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.

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 29 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) populations22 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, 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=some 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. 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. 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 χ² 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, 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)

| Demographics                      | Received test for COVID-19 | n   | %  | n   | %  | X² test statistic | P value |
|-----------------------------------|----------------------------|-----|----|-----|----|-------------------|---------|
|                                   | No                         |     |    | Yes |    |                   |         |
|                                   | n                          | 346 | 64.55 | 190 | 35.45 |                   |         |
| **All**                           |                            |     |      |     |      |                   |         |
| **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 |
| No                                |                            |     |      |     |      |                   |         |
| Table 1 | Continued |
|---------|-----------|

| Received test for COVID-19 | No | Yes | **X² test statistic** | **P value** |
|-----------------------------|----|-----|------------------------|------------|
| **n** | **%** | **n** | **%** | **P value** | **P value** |
| | | | | | |
| 346 | 64.55 | 190 | 35.45 | | |

| **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) |
|---------|--------------------------------------------------------------------------------|
| **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
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 |
|-----------------------|--------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Demographics          | Multivariable                                          | Multivariable                                                            | Multivariable                                                   | Multivariable                                                                                                       |
|                       | aOR  95% CI  P value   | aOR  95% CI  P value   | aOR  95% CI  P value   | aOR  95% CI  P value   |
| **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  |
| No (30+)              | 1 – – – | 1 – – – | 1 – – – | 1 – – – |
| **Gender spectrum**   |                                                        |                                                                        |                                                                |                                                                                                                                 |
| Non-binary            | 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 |
| 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 |
| **Level of education**|                                                        |                                                                        |                                                                |                                                                                                                                 |
| Less than high school | 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 |
| 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 |
| **Socioeconomic income** |                                                        |                                                                        |                                                                |                                                                                                                                 |
| Lower                 | 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 |
| 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** |
| **Region**            |                                                        |                                                                        |                                                                |                                                                                                                                 |
| South-East Asia       | 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 |
| 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 |
| 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 |
| 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 **0.006** | 1.23 1.07 to 1.42 **0.003** |
| 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 0.80 to 1.39 0.681 |
| **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               |                                                        |                                                                        |                                                                |                                                                                                                                 |
| 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                                             | P value                                         |
| **Yes**              | 1.07                                                    | 0.94 to 1.22                                   | 1.01                                           | 0.87 to 1.18                                   | 1.01                                           | 0.87 to 1.18                                   | 1.01                                           | 0.85 to 1.19                                   | 0.912                                           |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Suicide ideation     |                                                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Often/all the time   | 1.02                                                    | 0.92 to 1.14                                   | 1.06                                           | 0.94 to 1.18                                   | 1.03                                           | 0.91 to 1.16                                   | 0.97                                           | 0.85 to 1.10                                   | 0.664                                           |
| Never                | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Active alcohol use disorder | 1.1                                                    | 1.01 to 1.21                                   | 1.12                                           | 1.01 to 1.25                                   | 1.14                                           | 1.02 to 1.27                                   | 1.14                                           | 1.02 to 1.29                                   | 0.021                                           |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Tobacco use          |                                                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Yes                  | 0.87                                                    | 0.79 to 0.95                                   | 0.85                                           | 0.77 to 0.95                                   | 0.86                                           | 0.77 to 0.94                                   | 0.85                                           | 0.76 to 0.95                                   | 0.007                                           |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Gender affirmation   |                                                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Hormone utilisation  |                                                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Yes                  | 1.14                                                    | 1.04 to 1.24                                   | 1.14                                           | 1.03 to 1.25                                   | 1.1                                             | 0.99 to 1.23                                   | 1.09                                           | 0.98 to 1.22                                   | 0.088                                           |
| **No, not applicable** | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Limited access to therapy or counselling | 1.01                                                    | 0.79 to 1.28                                   | 1.01                                           | 0.78 to 1.28                                   | 0.94                                           | 0.72 to 1.22                                   | 1                                               | –                                               |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Limited access to surgery | 1.31                                                    | 1.03 to 1.67                                   | 1.31                                           | 1.02 to 1.67                                   | 1.32                                           | 1.01 to 1.74                                   | 1                                               | –                                               |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Limited access to medical materials | 0.9                                                     | 0.69 to 1.17                                   | 0.86                                           | 0.65 to 1.12                                   | 0.86                                           | 0.65 to 1.12                                   | 1                                               | –                                               |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Limited access to non-medical materials | 1.12                                                    | 0.91 to 1.39                                   | 1.15                                           | 0.89 to 1.38                                   | 1.06                                           | 0.83 to 1.35                                   | 1                                               | –                                               |
| **No**               | 1                                                       | –                                               | 1                                               | –                                               | 1                                               | –                                               | 1                                               | –                                               |
| Economic challenges  |                                                         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |
| Had more than 20% reduction in income | 1.15                                                    | 1.04 to 1.29                                   | 1.16                                           | 1.03 to 1.31                                   | 1.16                                           | 1.03 to 1.31                                   | 1                                               | –                                               |
| **Yes**              | 1.15                                                    | 1.04 to 1.29                                   | 1.16                                           | 1.03 to 1.31                                   | 1.16                                           | 1.03 to 1.31                                   | 1                                               | –                                               |
| 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                                                       |
| No                    | 1                                                    | –                                                             | 1                                                             | –                                                            | –                                                             | 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                                                             | –                                                            | –                                                             | 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                                                             | –                                                            | –                                                             | 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. This result holds with prior research showing that higher overall income is associated with increased COVID-19 testing. 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. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect. Participants who reported the pandemic overall, particularly as lockdown initiatives went into effect.

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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, 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. 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, 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.

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. 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, 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 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. 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. 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. 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, 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-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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REFERENCES
1 Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. Lancet Infect Dis 2020;20:533–4.
2 Hussain A. Stringency in policy responses to Covid-19 pandemic and social distancing behavior in selected countries. Stringency in policy responses to Covid-19 pandemic and social distancing behavior in selected countries (April 20, 2020).
3 Chetty R, Friedman JN, Hendren N. The economic impacts of COVID-19: evidence from a new public database built using private sector data: national Bureau of economic research, 2020.
4 Czeisler Mark E, Lane RI, Petrosky E, et al. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic - United States, June 24–30, 2020. MMWR Mortal Wkly Rep 2020;69:1049.
5 Ganson KT, Tsai AC, Weiser SD, et al. Job insecurity and symptoms of anxiety and depression among U.S. young adults during COVID-19. J Adolesc Health 2021;68:53–6.
6 Salari N, Hosseinian-Far A, Jalali R. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. Global Health 2020;16:1–11.
7 Salerno JP, Williams ND, Gattamorta KA. LGBTQ populations: Psychologically vulnerable communities in the COVID-19 pandemic. In: Psychological Trauma: Theory, Research, Practice, and Policy, 2020.
8 Dribble LA, Eilason MJ. Introduction to special issue: impacts of the COVID-19 pandemic on LGBTQ+ health and well-being. J Homosex 2021;68:545–59.
9 Santos G-M, Ackerman B, Rao A. Economic, mental health, HIV prevention and HIV treatment impacts of COVID-19 and the COVID-19 response on a global sample of cisgender gay men and other men who have sex with men. AIDS and Behavior 2020;1–11.
10 Raine S, Liu A, Mintz J, et al. Racial and ethnic disparities in COVID-19 outcomes: social determination of health. Int J Environ Res Public Health 2020;17:8115.
11 Ruprecht MM, Wang X, Johnson AK. Evidence of social and structural COVID-19 disparities by sexual orientation, gender identity, and race/ethnicity in an urban environment. J Urban Health 2020;1–14.
12 Chatterjee S, Biswas P, Guria RT. LGBTQ care at the time of COVID-19. Diabetes Metab Syndr 2020;14:1757–8.
13 Rentch CT, Kidwai-Khan F, Tate JP, et al. Patterns of COVID-19 testing and mortality by race and ethnicity among United States veterans: A nationwide cohort study. PLoS Med 2020;17:e1003379.
14 Kim HN, Lan MF, Nkgyen E, et al. Assessment of disparities in COVID-19 testing and infection across language groups in Seattle, Washington. JAMA Netw Open 2020;3:e2021213-e.
15 Behzadifar M, Ghanbari MK, Bakhitari A, et al. Ensuring adequate health financing to prevent and control the COVID-19 in Iran. Int J Equity Health 2020;19:14.
16 Manabe YC, Sharifstein JS, Armstrong K. The need for more and better testing for COVID-19. JAMA 2020;324:2153–4.
17 Hopman J, Allegrenzi B, Mehtar S. Managing COVID-19 in low- and middle-income countries. JAMA 2020;323:1549–50.
18 Shadmi E, Chen Y, Dourado I, et al. Health equity and COVID-19: global perspectives. Int J Equity Health 2020;19:1–16.
19 Cheng MP, Papenburg J, Desjardins M, et al. Diagnostic testing for severe acute respiratory syndrome-related coronavirus 2: a narrative review. Ann Intern Med 2020;172:726–34.
20 West CP, Montori VM, Sampathkumar P. COVID-19 testing: the threat of false-negative results. Mayo clinic proceedings; 2020. Elsevier, 2020: 1127–9.
21 Operario D, Yang M-F, Reisner SL, et al. Stigma and the SYNDMIC of HIV-related health risk behaviors in a diverse sample of transgender minority communities (J-TEX). J Urban Health 2014;91:544–57.
22 White Hughto JM, Murchison GR, Clark K, et al. Geographic and individual differences in healthcare access for U.S. transgender adults: a multilevel analysis. LGBT Health 2016;3:424–33.
23 White Hughto JM, Reisner SL, Pachankis JE. Transgender stigma and health: a critical review of stigma determinants, mechanisms, and interventions. Soc Sci Med 2015;147:222–31.
24 King WM, Gammarelli KE. A scoping review examining social and legal gender affirmation and health among transgender populations. Transgend Health 2021;6:5–22.
25 Restar AJ, Sherwood J, Edeza A, et al. Expanding gender-based health equity framework for transgender populations. Transgend Health 2021;6:1–4.
26 Seelman KL, Colon-Diaz MJ, LeCroix RH, et al. Transgender noninclusive healthcare and delaying care because of fear: connections to general health and mental health among transgender adults. Transgend Health 2017;2:17–28.
27. Kcomt L, Gorey KM, Barrett BJ, et al. Healthcare avoidance due to anticipated discrimination among transgender people: a call to create trans-affirmative environments. *SSM Popul Health* 2020;11:100608.

28. Whittington C, Herd R, Millard K, Calderón C. The Lives & Livelihoods of Many in the LGBTQ Community Are At Risk Amidst COVID-19: Crisis Human Rights Campaign Foundation, 2020.

29. Gibb JK, DuBois LZ, Williams S, et al. Sexual and gender minority health vulnerabilities during the COVID-19 health crisis. *Am J Hum Biol* 2020;32:e23499.

30. Roberts SA, Williams CR, Grimstad FW. Considerations for providing pediatric Gender-Affirmative care during the COVID-19 pandemic. *J Adolesc Health* 2020;67:635–7.

31. Cailiih S, Grasso C, Keuroghlian A, et al. Sexual and gender minority health in the COVID-19 pandemic: why data collection and Combating discrimination matter now more than ever. *Am J Public Health* 2020;110:1360–1.

32. Reisner SL, Deutsch MB, Bhasin S, et al. Advancing methods for us transgender health research. *Curr Opin Endocrinol Diabetes Obes* 2018;25:198–207.

33. Löwe B, Wahl I, Rose M, et al. A 4-item measure of depression and anxiety: validation and standardization of the patient health Questionnaire-4 (PHQ-4) in the general population. *J Affect Disord* 2010;122:86–95.

34. Bush K, Kivlahan DR, McDonell MB, et al. The audit alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. *Arch Intern Med* 1998;158:1789–95.

35. Restar A, Jin H, Operario D. Gender-inclusive and gender-specific approaches in trans health research. *Transgend Health* 2020.

36. Baral S, Rao A, Twahirwa Rwema JO, et al. Competing health risks associated with the COVID-19 pandemic and response: a scoping review. *medRxiv* 2021. doi:10.1101/2021.01.07.21249419. [Epub ahead of print: 08 Jan 2021].

37. Brown CS, Ravallion M. Inequality and the coronavirus: socioeconomic covariates of behavioral responses and viral outcomes across US counties: national Bureau of economic research, 2020.

38. Sallie SN, Ritou V, Bowden-Jones H, et al. Assessing international alcohol consumption patterns during isolation from the COVID-19 pandemic using an online survey; highlighting negative emotional mechanisms. *BMJ Open* 2020;10:e044276.

39. Chodkiewicz J, Talarowska M, Miniszewska J, et al. Alcohol consumption reported during the COVID-19 pandemic: the initial stage. *Int J Environ Res Public Health* 2020;17:4677.

40. Hong W, Liu R-D, Ding Y, et al. Social media exposure and college students’ mental health during the outbreak of CoVID-19: the mediating role of rumination and the Moderating role of mindfulness. *Cyberpsychol Behav Soc Netw* 2021;24:282–7.

41. Lippi G, Henry BM. Active smoking is not associated with severity of coronavirus disease 2019 (COVID-19). *Eur J Intern Med* 2020;75:107–8.

42. Tsaginis P, Teixeira da Silva JA. Smoking prevalence and COVID-19 in Europe. *Nicotine Tob Res* 2020;22:1646–9.

43. Simons D, Shahab L, Brown J, et al. The association of smoking status with SARS-CoV-2 infection, hospitalization and mortality from COVID-19: a living rapid evidence review with Bayesian meta-analyses (version 7). *Addiction* 2021;116:1319–68.

44. Lo E, Lasnier B. Active smoking and severity of coronavirus disease 2019 (COVID-19): the use of significance testing leads to an erroneous conclusion. *Eur J Intern Med* 2020;77:125–6.

45. CDC COVID-19 Response Team. Preliminary Estimates of the Prevalence of Selected Underlying Health Conditions Among Patients with Coronavirus Disease 2019 - United States, February 12–March 28, 2020. MMWR Morb Mortal Wkly Rep 2020;69:mmwr. mmr6913e2:382–6.

46. Schwindt R, Elkhadragy N, Hudmon KS. Tobacco-Related health disparities in Gender-Diverse populations: a call to action. *Transgend Health* 2020;5:86–9.

47. Flaherty AJ, Sharma A, Crosby DL, et al. Should Gender-Affirming surgery be Prioritized during the COVID-19 pandemic? *Otolaryngol Head Neck Surg* 2020;163:1140–3.

48. Wang Y, Pan B, Liu Y, et al. Health care and mental health challenges for transgender individuals during the COVID-19 pandemic. *Lancet Diabetes Endocrinol* 2020;8:564–5.

49. Wylie K, Knudson G, Khan SI, et al. Serving transgender people: clinical care considerations and service delivery models in transgender health. *Lancet* 2016;388:401–11.

50. Han E, Tan SNJ, Turk E, et al. Lessons learnt from easing COVID-19 restrictions: an analysis of countries and regions in Asia Pacific and Europe. *The Lancet* 2020;396:1525–34.

51. World Health Organization. A new commitment for vaccine equity and defeating the pandemic, 2021. Available: https://www.who.int/news-room/commentaries/detail/a-new-commitment-for-vaccine-equity-and-defeating-the-pandemic

52. Cénat JM, Dalexis RD, Kdkou-Kpou CK, et al. Social inequalities and collateral damages of the COVID-19 pandemic: when basic needs challenge mental health care. *Int J Public Health* 2020;65:s00038-020-01426-y.

53. Liu R-D, Ding Y, et al. Social media exposure and college students' mental health during the outbreak of CoVID-19: the mediating role of rumination and the Moderating role of mindfulness.