and improved air ventilation [23]. Outdoor settings may allow for more social distancing, and people who visit community parks and playgrounds often do so with children, family members, or members of their household which may not require mask use. On the other hand, these factors may be limited by small neighborhood parks and high frequency of park use in dense urban settings such as NYC. Little research is available to date in such settings. Current mandates are ambiguous regarding different types of outdoor public spaces. More empirical data can inform clearer mask policies.

Our results also showed a disparity in proper mask use by sex. Females were more likely to wear masks than males. This is in line with several previous studies focused on indoor settings, self-reported mask use, and observational data from Philadelphia and China [22,24–27]. These results indicate the need for more targeted public health messaging towards males. Possible reasons for not wearing masks in general include stigma such as perceived weakness, threat to masculinity, and infringement on independence and liberty [24–26]. Therefore, recommended public health messaging strategies for males include a focus on community- and family-protective effects, heroism, patriotism, and a reinforcement of masculinity and strength associated with masks [24,26].

Our results also showed a negative association between proper mask use and age, confirming age differences in previous literature of self-reported mask use and observational results from Philadelphia and China [22,25,27]. Public health mask guidelines have been particularly mixed for children. For example, in contrast to the statewide mask mandate in New York that requires everyone over the age of two years to wear a mask, the World Health Organization published recommendations that excluded children younger than 5 years from wearing a mask and cautiously advised mask-wearing under supervision until 11 years of age [28]. Other barriers to mask compliance among youth include low perceived threat from infection despite concerns about transmission to their family and community members, peer pressure, disbelief in public health messaging, distrust in politicians, and conflicting messages or misinformation [25,29]. Therefore, public health messages should be consistent, reliable, from non-political and credible sources, and highlight the personal responsibility of protecting their loved ones, as well as emphasize the benefit of a quicker return to normalcy given mask compliance [11,29].

Interestingly, although physical activity showed a significant bivariate relationship with proper mask use, it was no longer a significant factor after adjusting for sex, age, and covariates. Social activity showed similar results. These findings suggest that these activities may be somewhat sex- and age-dependent, where women and adults were more likely to be less active than men and youth and the reverse may be true for social activity in parks [30,31]. However, our data could not provide information on whether people from the same household were socializing, in which case masks might not be required if no other people were in proximity.

The most effective strategies in increasing mask compliance are consistent mask wearing guidelines, mask mandates in all states, and community-tailored public health messaging towards marginalized communities [10,11,25]. These strategies could prevent further lockdowns, mitigate economic losses, reduce mortality rates, and decrease the burden of disease for individuals. A simulated model found a mortality rate reduction of 55% in New York State, if at least 80% of the population complied with mask use [6]. Yet, in retail settings without a store or state mandate, research has found a compliance rate of only 41% [25].

Improvements in public health messaging regarding compliance and proper use of masks are essential, particularly as part of a comprehensive effort to decrease the disproportionate burden of COVID-19 infection and mortality rates among Black and Latino communities. To target these communities, public health messaging must be tailored and avoid a one-size-fits-all approach. Tailored messages should focus on language and cultural nuances, and wider public health programs should actively address fundamental causes of health inequity, which are often linked to contextual factors, such as racial segregation or power imbalances [4,32,33]. These programs must focus on cross-sectoral strategies and meaningful engagement of the targeted communities. Previous research on mask use compliance strategies has shown that local, cultural values may be beneficial in predicting and encouraging mask use [22]. Furthermore, collectivism, or how mask wearing affects community and family members, is positively associated with mask adherence, compared to individualism which emphasizes personal protection only [34]. Hence, individualistic communities and countries such as the US may benefit from prioritizing the public's welfare over individual protection [34].

To combat the unequitable burden of COVID-19 in marginalized communities and ensure equitable distribution of resources, social determinants of health must first be addressed [4,32,35]. Lessons learned from previous epidemics such as Zika or Ebola have shown that local communities and local leadership must be directly involved in the development process of public health messaging and programs to increase trust, avoid stigmatization, empower community members, and increase compliance with measures [4,32,35,36]. Specific recommendations include citywide mitigation operations that directly involve Black and Latino community members and leaders to assess actual needs, provide targeted communication and education resources, and expand access to testing, treatment, and supportive services [5,35].

Despite mask mandates being lifted for those who are vaccinated in many parts of the U.S., vaccination rates remain below the level required for herd immunity. The development of new SARS-CoV-2 variants, including Omicron which is highly transmissible and vaccine-resistant, is alarming; however, mask use continues to be a

recommended protection against all variants [37,38]. As such, the results of this study are of particular importance for increasing proper mask use on a large scale to effectively combat COVID-19, future pandemics, and similar public health crises. Through this paper, we hope to call attention to the gaps in public health messaging in key target groups. Consistent and clear mandates are an essential part of the public health response to an epidemic, and there is work to do be done now in anticipation of future crises. Lessons learned in this paper can inform efforts to increase acceptance of and compliance with mask wearing campaigns.

It is noteworthy that almost 40% of our sample of park users demonstrated willingness to wear masks (even if improperly) in small neighborhoods parks, considering the backdrop of vocal anti-mask campaigns nationally in the U.S. NYC Parks implemented several COVID-19 safety measures throughout the pandemic. First, park amenities were closed during the peak of the pandemic in March 2020 and only re-opened when NYC was meeting state guidelines per the statewide phased re-opening plan (around late Spring 2020). Second, NYC Parks opted to proactively recommend that park visitors both wear masks *and* socially distance while in parks, which goes beyond the NYC mask mandate [39]. Third, NYC Parks launched a social media campaign informing park visitors on social distance guidelines, introducing safety measures, and encouraging park visitors to both wear a mask and maintain distance. All of this was amplified by the distribution of free masks in parks since May 2020 and the display of banners with 6 feet measurements for reference. The initiatives taken by NYC Parks serve as an excellent example of a cross-sectoral approach to public health. Such concerted efforts across sectors may play an important role in creating a mask-wearing normative culture in NYC, contrary to many parts of the country.

Strengths and limitations

This study is one of the first in the U.S. to include observed mask use in NYC neighborhoods parks located in underserved communities with a large proportion of Black and Latino residents. However, the study design limited our ability to observe temporal changes in behavior at different points of the epidemic and limited the scope of assessable factors of mask compliance. Due the field audit nature of the study measurement, we also did not have more detailed demographic data on park users, and whether observed park users not socially distancing belonged to the same household. Lastly, given that this study included a convenience sample of small neighborhood parks in low-income minority communities, findings may not be generalizable. We would caution against extrapolating our findings to all NYC parks, particularly larger parks such as Central Park (Manhattan), Van Cortlandt Park (Bronx), or Prospect Park (Brooklyn), which are quite different in size, geography, amenities, and volume of park visitors.

Public health implications

Our study calls for particular attention towards improved public health messaging to increase mask adherence both for COVID-19 and future public health crises. More research and tailored strategies are particularly needed among males and youth. There is a need for consistent and reliable information from credible, nonpartisan sources on the proper use of masks, including in outdoor settings such as parks.

Conclusion

At a time where public interest in mask use may be decreasing, this study provides important results showing that there is a great need to improve public health messaging for future pandemics and similar public health crises. This study also shows that new strategies are needed to tailor mask-wearing and similar public health messages to different groups in the community, in particular the youth, males, and marginalized communities. Mask use compliance and improved public health messaging should therefore be a central focus for pandemic and emergency preparedness. Future research could employ a mix of audits, surveys, and qualitative methods to shed light on a broader set of individual, contextual, psychosocial, cultural, and political factors that may influence mask use is needed. In addition, more research is warranted to design and test the effectiveness of public health campaigns in diverse population groups regarding mask use and other COVID-19 prevention and control efforts.

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CRediT authorship contribution statement

The following describes the individual contributions of all authors to this manuscript: **Lisa Hitch:** Literature review, Data Interpretation, Writing – original draft, Accessed & Verified Underlying data, Peer-Review Revisions. **Marie A Sillice:** Writing – review & editing, Data Interpretation, Peer-Review Revisions. **Hanish Kodali:** Writing - review & editing, Data Analysis, Data Interpretation, Accessed & Verified Underlying data. **Katarzyna Wyka:** Writing - review & editing, Data Analysis, Data Interpretation, Accessed & Verified Underlying data. **Javier Otero Peña:** Writing – review & editing, Data Interpretation, Accessed & Verified Underlying data. **Terry TK Huang:** Supervision, Funding acquisition, Data Interpretation, Writing – review & editing, Peer-Review Revisions.

Declaration of interest

We declare no conflict of interests.

Data Sharing Statement

Individual, observational data (does not include any identifiers or personal data) can be made available upon request. Please direct any requests to: parcs@sph.cuny.edu.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jiph.2022.02.006.

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