BMJ Global Health

Prevalence and associations of COVID-19 testing in an online sample of transgender and non-binary individuals

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ABSTRACT

Background Testing for COVID-19 and linkage to services is fundamental to successful containment and control of transmission. Yet, knowledge on COVID-19 testing among transgender and non-binary communities remains limited.
Methods Between October 2020 and November 2020, we examined the prevalence and associations of COVID-19 testing in an online sample of transgender and non-binary people (n=536). Multivariable hierarchical logistic regression analyses examined associations between COVID-19 testing and participants' sociodemographic, mental health, substance use, gender affirmation, economic changes and healthcare experiences.
Results Prevalence of COVID-19 testing in this sample was 35.5% (n=190/536). In the final model, transgender and non-binary participants from upper socioeconomic income background and Europe, who reported having active alcohol use disorder, limited access to gender-affirming surgery, had more than 20% reduction in income, and experienced mistreatment in a health facility due to gender identity had significantly increased odds of COVID-19 testing (all p<0.05); those who reported recent tobacco use had significantly lower odds of COVID-19 testing (p=0.007).
Conclusions These findings highlight structural disparities in COVID-19 testing and reinforce the importance of increasing testing strategies for transgender and non-binary populations.

Key questions

What is already known?
► The COVID-19 pandemic had disproportionately impacted marginalised communities across the world, including transgender and non-binary communities.
► Public health response to COVID-19 testing strategies has been expansive, yet the current literature on COVID-19 testing and the social and structural factors that could impact this public health recommended behaviour among trans and non-binary populations have not yet been characterised.

What are the new findings?
► In this sample of trans and non-binary people across the world, about one-third (35.5%) reported receiving COVID-19 testing.
► The hierarchical logistic regression model showed several associated factors to increase the odds of COVID-19 testing, including being from upper socioeconomic income, from Europe, having active alcohol use disorder, having limited access to gender-affirming surgery, a reduction in income and having experienced mistreatment in a health facility due to gender identity.
► Recent tobacco use was associated with lower odds of COVID-19 testing.

What do the new findings imply?
► This study provides critical insights into the factors associated with COVID-19 testing and supports the need for more targeted testing strategies among transgender and non-binary populations.

INTRODUCTION

As of 19 August 2021, there have now been 209 million confirmed cases and 4.3 million deaths as a result of the novel COVID-19 pandemic.[1] Many countries have relied on a wide range of measures to slow the spread of the virus, such as closure of schools and businesses, travel restrictions and border closures.[2] These interventions, important for curbing viral transmission, have also upended healthcare systems and had a substantial impact on access to care, mental health, substance use and economic stability around the world.[3–7]

The impacts of COVID-19 may be widespread, but emerging evidence indicates that already marginalised communities have been disproportionately affected.[8 9] The COVID-19 pandemic has exacerbated existing health disparities and social inequities, largely along lines of race and ethnicity, socioeconomic status, and gender identity and sexual orientation.[8 10–12] Many structural barriers affect populations placed

at social, economic and politic disadvantage, and who are seeking COVID-19 testing, vaccinations or treatment.[11 13] While vaccinations against COVID-19 continue to be rolled out around the world, testing interventions remains a crucial step for minimising the spread of the SARS-CoV-2 virus; for some, however, access to testing remains elusive.[14–19]

In several countries around the world, expansive testing strategies such as mobile drive-through testing sites, drop-in pharmacy centres, clinic and hospital facilities, and university/campus health centres have been a 'cornerstone of successful containment strategies', while in others, testing backlogs, shortages and mixed testing modalities have only further complicated efforts to curb viral spread.[16 19 20] Transgender and non-binary individuals already experience greater barriers to care—be it primary care and/or gender-affirming care such as counselling and therapy services, hormone therapy, surgeries, durable medical equipment (eg, vaginal dilators, chest compressors, etc) and non-medical supplies (binders and packers, wigs, shaving supplies, etc)—and mental health challenges due to widespread stigma, mistreatment and discrimination, and a scarcity of providers trained in gender-affirming practices only make healthcare even less accessible.[21–27] Given the unprecedented nature of the COVID-19 crisis and existing hurdles to care for transgender and non-binary people, coordinated and targeted efforts to prioritise populations at most risk are crucial. Previous research indicates, however, that marginalised communities are often neglected amid crises and large-scale disasters.[28] Recent reports regarding disparities in testing, treatment and mortality also seem to confirm this.[29 30] Data on COVID-19 testing and its associations among transgender and non-binary communities are urgently needed to assess the degree to which critical public health interventions are reaching these communities.

Given that current COVID-19 surveillance systems remain systematically gender non-inclusive, that is, they only define and recognise binary cisgender identities in its data collection,[25 31] it is not known whether COVID-19 testing strategies are reaching transgender and non-binary populations, particularly when these populations continue to be hidden, overlooked and invisible in the healthcare systems.[31] As such, this study sought to characterise and examine the prevalence of COVID-19 testing and potential associations in transgender and non-binary populations across sociodemographic, mental health and substance use, gender affirmation, economic changes and healthcare experiences.

METHODS

The Strengthening the Reporting of Observational Studies in Epidemiology guidelines for reporting cross-sectional studies can be found in online supplemental table 1.

Study procedures and sample

Between 25 October 2020 and 26 November 2020, Johns Hopkins University, Hornet and Her social networking apps collaborated to launch the COVID-19 Disparities Survey II Project, an online survey examining the impact of the COVID-19 pandemic on lives and well-being of transgender and non-binary people who are active app members across the world. Partnerships with Hornet and Her social networking apps as a channel for survey deployment were deemed strategic by the study team given that both apps catered to members of the lesbian, gay, bisexual, transgender, queer and non-binary individuals, who are often under-represented in research. This study specifically analyses trans and non-binary people's experiences and well-being in the context of COVID-19 pandemic. The survey was deployed in 14 languages. Participants were recruited using a non-randomised sampling approach via Hornet and Her social networking apps. Specifically, link to survey invitations was sent to the inboxes of members who had used the apps in the past year. Participants who were interested in the study and clicked on the survey link were taken into the survey consent landing page that details an overview of the study, their rights to privacy, confidentiality and volunteer participation. Eligible participants were aged 18 years or older, an app member, have used the app in the past year and able to provide electronic written informed consent. No COVID-19 information or service navigation was offered to users within either of the apps.

Participants completed a one-time survey assessing sociodemographic, mental health and substance use, gender affirmation, economic challenges, healthcare experiences and COVID-19 testing and results. To increase data quality, we used a deduplication technique, which removed participants with any duplicated IP addresses to ensure there were no multiple survey responses, and removed participants with incomplete responses (ie, completed less than 90% of the survey).

Measures

Sociodemographic

Age was measured in years and categorised as young adults (yes=18–29 years old vs no=30 years old or older). Gender identity was assessed via a two-step method among transgender (trans) populations[32] using a cross-tabulation of assigned sex at birth (What is your assigned sex at birth?) and current gender identity (How would you define your gender identity?) variables to provide gender categories of gender non-binary (genderqueer, gender non-conforming, gender expansive), trans feminine (eg, woman, trans woman) and trans masculine (eg, man, trans man). Education was categorised as less than high school/high school, or trade/some college or more. Socioeconomic income was coded into lower/middle/upper levels. For region, we used the WHO's definition to aggregated country-level data into South-East Asia, Americas, Eastern Mediterranean, Africa, Europe and Western Pacific.

Mental health and substance use

Depression and anxiety were assessed using the 4-item Patient Health Questionnaire,[33] which asks how often in the past 2 weeks participants experienced: (1) feeling nervous, anxious or on edge, (2) not being able to stop or control worrying, (3) feeling down, depressed or hopeless, and (4) little interest or pleasure in doing things. Responses were recorded in a 4-point Likert scale from 0=not at all, 1=several days, 2=more than half the days and 3=nearly every day. We used suggested clinical cut-off points for screening positive for anxiety (yes vs no) if total score was greater than or equal to 3 for the first two items and screening positive for depression (yes vs no) if total score was greater than or equal to 3 for the last two items.[33] Suicidal ideation was assessed by asking participants if they have ever thought about taking their own life in the past 6 months (no=never vs yes=often/all the time). To assess active alcohol use disorder, we used the Alcohol Use Disorders Identification Test (AUDIT-C), which is a 4-item scale for alcohol use screening. Responses were summed and categorised based on a standard cut-off score indicative of clinically significant screening.[34] To assess recent tobacco use, we asked participants about whether they have recently (<6 months) used tobacco products (yes vs no).

Gender affirmation

Gender-affirming hormone history was assessed; participant responses were coded as current utilisation (yes vs no/not applicable). Additionally, participants were asked a series of questions regarding whether the COVID-19 crisis limited their ability to access the following resources that are important for gender affirmation surgery: therapy or counselling services, surgeries specific to gender affirmation or transition, durable medical equipment (eg, vaginal dilators, chest compresses, etc) and non-medical supplies (eg, wigs, shaving supplies, binders, packers, breast forms, etc). Responses were recorded as yes versus no/not applicable.

Economic challenges

Participants were asked how much of their income was reduced due to COVID-19 crisis; responses were coded as more than 20% reduction (yes vs no). Participants were also asked if they were able to meet their basic needs (eg, food, clothing, shelter, transportation, education and healthcare) with their current income (yes vs no), and whether they had cut or skipped meals due to financial strains (yes vs no).

Healthcare experience

To assess healthcare experiences specific to avoidance and mistreatment, we asked participants if they have ever avoided healthcare services due to their gender identity (yes vs no), and if they ever felt that they were not treated well in a health centre due to their gender identity (yes vs no).

COVID-19 testing and result

To assess history of COVID-19 testing (the outcome of interest), we asked participants whether they had ever received a test to check for active coronavirus infection (usually a swab in nose/mouth/throat); participant responses were coded as yes versus no. Among those who indicated receiving a COVID-19 test, we then asked what the result of their active coronavirus tests was, and participant responses were coded as tested positive (yes vs no).

Data analysis

The sample was restricted to participants who had data on COVID-19 testing, resulting in a final analytical sample of n=536. Univariate descriptive statistics were conducted to provide summary variables (eg, mean, SD, frequency and percentages) of overall distribution and pattern of the outcome (COVID-19 testing) among this sample. We then used χ^2 tests to examine global differences by COVID-19 testing. Additionally, we restricted the sample to individuals who reported a positive test for COVID-19 (n=16) and provided summary variables for this subsample. Response rates were not possible to calculate given that the survey link was anonymised, and therefore the parent study did not have a known sample pool size (ie, denominator) from which survey participants can be drawn from.

Next, using the full sample (n=536), bivariate analyses were conducted to examine factors associated with COVID-19 testing; variables associated with the outcome at p<0.20 were included in the subsequent models. Hierarchical, stepwise, multivariable logistic regression analyses were then used to examine factors associated with COVID-19 testing. Specifically, variables were entered in five blocks beginning with Block 1: Sociodemographic, followed by Block 2: Block 1+Mental Health and Substance Use, Block 3: Blocks 1–2+Gender Affirmation, Block 4: Blocks 1–3+Economic Changes, and Block 5: Blocks 1–4+Healthcare Experience. Following methodological guidelines for conducting trans research,[35] we conducted a gender-inclusive analytical approach—that is, given that no significant differences in COVID-19 testing by gender identity were observed, we did not analyse the models by gender groups; instead, we used the full sample controlling for gender identity in the adjusted models. Statistical significance was set at p<0.05. All statistical analyses were conducted in StataSE V.16.1.

RESULTS

Sample characteristics

Table 1 displays the sample characteristics of transgender and non-binary adults included in the analysis (n=536). A total of 35.5% of the sample reported ever receiving the COVID-19 test.

The full sample's mean age was 33.28 years (SD=10.6) and less than half of participants were younger adults under the age of 30 (32.9%). Most of the participants identified as non-binary (67.9%), followed by trans

Table 1 Characteristics of transgender and non-binary adults in the COVID-19 Disparities Survey II (n=536)

			Received test for COVID-19					
			No		Yes			
			n	%	n	%	X^2 test statistic	P value
	All		346	64.55	190	35.45		
Demographics								
Age								
Continuous range: 18–81 (M, SD)	33.28	10.62	33.77	10.79	32.37	10.26	1.460	0.073
Young adult								
Yes (18–29)	230	42.91	141	40.75	89	46.84	1.857	0.173
No (30+)	306	57.09	205	59.25	101	53.16		
Gender spectrum								
Non-binary	364	67.91	237	68.50	127	66.84	0.154	0.926
Trans feminine	131	24.44	83	23.99	48	25.26		
Trans masculine	41	7.65	26	7.51	15	7.89		
Level of education								
Less than high school	22	4.11	12	3.48	10	5.26	1.283	0.527
High school, or trade	153	28.60	102	29.57	51	26.84		
Some college or more	360	67.29	231	66.96	129	67.89		
Socioeconomic income								
Lower	81	15.25	57	16.67	24	12.70	11.909	**0.003**
Middle	410	77.21	269	78.65	141	74.60		
Upper	40	7.53	16	4.68	24	12.70		
Region								
South-East Asia	109	20.34	80	23.12	29	15.26	11.535	**0.042**
Americas	91	16.98	63	18.21	28	14.74		
Eastern Mediterranean	26	4.84	18	5.20	8	4.21		
Africa	6	1.12	2	0.58	4	2.11		
Europe	288	53.73	171	49.42	117	61.58		
Western Pacific	16	2.99	12	3.47	4	2.11		
Mental health and substance use								
Depression								
Yes	209	39.96	132	38.94	77	41.85	0.421	0.516
No	314	60.04	207	61.06	107	58.15		
Anxiety								
Yes	190	35.98	117	34.21	73	39.25	1.327	0.249
No	338	64.02	225	65.79	113	60.75		
Suicide ideation								
Often/all the time	188	36.50	120	35.82	68	37.78	0.193	0.660
Never	327	63.50	215	64.18	112	62.22		
Screened positive for alcohol use disorder								
Yes	178	35.04	111	33.53	67	37.85	0.945	0.331
No	330	64.96	220	66.47	110	62.15		
Tobacco use								
Yes	272	52.11	184	54.60	88	47.57	2.3665	0.124

Continued

Table 1 Continued

	All		Received test for COVID-19				X² test statistic	P value
			No		Yes			
			n	%	n	%		
			346	**64.55**	**190**	**35.45**		
No	250	47.89	153	45.4	97	52.4		
Gender affirmation								
Hormone utilisation								
Yes	280	59.45	164	54.30	116	68.64	9.236	**0.002**
No, not applicable	191	40.55	138	45.70	53	31.36		
Limited access to therapy or counselling								
Yes	54	11.56	24	7.87	30	18.52	11.734	**0.001**
No	413	88.44	281	92.13	132	81.48		
Limited access to surgery								
Yes	54	11.84	20	6.85	34	20.73	19.387	**<0.001**
No	402	88.16	272	93.15	130	79.27		
Limited access to medical materials								
Yes	41	8.76	19	6.19	22	13.66	7.384	**0.007**
No	427	91.24	288	93.81	139	86.34		
Limited access to non-medical materials								
Yes	55	11.73	23	7.49	32	19.75	15.400	**<0.001**
No	414	88.27	284	92.51	130	80.25		
Economic challenges								
Had more than 20% reduction in income								
Yes	258	48.31	159	46.09	99	52.38	1.937	0.164
No	276	51.69	186	53.91	90	47.62		
Had not been able to meet basic needs with current income								
Yes	502	94.18	324	93.91	178	94.68	0.131	0.717
No	31	5.82	21	6.09	10	5.32		
Had cut or skipped meals due to financial strains								
Yes	329	64.51	219	66.16	110	61.45	1.126	0.289
No	181	35.49	112	33.84	69	38.55		
Healthcare experience								
Avoided healthcare services due to gender identity								
Yes	150	30.67	96	29.81	54	32.34	0.329	0.566
No	339	69.33	226	70.19	113	67.66		
Mistreated in health facility due to gender identity								
Yes	138	28.75	67	21.68	71	41.52	21.148	**<0.001**
No	342	71.25	242	78.32	100	58.48		
COVID test								
If received test (n=190), COVID positive test result								
Yes	16	8.42						
No	174	91.58						

Bold values are significant at p<0.05. Column percentages are reported. Sample sizes stratified by variables may not add up to total sample size due to missingness.

feminine (24.4%) and trans masculine (7.7%). The majority of the sample attained some college or more education (67.3%), and from middle socioeconomic income background (77.2%). Most respondents were from Europe (53.7%), followed by South-East Asia (20.3%) and Americas (17.0%).

A high proportion of participants had mental health symptoms and substance use history. Specifically, more than one-third of the sample screened positive for depression and anxiety (40.0% and 36.0%, respectively), reported having suicidal ideation (36.5%), active alcohol use disorder (35.0%) and recent tobacco use (52.1%).

In terms of gender affirmation access, majority currently use hormone (59.5%). Among those who used gender-affirming care, about one-tenth of the sample experienced limited access to gender-affirming therapy or counselling (11.6%), surgery (11.8%), durable medical equipment (8.8%) and non-medical supplies (11.7%).

A total of 48.3% of participants reported having more than 20% reduction in income due to the COVID-19 crisis. A majority of the sample reported not being able to meet basic needs with current income (94.2%) and had cut or skipped meals due to financial strains (64.5%).

Additionally, a total of 30.7% reported ever having avoided healthcare services due to their gender identity, and 28.8% reported ever experiencing mistreatment in a health facility due to gender identity.

Subsample characteristics of adults with positive COVID-19 test

As shown in table 2, among those who tested positive for COVID-19 (n=16, 8.4%), the mean age was 28.13 years (SD=7.3), and the majority were older than age 30 (75.0%), identified as non-binary (68.8%), attained some college or more education (43.6%), were from middle socioeconomic income background (50.0%) and mostly from Europe (75.0%). Most participants who tested positive for COVID-19 had screened positive for depression and anxiety (62.5% and 50.0%, respectively), and had active alcohol use disorder (43.6%) and recent tobacco use (62.5%). Majority were not using hormones (68.8%). Among those who used gender-affirming care in this subsample, less than half experienced limited access to gender-affirming therapy or counselling (43.8%), surgery (37.5%), durable medical equipment (18.8%) and non-medical supplies (37.5%). Additionally, about one-third (37.5%) reported having more than 20% reduction in income. The majority of those who tested positive for COVID-19 reported not being able to meet basic needs with current income (93.8%) and had to cut or skip meals due to financial strains (56.3%). A total of 37.5% of this subsample reported avoiding healthcare services due to their gender identity, and 56.3% reported ever experiencing mistreatment in health facility due to gender identity.

Table 2 Characteristics of transgender and non-binary adults who reported a positive COVID-19 test in the COVID-19 Disparities Survey II (n=16)

	All	
Demographics		
Age		
Continuous range: 19–45 (M, SD)	28.13	7.31
Young adult		
Yes (18–29)	12	75.00
No (30+)	4	25.00
Gender spectrum		
Non-binary	11	68.75
Trans feminine	3	18.75
Trans masculine	2	12.50
Level of education		
Less than high school	5	31.25
High school, or trade	4	25.00
Some college or more	7	43.75
Socioeconomic income		
Lower	3	18.75
Middle	8	50.00
Upper	5	31.25
Region		
South-East Asia	0	0.00
Americas	2	12.50
Eastern Mediterranean	1	6.25
Africa	1	6.25
Europe	12	75.00
Western Pacific	0	0.00
Mental health and substance use		
Depression		
Yes	10	62.50
No	6	37.50
Anxiety		
Yes	8	50.00
No	8	50.00
Suicide ideation		
Often/all the time	5	31.25
Never	10	62.50
Missing	1	6.25
Active alcohol use disorder		
Yes	7	43.75
No	5	31.25
Missing	4	25.00
Tobacco use		
Yes	10	62.50
No	6	37.50

Continued

Table 2	Continued		
		All	
Gender affirmation			
Hormone utilisation			
Yes		5	31.25
No, not applicable		11	68.75
Limited access to therapy or counselling			
Yes		7	43.75
No		9	56.25
Limited access to surgery			
Yes		6	37.50
No		8	50.00
Missing		2	12.50
Limited access to medical materials			
Yes		3	18.75
No		11	68.75
Missing		2	12.50
Limited access to non-medical materials			
Yes		6	37.50
No		9	56.25
Missing		1	6.25
Economic challenges			
Had more than 20% reduction in income			
Yes		6	37.50
No		10	62.50
Had not been able to meet basic needs with current income			
Yes		15	93.75
No		1	6.25
Had cut or skipped meals due to financial strains			
Yes		9	56.25
No		7	43.75
Healthcare experience			
Avoided healthcare services due to gender identity			
Yes		6	37.50
No		9	56.25
Missing		1	6.25
Mistreated in health facility due to gender identity			
Yes		9	56.25
No		5	31.25
Missing		2	12.50

Column percentages are reported. Sample sizes stratified by variables may not add up to total sample size due to missingness.

Bivariate and multivariate regressions

Table 1 presents bivariate regression analyses results examining global differences by COVID-19 testing. Socioeconomic income, region, current hormone utilisation, limited access to gender-affirming therapy or counselling, surgery, non-medical supplies and having been mistreated in health facility due to their gender identity were each significantly associated with COVID-19 testing (all p<0.05). Bivariate statistically significant differences were not observed between mental health and substance use indicators and COVID-19 testing, as well as economic change and COVID-19 testing.

Table 3 presents the adjusted, multivariable hierarchical logistic regression analyses examining factors associated with COVID-19 testing among the full sample. In the final multivariable model (Block 5), odds of COVID-19 testing was significantly higher among transgender and non-binary participants who reported from upper socioeconomic income backgrounds (adjusted OR (aOR)=1.38, 95% CI 1.08 to 1.78, p=0.010), from Europe (aOR=1.18, 95% CI 1.01 to 1.37, p=0.03), had active alcohol use disorder (aOR=1.14, 95% CI 1.02 to 1.29, p=0.021), had limited access to gender-affirming surgery (aOR=1.32, 95% CI 1.01 to 1.74, p=0.046), had more than 20% reduction in income (aOR=1.16, 95% CI 1.03 to 1.31, p=0.010) and had experienced mistreatment in a health facility due to gender identity (aOR=1.15, 95% CI 1.10 to 1.34, p=0.042). Transgender and non-binary participants who reported recent tobacco use had significantly lower odds of COVID-19 testing (aOR=0.85, 95% CI 0.76 to 0.95, p=0.007).

DISCUSSION

This study found that only one-third of the transgender and non-binary individuals reporting being tested for COVID-19. We also found a number of factors associated with increased testing among this sample. Given that transgender and non-binary people are a commonly understudied population in research, particularly in COVID-19 surveillance studies, our study yields important insights into testing behaviours among this group, including socioeconomic factors (such as reporting being from upper socioeconomic income background, having a reduction in income due to the pandemic), healthcare access factors (such as access to gender-affirming surgery or experiencing discrimination in a healthcare setting) and substance use behaviours (including having active alcohol use disorder), all being associated with increased testing. In addition, there was an inverse association between smoking tobacco and COVID-19 testing. Collectively, these results demonstrate the range of factors among transgender and non-binary people during the COVID-19 pandemic that may contribute to healthcare behaviours.

Within this sample, socioeconomic factors had among the highest effect sizes. Specifically, the odds of testing for COVID-19 were increased by 38% for those from higher socioeconomic income backgrounds. This may be reflective of having greater healthcare access that would allow an individual to seek testing, or reflective of certain upper socioeconomic professions that lead to a higher risk of being exposed to COVID-19 and therefore need testing, such as being a physician

Table 3 Hierarchical multivariable logistic regression analyses examining factors associated with COVID-19 testing among transgender and non-binary adults in the COVID-19 Disparities Survey II (n=536)

	Block 1: Demographics			Block 2: Demographics, Mental Health and Substance Use			Block 3: Demographics, Mental Health and Substance Use, and Gender Affirmation			Block 4: Demographics, Mental Health and Substance Use, Gender Affirmation, and Economic Challenges			Block 5: Demographics, Mental Health and Substance Use, Gender Affirmation, Economic Challenges, and Healthcare Experience		
	Multivariable			Multivariable			Multivariable			Multivariable			Multivariable		
	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value
Demographics															
Young adult															
Yes (18–29)	1.06	0.97 to 1.16	0.161	1.05	0.96 to 1.16	0.262	0.99	0.89 to 1.09	0.853	1.01	0.91 to 1.12	0.84	1.02	0.91 to 1.14	0.699
No (30+)	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
Gender spectrum															
Non-binary	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
Trans feminine	0.94	0.84 to 1.04	0.261	0.95	0.84 to 1.06	0.378	0.95	0.84 to 1.07	0.446	0.94	0.83 to 1.07	0.407	0.92	0.80 to 1.07	0.3
Trans masculine	0.99	0.83 to 1.17	0.921	0.99	0.83 to 1.19	0.999	0.99	0.82 to 1.20	0.948	0.97	0.79 to 1.18	0.77	0.97	0.79 to 1.20	0.819
Level of education															
Less than high school	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
High school, or trade	1.06	0.84 to 1.33	0.602	1.1	0.85 to 1.42	0.435	1.17	0.87 to 1.56	0.282	1.26	0.93 to 1.70	0.126	1.25	0.91 to 1.70	0.155
Some college or more	1.08	0.86 to 1.34	0.487	1.13	0.88 to 1.45	0.315	1.19	0.90 to 1.58	0.21	1.3	0.97 to 1.75	0.071	1.29	0.96 to 1.74	0.083
Socioeconomic income															
Lower	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
Middle	1.06	0.94 to 1.20	0.318	1.08	0.95 to 1.24	0.226	1.14	0.98 to 1.32	0.083	1.17	0.99 to 1.38	0.052	1.11	0.93 to 1.32	0.239
Upper	1.32	1.09 to 1.60	**0.003**	1.29	1.05 to 1.59	**0.013**	1.34	1.08 to 1.67	**0.007**	1.4	1.11 to 1.77	**0.004**	1.38	1.08 to 1.78	**0.01**
Region															
South-East Asia	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
Americas	1.05	0.91 to 1.21	0.481	1.1	0.94 to 1.29	0.194	1.08	0.92 to 1.28	0.314	1.11	0.94 to 1.32	0.188	1.12	0.93 to 1.34	0.208
Eastern Mediterranean	1.08	0.86 to 1.34	0.494	1.14	0.89 to 1.46	0.282	1.09	0.84 to 1.41	0.474	1.12	0.87 to 1.45	0.348	1.19	0.89 to 1.58	0.22
Africa	1.68	1.09 to 2.58	**0.018**	0.86	0.33 to 2.18	0.753	0.81	0.32 to 2.03	0.655	0.76	0.30 to 1.94	0.574	0.81	0.31 to 2.13	0.682
Europe	1.13	1.01 to 1.27	**0.031**	1.21	1.06 to 1.37	**0.003**	1.2	1.05 to 1.38	**0.008**	1.23	1.07 to 1.42	**0.003**	1.18	1.01 to 1.37	**0.029**
Western Pacific	1.01	0.78 to 1.32	0.885	1.02	0.77 to 1.34	0.87	1.04	0.79 to 1.37	0.774	1.05	0.79 to 1.37	0.681	1.04	0.79 to 1.38	0.749
Mental health and substance use															
Depression															
Yes				0.98	0.86 to 1.11	0.787	0.98	0.84 to 1.13	0.8	0.95	0.81 to 1.10	0.505	0.94	0.80 to 1.11	0.508
No				1	–	–	1	–	–	1	–	–	1	–	–
Anxiety															

Continued

Table 3 Continued

| | Block 1: Demographics | | | Block 2: Demographics, Mental Health and Substance Use | | | Block 3: Demographics, Mental Health and Substance Use, and Gender Affirmation | | | Block 4: Demographics, Mental Health and Substance Use, Gender Affirmation, and Economic Challenges | | | Block 5: Demographics, Mental Health and Substance Use, Gender Affirmation, Economic Challenges, and Healthcare Experience | | |
| | Multivariable | | | Multivariable | | | Multivariable | | | Multivariable | | | Multivariable | | |
	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value
Yes	1.14	1.04 to 1.24	**0.004**	1.07	0.94 to 1.22	0.284	1.01	0.87 to 1.18	0.802	1.01	0.87 to 1.18	0.826	1.01	0.85 to 1.19	0.912
No	1	–	–	1	–	–	1	–	–	1	–	–	1	–	–
Suicide ideation															
Often/all the time				1.02	0.92 to 1.14	0.603	1.06	0.94 to 1.18	0.313	1.03	0.91 to 1.16	0.573	0.97	0.85 to 1.10	0.664
Never				1	–	–	1	–	–	1	–	–	1	–	–
Active alcohol use disorder															
Yes				1.1	1.01 to 1.21	**0.046**	1.12	1.01 to 1.25	**0.026**	1.14	1.02 to 1.27	**0.016**	1.14	1.02 to 1.29	**0.021**
No				1	–	–	1	–	–	1	–	–	1	–	–
Tobacco use															
Yes				0.87	0.79 to 0.95	**0.005**	0.85	0.77 to 0.95	**0.004**	0.86	0.77 to 0.94	**0.004**	0.85	0.76 to 0.95	**0.007**
No				1	–	–	1	–	–	1	–	–	1	–	–
Gender affirmation															
Hormone utilisation															
Yes				1.14	1.03 to 1.25	**0.007**	1.1	0.99 to 1.23	0.059	1.09	0.98 to 1.22	0.088	1.05	0.93 to 1.18	0.37
No, not applicable				1	–	–	1	–	–	1	–	–	1	–	–
Limited access to therapy or counselling															
Yes							1.01	0.79 to 1.28	0.932	1.01	0.78 to 1.28	0.979	0.94	0.72 to 1.22	0.675
No							1			1			1		
Limited access to surgery															
Yes							1.31	1.03 to 1.67	**0.028**	1.31	1.02 to 1.67	**0.03**	1.32	1.01 to 1.74	**0.046**
No							1	–	–	1	–	–	1	–	–
Limited access to medical materials															
Yes							0.9	0.69 to 1.17	0.46	0.86	0.65 to 1.12	0.279	0.86	0.65 to 1.15	0.328
No							1	–	–	1	–	–	1	–	–
Limited access to non-medical materials															
Yes							1.12	0.91 to 1.39	0.271	1.15	0.89 to 1.38	0.341	1.06	0.83 to 1.35	0.616
No							1	–	–	1	–	–	1	–	–
Economic challenges															
Had more than 20% reduction in income															
Yes										1.15	1.04 to 1.29	**0.008**	1.16	1.03 to 1.31	**0.010**

Continued

Table 3 Continued

	Block 1: Demographics			Block 2: Demographics, Mental Health and Substance Use			Block 3: Demographics, Mental Health and Substance Use, and Gender Affirmation			Block 4: Demographics, Mental Health and Substance Use, Gender Affirmation, and Economic Challenges			Block 5: Demographics, Mental Health and Substance Use, Gender Affirmation, Economic Challenges, and Healthcare Experience		
	Multivariable			Multivariable			Multivariable			Multivariable			Multivariable		
	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value	aOR	95% CI	P value
No										1	–	–	1	–	–
Had not been able to meet basic needs with current income															
Yes										0.94	0.75 to 1.20	0.665	0.96	0.74 to 1.25	0.805
No										1	–	–	1	–	–
Had cut or skipped meals due to financial strains															
Yes										0.96	0.84 to 1.10	0.612	0.94	0.82 to 1.09	0.453
No										1	–	–	1	–	–
Healthcare experience															
Avoided healthcare services due to gender identity															
Yes													1.03	0.89 to 1.19	0.651
No													1	–	–
Mistreated in health facility due to gender identity															
Yes													1.15	1.10 to 1.34	**0.042**
No													1	–	–

Bold values are significant at p<0.05. Hierarchical multivariable regression analyses used backward stepwise procedure. Variables with a p value <0.20 in bivariate analyses were included in the model.
aOR, adjusted OR.

or essential government worker.[36] This result holds with prior research showing that higher overall income is associated with increased COVID-19 testing.[37] We also found reduction in income during the COVID-19 pandemic being associated with increased testing, which may also reflect the type of work people are engaged in. Those individuals may be in industries hard hit by the pandemic (eg, small business retail), who have either lost their jobs or have reduced work hours to have more time to get tested when clinics and other facilities are open.

Substance use factors were also found to be related to COVID-19 testing: screening positive for active alcohol use disorder, as measured by the AUDIT-C, was associated with increased odds of testing. While it is challenging to interpret substance use associations with testing behaviours, other studies have found, more broadly, that younger people are drinking less during the pandemic overall, particularly as lockdown initiatives went into effect.[38 39] Participants who reported alcohol use in these aforementioned studies were more likely to be older and essential workers, which, if a similar pattern holds in our sample, may lead to a need (or perceived need) to be tested more often. Additionally, this relationship may be indicative of changing socialisation opportunities, and the lockdowns restricting gatherings. It is plausible that those who are attending gatherings and drinking may perceive this as a higher risk behaviour and seek testing afterwards, while individuals adhering to lockdown restrictions and public health guidance to avoid such gatherings may have less occasion to drink and less perceived need for testing as a result. Lastly, COVID-19-related ruminative thoughts may partially explain the association between alcohol use and COVID-19 testing.[40] For instance, it is also possible that increased drinking behaviour during COVID-19 pandemic is a form of coping strategy for those who may have pandemic-related rumination—that is, those who may experience the distress of the pandemic repetitively could elicit pertinent ruminative thoughts about their experiences in the context of the pandemic.[40] While these associations are found in other studies with different populations, future research is needed specific to trans and non-binary communities to delineate and evaluate these postulations.

We also found an association between smoking of tobacco and decreased COVID-19 testing. A similar inverse relationship between COVID-19 outcomes and tobacco smoking has been reported across a range of study populations and study designs,[41–43] and may be generally indicative of testing behaviours among current smokers. Methodological commentaries have noted that hypothesis testing between smoking and COVID-19 is subject to important limitations that may obfuscate certain associations.[44] Given that the Centers for Disease Control and Prevention and similar public health authorities have stated that smoking tobacco increases the risk of severe COVID-19 and tobacco

is well known to impact lung function,[45] individuals who continue to smoke may be staying home, and less likely to engage in risk behaviours that would prompt needing testing (such as going to social gatherings or travelling). There remains a need for studies that specifically interrogate substance use patterns and attitudes to further understand this in populations placed at higher risk of substance use, such as transgender and non-binary samples.[46]

Healthcare access variables were expectedly associated with testing behaviours in our sample as well. Notably, transgender and non-binary people often experience reduced access to healthcare more broadly. Medical discrimination towards this population, including for non-transgender-specific healthcare needs, has been well documented.[26 27] Therefore, these results reflect the nuanced challenges that lack of healthcare access poses to transgender and non-binary people in our sample, and the importance of conducting broad-based outreach for these populations. For instance, having limited access to gender-affirming surgery increased the odds of testing, which may show that while gender-affirming surgery was limited during the pandemic, the ability to get tested for COVID-19 was readily accessible for people who are already engaged with the health system when it was offered. In addition, previous research has noted the additional concerning mental health challenges that may occur due to limited or postponed gender-affirming surgery,[47 48] which suggest that this postponement may lead to increased testing but may not reduce COVID-19 incidence in this population, and further research on the impact of limited or postponed surgery must be done.

Lastly, we found that reporting mistreatment at a health facility was associated with increased testing, and the majority of those who tested positive reported previous mistreatment (56.25%, n=9). This finding may be related to the increased access of testing sites not based in hospitals, clinics or other normative health facilities where previous negative experiences between providers and transgender and non-binary patients may have occurred. For instance, if people had prior negative experiences in a health facility, they may be open to seeking rapid COVID-19 test in a drive-through or pharmacy testing facility instead where there is less provider and patient interaction. Given COVID-19 testing is also not a gender-specific service that can likely 'out' someone's gender identity, individuals may be more willing to get tested than receive other seemingly gendered services such as hormone therapies or reproductive health appointments where disclosure of gender identity and exposure to provider mistreatment are likely to occur. This comports with prior calls for greater health outreach to transgender and non-binary communities,[27 49] as the interest in COVID-19 testing services persists. Overall, though, these results show that prior discriminatory experiences are not necessarily indicative that transgender and non-binary people are

unlikely to seek future COVID-19 testing and other related services such as vaccine and treatment.

Other findings worth noting include the regional differences between Europe and South-East Asia. The significantly higher odds of COVID testing observed among transgender and non-binary people from Europe compared with South-East Asia are likely reflective of the geographical differences in COVID-19 testing strategies and approaches across the world. For example, one study described how European and Asian countries have implemented symptom-based testing versus mass testing based on full and partial lockdown restrictions.[50] Additionally, the different kinds of healthcare systems and health insurance plans could also contribute to the way transgender and non-binary communities across regions access and receive COVID-19 testing. Research that further explores this finding is needed to understand what other specific structural factors are significantly impacting countries' testing strategies among transgender and non-binary communities.

Taken together, these findings indicate that a variety of factors affect the willingness and ability of transgender and non-binary people to access COVID-19 testing. Many of these factors underscore concerns that transgender and non-binary people may have greater coexisting healthcare needs and may be in precarious socioeconomic circumstances due to job loss or engaged in essential occupations where their ability to limit exposure to the coronavirus is limited. The WHO has prioritised equity considerations in both testing and vaccine access, and the findings of this study highlight the importance of using equity frameworks that consider gender identity as a unique contributor to vulnerability both to COVID-19 exposure and to a lack of testing and vaccine access.[51] Key interventions to increase access to these services for transgender and non-binary people may include leveraging their existing relationships with the healthcare system, such as encounters with primary care providers in surgical centres that are starting to renew their offerings of gender-affirming procedures as the course of the pandemic begins to shift away from severe hospital overcrowding. Moreover, it is also critical for the public health and policymakers to address other basic social and structural needs such as employment, food and housing of transgender and non-binary communities particularly those who are highly impacted by COVID-19. As such, results of this study point to the need for innovative testing strategies to be tightly implemented in tandem with other programmatic services, policies and scientific interventions that address unmet basic needs.[52] Affirming and culturally responsive outreach and facility protocols are also critical for this population, which has high rates of exposure to negative experiences in healthcare settings. Finally, collecting data on gender identity in COVID-19 testing and vaccine procedures,[31] as several states are beginning to do, is an essential component of ensuring that these services are reaching transgender and non-binary communities.

Limitations
This study has limitations. First, recruitment for this study used a non-random sampling strategy via social networking apps to reach transgender and non-binary individuals; as such, this sample is not representative of the entire transgender and non-binary population. Second, our results are not generalisable and only limited to transgender and non-binary app users who frequent these networking apps. Third, while we aimed to minimise multiple survey responses from entering the survey by only allowing unique IP address, it is still possible that deduplication of responses is not eliminated given that IP addresses are specific to devices and not individuals. Fourth, the cross-sectional nature of this data set means that findings do not reflect changes in COVID-19 testing behaviour over time for this sample and reduces our ability to make any inferences, as temporally all data were collected at the same time. Fifth, our survey did not assess frequency and number of times participants received COVID-19 testing, and thus our primary outcome (any history of testing) reflects a lower threshold of necessary testing behaviour. Sixth, we did not have enough participants who reported having positive COVID-19 testing results in order to examine associations with having COVID-19; we thus focused instead on testing behaviours. We present the descriptive findings among participants with COVID-19, but it is challenging to compare these with our broader population or other lesbian, gay, bisexual, transgender and queer (LGBTQ+) populations from other studies. Lastly, all measures were self-reported and therefore prone to report bias. Future research should use other sources of data (eg, surveillance data) that can confirm/disconfirm or provide other insights into the findings of this study.

Strengths
Despite these challenges, this study had a number of strengths that bolster its findings. First, it had a large sample of transgender and non-binary individuals, so it was well powered to conduct hypothesis testing. Our sample had a majority of non-binary people, who are often under-represented in LGBTQ+ research, and we were able to test for between-gender group differences among these populations. We also had a diverse range of sociodemographic and of gender-affirming health services people have accessed in the past (such as hormone therapy or surgeries), which allowed us to find a number of important associations when controlling for these sociodemographic factors.

CONCLUSIONS
Our study provides critical insights into the factors associated with COVID-19 testing among transgender and non-binary people. Several factors from domains

of sociodemographic, substance use, gender affirmation, socioeconomic changes and healthcare experiences were associated with COVID-19 testing in our models. There remains a need for more targeted studies to assess risk factors for COVID-19 infection, beyond testing, in transgender and non-binary populations, as well as longitudinal assessments of risk factors and of vaccine-related behaviours. However, this study is an important step increasing our understanding of how marginalised populations have been affected during COVID-19.

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