



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.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief report

Prevalence and predictors of mask use on a large US university campus during the COVID-19 pandemic: A brief report

Kenneth Burnell^a, Meredith Robbins^a, Sharon Kulali^{b,c}, Ellen M. Wells PhD, MPH^{a,c,*}^a School of Health Sciences, Purdue University, West Lafayette, IN, USA^b Department of Biochemistry, Purdue University, West Lafayette, IN, USA^c Department of Public Health, Purdue University, West Lafayette, IN, USA

Key words:

COVID-19

Personal protective equipment

Masks

Universities

A B S T R A C T

This observational study was conducted to determine the prevalence and correlates of wearing masks at a large Midwestern US university during the COVID-19 pandemic. A total of 7,237 individuals were observed over 24 hours. Overall mask use prevalence was 90.6% (95% confidence interval: 89.9, 91.2); mask use was significantly associated with being indoors (vs outdoors), female (vs male), and at the athletic center (vs the student union).

© 2021 Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved.

INTRODUCTION

During the COVID-19 pandemic, near-ubiquitous use of masks in community settings was recommended.¹ However, personal protective equipment is considered to be one of the least effective hazard control measures due to their reliance on an individual's behavior.² The extent to which individuals have worn masks in nonoccupational settings, particularly in institutions of higher education, is not yet fully described. Therefore, the goal of this research was to determine the prevalence and correlates of mask use on a large United States university campus.

METHODS

In fall 2020, there were >40,000 students on campus taking in-person and/or online classes. University policy required wearing masks at all time while indoors (if not eating) and required wearing masks outdoors (if not social distancing). Removal of masks indoors for eating or drinking was permitted for <15 minutes if social distancing could be observed. All students, faculty, and staff completed a pledge stating that they would follow

these policies; violators could face disciplinary action. Information regarding these policies were posted widely in print and electronic formats throughout the semester.

Data were collected using direct observation on weekdays from 9:00 AM to 6:30 PM. Observers were 3 undergraduate students with prior research experience. They were trained using written materials and in-person meetings. A standardized data collection form was used to collect data outside (near the building entrance) or inside (in a common area) one of 3 locations on campus (student union/academic building/athletic center) over the course of one hour. Observers collected data on all persons in the area, including mask use (none/incorrectly worn/correctly worn), perceived gender (male/female/unknown), and perceived student status (student/nonstudent/unknown). If there was any uncertainty about gender or student status, observers were instructed to mark "unknown." Correct usage was based on US Centers for Disease Control and Prevention guidelines.

Data were analyzed using Stata 16.0 (College Station, TX, USA). Few individuals were wearing masks incorrectly (<10%), so this category was combined with correctly wearing masks for analyses. Logistic regression models were used to assess correlates of mask use. Adjusted regression models included gender (male/female/unknown), student status (student/nonstudent/unknown), location relative to the building (inside/outside), and building (student union/academic building/athletic center). Standard errors were adjusted for potential correlation based on collection period.

* Address correspondence to Ellen M. Wells, PhD, MPH, School of Health Sciences, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47906, USA.

E-mail address: wells54@purdue.edu (E.M. Wells).

Conflicts of interest: The authors declare that they have no competing interests with respect to this work.

RESULTS

Overall, 6555 out of the 7237 observed persons wore masks (90.6%; 95% confidence interval (CI): 89.9, 91.2) (Table 1) during 24 collection periods (24 hours). 2063 out of 2,140 persons were wearing masks indoors (96.4%; 95% CI: 95.5, 97.1); 4492 out of 5097 people wearing masks outdoors (88.1%; 95% CI: 87.2, 89.0). Observed mask use did not significantly change over time (Fig 1).

Overall, a higher proportion of women wore masks (vs men) and a more students wore masks compared to nonstudents (Table 1). Mask use prevalence was highest at the athletic center and lowest at the student union. Patterns were similar when stratified by location.

In adjusted logistic regression models, individuals wearing masks were significantly more likely to be female (vs male), inside (vs outside), and at the athletic center (vs the student union) (Table 1). Results were similar in unadjusted models and when stratified

Table 1
Relationship of demographic and location characteristics with wearing masks on a large university campus, September–November 2020

Category	Variable	N wearing masks/ N total	Percent wearing masks (95% CI)	Adjusted odds ratio (95% CI)*†
Indoors only, N = 2,140‡				
Gender	Female	977/1,008	96.9 (95.7, 97.8)	referent
	Male	1,081/1,127	95.9 (94.6, 96.9)	0.76 (0.36, 1.60)
	Undetermined	5/5	NC	NC
Student status	Nonstudent	183/191	95.8 (91.8, 97.9)	referent
	Student	1,871/1,940	96.4 (95.5, 97.2)	1.15 (0.30, 4.36)
	Undetermined	9/9	NC	NC
Building	Student union	324/337	96.1 (93.5, 97.7)	referent
	Academic building	1,435/1,482	96.8 (95.8, 97.6)	1.18 (0.40, 3.50)
	Athletic center	304/321	94.7 (91.6, 96.7)	0.70 (0.24, 2.01)
Outdoors only, N = 5,097				
Gender	Female	1,993/2,205	90.4 (89.1, 91.5)	referent
	Male	2,485/2,875	86.4 (85.1, 87.6)	0.67 (0.56, 0.81)
	Undetermined	14/17	82.4 (57.3, 94.2)	0.52 (0.22, 1.25)
Student status	Nonstudent	394/470	83.8 (80.2, 86.9)	referent
	Student	4070/4,591	88.7 (87.7, 89.5)	1.39 (0.99, 1.95)
	Undetermined	28/36	77.8 (61.5, 88.5)	0.76 (0.56, 1.04)
Building	Student union	1,397/1,632	85.6 (83.8, 87.2)	referent
	Academic building	2,295/2,591	88.6 (87.3, 89.7)	1.25 (0.78, 2.02)
	Athletic center	800/874	91.5 (89.5, 93.2)	1.74 (1.36, 2.23)
Overall, N = 7,237				
Gender	Female	2,970/3,213	92.4 (91.5, 93.3)	referent
	Male	3,566/4,002	89.1 (88.1, 90.0)	0.68 (0.57, 0.82)
	Undetermined	19/22	86.4 (65.2, 95.5)	0.60 (0.25, 1.42)
Student status	Nonstudent	577/661	87.3 (84.5, 89.6)	referent
	Student	5,941/6,531	91.0 (90.2, 91.6)	1.36 (0.98, 1.89)
	Undetermined	37/45	82.2 (68.3, 90.9)	0.80 (0.55, 1.16)
Building	Student union	1,721/1,969	87.4 (85.9, 88.8)	referent
	Academic building	3,730/4,073	91.6 (90.7, 92.4)	1.26 (0.82, 1.95)
	Athletic center	1,104/1,195	92.4 (90.7, 93.8)	1.54 (1.11, 2.14)
Location	Outside	4,492/5,097	88.1 (87.2, 89.0)	referent
	Inside	2,063/2,140	96.4 (95.5, 97.1)	3.1 (2.14, 5.53)

95% CI = 95% confidence interval; NC = not calculated.

*Standard errors are adjusted for clusters based on sampling event (N=24). Values are odds ratio (95% confidence interval).

†The adjusted model includes all variables shown the table.

‡N = 2,126 for adjusted regression model.

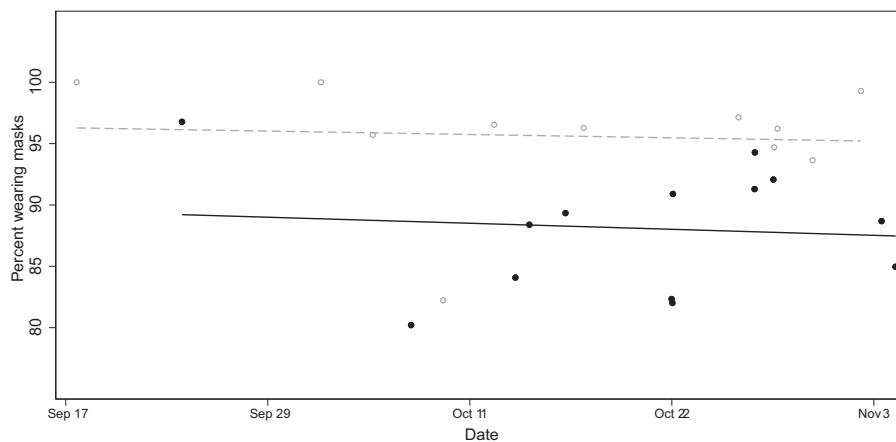


Fig 1. Percent of individuals wearing masks at each observational period over time, either indoors (hollow circle) or outdoors (solid circle). Lines indicate trend over time indoor observations (dashed line) and outdoor observations (solid line).

by location, although indoor observations were not statistically significant.

DISCUSSION

We report a very high mask use prevalence in this study; across all categories observed, mask use prevalence was >80%. This is higher than several studies of mask use in health care settings, some of which have reported prevalence lower than 50%.^{3,4} In contrast, research conducted during the COVID-19 pandemic reported somewhat higher mask use prevalence either on university campuses (85.5%)⁵ or community settings (65.7% to 89%).^{1,6,7} This was not universal, as Deschanvres et al. still reported lower mask use prevalence in a community setting during the pandemic (56.4%).⁸ Prior work suggests that requirements (vs guidelines), training, and/or a concern about specific risks may contribute to increased mask use prevalence^{3,4,8–10}; these might contribute to our results. Similarly, higher use when masks are required versus recommended likely explains the higher mask use prevalence observed indoors versus outdoors in this, and other studies.^{5,6,8}

We observed a higher mask use prevalence among women versus among men. This trend is reported in many^{6,8,10} but not all^{1,3} prior studies. Although not statistically significant, our finding that the student mask use prevalence was higher than that of nonstudents is not consistent with to prior reports suggesting less mask use among young adults in community settings^{1,7,8,10}; however, it is consistent with a high student mask use reported from other university campuses.⁵ Anecdotal reports from observers suggest the nonstudents were largely campus visitors or contractors, who could have had less training and a much lower chance of disciplinary action, which may have contributed to prevalence of mask use.

The highest mask use prevalence was at the athletic center, followed by the academic building and the student union. The exact reason for this is unknown. Some possibilities are that individuals could be barred from using the athletic facility if found to be in violation of the mask use policy. The results also reflect the likely proportion of campus visitors to the various buildings or the likelihood of eating inside the buildings. Both visitors and eating would be highest in the student union and lowest in the athletic complex. Data collectors

noted individuals who recently ate may not have replaced their mask immediately.

A substantial limitation is that observers were also asked to use their own judgement to assess gender and student status. For this reason, observers were encouraged to indicate “unknown” if they were unable to make a determination, and this category was retained in analyses. Additionally, race/ethnicity data were not collected because direct observation could result in a high level of misclassification for this variable.

This study also has several strengths. Data were collected on a large sample of individuals. Additionally, as a direct observational study, these results are not subject to reporting bias. Overall, this adds to scientific knowledge for face mask use in academic settings where mask use was required.

References

1. Fisher KA, Barile JP, Guerin RJ, et al. Factors associated with cloth face covering use among adults during the COVID-19 pandemic - United States, April and May 2020. *MMWR Morb Mortal Wkly Rep.* 2020 Jul 17;69:933–937.
2. NIOSH. Hierarchy of Controls [Internet]. 2020. Available at: <https://www.cdc.gov/niosh/topics/hierarchy/default.html>. Accessed May, 17 2021.
3. Moore D, Gamage B, Bryce E, Copes R, Yassi A, BC Interdisciplinary Respiratory protection study group. Protecting health care workers from SARS and other respiratory pathogens: organizational and individual factors that affect adherence to infection control guidelines. *Am J Infect Control.* 2005 Mar;33:88–96.
4. Nichol K, McGeer A, Bigelow P, O'Brien-Pallas L, Scott J, Holness DL. Behind the mask: determinants of nurse's adherence to facial protective equipment. *Am J Infect Control.* 2013 Jan;41:8–13.
5. Barrios LC, Riggs MA, Green RF, et al. Observed face mask use at six universities - United States, September–November 2020 *MMWR Morb Mortal Wkly Rep.* 2021 Feb 12;70:208–211.
6. Ganczak M, Pasek O, Duda-Duma Ł, Świstara D, Korzeń M. Use of masks in public places in Poland during SARS-Cov-2 epidemic: a covert observational study. *BMC Public Health.* 2021 Feb 23;21:393.
7. Hutchins HJ, Wolff B, Leeb R, et al. COVID-19 mitigation behaviors by age group - United States, April–June 2020. *MMWR Morb Mortal Wkly Rep.* 2020 Oct 30;69:1584–1590.
8. Deschanvres C, Haudebourg T, Peiffer-Smadja N, et al. How do the general population behave with facemasks to prevent COVID-19 in the community? A multi-site observational study. *Antimicrob Resist Infect Control.* 2021 Mar 29;10:61.
9. Lai X, Wang X, Yang Q, et al. Will healthcare workers improve infection prevention and control behaviors as COVID-19 risk emerges and increases, in China? *Antimicrob Resist Infect Control.* 2020 Jun 11;9:83.
10. Haischer MH, Beilfuss R, Hart MR, et al. Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PLoS One.* 2020;15:e0240785.